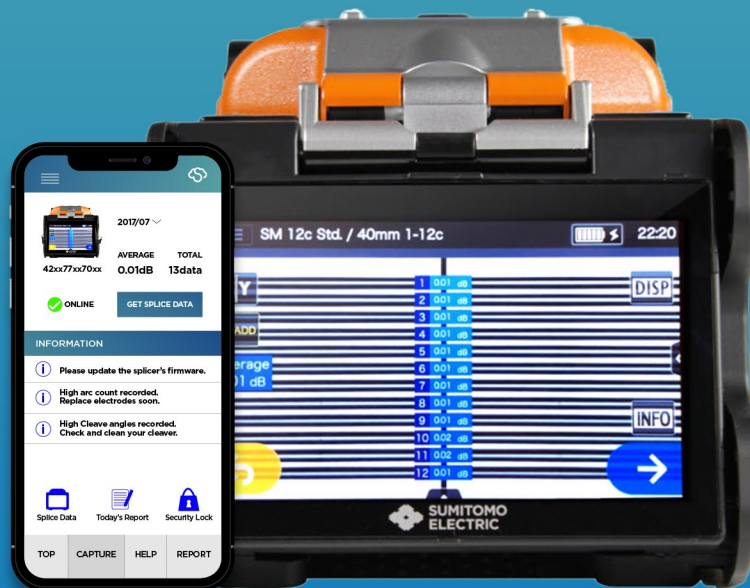




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JANUARY/FEBRUARY 2022

A Deal Born In Broadband

Executive Insights With

Brightspeed Founding Leaders:

Bob Mudge, CEO; Chris Creager,
CAO; And Tom Maguire, COO

Bob Mudge



Chris Creager



Tom Maguire



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The \$65B Digital Divide Gordian Knot

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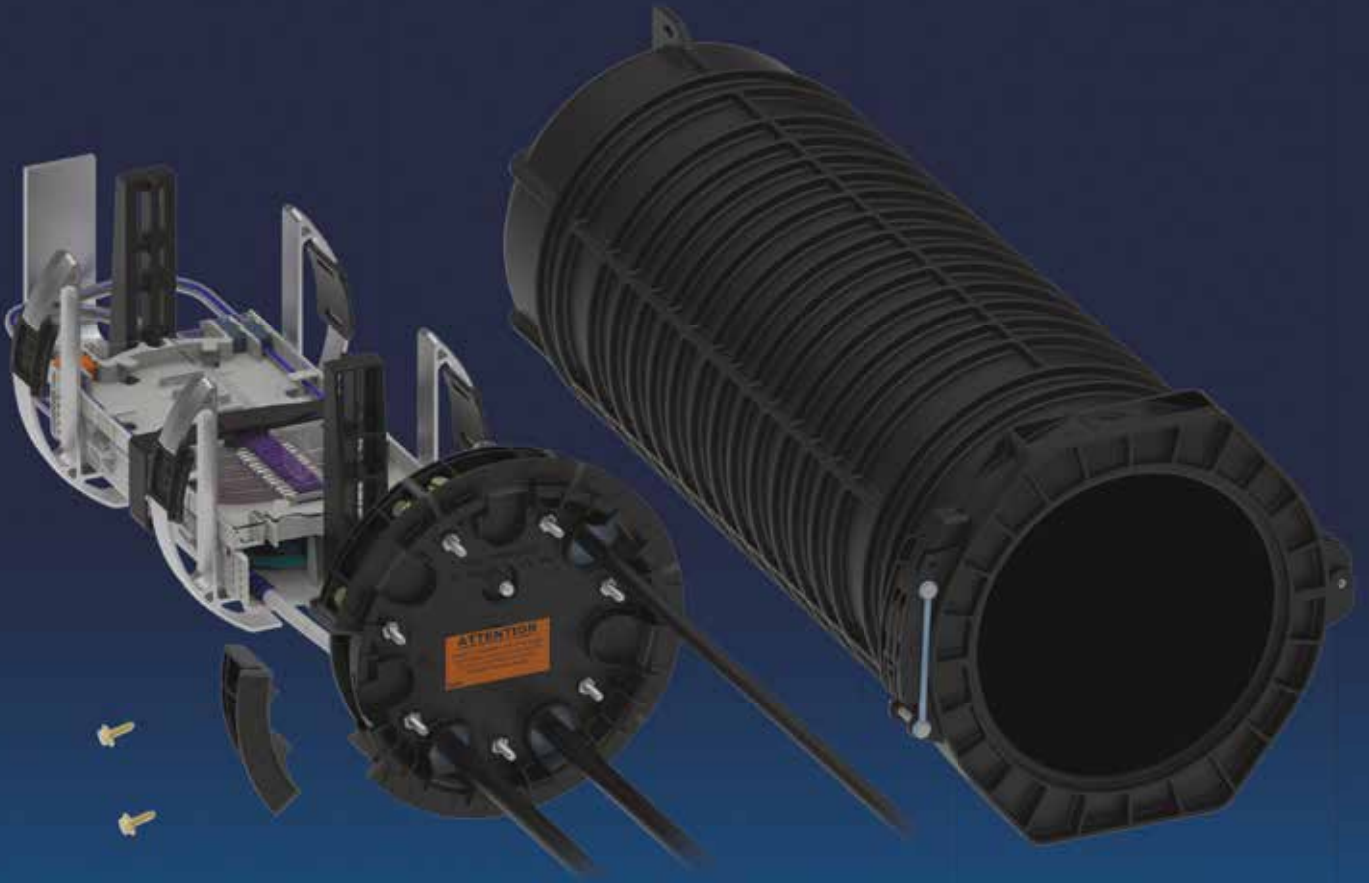
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EDITOR'S NOTE

by Sharon Vollman



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Follow Sharon on Twitter and LinkedIn for further conversation and insights.

Visit www.isemag.com/contribute for more information on submitting an article to ISE magazine in print, digital, and online.

3 Guys And Some Fiber

I'm not a huge phone talker. But, when I saw the caller ID from an old industry friend, I smiled. "Did you read the email and PR I sent you?" he asked nonchalantly with his east coast accent.

I responded with a bit of industry skepticism. "Yes. I wish those guys luck. It's not going to be easy or fun."

"But did you read the whole thing?"

"No. Just skimmed it. Why?" I asked.

"I'm one of the guys."

"Whaaaaat?" I laughed. "Tom! Why in the world would you do this now? I soooo need the back story!" My editorial curiosity was killing me.

Tom Maguire told me the entire story as if it were commonplace. Like a \$7.5B PE investment from Apollo happens every day. Like 3 retired Verizon execs would agree to retire their retirement to transform copper-laden assets from Lumen into a fiber-based Internet company serving 20 hard-to-serve states.

I asked if we could do a cover interview with him and his co-founders. He seemed amenable but had to check with Chris Creager and Bob Mudge. I questioned how in the heck the 3 of them could make time given the \$7.5B to-do list they had on their respective work-from-everywhere plates.

Still, I acted like it was going to happen.

Over the next few months, our team did its editorial thing. We shared questions for them to answer. We pestered them about photography and sent even more questions probing into the details about how 3 guys, working remotely from Florida, Arizona, and Massachusetts, would make this entity profitable amid the pandemic's Great Resignation and supply chain realities.

Still, they continued to do what they said they were going to do, each serving as their own version of Chief Cook and Bottle Washer.

Fast-forward to now. Bob, Chris, and Tom, are deep in regulatory approvals, network planning, vendor partner vetting, hiring their teams, and dealing with loads of legal stuff that makes me cringe. Yet, they make time to do all of the little annoying things we ask for this cover interview.

And, I'm still shaking my head in disbelief.

Why? Because it often seems there are more people who don't live up to their word than those who do. Especially when they are kind of big deals.

Not Tom Maguire. He's the real deal. Over the many years I've known him, I can tell you he's always lived up to his word. And, I can confidently say that Bob and Chris are cut from the same cloth.

That's why I invite you to read my interview with Bob, Chris, and Tom (known as BCT to their team), on page 12. They share how they plan to run the new company, Brightspeed, differently. (Sure, you've heard that before, right?)

I also invite you to put YOUR skepticism away and not dismiss what they promise to do -- as I'm going to do. Because I believe if anyone can make a real difference in bridging The Digital Divide across 20 states, these guys can.

Sharon

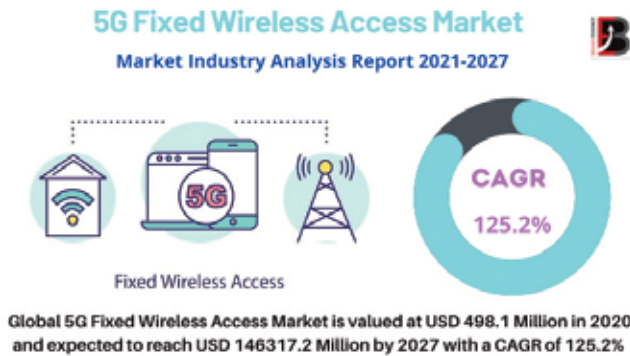
Sharon Vollman, Editorial Director

FACTOIDS OR RESOLUTIONS?

We'll Take The Factoids, Please!

FWA On Steroids

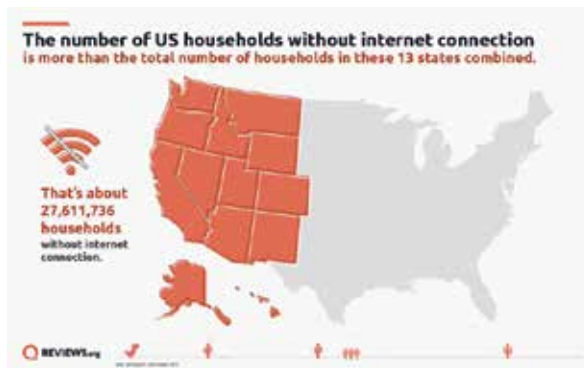
The Global 5G fixed wireless access market was valued at USD \$498.1 Million in 2020. It's expected to reach approximately USD \$146317.2 Million by 2027. That means 125.2% CAGR over the forecast period.



Source: <https://brandessenceresearch.com/semiconductor/g-fixed-wireless-access-market>

Still?

The total number of American households without Internet is approximately 27,611,736. That's greater than the total number of households in Alaska, Arizona, California, Colorado, Hawaii, Idaho, Kansas, Montana, Nevada, New Mexico, Oregon, Utah, and Washington, combined.



Source: <https://www.reviews.org/internet-service/how-many-us-households-are-without-internet-connection/>

5G Forecast 2022-2032

By the end of 2032, consumer mobile services are anticipated to generate \$800 billion in revenue, and 5G macro infrastructure markets will expand 7 times larger than in 2020, according to a recent report by IDTechEx.

Source: <https://www.idtechex.com/en/research-report/5g-technology-market-and-forecasts-2022-2032/835>



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COPPER EXPERT

by Don McCarty

An Old Telco Guy Looks Back, Moves Forward

I feel privileged to have participated in the growth of the telecommunications industry. I've trained copper cable technicians for 50 years and, although at age 78 I'm no longer up for the constant travel, I continue to write and consult. Every month I post my cell number so techs can call or text for advice -- and I love hearing from you.

Looking both backwards and forwards, it's mind boggling to think that over the past 150 years, we've gone from the genesis of the telecommunications industry -- telegraph machines, and wire and Morse code -- to the massively distributed fiber that enables an ultra-fast and highly reliable broadband industry.

Yet between telegraph wire and fiber is the long, long history of the hard-working, paired-copper industry.

Copper cable experienced tremendous change in physical composition before it was able to step up as the precursor to expanded telecommunications opportunities. Starting as paper- or pulp-insulated copper encased in lead, water ingress was a constant problem, and customers experienced massive telephone line failures with every big storm.

Eventually, cable providers created filled PIC, making copper a stable platform that could support the birth of a true telecommunications industry that began with FAX machines and modems. And, so came the advent of the Internet -- and we were off to the races! From there, the passion for more, faster, and better, brought us to tremendous advancements in copper and eventually to fiber.

I welcome fiber and all the good it has brought. It's enabled global connection and helped drive down the prices of technology as the number of users of digital equipment, whether personal use or business use, has expanded dramatically. Every day new services, applications, and products, dependent upon broadband service are created, driving the demand for faster connectivity. Even though I date back many, many years, I struggle to remember a world without the many benefits of digital technology enabled by fast Internet that we enjoy today.

With the capabilities and efficiency of fiber, is there a fit for copper in the future? While it won't be soon enough, I believe that one day we will have fiber to nearly every residence. Nevertheless, the role of copper continues to grow because of demand in the data center, where copper cable is shown to provide fast transmission up to 10 meters. And used inside away from elements, rodents, and electrical noise, it remains cost-effective, highly reliable, low latency, and draws little power.

New technology like Power over Ethernet (PoE) continues to push the technical capabilities of copper.

What I worry about is the many customers who still depend upon copper for phone, TV, and Internet. It's not profitable to extend fiber to many. Telcos are abandoning these previously loyal customers. For those telcos who still support customers dependent on paired copper, they have fewer and fewer techs who have the training needed to deal with the challenges of locating faults, repairing, and maintaining, copper cable; it's a lot more complex than repairs to fiber.

For those technicians who do the hard work to become copper experts, you are heroines and heroes, and I thank you for your dedication and talent. I'm here for you, and hope my words help. And please call if you are stuck. I mean that.

There is much more to the story of how copper fits in the business environment, but I'm out of my league here and others can tell this story much better.

So now it's time for my regular lecture on provisioning cable on page 10.

AN INTERESTING TIDBIT: if you are familiar with **POTS**, you may be incorrect about what that term meant initially. POTS is not **Plain Old Telephone Service** but is **Post Office Telephone Service**. Switching operators were federal employees located in the local post office buildings.



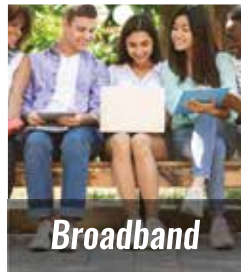
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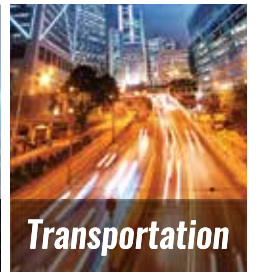
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Provisioning And Maintaining POTS Circuits

The Basics

COPPER EXPERT

by Don McCarty

dmccarty@mccartyinc.com

For more information, email or visit
www.mccartyinc.com.

Don McCarty is the Copper Expert columnist for ISE magazine, discussing the issues around provisioning, testing, and maintaining copper for all services from POTS to IPTV. Don is also President of and the Lead Trainer for McCarty Products, a technical training and products company training field technicians, cable maintenance, installation repair, and Central Office technicians and managers.

From time to time we receive a call from a field technician who is having a problem restoring service to a POTS circuit. They test the cable pair with their multi-function test set looking for DC faults. When found and fixed, in most instances, service is restored. Those cases of trouble that are still not working can often be attributed to a transmission or a circuit design fault. These types of faults really eat up field technician's time and are the root cause of many repeat reports. Fortunately, today's field technician's multi-function test set has transmission testing capability built into it.

Circuit Design Fault

As an example of a circuit design fault, I was in the field with a technician who was the third man out working on a repeat complaint from a fire station reporting no dial tone at times. The line tested good. We were only a couple of miles from the Central Office (CO), so low current should not have been a factor.

I suggested running transmission tests, as everything else checked out but nothing was fixed. The set showed a low loop current condition measuring around 20 mA. Other pairs in the same count also tested low. Loop treatment was indicated because of a circuit design problem.

A week later, the technician called with the fix. A new CO had been installed and fed the fire station with

only 26 gauge cable. The fire station and all subscribers beyond the fire station needed loop treatment.

So, check that loop current. Insufficient loop current might be the culprit in such complaints as: no dial tone, reach wrong numbers, can't be heard, bell rings, can't answer bell rings after answer. Loop current must be sufficient to provide talk battery and operate supervision and signaling equipment, such as: dial tone request, touch-tone pad operation, ring trip when a call is answered, and talk battery to the telephone transmitted.

When used at the network interface, a transmission test set simulates any telephone in the house when measuring loop current. If the current is inadequate at the network interface, the telco's responsibility for loop current is met. So, when it is low, loop treatment is in order.

Excessive Loss

Loss is next. Loss and current problems are usually interrelated. If a current problem exists, most likely so does excessive loss. Such a problem affects both touch-tone performance and voice volume.

The Telcos guarantee a minimum acceptable standard of sound over their lines. A transmission test set determines that the standard is met much better than the human ear can. Loss tests measure the sound characteristics of a circuit in decibels (dB). The amplitude of the signal is attenuated by 4 primary

factors: conductor resistance, insulation loss, capacitance, and inductance.

When a marginal or unacceptable loss is encountered, it is affected by the entire circuit, including bridged tap and wire beyond the customer.

- If such a condition is suspected, test the neighbor's pair.
- If loss is acceptable there, test both pairs for loop treatment.
- If the acceptable pair is treated, order treatment for the trouble pair.
- If the neighbor's pair is not treated, you have a single pair problem here (excessive bridged tap or wire beyond the workout terminal).

Only when loss is found acceptable can the next parameter be tested.

Just listening for noise on a circuit can be an almost futile task. Let's take the intermittent noise complaint: the customer complains in the evening of high noise. A technician is dispatched in the morning and checks the circuit at 10:00 A.M. -- when everyone is at work and the power influence in the area is down. The circuit sounds good. The customer comes home, and, like everyone else in the neighborhood, turns on the TV, the stove, and the washer and dryer. The power load increases, power influence goes up, and the line noises up.

This noise heard by the customer is often caused by such physical factors as pair trouble, an open lateral, water, or bad splicing. If all physical factors test OK, the noise is most probably caused by induced AC current from adjacent power lines. This is often called *line born* noise and is caused by an imbalance in the capacitance or resistance of the pair.

If the pair is balanced, the AC current flow is equal and opposite, thus canceling, and no current flows to ground. Any unbalance, either resistive or capacitive,

causes current (equal to the difference in the balance between the 2 conductors) to flow to ground and "noiseup" the circuit.

Balance Is Critical

Circuit noise (noise metallic) and power influence are interrelated, each being dependent upon the other to form acceptable balance.

When noise metallic is marginal or unacceptable and power influence is acceptable, suspect a pair problem and go after it. The pair is unbalanced either resistively (going open) or capacitively (one side open on a lateral, beyond the workout terminal, or crossed with a nonworking pair).

In most instances, a capacitive unbalance can be identified and isolated with an open meter. If not, use the location techniques for finding a resistive unbalance. This type of problem pertains only to this pair and this customer, and can be isolated and repaired by the first man out.

When both noise metallic and power influence are marginal or unacceptable, suspect a grounding, bonding, or associated power company problem (open capacitor bank, bad transformer, open neutral, etc.). These are problems for a transmission team. **But record the test results.**

The records of all field tests allow computer analysis of the approximate area of the problem, and the trouble can quickly be pinned down by the transmission team. They wouldn't have the slightest clue as to where to start without the technician's original input.

A Final Thought

While at the network interface, check the network interface ground. Use the transmission test set to measure the

resistance between the CO ground and the protector ground. The station ground should test 25 Ohms or less to assure that the carbons at the protector fires when power or lightning is present on the circuit, and protects the customer and station equipment from damage. If the test shows resistance greater than 25 Ohms, remake the ground.

Circuit quality is an individual responsibility. No one but the field technician, standing at the protector with dial tone present, can guarantee that the service is acceptable. If this is understood in all levels of outside plant responsibilities, the customer will be taken care of both immediately and, equally important, in the long term. ■

Signing Off

First, I wish us all a wonderful 2022. We all hope the challenges of the past 2 years are fading. If you are a copper tech, please maintain your best copper skills because many people depend upon you and will for some time to come. I hope this column is of interest. If so, let me know. And, if not, also let me know. I'm always looking for ideas for my next column and your input is valued. You can reach me at dmccarty@mccartyinc.com or text or call me at 831.818.3930. Thank you for your readership.

A Deal Born In Broadband

Executive Insights With

Brightspeed Founding Leaders:

Bob Mudge, CEO; Chris Creager, CAO; And Tom Maguire, COO

Bob Mudge

Chris Creager

Tom Maguire



By Sharon Vollman, ISE

Topic: How Did You Pull This Off?

ISE: Before we get into anything else, there is something that I am very curious about. How were you able to carry out this transaction, given all of the obstacles in 2020 and 2021?

BOB MUDGE: We had an amazing team of people scattered across the country who put in countless hours of hard work ... but none of this would have happened had it not been for technology.

Think about this: none of us were actually in the same place at any point in this -- most of us weren't even in the same state. As a result we had an amazing number of video conferences and passed a ton of data back and forth; thankfully everyone had a strong broadband connection.

This \$7.5B transaction shows what can be accomplished with a strong broadband network.

TOM MAGUIRE: It was a fantastic experience. We worked with people that I've never actually met face-to-face. Bob, Chris, and I have been in the same physical location only 2 times since we started working on this in early 2020. It's a good thing that we all had access to strong broadband. I used a FTTH connection in Florida and never missed a beat. This really helped drive our vision.

Topic: Vision And Execution

ISE: Speaking of that, the Brightspeed vision statement says *Our vision is to accelerate the upgrade of copper to fiber optic technologies, bringing faster and more reliable Internet service to many rural markets traditionally underserved by broadband providers, while delivering best-in-class customer experience.* What drove you to launch Brightspeed now? And why?

BOB MUDGE: I was working with Apollo Global Management on an unrelated project, and they raised the notion of purchasing some ILEC assets. They immediately reached out to what we consider the best TMT consulting team at Altman Solon to study a number of options.

TOM MAGUIRE: As things began to focus a bit, Bob asked Chris and me if we were interested in joining the effort. Soon after, Apollo asked if any of us would be interested in sticking around to stand up the new business and manage the resulting carve-out. We agreed to do it under one condition: it was all of us or none of us. The rest, as they say, is history.

BOB MUDGE: Getting to do this again was such a compelling opportunity that we had to say "Yes!" We can't wait to create the excitement that accompanies growth for those Lumen employees who will be joining us.

CHRIS CREAGER: Our new fiber network will be very empowering to the communities that we'll serve. Customers need the sort of speeds and capabilities that we'll be offering for education, healthcare, and to drive growth for small businesses. We will also be well-positioned to support enterprise and wireless carriers.

ISE: What are the symmetrical speeds Brightspeed plans to offer? Share a few creative and out-of-the-box field solutions Brightspeed is employing to do that.

TOM MAGUIRE: We plan on offering Gig-speed plus, but it's not all about the speed; we are very focused on the customer's in-home experience because we think that's where the rubber meets the road.

It's been our experience that many customers don't really focus on the data speeds, but they are very aware of how things work (or don't) in their homes and places of business. This is why we're working with the best vendors to deliver both great speed AND the best in-home experience.

CHRIS CREAGER: Things have evolved greatly since we first rolled out Fios (the nation's first large-scale FTTH deployment) almost 20 years ago, and we want to leverage the best technology we can get. Case in point, we are looking at very promising technologies in the field, some of which have been seen in the pages of ISE magazine, that should allow us to be more efficient in terms of required investment and speed to market.

Topic: Funding

ISE: Apollo Management is expected to invest approximately \$2B in this FTTH strategy. That's a hefty investment for a start-up. Congratulations!

TOM MAGUIRE: That's the funding they've committed. We are also looking to see if there are sources of additional funding so we can do even more.

CHRIS CREAGER: Apollo has committed funding to build fiber to nearly half of the homes and businesses in the footprint. To the extent there are other sources, we'd like to build even more. We believe in providing access to the best broadband for as many customers as possible.

ISE: When will the first few regions be live? What is the average take-rate expectation across those regions? How quickly do you expect a ROI associated with that \$2B investment?

TOM MAGUIRE: Regulatory approval is key. We cannot start offering service, or even building anything of significance, until we cross that hurdle. Think of it this way: if you were buying a house, would the owner allow you to remodel before the sale closed?

We're already working on plans to hit the ground running on Day 1, with plans to open our first consumer locations within a few months, but we have a long way to go. Fortunately, we have great partners at Lumen and in the vendor community, so we're well on our way to putting shovels in the ground as soon as we can.

BOB MUDGE: We are planning to close this deal around 3Q in 2022. As Tom said, the first step is to gain regulatory approvals and to fully stand up the portion of Lumen we are purchasing. We are challenging ourselves to begin placing fiber as soon as the deal closes. Apollo sees this as a long-term investment, and they are very patient and disciplined with their investments. I have no doubt that we will gain very strong market share.

Topic: Growth And Balance

ISE: When a business is growing too rapidly, it can significantly increase the demands on each individual employee, and on your team as a whole. This can easily lead to stressed-out employees, low morale, and in-fighting. With Brightspeed's aggressive growth targets, how will you ensure that the passionate team members who signed on for this new adventure remain energized and pulling together?

BOB MUDGE: It's true that rapid growth can be stressful, but I believe that having a new sense of purpose, and the capital to deliver new products and services, will be exciting and energizing for the Lumen employee who will join us. We have said it since the beginning, and we mean it: **people matter**. We intend to celebrate our progress along the way and to ensure that our employees feel like active contributors to our mission as a company.

TOM MAGUIRE: If experience has taught us anything in this business, it's taught us that we will be successful only if our teams are. We realize that we need to keep everything in balance.

We have a great Chief Human Resources Officer, Colon McLean, to help with this. Interestingly, he's one of the non-telco folks on the team. (Yes, we know a few of those.) Colon brings a wealth of relevant experience from his tenure with Duke Energy, and understands the value we place on hiring and retaining talented, experienced people.

CHRIS CREAGER: In the short time since we announced the formation of Brightspeed, people have been proactively reaching out to us, and the feedback has been overwhelmingly positive. There is a feeling of excitement about being part of the initiation of a new company in this industry.

Topic: Labor Challenges

ISE: In May 2021, Veriforce reported on a survey of telecom executives who were said to collectively employ more than 240,000 contractors. According to the study, the top challenge facing telecom companies is currently skilled workforce availability with 86% of company executives naming skilled labor as the top challenge facing the industry. What are your thoughts about this?

(Source: <http://www.rvallc.com>, Exceptional Market Research by RVA Market Research and Consulting)

TOM MAGUIRE: It's pretty clear that we're going to face headwinds, be they skilled labor, supplies, even vehicles, but we are taking steps to

mitigate these issues as much as we can. We've already begun talking to vendor partners to ensure that our needs and plans are clear. And we're already placing orders and securing capacity where we will need it.

BOB MUDGE: Our vendor partners certainly play a role in our success. Building trust with our incoming employees from Lumen is extremely important, too. We don't want to underestimate the impact on them of moving to a new company. I hope that by the time the deal closes, they feel excited about their future with Brightspeed, and they feel confident that this leadership team understands the

high-quality Internet. *Diversity* isn't a buzzword to us; we believe diversity promotes equity in the communities we serve.

Topic: Deployment Partners

ISE: Utilizing contracting companies to execute your FTTP build requires a lot of trust. Since trust grows with time, it makes sense to leverage relationships you had as Verizon executives. That said, you don't want all of your fiber "eggs" in one basket. So, you may also be entering into entirely new contracting relationships. Share your thoughts about this.

“At the end of the day, I think people will find us to be a team that walks the talk. We don't make empty promises. We like to engage with our people, our customers and other key stakeholders. This includes Union leadership and regulators. We know that we do not know everything, so we look for people who can help make things better.”

— Tom Maguire, Chief Operating Officer, Brightspeed

value of their work. We are here to grow and win, and I hope they see that very quickly.

CHRIS CREAGER: We recognized that the industry is facing hiring and retention challenges when we first discussed our vision for Brightspeed, and we knew we wanted to be an appealing employer. Part of that appeal is our focus on building a diverse team of employees who are fierce advocates for more accessible, inclusive, and

TOM MAGUIRE: You nailed it: trust is essential. I've talked to a lot of folks in the past few years about what it takes to be a successful contractor, and I've said it's pretty simple: deliver things in a safe, quality manner at the right price. Anyone can come in and submit the lowest bid for 1 or 2 jobs, but we want partners who are going to be around for the \$2B+ program.

To that end we plan on working with friends both old and new. We will also be leveraging

Topic: 5G And Fiber

ISE: Talk about Brightspeed's collaboration intentions to work with other major industry players and their 5G rollouts.

TOM MAGUIRE: While most of our work will focus on mass markets, we're also very aware of the needs of the large business/enterprise and wholesale markets. Our program will look like Verizon's One Fiber project; we will build a network that will work for any customers. But it won't just be about fiber as we will offer the features and functionality that people need today.

CHRIS CREAGER: While the residential and small business aspect of this transaction is getting all of the attention, we are going to be equally focused on enterprise and wholesale. Our modeling for where we build fiber will consider enterprise and wholesale locations so that we can serve them faster and more economically.



the relationships that Lumen has in place today. I can happily say that we've had great conversations to date about this with a number of excellent companies.

Topic: Proactive Network Management

ISE: ICT industry analysts and observers often focus on service providers' CapEx budgets. But the reality is that OpEx can make

or break a provider's bottom line. The key to controlling OpEx is to improve network life cycle management for complex fiber and legacy networks in a cost-efficient manner. What are some proactive approaches Brightspeed will employ early on to control OpEx over time?

BOB MUDGE: We have experience maximizing the fiber investment to reduce costs. We will have the ability to eliminate some

high-cost legacy copper plant and to serve our customers with far more reliable fiber. Additionally, we can reduce future fiber install truck rolls by designing the network and OSS systems in a way that future customers can easily self-activate their service.

CHRIS CREAGER: We are thinking that a number of the strategies we used during Verizon's network transformation are applicable to these markets, whether the customer is near a fiber build or not.

Topic: Connecting The Underserved for Remote Learning

ISE: According to a recent survey conducted by Digital Wish, 19% of students do not have Internet connectivity at home, and over 21% do not have access to a computing device, impacting their ability to adequately participate in remote learning. Brightspeed is embracing a new model to help the underserved. How will Brightspeed's model be quicker than other broadband providers when the new company is facing similar labor and supply chain issues?

(Source: <https://www.digitalwish.com/dw/digitalwish/home>)

TOM MAGUIRE: There are 2 issues at play here: 1.) How do we simplify the construction of the network? and 2.) How do we ensure that our partners are well-positioned to help us deliver on our goals?

I touched on the first issue a little bit before when I mentioned the promising technology in the field. We're hoping to leverage this approach to reduce the need

for splicing and placing -- 2 areas that are somewhat constrained these days due to market demands. This should allow us to move quicker because we won't be competing or waiting for those limited resources.

The second issue goes back to engaging excellent vendor partners who share our mission to help the underserved. We feel good about the vendor discussions we have had and will continue to have up to closing.

Topic: Vendor Collaboration

ISE: What "secret sauce" should potential vendor partners use to work successfully with the Brightspeed team? Why is it different than working with other broadband providers?

TOM MAGUIRE: Given the newer technology, we're looking for partners to consider "cost-plus" models as opposed to the traditional Time & Material or Statement of Work ways of conducting business.

Topic: Walking Your Talk

ISE: The Brightspeed website shares how the company is committed to being a leader in defining a new way to work. It says the company will "meet you where you are, by providing sensible remote and hybrid work arrangements." If other broadband companies are offering similar models, why should highly talented professionals work with Brightspeed instead of the big-name broadband companies?

BOB MUDGE: Unlike some other providers, we have a tight focus on improving broadband to homes and businesses. That's our primary goal. For businesses we will overlay cutting edge, but simple, applications. Additionally, we are doing this in areas of the country where we believe customers will be surprised and delighted by the outcome. That's a great reason to work with us.

TOM MAGUIRE: Another thing that sets us apart is the fact that our multi-year program is fully funded by the Apollo team. We're extremely fortunate to have that partnership.

I would add that our focus on growth is attractive. While we are intent on giving excellent service to our embedded base of customers, we are also focused on the future.

“Growing fast is a challenge. But it is far more fun and energizing than shrinking fast. We will celebrate our progress along the way and ensure that our employees feel connected to our purpose and beliefs.”

-- Bob Mudge, Chief Executive Officer, Brightspeed

CHRIS CREAGER: Agreed. Our market sets us apart. Deploying the latest technology to urban areas of the US is great, but people living in those areas already have choices for a strong broadband provider. We are bringing fiber broadband to areas that have been neglected. Closing that Digital Divide is truly powerful!

LEADERSHIP QUESTIONS

Topic: Honesty

ISE: What is it like to work for you?

(Source: Robert Sutton, author and management professor at Stanford via <http://www.inc.com>)

TOM MAGUIRE: At the end of the day, I think people will find us to be a team that walks the talk. We don't make empty promises.

We like to engage with our people, our customers, and other key stakeholders. This includes Union leadership and regulators. We know that we do not know everything, so we look for people who can help make things better.

We are also people who hold others to the standards we set for ourselves. If folks are willing to step up and do what needs to be done to hit our targets, we'll be their biggest champions.

BOB MUDGE: We are not here to surprise or outsmart anyone. Tom, Chris, and I share an important trait: the burning desire to deliver on our objectives and promises. People working with us do not find us getting distracted on secondary priorities -- and we don't want our people to get distracted either.

“Folks have been reaching out because they are excited about what we are doing, as well as the social importance of how and where we plan to transform the business.”

— Chris Creager, Chief Administrative Officer, Brightspeed

Topic: Failure

ISE: What happens at Brightspeed when people fail?

TOM MAGUIRE: Depending on the situation, failure in and of itself is not a bad thing.

For example, if someone tries something to improve our processes, systems, or products and fails, we'll learn from that and move forward.

However, if someone fails to treat others with respect or repeatedly fails to deliver on commitments, then we'll have an issue.

We worked hard on our core beliefs and are very committed to them:

- We believe people matter.
- We believe in thinking like customers.
- We believe in being real.
- We believe in delivering on big ideas.
- We believe in the speed of light.
- We believe in celebrating success.

BOB MUDGE: Tom said it well. Some failures are simply steps on the way to success. Fail. Correct. Move forward.

(Source: Bob Sutton and Jeff Pfeffer, Stanford professors, via <http://www.inc.com>)

Topic: Risk

ISE: What's the biggest professional risk you've taken?

TOM MAGUIRE: This question is a tough one. IF you asked me this earlier in my career, I would have come up with something that happened to be a hot issue of the time.

But looking back, I'm not sure I took enough risks. I should have challenged more, pushed the envelope harder.

BOB MUDGE: Probably taking on this assignment when my wife thought I had retired! ■



Bob Mudge is Chief Executive Officer, Brightspeed. Bob's leadership roles at Verizon and other telecommunications entities span the gamut from network

operations to marketing and strategy. He has deep expertise in public and private companies and has served as an advisor to multiple private equity firms. While the breadth and depth of his industry experience is crucial in his role as Brightspeed's Chief Executive Officer, his ability to develop excellent teams that deliver exceptional customer service and growth sets him apart in the industry.



Chris Creager is Chief Administrative Officer, Brightspeed. Chris brings a wealth of leadership experience in transforming wireline telecom businesses and driving

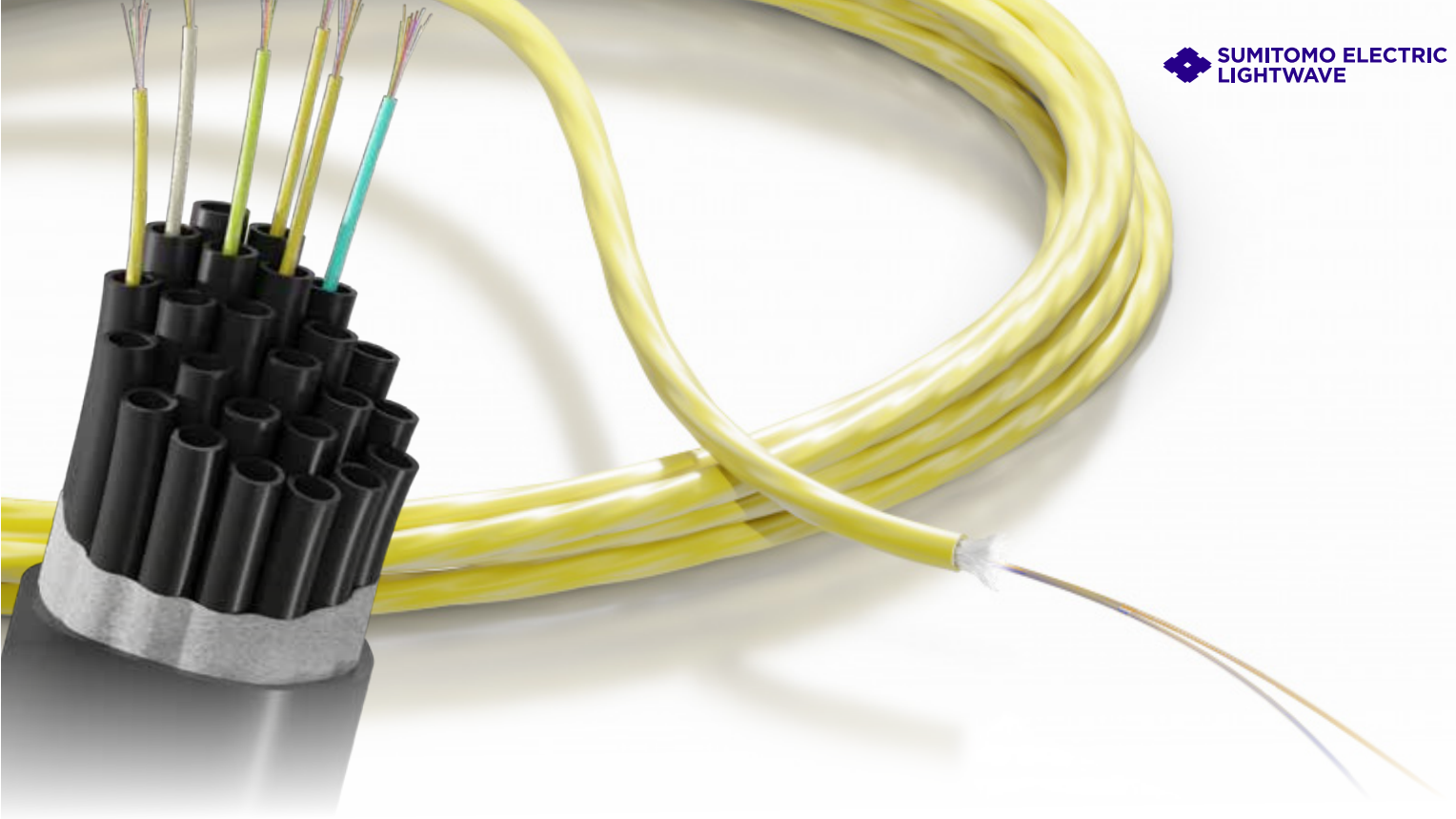
customer growth. During his tenure with Verizon, he led large network and multi-billion-dollar business units that created powerful fiber optic access to millions of homes and businesses. Highly skilled in leading telecom mergers and acquisitions, Chris is focused on ensuring that Brightspeed delivers all its brand implies, for customers and employees.



Tom Maguire is Chief Operating Officer, Brightspeed. Tom's telecommunications experience spans four decades, from an early career as a field technician

to subsequently leading many facets of the business. This experience brings a unique perspective to Brightspeed's business model and influences Tom's belief that operations is most effective when it works with other parts of the organization to provide the best customer experience. Tom looks forward to engaging the Brightspeed operations teams to leverage state-of-the-art technology to serve existing and future customers.

For more information, visit <https://brightspeed.com>. You can follow Brightspeed on LinkedIn: <https://www.linkedin.com/company/brightspeed>.



Sumitomo Electric Lightwave's FutureFLEX® Air-Blown Fiber® Solutions

FutureFLEX® Air-Blown Fiber® offers unprecedented ease of installation, flexibility, and cost savings across a wide range of design needs for current and future network requirements. Air-Blown Fiber® greatly reduces initial man-hour installation costs as well as future network/capacity expense.

The technology and design of the FutureFLEX® Air-Blown Fiber® solution provides immediate scalability with installations of exact fiber types and count required in real time.

Benefits of using Air-Blown Fiber® Solutions

- Install Fiber Bundle when needed
- Fast and Easy Installation
- Remove inactive/outdated Fiber Bundle
- Replace with higher count, different fiber type & more



Keeping Rural America Connected

According to the U.S. Energy Information Administration (EIA), the average duration of power interruptions experienced by U.S. customers annually is just shy of 2 hours. Keep in mind the annual average does not factor in major events such as heatwaves, tornadoes, hurricanes, or other natural disasters that may skew the reporting.

During their most recent study in 2018, the EIA found that when major events are included the average duration of power disruptions jumps up to 5.8 hours per customer. An average that is sure to rise as the amount and intensity of natural disasters increases along with our reliance on an already overloaded power grid.

Interruptions in power vary in frequency and duration across the 3,000+ electric distribution systems currently in the United States. In past years, a few disruptions in service may have been tolerable. However, in today's environment, any disruption is unacceptable. Whether it is for a business, single-family home or multiple dwelling units, dependable internet is a must and making compromises on the equipment powering your network has the potential of affecting your customer's livelihood.

TITAN Outdoor UPS (above)
NEO Indoor UPS (right)

How do you protect your customers from disruptions in power?

Hoping the next major power disruption won't happen is an ineffective and dangerous plan. Instead, special consideration should be given for implementing a well-designed backup plan that incorporates both battery and solar uninterruptible power sources. The availability and utilization of reliable, easy-to-install backup power equipment at the residence or business creates a more resilient network that provides uninterrupted power at a time when it is valued the most. Keeping customers connected and happy.

For solutions to your UPS needs and input during the design stage go to www.escipcorp.com. You will find a number of solutions, alternatives and contact information for sales and production engineers.

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ISE EXPO 2021

Contractor's Forum Highlights



By Janice Oliva, ISE

At ISE EXPO 2021 in Fort Worth, Texas, I was able to have a LIVE and candid conversation with industry executives from Biarri Networks, Finley Engineering Company, and Wolf Line Construction. We discussed their thoughts related to key issues facing the ICT industry, and specifically their ability to help service providers deliver the necessary broadband networks our communities need. Face-to-face, we discussed challenges in design and planning, workforce and timelines, funding, technology, and more. I know you'll find their responses insightful and supportive of what's needed to prepare our industry for the future.

Happy learning!
Janice Oliva
Publisher, ISE Magazine



Janice Oliva, ISE:

What advice do you have for designing and planning fiber networks on tight timelines and even tighter budgets?

Ben Humphrey, VP, Chairman of the Board, Finley Engineering Company:

- Use GIS-based tools and data to prepare high level design and budgets to present to potential funding sources and partners.
- Do not limit yourself to one construction method or technology. Consider alternatives such

as aerial plant, ADSS, distributed split, and Fixed Wireless.

- Look for funding/build partners such as state, county, municipals, RECs, and private companies.
- Use industry standard equipment and materials to avoid custom-built, which drives up the cost.

Paul Sulisz, CEO, Biarri

Networks: Use technology that has already been proven to help get you through these stages quicker. Since you will need to work with large data sets to get there efficiently and with greater certainty, get the help of people who know how to do this quickly and effectively on your behalf -- partner with people who have results.

Work in a way that incentivizes lowest cost, and is predictable. For example, pricing it on a homes-passed method gives better pricing predictability than pricing per foot.

ISE: Do you have a playbook for working with municipalities to improve fiber deployment timelines? If so, share your best practice(s).

Ben Humphrey, Finley Engineering Company:

- Make sure you research the laws concerning municipal-owned communications facilities. Educate the people involved in the project.
- Understand the processes involved with city council meetings, public information requirements, competitive bidding requirements, and processes.
- Have local champions that support the project such as business owners, the medical community, schools and members of the community.

Ben Humphrey

FINLEY
Engineers and Consultants



- Be upfront in talking with the Municipality about what you're doing. Informal introductions and conversations can make it easier for dialogue when problems arise.

Paul Sulisz, Biarri Networks:

- Find a team of vendors who have done it all before, whereby they all bring certain skills and expertise to the table, AND they are doing it for the right reasons.
- Find partners who are willing to transparently collaborate on an approach that allows full transparency throughout the process.
- Maintain standard, open, and interoperable, schemas so you can go fast, AND are ready to accelerate when asked.

ISE: Describe your best experience with a partnership, and why it worked so well.

Ben Humphrey, Finley Engineering Company: One of

the best was a partnership with a Rural Electric Cooperative (REC) and private communications company. REC applied for and received CAF II funding to serve 326 customers in NW Minnesota. The co-op would use their own poles and construction crews to install fiber, saving money and time. They would also own and operate the fiber down to the subscriber and the customer premises.

The private communications company would provide re-branded services over the fiber, operate the optical line terminal, provide Triple Play services, and technical support.

The benefits of this kind of partnership are numerous, including more tools and services to better serve their members. The merger of the 2 resources quickly delivered economic development opportunities across northern Minnesota that are life-changing to their residents.

Paul Sulisz, Biarri Networks:

We work with a number of great partners. While they have different approaches or business models,

we collaborate transparently and partner for success with our clients.

Our best experiences come from programs of work that are based on strong relationships first. These are not transactional deals. We work hard to align to work with people who share our values and are driven by a similar purpose.

ISE: What is your biggest pain point? Share some insights about how you're overcoming it.

Ben Humphrey, Finley Engineering Company: Like everyone else, our primary pain point is the difficulty in finding, hiring, and maintaining, staff. We are fortunate in that we have multiple locations and can share resources across the company.

We've worked to overcome this challenge by cross-training to give our associates a broader experience base. They can then move into various projects and fill gaps as necessary.

We also provide flexibility in work hours, working from home and use of technology.

Finally, we work with local high schools, colleges, and vocational schools, with shadowing and internships. We act as advisors in curriculum development of training programs and classes related to our industry.

Colin Garner, Vice President, Wolf Line Construction: Our primary pain point is poor material management. Supply chain constraints have really elevated this point lately due to a number of factors. If the client isn't ahead on their materials, their deployment is behind.

We believe early communication about the need for materials is critical. Supporting a client through planning is the best way to overcome this.



Consultant egos can be challenging. We have found some hard-headed consultants who are behind on technology, deployment methodology, and project management. We are in a new, evolving era of broadband. Clients need support for their deployments, but they also need innovation and flexibility.

Paul Sulisz, Biarri Networks:

A huge pain point occurs when there is a lack of understanding of what is really needed to get things moving. That means understanding what data is needed, and whether additional information is needed to get the right partners to the table. Insufficiently detailed plans can also hinder getting a jump on key logistical hurdles such as labor and materials -- both of which are in high demand.

The best solution is to look to those with a solid track record of doing what they say they were going to do. If you are not sure if they have actually done it, then ask for references!

ISE: Tell us about your top 2 tools in your company's toolbox. They could be your team, software/hardware, network design tool. etc.

Ben Humphrey, Finley Engineering Company: As a professional services company, our most import asset is our people and the expertise they bring to our customers. We also have trusted partners we collaborate with to provide complete turnkey solutions.

Colin Garner, Wolf Line Construction: We have a great team of engineers who support our deployments by providing work plans, Quality Assurance plans, and tracking tools, for our crews. This group provides reporting, tracking, and documentation, for our clients, which is a great value add; it helps communicate the status of the project, and allows everyone to stay informed on the status of the project.

We also believe our qualified electrical workers who install fiber optic networks safely and efficiently are another great asset. Using a competent, well-trained work force provides a high-quality product for utilities.

Paul Sulisz, Biarri Networks:

We believe in a data-driven approach to designing and building networks. Our teams have worked with more data globally than most. And, since we've seen most challenges before, these insights and experiences are hard to replicate.

Our platform also enables true geospatial collaboration from start to finish of the build.

ISE: What advice would you give to a contractor just entering into today's market?

Ben Humphrey, Finley Engineering Company:

- Your reputation is the most important thing you need to maintain. Treat your customers and associates with respect. Remember The Golden Rule.

- Long-term relationship building is key to being successful in this marketplace.
- Provide quality services and/or products, and state what sets you apart from the rest.
- Give back to your community, and help those less fortunate than you.

Colin Garner, Wolf Line

Construction: Take care of your workforce. Train and invest in your workforce so they are qualified to deploy networks safely and efficiently; it is the single most important investment you can make.

Paul Sulisz, Biarri Networks:

Be careful who you partner with, and maintain very clear, transparent communications with all other contractors and stakeholders. ■

Paul Sulisz, CEO, Biarri Networks

Paul Sulisz's career within telecommunications spans 20+ years, involving work in the fiber/fixed access networks, wireless networks including cellular and microwave deployments, and has been actively involved in multiple global deployments. Over the last 6 years, Paul has focused on producing and deploying innovative approaches to

digital design, engineering, and construction, whilst building a global capability for Biarri Networks -- all in an effort to help connect the world! Paul is the CEO of Biarri Networks, and resides with his family in Denver, Colorado.

<https://biarrinetworks.com>

<https://www.linkedin.com/company/biarrinetworks>

<https://twitter.com/BiarriNetworks>

<https://www.facebook.com/BiarriNetworks>

**Ben Humphrey, VP, Chairman of the Board
Finley Engineering Company**

Ben Humphrey has been with Finley Engineering Company, Inc. since 1977. Ben has a wealth of experience in the broadband field and in numerous leadership positions with Finley. Currently, he serves as Vice President of the Minnesota Division in Slayton, Minn. He was appointed Chairman of the Board of Directors for Finley in 2014. Strategic and visionary, Ben is often called into projects early in the discussion phase as an experienced consultant who knows the questions that need to be addressed. He draws from firsthand experience in the development of strategy and implementation plans. Over the years, Ben has led substantial projects building fiber and broadband networks for our clients. Ben launched the effort that has now become our Business Development Group, and supported the development of our Fixed Wireless Group. As Chairman, Ben works closely with our Board of Directors and Management to set our company's direction and strategy.

b.humphrey@finleyusa.com

<https://www.facebook.com/FinleyEngineeringCompanyInc>

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<https://vimeo.com/finleyengineering/videos>



**Colin Garner, Vice President
Wolf Line Construction**

Colin Garner is the Vice President of Wolf Line Construction, a construction services company focused on broadband deployments for rural electrical cooperatives. Mr. Garner, a registered professional engineer, received his undergraduate degree in Engineering from the University of British Columbia, and an MBA from the University of South Carolina. He has an extensive background in finance, infrastructure and utility construction, and has worked in North Africa, Canada, Australia, and the United States.

<https://www.wolflineconst.com>

ISE Innovator Q&A With Mark Boxer, Technology Manager, Solutions And Applications Engineering, OFS

ISE: Who is OFS and what should we know about you?

Boxer: OFS is an original inventor of optical fiber technology and one of the most important fiber optic innovators in the world. Our lineage goes back to 1876 and includes the rich history of Bell Labs. With inventions as fundamental as full spectrum fiber, gel-free cables, and the LC connector, we pioneered many products that are now commonplace in today's networks. OFS is headquartered in Norcross, Georgia, a suburb of Atlanta, with additional factories around the US and around the world.

ISE: How is OFS helping network operators take fiber everywhere?

Boxer: According to the latest numbers from the Fiber Broadband Association and RVA, only 25 million of the 136 million US homes are connected to fiber. There's a tremendous opportunity to connect residences to the fiber broadband.

To make this connection, the final drop to the home and MDU often requires many tight bends to reach the ONT location.

OFS pioneered an ultra-bend-insensitive solid glass fiber called EZ Bend® fiber well over a decade ago. It's now been deployed in millions of living units around the world. Its bending performance is essential for reliable service in drop cabling to and in the home, even more so as the industry moves from GPON at 1490 nm to XGS-PON at 1577 nm, a more bend sensitive wavelength.

EZ Bend fiber is at the core, pun intended, of OFS' broad array of EZ-Bend and InvisiLight Solutions. [Learn more on how we use EZ-Bend fiber at https://youtu.be/dESIZf5Wfa4](https://youtu.be/dESIZf5Wfa4).

ISE: What does OFS recommend for single-family home applications?

Boxer: We have a simple 3-step approach.

1. **Choose the drop terminal** – OFS offers different types of terminals, and generally advocate for non-proprietary, non-hardened connectors, as we find they're more cost-effective and available with similar ease of installation.

2. **Choose the drop cable** – OFS offers different choices, from classic flat drops to the InvisiLight Drop Solution, where a single EZ Bend cable can run from the terminal to the home and easily be stripped down to InvisiLight to reach the ONT.

3. **Choose the termination method** – OFS offers factory terminated drop cables, or cables that can be field terminated with OFS' Fitel Fusion splice-on connectors that offer competitive cost vs. mechanical connectors, with the advantage of fusion splice reliability. Of course, a customer can also choose to splice EZ-Bend pigtails or to directly splice connections, and many customers do just that.

You can learn more at <https://www.youtube.com/watch?v=CrXyypo0Vs>.

ISE: More service providers are focusing on MDU buildings. What's OFS' approach to the MDU space?

Boxer: We're seeing a ton of interest by carriers deploying fiber into every MDU living unit, for good reason. Fiber-to-the-MDU can be installed very quickly and at significantly lower cost per connection vs. single-family homes, and unlike copper is ready for upcoming 10, 25, and 50 Gigabit systems.

OFS has led in this space for a long time, and we've developed solutions over the past decade for the many different types of MDU buildings. Our mix-and-match approach provides the optimum solution for the different pathways available in each MDU.

All are designed to be installed quickly and easily with low visibility and ultra-bendability.

Starting at the living unit and working backward, the InvisiLight ILU (Indoor Living Unit) solution is a 600 or 900 µm fiber that is typically adhered in the wall/ceiling crevice from the ONT to the hallway. Different types are available depending on whether the ONT is wall-mounted or desk-mounted. [Learn more at https://vimeo.com/417018894](https://vimeo.com/417018894).

For MDUs with a hallway, the InvisiLight MDU Solution is installed down hallways with the same process and tools as the InvisiLight ILU Solution. A fiber is terminated above each doorway to connect to the InvisiLight ILU in the unit. [More information is at https://vimeo.com/274762436/3653a9dc60](https://vimeo.com/274762436/3653a9dc60).

For MDUs where the cable is best installed outside the building, the InvisiLight Façade solution features different point of entry modules for breezeway and side-of-building applications.



Mark Boxer is Technical Manager, Solutions and Applications Engineering for OFS. In this role, he assists customers deploying fiber in a wide variety of

network design scenarios around the world and analyzes trends in telecommunications markets that drive new product innovation. Mark has a BME degree from Georgia Tech and has spent his 30+ year career in the fiber industry. His experience includes varied roles in manufacturing and applications engineering for fiber-based products and markets. Other activities include inventor of 6 US Patents, member and past Secretary of the IEEE Power Engineering Society Fiber Optic Working Group, contributing member to the Fiber Broadband Association (FBA) (formerly FTTH Council) Technology Committee and Board of Directors member of the FBA.

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The \$65B DIGITAL DIVIDE Gordian Knot

3 Concerns And 3 Recommendations



A Gordian Knot is a metaphor for both a problem solvable only with bold action, and an intractable problem or a complex, severe, and enduring, conflict. Do the current Digital Divide solutions create such a knot?

By Michael Render

The \$65 billion current infrastructure bill has now been passed into law to help solve The Digital Divide. There is additional federal funding coming from the RDOF phase auction completed in 2020 and a proposed phase 2, as well as state broadband funding available under the American Rescue Plan Act of 2021.

While the funding is critical, we must also explore 3 concerns related to how these funds will be best put to use -- in terms of both the final product outcome and the process.

Concern #1: Product Outcome Performance And Sustainability

The broadband infrastructure resulting from this bill must be capable of propelling rural America for generations. As an example, the rural electrification bill of 1936 rejected calls for inferior solutions (such as funding small low voltage DC wind generators at each home to occasionally run a few lights and a single radio) and created high-quality sustainable infrastructure. The resulting grid has already served rural America for nearly a century, with ever increasing applications for electricity -- applications never imagined in 1936.

Rural broadband infrastructure must have the same longevity. The growth of Internet use in rural areas over the past 20 years is apparent, from emails and

early websites in 2001 to video conferencing and precision farming in 2021. The vision of the next 20 years is now becoming evident: augmented and virtual reality applications, including for employment, and autonomous vehicles and machinery with high-speed connections, precision farming... which will continue to expand and drive unprecedented digital demand. All these require high bandwidths in both directions. Even today, during peak periods of productivity and collaboration, upload needs exceed download needs.

How can we maximize the outcome of the infrastructure bill? While the broadband bill allows solutions down to 100/20 Mbps, it is of upmost importance that far higher quality symmetrical Internet be funded wherever possible to meet both current and future network demand. In almost all cases, rural home broadband infrastructure should be capable of eventually carrying many gigabits -- in both directions. Optical fiber all the way to the end point is the only known medium capable of meeting this

demand. If other solutions are allowed for extremely remote outliers, rigorous standards must be applied. There absolutely cannot be a call for the government to correct the problem of rural broadband again.

Concern #2: Process: Quality And Practicality Of The Award Phase

Without carefully crafted guidelines and timetables for the award phase, the implementation of the federal broadband infrastructure program could result in a program that does not select the most qualified construction and operation companies or access as much domestic labor and material supply as possible.

It takes time for government-funded programs to develop structure as well as to review, vet, and select, recipients. Past programs have taken 15-19 months from enactment to the announcement of initial awards. (See Figure 1.)

Most funding will be funneled to individual states for distribution. While this allows more

TIMETABLE IN MONTHS FOR PAST BROADBAND GOVERNMENT FUNDING PROGRAMS

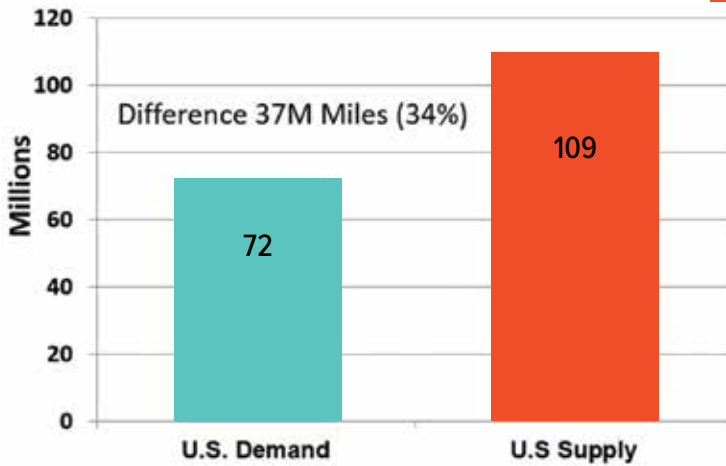
| GOVERNMENT PROGRAM | DEVELOP CRITERIA FOR AWARDS | FIRST AWARD ANNOUNCEMENT | FINAL AWARD ANNOUNCEMENT |
|--|--------------------------------|-----------------------------|-----------------------------|
| Broadband Technologies Opportunity Prog (2010) | 6 | 15 | 19 |
| American Recovery and Reinvestment Act (2009) | 6 | 15 | 20 |
| Connect America Fund II (2017) | 6 | 19 | 40 |
| RDOF Phase I (2020) | 3 | TBD (16+) | TBD |

Figure 1. Broadband Technologies Opportunity Programs' Timelines

U.S. FIBER DEMAND AND SUPPLY

RVA ANALYSIS FIBER MILES - 2021

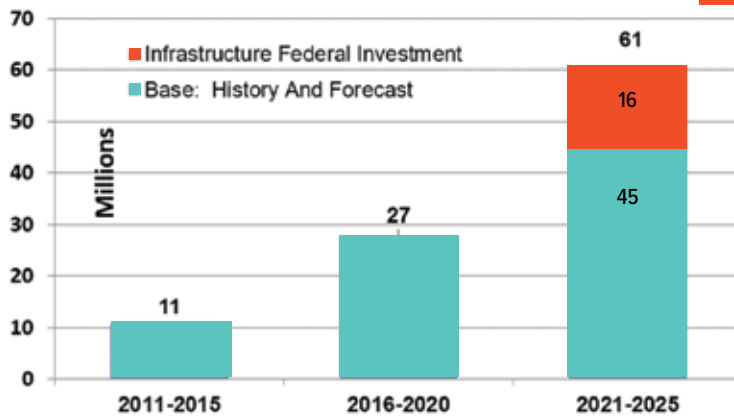
Figure 2.



NORTH AMERICAN NEW FTTH HOMES PASSED

2.3X PREVIOUS PERIOD

Figure 3.



local knowledge of true need, the states have varying degrees of experience in selecting and funding broadband projects.

How can we maximize the effectiveness of the award phase? First, enough time must be allowed for the allocation of funding. Second, various entities should step up to assist states with less experience, including both federal agencies and private entities such as industry associations and non-profits. At this

writing, various groups such as the Fiber Broadband Association and Pew Charitable trusts are setting up consulting assistance for the states where needed.

Concern #3: Process: Quality and Practicality Of Construction Phase

Potential problems with the construction phase include both the materials supply chain and labor availability.

An obvious first question: is optical fiber supply a potential point of shortage in the United States? Based on everything we know, barring some unforeseen worldwide raw material shortage, the short answer appears to be that domestic optical fiber (the glass fibers) and optical fiber cable (multiple optical fibers in one jacket) will not likely be a significant and long-lasting point of shortage -- even if the new federal broadband infrastructure investment is concentrated in a short build-out period.

Overall, US manufacturers of the glass optical fiber have done an excellent job in anticipating demand and keeping up with the curve. At present, RVA analysis of domestic fiber demand and capacity shows a headroom in US supply compared to US demand.

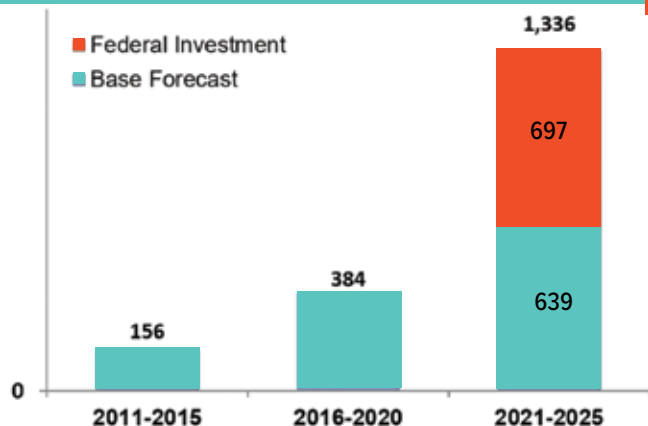
We believe this based on 3 crosschecks: 1) directly modeling current supply and demand, 2) asking manufacturers directly, and 3) most definitively, reviewing export records. US manufacturers of optical fiber currently export most of their overage capacity. According to data from the Global Trade Information Services, net of imports, there are currently about 37 million optical fiber miles exported annually. (See Figure 2.)

This current headroom, if turned to meet domestic demand, should handle all the increased demand from both the Rural Digital Opportunity Fund and the federal broadband infrastructure fundings -- an estimated incremental 27 million miles of optical fiber annually, even if a short construction window is maintained.

FTTH LINEAR CONSTRUCTION MILES TO PASS HOMES

3.5X PREVIOUS PERIOD

Figure 4.



Turning to fiber cable (fibers in a jacket), there is a verified short-term availability concern. There has been a large domestic surge in demand for cable with some limitations in production. The supply-side problem relates primarily to the capacity of current cable making plants, as well as the availability of some resins and metals (for cable protection) used in cabling. Fortunately, raw material problems appear to be short-term, and new cable manufacturing capacity can be installed in less than a year.

Semiconductors for electronics are also a significant current concern as reported by US Telecom to the FCC. This concern may too be short-lived. In June 2021, the U.S. Senate approved the U.S. Innovation and Competition Act (USICA) which allocated \$52 billion for domestic semiconductor manufacturing. We believe most supply chain disruptions will be resolved and the free market will drive suppliers to respond to the incremental demand caused by

any existing or proposed broadband infrastructure programs.

Labor is perhaps the most difficult concern. Without carefully crafted guidelines and sufficient timetables for the construction phase of the program, the construction process could result in excessive competition for labor and resources in short term -- impacting both availability and cost. Concerns about finding qualified labor for construction and, specifically, telecom construction, is based on actual data.

- Reviewing construction workers overall, the 2020 *Construction Hiring and Business Outlook* report by the Associated General Contractors of America found that 76% of construction businesses with open positions are having a difficult time finding qualified skilled labor.
- In May 2021, Veriforce reported on a survey of telecom executives who were said to collectively employ more than 240,000 contractors. According to the study, the top challenge

facing telecom companies is currently skilled workforce availability, with 86% of company executives naming skilled labor as the top challenge facing the industry.

- The availability of aerial pole and line workers may currently be the highest point of labor availability stress. In 2020, Commissioner Brendan Carr of the Federal Communications Commission, noted in interviews that there were at least 20,000 available jobs for tower climbers to install equipment. Based on RVA interviews, other current needs identified included horizontal directional drill operators and fiber splicers. Brookings likewise noted the need for 18,000 line installers.

Based on a *January 2021 FTTH forecast* from RVA LLC predicting the likely deployment from more than 1,200 large and small private and municipal FTTH providers in the US, the period 2021-2025 will likely show record deployment even before considering new federal rural investment programs. The number of homes-passed in the period is currently expected to grow by 45 million, 1.7 times over the previous 5-year period.

If the current infrastructure bill and other federal broadband investment programs were all limited to the period of 2021-2025, large and perhaps unworkable labor projections appear. The new infrastructure bill will add an estimated 16 million homes passed to the forecast and, when combined with the base forecast of 45 million homes passed (which includes other

government programs) would bring the total to 61 million homes in the 5-year period, representing an increase of 2.3 times the previous 5-year period.

More homes will be passed in the next 5 years than in all of FTTH history combined.

This will put us well on the way to meeting the goal of connecting all Americans to high-quality broadband service. (See Figure 3.)

Another important aspect of federal rural broadband funding is that, by definition, nearly all funding will go to less dense areas, meaning the average

Meanwhile, underlying activity for other telecom work, especially 5G, is also expanding, placing further stress on employment resources. Closer and more frequent 5G towers are primarily served with fiber all the way to the radio head. Twelve (12) leading telecom industry trade associations wrote a letter in January 2021 to President Biden urging more workforce development. It was projected that 5G alone would create 3 million direct and indirect jobs by 2025. A letter from the 5G industry concluded *“While the jobs are there, our*

Though less of a concern than labor, a longer timeline also decreases the likelihood of intermittent material supply shortages. This also ensures a greater percentage of products will come from domestic supply chains and domestic manufacturing, furthering government objectives to stimulate American jobs.

But with or without a longer construction phase, strong and intentional efforts and programs from both industry and government are needed to automate processes wherever possible, and to recruit, train, and certify more workers.

“Twelve leading telecom industry trade associations wrote a letter in January 2021 to President Biden urging more workforce development. It was projected that 5G alone would create 3 million direct and indirect jobs by 2025 and contribute \$500 billion annually to the US economy.”

distance between each home increases versus suburban deployment. Comparing an estimated average 230 linear feet of cable required to pass each qualifying rural home, with 75 linear feet required for each suburban or urban home, suggests the increase in linear feet of new rural infrastructure would multiply the scale of build-out by 3.5 times the previous 5 years. The line lengths have a strong correlation to the amount of labor required. Such a large increase in fiber line installation represents a profound and probably unworkable stress on labor supply. (See Figure 4.)

American workforce is not currently ready to fill them.”

How can we maximize the effectiveness of the construction phase given labor concerns?

Despite the urgent need for better rural broadband, it appears that, if possible, extending the construction phase to, say, 8 years beyond the award phases to flatten the curve would be optimum. This longer period would greatly increase the likelihood of being able to sufficiently recruit, develop, train, and certify, the necessary workforce, and to maintain the quality and sustainability of work completed.

Assistance in this effort may come from community colleges, technical colleges, workforce development agencies, industry, and government at all levels. More apprenticeship or internship programs must be developed that blend field work, technical training, and college preparation, or progress, if desired, using novel partnerships between industry and educators. As an example, the Fiber Broadband Association is currently setting up labor training and certification programs in several states. ISE is expanding its professional development programs.

Conclusion

1. The final government-funded infrastructure must be capable of propelling rural America for generations -- primarily with the capability of at least Gigabit speeds in both directions (symmetrical) through optical fiber.
2. US government funding should support US jobs and US-made materials whenever possible.
3. To minimize the stress on labor and materials, and ensure an effective and efficient process, we suggest an 8-year construction window if possible -- to balance the urgency of need with the quality of result. Material constraints, such as semiconductor shortages and

sufficient fiber capacity, are viewed as short-term problems and will likely resolve, but require diligence. The labor constraint is more concerning and will also require concentrated efforts from both the private and public sectors -- even given a longer time horizon.

The bottom line is this: the infrastructure bill creates the opportunity to greatly decrease The Digital Divide -- especially the availability component. But the actions taken today *must not* create a framework for a new Digital Divide tomorrow! ■

RESOURCES AND NOTES

This adaptation is created from the white paper *Maximizing the Impact of U.S. Public Investment in Rural Broadband*, July 2021. The complete text and sources can be found and downloaded at: www.rvallc.com/smart-city-5g-digital-divide-reports.

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Fiber Distribution Hub Series

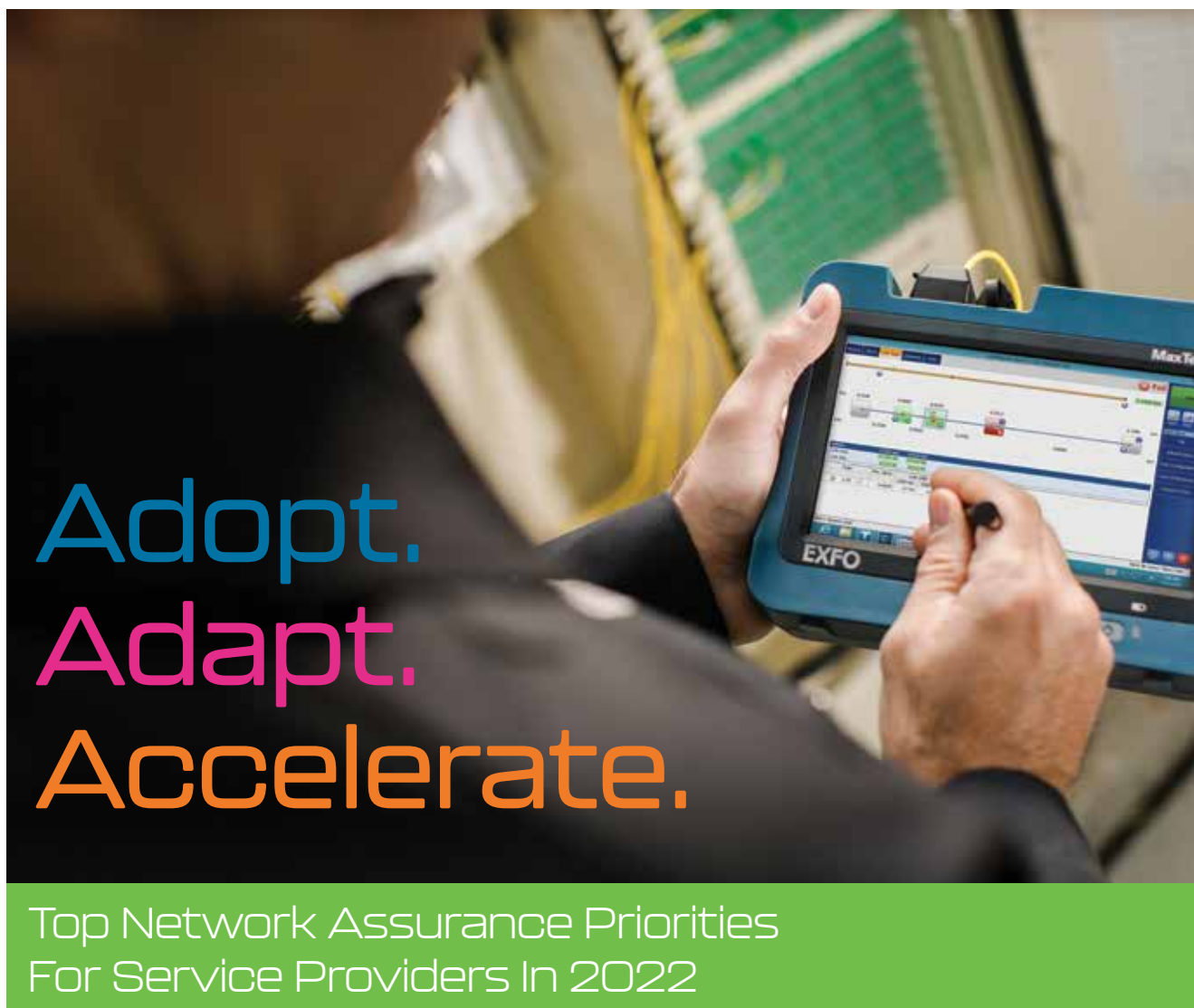


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Adopt.
Adapt.
Accelerate.

Top Network Assurance Priorities For Service Providers In 2022

By Stéphane Chabot

As the world moves towards a new normal in the wake of the global COVID-19 pandemic, communications service providers are focused on the next set of challenges and opportunities on the horizon.

The pace of network transformation has not slowed; it has, like bandwidth demand, accelerated significantly. With the availability of sophisticated solutions for everything from business and personal collabora-

tion to the Internet of Things (IoT) and gaming/entertainment, there is amped-up demand for high-speed, reliable services for enterprises and end-users.

The motto associated with the long-running American television show *Survivor* is, *Outwit. Outplay. Outlast*. Perhaps for service providers, the mantra for 2022 is *Adopt. Adapt. Accelerate.* as they tackle the following top priorities for 2022.

Adopt

Global 5G connections are growing rapidly -- reported as up 41% from Q1 to Q2 2021 according to 5G Americas based on data from Omdia. In the second quarter of 2021, global wireless 5G connections reached 429 million, the data from Omdia reveals. It seems the rapid pace of 5G adoption globally shows no signs of slowing as service providers move to the next generation of mobile technology.

What may be overlooked, however, is the necessity for a

Figure 2. Automated field testing solutions empower technicians.

reliable, ubiquitous, and always-on, optical fiber infrastructure to support 5G rollouts with 5G fiberization. Fiber everywhere will be key to successful 5G deployment, and service providers will be extending the fiber reach of their networks to connect seamlessly and reliably from the core to the edge of the network.

Paramount to providing that secure infrastructure will be testing -- testing at every stage from design to construction, and turn-up/troubleshooting to long-term monitoring. This is essential to ensure that all connection points are secure and that network spans are deployed first-time-right to minimize OpEx and truck-rolls. Mission-critical mobile communications will rely heavily on fiber infrastructure to be available and reliable 24/7, with issues flagged and mitigated before they become service-affecting.

A key focus for service providers during 2022 will be ensuring best Quality of Service (QoS) based on a high-performance fiber infrastructure supporting 5G networking.

Adapt

An important part of the fiber everywhere mindset resides in the access network, the fiber-to-the-premises (FTTP) or fiber-to-the-home (FTTH) scenario, to ensure ultra-fast broadband connectivity to homes and multi-dwelling units (MDUs). Similar to FTTH initiatives, a fiber-deep strategy pushes the optical-to-electrical conversion closer to subscribers, which increases potential bandwidth to homes and cuts power and maintenance costs.

The global COVID-19 pandemic shone a spotlight on the critical role of FTTH for working, learning, and socializing; consumers

and businesses will continue to expect access to high-speed symmetric broadband in 2022. (See Figure 1.) That translates into testing at every step of the deployment process -- not relying solely on manufacturers' pre-testing of equipment. This can prevent a "plug-and-pray" scenario which can have disastrous results. Field automated testing solutions can help service provider workforce technicians become test experts in no time, avoiding the unnecessary repairs and repeat truck rolls that add expense and delays.

Service providers will continue to prioritize FTTH throughout 2022 to deliver services to end-user customers, especially

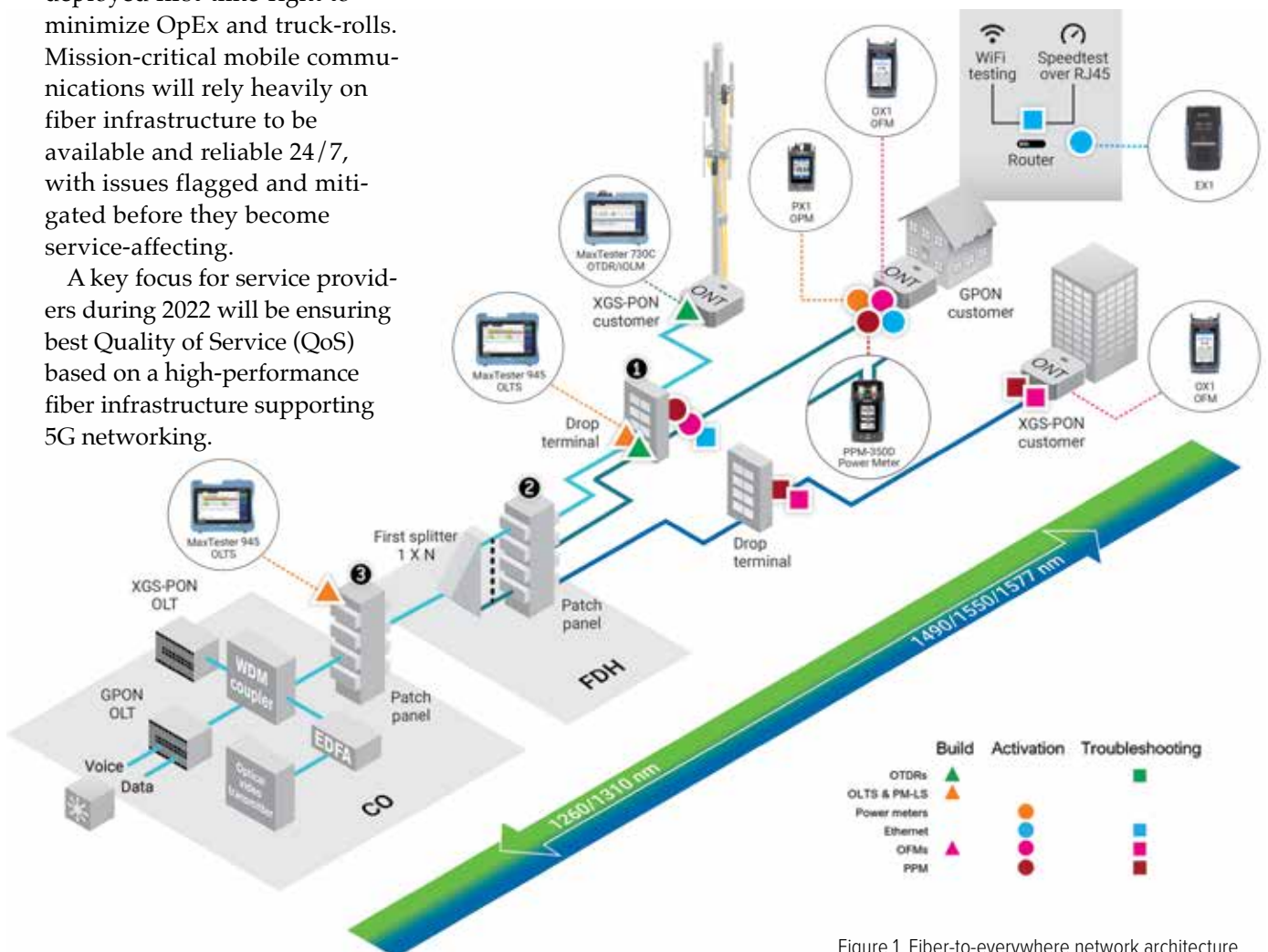


Figure 1. Fiber-to-everywhere network architecture.

given the numerous broadband stimulus packages being offered by governments globally. And adopting the latest test technologies helps ensure optimum performance.

A perfect example of this need for adaptation can be found in data centers. The Internet of Things (IoT) or machine-to-machine connectivity is becoming the dominant form of communication as sophisticated servers share traffic, and networks support connected devices. While humans are tolerant of

data centers closer to the network edge, heating up the competition for low-latency services. This puts pressure on service providers to ensure that data centers are ready for the onslaught of mission-critical traffic traversing the network and converging at the data center.

Growth in interconnect bandwidth is happening even within the confines of data centers, necessitating reliable infrastructure with low latency and packet loss. As service providers transform their data

ers and to deliver a more extensive suite of services is the name of the competitive game. Clearly, service providers will be placing major emphasis on cost-effectively achieving high-speed networking while maintaining QoS.

Successful high-speed deployment depends on accurate fiber characterization and troubleshooting in the end-to-end network. Industry advances in Optical Time Domain Reflectometer (OTDR) technology have automated field testing during the construction phase, providing

“An important part of the fiber everywhere mindset resides in the access network, the fiber-to-the-premises (FTTP) or fiber-to-the-home (FTTH) scenario, to ensure ultra-fast broadband connectivity to homes and multi-dwelling units (MDUs). Similar to FTTH initiatives, a fiber-deep strategy pushes the optical-to-electrical conversion closer to subscribers, which increases potential bandwidth to homes and cuts power and maintenance costs.”

network outages and degradations, machines are not because of their inherent mission-critical functionality and performance subject to signal loss and latency. According to the GSMA's 2020 report *The Mobile Economy*, IoT connections will reach almost 25 billion globally by 2025, up from 12 billion in 2019.

The exponential growth in data traffic and demand for cloud services and virtualization is driving data center transformation, with operators moving from copper to fiber and 10 Gbps to 100/400 Gbps. And data centers are proliferating at the edge of the network to better support broadband and wireless communications in core metro networks.

Hyperscalers continue to build

centers, test solutions that can certify fiber, perform validation testing for Ethernet, and Optical Transport Networking (OTN), plus test solutions for quick and efficient connector testing, are important to ensure QoS. This is another key area of focus for service providers in 2022.

Accelerate

This year, service providers continue to be focused on delivering services faster with high quality while striving to be cost-effective. High-speed networking of 400 to 800 Gbps is a reality, and service providers will invest more and more in ultra-high-speed transmission.

Getting more data down the pipe faster to serve more custom-

greater accuracy and efficiency. EXFO's intelligent Optical Link Mapper (iOLM) takes OTDR testing a step further using multi-pulse acquisitions and advanced algorithms to deliver information on every element in a fiber link. (See Figure 2.)

Best Principles For 2022

This year, service providers are accelerating bandwidth with new deployments and high-speed networking, using advanced test technology to ensure QoS. That means they must embrace **4 key best practices** as they move forward:

1. Adopt automated processes to ensure that they succeed with first-time-right deployments.

2. Pay attention to outsourced deployments. While field testing solutions can help technicians be more proficient, service providers who are outsourcing more network builds and hiring more contractors may feel they lack oversight to ensure that deployments are being done according to their standards. Remote, cloud-based solutions can provide that needed visibility for live key performance indicator (KPI) reporting and business intelligence (BI) dashboards.

3. Consider remote network monitoring that delivers end-to-end visibility of the network and identify bottlenecks or issues before they can cause outages.

4. Automating processes and taking advantage of advanced test tools are imperative for service providers to scale operations and expand their network reach and capabilities, and this is a top area of focus in 2022.

Emerging from challenging times, service providers are now stepping up to expansive opportunities. It's time for service providers to *Adopt, Adapt, and Accelerate*. to meet their targets by focusing on key priorities and leveraging the latest test technology to succeed.

RESOURCES AND NOTES

<https://www.globenewswire.com/news-release/2021/09/22/2301608/0/en/Global-5G-Connections-Are-Growing-Rapidly.html>

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// Progress is impossible without change,
and those who cannot change their minds
cannot change anything. //

--GEORGE BERNARD SHAW

By Kevin Maes

To say the telecom industry has changed over the last 20 years is an understatement. *What* we do, *How* we do it, and *Who* is coming into the industry, has all undergone a radical change. *What* and *How* we do things these days is driven by the new infusion of capital that has been made available, and rapid advances in technology, as well as the unprecedented demand for more and faster data across nearly every inch of the world.

When we take a glass-half-full approach to *Who* is coming into our industry, we can see that today's telecom engineers compliment today's *What* and *How* very nicely, but leading the modern engineer comes with a new set of challenges that

leaders in our industry have not had to deal with before.

Here's what we know about these folks.

Who Are They?

People entering the telecom industry these days are drawn to the monumental challenges at hand: they want to make a difference in the world and see broadband as a path to contribute to lifting communities up in opportunities. They treat challenges that arise in telecom as puzzles they can solve using data and technology.

While it's fair to say most people who have dedicated their professional career to this industry have been keen to tackle challenges and problem



solve, today's new engineer is more technologically advanced. Therefore, this person leads with technology to solve today's industry challenges. The new engineer inherently knows how and where to find data and plug it into tools that in turn allow companies and consumers to know and do more with maps and data visualization than ever before.

From Where Do They Come?

Those interested in working in telecom at this time generally come by way of Technical Colleges, Community Colleges, and 4-year Universities. They generally begin in internships that are either gained through school partnerships or stand-alone opportunities offered by companies.

More and more institutions are offering a wide range of training and education that encompasses

directly from high school, but by and large the trend is that those drawn to today's telecom opportunities have some post high school training.

What Do They Bring To The Table?

The new engineer has a genuine curiosity that can, at times, give people seasoned in the industry pause. A training style of *This is how we do it* will most likely be met with *Why?*, and once they have some experience under their belt, they will likely offer suggestions for other ways of getting a task completed.

Can this be frustrating when time is of the essence? Sure, but in the long run, having a problem-solving acumen and a unique perspective is exactly what is needed to keep the industry moving forward and at the rapid pace that's now required.

maps that were usually hand-drawn and, in later years, CAD-drawn.

Now, data sets are built or stitched together from the desk using online parcel data, soil data, and up-to-date imagery. The data sets are then analyzed from the desk using BI reports, Excel, KMZ, and other tools. Finally, someone goes out to the field to verify data using mobile apps, drones, lidar, and ground penetrating radar when needed. This new way of doing things not only speeds up the process but it also makes for much more accurate data in the long run.

While the new engineer is a seemingly perfect fit for the direction our industry has taken in recent years, they also come with a challenge that is of no fault of their own: *they lack experience.*

To recruit and retain those coming into the industry at this time, it's important for leaders (managers all the way up to

// Because it's such a connected world these days, the standard 9-to-5 box no longer exists. Today's engineer *will* get the work done -- but probably not on a traditional 9-to-5 schedule. //

the traditional skills still needed in the industry as well as technology-enhanced skills such as using Imagery websites, software like ArcGIS, operating a drone, building mobile applications, and writing code.

This is not to say that there are not people entering the industry

When Old Meets New

Once upon a time, say, 10 or 20 years ago, it was standard practice for a telecom engineer to physically go out in the field and then build or create the data themselves. This was accomplished using Old or Existing

CEOs) to understand how to create a win-win across their organization to retain talent and to ensure that their company continues to thrive for the long haul.

Here Are 5 suggestions.

1. Keep Them Busy To Keep Them Interested

We're ushering in a new era in our industry, and it's common that leaders task the new engineer with outdated tasks -- or no tasks at all -- because they don't quite know what to give them to do. The attention span of the modern engineer tends to be short, and jobs are plentiful, so have a success plan in place for your new hires *before* you hire them to increase your chances that they stick around.

2. Be Patient

This is easier said than done in the current high stakes and high stress environment we all face. Still, Rome wasn't built in a day, and your team of future leaders simply needs more time to develop. This is in stark contrast to how things were done in the past in our industry where it was largely trial by fire and sink or swim.

Quite simply, the old ways of bringing along new engineers does not work anymore. Expecting too much too soon from today's engineer will undoubtedly create a revolving door at your organization. Is it challenging to be patient, especially in these get-it-done-yesterday times? Absolutely. But it will be worth it in the long run when you find that you are more often able to retain good talent.

3. Allow For Autonomy, And Accept That They Will Make Mistakes And Learn From Them

This is another tough pill for many leaders to swallow because the stakes are high and time is money. But you will find that this is the only way to move forward with today's engineer.

Micromanaging is a road to nowhere, and to think that people with little to no practical experience will not make mistakes in the early days of their tenure is doing your and your team a disservice. Have solid QC processes in place to ensure that mistakes do not impact the client and then -- let go.

Because it's such a connected world these days, the standard 9-to-5 box no longer exists. Today's engineer *will* get the work done -- but probably not on a traditional 9-to-5 schedule.

4. Offer Encouragement

It's always been the case that tough love doesn't work for some people, but today's leaders need to take it one step further and be aware that it doesn't work for the new engineer at all. These are deep waters your team is being asked to swim in these days, and your new team members will respond better to support in the form of praise. Keep in mind that this praise needs to be sincere or it will have an adverse effect on everyone on your team.

5. Model Soft Skills

Leaders today are being called upon to dig deep into their soft-skills toolbox to train and inspire today's engineers. Whether this approach resonates with you or not, this is the modern landscape and it is important to adapt. As a leader, you must walk your talk. That means working on your own soft skills, and taking the high road when it's difficult.

There is a Zen proverb: *Let go or be dragged*. This could not be more true today. As many of our experienced team members retire, we're working hard to value and recognize the contributions of our veteran team members who are still an important part of our organizations. We must also usher in a new generation of engineers who will ultimately help our companies and our communities get to the next level in the telecommunications space. ■



Kevin Maes is VP of Engineering, Millennium Geospatial. For more than 25 years, Kevin continues to design and engineer networks on a

national footprint, and building FTTH for 20+ years across Rural America. Kevin leads Millennium Geospatial's strategic initiatives that are resulting in data-driven solutions throughout the country. Kevin spent time in the US Army (Infantry). He is married with a son, and is an avid fly fisherman. For more information, visit <https://millenniumgeospatial.com/>. Follow Millennium Geospatial on Facebook, LinkedIn, Pinterest, and YouTube.

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MNO and MSO 5G Collab?

Overlaying Mid-Band Spectrum
Backhaul/Fronthaul Onto HFC

By John Ulm

Cable 10G and Wireless 5G seem like completely separate technologies, but service providers can evolve by combining them in their networks.

5G runs over several different frequency bands, and each band has its own features. C-band and CBRS (Citizens Broadband Radio Service) frequencies offer some new mid-band spectrum that could be a mainstay of 5G in the future.

5G's reach covers a significant number of mobile users with data rates above 1 Gigabit, but its deployments typically require many more cell sites than current 4G LTE macro cells, and those cell sites will be closer together. This situation presents an opportunity for MSOs to leverage their existing HFC infrastructure for providing both backhaul and power to those new cell sites.

Small Cell Deployments

5G services require much more densely located antennas. For cable operators, the most enticing 5G use case that takes advantage of their HFC infrastructure is the small cell deployment. Perhaps the 2 most obvious applications would be 1) strand mounted small cells (on aerial coaxial plant) and 2) pole-mounted small cells (mounted on streetlights). Streetlights may be the best or only option for underground plants in some cases. Streetlights also have an advantage over strand mounts as they are at a higher elevation (i.e., 45' vs. 30'), which enhances the reach of the antenna.

Figure 1 provides some small cell range estimates for C-Band, CBRS and WiFi 6E. The coverage is impacted by the transmit power, which varies quite a bit between technologies. WiFi 6E could be also seen at a disadvantage as it is using the 6GHz band, which has higher path losses than the 3.5 to 4.0 GHz bands used by CBRS and C-Band. Rural areas tend to have fewer obstructions and typically have farther reach.

Mapping 5G Mid-Band Small Cells To HFC

The 3GPP's 5G-R RAN2 specification included several functional split options. A discussion is detailed in the white paper "A Survey of the Functional Splits Proposed for 5G Mobile Crosshaul Networks" (1). Today, most 5G industry focus is on 1 of 2 options:

- **Option 2 ("Midhaul"):** a high-level centralized unit (CU) and a distributed unit (DU) split which separates control and user planes. The DU and remote radio unit (RRU) might be combined into a single entity as a self-contained access point.
- **Option 7.2 Cat A ("Fronthaul"):** a low-level split that allows for high reliability and low latency communications and near-edge deployment. This split takes place between the Hi-PHY (Physical Layer) and Low-PHY. In this split, only the Low-PHY and RF functions are in the access point.

Small cell bandwidth capacity requirements are greatly reduced for Option 2 Midhaul. Option 7.2 Cat A Fronthaul might require a 10 Gbps fiber link while Option 2 Midhaul can be carried over cable using DOCSIS 3.1 technology.

In the paper *Overlaying Mid-Band Spectrum Backhaul/Fronthaul onto HFC – A Symbiotic Convergence of Cable & Wireless* from SCTE Cable-Tec Expo 2021, I present some detailed case studies on mapping 5G Mid-band small cells to HFC. For N+3 plant and a wide range of homes-passed densities (i.e., 37 to 274 HP/mile), a single CBRS small cell that is co-located with the fiber node is sufficient to cover most of the homes. These small cells could leverage either midhaul or fronthaul. For those nodes that need additional coverage, only 1 or 2 small cells per DOCSIS networks using Option 2 mid-haul are needed.

Operators with larger HFC cascades (e.g., N+5, N+6) are expected to need additional small cells to achieve their coverage. Another case study from the article *Overlaying*

Mid-Band Spectrum Backhaul/Fronthaul onto HFC looks at a much larger North American metro suburban area (2). It considers a 3.5 square mile area that covered 9 nodes that were mostly N+6. Overall density was about 100 homes passed (HP) per mile while individual nodes varied from 75 to 165 HP/mile.

Figure 2 displays 9 CBRS small cells located next to or near the fiber nodes. These small cells provide access to power and fiber backhaul, allowing an Option 7.2x fronthaul interface. Figure 2 shows less than half of the area has coverage, even with the extended 350m streetlight range. If the operator's goal is just to off-load some mobile data onto its network, this coverage might be good enough.

Figure 3 shows area coverage as filled with coax strand-mount CBRS small cells. These small cells would use DOCSIS 3.1 for midhaul. That case would require 23 additional coax-based small cells to get reasonably complete coverage. Note that using street-light mounting increases the coverage area to 350-500m and

| MID-BAND SMALL CELL RANGES | EIRP | MOUNTING LOCATION | REASONABLE RANGE (MORE URBAN) | STRETCH RANGE (MORE RURAL) |
|----------------------------|-------|-------------------|-------------------------------|----------------------------|
| C-Band | 52-58 | Streetlight | 600m (~2000') | 900m (~3000') |
| | | Strand | 425m (~1400') | 640m (~2100') |
| CBRS | 47-53 | Streetlight | 340m (~1150') | 500m (~1650') |
| | | Strand | 240m (~800') | 360m (~1200') |
| 6GHz Wi-Fi 6E | 36 | Streetlight | 70m (~240') | 100m (~325') |
| | | Strand | 50m (~175') | 70m (~240') |

Figure 1. Small Cell & Strand-Mount Coverage Range Estimates



Figure 2. N+6 Suburban area with Small cells at Fiber Node.



Figure 3. N+6 Suburban area with Small cells at Fiber Node + HFC coax.

might eliminate a third of these coax-connected cells.

Our HFC design team did a N+0 upgrade design for the study area. (3) This upgrade pushes fiber much deeper. Total fiber mileage for N+0 upgrade increases from 8.55 miles to 24.8 miles. Note in the N+0 design that there are now 110 fiber nodes compared to a total of 32 small cells for this area.

In general, N+0 upgrades tend to be relatively expensive because of the amount of fiber being pulled. As shown, N+0 designs also push the fiber much deeper than is needed for CBRS small cell coverage. The study estimated that an N+2 upgrade might have fiber node placements that align nicely with CBRS small cell placements.

These case studies show that N+2/N+3 might be an optimal HFC design target for operators thinking of 5G mid-band convergence. As time progresses and bandwidth needs continue to rise, an operator might want to migrate from a DOCSIS-based backhaul to a fiber backhaul. So, the operator might consider how it will eventually pull fiber to these small cells on the HFC coax plant as part of their overall fiber deeper strategy.

Potential Mid-Band Opportunities

CBRS/C-Band small cell reach covers a significant number of mobile users with substantial data rates. But its deployments need many more cell sites than current LTE macro cells. This should present an opportunity for MSOs to leverage their existing HFC infrastructure for both backhaul and power.

For rural locations, MNOs have typically used low-band frequencies to maximize the distances between their macro tower base stations. This type of spacing may not be suitable for C-Band delivery from the tower to reach the entire community. As 5G bandwidth needs increase, MNOs may decide that deploying C-Band small cells is more economical than building more macro towers. Cable operators can provide the location (i.e., strand-mount) along with power and backhaul as a service to the MNO that owns the C-Band spectrum. Alternatively, cable operators might deploy their own 5G mobile network leveraging CBRS over their own infrastructure.

In rural areas, cable operators can use GAA to access the CBRS spectrum. If the MSO is acting as a virtual MNO (vMNO), it might choose to place a handful of CBRS small cells in the busiest locations as an offload strategy; or the MSO might build out the CBRS small cells across its HFC plant for more complete coverage. Note that 100 MHz of spectrum can enable impressive user equipment data rates of 2 Gbps down by 300 Mbps up.

In urban settings, 4G capacity needs have already forced the MNOs to locate macro towers much closer together. So, they will likely be in a much better position to offer C-Band from macro towers leveraging sophisticated antenna arrays and beam forming algorithms. The need for C-Band small cells is expected to be much smaller, but it may still be needed in hot spots to help reduce congestion. Therefore, the CBRS small cell will be seen as key for MSOs in urban settings. But there will potentially be many others competing to get CBRS spectrum in these settings.

Conclusion

HFC is well-suited to support a mid-band transport infrastructure as I have described. DOCSIS 3.1 mid-haul can be leveraged extensively early on in the transition to 5G to get wide coverage quickly. Dense urban areas may eventually require complex 5G antenna/MIMO systems with fiber fronthaul, which integrates nicely with an N+2 fiber deep strategy. But even with MIMO systems deployed, additional cells with DOCSIS xHaul will be needed to

fill the coverage holes. In the future, DOCSIS 4.0 is estimated to enable even higher capacities at these cable cell sites.

So, even though they may seem like separate technologies, cable and Mid-band wireless (C-Band and CBRS) are much stronger when used together. ■

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Drowning In Data?

You Need A GIS Life Preserver

By Chris Konechne

When decisions need to be made, the importance of having quality data cannot be understated. However, quality data alone may not be enough. In an environment where the abundance of data becomes overwhelming, there needs to be a way to obtain the information that can intelligently inform your decisions.

Using quality and readily available data in conjunction with Geographic Information System (GIS) analytics can help uncover new opportunities and assist in planning and building out infrastructure with greater efficiency. This provides visibility into the population in a given service area, what is needed, and what it takes to get it to them.

By creating custom-tailored, purpose-built maps to develop reliable and accurate assessments, GIS analytics presents the

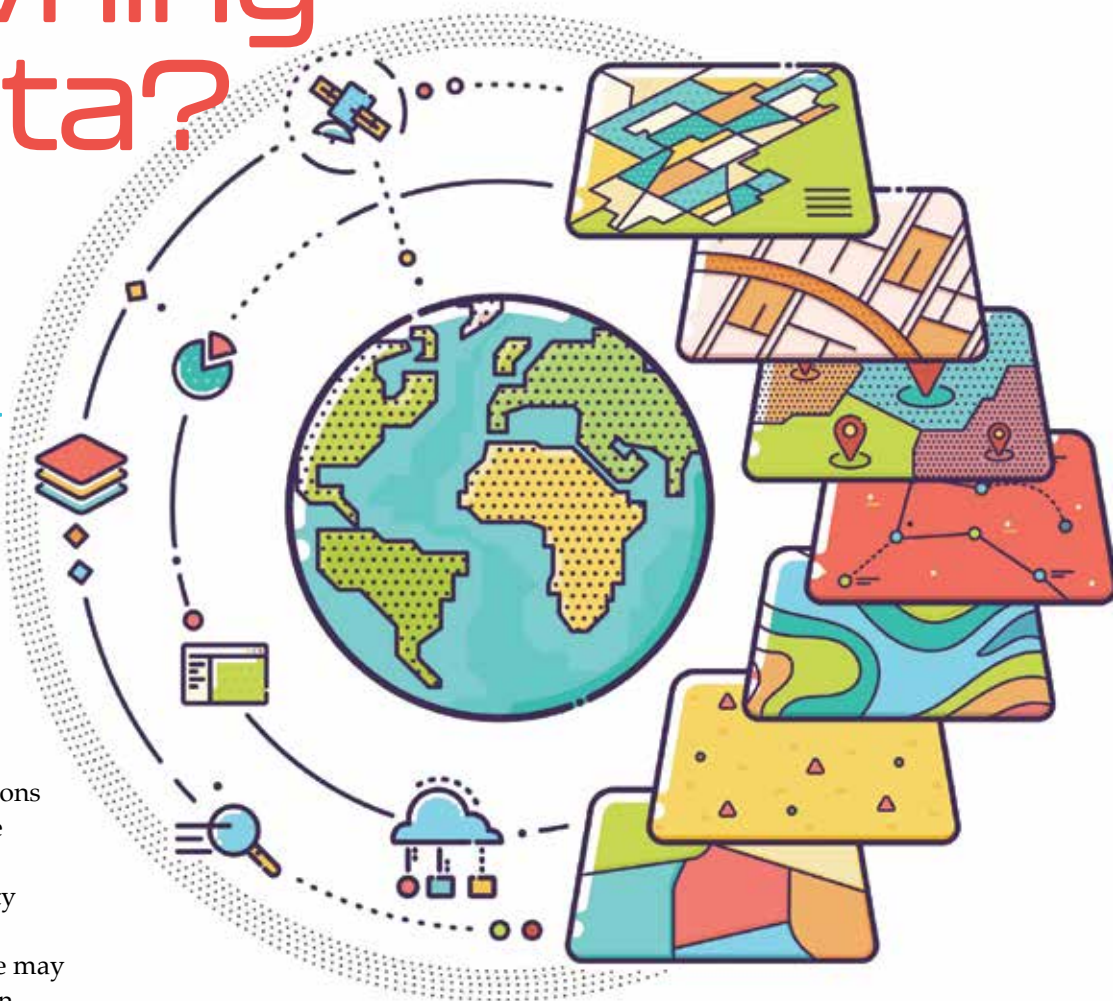
relevant, fact-based information you need in an easily digestible format, allowing you to discard the frequently unreliable cookie-cutter estimates that get in the way of good decision-making.

This article reviews the availability of data, its sources, and the benefits that can be derived by converting it into detailed geographic representations that enable forward-looking companies to visualize, discover, and accurately evaluate, new opportunities. Then, convert those opportunities into working projects that deliver revenue.

Illustration of how multiple types of information can be layered using GIS.

Data Overload = Swimming With Sharks

Understanding the geographic areas to which you have access is essential for locating new opportunities and developing effective strategies for imminent builds as well as for future projects. Drilling down into the granular details required to advance a project with confidence frequently requires collecting and managing large



amounts of data. Historically, this has involved the time-consuming and cost-intensive tasks of gathering physical data, and working out the details with a pen and pencil or a complex spreadsheet.

Today, much of this data is available digitally, often for free or at a very low cost from public sources, such as city, state, county, and federal, offices. Grant studies and 911 databases at the state or county level can also supply enormous amounts of information.

A vast amount of usable data is available but it never gets effectively utilized.

Over the last 5 years, the increase in available data has been phenomenal. The primary challenges arise in locating and accessing the data that's needed -- and the managing and parsing of the data without being

overwhelmed by it. Learning to key in on the right information and to scale it to a size that's both manageable and useful is essential, and has been a stumbling block for many.

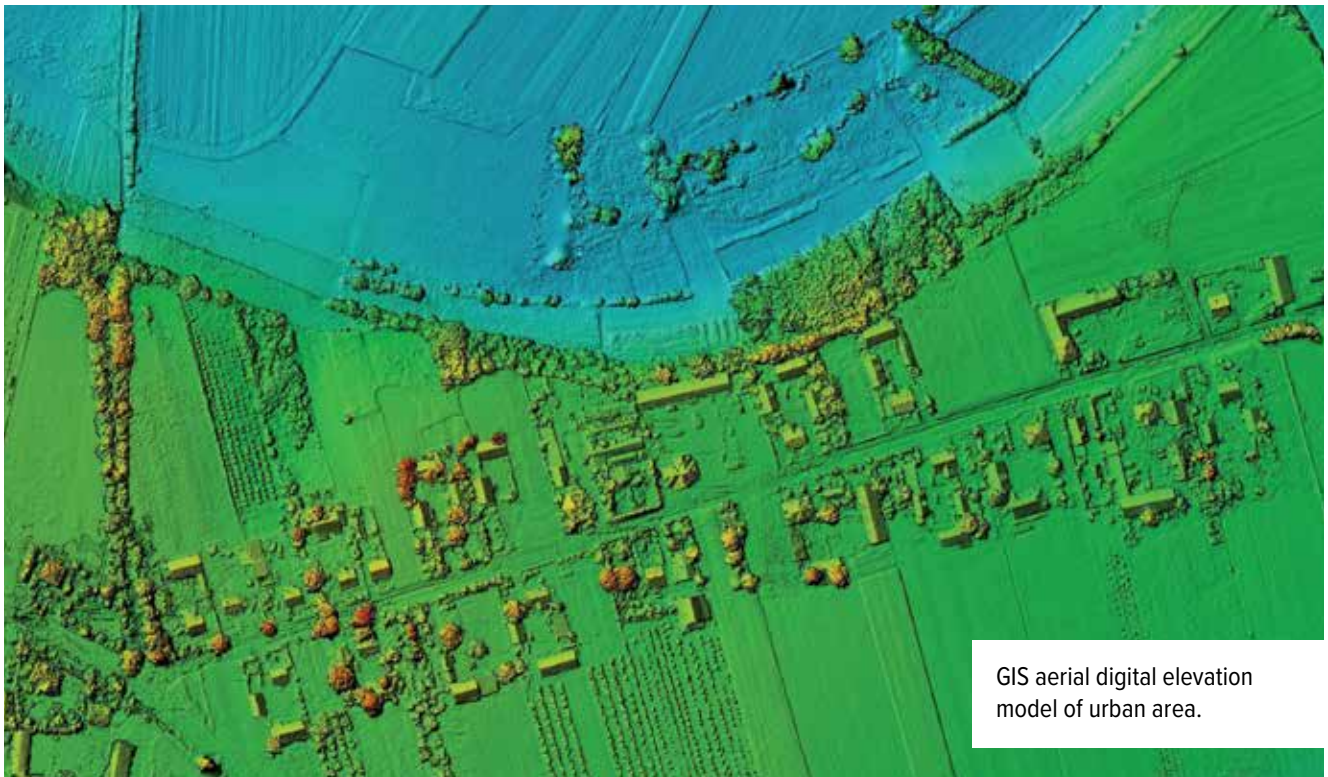
Keep The Horizon In View

GIS is a system that connects geospatial data to a map, integrating location data with descriptive information. In short, it can take enormous amounts of data to create clear and understandable custom maps that allow for the visualization of opportunities that exist and choices that are available in a selected region.

And the visual component is crucial, as it reveals patterns, relationships, and geographic context, clearly; it turns georeferenced data sets into visualized

databases that allow you to focus instantly on what can and cannot be done. This information can be presented in a way that is understandable and digestible, even to board members who may not be well-versed in the significance of what the detailed data represents.

For example, GIS can be used to create easy-to-read custom color-coded maps that plainly indicate county lines overlaid by grids that illustrate areas already served by existing fiber. For instance, superimposed over that map, areas that were won in competing RDOF auctions can be shown, along with road maps that help assess route miles that need to be built, with address points that exist within the area. Additional information can be included, such as territory marked for endangered species and wetlands, that may affect



GIS aerial digital elevation model of urban area.

planning decisions. The details and data are granular, but they can be composed quickly, layer by layer, into a robust visual map that reveals, at a quick glance, information that could take days or weeks to tease out from the raw data alone.

With today's mapping resources and analytics, a shovel-ready budget can be prepared in a fraction of the time it used to take. GIS allows a company to proactively study a specific area at a fairly low cost, and to have that information with a budget already worked out and in their pocket before a program is even announced. It can turn what might have been an unworkable task of gathering enough information to make a meaningful submission to a grant authority into a cost-effective study for a particular area that is ready in advance when the opportunity arises.

A few hours of preparation and analysis of data from readily available sources can yield enough information to make a solid cost estimate, in many cases. In fact, creating area maps by simply using the tools that are currently available can represent substantial time savings over attempting to manage the data manually. Clearly, this can result in substantial savings in terms of traditional investigation costs.

No S.O.S. Calls

For counties and municipalities looking to foster broadband programs, GIS mapping can be performed when assessing feasibility, taking guesswork out of financial estimates and

helping to assign a hard number to projected costs. With these numbers in place, it becomes possible to work backwards to determine how much assistance is needed to build out a project, while providing enough detail to encourage telcos and electric co-ops to engage.

Models can be created for areas that are not currently shovel-ready, and assign reliable cost values to them. This is important so when an opportunity for funding becomes available, GIS research can be submitted to the applicable grant agency, and these models can be considered sufficient to qualify as shovel-ready.

It's now possible to determine a number of critical factors that could affect the cost of construction without ever needing to put feet on the ground, while being far more accurate than competing methods would allow. Uncertainties that can delay a project or lead to cost overruns are reduced by having key information earlier in the development process, such as how much aerial vs. buried fiber is required, how many poles need to be touched, or how many poles are at risk.

And the value of this work is not lost once funding has been received or the construction phase has been entered. For instance, preliminary orders for fiber can be based on the data that's been collected and the maps that have been created. As projects and developments grow and change over time, the maps are easily updated to assist in future project development.

Life Preserver For The Future

Finally, the data collected and managed through GIS analytics becomes a living document. If a project has been put on hold for an extended period of time, nothing is lost; the information and maps can be updated quickly -- usually in a matter of minutes, rather than days, as new data is simply integrated into the existing structure.

Timelines on many projects are incredibly short, and the need to move fast is essential. Intelligent GIS mapping offers the ability to identify and act on opportunities quickly. Additional benefits that arise from bringing GIS mapping into the picture affect planning, budgeting, efficiency, and reporting, and can also lead to improved management and decision-making.

The efficiency and reliability of this low-cost option, especially when compared to gathering data and parsing it manually, helps with making educated choices that are critical for broadband and telecommunications solutions. ■



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See You in Denver

A photograph of the Denver skyline at night, with several skyscrapers illuminated in warm orange and yellow lights against a dark blue sky. The city lights are reflected in the foreground, which appears to be a dark, silhouetted area.

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Ready For The 5G Economy?

It's Here.

By Mike Murphy

5G is no longer about potential and promise, but reality. Deployments in the US have moved beyond a few isolated cities to the beginnings of a true coast-to-coast network, bringing blazing-fast speed, low latency, secure, and reliable, connectivity to businesses across the country.

This network, which is fully underway but still needs acceleration, will be the backbone for a new digital economy that will transform industry, disrupting sectors like manufacturing, oil and gas, mining, and more that have

been slower than other industries to embrace digitization.

The network connectivity and unique capabilities 5G brings will power a number of different breakthrough technologies, including private networks, artificial intelligence/machine learning, mixed reality, and advanced robotics. 5G is more than the next generation of connectivity, it's a true computing and digital services platform -- a building block for next-gen use cases, and an economic growth engine that is driving the 4th Industrial Revolution.

Overall, America's wireless service providers are investing an estimated \$275 billion into

building 5G networks, according to the CTIA. It speaks to the speed and the urgency of the demand for these networks and the transformational services they will provide.

Economic Potential

Why this is all so exciting and urgent is the economic potential 5G brings. According to the CTIA, 5G has the potential to transform industries, leading to \$500 billion in US economic growth, driving \$275 billion in new investments and creating 3 million new jobs -- essentially creating a 5G economy.

We know this potential is real

because of the ecosystem that grew from 4G/LTE mobile broadband. 4G brought reliable video and location services to people's phones, and laid the foundation for an app economy that created \$250 billion in GDP growth and 20 million new jobs while introducing the world to companies like Uber and Airbnb™.

The 5G economy won't center around apps, but rather the benefits the high speed, low latency, and superior security, that 5G brings to enterprises. 5G is more than a faster, incremental improvement over 4G. It will enable revolutionary new processes, and make tasks that seemed impossible only a few short years ago possible.

The 5G economy has the potential to boost every industry.

- For example, in healthcare, 5G-enabled technologies like remote patient monitoring, or even surveys conducted with robots, could generate \$305 billion in healthcare cost savings every year, according to the CTIA.
- In the transportation sector, 5G could save \$450B annually in costs through innovations like self-driving cars, emissions reductions, and, even more exciting -- it could even save 22,000 lives every year by reducing accidents.

Digitization Transforms Business

No longer a promise, the era of the 5G powered business is here. Digitization, powered by 5G, helps industries become more

agile, efficient, and data driven. 5G expansion allows businesses of all types to reap the benefits of enhanced mobility, flexibility, reliability, and security.

There's also an impact on the bottom line. According to a study by Arthur D. Little in partnership with Ericsson, by 2030, the expected industry digitalization revenues for Information Communication Technology players worldwide across all industries are expected to be around \$3.8 trillion. That means there's a tremendous appetite and desire for digitization.

Another study found that nearly 75% of IT decision-makers in enterprises believe digitalization is crucial to the future of their business, and more than 60% have clear plans in place.

Digitization efforts for industry will include things like:

- Real-time sensor networks, allowing businesses to monitor and adjust operations in real time and increase efficiency.
- 5G-powered *digital twinning* will enable companies to predict when components and processes will wear out or require maintenance.
- And enhanced automation, driven by AI optimized with edge computing and the speed and low latency of 5G, could bring revolutionary impacts to a whole host of industries.

One industry that clearly stands to benefit from 5G-powered digitization efforts is manufacturing. According to the National Association of Manufacturers (NAM), 91% of manufacturers believe 5G will be critical to the future of their businesses.

Research by McKinsey and Company notes several capabilities 5G will bring to the sector, including moving the automation of complicated machinery to the cloud, and augmented reality to make maintenance tasks more streamlined and effective.

Additionally, the massive amount of data 5G will make possible, by powering real-time sensor networks and dozens (if not thousands) of connected devices through the IoT, will greatly boost efficiency by doing things like speeding up the decision-making process, allowing quick detection of security threats, and more.

Ericsson's first smart factory on US soil opened its doors in 2020. Located in Lewisville, Texas, the factory is both a critical part of the 5G supply chain, assembling radios close to where communications service providers are rolling out 5G networks, and a living example of how 5G powered factories are kicking off a 4th Industrial Revolution.

At the factory, 5G-enabled automated guided vehicles are increasing efficiency, reducing manual material handling by 65%, and giving factory workers time to focus on other tasks. Another technology possible only with 5G -- digital twinning -- has led to a 50% reduction in unplanned downtime; 25% improvement in throughput (in terms of production capacity); and a 30% reduction in errors and waste. (A digital twin is a virtual representation of an object or process that is updated with real-time data and uses AI/Machine Learning to help make decisions, like when a part needs to be replaced or a



process tweaked to make it more efficient.)

Manufacturers are excited about the possibilities 5G brings to their industry. In the NAM study cited earlier, 9 in 10 manufacturers said they expect 5G to lead to the creation of new processes (88%) and new businesses (86%) -- meaning it will lead to new technology we haven't even imagined yet.

The Private Network Potential

One thing that ties all of these use cases together is the power of private 5G networks to give all manner of industries a digital edge.

Private networks can be physical or virtual, and are communications networks separate from the public Internet. When powered by 5G, they can inject a new level of agile intelli-

gence into any facility, taking the wealth of information captured from real-time sensor networks. These networks help managers keep tight control of network resource allocation, and also ensure that critical data remains on-site, a major factor for security. And that threat is real -- 22% of smart factories experienced a cyberattack in 2019.

5G private networks have the potential to transform every industry, but in particular mining, ports, warehouses, airports, and energy facilities, will benefit. In mining, for example, private 5G networks could automate more processes like haulers and drill rigs, plus the ability to monitor and automate heavy fixed assets.

Safety is another major benefit. Connected mining can potentially save up to 1,000 lives and prevent 44,000 injuries over the

next decade, as cellular-enabled connected equipment generates large amounts of data, and enables operators to spot potentially dangerous situations before anyone gets hurt.

The 5G Economy Will Boom

The 5G-enabled economy has the potential to revolutionize any number of industries, create jobs, and bring an economic boom to the US. But it has to be nurtured -- the deployment of 5G networks across the country needs to remain on pace. There is also a strong need for skilled workers to build, deploy, and maintain, these networks.

It is urgent because the potential is so great. The groundwork that's being laid for this 5G platform will pay off in transformed industries and a booming economy. ■

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The logo for the International Society for Environmental & Estuarine Science (ISE). It features the letters 'I', 'S', and 'E' in a bold, blue, sans-serif font. The letters are stylized with a pixelated or mosaic-like texture, composed of various shades of blue squares. The 'I' and 'E' have horizontal lines at their top and bottom, respectively, suggesting a stylized 'H' or 'E' structure.

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Team Fenex, a Division of
Synergy Power Group, LLC

U-TECK

**MATERIAL HANDLING
EQUIPMENT**

Budco, Inc.

MDU SOLUTIONS

3-GIS
Comtest Networks
ESPi
Lindsay Broadband
MaxCell
Positron Access Solutions Corp.
Tii Technologies, Inc.
Wavenet, Inc.

MDU STRATEGIES/TACTICS

3-GIS
CommScope
Comtest Networks
Dycom Industries, Inc.
ESPi
Esri
Go!Foton
Lindsay Broadband
Pearce Services, LLC
Positron Access Solutions Corp.

**MOBILE BACKHAUL
EQUIPMENT**

CommScope
Go!Foton
Lindsay Broadband
Pearce Services, LLC

**MOBILE BACKHAUL
ROUTERS**

Pearce Services, LLC

**MOBILE BACKHAUL
SOLUTIONS**

CommScope
Go!Foton
IQGeo
Lindsay Broadband
Pearce Services, LLC

MONOPOLES

Pearce Services, LLC
Supply Solutions

**MOUNTS/MOUNTING
EQUIPMENT**

A-Aerial Service Company, Inc.
CommScope
ESPi
GMP Tools
MacLean Network Solutions
Pearce Services, LLC

Supply Solutions
U-TECK

MOUNTS/MOUNTING EQUIPMENT: TOWER

A-Aerial Service Company, Inc.
CommScope
GMP Tools
Pearce Services, LLC
Supply Solutions

MULTIDUCT SYSTEMS

Dura-Line

NETDEV OPS/IT INTEGRATION

3-GIS
Fujitsu Network Communications, Inc.

PADS

Lindsay Broadband
Positron, Inc.
Supply Solutions

PAIR IDENTIFIERS

Supply Solutions

PLATFORMS

GMP Tools
U-TECK

PLUGS

A-Aerial Service Company, Inc.

POLE INSPECTION SERVICES

Fujitsu Network Communications, Inc.
Maverick Corporation
Pearce Services, LLC
Spectrum Planning, Inc.

POLE LINE HARDWARE

A-Aerial Service Company, Inc.
GMP Tools
MacLean Network Solutions
Millennium
Power & Tel
Supply Solutions
Tech Products, Inc.
U-TECK

POLE MANAGEMENT SOFTWARE

Esri
IQGeo
Maverick Corporation
Pearce Services, LLC
Trimble

POLE RESTORATION

FS3, Inc.
Maverick Corporation

POLE TAGS/MARKERS

A-Aerial Service Company, Inc.
Budco, Inc.
Millennium
Pearce Services, LLC
Power & Tel
Pro-Mark Utility Supply, Inc.
Supply Solutions
U-TECK

POLES/POSTS/ACCESSORIES

GMP Tools
Power & Tel
Supply Solutions
U-TECK

POWER/BACKUP POWER

EnerSys
ESPi
Lindsay Broadband
MPINarada
Power & Tel
Supply Solutions

PRIVATE NETWORKS

3-GIS
Go!Foton
Lindsay Broadband

PRODUCT RESEARCH AND TESTING

Go!Foton
Positron, Inc.

PULLERS/PULLING EQUIPMENT

A-Aerial Service Company, Inc.
FS3, Inc.
GMP Tools
Jameson, LLC
Millennium
Supply Solutions
U-TECK

PULLING EYES

A-Aerial Service Company, Inc.
FS3, Inc.
GMP Tools
Power & Tel
Supply Solutions

PUMPS/ACCESSORIES

A-Aerial Service Company, Inc.
FS3, Inc.
GMP Tools
Team Fenex, a Division of Synergy
PowerGroup, LLC

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PUSHERS/PULLERS/DRIVERS

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Jameson, LLC
Plumettaz America Corp.
Supply Solutions

RACKS/REELS

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GMP Tools
Go!Foton
Power & Tel
Supply Solutions
U-TECK

RECORDS MAINTENANCE AND MANAGEMENT

3-GIS
Maverick Corporation

REPAIR AND RESTORATION SERVICES

Celerity Integrated Services, Inc.
GMP Tools

RODDING EQUIPMENT: CABLE/CONDUIT

FS3, Inc.
GMP Tools
Jameson, LLC
Plumettaz America Corp.
Supply Solutions

ROPE/TWINE

FS3, Inc.
GMP Tools
Plumettaz America Corp.
Supply Solutions

ROW (RIGHT-OF-WAY) SERVICES

CHR Solutions
Finley Engineering Company, Inc.
MOUNTAIN, LTD.

RURAL NETWORK SOLUTIONS

3-GIS
CHR Solutions
ESPi
Esri
Go!Foton
IQGeo
Lindsay Broadband
Maverick Corporation
Power & Tel
Tii Technologies, Inc.

RURAL NETWORKS

Fujitsu Network
Communications, Inc.

SHELVING/STORAGE RACKS

Power & Tel
Supply Solutions
Wavenet, Inc.

SHIELDS

GMP Tools
Supply Solutions

SLINGS

FS3, Inc.
Supply Solutions

SLITTERS

Budco, Inc.
FS3, Inc.
GMP Tools
Supply Solutions

SUPPLY CHAIN SOLUTIONS

ESPi
Power & Tel

SURGE SUPPRESSORS/EQUIPMENT

Power & Tel
Telecom Problem Solvers, LLC

SURVEYING

3-GIS
Maverick Corporation
Trimble

SWEEPS/SWEEPERS

Millennium

SWITCHES

Positron Access Solutions Corp.
Power & Tel

TAPE: MEASURING

A-Aerial Service Company, Inc.
FS3, Inc.
Power & Tel
Supply Solutions

TAPE: PULLING

A-Aerial Service Company, Inc.
FS3, Inc.
Millennium
Power & Tel
Supply Solutions
U-TECK

TENSION METERS

Supply Solutions

TERMINAL BLOCKS/ACCESSORIES

Comtest Networks
Supply Solutions
Tii Technologies, Inc.

TERMINALS: CABLE

A-Aerial Service Company, Inc.
CommScope
Comtest Networks
Go!Foton
Supply Solutions

TERMINALS: FIBER

A-Aerial Service Company, Inc.
Comtest Networks
Go!Foton
Supply Solutions
Tii Technologies, Inc.

TERMINALS: VIDEO

CommScope
Go!Foton
Supply Solutions

TERMINALS: WIRELESS

Go!Foton
Supply Solutions
Tii Technologies, Inc.

TERMINATING KITS/SUPPLIES

Go!Foton
Supply Solutions

TESTING LABORATORIES

Go!Foton

TESTING/INSPECTION/REPAIR SERVICES

Celerity Integrated Services, Inc.
CHR Solutions
Maverick Corporation

TOOLS/EQUIPMENT HOLDERS

GMP Tools
Jameson, LLC
Supply Solutions
U-TECK

TOOLS: LINEMAN'S

A-Aerial Service Company, Inc.
Budco, Inc.
FS3, Inc.

GMP Tools
Jameson, LLC
Millennium
Supply Solutions

TORCH EQUIPMENT/SUPPLIES

Supply Solutions

TOWER INSPECTION SERVICES

Fujitsu Network
Communications, Inc.
Maverick Corporation
Pearce Services, LLC
Positron, Inc.

TOWER INSTALLATION SERVICES

Maverick Corporation
Pearce Services, LLC

TOWERS

Pearce Services, LLC

TOWERS: EQUIPMENT

A-Aerial Service Company, Inc.
Supply Solutions

TOWERS: ERECTION/MAINTENANCE SERVICES

Maverick Corporation
Positron, Inc.

TOWERS: LIGHTING/BEACONS

Pearce Services, LLC

TOWERS: LOCATION/DB SERVICES

Esri
Maverick Corporation

TOWERS: MOBILE/CELL SITES

CommScope
Maverick Corporation
Pearce Services, LLC

TRANSMISSION EQUIPMENT

Positron, Inc.

TRANSMITTERS/RECEIVERS

FS3, Inc.
Go!Foton
Jameson, LLC
Lindsay Broadband
Power & Tel

TRENCHERS/ACCESSORIES

Supply Solutions
U-TECK

UNDERGROUND DAMAGE SYSTEMS/EQUIPMENT

GMP Tools
Pro-Line Safety Products

UNDERGROUND INSTALLATION STRATEGIES & EQUIPMENT

Go!Foton
Maverick Corporation
MaxCell

UNIFIED COMMUNICATIONS

Go!Foton

USER NETWORK INTERFACE TESTING

Pearce Services, LLC

VENTILATION/GAS DETECTION PRODUCTS

U-TECK

VIDEO INSPECTION CAMERA

Pearce Services, LLC
Vivax-Metrotech Corp.

WIRELESS

Fujitsu Network Communications, Inc.

WIRELESS & WIRELINE INTEGRATION SOLUTIONS

CHR Solutions
CommScope
Dycom Industries, Inc.
Esri
Lindsay Broadband
Maverick Corporation

ZONING/LEGAL/REGULATORY

Maverick Corporation
Pearce Services, LLC

Core/Legacy**ANCHORS**

American Power Systems, LLC
Border States Electric
Power & Tel
Powerline Hardware
Supply Solutions

BINDERS/POSTS

Border States Electric
Comtest Networks
Supply Solutions

BINS

Border States Electric
Supply Solutions

CABLE CUTTERS

Border States Electric
Budco, Inc.
FS3, Inc.
Jameson, LLC
Millennium
PPC Broadband
Supply Solutions

CABLE PLACING EQUIPMENT

Border States Electric
Budco, Inc.
CommScope
FS3, Inc.
GMP Tools
Jameson, LLC
Millennium
Powerline Hardware
Supply Solutions
U-TECK

CABLE PROTECTION EQUIPMENT

Border States Electric
Budco, Inc.
Petroflex North America
Positron, Inc.
PPC Broadband
Supply Solutions
Telecom Problem Solvers, LLC

CAPS

Border States Electric
FS3, Inc.
Power & Tel
Supply Solutions

COAXIAL CABLE

Border States Electric
CommScope
Michels Power, Inc.
Millennium
Petroflex North America
Power & Tel
PPC Broadband
Southwire Company, LLC
Superior Essex
Supply Solutions
Wavenet, Inc.

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Supply Solutions

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 PPC Broadband
 Superior Essex
 Supply Solutions
 Wavenet, Inc.

COPPER CLOSURES

Border States Electric
 Comtest Networks
 PPC Broadband
 Supply Solutions
 Tii Technologies, Inc.

COPPER COMPONENTS

Border States Electric
 Comtest Networks
 Power & Tel
 Supply Solutions

COPPER ETHERNET EQUIPMENT

Border States Electric
 Comtest Networks
 Positron Access Solutions Corp.
 PPC Broadband
 Supply Solutions
 Tii Technologies, Inc.
 VeEX, Inc.

COPPER SPLICING EQUIPMENT

Border States Electric
 Comtest Networks
 PPC Broadband
 Supply Solutions
 U-TECK

COPPER STRIPPERS

Border States Electric
 Jameson, LLC
 Supply Solutions

COPPER-TO-FIBER MIGRATION SOLUTIONS

Border States Electric
 Comtest Networks
 Michels Power, Inc.

COUPLERS

Border States Electric
 Dura-Line
 FS3, Inc.

Go!Foton
 Lindsay Broadband
 Millennium
 Power & Tel
 PPC Broadband
 Supply Solutions

CRIMPERS

Border States Electric
 FS3, Inc.
 PPC Broadband
 Supply Solutions

CROSS-CONNECT PRODUCTS

Border States Electric
 Comtest Networks
 Go!Foton
 Tii Technologies, Inc.
 Wavenet, Inc.

DATA NETWORK INTERFACE EQUIPMENT

Border States Electric
 Go!Foton
 Supply Solutions
 Tii Technologies, Inc.

DECOMMISSIONED EQUIPMENT/SERVICES

Fujitsu Network
 Communications, Inc.
 Supply Solutions

DLC SYSTEMS AND EQUIPMENT

Border States Electric
 CommScope
 Comtest Networks
 Supply Solutions

DSL EQUIPMENT

Border States Electric
 Comtest Networks
 Positron Access Solutions Corp.
 Supply Solutions
 Telecom Problem Solvers, LLC
 VeEX, Inc.

G.FAST EQUIPMENT

Comtest Networks
 Positron Access Solutions Corp.
 Supply Solutions
 Telecom Problem Solvers, LLC
 Tii Technologies, Inc.
 VeEX, Inc.

HEADEND EQUIPMENT

Border States Electric

CommScope
 Go!Foton
 Lindsay Broadband
 Power & Tel
 PPC Broadband
 Supply Solutions
 VeEX, Inc.

HFC CABLE

CommScope
 PPC Broadband
 Supply Solutions

HOT STICKS

Border States Electric
 Michels Power, Inc.
 Positron, Inc.
 Supply Solutions

HYBRID NETWORKING EQUIPMENT

Border States Electric
 CommScope
 Positron, Inc.
 Supply Solutions
 Tii Technologies, Inc.

INSIDE WIRING CABLE

Border States Electric
 CommScope
 Michels Power, Inc.
 Petroflex North America
 Power & Tel
 Southwire Company, LLC
 Supply Solutions
 Wavenet, Inc.

INTEGRATED ACCESS DEVICES

Border States Electric
 Supply Solutions

LOAD COILS/CASES

Border States Electric
 Supply Solutions

LOOP EXTENDERS

Border States Electric
 CommScope
 Supply Solutions

MISCELLANEOUS COPPER PRODUCTS

Border States Electric
 Comtest Networks
 Positron, Inc.
 Powerline Hardware
 Supply Solutions
 Tii Technologies, Inc.

MULTIMETERS

Border States Electric
 Supply Solutions

NETWORK INTERFACE DEVICES (NIDS)

Border States Electric
 Comtest Networks
 Go!Foton
 Positron, Inc.
 Supply Solutions
 Tii Technologies, Inc.

NETWORK MANAGEMENT SYSTEMS

Border States Electric
 VeEX, Inc.

PULL/SPLICE BOXES

Border States Electric
 FS3, Inc.
 Michels Power, Inc.
 Millennium
 Power & Tel
 PPC Broadband
 Supply Solutions

REPAIR KITS

Border States Electric
 FS3, Inc.
 Power & Tel
 Supply Solutions

SPLICE ENCAPSULANTS

Border States Electric
 Supply Solutions

SPLITTERS

Border States Electric
 Comtest Networks
 Go!Foton
 Lindsay Broadband
 Power & Tel
 PPC Broadband
 Supply Solutions
 Tii Technologies, Inc.

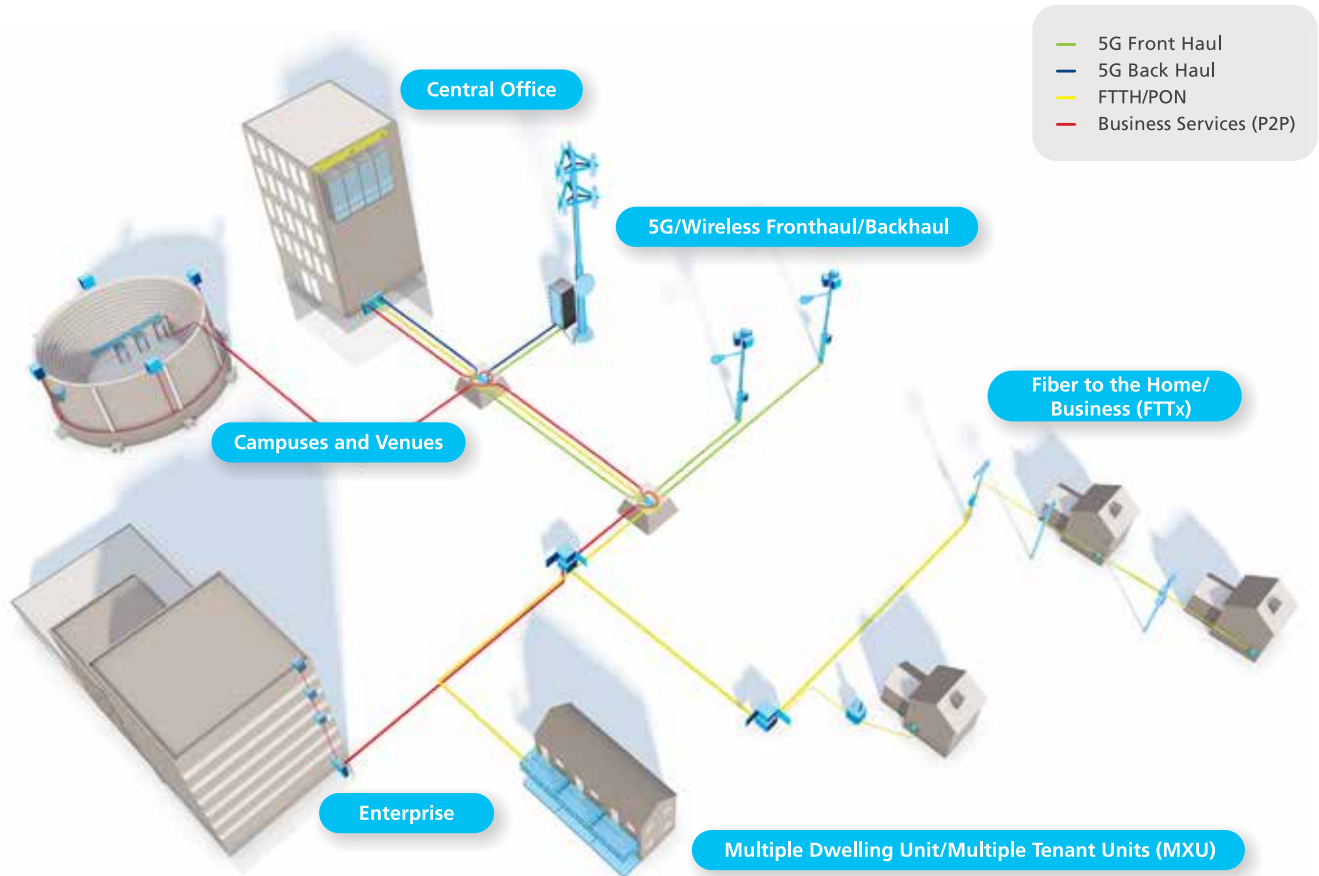
TDRS

Border States Electric
 Budco, Inc.
 Supply Solutions

TELECOMMUNICATIONS LINE PROTECTOR UNITS

Border States Electric
 Comtest Networks
 Petroflex North America
 Positron, Inc.
 Supply Solutions

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WL Plastics

TWISTED PAIR CABLE

Border States Electric
CommScope
Power & Tel
PPC Broadband
Southwire Company, LLC
Supply Solutions
Wavenet, Inc.

VOLT METERS

Border States Electric
Pearce Services, LLC
Supply Solutions

Education

CERTIFICATION

BICSI
Plumettaz America Corp.

EDUCATIONAL BOOKS/ MAGAZINES/ETC.

BICSI
Telecom Problem Solvers, LLC

EDUCATIONAL INSTITUTIONS

BICSI

ENGINEERS/TECHS

Telecom Problem Solvers, LLC

PROFESSIONAL ORGANIZATION

BICSI
CommScope
Trimble

TRAINING AND EDUCATIONAL SERVICES

BICSI
CommScope
FiberStory
Plumettaz America Corp.
Ross FiberOptic, LLC
Telecom Problem Solvers, LLC

FTTX

AIR BLOWN FIBER

Border States Electric
Dura-Line
Fiber Optics Network Cable
Solutions

Hexatronic
Michels Power, Inc.
Millennium
MP Nexlevel
Plumettaz America Corp.
Prysmian Group
Supply Solutions
Taihan Fiberoptics

BACKHAUL/FRONTHAUL/ OFFLOAD SOLUTIONS

Border States Electric
Dycom Industries, Inc.
Fujitsu Network
Communications, Inc.
Go!Foton
INNO Instrument America, Inc.
Jameson, LLC
KGPCo
Lindsay Broadband
Maverick Corporation
MaxCell
Michels Power, Inc.
Multilink, Inc.
Supply Solutions
Taihan Fiberoptics
Western Pacific
Telecommunications

BEND INSENSITIVE FIBER (BIF)

Border States Electric
Corning
Go!Foton
OFS
Power & Tel
Taihan Fiberoptics
Tii Technologies, Inc.

BOXES: PULL/SPLICE

Border States Electric
Charles Industries, LLC
FS3, Inc.
Michels Power, Inc.
Millennium
Multicom, Inc.
R&M USA, Inc.
Supply Solutions
Tii Technologies, Inc.
UCL Swift Americas
Western Pacific
Telecommunications

BPON EQUIPMENT

CommScope
Go!Foton
Supply Solutions
UCL Swift Americas

CABLE ASSEMBLIES/ PATCHCORDS

Border States Electric
Clearfield
Corning
Cyber Power Systems (USA), Inc.
Fiber Optics Network Cable
Solutions
Fiber Plus International
Fiberdyne Labs, Inc.
FIBERONE
Go!Foton
Multicom, Inc.
Multilink, Inc.
Power & Tel
PPC Broadband
R&M USA, Inc.
Supply Solutions
Taihan Fiberoptics
Tii Technologies, Inc.

CLEANING SUPPLIES/ EQUIPMENT

Border States Electric
Go!Foton
Millennium
Power & Tel
Supply Solutions
UCL Swift Americas

CLEAVERS

Border States Electric
INNO Instrument America, Inc.
Millennium
Multicom, Inc.
Supply Solutions
UCL Swift Americas

COMPONENTS/SYSTEMS

3-GIS
Border States Electric
Cyber Power Systems (USA), Inc.
FIBERONE
Finley Engineering Company, Inc.
Go!Foton
Hexatronic
Netcon
R&M USA, Inc.
SaskTel International
Supply Solutions
UCL Swift Americas

COMPONENTS: FIBER

Border States Electric
Clearfield
Fiber Plus International
Finley Engineering Company, Inc.
Go!Foton
Hexatronic

INNO Instrument America, Inc.
KGPCo
Michels Power, Inc.
Millennium
Multicom, Inc.
Power & Tel
Prysmian Group
R&M USA, Inc.
Supply Solutions
Taihan Fiberoptics
UCL Swift Americas

CONNECTORS

Blue Diamond Industries, LLC
Border States Electric
CommScope
Corning
Dura-Line
FIBERONE
Go!Foton
INNO Instrument America, Inc.
Michels Power, Inc.
Millennium
Multicom, Inc.
Power & Tel
PPC Broadband
Prysmian Group
R&M USA, Inc.
Supply Solutions
UCL Swift Americas
Walker and Associates

CONNECTORS/FIELD INSTALLABLE

Border States Electric
Clearfield
Go!Foton
INNO Instrument America, Inc.
Michels Power, Inc.
Multicom, Inc.
Multilink, Inc.
Power & Tel
R&M USA, Inc.
Supply Solutions
Taihan Fiberoptics
Tii Technologies, Inc.
UCL Swift Americas

CPE (CUSTOMER PREMISES EQUIPMENT)

American Power Systems, LLC
Border States Electric
CommScope
Go!Foton
Lindsay Broadband
Multicom, Inc.
Positron Access Solutions Corp.
Power & Tel
R&M USA, Inc.



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Let's face it, network consolidation is hard. But it's necessary—now more than ever.

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<https://www.fujitsu.com/us/products/network/services-support/network-modernization/>



Supply Solutions
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UCL Swift Americas
Zyxel Communications

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Border States Electric
Go!Foton
Multilink, Inc.
Power & Tel
R&M USA, Inc.
Supply Solutions
Tii Technologies, Inc.
Wavenet, Inc.

DARK FIBER PROVIDERS

CommScope
Supply Solutions

DISPERSION ANALYZERS

Border States Electric
Supply Solutions

DROP CABLE

Border States Electric
Clearfield
Corning
Fiber Optics Network Cable
Solutions
Go!Foton
Michels Power, Inc.
Millennium
Multicom, Inc.
Power & Tel
PPC Broadband
Superior Essex
Supply Solutions
Taihan Fiberoptics
Tii Technologies, Inc.
UCL Swift Americas
Walker and Associates

DWDM/CWDM/WDW TECHNOLOGIES

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Fiberdyne Labs, Inc.
FIBERONE
Fujitsu Network
Communications, Inc.
Go!Foton
Lindsay Broadband
Multicom, Inc.
PPC Broadband
R&M USA, Inc.
Supply Solutions
UCL Swift Americas
VeEX, Inc.
Walker and Associates

ENCAPSULATION/ SEALER KITS

Border States Electric
Supply Solutions

ETHERNET EQUIPMENT

Border States Electric
Positron Access Solutions Corp.
Power & Tel
VeEX, Inc.
Zyxel Communications

FDH

Border States Electric
Corning
FIBERONE
Go!Foton
Multilink, Inc.
Power & Tel
R&M USA, Inc.
Supply Solutions
Tii Technologies, Inc.

FIBER IDENTIFIERS

Border States Electric
Budco, Inc.
Go!Foton
Power & Tel
PPC Broadband
Supply Solutions
VeEX, Inc.

FIBER OPTIC CABLE

Border States Electric
Clearfield
CommScope
Corning
Fiber Optics Network
Cable Solutions
Finley Engineering Company, Inc.
Go!Foton
Hexatronic
KGPCo
Michels Power, Inc.
Millennium
Multicom, Inc.
OFS
Power & Tel
PPC Broadband
Prysmian Group
Rosenberger Site Solutions, LLC
Supply Solutions
Taihan Fiberoptics
Tii Technologies, Inc.
Wavenet, Inc.

FIBER OPTIC CLEANERS/ CLEANING TOOLS

Border States Electric
Budco, Inc.
FIBERONE
FS3, Inc.
Go!Foton
INNO Instrument America, Inc.
Millennium
Power & Tel
PPC Broadband
Ripley Tools, LLC
Supply Solutions
UCL Swift Americas

FIBER OPTIC CONNECTORS

Border States Electric
FIBERONE
Go!Foton
INNO Instrument America, Inc.
Millennium
Multicom, Inc.
Multilink, Inc.
Power & Tel
PPC Broadband
R&M USA, Inc.
Supply Solutions
UCL Swift Americas

FIBER OPTIC METERS

Border States Electric
Budco, Inc.
FS3, Inc.
Millennium
Multicom, Inc.
Power & Tel
PPC Broadband
Supply Solutions
VeEX, Inc.

FIBER OPTIC TESTING EQUIPMENT

Border States Electric
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Fiber Plus International
FS3, Inc.
INNO Instrument America, Inc.
Millennium
Multicom, Inc.
Power & Tel
PPC Broadband
Ripley Tools, LLC
Supply Solutions
UCL Swift Americas
VeEX, Inc.

FIBER OPTIC WIPES/ SWABS/SOLUTIONS

Border States Electric
FS3, Inc.
Power & Tel
Ripley Tools, LLC
Supply Solutions

FIBER POSITIONERS/ ALIGNERS

Border States Electric
Supply Solutions

FIBER TERMINALS EXPANDED

Border States Electric
Charles Industries, LLC
Clearfield
PPC Broadband
Supply Solutions
Western Pacific
Telecommunications

FTTH EQUIPMENT

Border States Electric
Charles Industries, LLC
Clearfield
CommScope
Cyber Power Systems (USA), Inc.
ESPi
FIBERONE
Finley Engineering Company, Inc.
Go!Foton
Hexatronic
INNO Instrument America, Inc.
Jameson, LLC
Lindsay Broadband
Multicom, Inc.
Plumettaz America Corp.
Power & Tel
PPC Broadband
R&M USA, Inc.
Supply Solutions
Tii Technologies, Inc.
UCL Swift Americas
VeEX, Inc.
Walker and Associates
WL Plastics
Zyxel Communications

FTTP EQUIPMENT

Border States Electric
Clearfield
CommScope
Comtest Networks
FIBERONE
Finley Engineering Company, Inc.
Go!Foton
Hexatronic

INNO Instrument America, Inc.
Jameson, LLC
Lindsay Broadband
Multicom, Inc.
Plumettaz America Corp.
Power & Tel
PPC Broadband
R&M USA, Inc.
Supply Solutions
Tii Technologies, Inc.
UCL Swift Americas
VeEX, Inc.
WL Plastics
Zyxel Communications

FTTX EQUIPMENT

Border States Electric
Charles Industries, LLC
CommScope
Cyber Power Systems (USA), Inc.
FIBERONE
Finley Engineering Company, Inc.
Go!Foton
Graybar
Hexatronic
INNO Instrument America, Inc.
Jameson, LLC
KGPCo
Lindsay Broadband
Multicom, Inc.
Multilink, Inc.
Oldcastle Infrastructure
Pearce Services, LLC
Plumettaz America Corp.
Positron Access Solutions Corp.
Power & Tel
PPC Broadband
R&M USA, Inc.
Supply Solutions
Tii Technologies, Inc.
UCL Swift Americas
U-TECK
VeEX, Inc.
Walker and Associates
WL Plastics
Zyxel Communications

FUSION SPLICERS

Border States Electric
Budco, Inc.
FS3, Inc.
INNO Instrument America, Inc.
Millennium
Multicom, Inc.
OFS
Power & Tel
Supply Solutions
UCL Swift Americas

GATEWAYS/CONNECTED HOME EQUIPMENT

Border States Electric
Lindsay Broadband
Positron Access Solutions Corp.
Power & Tel
Supply Solutions
Zyxel Communications

GIGABIT PON EQUIPMENT

Border States Electric
CommScope
Comtest Networks
Fiberdyne Labs, Inc.
Go!Foton
Multicom, Inc.
Positron Access Solutions Corp.
Power & Tel
R&M USA, Inc.
Supply Solutions
Tii Technologies, Inc.
VeEX, Inc.
Zyxel Communications

GPON EQUIPMENT

Border States Electric
CommScope
Comtest Networks
Fiberdyne Labs, Inc.
FIBERONE
Go!Foton
Millennium
Multicom, Inc.
Pearce Services, LLC
Power & Tel
Supply Solutions
Tii Technologies, Inc.
UCL Swift Americas
VeEX, Inc.
Walker and Associates
Western Pacific Telecommunications
Zyxel Communications

HDTV EQUIPMENT

Border States Electric
Multicom, Inc.

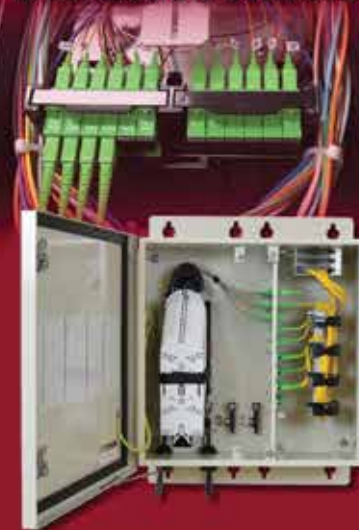
HYBRID ARCHITECTURES

Border States Electric
Go!Foton
Lindsay Broadband
Multicom, Inc.
PPC Broadband
Supply Solutions
Western Pacific Telecommunications

HYBRID FIBER COAX

Border States Electric
CommScope

Fast, Flexible FTTX Distribution Solutions



CFIT Fiber Hubs

Rugged outdoor fiber distribution hubs provide up to 96 fiber ports (three 1x32 splitters) for passive optical networks at MDU locations



Fiber Transition Terminals (CFTT)

Ideal for low density fiber circuits, CFTT serve as a customer demarcation point and slack storage enclosure for fiber at the customer premises



BDO Fiber Distribution Pedestals

Non-metallic fiber splice pedestals for both greenfield and brownfield FTTP, with a variety of sizes supporting 48 to 576 fibers and fiber-only or copper/fiber splice points

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UCL Swift Americas

IDENTIFICATION SYSTEMS

3-GIS
Border States Electric
Go!Foton
Netcon
Supply Solutions
Tech Products, Inc.

INSPECTION EQUIPMENT

Border States Electric
Supply Solutions
Trimble
UCL Swift Americas

INSTALLATION/ DEPLOYMENT

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Hexatronic
Maverick Corporation
Millennium
U-TECK
WL Plastics

LOOSE TUBE CABLE

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Corning
Fiber Optics Network Cable
Solutions
Go!Foton
Millennium
Multicom, Inc.
OFS
Power & Tel
Prysmian Group
Supply Solutions
Taihan Fiberoptics

MAINTENANCE SOLUTIONS

IQGeo
Michels Power, Inc.

MARKING SYSTEMS

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FS3, Inc.
Go!Foton
Millennium
Power & Tel
Supply Solutions

Tech Products, Inc.
U-TECK

MDU INTERIOR MOULDING/PATHWAYS

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Dura-Line
OFS
PPC Broadband
Supply Solutions
Tii Technologies, Inc.

MICRO TRENCHING EQUIPMENT/SERVICES

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Supply Solutions
U-TECK

MICRODUCT

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Clearfield
Dura-Line
FS3, Inc.
Hexatronic
MaxCell
Michels Power, Inc.
Millennium
Power & Tel
PPC Broadband
Prysmian Group
Supply Solutions
WL Plastics

MIDDLEWARE

Power & Tel
Supply Solutions

MISCELLANEOUS EQUIPMENT

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Power & Tel
Supply Solutions
UCL Swift Americas
U-TECK

MODULATORS

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Power & Tel
Supply Solutions

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Go!Foton
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Positron Access Solutions Corp.
Power & Tel
PPC Broadband
Supply Solutions
VeEX, Inc.

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Communications, Inc.
Go!Foton
Hexatronic
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Pearce Services, LLC
Positron Access Solutions Corp.
SaskTel International
Supply Solutions
UCL Swift Americas

ONU DEVICES

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Supply Solutions

ORGANIZERS

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R&M USA, Inc.
Supply Solutions

PATCH PANELS

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FIBERONE
Go!Foton
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Multicom, Inc.
Multilink, Inc.
Power & Tel
PPC Broadband
R&M USA, Inc.
Rosenberger Site Solutions, LLC
Supply Solutions
Tii Technologies, Inc.
UCL Swift Americas
Wavenet, Inc.

PIGTAILS/JUMPERS/ ASSEMBLIES

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Solutions
Fiberdyne Labs, Inc.
FIBERONE

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Millennium
Multicom, Inc.
Multilink, Inc.
OFS
Power & Tel
PPC Broadband
Prysmian Group
R&M USA, Inc.
Supply Solutions
Taihan Fiberoptics
Tii Technologies, Inc.
UCL Swift Americas

POLISHERS

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Supply Solutions

PON EQUIPMENT/ SOLUTIONS

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CommScope
Comtest Networks
Go!Foton
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Power & Tel
PPC Broadband
SaskTel International
Tii Technologies, Inc.
UCL Swift Americas
Walker and Associates
Zyxel Communications

PRECONNECTORIZATION EQUIPMENT

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Fiberdyne Labs, Inc.
FIBERONE
Supply Solutions
UCL Swift Americas

RESTORATION KITS/SERVICES

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Go!Foton
Maverick Corporation
Supply Solutions
UCL Swift Americas

RIBBON CABLE

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Fiber Optics Network Cable
Solutions
Go!Foton
Millennium

OFS
Power & Tel
Prysmian Group
Supply Solutions
Taihan Fiberoptics
UCL Swift Americas

SONET PRODUCTS

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Supply Solutions
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SONET TESTERS

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Pearce Services, LLC
Supply Solutions
VeEX, Inc.

SPLICE CASES/ CLOSURES/ENCLOSURES

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FS3, Inc.
Go!Foton
Millennium
Multicom, Inc.
Multilink, Inc.
Oldcastle Infrastructure
Power & Tel
PPC Broadband
R&M USA, Inc.
Supply Solutions
Taihan Fiberoptics
Tii Technologies, Inc.
UCL Swift Americas
U-TECK
Walker and Associates
Western Pacific Telecommunications

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FS3, Inc.

INNO Instrument America, Inc.
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Millennium
Ripley Tools, LLC
Supply Solutions
UCL Swift Americas

SUBMARINE CABLE EQUIPMENT

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SYSTEM INTEGRATION SERVICES

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Fujitsu Network Communications, Inc.
Maverick Corporation
Netcon
SaskTel International
Supply Solutions

TRANSCEIVERS

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Go!Foton
Lindsay Broadband
Power & Tel
PPC Broadband
Supply Solutions

ULTRABROADBAND ETHERNET (UBE) PRODUCTS

Supply Solutions

WDM PON/XGSPON

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FiberStory
Go!Foton
Maverick Corporation
SaskTel International
Supply Solutions
UCL Swift Americas
VeEX, Inc.
Walker and Associates
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I&M / Network Reliability / Cybersecurity

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Communications, Inc.
SaskTel International
Zyxel Communications

BROADBAND CABLE

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Supply Solutions

**BROADBAND DSL
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SERVICES**

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Positron Access Solutions Corp.
Telecom Problem Solvers, LLC

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Communications, Inc.
Maverick Corporation
Positron Access Solutions Corp.
SaskTel International
Telecom Problem Solvers, LLC

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Border States Electric

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EQUIPMENT**

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Supply Solutions

**BUILDING & SHELTERS:
SUPPLIES**

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**CABINETS:
INDOOR/OUTDOOR/
WIRELESS**

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Border States Electric

EnerSys
Fujitsu Network
Communications, Inc.
Supply Solutions
Thermal Edge
Tii Technologies, Inc.

CABLE ACCESSORIES

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Border States Electric
Phoenix Contact
Supply Solutions
Tii Technologies, Inc.
WL Plastics

CABLE BLOCKS

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Supply Solutions
Tii Technologies, Inc.

CABLE CAPS

Border States Electric
Supply Solutions

CABLE CLIPS

Border States Electric
Supply Solutions

CABLE COMPOUNDS

Border States Electric

CABLE PAYOUT EQUIPMENT

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Jameson, LLC
U-TECK

**CABLE PRESSURIZATION
ALARMS/MONITORS**

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Wavenet, Inc.

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HARDWARE**

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Supply Solutions

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Wavenet, Inc.
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CEVS

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CLOSURES

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DSLAMS

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Supply Solutions

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Supply Solutions
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FS3, Inc.
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Phoenix Contact
Supply Solutions
UCL Swift Americas

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FS3, Inc.
Jameson, LLC
Phoenix Contact
Supply Solutions
Wavenet, Inc.

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Phoenix Contact
Supply Solutions

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Jameson, LLC
Phoenix Contact
Plumettaz America Corp.
Supply Solutions

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Plumettaz America Corp.
Supply Solutions

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FS3, Inc.
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FS3, Inc.
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FS3, Inc.
Supply Solutions

TRUCKS

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VAULTS & ACCESSORIES

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FS3, Inc.
Supply Solutions

**VAULTS: ENVIRONMENTAL
& UNDERGROUND**

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Supply Solutions

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IoT/M2M****AUTONOMOUS VEHICLES**

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Trimble

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Superior Essex
Wavenet, Inc.
Zyxel Communications

CAT5E CABLING

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Prismian Group
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CLOUD SOLUTIONS**

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Zyxel Communications

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Positron Access Solutions Corp.
Power & Tel
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Zyxel Communications

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Pearce Services, LLC
Prismian Group

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CHR Solutions
Phoenix Contact
Zyxel Communications

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Go!Foton
Pearce Services, LLC
Power & Tel

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Go!Foton
Maverick Corporation
MaxCell
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DRONE TECHNOLOGIES

Trimble

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Go!Foton

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ELECTRONICS

Pearce Services, LLC
Power & Tel
Prysmian Group

ETHERNET CABLES

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Prysmian Group
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Positron Access Solutions Corp.
Prysmian Group
Zyxel Communications

GATEWAYS

Lindsay Broadband
Power & Tel
Zyxel Communications

HOME NETWORK MANAGEMENT

Zyxel Communications

HOME NETWORKING

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Positron Access Solutions Corp.
Power & Tel
Wavenet, Inc.
Zyxel Communications

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Maverick Corporation

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MaxCell

IN-HOME TERMINATIONS/ FILTERS/SPLITTERS

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Power & Tel

IT INTEGRATION

Esri

MASSIVE IOT SOLUTIONS

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MOCA EQUIPMENT

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Positron Access Solutions Corp.
Wavenet, Inc.

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CHR Solutions
EnerSys
Esri
Go!Foton

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Maverick Corporation
Phoenix Contact

NETWORK SURVEILLANCE EQUIPMENT

EnerSys

NETWORKING DEVICES

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Phoenix Contact
Power & Tel

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Positron Access Solutions Corp.

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NETWORKING VPN

Phoenix Contact

NETWORKING WAN/LAN

Phoenix Contact
Zyxel Communications

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Maverick Corporation

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Pearce Services, LLC
Power & Tel

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Power & Tel

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Lindsay Broadband
Positron Access Solutions Corp.
Trimble

SMART GRID SYSTEM/EQUIPMENT

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Go!Foton

SMART HOME SYSTEMS

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Wavenet, Inc.
Zyxel Communications

SMART UTILITIES

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Go!Foton

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Lindsay Broadband
Power & Tel
Zyxel Communications

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Power & Tel
Zyxel Communications

WIRELESS CPE/GATEWAYS

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Power & Tel
Zyxel Communications

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Phoenix Contact
Power & Tel
Zyxel Communications

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Phoenix Contact
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Mapping/GIS

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Trimble
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Maverick Corporation
Netcon
Pearce Services, LLC
Spectrum Planning, Inc.
VeEX, Inc.
VETRO, Inc.

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Finley Engineering Company, Inc.
IQGeo
Millennium
Pearce Services, LLC
Trimble

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Maverick Corporation
Netcon
Pearce Services, LLC
Tech Products, Inc.
Trimble

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Maverick Corporation
Millennium
Pearce Services, LLC
Trimble

ONE TOUCH MAKE READY SOLUTIONS

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Esri
Maverick Corporation
Pearce Services, LLC

RDOF SOLUTIONS

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Positron Access Solutions Corp.
VETRO, Inc.
Services
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Michels Power, Inc.
Millennium
MOUNTAIN, LTD.
Netcon
Pearce Services, LLC
Spectrum Planning, Inc.

TRAINING

3-GIS
Esri
Maverick Corporation

TRANSPORTATION AND LOGISTICS

3-GIS
Esri
Trimble

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Power & Tel
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Supply Solutions

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Millennium

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Power & Tel
Supply Solutions

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Power & Tel
Supply Solutions

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Lindsay Broadband
Power & Tel
Supply Solutions
Tii Technologies, Inc.

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Positron, Inc.

CABLE GUARDS: RODENTS

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Supply Solutions
WL Plastics

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Petroflex North America
Rainbow Technology Corporation

CASES: CARRYING

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Supply Solutions
Tech Products, Inc.

CHANNEL POSTS

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Millennium

CHEMICALS

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Supply Solutions

CLEANERS

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Power & Tel
Supply Solutions

CLEANERS: CABLE

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Power & Tel
Rainbow Technology Corporation
Supply Solutions

CLEANERS: CONDUIT

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Supply Solutions

CLEANERS: MISC.

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Supply Solutions

COPPER EXTENDERS

Border States Electric
Supply Solutions

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Border States Electric
Rainbow Technology Corporation
WL Plastics

DAMPERS: VIBRATION

Border States Electric

DISTRIBUTORS

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WL Plastics

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Supply Solutions
U-TECK

FOAM KITS/URETHANE

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Supply Solutions

FRAMES: PAYOUT/PULL IN

Border States Electric
Supply Solutions

GIGABIT ETHERNET EQUIPMENT

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Positron Access Solutions Corp.
Wavenet, Inc.
WL Plastics

HANDSETS

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Supply Solutions

HERBICIDE

Rainbow Technology Corporation

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Team Fenex, a Division of
Synergy Power Group, LLC

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Rainbow Technology Corporation
Supply Solutions

INTERCOMS

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INVERTERS

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Exeltech

JACKS: MODULAR

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Positron, Inc.
Supply Solutions

LINE CARDS

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Petroflex North America
Plumettaz America Corp.
Power & Tel
Rainbow Technology Corporation
Supply Solutions

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FS3, Inc.
Millennium
Petroflex North America
Plumettaz America Corp.
Supply Solutions

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Go!Foton

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Border States Electric

SOLVENTS

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Power & Tel

TARPS

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Millennium
U-TECK

Public/ Private Partnerships (P3)

CONSULTANTS

3-GIS
Finley Engineering Company, Inc.
Fujitsu Network
Communications, Inc.
SaskTel International
Supply Solutions
Trimble
VETRO, Inc.

INVESTORS

Millennium

NETWORK ARCHITECTURE

3-GIS
Budco, Inc.
EnerSys
Finley Engineering Company, Inc.
Fujitsu Network
Communications, Inc.
Graybar
Lindsay Broadband
Oldcastle Infrastructure
Plumettaz America Corp.

Powerline Hardware
SaskTel International
Supply Solutions
VeEX, Inc.

PUBLIC PRIVATE PARTNERSHIPS

Black & Veatch
Finley Engineering Company, Inc.
Fujitsu Network
Communications, Inc.
Michels Power, Inc.
SaskTel International

Network Transformation/ Simplification

AI SOLUTIONS

Esri
Go!Foton

ARCHITECTURAL MODELING

3-GIS
CHR Solutions
CommScope
Esri
Finley Engineering Company, Inc.
IQGeo
Maverick Corporation
Trimble
WL Plastics

ARTIFICIAL INTELLIGENCE TECHNOLOGIES

Esri
Fujitsu Network
Communications, Inc.
Go!Foton
Maverick Corporation

AUTOMATION

Fujitsu Network
Communications, Inc.

AUTOMATION SOLUTIONS

3-GIS
Esri
Go!Foton
IQGeo
Maverick Corporation
SaskTel International

CENTRAL ORCHESTRATION

Fujitsu Network
Communications, Inc.

CENTRAL ORCHESTRATION/ SIMPLIFICATION

Comtest Networks
Esri
Go!Foton

CORD EQUIPMENT

EnerSys
Fujitsu Network
Communications, Inc.
Go!Foton

DIGITAL TRANSFORMATION

3-GIS
Esri
IQGeo
SaskTel International

MACHINE LEARNING SOLUTIONS

Esri
Fujitsu Network
Communications, Inc.
Go!Foton

NETWORK SLICING TECHNOLOGIES

Finley Engineering Company, Inc.
Fujitsu Network
Communications, Inc.

OPEN-SOURCE NETWORKS

Esri

ORCHESTRATION

Fujitsu Network
Communications, Inc.

SDN

Esri
Finley Engineering Company, Inc.
Go!Foton

SDN/NFV

Fujitsu Network
Communications, Inc.

SYSTEMS INTEGRATION

CommScope
EnerSys
Esri
Finley Engineering Company, Inc.
Fujitsu Network Communications, Inc.
Go!Foton
IQGeo
SaskTel International

VIRTUAL REALITY (VR)

Esri

VIRTUALIZATION TECHNOLOGIES/ SOLUTIONS

CHR Solutions
Esri
Fujitsu Network Communications, Inc.
IQGeo
Trimble

**Power/
Sustainability****BACKUP ALARMS**

Border States Electric
EnerSys
ESPi
LEOCH® Battery Corporation

BATTERIES

American Power Systems, LLC
Border States Electric
Cyber Power Systems (USA), Inc.
East Penn Manufacturing Co.
EnerSys
ESPi
GS Yuasa Energy Solutions, Inc.
LEOCH® Battery Corporation
Lindsay Broadband
Maverick Corporation
Michels Power, Inc.
MPINarada
Power & Tel

**BATTERIES:
BACKUP POWER SYSTEMS**

American Power Systems, LLC
Border States Electric
Cyber Power Systems (USA), Inc.
East Penn Manufacturing Co.
EnerSys
ESPi
GS Yuasa Energy Solutions, Inc.

LEOCH® Battery Corporation
Lindsay Broadband
MPINarada
Phoenix Contact
Power & Tel

**BATTERIES:
CHARGERS & TESTERS**

American Power Systems, LLC
Border States Electric
EnerSys
ESPi
Lindsay Broadband
Power & Tel

BATTERIES: PORTABLE

American Power Systems, LLC
Border States Electric
EnerSys
ESPi
Lindsay Broadband

**BATTERIES:
RACKS & ENCLOSURES**

American Power Systems, LLC
Border States Electric
Cyber Power Systems (USA), Inc.
EnerSys
ESPi
GS Yuasa Energy Solutions, Inc.
LEOCH® Battery Corporation
Lindsay Broadband
MPINarada
Power & Tel

**BATTERIES:
TRANSPORTABLE**

American Power Systems, LLC
Border States Electric
EnerSys
ESPi
GS Yuasa Energy Solutions, Inc.
Lindsay Broadband

EMERGING TECHNOLOGIES

Border States Electric
EnerSys
ESPi
Finley Engineering Company, Inc.
Maverick Corporation
MPINarada

**ENERGY SOURCES:
ALTERNATE**

Border States Electric
EnerSys
ESPi
Maverick Corporation

ENERGY SOURCES: OTHER

Border States Electric
ESPi
Maverick Corporation

**ENERGY SOURCES:
PHOTOVOLTAIC**

American Power Systems, LLC
Border States Electric
EnerSys
ESPi
Maverick Corporation

ENERGY SOURCES: SOLAR

American Power Systems, LLC
Border States Electric
EnerSys
ESPi
Finley Engineering Company, Inc.
Maverick Corporation

ENERGY SOURCES: WIND

Border States Electric
Finley Engineering Company, Inc.
Maverick Corporation

**ENERGY SOURCES:
WIND TURBINES**

Border States Electric

FUEL CELLS

Border States Electric
EnerSys

GENERATOR SETS

Border States Electric
EnerSys
Lindsay Broadband

GENERATORS

Border States Electric
EnerSys
Power & Tel

**GREEN TELECOM:
BACKUP POWER**

American Power Systems, LLC
Border States Electric
Cyber Power Systems (USA), Inc.
East Penn Manufacturing Co.
EnerSys
ESPi
Esri
Exeltech
GS Yuasa Energy Solutions, Inc.
LEOCH® Battery Corporation
Lindsay Broadband
MPINarada

**GREEN TELECOM:
ENERGY EFFICIENCY**

American Power Systems, LLC
Border States Electric
Cyber Power Systems (USA), Inc.
EnerSys
ESPi
Esri
LEOCH® Battery Corporation
Lindsay Broadband
MPINarada

**GREEN TELECOM:
EQUIPMENT RECYCLING**

American Power Systems, LLC
East Penn Manufacturing Co.
EnerSys
Esri

**GREEN TELECOM:
FLEET MANAGEMENT**

Border States Electric
EnerSys
Esri
Green Telecom: Other
Border States Electric
EnerSys
Esri
WL Plastics

**GREEN TELECOM: REDUCE
CARBON FOOTPRINT**

East Penn Manufacturing Co.
EnerSys
Esri
Lindsay Broadband
MPINarada
Superior Essex

**GREEN TELECOM:
SUSTAINABLE
ENVIRONMENT**

East Penn Manufacturing Co.
EnerSys
Esri
GS Yuasa Energy Solutions, Inc.
Superior Essex

**GREEN TELECOM:
VEHICLES**

EnerSys
Esri

**GROUNDING/BONDING
EQUIPMENT & SYSTEMS**

Border States Electric
EnerSys
GMP Tools
Maverick Corporation

Positron, Inc.
Power & Tel

HYBRID POWER SOLUTIONS

American Power Systems, LLC
Border States Electric
ESPi
Southwire Company, LLC

PORTABLE POWER UNITS

American Power Systems, LLC
Border States Electric
EnerSys
ESPi
Lindsay Broadband

POWER & ENERGY

American Power Systems, LLC
Border States Electric
Cyber Power Systems (USA), Inc.
EnerSys
ESPi
Exeltech
Finley Engineering Company, Inc.
GMP Tools
GS Yuasa Energy Solutions, Inc.
LEOCH® Battery Corporation
Lindsay Broadband
Maverick Corporation
Michels Power, Inc.
MPINarada
Powerline Hardware
Southwire Company, LLC

POWER CONVERTERS

American Power Systems, LLC
Border States Electric
EnerSys
ESPi
Lindsay Broadband

POWER EQUIPMENT

American Power Systems, LLC
Border States Electric
Cyber Power Systems (USA), Inc.
EnerSys
ESPi
Exeltech
Lindsay Broadband
MPINarada
Power & Tel
Powerline Hardware

POWER: AC/DC EQUIPMENT

American Power Systems, LLC
Border States Electric
Cyber Power Systems (USA), Inc.
EnerSys
ESPi

Lindsay Broadband
Maverick Corporation
Phoenix Contact
Power & Tel

POWER: CONTROL/ MONITORING SYSTEMS

American Power Systems, LLC
Border States Electric
EnerSys
ESPi
GS Yuasa Energy Solutions, Inc.
Phoenix Contact
Quest Controls

POWER: PORTABLE

American Power Systems, LLC
Border States Electric
EnerSys
ESPi
Lindsay Broadband

POWER: SOLAR SOURCES

American Power Systems, LLC
Border States Electric
EnerSys
ESPi
LEOCH® Battery Corporation
Maverick Corporation

SMART GRID GOODS

Border States Electric
EnerSys
Maverick Corporation

SMART GRID SERVICES

Border States Electric
EnerSys
Finley Engineering Company, Inc.
Maverick Corporation

SMART GRID TECHNOLOGY

Border States Electric
Finley Engineering Company, Inc.
Maverick Corporation

SUSTAINABLE SOLUTIONS

Border States Electric
EnerSys
ESPi
Esri
Finley Engineering Company, Inc.
GS Yuasa Energy Solutions, Inc.
LEOCH® Battery Corporation
Maverick Corporation
MPINarada
Superior Essex
WL Plastics

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COMPETITIVELY PRICED



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SYSTEMS INTEGRATION SOLUTIONS

Border States Electric
Esri
Finley Engineering Company, Inc.

UPS

American Power Systems, LLC
Border States Electric
EnerSys
ESPi
GS Yuasa Energy Solutions, Inc.
LEOCH® Battery Corporation
Lindsay Broadband
MPINarada
Phoenix Contact
Power & Tel

Safety**ALARM SYSTEMS**

American Power Systems, LLC
Border States Electric

BONDING PRODUCTS

Border States Electric
FS3, Inc.
GMP Tools
Supply Solutions

CABLE IDENTIFICATION KITS

Border States Electric
Budco, Inc.
Craftmark Cable Markers
FS3, Inc.
Power & Tel
Pro-Line Safety Supply, Inc.
Supply Solutions
Tech Products, Inc.
U-TECK
WL Plastics

CLIMBING EQUIPMENT & SUPPLIES

Border States Electric
Graybar
Supply Solutions

COVID-19 NETWORK IMPACT SOLUTIONS

Border States Electric

CYBERSAFETY

Border States Electric
CHR Solutions

CYBERSECURITY

Border States Electric
CHR Solutions
Phoenix Contact

DAMAGE PREVENTION EQUIPMENT

Border States Electric
Budco, Inc.
Craftmark Cable Markers
FS3, Inc.
Pro-Line Safety Products
Pro-Mark Utility Supply, Inc.
U-TECK

DECALS

Border States Electric
Budco, Inc.
Craftmark Cable Markers
FS3, Inc.
Power & Tel
Pro-Mark Utility Supply, Inc.
Supply Solutions
Tech Products, Inc.

DIG WARNING INFORMATION

Border States Electric
Budco, Inc.
Craftmark Cable Markers
FS3, Inc.
Pro-Line Safety Products
Pro-Mark Utility Supply, Inc.

DISASTER PREPARATION & RECOVERY

Border States Electric
CHR Solutions
Jameson, LLC
Lindsay Broadband
Power & Tel

ELECTRICAL PROTECTION

Border States Electric
Positron, Inc.
Telecom Problem Solvers, LLC

FALL PROTECTION EQUIPMENT

Border States Electric
Budco, Inc.
FS3, Inc.
Graybar
Rainbow Technology Corporation
Supply Solutions

FIRE STOPS

Border States Electric

FIRST AID KITS AND SUPPLIES

Border States Electric
FS3, Inc.
Rainbow Technology Corporation
Supply Solutions

FLAGS

Border States Electric
Budco, Inc.
FS3, Inc.
GMP Tools
Pro-Line Safety Products
Supply Solutions
Wavenet, Inc.

GAS & MOISTURE DETECTORS

Border States Electric
FS3, Inc.
Rainbow Technology Corporation
U-TECK

GROUNDING PRODUCTS

Border States Electric
FS3, Inc.
Positron, Inc.
Power & Tel

HARNESSES

Border States Electric
FS3, Inc.
Rainbow Technology Corporation
Supply Solutions

HEARING PROTECTION

Border States Electric
FS3, Inc.
Rainbow Technology Corporation
Supply Solutions

INSPECTION SERVICES: SAFETY

Batavia Services, Inc.
Border States Electric
Trimble

LABELS & LABELING SYSTEMS

Border States Electric
Craftmark Cable Markers
FS3, Inc.
Power & Tel
Pro-Mark Utility Supply, Inc.
Supply Solutions
WL Plastics

LIGHTING DEVICES

Border States Electric
FS3, Inc.
Jameson, LLC
Positron, Inc.
Supply Solutions
U-TECK

LOCATING & MARKING PRODUCTS

Border States Electric
Budco, Inc.
Craftmark Cable Markers
FS3, Inc.
Graybar
Jameson, LLC
Power & Tel
Pro-Line Safety Products
Pro-Mark Utility Supply, Inc.
Supply Solutions
U-TECK

MARKING SYSTEMS

Border States Electric
Budco, Inc.
Craftmark Cable Markers
FS3, Inc.
Power & Tel
Pro-Line Safety Products
Pro-Mark Utility Supply, Inc.
Supply Solutions

NETWORK MANAGEMENT SOLUTIONS/RELIABILITY TOOLS

Border States Electric
CHR Solutions
Supply Solutions

NETWORK RELIABILITY

Border States Electric
Lindsay Broadband
MPINarada
Pearce Services, LLC
Positron, Inc.
Telecom Problem Solvers, LLC

PERSONAL FALL ARREST SYSTEMS (PFAS)

Border States Electric
FS3, Inc.

PPE EQUIPMENT/FABRIC

Border States Electric
FS3, Inc.
Milwaukee Tool
Power & Tel
Supply Solutions
U-TECK

PROTECTION EQUIPMENT

Border States Electric
FS3, Inc.
Milwaukee Tool
Positron, Inc.
Power & Tel
Supply Solutions
Telecom Problem Solvers, LLC
U-TECK
WL Plastics

**PROTECTION:
BUILDING ENTRY**

Border States Electric
Supply Solutions

PROTECTION: CO/RTS

Border States Electric

**RESPIRATORS/
RESUSCITATORS**

Border States Electric

**SAFETY EQUIPMENT
& ACCESSORIES**

Border States Electric
FS3, Inc.
Positron, Inc.
Power & Tel
Rainbow Technology Corporation
Supply Solutions
U-TECK

**SAFETY MANAGEMENT
PROGRAMS**

Border States Electric
Maverick Corporation

SCAFFOLDS

Border States Electric

SEALING PRODUCTS

Border States Electric
Power & Tel
Supply Solutions

SECURITY EQUIPMENT

Border States Electric
Power & Tel

SECURITY LOCKS

Border States Electric
Supply Solutions

SECURITY MISC.

Border States Electric
Supply Solutions

SECURITY SYSTEMS

Border States Electric

**SHORING/SHIELDING
SYSTEMS**

Border States Electric

SIGNS & ACCESSORIES

Border States Electric
Craftmark Cable Markers
FS3, Inc.
GMP Tools
Pro-Mark Utility Supply, Inc.
Supply Solutions
Tech Products, Inc.

SKIN PROTECTION

Border States Electric
FS3, Inc.
Rainbow Technology Corporation

**SPILL CLEANUP
KITS & EQUIPMENT**

American Power Systems, LLC
Border States Electric

TAGS

Border States Electric
Craftmark Cable Markers
FS3, Inc.
Supply Solutions
Tech Products, Inc.

TAGS: CABLE

Border States Electric
Budco, Inc.
Craftmark Cable Markers
FS3, Inc.
Supply Solutions
Tech Products, Inc.
U-TECK

**TAPE: UNDERGROUND
WARNING**

Border States Electric
Budco, Inc.
FS3, Inc.
Pro-Line Safety Products
Rainbow Technology Corporation
Reef Industries
Supply Solutions

**TRAFFIC CONTROL
EQUIPMENT: CONES**

Border States Electric
FS3, Inc.
Supply Solutions

**TRAFFIC CONTROL
EQUIPMENT: FLAGS**

Border States Electric
FS3, Inc.
Supply Solutions

**TRAFFIC CONTROL
EQUIPMENT: MISC.**

Border States Electric
FS3, Inc.
Laser Tech
Supply Solutions
Team Fenex, a Division of
Synergy Power Group, LLC

**TRAFFIC CONTROL
EQUIPMENT: SIGNS**

Border States Electric
Craftmark Cable Markers
FS3, Inc.
Supply Solutions

**UNDERGROUND
MARKING TAPE/MARKERS**

Border States Electric
Budco, Inc.
Craftmark Cable Markers
FS3, Inc.
Pro-Line Safety Products
Pro-Mark Utility Supply, Inc.
Rainbow Technology Corporation
Reef Industries
Supply Solutions
Tech Products, Inc.
U-TECK

VISION PROTECTION

Border States Electric
FS3, Inc.
Supply Solutions

**WORK AREA
PROTECTION EQUIPMENT**

Border States Electric
Budco, Inc.
FS3, Inc.
GMP Tools
Power & Tel
Rainbow Technology Corporation
Supply Solutions

Testing**AUTOMATION/MONITORING**

Border States Electric

CABLE ANALYSIS & TESTING

American Power Systems, LLC

Border States Electric
Celerity Integrated Services, Inc.
Graybar
Power & Tel
Supply Solutions
Telecom Problem Solvers, LLC
VeEX, Inc.

**CABLE PREVENTIVE
MAINTENANCE EQUIPMENT**

Border States Electric
Supply Solutions

**COMPUTERS & PERSONAL
DEVICES FOR FIELD TECHS**

Border States Electric
Laser Tech
Supply Solutions

**DISTANCE MEASURING
EQUIPMENT & TOOLS**

Border States Electric
FS3, Inc.
Laser Tech
Supply Solutions

FIELD TECH TOOLS

Border States Electric
Laser Tech
Millennium
Positron, Inc.
Power & Tel
Ripley Tools, LLC
Supply Solutions
VeEX, Inc.

MULTIMETERS

Border States Electric
FS3, Inc.
Millennium
Supply Solutions
VeEX, Inc.

**NETWORK ANALYSIS
PERFORMANCE TOOLS**

Border States Electric
Supply Solutions

NETWORK RELIABILITY

Border States Electric
Positron, Inc.
Telecom Problem Solvers, LLC
VeEX, Inc.

OTDRS

Border States Electric
Budco, Inc.
Fiber Plus International
FS3, Inc.

Graybar
INNO Instrument America, Inc.
Millennium
Multicom, Inc.
Power & Tel
Ripley Tools, LLC
Ross FiberOptic, LLC
Supply Solutions
VeEX, Inc.

POWER METERS

Border States Electric
Budco, Inc.
FS3, Inc.
Graybar
INNO Instrument America, Inc.
Millennium
Power & Tel
Ripley Tools, LLC
Supply Solutions
VeEX, Inc.

SERVICE ASSURANCE TECHNOLOGIES

3-GIS
Positron, Inc.

TEST EQUIPMENT: FWA

Border States Electric

TEST EQUIPMENT: BASE STATION

Border States Electric

TEST EQUIPMENT: BATTERIES

American Power Systems, LLC
Border States Electric
Megger
Power & Tel

TEST EQUIPMENT: CATV

Border States Electric
Budco, Inc.
Megger
Power & Tel
Supply Solutions
VeEX, Inc.

TEST EQUIPMENT: CENTRALIZED

Border States Electric
Supply Solutions

TEST EQUIPMENT: COAXIAL/HFC

Border States Electric

TEST EQUIPMENT: COPPER

Border States Electric
Supply Solutions
VeEX, Inc.

TEST EQUIPMENT: DSL

Border States Electric
Supply Solutions
VeEX, Inc.

TEST EQUIPMENT: ELECTRONIC

Border States Electric
Supply Solutions

TEST EQUIPMENT: ETHERNET

Border States Electric

TEST EQUIPMENT: FIBER

Border States Electric
Budco, Inc.
Graybar
INNO Instrument America, Inc.
Michels Power, Inc.
Millennium
Multicom, Inc.
Power & Tel
Ripley Tools, LLC
Ross FiberOptic, LLC
Supply Solutions
VeEX, Inc.
Vivax-Metrotech Corp.

TEST EQUIPMENT: HFC

Border States Electric
INNO Instrument America, Inc.
Supply Solutions
VeEX, Inc.

TEST EQUIPMENT: MICROWAVE

Border States Electric
Supply Solutions

TEST EQUIPMENT: POWER

Border States Electric
Michels Power, Inc.
Supply Solutions

TEST EQUIPMENT: REBUILT

Border States Electric
Supply Solutions

TEST EQUIPMENT: RENTALS

Border States Electric
Millennium

TEST EQUIPMENT: WIFI

Border States Electric
Ripley Tools, LLC
Supply Solutions
VeEX, Inc.

TEST EQUIPMENT: WIRELESS

Border States Electric
Ripley Tools, LLC
Supply Solutions
VeEX, Inc.

TESTERS: BATTERY CHARGE

Border States Electric
Supply Solutions

TESTERS: DISCHARGER

Supply Solutions

TESTING EQUIPMENT: VIRTUALIZATION

Border States Electric

Trends/ Research

ANALYSTS/CONSULTANTS

3-GIS
CHR Solutions
Telecom Problem Solvers, LLC
Trimble

REPORTS/FORECASTING SERVICES

Power & Tel

RESEARCH COMPANIES

CommScope
Go!Foton

SUBJECT MATTER EXPERTS

3-GIS
American Power Systems, LLC
CHR Solutions
CommScope
FIBERONE
Go!Foton
MPINarada
Power & Tel
SaskTel International
Telecom Problem Solvers, LLC

Wireless

4G SOLUTIONS

American Power Systems, LLC
Arium Stream, LLC
Border States Electric
East Penn Manufacturing Co.
Finley Engineering Company, Inc.
Go!Foton
Michels Power, Inc.
Pearce Services, LLC
SaskTel International
WL Plastics

5G SOLUTIONS

American Power Systems, LLC
Arium Stream, LLC
Black & Veatch
Border States Electric
CommScope
East Penn Manufacturing Co.
Finley Engineering Company, Inc.
Fujitsu Network Communications, Inc.
Go!Foton
Graybar
INNO Instrument America, Inc.
KGPCo
Lindsay Broadband
Maverick Corporation
Michels Power, Inc.
MPINarada
Oldcastle Infrastructure
Pearce Services, LLC
PPC Broadband
Prysmian Group
SaskTel International
Supply Solutions
Tii Technologies, Inc.
VeEX, Inc.
WL Plastics
Zyxxel Communications

6G SOLUTIONS

American Power Systems, LLC
Arium Stream, LLC
Border States Electric
Go!Foton
Lindsay Broadband
Michels Power, Inc.
Pearce Services, LLC
WL Plastics
Zyxxel Communications

ANTENNAS

Border States Electric
CommScope
Fujitsu Network
Communications, Inc.
INNO Instrument America, Inc.
Lindsay Broadband
Maverick Corporation
Pearce Services, LLC
Supply Solutions

**ANTENNAS/
ROOFTOP SYSTEMS**

Border States Electric
CommScope
Lindsay Broadband
Pearce Services, LLC
Supply Solutions

**ARTIFICIAL INTELLIGENCE
(AI) SYSTEMS**

Go!Foton

BACKHAUL EQUIPMENT

Border States Electric
Clearfield
CommScope

Finley Engineering Company, Inc.
Fujitsu Network
Communications, Inc.
Go!Foton
Jameson, LLC
Lindsay Broadband
MPINarada
Pearce Services, LLC
PPC Broadband
Supply Solutions
UCL Swift Americas
VeEX, Inc.

**BACKHAUL EQUIPMENT/
TECHNOLOGIES**

Border States Electric
Clearfield
CommScope
EnerSys
Finley Engineering Company, Inc.
Fujitsu Network
Communications, Inc.
Go!Foton
Lindsay Broadband
Pearce Services, LLC
PPC Broadband
Supply Solutions

UCL Swift Americas
VeEX, Inc.

**BANDWIDTH
MANAGEMENT TOOLS**

Border States Electric

BASE STATION EQUIPMENT

Border States Electric
Charles Industries, LLC
CommScope
EnerSys
MPINarada
Pearce Services, LLC

**BIDIRECTIONAL
AMPLIFIERS**

Border States Electric
Supply Solutions

**BROADBAND WIRELESS
ACCESS (BWA) EQUIPMENT**

Border States Electric
Finley Engineering Company, Inc.
Lindsay Broadband

**CELL DENSIFICATION
EQUIPMENT**

Border States Electric
Pearce Services, LLC
PPC Broadband

**COAX CABLE
MODEMS/CMTS**

Border States Electric
CommScope
EnerSys
Lindsay Broadband

**CONNECTED
HOME EQUIPMENT**

Border States Electric
Clearfield
CommScope
Positron Access Solutions Corp.
Tii Technologies, Inc.
Wavenet, Inc.

CRAN EQUIPMENT

Fujitsu Network
Communications, Inc.
Maverick Corporation
Pearce Services, LLC



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MARKING
TAPES**

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DAS/EQUIPMENT & SERVICES

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Clearfield
Lindsay Broadband
Maverick Corporation
MPINarada
Pearce Services, LLC
Zyxel Communications

DAS/HEADEND UNITS

Border States Electric
CommScope
EnerSys
Pearce Services, LLC

DAS/REMOTE UNITS

Border States Electric
EnerSys
Pearce Services, LLC

DAS/SMALL CELL ANTENNAS

Border States Electric
CommScope
EnerSys
Pearce Services, LLC

DAS/SMALL CELL CABINETS

Border States Electric
Charles Industries, LLC
Clearfield
CommScope
EnerSys
Go!Foton
Pearce Services, LLC
Tii Technologies, Inc.

DAS/SMALL CELL CABLING

Border States Electric
Clearfield
CommScope
Dycom Industries, Inc.
EnerSys
Go!Foton
Pearce Services, LLC
Tii Technologies, Inc.

DAS/SMALL CELL CONCEALMENT

Border States Electric
Charles Industries, LLC
CommScope
EnerSys
Go!Foton
Pearce Services, LLC

DAS/SMALL CELL CONNECTORS

Border States Electric
EnerSys
Pearce Services, LLC
Tii Technologies, Inc.

DRONES/UAS

Border States Electric
Pearce Services, LLC
Trimble

ETHERNET CELL SITE GATEWAYS

Border States Electric
Lindsay Broadband
Pearce Services, LLC

ETHERNET CELL SITE ROUTERS

Border States Electric
Pearce Services, LLC

ETHERNET TECHNOLOGIES & EQUIPMENT

Border States Electric
Lindsay Broadband
Pearce Services, LLC
Positron Access Solutions Corp.
VeEX, Inc.

ETHERNET-ONLY MICROWAVE EQUIPMENT

Border States Electric
CommScope

ETHERNET-ONLY MICROWAVE PRODUCTS

Border States Electric
CommScope

FEMTOCELLS

Lindsay Broadband

FIBER-TO-THE-ANTENNA EQUIPMENT

Border States Electric
Clearfield
Finley Engineering Company, Inc.
Go!Foton
Jameson, LLC
Lindsay Broadband
UCL Swift Americas

FIBER-TO-THE-CELL-SITE EQUIPMENT

Border States Electric
Charles Industries, LLC

Clearfield
Go!Foton
Jameson, LLC
Lindsay Broadband
MP Nexlevel
PPC Broadband
UCL Swift Americas

FIXED WIRELESS ACCESS (FWA) EQUIPMENT

Border States Electric
CommScope
Finley Engineering Company, Inc.
Go!Foton
Lindsay Broadband
Positron Access Solutions Corp.
Zyxel Communications

FRONTHAUL EQUIPMENT

Border States Electric
EnerSys
Finley Engineering Company, Inc.
Go!Foton
Jameson, LLC
VeEX, Inc.

GATEWAYS & SWITCHES

Border States Electric
Lindsay Broadband
Phoenix Contact
Positron Access Solutions Corp.
Power & Tel
Zyxel Communications

IN-BUILDING ANTENNA ACCESS POINTS

Border States Electric
Positron Access Solutions Corp.

LIGHTNING PROTECTION EQUIPMENT

Border States Electric
Pearce Services, LLC
Phoenix Contact
Positron, Inc.

LTE EQUIPMENT

Border States Electric
EnerSys
Finley Engineering Company, Inc.
Lindsay Broadband
MPINarada
Zyxel Communications

MICRO SITES OFFLOAD EQUIPMENT/TECHNOLOGIES

Border States Electric
Pearce Services, LLC

MICROCELLS

EnerSys
Pearce Services, LLC

MICROWAVE BACKHAUL PRODUCTS

Arium Stream, LLC
Border States Electric
Finley Engineering Company, Inc.
Pearce Services, LLC

MICROWAVE PRODUCTS

Arium Stream, LLC
Border States Electric
CommScope
Finley Engineering Company, Inc.
Pearce Services, LLC

MICROWAVE RADIO (TDM, ETHERNET, DUAL TM/ETHERNET)

Arium Stream, LLC
Border States Electric
CommScope
Finley Engineering Company, Inc.
Pearce Services, LLC

MICROWAVE SYSTEMS/DESIGN

Arium Stream, LLC
Border States Electric
CHR Solutions
Finley Engineering Company, Inc.
Maverick Corporation
Pearce Services, LLC

MIMO/MASSIVE MIMO/MU-MIMO

Border States Electric
CommScope
Finley Engineering Company, Inc.
Lindsay Broadband
Pearce Services, LLC

MOBILE BACKHAUL EQUIPMENT

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CommScope
EnerSys
Lindsay Broadband
PPC Broadband

**MOBILE CONTENT
DELIVERY EQUIPMENT**

CommScope

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Fujitsu Network
Communications, Inc.**NEW RADIO
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Finley Engineering Company, Inc.**NON-PSEUDOWIRE-
ENABLED IP**

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Finley Engineering Company, Inc.
Pearce Services, LLC**POINT-TO-POINT SYSTEMS**Arium Stream, LLC
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Finley Engineering Company, Inc.
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Maverick Corporation
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Clearfield
CommScope
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Pearce Services, LLC
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Border States Electric

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SERVICES**Arium Stream, LLC
Border States Electric
CommScope**TOWERS/SUPPORT
STRUCTURES**Border States Electric
Finley Engineering Company, Inc.**TRANSPORTATION AND
LOGISTICS SYSTEMS**Border States Electric
Trimble**WCPE (WIRELESS CPE)/
GATEWAYS**Border States Electric
Lindsay Broadband**WEARABLES**

Border States Electric

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Pearce Services, LLC
Power & Tel
Zyxel Communications**WIFI NETWORKING
SOLUTIONS**Border States Electric
CommScope
Finley Engineering Company, Inc.
Phoenix Contact
Power & Tel
Zyxel Communications**WIFI TECHNOLOGIES
& EQUIPMENT**Border States Electric
CommScope
Finley Engineering Company, Inc.
Lindsay Broadband
Power & Tel
VeEX, Inc.
Zyxel Communications**WIMAX BASE STATIONS**Border States Electric
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Pearce Services, LLC
Wireless Miscellaneous
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3-GIS



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350 Market St. NE, Suite C
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256.560.0744
3-gis.com

Since 2006, 3-GIS has empowered companies to achieve better operating efficiencies and to meet the challenges of building increasingly complex fiber networks. 3-GIS uses a data driven approach based on geospatial reference, rules-based calculations, mobility, and web-based services to realize market opportunities of fiber assets. Our fully-configurable solutions allow users to plan, design, and manage networks; provide real-time data used enterprise-wide; and enable automation for faster service activation, in one seamless system. With development, design services, product support, and operational staff in 5 countries. In 2020, 3-GIS was acquired by SSP Innovations, further strengthening 3-GIS as the market leader in fiber network management.

CATEGORIES: C&E/PLANNING | FTTH | I&M/ NETWORK RELIABILITY/CYBERSECURITY | CLOUD/ IOT/M2M | MAPPING/GIS | NETWORK TRANSFORMATION/SIMPLIFICATION | PUBLIC/PRIVATE PARTNERSHIPS (P3) | TESTING | TRENDS/RESEARCH



A-Aerial Service Company, Inc.

3462 Webster Ave.
Perris, CA 92571
800.256.5186
linemen-tools.com

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you with product selection. A-Aerial also offers boom truck and equipment rentals as well as fiber blowing machine rentals nationwide.

CATEGORIES: C&E/PLANNING



American Power Systems, LLC

26507 79th Ave. South
Kent, WA 98032
520.668.8959
ampowersys.com

American Power Systems offers quality products and services for DC power products, batteries (12v VRLA, 2v VRLA, flooded), DC power (rectifiers, DC plants, chargers, inverters, converters, racks, trays, safety, cabinets).

American Power Systems has emerged as one of the leaders in providing stationary battery power, installations services and battery maintenance programs. We offer full EF&I services in the Telecom, UPS and Energy markets. Engineering, Project Management, Installation & Removal, Site Audits, Load Testing, Logistical Support, Certified Battery Disposal, Training.

CATEGORIES: C&E/PLANNING | CORE/LEGACY | FTTH | I&M/NETWORK RELIABILITY/CYBERSECURITY | CLOUD/IOT/M2M | POWER/SUSTAINABILITY | SAFETY | TESTING | TRENDS/RESEARCH | WIRELESS



Batavia Services, Inc.

1425 Atlantis Dr., Suite A
Webster, TX 77598
281.474.2474
laddermatters.com

Batavia Services is a nationwide on-site ladder inspection and repair company that provides cost-saving solutions to prevent premature ladder failure thereby reducing liability and replacement costs. We maintain and repair ladders according to manufacturer specifications. Our service programs include all types of ladders and ladder rack maintenance and repairs.

CATEGORIES: MISCELLANEOUS | SAFETY



BICSI

8610 Hidden River Parkway
Tampa, FL 33637
813.979.1991
bicsi.org

BICSI is a professional association supporting the advancement of the information and communications technology (ICT) profession and currently serves more than 26,000 members and credential holders. BICSI is the preeminent resource for the Connected World. Headquartered in Tampa, Florida, USA, the BICSI membership spans nearly 100 countries. We provide Education and Training, Conferences and Events, Credentials and Certification Programs, Standards and Best Practices, Reference Manuals, Community and Membership, What is ICT?, Voice/Data/Audio/Video Technologies, Electronic Safety & Security, Project Management (Telecommunications), Design, Integration & Installation of Telecommunications Distributions, All Fiber- and Copper-Based Distribution Systems and Infrastructure, Commercial Transportation of Information and Data, Wireless Networks, Data Center Design, and Outside Plant Cabling.

CATEGORIES: EDUCATION



Arium Stream, LLC



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101 E. Park Blvd.
Plano, TX 75074
972.845.7420 / 844.444.9250
ariumstream.com

Arium Stream, LLC is the designer, developer and distributor of dBm Planner, an all-in-one software suite for Mobile Backhaul engineering. Our key objective is to provide software and services to the wireless industry, for easy, accurate and costless design of high capacity transport networks (i.e. 4G/5G/6G Cellular Systems). Arium Stream, LLC is a registered company located in Dallas area, Texas, United States.

CATEGORIES: MAPPING/GIS | WIRELESS



Black & Veatch



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913.458.2000
bv.com

Ranked one of the top telecommunications firms by ENR, Black & Veatch delivers leading innovative, efficient and field-tested solutions to the rapidly evolving challenges of multi-technology network infrastructure. With more than 110 offices worldwide, we're able to expeditiously scale engineering, procurement and construction services for fiber/broadband, wireless and smart city/IoT demands.

CATEGORIES: C&E/PLANNING | FTTX | PUBLIC/
PRIVATE PARTNERSHIPS (P3) | WIRELESS



Blue Diamond Industries, LLC

4040 Finn Way, Suite 240
Lexington, KY 40517
859.224.0415
bdiky.com

Blue Diamond Industries, a member of the Hexatronic Group of Sweden, is headquartered in Lexington, KY, with manufacturing facilities in Middlesboro, KY, near the Tennessee border and Aubrey, TX, just north of Dallas. Blue Diamond Industries is a valued market leader in providing HDPE (High Density Polyethylene) conduit solutions for the protection of fiber optic, data and power cables. Blue Diamond conduit solutions of duct, innerduct and microduct support the needs of a loyal customer base by providing optimal service and value through delivery, technology, and economic benefit. Blue Diamond's highly efficient manufacturing locations provide the production agility necessary to support the demands of the rapidly growing infrastructure expansion throughout the US market.

CATEGORIES: C&E/PLANNING | FTTX



Border States Electric

2400 38th St. South
Fargo, ND 58104
866.483.7289
borderstates.com

Border States has helped customers build Fiber-to-the-Home networks for over a decade, partnering with the best manufacturers in the industry. These manufacturers, combined with our teams and nearly 100 locations across 22 states, make us the best addition to your project! Employee-owned, customer driven.

CATEGORIES: CORE/LEGACY | FTTX | I&M/
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Budco, Inc.



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2004 N. Yellowwood Ave.
Broken Arrow, OK 74012
800.331.2246
budcocable.com

Budco is a distribution company for cable and fiber construction, installation and identification tools and products. Build It, Install It, Identify It... Budco represents the manufacturers whose products have built the telecommunications industry as we know it. For over 50 years, Budco has been serving the cable professional every step of the way.

CATEGORIES: C&E/PLANNING | CORE/LEGACY | FTTX |
I&M/NETWORK RELIABILITY/CYBERSECURITY | PUBLIC/
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CALIENTÉ
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Caliente, LLC

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Fort Wayne, IN 46803
260.426.3800
calientellc.com

Caliente, LLC is a manufacturer of AC and DC battery heater mats, including constant

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CATEGORIES: MISCELLANEOUS



Celerity Integrated Services, Inc.



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3500 AM Dr.
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CATEGORIES: C&E/PLANNING | TESTING



Charles Industries, LLC

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847.806.6300
charlesindustries.com

Charles Industries, LLC supplies a comprehensive line of Innovative Enclosed Solutions™ for fiber distribution at the customer premises, business, cell tower or other network edge location. Environmental enclosures include buried distribution pedestals and hubs, equipment and power cabinets, handholes, aerial splice closures, demarcation terminals, NID, concealment shrouds, and multi-purpose housings.

CATEGORIES: FTTX | WIRELESS



CHR Solutions

9700 Bissonnet, Suite 2900
Houston, TX 77036
713.351.5111
chrsolutions.com

Building the future of Broadband. CHR Solutions specializes in products and services that enable better broadband. We specialize in B/OSS Business Software solutions, Broadband Engineering services (including outside plant and network design), and Managed IT and NOC services that address the operational and marketplace challenges faced by today's Broadband providers. Our approach ensures our clients improve operations and grow revenue. Our legacy was built by providing comprehensive services to design, build and operate a network. For more information, visit chrsolutions.com.

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Clearfield

7050 Winnetka Ave. N.
Minneapolis, MN 55428
763.476.6866
SeeClearfield.com

Clearfield is "Enabling the Lifestyle that Better Broadband Provides" by removing the barriers to rapid fiber deployments. When it comes to distribution, consolidation, management and protection of fiber, nothing comes close to Clearfield's stream-lined, practical approach. With labor lite technologies and products designed for scalable deployment, craft-friendly operation and unsurpassed performance, Clearfield innovates to reduce your pre-engineering and skilled labor requirements while delivering the lowest total cost of ownership. Whether you're delivering fiber-to-the-business, home, or cell site, Clearfield has the flexibility to deploy the product platform for your entire range of applications.

CATEGORIES: FTTX | WIRELESS



CommScope

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Hickory, NC 28602
828.324.2200
commscope.com

CommScope pushes the boundaries of communications technology with game changing ideas and groundbreaking discoveries that spark profound human achievement. We collaborate with our customers and partners to design, create, and build the world's most advanced networks. It is our passion and commitment to identify the next opportunity and realize a better tomorrow. Discover more at commscope.com.

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Comtest Networks

171 MacFarlane Rd., Unit E
Ottawa, ON K2E 6V4 Canada
877.369.5499
comtestnetworks.com

Comtest Networks enhances the experience of broadband for millions of customers around the world. Comtest improves the quality and reliability of next-generation networks while enhancing the customer experience overall. Comtest designs, engineers, and manufactures all of our products here in North America and we are changing the landscape of Broadband through continuous innovation.

CATEGORIES: C&E/PLANNING | CORE/LEGACY | FTTX | NETWORK TRANSFORMATION/SIMPLIFICATION

CORNING

Corning

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Charlotte, NC 28216
828.901.5000
corning.com/optical-communications

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CATEGORIES: FTTX



Craftmark Cable Markers

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Fort Worth, TX 76119
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craftmarkid.com

Craftmark is a world leader in manufacturing fiber optic cable markers, tags, signs, labels and decals for both underground as well as aerial installations. Craftmark's Ultra-Mark Snap On cable marker is the standard of the industry with an outdoor life of 7-10 years.

CATEGORIES: SAFETY



Cyber Power Systems (USA), Inc.



4241 12th Ave. E., Suite 400
Shakopee, MN 55379
877.297.6937
cyberpowersystems.com

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CATEGORIES: FTTX | POWER/SUSTAINABILITY



Dura-Line



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800.847.7661
duraline.com

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CATEGORIES: C&E/PLANNING | CORE/LEGACY | FTTX



Dycom Industries, Inc.



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11780 U.S. Hwy 1, Suite 600
Palm Beach Gardens, FL 33408
561.627.7171
dycomind.com

Dycom Industries, Inc. is a leading provider of engineering, construction, program and project management, material provisioning, subscriber installations, maintenance, and underground facility locating services to the telecommunications and utility industries. Dycom is composed of over 40 operating companies operating in 50 states with hundreds of field offices in North America. We have engineered and constructed hundreds of thousands of miles of fiber meeting the needs of our customers while upholding the customer service and quality standards our

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CATEGORIES: C&E/PLANNING | FTTX | I&M/
NETWORK RELIABILITY/CYBERSECURITY | WIRELESS



East Penn Manufacturing Co.

PO Box 147
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610.682.6361
eastpennmanufacturing.com

Since 1946, East Penn Manufacturing Co. has developed an enviable reputation for world-class products. East Penn is a leading manufacturer of Deka valve-regulated lead acid (VRLA) batteries and battery systems including the revolutionary Deka Fahrenheit in both 12- and new 2-volt configurations. Our diverse product line covers a wide variety of Reserve Power applications including Telecommunications, UPS systems, Utilities, Switchgear, Solar, and Emergency Lighting. Our customer centric focus, paired with our premium product line and lifelong commitment to sustainability are a few key reasons why East Penn is perfectly positioned to be your energy storage partner for life.

CATEGORIES: POWER/SUSTAINABILITY | WIRELESS



EnerSys

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Reading, PA 19605
610.208.1991
enersys.com

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ESPi



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CATEGORIES: C&E/PLANNING | FTTX | MISCELLANEOUS | POWER/SUSTAINABILITY



Esri

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Redlands, CA 92373
909.793.2853
esri.com

Esri applies "The Science of Where" to unlock data's full potential in every telecommunication organization. We continue to pioneer real-world problem solving using geographic information systems (GIS). Our mapping and analytics connect everyone, everywhere through a common visual language that inspires positive change in telecom industry and the communities they serve. Using this powerful platform to reveal deeper insights in their data, Esri users are creating the maps that run the world.

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Exeltech

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Exeltech manufactures pure sine wave DC to AC power inverter systems that range from 125 Watts to 180 Kilowatts. We offer over 30,000 different system configurations to choose from and can customize systems to meet specific specifications. We were founded based on the philosophy that efficiencies in the manufacturing process through product design, coordinated with facility layout, is paramount to productivity and the key to a quality inverter product. Our commitment to quality and total customer satisfaction has allowed us to become innovators in the DC to AC power product market for over 30 years.

CATEGORIES: MISCELLANEOUS | POWER/
SUSTAINABILITY



Fiber Optics Network Cable Solutions

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Laredo, TX 78045
888.227.1072
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We are a design, manufacturing and sales organization that provides turnkey fiber optic solutions to broadband companies in the US, Canada and the Caribbean through a team committed to our customer satisfaction. FONCS® has a complete line of fiber optic products, pole hardware, splice closures, fiber optic cable, fiber optic assemblies and more.

CATEGORIES: FTTX



Fiber Plus International

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gofiberplus.com

Fiber Plus International designs and manufactures fiber optic connectivity

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CATEGORIES: FTTX | TESTING



Fiberdyne Labs, Inc.

127 Business Park Dr.
Frankfort, NY 13350
800.894.9694
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CATEGORIES: FTTX



FIBERONE

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866.434.8877
fiberonellc.com

FIBERONE designs, manufactures, and supplies a complete line of fiber optic connectivity products for communication networks. Typical applications include FTTx, Telecommunications, CATV and Data communication systems. Fiber Network Products include, Optical Splitters, Fiber Jumpers, Fiber Terminals, Fiber Cassettes, Fiber Distribution Hubs, Fiber Cabinets, WDM, CWDM, DWDM and Fiber Patch Panels.

CATEGORIES: FTTX | TRENDS/RESEARCH



FiberStory

PO Box 1518
Port Hadlock, WA 98339
425.830.5939
fiber-story.com

FiberStory provides consulting, customized training, and speaking at conferences and meetings. Specializing in fiber optics the company provides technology assessments of the physical plant in dealing with migrations from legacy FTTx systems, TWDM and Terabit transmission systems. FiberStory is a member of the Fiber Broadband Associations Technology and the Utility Telecom Council's (UTC) Fiber Optic Committees while also working with the Optical Society of America (OSA) in coordinating special events including FTTH, 100 Gb/s+, and Test and Measurement center. FiberStory is vendor neutral and also writes articles for publications and organizations.

CATEGORIES: EDUCATION | FTTX



Finley Engineering Company, Inc.

104 East 11th St.
Lamar, MO 64759
417.682.5531
finleyusa.com

At Finley, we don't just claim to be experts in rural Broadband funding and deployment, we have a proven track record that is unparalleled in the industry. We have helped secure millions of dollars in grants and loans on behalf of our clients. And after more than 68 years and hundreds of implementations, we've seen just about everything, and crafted the right future-ready solutions for even the toughest deployment challenges. From the initial feasibility study to the deployment of your network, we are with you every step of the way, your trusted partner from start to finish.

CATEGORIES: C&E/PLANNING | FTTX | MAPPING/
GIS | NETWORK TRANSFORMATION/SIMPLIFICATION | POWER/SUSTAINABILITY | PUBLIC/PRIVATE PARTNERSHIPS (P3) | WIRELESS



FS3, Inc.



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9030 64th St. NW
Annandale, MN 55302
320.274.7223
fs3inc.biz

FS3 began in July of 2003 as a material supplier to the Utility Industry focusing on underground materials like conduit, cable installation equipment, handholes, work-zone safety, PPE and related items. Through the years, we have been adding products at the request of our customers and we now offer HDD tooling and accessories, various styles of reel trailers, custom truck-mount reel handling equipment, innovative restoration equipment and much more! Please contact us for product quotations and to check for product availability. We like the challenge of sourcing new products and would appreciate the opportunity to provide this service on your behalf.

CATEGORIES: C&E/PLANNING | CORE/LEGACY | FTTX | I&M/NETWORK RELIABILITY/CYBERSECURITY | MISCELLANEOUS | SAFETY | TESTING



Fujitsu Network Communications, Inc.

2801 Telecom Pkwy
Richardson, TX 75082
972.690.6900
fujitsu.com/us/products/network/

Fujitsu Network Communications, Inc. customizes digital transformation solutions for network operators, service providers and content providers. We combine best-in-class hardware, software and services to enable cost savings, faster services delivery and improved network performance. Working closely with our ecosystem partners, we design, build, operate and maintain better networks for the connected world.

CATEGORIES: C&E/PLANNING | CORE/LEGACY | FTTX | I&M/NETWORK RELIABILITY/CYBERSECURITY | NETWORK TRANSFORMATION/SIMPLIFICATION | PUBLIC/PRIVATE PARTNERSHIPS (P3) | WIRELESS



GMP Tools

3111 Old Lincoln Hwy
Feasterville-Trevoze, PA 19053
215.357.5500
gmptools.com

General Machine Products is a manufacturer of a wide range of products for the telecommunications, power utility and cable television industries, and the contractors who serve them. The company's total capabilities include the development, prototyping and manufacturing of Aerial Cable Construction Equipment & Tools, Copper & Fiber Cable Placing and Blowing Equipment, Manhole & Duct Tools, Installer's Hand Tools, Warning Signs, Tents and Tarps, Winches, Motor Vehicle Accessories, Specialty Hardware, Related Supplies, and more!

CATEGORIES: C&E/PLANNING | CORE/LEGACY | POWER/SUSTAINABILITY | SAFETY



GoFoton



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28 World's Fair Dr.
Somerset, NJ 08873
732.469.9650
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GoFoton brings innovation to the market with proven expertise in optics and photonics that solves real world problems for its customers with a scalable and customized approach. The company serves the telecom and data center markets with long haul, metro, and broadband wireline and wireless access applications, and also supplies optical materials and components to the imaging, medical, and instrumentation industries. A global enterprise with sales offices in the US, Europe, and Japan, GoFoton maintains R&D and manufacturing facilities in the US, Japan, China, and the Philippines.

CATEGORIES: C&E/PLANNING | CORE/LEGACY | FTTX | CLOUD/IOT/M2M | MISCELLANEOUS | NETWORK TRANSFORMATION/SIMPLIFICATION | TRENDS/RESEARCH | WIRELESS



Graybar



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Graybar, a Fortune 500 corporation and one of the largest employee-owned companies in North America, is a leader in the distribution of high quality electrical, communications, industrial, security and networking products, and specializes in related supply chain management and logistics services. Through its network of more than 290 North American distribution facilities, it stocks and sells products from thousands of manufacturers, serving as the vital link to hundreds of thousands of customers. For more information, visit graybar.com or call 1.800.GRAYBAR.

CATEGORIES: FTTX | PUBLIC/PRIVATE PARTNERSHIPS (P3) | SAFETY | TESTING | WIRELESS



GS Yuasa Energy Solutions, Inc.

1150 Northmeadow Pkwy, Suite 110
Roswell, GA 30076
800.472.2879
GSYuasa-ES.com

GS Yuasa Energy Solutions, Inc. is a subsidiary of GS Yuasa Group, the world's second largest battery manufacturer which specializes in lead acid, lithium, and other battery chemistries. In the US, GS Yuasa's focus is on VRLA products for telecommunication, FTTX, UPS, electrical utility, security, renewable energy, and related markets.

CATEGORIES: POWER/SUSTAINABILITY



Hexatronic

4040 Finn Way, Suite 240
Lexington, KY 40517
859.554.8877
hexatronic.com

Hexatronic offers a wide selection of passive fiber system solutions and products for FTTH, metro, access and transportation networks. Our complete end-to-end system solutions utilize blown fiber technology and include all components needed to build the entire cabling infrastructure as well as providing the capacity for upgrading and extending the network. Our solutions deliver the lowest total cost of ownership along with the highest levels of system flexibility, scalability, and speed of installation. Based on the extensive experience from the companies within Hexatronic, we are able to offer one of the broadest fiber optic product portfolios.

CATEGORIES: FTTH



INNO Instrument America, Inc.



2010 Valley View Ln., Suite 140
Dallas, TX 75234
214.484.3627
innoinstrument.com

Founded in 2007, INNO Instrument is a global company, headquartered in Korea, with 7 branch offices and over 120 distributors worldwide. Located in Dallas, Texas, INNO Instrument America, Inc. is dedicated to support and service in America. INNO Arc-fusion, fiber-splicers, are truly innovative products designed to satisfy the stringent requirements of the fiber industry. The complete line of View fiber-splicers, high-precision cleavers, and accessories are world-class products utilized in the installation, maintenance, monitoring, and trouble-shooting of optical networks. With the evolution of core technologies, we draw upon a wealth of fiber experience and innovation to develop intelligent fusion splicers, cleavers, and related accessories to connect the world.

CATEGORIES: FTTH | MAPPING/GIS | TESTING | WIRELESS



IQGeo



1670 Broadway, Suite 2215
Denver, CO 80202
720.577.4732
iqgeo.com

IQGeo provides award-winning geospatial software solutions to telecommunication and utility network operators from large multinationals to small regional providers. We work with these operators to meet their network transformation ambitions to deliver the latest fiber and 5G technology and modernize and decarbonize utility grids. The IQGeo and OSPlinsight software suite achieves this by improving productivity and collaboration across planning, design, construction, maintenance, and sales processes, while reducing costs and operational risks. Our software easily integrates with a wide range of data sources to create and maintain a single accurate view of increasingly complex network assets that is easily accessible by anyone, anywhere. Whether using our enterprise IQGeo network design and management software, or our targeted OSPlinsight fiber network documentation and design software, we enable a "System of Action" that accelerates processes, breaks down information silos, and improves data quality.

CATEGORIES: C&E/PLANNING | FTTH | MAPPING/GIS | NETWORK TRANSFORMATION/SIMPLIFICATION



Jameson, LLC



1451 Old N. Main St.
Clover, SC 29710
800.346.1956
jamesontools.com

Jameson is a leading supplier of tools and equipment for overhead and underground broadband cable installation and maintenance, professional tree trimming/line clearance products, and high-performance equipment lighting, work lighting, and

wide-area lighting solutions. Wherever the job takes you, count on Jameson.

CATEGORIES: C&E/PLANNING | CORE/LEGACY | FTTH | I&M/NETWORK RELIABILITY/CYBERSECURITY | MISCELLANEOUS | SAFETY | WIRELESS



KGPCo

3305 Hwy 60 West
Faribault, MN 55021
800.328.5142
kgpco.com

KGPCo is a key strategic partner to the world's leading communication and technology companies creating the next generation of networks. By uniquely combining Network Services and Supply Chain Solutions to build, optimize, and maintain networks, our team's expertise enables our customers to navigate today's challenges, implement tomorrow's innovations, and build the future. The KGPCo OneTouch™ provides a single source for everything from design and architecture to production and sourcing to installation and support. From ground to cloud, KGPCo is the only company in the industry that offers a complete range of solutions and an integrated approach to build, optimize, and maintain networks.

CATEGORIES: FTTH | WIRELESS



Laser Tech

6912 S Quentin St., Suite A
Centennial, CO 80112
303.649.1000
lasertech.com/Telecommunication

Laser Tech's TruPulse laser rangefinders bring accuracy and efficiency to your workflow to create a powerful solution that can streamline your operation. Add our data collection apps to improve productivity in both the field and office by choosing the right amount of detailed data needed to complete a project. Whether your crew needs to measure encroaching vegetation, determine pole inventory, attachment heights or distances, or calculate span, sag, and tension values, laser offset mapping is a complete solution that equips users with precise, reliable, and repeatable



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lead battery technology to reclaim lead, acid and plastics

measurements that are needed to perform any job function, while remaining in safe terrain.

CATEGORIES: I&M/NETWORK RELIABILITY/
CYBERSECURITY | SAFETY | TESTING



LEOCH® Battery Corporation

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Foothill Ranch, CA 92610
949.588.5853
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LEOCH is a global leader in battery manufacturing. We offer NEBS™ Level 3 certified battery solutions for both outside plant and central office battery systems. Our patented designs include: Pure Lead, Tubular GEL, Tubular Flooded, Hybrid GEL, Lithium and much more! Whether your requirement demands long life, maximum performance, partial-state-of-charge operation or unique footprints -- we have the right battery to fit your needs!

CATEGORIES: POWER/SUSTAINABILITY



Lindsay Broadband



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Peterborough, ON K9J 6X6 Canada
705.742.1350
lindsaybb.com

For 65+ years, service providers worldwide have been trusting Lindsay Broadband with their networks. Why? Because Lindsay's end-to-end solutions are built to withstand nature's extremes, maintain network reliability, and meet custom requirements. Lindsay understands the cable, wired and wireless communications industries. Our engineering teams design cutting-edge solutions, and support legacy technologies/offers to provide our customers with the exact solutions they need to keep them connected. As a technology leader, Lindsay offers engineering, design assistance, customized solutions, and training to complement our portfolio of solutions. Lindsay's RF, optical, powering and business connectivity solutions connect today's most discriminating

operators with demanding end users around the world. Discover more at lindsaybb.com.

CATEGORIES: C&E/PLANNING | CORE/LEGACY |
FTTX | CLOUD/IOT/M2M | MISCELLANEOUS |
POWER/SUSTAINABILITY | PUBLIC/PRIVATE
PARTNERSHIPS (P3) | SAFETY | WIRELESS



MacLean Network Solutions

610 Pond Dr.
Wood Dale, IL 60191
800.350.1650
macleannetworksolutions.com

MacLean Network Solutions offers a comprehensive line of Outside Plant Hardware for all your pole to pole, pole to house, guying and anchoring, and grounding and bonding needs. We serve all areas of the Communications market, which includes Telephone, Broadband, Satellite, Electrical Coop, and Wireless/Small Cell applications. Our domestic manufacturing footprint allows us to provide the highest level of service, and we proudly back our products with application training and support, which MacLean Network Solutions uniquely provides to the market.

CATEGORIES: C&E/PLANNING



Maverick Corporation

One Westinghouse Plaza, Suite D6
Boston, MA 02136
617.361.6700
maverickcorporation.com

Maverick Corporation is a full-service Engineering, Procurement, Construction and Operator of large-scale communications and power networks. We are headquartered in Boston, with offices throughout the country as well as in Europe, and have completed projects throughout the world. Our dedicated global team of over 175 deliver detailed design, innovative engineering, professional installation, and comprehensive infrastructure management. We provide these services to municipal and state governments, power companies, communications service providers, as well as oil and gas companies throughout the world. We pride ourselves on our unparalleled track record for quality and

our unwavering commitment to safety.

CATEGORIES: C&E/PLANNING | FTTX | I&M/
NETWORK RELIABILITY/CYBERSECURITY | CLOUD/
IOT/M2M | MAPPING/GIS | MISCELLANEOUS |
NETWORK TRANSFORMATION/SIMPLIFICATION |
POWER/SUSTAINABILITY | SAFETY | WIRELESS



MaxCell



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600 Plum Creek Dr.
Wadsworth, OH 44281
888.387.3828
maxcell.us

MaxCell's conduit maximization solutions allow operators to maximize their OSP and ISP network capacity while reducing total system cost. MaxCell also provides faster deployments, lower costs and preserves future bandwidth space. The MaxSpace service reclaims existing conduit space by safely removing innerduct overactive cables.

CATEGORIES: C&E/PLANNING | FTTX | CLOUD/
IOT/M2M

Megger

Megger

2621 Van Buren Ave.
Norristown, PA 19403
610.676.8500
us.megger.com

For over 130 years, Megger has been the premier provider of portable electric test and measurement instruments. Megger is known as the expert in qualifying the telecom power grid, and is best known for its world famous range of insulation testers. Precision test equipment for communications applications is essential to a professional test and installation engineer's job. While the communications model means you must work across all 5 layers (physical, data, network, transport and application) Megger's test equipment ensures the physical transmission layer, connectors and interconnection devices work correctly, and also provide essential connectivity information from coupled devices for added-value service issues on the remaining layers. Effective 4/1/22, new address is: 400 Opportunity Way, Phoenixville, PA 19460.

CATEGORIES: TESTING



Michels Power, Inc.

1775 E. Shady Ln.
Neenah, WI 54956
920.720.5200
michels.us

Michels Power, Inc. provides overhead power line and underground utility construction for your electric utility system. Our project leadership team is accomplished at completing all facets of large-scale electric utility system construction from small-scale systems to more complex projects. Our comprehensive project oversight ranges from logistics and scheduling to quality assurance and construction. Our experience includes EPC contracts on significant power projects involving transmission lines, structure foundations, heavy civil and horizontal directional drilling. We are proud to be one of the largest private power utility electrical contractors in the United States.

CATEGORIES: CORE/LEGACY | FTTH | MAPPING/GIS | POWER/SUSTAINABILITY | PUBLIC/PRIVATE PARTNERSHIPS (P3) | TESTING | WIRELESS



Millennium

120 S. Wright St.
Delavan, WI 53115
866.249.8705
mymillennium.us

Connecting communities across America since 2004, Millennium is the national distributor of fiber optic materials for broadband networks. By focusing on client-driven inventory, flexible financing options, and a personalized approach to service, we partner with our clients to build fiber networks. Millennium offers dedicated support for your projects to the very last mile.

CATEGORIES: C&E/PLANNING | CORE/LEGACY | FTTH | MAPPING/GIS | MISCELLANEOUS | PUBLIC/PRIVATE PARTNERSHIPS (P3) | TESTING



Milwaukee Tool

13135 W Lisbon Rd.
Brookfield, WI 53005
317.502.3788
milwaukeeetool.com

Since the company began in 1924, Milwaukee Tool has led the industry in developing innovative solutions that deliver increased productivity and unmatched durability for professional construction users. Whether it is through our world-leading M12™ and M18™ cordless systems, the ground-breaking performance of our M12 and M18 FUEL™ products, jobsite lighting, time-saving accessories, or innovative hand tool and storage products, we are dedicated to delivering a continuous flow of advanced, trade-specific solutions. We invest the time to work side-by-side with real users to understand the demands of a constantly changing workplace and how we can best deliver solutions for a safer, more productive jobsite. Through a thorough evaluation of the job at hand (the frustrations, needs, and previous limitations) we set out to completely rethink a solution and deliver the game-changing innovation seen across all our product lines. Milwaukee Tool is not simply a manufacturer -- we are progressive problem solvers.

CATEGORIES: SAFETY



MOUNTAIN, LTD.

52 Farm View Dr., Suite 201
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800.322.8627
mountainltd.com

Since 1979, MOUNTAIN, LTD. has successfully created and supported engineering solutions for traditional and wireless telecom providers across the United States. As a national leader in the industry, we provide high-quality engineering, on-time service, and skilled personnel paired with innovative technology and creative strategies. Specialties include OSP/ISP engineering, design, permitting, Right-Of-Way and CAD. Our expansive project management teams support traditional and wireless engineering work including resource management, milestone tracking, real-time

reporting, and turnkey delivery. Beyond engineering, we can supplement your team with qualified personnel across diverse industries for any length of engagement, with our internal teams offering seamless personnel management.

CATEGORIES: C&E/PLANNING | MAPPING/GIS



MP Nexlevel

500 County Rd. 37 E.
Maple Lake, MN 55358
320.963.2400
mpnexlevel.com

For more than 5 decades, MP Nexlevel has offered expertise in planning, installation and maintenance of aerial and underground infrastructure work. Our comprehensive construction services, FTTH, directional drilling, splicing, plowing, trenching and more cover the entire spectrum of overhead and underground infrastructure installation. Our experienced team of project managers, foremen, journeymen, linemen, and cable installers have the qualifications, certifications and technical training to get the job done.

CATEGORIES: FTTH | WIRELESS



MPINarada



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Newton, MA 02464
800.982.4339
mpinarada.com

MPINarada is a leader of one of the broadest and most reliable VRLA and lithium battery solutions for telecom, data center, colocation, edge, grid, microgrid, and C&I energy storage. MPINarada provides outstanding sales support, engineering and design, and has multiple warehouse facilities.

CATEGORIES: C&E/PLANNING | POWER/SUSTAINABILITY | SAFETY | TRENDS/RESEARCH | WIRELESS



Multicom, Inc.

1076 Florida Central Pkwy
Longwood, FL 32750
800.423.2594
multicominc.com

Established in 1982 and celebrating nearly 40 years as an industry leader, Multicom is a manufacturer and full-line stocking distributor for end-to-end integration of communication solutions. Multicom stocks over 20,000 products that are produced and assembled at Multicom factories, in addition to more than 425 of the world's other major manufacturers. These products are used to acquire, process, and distribute television, data, voice, security, and traffic control signals over fiber optic, copper, and coax cable. Multicom and the Multicom logo are registered trademarks of Multicom, Inc. Multicom is a Service-Disabled Veteran-Owned Small Business (SDVOSB).

CATEGORIES: FTTX | TESTING



Multilink, Inc.

580 Ternes Ln.
Elyria, OH 44035
440.366.6966
gomultilink.com

Multilink is a telecom industry-leading designer, developer, and manufacturer of OSP and LAN PREMISE products including patch and splice enclosures, cables, assemblies, optical splitters, and cabinets. We also offer a large variety of fiber distribution hub cabinets and architectural raceway molding for existing networks, 5G builds, and future network infrastructures.

CATEGORIES: FTTX



Netcon



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We provide a software ConnectMaster that maximizes savings with enhanced GIS technology. Planning: technical choices, target areas and cost estimation. Design: faster design and better BOM accuracy. Construction: mitigation of errors, work orders and project commissioning. Operation: faster viability studies, field support, capacity management, geo-marketing. Maintenance: faster response to failures.

CATEGORIES: FTTX | MAPPING/GIS



A Furukawa Company

OFS



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2000 NE Expressway
Norcross, GA 30071
888.342.3743
ofsoptics.com

OFS is a world-leading designer, manufacturer and provider of optical fiber, fiber optic cable, connectivity, fiber-to-the-subscriber (FTTx) and specialty photonics products. We provide reliable, cost-effective solutions for a broad range of applications including telecommunications, medicine, industrial automation, sensing, government, aerospace and defense. These products help our customers meet the needs of consumers and businesses, both today and into the future. Headquartered in Norcross (near Atlanta) Georgia, USA, OFS is a global provider with facilities in China, Denmark, Germany, Russia and the United States. OFS is part of Furukawa Electric Company, a multi-billion dollar leader in optical communications.

CATEGORIES: FTTX | MISCELLANEOUS



Oldcastle Infrastructure

7000 Central Pkwy NE, Suite 800
Atlanta, GA 30328
888.965.3227
oldcastleinfrastructure.com

Oldcastle Infrastructure provides the largest product breadth of concrete, polymer, and composite underground/at grade enclosures protecting essential infrastructure connections for Communications and Telecom projects. Oldcastle Infrastructure consists of multiple production facilities in the United States to meet the growing demands of customers. Oldcastle Infrastructure is a part of CRH, a global leader in building materials. For more information, visit oldcastleinfrastructure.com.

CATEGORIES: FTTX | MAPPING/GIS | PUBLIC/PRIVATE PARTNERSHIPS (P3) | WIRELESS



Pearce Services, LLC

1222 Vine St.
Paso Robles, CA 93446
805.467.2528
pearce-services.com

Founded in 1998, Pearce Services is a leading self-performing telecom infrastructure service provider, specializing in repairs, maintenance, installations, and engineering for our nation's mission-critical infrastructure. Our professional and safe Field Technicians support our customers around the clock to optimize response times, ensure quality, accountability, and safety. Our logistical density and niche technical expertise delivers better quality and response times at competitive prices.

CATEGORIES: C&E/PLANNING | CORE/LEGACY | FTTX | CLOUD/IOT/M2M | MAPPING/GIS | SAFETY | WIRELESS



Petroflex North America

1305 N. I-35
Gainesville, TX 76240
940.668.7283
petroflexna.com

Headquartered in Gainesville, Texas, the Petroflex family was founded by Pete and Susie Shauf in 1983. The company is a leading extruder of HDPE conduit and accessories. We specialize in preinstalling cable inside our conduit for the Cableguard™ products. Products are sold throughout the United States directly to a network of wholesale distributors. The manufacturing facilities operate 24 hours a day, 7 days a week. Petroflex believes customer retention is directly tied to service and quality of product. With this guiding principle in mind, we offer the "Picture Perfect" system in order to better serve and evaluate the needs of our customers. As part of this program, a package is sent with every order that includes the bill of lading, packing slip, a picture of the product as it left the warehouse and a postcard for the recipient to report to Petroflex the condition of the product upon arrival.

CATEGORIES: CORE/LEGACY | MISCELLANEOUS



Phoenix Contact

586 Fulling Mill Rd.
Middletown, PA 17057
717.944.1300
phoenixcontact.com/us

Phoenix Contact is a global market leader based in Germany. We produce future-oriented components, systems, and solutions for electrical controls, networking, and automation. With a worldwide network reaching across more than 100 countries with over 17,100 employees, we maintain close relationships with our customers, something we believe is essential for our shared success. Phoenix Contact provides surge protection, connection technology, and automation control solutions to the ICT and telecommunications industry. Our wide range of products can optimize power and fiber distribution, so you can improve management of virtually every critical function of network reliability, including protection, connection, monitoring, and communications.

CATEGORIES: I&M/NETWORK RELIABILITY/
CYBERSECURITY | CLOUD/IOT/M2M | POWER/
SUSTAINABILITY | SAFETY | WIRELESS



Plumettaz America Corp.



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CATEGORIES: C&E/PLANNING | EDUCATION | FTTX |
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MISCELLANEOUS | PUBLIC/PRIVATE PARTNER-
SHIPS (P3)

existing telephone pairs or coax. Serving carriers and ISPs for over 50 years.

CATEGORIES: C&E/PLANNING | CORE/LEGACY |
FTTX | I&M/NETWORK RELIABILITY/CYBERSECURITY |
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WIRELESS



Positron, Inc.

5101 Buchan St., Suite 220
Montreal, QC H4P 2R9 Canada
514.345.2220 / 888.577.5254
positronpower.com

Positron manufactures testers for energized insulators on high voltage transmission lines and on equipment in substations to prevent power outages, equipment damage and eliminate danger to personnel. Used for preventative maintenance and for safety to ensure safe conditions for personnel working in high voltage environments. Positron also provides high voltage isolation and protection products to protect communication equipment and personnel in substations and other high voltage facilities.

CATEGORIES: C&E/PLANNING | CORE/LEGACY |
MISCELLANEOUS | POWER/SUSTAINABILITY |
SAFETY | TESTING | WIRELESS



Positron Access Solutions Corp.



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at www.isebuyersguide.com

5101 Buchan St., Suite 220
Montreal, QC H4P 2R9 Canada
514.345.2220 / 888.577.5254
positronaccess.com

Positron's G.hn Gigabit Access Multiplexer (GAM) extends Gigabit services in buildings (MDU/MTU) in hours without the need for construction disruption to extend fiber at 25% of the cost. This innovation earned Positron the honor of Highly Commendable Global Telecoms (GLOTEL) Award for Fixed Network Evolution in 2021. It enables an ROI of 4-5 months, reduced CapEx and the fastest time to revenues. In service at 75 carriers, the GAM is a fully featured carrier grade product deployed indoors or outdoors that reuses the



Power & Tel

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Piperton, TN 38017
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ptsupply.com

Longevity, Diversity, and Value -- Founded in 1963, and spanning 3 generations, Power & Tel is a national stocking distributor of communication equipment enabling connectivity -- providing even the most ancillary of products. We ensure your entire list of materials is well-advised and on the jobsite, allowing contractors, carriers, and service providers the ability to finish projects on time and within budget.

CATEGORIES: C&E/PLANNING | CORE/LEGACY |
FTTX | CLOUD/IOT/M2M | MISCELLANEOUS |
POWER/SUSTAINABILITY | SAFETY | TESTING |
TRENDS/RESEARCH | WIRELESS



Powerline Hardware

6841 Phillips Pkwy Dr. S.
Jacksonville, FL 32256
904.288.9880
powerlinehardware.com

Powerline Hardware (PLH) is a world-class global provider of high-quality Distribution Hardware, Insulators, Cutout Switches, Anchoring and Grounding Products, Aerial, Telecom and Cable TV hardware. PLH has a long-established tradition of excellence in our marketplace. Our size and ability, combined with our commitment to meet the different needs of our customers, has provided us with client relationships that span decades. PLH was established in 1989. Located in Jacksonville, FL, we carry a large inventory of ready-to-ship products for your aerial plant and drop installation needs.

CATEGORIES: CORE/LEGACY | MISCELLANEOUS | POWER/SUSTAINABILITY | PUBLIC/PRIVATE PARTNERSHIPS (P3)



PPC Broadband

6176 E. Molloy Rd.
East Syracuse, NY 13057
800.800.6652
ppc-online.com

PPC is a global connectivity leader for next-generation broadband, video and wireless service providers. For more than 75 years, the world's largest communications companies have counted on PPC to equip their diverse range of network architectures. Known for technical innovation, PPC holds more patents in connector technology than any other company in the world and offers a broad range of end-to-end copper and fiber solutions, firmly positioning PPC to support the evolving world of next-generation networks. And today, with world-class engineers and state-of-the-art testing facilities, our focus on innovation is as strong as ever.

CATEGORIES: CORE/LEGACY | FTTX | WIRELESS



Pro-Line Safety Products

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West Chicago, IL 60185
800.554.3424
prolinesafety.com

Pro-Line Safety is a global leader in R&D, engineering, and manufacturing of utility marking and locating systems. We offer complete solutions for above and underground utility structures, from tracer wire and marking tape to stake flags and marking posts and more.

CATEGORIES: C&E/PLANNING | MAPPING/GIS | SAFETY



Pro-Mark Utility Supply, Inc.

2603 Pacific Park Dr.
Whittier, CA 90601
562.692.6161
promarksupply.com

Pro-Mark Utility Supply, Inc. is a leading manufacturer of Marker Posts, Utility Signs and Terminal Enclosures with over 25 years of experience in identifying and marking buried cable and fiber optic lines. Pro-Mark's marking systems and products are made to perform, identify and prevent damage to avoid dangerous accidents.

CATEGORIES: C&E/PLANNING | SAFETY



Prysmian Group

4 Tesseneer Dr.
Highland Heights, KY 41076
859.572.0000
na.prysmiangroup.com

Prysmian Group serves the most comprehensive range of markets including power transmission and distribution, telecommunications, construction and infrastructure, energy projects and specialty industries for countless applications in the United States and Canada. For the Energy industry, Prysmian Group

designs and produces cables and solutions for the transmission and distribution of low, medium, high and extra high voltage systems. For the Telecom industry, the Group is the world's largest provider of cutting-edge cables for voice, video and data transmission, offering a comprehensive range of optical fiber and copper cables and connectivity systems.

CATEGORIES: FTTX | CLOUD/IOT/M2M | WIRELESS



Quest Controls

208 9th Street Dr. West
Palmetto, FL 34221
941.729.4799
questcontrols.com

Quest Controls' solution is designed for today's telecom providers. By combining hardware, software, and responsive end-to-end customer service, clients get an unmatched suite that meets their requirements. Our remote monitoring reduces service costs by identifying and resolving issues before they become major network events and saves additional money by managing our customer's energy systems.

CATEGORIES: C&E/PLANNING | I&M/NETWORK RELIABILITY/CYBERSECURITY | POWER/SUSTAINABILITY



R&M USA, Inc.



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840 Yosemite Way
Milpitas, CA 95035
408.945.6626
rdm.com

Since 1964, R&M has been developing and producing high-quality, future-proof connection and distribution technology. R&M is now one of the world's leading manufacturers and suppliers of innovative cabling systems for data and communication networks. Both quality-conscious and innovative, R&M covers the entire range of copper-based and fiber-optic connectivity. R&M cabling solutions can be used in: Telecommunication and Internet networks, Fiber-to-the-Home and smart cities, all kinds of data centers, local data networks for campuses, offices, intelligent buildings, apartments, and

Internet of Things. Software for automated network management rounds out the portfolio. Clients who opt for R&M invest in sustainably reliable, scalable, and migration-capable infrastructures. The result: Networks with guaranteed, measurably superior performance. The future of digital communication is secured.

CATEGORIES: FTTX



Rainbow Technology Corporation

261 Cahaba Valley Pkwy
Pelham, AL 35124
800.637.6047
rainbowtech.net

We market specialty OSP products to utility and industrial markets, nationally and internationally. Our product line includes Wasp and Ant Sprays, Fire Ant Products, Insecticides, Insect Repellents, Herbicides, Lubricants, Personal Protection Equipment, Spill Kits, Hand and Tool Cleaners, Sunscreens, Marking Paints, Fiber Optic Cleaning Products, Sealing Foams, Satellite Post Foam and Augers, Sealants, and much more.

CATEGORIES: MISCELLANEOUS | SAFETY



Reef Industries



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9209 Alameda Genoa Rd.
Houston, TX 77075
800.231.6074
reefindustries.com

Reef Industries is a plastic film and laminate manufacturer with more than 60 years of experience. We specialize in custom plastic laminates that help customers tackle the challenges they face when needing solutions to safeguard and prolong the service life of their investments. Our products range from covers that protect equipment during outdoor storage to underground marking tape that ensures buried utilities are protected from accidental dig-ins. Reef Industries provides customers with dependable and proven high-quality materials for long-term performance.

CATEGORIES: SAFETY



Ripley Tools, LLC

46 Nooks Hill Rd.
Cromwell, CT 06416
800.528.8665
ripley-tools.com

Ripley Tools, LLC is a quality product design and manufacturing company founded and based in the US for over 80 years. With a full line of wire and cable preparation tools, we are proud to serve technicians and installers across a variety of global markets including the CATV, telecommunications, electrical, wireless, fiber optic and utility industries.

CATEGORIES: FTTX | TESTING

Rosenberger Site Solutions

Rosenberger Site Solutions, LLC

PO Box 4268
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337.598.5250
rosenbergeronline.us

Rosenberger Site Solutions, LLC offers a fully developed system solution based on high-quality cables, connectors and assembly accessories for connection from the antenna down to the base station. Products Include: Fiber-to-the-Tower, Small Cell Solutions, The Qube-Multiple Radio Shroud, Hybrid Cables, DAS Components, Coaxial Cables, Connectors, Jumper Assemblies, Installation Tools and Accessories, PIM Analyzers, Antennas and mounts, Items etc. Call 866.598.5250 or visit www.RosenbergerOnline.us.

CATEGORIES: FTTX



Ross FiberOptic, LLC

5 Red Hill Rd.
Aston, PA 19014
610.331.0639
rossfibersolutions.com

Ross FiberOptic is a provider of quality fiber optic supplies and education such as: Test equipment Anritsu OTDRs, Jonard fiber optic tools, US Conec fiber optic cleaners, Sumitomo fusion splicers and a Light

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CATEGORIES: EDUCATION | TESTING



SaskTel International



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877.242.9950
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SaskTel International (SI) partners with telecoms, CSPs, service providers and government agencies around the globe to provide BSS/OSS software, and advisory/professional services for FTTX and wireless networks including: strategy, engineering, design, operational improvement and P3 solutions that enable digital transformation. SI, established in 1986, is a fully owned subsidiary of a telecommunications company, SaskTel, with over \$1.3 billion in annual revenue and over 1.6 million customer connections. Through this partnership we provide clients with access to a pool of 3,500 telecom subject matter experts. Solutions built for the telecommunications industry by a telecom.

CATEGORIES: FTTX | I&M/NETWORK RELIABILITY/ CYBERSECURITY | NETWORK TRANSFORMATION/ SIMPLIFICATION | PUBLIC/PRIVATE PARTNERSHIPS (P3) | TRENDS/RESEARCH | WIRELESS



Southwire®

Southwire Company, LLC

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Southwire's telecom power products are among the premier LSZH central office DC and AC power cables in the industry. Our TelcoFlex cables are used to power all levels of telecom equipment and battery backup systems used in the central office, CATV head-end, data center, and cell tower equipment shelter environments.

CATEGORIES: CORE/LEGACY | POWER/SUSTAINABILITY



Spectrum Planning, Inc.

2150 Bluestone Dr.
St. Charles, MO 63303
314.220.6075
spectrumplanning.com

Spectrum Planning, Inc. was founded in 1999 as a new engineering and mapping business with years of experience. Our client list today includes companies such as Charter, Dycom, Charter Communications, CommScope, Co-Mo Connect, Unite Private Networks, Vyve Broadband, as well as various other companies.

CATEGORIES: C&E/PLANNING | FTTX | MAPPING/GIS



Superior Essex



5770 Powers Ferry Rd., Suite 400
Atlanta, GA 30327
770.657.6000
superioressexcommunications.com

Superior Essex is the world's largest producer of Outside Plant copper communications wires, and as a company operating at the forefront of emerging communications technologies for decades, we have long been aware of, and prepared for, the dawn of 5G connectivity with the OSP fiber and hybrid cables that enable it all.

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Supply Solutions

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supplysolutionsstore.com

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product is on time and on budget. We stock your items so you have what you need, when you need it. All of this is backed by a customer support team that will stop at nothing to ensure you are happy with your experience.

CATEGORIES: C&E/PLANNING | CORE/LEGACY | FTTX | I&M/NETWORK RELIABILITY/CYBERSECURITY | MISCELLANEOUS | PUBLIC/PRIVATE PARTNERSHIPS (P3) | SAFETY | TESTING | WIRELESS



Taihan Fiber Optics

221 River St., Suite 9
Hoboken, NJ 07030
201.784.1117
tfo.co.kr

Taihan Fiber Optics is a Korean company, one of the few companies worldwide with its own vertical integrated product lines in fiber optics with more than 40 years experience, having a total fiber solution for broadband infrastructures.

CATEGORIES: FTTX



Team Fenex, a Division of Synergy Power Group, LLC

610 Illinois Ave.
Sandoval, IL 62882
800.883.3639
teamfenex.com

We are designers and manufacturers of mobile power, fiber optic, and HVAC equipment. Team Fenex has a full line of specialty trailers and truck bodies to support both underground and aerial applications in the Telecommunications, Power utility, municipality, and CATV industries. Please visit our website or join us on Facebook for more information.

CATEGORIES: C&E/PLANNING | MISCELLANEOUS | SAFETY



Tech Products, Inc.

105 Willow Ave.
Staten Island, NY 10305
718.442.4900
techproducts.com

Tech Products, Inc. is an innovator of FO and copper cable marking systems since 1948. Our brands include Everlast®, Fasttags, TechBrite and Tech-3D. We manufacture everything from signs, pole tags, cable markers, surface markers and do-not-dig products. Our customer service people are from the industry and can help you find what works best for your organization.

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Telecom Problem Solvers, LLC

2261 Northpark Dr., Suite 428
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CATEGORIES: C&E/PLANNING | CORE/LEGACY | EDUCATION | I&M/NETWORK RELIABILITY/ CYBERSECURITY | MISCELLANEOUS | SAFETY | TESTING | TRENDS/RESEARCH



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CATEGORIES: I&M/NETWORK RELIABILITY/
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Tii Technologies, Inc.



141 Rodeo Dr.
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More than 55-year leader, Tii provides the communications industry with fiber and copper products supporting the ever-changing demands of today's broadband networks. Our vertically integrated global organization, combined with quick turnaround product development and manufacturing, allows Tii to offer a wide range of solutions ensuring quality performance, safety and reliability.

CATEGORIES: C&E/PLANNING | CORE/LEGACY |
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VeEX, Inc.

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CATEGORIES: CORE/LEGACY | FTTX | I&M/
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VETRO, Inc.

215 Commercial St., Fifth Floor
Portland, ME 04101
207.221.6627
vetrofibermap.com

VETRO, Inc. launched from NBT Solutions, LLC, a custom GIS development services company originally formed in 2008. In delivering location-based applications and services to a range of industries, the founding partners identified a growing need among telecom industry clients for an open architecture, cloud-based, flexible GIS solution for the increasing complexity of fiber optic networking. In response, the company launched VETRO in 2016 and pivoted to a product based company with the sole focus of addressing this market need.

CATEGORIES: MAPPING/GIS | PUBLIC/PRIVATE PARTNERSHIPS (P3)



Vivax-Metrotech Corp.



3251 Olcott St.
Santa Clara, CA 95054
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vivax-metrotech.com

Vivax-Metrotech develops and manufactures products for buried utility locating, fiber-optic cable locating, ferrous metal detection, coating analysis, and performing ACVG surveys on cathodic protected pipes, finding sheath to ground faults on cables, inspecting the interior of pipes and ducts, and mapping of buried utilities. Vivax-Metrotech products are backed by our worldwide network of distributors and service centers, bringing the customer local sales, training, and local service.

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CATEGORIES: FTTX



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Wavenet, Inc. is a leading manufacturer of wire and cable, connectivity, racks, cabinets, enclosures and cable management products that are designed for low voltage structured cabling infrastructure and telecommunications industry.

CATEGORIES: C&E/PLANNING | CORE/LEGACY | EDUCATION | FTTX | NETWORK TRANSFORMATION/SIMPLIFICATION | PROFESSIONAL DEVELOPMENT/LEADERSHIP | PUBLIC/PRIVATE PARTNERSHIPS (P3) | SAFETY | TRENDS/RESEARCH



Western Pacific Telecommunications

4147 Avenida de la Plata
Oceanside, CA 92056
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Western Pacific Telecommunications (WPT) is a worldwide manufacturer of a full line of outside plant related products used in the construction and maintenance of high quality fiber optic networks. Corporate offices are located in Oceanside, California. Established in 1983, WPT has built a reputation for providing the communications industry with products designed to meet the specific needs and specifications of both the National and International telecom service providers.

CATEGORIES: FTTX



WL Plastics

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CATEGORIES: FTTX | I&M/NETWORK RELIABILITY/
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