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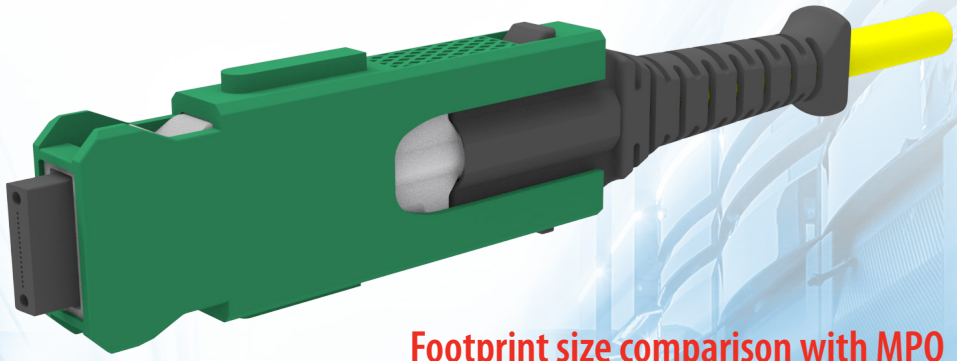
Next Generation Multi-Fiber Connector

SN®-MT CONNECTOR

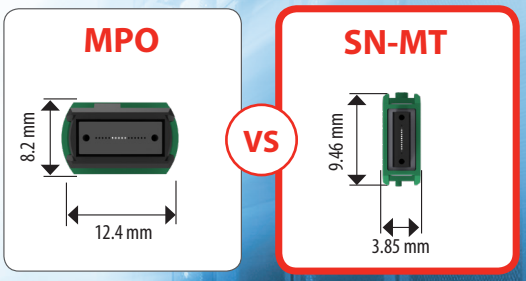
Available in 8F and 16F in one row

NEW Multi-Fiber Connector same footprint as SN Connector



2.7x density increase Compared to MPO-16F

Footprint size comparison with MPO



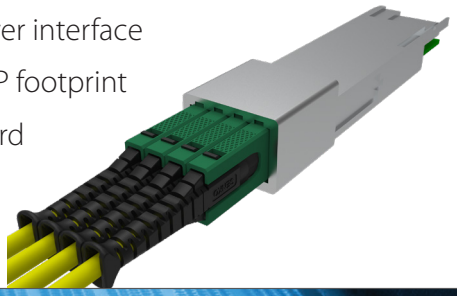
FEATURES

- Carries a maximum of 16-fiber in a row
- Same connector footprint as SN duplex
- Carries many features from the SN Duplex
- The industry's highest density connector
- Fiber density per 1RU is improved by
  - 2.7 time over MPO-16F
  - 1.3 time over MPO-32F
- Insertion loss targeted 0.35dB max for SM

APPLICATIONS

- Face plate density improvement
  - Patch panel, cassette
  - Co-packaged optics face plate
- Pluggable transceiver interface
- 4x SN-MT fit in QSFP footprint
- Inside box mid-board interconnect

4x **SN-MT** *in 1 transceiver*



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ISE

ICT SOLUTIONS & EDUCATION

MARCH 2022

Executive Insights With JIM CAPUANO

CEO, Horizon

ALSO INSIDE

Here Today, PON Tomorrow

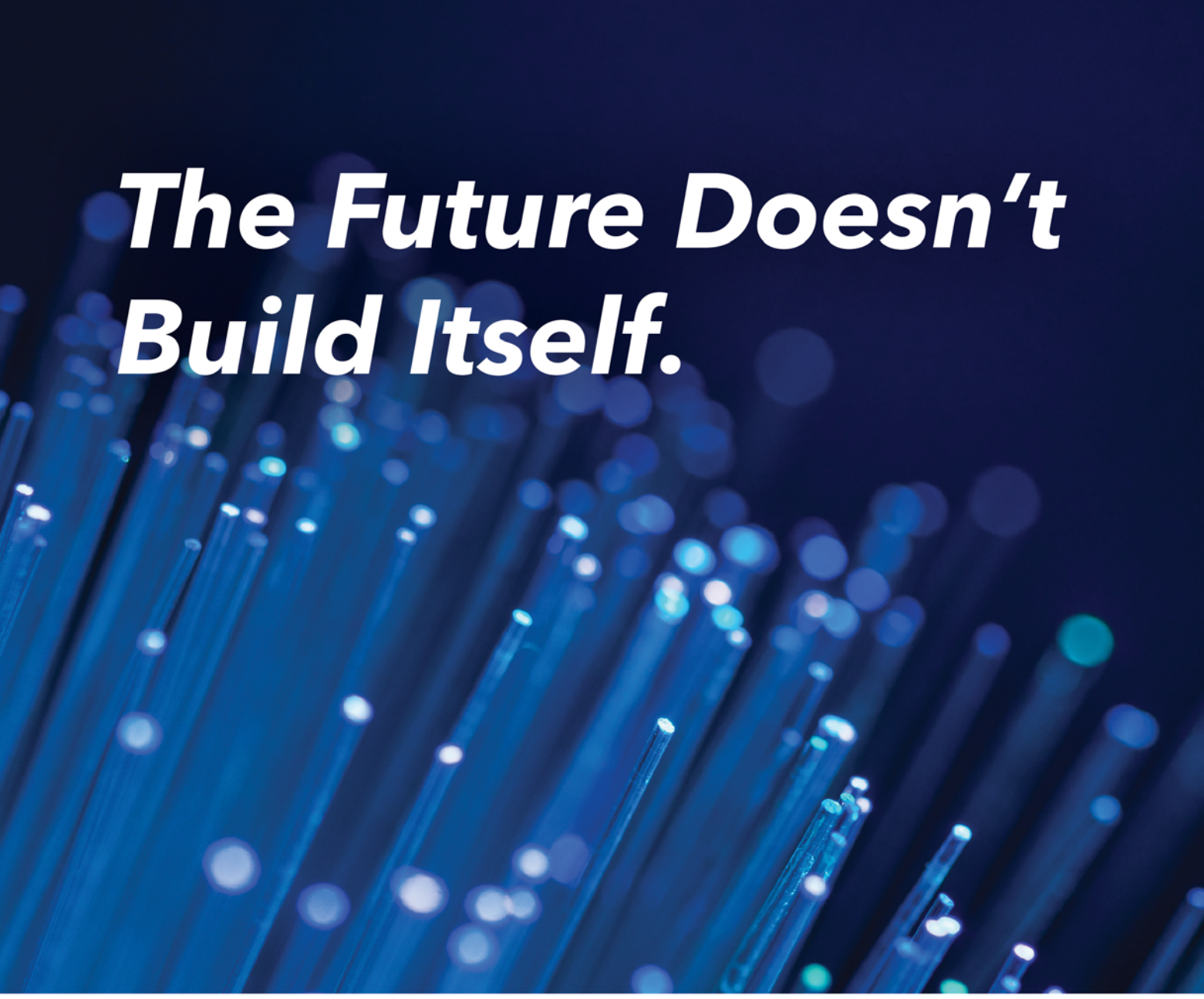
Upskilling Engineers for 5G Success

It's All About Your Reaction

Construction Without Disruption

Level the 5G Playing Field

VOLUME 40, ISSUE 2 www.isemag.com



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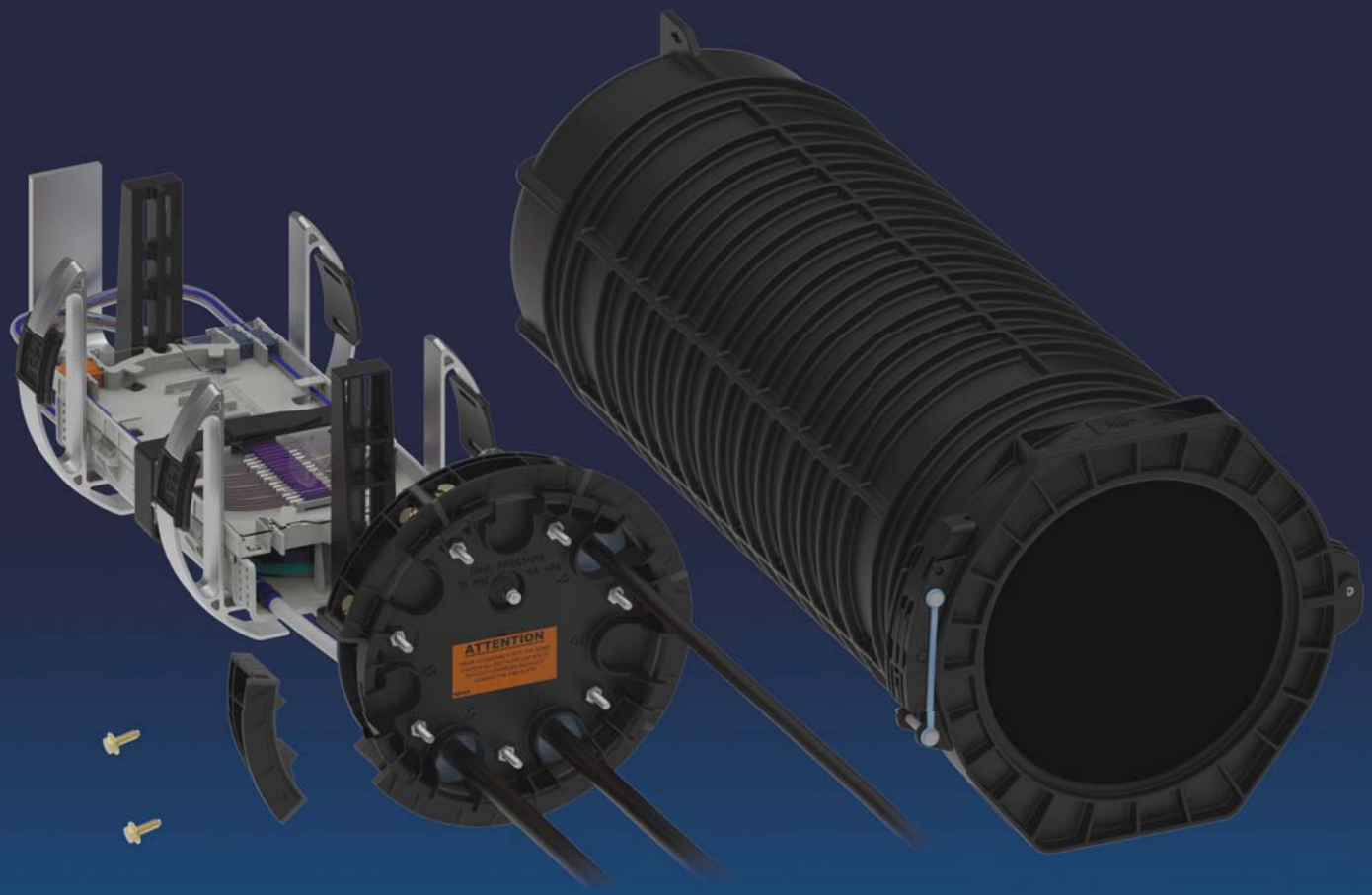

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ISE MAGAZINE March 2022 • Volume 40 • Issue 2.
ISE magazine (ISSN 2470-0517, print; 2470-0525, online). ISE magazine is published monthly, except for combined January/February and November/December issues. ISE magazine is published by Endeavor Business Media, LLC, 1233 Janesville Avenue, Fort Atkinson, WI 53538. Periodicals Postage Paid at Schaumburg Post Office, Schaumburg, IL 60194, and additional mailing offices. POSTMASTER: Send address changes to ISE magazine, PO Box 3257, Northbrook, IL 60065-3257.

ISE magazine is free to professionals in the ICT industry and related contractors. Rates outside this audience are: $32.00 for one year, $56.00 for two years, $73.00 for three years. Shipping and handling is required for all international subscriptions: Canada $50.00 per year, all other international $115 per year. Single copies available; cost varies depending on shipping fees. All fees are payable in advance in U.S. funds. Executive, Editorial, Circulation and Advertising offices: 1233 Janesville Avenue, Fort Atkinson, WI 53538.

EDITOR'S NOTE
by Sharon Vollman

@svollman
@SharonVollman
svollman@isemag.com

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.

Getting Real

Horizon is an aggressive CSP with a fiber-forward plan to serve more businesses, carriers and residential customers throughout Ohio and the greater Midwest region.

Below are some short takeaways from our Executive Insights interview with Jim Capuano, Horizon's CEO.

On fiber deployment realities:

"The amount of construction that is underway, not to mention what is coming down the pipe with the additional federal money that has been approved, is going to tax every service provider. The likely inflation of construction cost will be interesting. I believe that the ability to deploy the networks is going to be limited by make-ready costs, the municipality's ability to approve permits, the availability of construction contractors, as well as the ability to find a source for additional people to add to the job market."

On network complexity:

"My experience is that the complexity of the networks is often too high, and it is largely driven by the skill sets present in the engineering teams. For instance, the methods used to build-out networks are typically based on where the engineering team began their careers…."

On vendor relationships:

"Another factor in decision-making is vendor roadmaps. We need to know going in that the vendor is going to keep making investments into the platform. R&D dollars show their level of commitment. It's also fair to point out that as the vendors roll out new cards and features, the cost for the previous cards typically comes down. We've tracked the rollout cost of 1G, 10G, and 100G optics, and found that with each step there was a significant reduction in the cost of the previous technology."

Horizon's CEO doesn't pull any punches when describing the challenges you all face day in and day out. They can be daunting, but not unsolvable if you embrace Einstein's approach: *If I had an hour to solve a problem, I'd spend 55 minutes thinking about the problem and 5 minutes thinking about solutions.*

Undoubtedly, preparation has great value to problem-solving. So, schedule a 10-minute break each day to read, listen, and learn how your fellow readers solve some of their network transformation problems. They may not have all of the answers but they could inspire a new thought about how to approach what's currently getting in your way.

Sharon

Sharon Vollman, Editorial Director

MARCH FUN FACTOIDS

Not Bad, Eh?

CPaaS (Communications Platform-as-a-Service) revenue generated in North America will reach $15 billion by 2026, rising from $3.7 billion in 2021.

Source: www.juniperresearch.com

FIBER FRENZY

Global optical communication and network equipment market size to generate $23.6 billion by 2028.

Source: https://www.marketstudyreport.com/request-a-sample/4345799/

STILL???!!!!

While 97% of urban Americans have access to a high-speed, fixed service, only 65% of residents in rural areas have this access, according to the Federal Communications Commission. In tribal lands, only 60%.

(See: Homework Gap and Connectivity Divide | Federal Communications Commission (fcc.gov) at https://www.fcc.gov/about-fcc/fcc-initiatives/homework-gap-and-connectivity-divide

MDU Cravings

53% of consumers report they value technology more now than before COVID-19.

31% of US broadband households, or 34 million households, live in MDUs.

40% of MDU renters in broadband households are interested in bulk broadband Internet bundled with their rent.

Energy management use cases can drive smart refrigerator sales.

Energy Management Features *are highly valued* among all smart appliance owners and intenders.

28% of those who own or intend to purchase a smart refrigerator, rank automatic adjustments to refrigerator features.

28% of those who own or intend to purchase a smart oven rank tips for energy efficiency among their most appealing appliance features.

24% of those who own or intend to purchase a smart clothes washer or dryer rank tips for energy efficiency among their most appealing appliance features.

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ISE
ICT SOLUTIONS & EDUCATION

Publisher
Janice Oliva
joliva@isemag.com

Editorial Director
Sharon Vollman
svollman@isemag.com

Managing Editor
Karen Adolphson

Art Director
Julie Whitty

Multimedia Account Executives
Robin Queenan
rqueenan@isemag.com

Mark Horn
mhorn@isemag.com

Production Director
Lisa Weimer
lweimer@isemag.com

Director of Custom Events & Education
Amy Mullally
amullally@isemag.com

Circulation Manager
Laura Moulton
circulation@isemag.com

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Endeavor Business Media, LLC

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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.

Each cable pair that is placed from a central office or a remote to a customer costs a few thousand to the telco for engineering, placement, heating up, and installation.

- When a technician cuts away from such a pair it takes 6.4 years of base-rate revenue before that customer will again show as profit to the telco.
- In addition, when a section is going bad, each cutover will decrease revenue on that pair and will bring additional costs due to the eventual major costs of section replacement.

A retired General Manager from a large telco I often worked with once said: *There's a gold mine out there in revenue pairs whose original minor problems were cut to a vacant pair to restore service.*

Today, most operating companies are using the customer for quality control and the identification of cable problems by waiting for complaints before they take action. This occurs despite the fact that these same companies have very elaborate computer programs to indicate potential problems in the field. For example, large telco's have a program that will indicate a potential cable failure weeks, and sometimes months, before service is affected. However, in my experience, many ignore such problems until the customer complaint is filed. Were proper preventive maintenance required, all these potential problems would be invisible to the customer. And that creates satisfied customers.

Maintenance technicians, who should be handling these cable problems, are, instead, spending most of their time fixing one-pair problems such as a buried drop repair or fixing a single pair for new service. A maintenance technician who finds himself primarily in this business is in repair, not maintenance. The need here is to shift efforts to find the causes of service interruptions, not the effect. **If this is done, the cost per access line can be cut in half.**

The Toughest Cases

Over the years, I've learned that many sections of cable could have been repaired had the cause been identified. **This proper analysis approach could possibly save hundreds of thousands of dollars and eliminate many, many dissatisfied customers.**

Usually, the cause was a splice that leaked or a damaged cable sheath. Left to time, these sections were inundated with water and they needed to be replaced. Training and working with many fine, innovative technicians, eventually we were able to save better than 50% of the bad sections by identifying and fixing the cause, rather than replacing them.

When the cause of the problem wasn't found, the section was given to engineering for replacement.

When a section is given to engineering for replacement, it can sometimes lie fallow for years before engineering gets around to replacing it. That's not always their choice but the higher ups want to see those budgets go towards fiber install and not copper.

In most instances, all this could be avoided if these copper problems were fixed by the first technician sent out on the trouble ticket. This person must be well-trained because these are tough cases and they must be given the time needed to do the job right. Additionally, this must be a team effort with cooperation between maintenance and engineering.

Free up the maintenance technician to handle cable problems and put a stop to the cut-to-clear approach. Get back in the maintenance business instead of repair business.

An Example: A company develops a strategic approach to proactive approach.

I worked with a company in Tucson, Arizona, that had a major problem with bad sections and unacceptable cable conditions.

- Cross-boxes and ready-access terminals needed replacement.
- The high ambient temperatures were playing havoc with PIC insulation.
- The plant in general needed to be locked up for its own protection.
- Customer demands for new service, along with service-affecting and out-of-service troubles, were pulling the maintenance technicians from preventive maintenance into the trouble load.
- Plant quality was rapidly deteriorating.

The telco administrator and his staff recognized the need for thorough preventive maintenance.

They Devised a 3-Step Approach

STEP 1. ANALYSIS. The lead technician I worked with had 49 pages of high-priority projects that needed fixing. In order to attack these, the maintenance crew needed to be free from the trouble load.

STEP 2. IDENTIFYING AND TRAINING A STRONG TEAM. He and his staff trained and equipped the service technicians to handle the one-pair problems including:

- Defective drops, wires pinched or opens in associated terminals.
- Cross-connects that were caused by other technicians in the course of their daily activity.
- Supervisors and managers who did not have a cable maintenance background were also trained to assist the technicians. This released the cable maintenance crews for the priority projects.

STEP 3. QUALITY AND TEAMWORK. Each and every technician, supervisor, and manager became part of a quality team, with customer service as their primary goal.

When following up a service tech's plant condition report, the maintenance tech would identify the long-term problem.

- A bad cable needing replacement.
- A terminal needed to be rebuilt, locked up, or replaced.
- Any repairs that couldn't be made on the spot.

Then the maintenance technician became the coordinator between engineering and construction.

When the job was completed, the maintenance technician personally informed the service technician who originally identified the problem that correction had been achieved. This communication helped morale and commitment to team-building; all participants are critical to the process.

Results didn't occur overnight, and many obstacles had to be overcome, including old habits and resistance to the new order: *We've always done it like this; it's worked fine.* And *The test sets don't work.* Training and constant communication between departments resolved most of these obstacles.

A Company That Doesn't Believe in Proactive Maintenance

The antithesis of the Tucson philosophy is exemplified by a manager we'll call Ike, who works in a similar climate elsewhere. Ike has an interesting approach and program: technicians are encouraged to cutover. Later, Ike sends out a restoration team to bulk-recover the cut pairs. This practice has problems:

PROBLEM: Pair problems are shot-gunned throughout the distribution plant. Some are single pair faults which could be fixed on the spot, and some are actual cable trouble which will eventually affect multiple pairs and force section replacement.

The bulk recovery theory masks potential cable faults which must be found and fixed at once.

PROBLEM: Preventive maintenance is hindered to the point where its cost becomes prohibitive. Analysis of bad sections can take months. By the time the cable is fully analyzed, the original trouble has caused the total destruction of the section. The only solution is mass cable replacement, and untrained technicians will destroy the new plant in a very few short years using the same bad practice.

The general defense of the cut-to-clear bulk recovery practice is that we are going fiber-to-the-house, anyway. But here we are in 2022, the time of full fiber is clearly not happening as quickly as originally anticipated. And by the time customers have struggled many years with unresolved problems, when fiber does reach them, they are more likely going to go to a competitor's fiber.

Excellent, hard-working, well-experienced technicians are out there and they know their stuff. They must be listened to, and they need to be treated as a critical part of the team so they can see and hear about the fruits of their labors.

The telco team in Tucson communicates. They are continually working to improve customer service and prepare their technicians for the fiber world, however far or close that is. Training and quality are a lifetime commitment by the staff, and they have the type of service that is transparent to their customers. Take a look at Tucson and their cost per access line and you'll see what quality service is. ***They have an attitude; the industry should study it.*** ■


Read Jim's perspective about network priorities, inflation of construction costs, vendor roadmaps and what our industry may be overlooking.
Executive Insights With
JIM CAPUANO
CEO, Horizon
By Sharon Vollman
HORIZON

Topic: Priorities

ISE: What are 2 of Horizon's network-related priorities for the end of 2021 and into 2022?

James Capuano, Horizon: Horizon's network-related priorities are to expand our existing fiber footprint within the major metro markets that we serve, primarily in Ohio and Indiana, and to deploy fiber in residential markets throughout Ohio.

Topic: Fiber Deployment

ISE: With more than 5,500 route miles of fiber, what are some creative field solutions Horizon is employing to deploy even more fiber to its small to large enterprises and wholesale carrier customers?

Capuano: We are trying many different techniques that vary by market. While fiber construction techniques haven't changed a whole lot over the last decade, our focus has shifted to advanced market planning and collaboration with possible anchor tenants, utility companies, and state and local government agencies.

While I said the techniques have not changed much, the equipment has improved. To take advantage of this, we also make sure we're partnering with the best construction vendors possible. Phoenix Communications is one of our trusted construction vendors. Without the support from partners like this, we wouldn't be able to bring the fiber that our communities rely on.

We have found that expansion in the metro markets for enterprise customers is more about identifying the pockets of potential customers using multiple data sets to enable us to target the addressable market opportunities. In some cases, sourcing an anchor tenant in the region has given us the catalyst to make a larger investment in a market. Unlike in the past, the one anchor opportunity typically will not be large enough to cover the entire expansion. We are not going back to the era of speculatively building without customer orders. Instead, I'd say that our methods have a larger degree of intelligence and thus far less risk.

Topic: RDOF

ISE: Horizon received $2,033,292 in RDOF funding. Congratulations! What are the best network deployment strategies providers should embrace to deliver on their commitment after receiving these funds?

Capuano: For clarification, Horizon did not receive $2 million in funding. While we did participate in the auctions, we did not "win" any of the areas.

We found that the reimbursements were bid down to a point that we didn't believe we could make a business case work in these rural areas. Our review of the build cost suggested that would not have been sufficient to offset what we are seeing in make-ready costs. I'm sure that your readers know that make-ready is the process that new attachers follow to gain access to utility poles. The utility that placed the pole is called the pole owner and is responsible for managing any changes to them. We would pay the pole owner to make space on the pole line for our cable. The make-ready work has become more expensive in many cases than the actual construction of the new cable run.

For much of my telecom career I have worked with others in the industry to find creative ways to reduce the cost and time of the make-ready process. The FCC's guidance on *one touch make-ready* has not had the effect hoped for by the telecommunications companies. The telecom companies had hoped that one touch make-ready would result in lower costs—which would have been realized by having one crew make all of the necessary moves on a pole, preventing the expense of multiple crews being dispatched overtime—and a quicker completion of the projects due to fewer mobilizations of crews to perform the work. Since 2018, when the guidance was released, we have found the cost is significantly higher and the time to complete is at best unchanged.

While we found RDOF not to be an effective way to fund rural build-outs, we have been actively working with state agencies to find creative ways to deploy more fiber into the most rural areas. As you can imagine, the more rural the area, the more difficult the economics are to make a solid business case. Our company has a history of working in rural Ohio in particular, and we're excited about being able to help get high-quality broadband products to these underserved areas.

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 fighting among the members of your previously unified team. With Horizon's aggressive growth targets, how

do you help ensure your team is integrating networks AND employees successfully?

Capuano: I believe that company culture is critical to weathering difficult times. Our management team spends a significant amount of time soliciting and evaluating feedback from the organization. There is no replacement for leadership and quick decision-making in stressful times.

Another key is to set reasonable goals. Setting goals that are unrealistic makes the team think that the leadership team is out of touch. Not that we do not set stretch goals, it's just that when we do, we communicate them as such. Transparency is a great way to build trust in the organization. People will strive for higher goals if they feel that the management team is shoulder-to-shoulder with them and that they are being heard throughout the process.

Topic: Labor Challenges

ISE: The US telecommunications industry employs a total of 672,000 workers, with average annual wages of $77,500. It's forecasted that 5G rollout and other technologies could create 850,000 more "new direct broadband and 5G jobs" through 2025. Executives in the US telecom network construction sector have been arguing that they're having difficulties finding enough skilled workers to deploy fiber and 5G networks. The CWA, which represents 700K workers in the telecom industry, says that may not be the case. What are your thoughts about this?

Capuano: First off, the labor challenge cannot be solved by telecom companies or labor unions alone. There is simply a significant shortage of people to take jobs in the United States. The number of people leaving the workforce is greater than the number joining, and the United States is going to need to come up with a plan to add people to the workforce.

It's interesting to point out that the building trades identified the shortage of people going into their trades 10 years ago and undertook a national campaign, driven largely by the building trade unions, to attract people—especially kids heading to high school—to the advantages of working in their fields. I believe that the CWA is probably right that it will be able to fill many of those jobs considering that it has the resources to market nationally and build programs to train new personnel.

Companies like ours are working with vocational schools and local governmental agencies to build programs to attract and train people who are interested in a career path. Horizon recently announced a partnership with the Tri-County Career Center in Nelsonville, Ohio, for a fiber optic - technician training program. (See https://www.youtube.com/watch?v=wKBjbCbayxk.) The program is part of Lt. Governor Jon Husted and Ohio's plan to bring affordable broadband to Ohio. Companies like Horizon are also going to need to establish training programs to bring in new people to fill their open positions. The ability to hire away people to fill your open positions is going to become very difficult and costly, and unlikely to be successful in the long-term.

To touch back on company culture, this is another area where culture is key—retention. As we've discussed, every company in the United States is finding it more and more difficult to identify, recruit, and hire, the labor that we need to be successful. Companies like ours must find ways to attract top quality talent and retain them to support our growth initiatives. Competitive benefit plans and compensation open the door to new hires, but a good culture is going to help keep them from jumping to a competitor.

Topic: Failure

ISE: What happens at Horizon when people fail? (Source: Bob Sutton and Jeff Pfeffer, Stanford professors via www.inc.com)

Capuano: When a failure happens, we look to find the root cause of the issue, which is typically a gap in process or a supplier issue. I've found that individuals are seldom directly responsible for failures in the business.

My larger concern is that we have few failures due to risk-taking. We are a very conservative business; our company is over 125 years old, and that legacy has resulted in slower decision-making and less risk-taking, but in recent years we have taken on initiatives to change that. I mentioned earlier that we often build-out areas without a deal that would pay for the entirety of the CapEx. The methods we use there are designed to take some risk without removing all financial controls. We've had great success doing this.

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NEXT GENERATION THINKING™

Topic: Hybrid Networks

ISE: If we want to close The Digital Divide, upgrade broadband speeds, and reduce latency for end users, hybrid networks may be the answer. However, many challenges arise using hybrid strategies. In your opinion, what are some of the most daunting network-related challenges for providers as they work to scale hybrid networks? While cost is the most obvious, what other things get in the way? How can they be remedied?

Capuano: The term hybrid networks can mean something different to every network designer. As an infrastructure provider and service provider, my definition is focused on the transport protocols that we use. My experience is that the complexity of the networks is often too high, and it is largely driven by the skill sets present in the engineering teams. For instance, the methods used to build-out networks are typically based on where the engineering team began their careers. If they began their careers in Information Technology roles, routers will have a strong presence in the network. Conversely, if someone started out working on older technologies like SONET or WDM, you'll likely start lower in the OSI stack in your designs.

I'm a big believer in simplification of network designs whenever possible. It makes troubleshooting easier for NOC personnel and field technicians, and it also makes capacity planning easier, and has a lower operating cost.

Our core network is typically designed with purpose-built links. The use of DWDM in the core has simplified the management and speed to resupply exhausted links, as well as the ability to establish express routes to reduce latency. The core IP routers connect to the core DWDM to take advantage of express routes based on traffic patterns. Core Ethernet switches also connect directly to the core DWDM and simplify the delivery of private line connections with reduced core network latency.

In our enterprise markets, edge networks must be able to support all of the services we offer and thus will result in more complexity. That said, we still try to simplify here as well. Active-Ethernet is a great foundation protocol that is used to establish links to customers and are the underpinnings for the services higher on the stack. Many of our customers order private line circuits along with dedicated Internet access, so Active-Ethernet is perfect in these situations. I believe that Dense Wavelength Division Multiplexing (DWDM)—which is used sparingly in our enterprise markets where we have high fiber counts and the distances between sites is shorter—will be used more as the bandwidth increments that customers order increase.

> "Another factor in decision-making is vendor roadmaps. We need to know going in that the vendor is going to keep making investments into the platform. R&D dollars show their level of commitment. It's also fair to point out that as the vendors roll out new cards and features, the cost for the previous cards typically comes down. We've tracked the rollout cost of 1G, 10G, and 100G optics and found that with each step there was a significant reduction in the cost of the previous technology."

The scale on the edge to support multiple 100GE or greater is too taxing for Ethernet networks. DWDM is the tool we use to solve large network requests.

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 providers' 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 you recommend to control OpEx?

Capuano: Horizon obviously has a focus on CapEx when deploying a new network, but the cost to maintain it needs to be front and center when deciding what to deploy. For example, shifting vendors is difficult to do when you factor in the investments that need to be made in maintenance contracts for sparing and management systems. I believe this is why you see many smaller and medium service

Topic: In Pursuit of Knowledge

ISE: What's the best book you've read this year?

Capuano: The 2 I'm sharing happen to be set during the 2nd world war, but this is coincidental. *The Splendid and the Vile: A Saga of Churchill, Family, and Defiance During the Blitz* by Erik Larson. I've always been interested in the leadership lessons that can be learned from history. Churchill is a favorite of mine because of his leadership skills and ability to communicate difficult messages while motivating his followers to overcome incredible odds. Another great read is *Beneath a Scarlet Sky: A Novel* by Mark Sullivan. Incredible telling of the true story of Pino Lenna's life as a young Italian during the second world war. His story to me is one of how happenstance and opportunity can lead to unbelievable achievement.

providers stick to 1 equipment vendor. The 2nd- and 3rd-year costs are just too much to absorb.

Another factor in decision-making is vendor roadmaps. We need to know going in that the vendor is going to keep making investments into the platform. R&D dollars show their level of commitment. It's also fair to point out that as the vendors roll out new cards and features, the cost for the previous cards typically comes down. We've tracked the rollout cost of 1G, 10G, and 100G, optics and found that with each step there was a significant reduction in the cost of the previous technology.

Topic: Overlooked Issues

ISE: What should all of us in the Information and Communication Technology (ICT) industry be talking about that we are not? Or, what current topic is the most important that needs additional and different attention?

Capuano: There is so much happening in our industry. The amount of construction that is underway, not to mention what is coming down the pipe with the additional federal money that has been approved, is going to tax every service provider. The likely inflation of construction cost will be interesting. I believe that the ability to deploy the networks is going to be limited by make-ready costs, the municipality's ability to approve permits, the availability of construction contractors, as well as the ability to find a source for additional people to add to the job market. These are some of the same issues we experienced during the BTOP era, and we are likely to relive them again.

Topic: Your Take

ISE: Share one problem/challenge you are passionate about solving for the ICT Industry.

Capuano: Cost-effective make-ready—this one issue has handicapped our ability to overcome The Digital Divide! The federal and state money that is being awarded to service providers is not going to the fiber and optronics that are needed to provide broadband access. The funds are being spent on upgrading utility infrastructure. To be clear, I'm not grousing about the utilities. These upgrades are needed to ensure that the underpinnings of our broadband infrastructure are solid. Commercial power is equally critical to ensure this. **My point is: why isn't there a larger initiative to improve the utility rights-of-way that doesn't saddle the broadband infrastructure provider with the cost?** Much of the broadband deployment is done with private funds, and attachment costs to be on the poles have killed many business cases. Simply put, more private money would be spent on broadband deployment if not for high make-ready costs. ■

James (Jim) Capuano is Chief Executive Officer of Horizon. Capuano has more than 30 years of experience in the telecommunications industry. Prior to joining Horizon, he served as Chief Operating Officer of FirstLight Fiber, in Albany, New York. His accomplishments at FirstLight include: multiple major network expansion initiatives, and the integration of more than 9 separate acquisitions, resulting in the largest fiber optic network in Northern New England and New York State. Capuano's other professional roles include: CTO at Unite Private Networks, in Kansas City, Missouri; COO at Veroxity Technology Partners, in Bedford, Mass.; and Vice President of Engineering and Operations at RCN Metro, in Westborough, Mass. In these positions, he led telecommunications engineering and operations, network construction, expansion selections and planning, product development, vendor assessment and selection, marketing, technical sales and business support. For more information, visit www.horizonconnects.com.

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Based in Columbus, Ohio, Horizon (horizonconnects.com) is a fiber optic broadband carrier operating in Ohio, Pennsylvania, West Virginia, Kentucky, Indiana, and Michigan.

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Here Today, PON Tomorrow

Evolving the Access Network to Support Any Speed

By Ken Ko

"During 2020 and 2021, the world has stopped going mobile, and the position and relevance of wireline has been cemented." This was the message delivered by Analysys Mason (https://www.analysysmason.com/) alongside its report: *Fixed Network Data Traffic: Worldwide Trends and Forecasts 2020-2026*. Marking a significant shift in broadband traffic, the research found, for the first time, that traffic on fixed networks grew faster than on mobile in about half of all countries modelled. Worldwide, fixed network traffic grew by 42% in 2020—a substantially higher growth than forecast before the COVID-19 pandemic.

These changes reflect the adjustments that much of the world had to make when the pandemic hit. Working from home became the norm for many as offices across the globe shutdown to adhere to national lockdowns. The lockdowns also brought about an increase in OTT video subscriptions and service stacking—all of which are likely to continue. According to Analysys Mason, traffic growth was also strong in emerging countries where mobile networks alone cannot keep up with the rising demand in underserved areas.

While many mobile operators may argue the introduction of 5G nationwide rollouts buck this trend, what is most relevant is that whether you are using a mobile device or a WiFi-enabled device when in the home or the office, most developed countries depend on the fixed broadband network to transport this traffic. In usage and transport, 5G and fixed traffic will depend on the fiber access network. Progressively this will be a PON network.

Looking ahead, Analysys Mason predicts that while there might be a slower growth short-term as the effects of lockdowns wear off, the growth rates for fixed and mobile will ultimately converge, with fixed access growth overtaking that of mobile by 2025. As in years past, access networks and the operators who run them are tasked with coping with this enormous growth in traffic.

As we see these predictions come to the fore, and traffic growth continuing at exponential

levels, what can we expect to see in terms of the technologies and developments that will meet this need? And how will access networks evolve to meet ever-changing requirements?

As PON technology has developed, demand for superfast fiber networks has grown alongside it. Government broadband targets, requirements for 5G backhaul, and increased use of the fixed network as a result of the COVID-19 pandemic, are all factors in this growth.

The result is a significant increase of rapidly growing PON deployments, most notably in the North America, EMEA, and Asia markets, in addition to the more mature Chinese market, according to Julie Kunstler, Senior Principal Analyst at Omdia (https://omdia.tech.informa.com/). Looking at these worldwide deployments, GPON continues to lead the way, covering a 70% shipment share—but this is set to change considerably as network capacity requirements continue to grow.

It's uPON Us

One of the biggest shifts we will see is the greater role played by 10 Gigabit Symmetrical PON (XGS-PON) in the coming year. The rate of XGS-PON deployments is already increasing rapidly.

Initially, this was seen in new fiber rollouts where it only made business sense to deploy PON technologies that will meet broadband demands for the next 5-to-10 years. Additionally, XGS-PON is increasingly being deployed in existing brownfield environments to coexist alongside existing GPON services. This is especially true in high density urban areas where operators are facing increasing demand for gigabit+ business services across the shared fiber infrastructure. Service providers such as CityFibre in the UK, AT&T in the US, and Chorus in New Zealand, are all investing in XGS-PON.

Looking ahead, the high demand for business, mobile, and residential, PON bandwidth ultimately require deployments that exceed 10 Gbps. Multiple standards are either complete or in process to support this need, including:

- **ITU-T G.9804,** which in its initial version will support 50G down and 25G up over single wavelengths, and which has earmarked a 50G symmetric version for further study.
- **IEEE 50G-EPON,** which runs over 2 wavelengths of 25G each. In the short term, the 25GS-PON Multi-Source Agreement (MSA), which combines IEEE 25G Optics with the ITU XGS-PON layer, is expected to start mass shipments in 2022.

Both the ITU and the MSA technologies have their adherents, and service providers must make informed choices based on their own network deployment strategies.

Looking a little farther out, both the IEEE and the ITU are developing SuperPON technologies that support up to 160 Gigabits aggregate over 16 wavelengths. Clearly, there is no shortage of innovation or bandwidth looking forward in PON technologies.

Wireline/Wireless Convergence

Standards are also playing a key role in the evolution of 5G, which, in turn, is impacting the access network more than ever before. The advent of 5G is seen by many operators as a prime opportunity to converge their fixed and mobile networks. The benefits include a seamless, access-independent service experience, multi-access connectivity, and a streamlined set of network functions required to operate their network. This

convergence also enables common technology, on-boarding, training, and services between fixed and mobile divisions, and common subscriber management, as well as the chance to extend the reach of core networks and service offerings.

To ensure the full benefits of the 5G ecosystem across wireless and wireline environments, key elements of the access network must be updated. The 5G-capable Residential Gateway (5G-RG) fully supports 5G Quality of Service (QoS) to the home, as well as 5G signaling protocols and capabilities.

On the network side, the Access Gateway Function (AGF) provides the interface between the wireline access network and the 5G core and supports both 5G-RGs and legacy Residential Gateways. Importantly, the AGF works with existing access nodes, providing a path to convergence that doesn't require massive upgrades. The AGF and other interface functions provide options that allow operators multiple migration paths to WWC.

A key feature of WWC is the capacity to multiplex multiple sessions, each as a unique connection between the 5G-RG and AGF on top of the customer VLAN for the converged fixed and mobile core network. This allows service providers to assign a unique User Plane Function (UPF) to different sessions, meaning video traffic, business traffic, and community WiFi, can all be assigned appropriate QoS and policies, as well as different owners for charging and billing.

A second enabler is multi-access with Access Traffic Steering, Switching, Splitting (ATSSS), which provides enhanced reliability by leveraging existing network coverage; if one link goes down, there is seamless availability for connectivity, bandwidth aggregation, and policy-based forwarding.

Copper to the Rescue

While the future is increasingly dependent on PON networks, copper continues to play an important role in extending fiber into and across the home. Broadband Forum's *TR-419* specifies the different ways that copper loops or coax can extend fiber's reach, both to single family homes and within multiple dwelling units (MDUs).

Today's access technologies designed for transmission over copper, including MGfast (ITU-T G.9711) and G.hn (ITU-T G.996x series), can provide multi-gigabit services, for example in MDUs where fiber service to the basement is extended across the building's existing wiring to each unit. These technologies make multi-gigabit broadband deployments faster and easier than a fiber-only solution could for a significant percentage of users.

Finally, the nature of the access network itself is changing significantly. Network transformation to virtualized architectures such as CloudCO, and the disaggregation and repartitioning of the network functions within, enables rapid and dynamic responses to usage patterns that can change throughout the day and as a result of special events. In particular, separation of the Control and User Plane implementations in functions across the network brings numerous advantages, including centralized control while simultaneously bringing the data-handling functions closer to the user, improving both performance and manageability at the same time.

Whatever the technology used, the key for coping with future anticipated traffic growth is to build an infrastructure that can support users' needs well into the future. The fiber and copper access technology trends described earlier do just that, while supporting migration paths that give operators flexibility with planning their deployments.

At the same time, network transformation helps operators plan efficient, scalable and dynamically responsive networks going forward. Operators with fixed and mobile networks can offer their users a consistent set of features and seamless performance as they move between wired and wireless connections. Viewed together, the trends in access network technologies continue to support the needs of both operators and end users for the foreseeable future. ■

ABOUT THE AUTHOR

Ken Ko is Managing Director at Broadband Forum. Ken has 40 years of experience in communications technology, having developed multiple generations of voice frequency and broadband modems for companies including Paradyne, AT&T, Rockwell Semiconductor, and ADTRAN. For more information, visit https://www.broadband-forum.org/, and follow us on Twitter: https://twitter.com/Broadband_Forum?s=20.

Upskilling Engineers for 5G Success

The Right Knowledge and Technology Is Mission-Critical

By Jay Cadman

5G is the future of telecommunications, and that future is arriving fast. The number of 5G mobile service subscriptions in the US is forecast to grow by 79% in 2022, and by 2024 there will be over 222 million wireless connections from 5G-enabled devices.[1]

The rapid acceleration of 5G adoption also presents a major revenue generation opportunity for telecom providers. But to realize 5G's full potential, businesses need a highly resilient network that can integrate an unprecedented volume of devices to deliver the full benefits of smart, connected technologies.

These resilient networks need to be managed and maintained by telecom engineers who are not only well-versed in the demands of 5G, but also have the operational systems and processes in place to proactively manage network expansion, changing technology and risk.

Managing the Challenges

While 5G opens new doors in terms of the products, services and business models for telecom companies, it's important we acknowledge the logistical challenges that accompany the 5G transition.

While the general public may understand it as *Fast 4G*, 5G is an entirely different cloud-native network built on software-defined networking (SDN) and Networks Function Virtualization (NFV).

5G networks are decentralized, which makes them more vulnerable to performance issues and outages, as distributed digital routing and short-range, small-cell antennae and 5G base stations are more exposed to natural hazards such as extreme weather conditions.

The *softwarization* of network components also increases 5G's security vulnerabilities. Greater process automation and proliferating connections mean the impact of network issues travel faster, while cybercriminals using 5G devices could potentially bypass security programs built for 4G technology. We're already seeing network operators responding to this by deploying cloud security and system redundancy software, to ensure that network data is duplicated and encrypted so there is no single point of failure.

It's not just network security and stability threats that raise the stakes, either. With 5G delivering instant, holistic, digital connectivity, customers expect consistently high performance. According to Deloitte research, 86% of business enterprises believe that advanced wireless capabilities will transform their organization within 3 years—and many network operators will be contractually bound to SLAs with 99.999% KPIs to deliver this standard of availability.[2]

Developing Engineers' Skill Sets

5G's rapid adoption is doing more than changing network operator demands. It's also impacting the role of telecom engineers and the skills required to deliver a secure, scalable service to customers.

Already, demand for 5G-confident telecoms engineers is rising, and the network's heavy reliance on fiber backhaul is also increasing the need for skilled network fiber engineers.

Moving to a disaggregated network means a shift to a modern, adaptable open-source software model to respond more quickly to changing requirements. Engineers must also develop an intimate knowledge of a much broader range of technologies to manage 5G requirements, including LTE-Advanced, Mobile Edge Computing, Network Slicing, IoT, and the aforementioned SDN/NFV.

In an AI environment, engineers deal with millions more data sensors which must be used to not only maintain telecoms networks more efficiently, but to preempt problems and put preventive plans in place to enhance 5G network resilience and performance.

To be truly 5G-ready, telecom providers need to create open, accessible networks that use geospatial technology, IoT, and AI, to provide rich, real-time data so they can better understand assets and increase network resilience, which ultimately minimizes downtime and prevents economic loss.

Advanced data capabilities are both a blessing and a curse for operators. More work needs to be done to keep everything running at full capacity, but more intelligent decisions can be made with the right operational infrastructure and geospatial data technologies in place.

For example, past behavior is the most effective indicator of future failure, and machine learning (ML) can combine historic and real-time data to accurately predict everything from sleeping cell detection and future node downtime to the chance of grid failure at each site. Capturing, integrating, and curating, data from every part of the network is critical to providing this holistic picture of risk.

An integrated data approach also impacts the way telecom engineers operate. Operators are creating location-based outage dashboards that utilize geospatial data to predict the sites most vulnerable to damage and degradation while recording existing asset maintenance issues. Organizations can use these insights to prioritize engineers' workload and to proactively mitigate major risks.

For telecom engineers, the 5G transition involves not only learning new skills for network maintenance and management; the technology they use plays a pivotal role in providing detailed, location-based data to enrich the risk management systems in place.

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wireless connections from 5G-enabled devices.

A combination of mobile employee devices and sensors in the field enables local data to be overlaid onto geospatial network data to provide real-time, location-based insights. In addition to supporting live risk assessment capabilities, this information allows companies to quickly understand the locations and causes of hazards, to develop an incident response strategy.

And even in cases where machine learning hasn't been able to predict problems, the speed and sophistication of geospatial data insights allows engineers and head office personnel to solve these edge cases collaboratively, utilizing best practice from other similar incidents to inform protocol and procedures.

Networks + Skills + Technology = 5G's Success

A high-performance network requires a high-performance management model to deliver on expectations, and the continuing rollout of 5G is pressurizing Telcos to accelerate their digital strategies.

The central factor to future network resilience is data quality; the quicker telecom companies can identify network weaknesses and single points of failure the sooner performance strategies can be developed. 5G-ready engineers are at the heart of delivering these strategies, using mobile software and geospatial data to identify hazards, solve problems, and protect the country's new ultra-fast 5G networks. ■

RESOURCES AND NOTES

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ABOUT THE AUTHOR

Jay Cadman is Senior Vice President, Enterprise of IQGeo. He has over 25 years of experience in successfully building B2B technology sales and marketing organizations. For more information, please visit https://www.iqgeo.com. You can follow us on Twitter @IQGeo_software.

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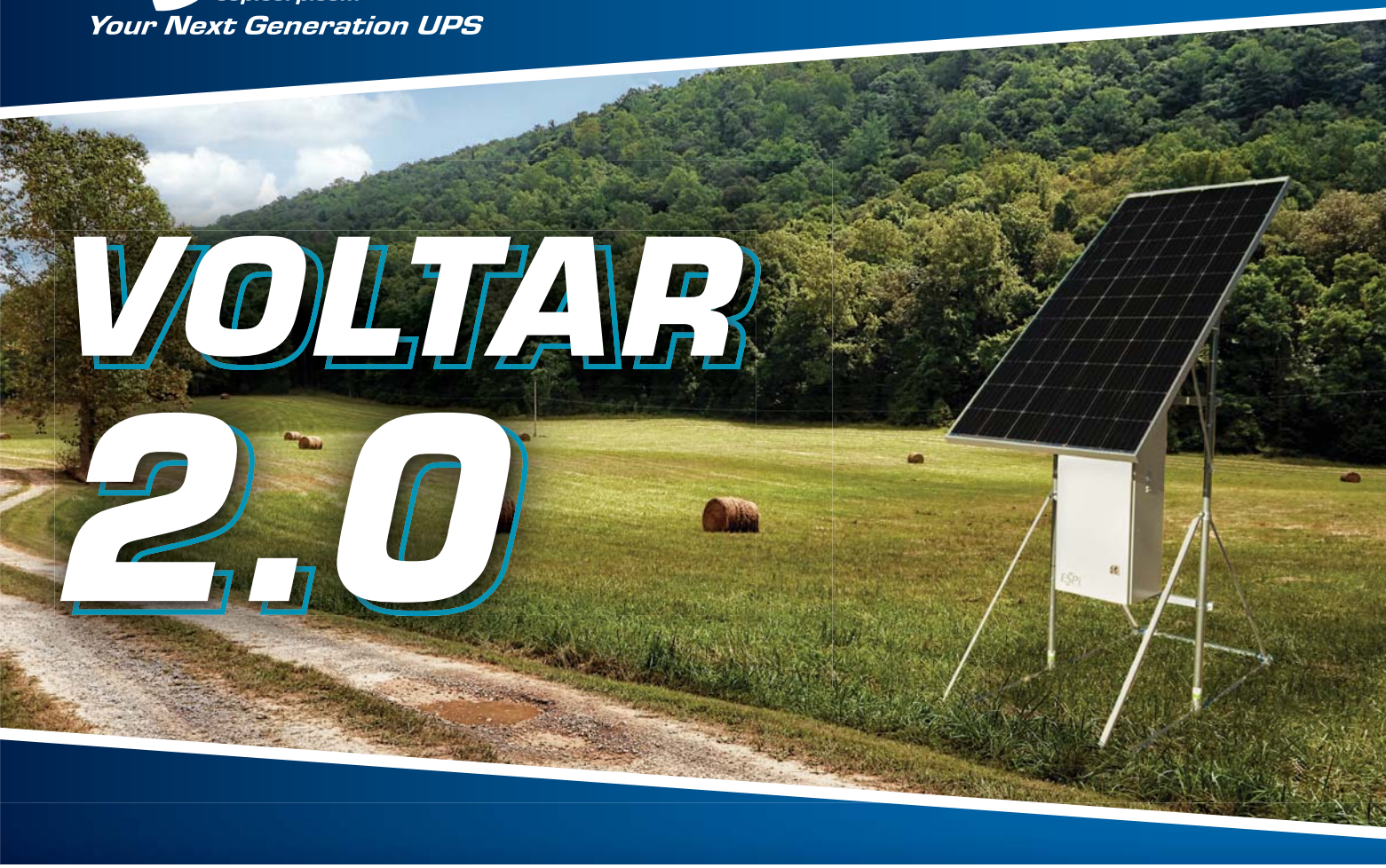

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G.hn and CATV Coexistence

MDU Gigabit Speeds Without Compromise

By Pierre Trudeau

G.hn is an access technology for operators looking to simplify their access network and reduce their costs with an Ethernet-like technology. The ITU-T G.9960 G.hn Wave-2 standard leverages the existing telephone wiring (UTP, CAT-3 or CAT 5/5e) or RG-6/RG-59 coax cabling (each coax port serves up to 16 subscribers) to deliver a gigabit Internet service to each apartment inside a Multi-Dwelling Unit (MDU) or Multi-Tenant Unit (MTU) without the cost, complexity, and delays, associated with in-building fiber installation.

With G.hn, operators deliver advanced services, such as gigabit high-speed residential Internet and 4K Internet Protocol television (IPTV) without the high capital and operational expenses associated with a fiber retrofit. Each G.hn subscriber port supports up to 1.7 Gbps of dynamically allocated bandwidth for near-symmetrical gigabit services. A G.hn Access Multiplexer (GAM) then connects to and extends multi-gigabit feeds from fiber terminating in the GAM via an ONT (Optical Network Terminal xPON) or fixed wireless access radios. It serves all residential gateways with gigabit Ethernet router ports using G.hn.

G.hn and CATV Spectrum

When operating over Coax, G.hn uses baseband spectrum from 5-200 MHz. Unlike Data Over Cable Service Interface Specifications (DOCSIS), G.hn dynamically allocates each tone to carry either upstream or downstream traffic to reflect the demand from the subscribers, achieving gigabit speeds in both directions.

The base definition of DOCSIS 3.1 allocates the 5-42 MHz range to upstream traffic, resulting in "up to" 100 Mbps of shared bandwidth across all subscribers on a Cable Modem Termination System (CMTS) port. DOCSIS vendors have recently introduced solutions to provide more upstream bandwidth by extending the spectrum for the upstream bands by reducing the spectrum used for the downstream direction. Two split levels are defined as per Figure 1.

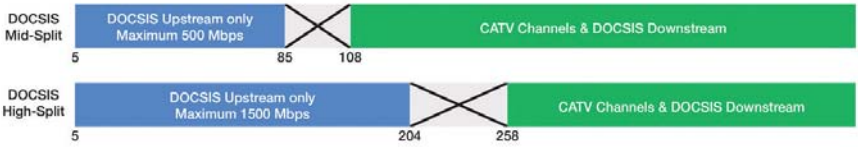

Figure 1. DOCSIS Spectrum allocation for Mid-Split and High-Split.

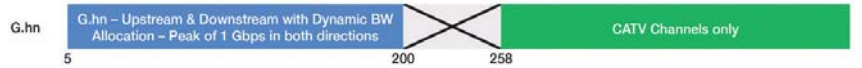

Figure 2. G.hn and CATV Spectrum Allocation

Figure 1 shows the Mid-Split approach extends the upstream spectrum to 5-85 MHz, resulting in about 500 Mbps. The High-Split approach extends the spectrum to 5-204 MHz for about 1.5 Gbps of throughput. A DOCSIS network is engineered to serve an average of 150 subscribers on the premises in which the peak use per subscriber is well below 5 Mbps downstream and below 350 Kbps (not Mbps) upstream. With the increase in bandwidth consumption for teleworking and remote learning, this no longer reflects the usage patterns we experience in 2021.

Looking at the G.hn spectrum, we see that the 5-200 MHz range handles upstream and downstream traffic using an Orthogonal Frequency-Division Multiplexing (OFDM) encoding. (See Figure 2.) *(This is somewhat different than with DOCSIS where the upstream is encoded with OFDM and the downstream uses Orthogonal Frequency-Division Multiple Access (OFDMA)).* The aggregate bandwidth of G.hn on coax is 1.7 Gbps (or 2 Gbps at the physical layer).

Before jumping to the conclusion that a High-Split approach offers more bandwidth than G.hn, it is important to remember that each coax port of a GAM can serve up to 16 subscribers (not several hundred as is the case with DOCSIS). This easily handles a peak average of 100 Mbps (dynamically split between upstream and downstream for each subscriber) and allows for peaks at 1 Gbps without problem. A 24-port GAM device, like the one Positron offers, can deliver 40 Gbps of capacity inside an MDU, with the actual total bandwidth being constrained by the available fiber link. For instance, the GAM would be able to handle the same bandwidth as four (4) 10GEPON or XGS-PON links. That means, the GAM will not be a limiting factor to extend the fiber service over the coaxial infrastructure of a building.

Coexistence With CATV

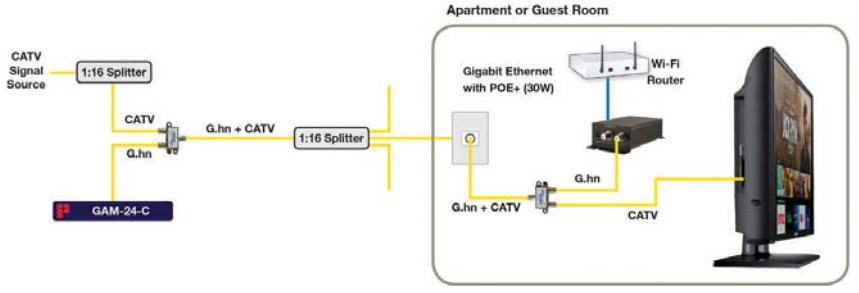

Figure 3. Combining G.hn and CATV on the same coaxial cable.

With DOCSIS High-Split, the Community Antenna Television (CATV) channels are allocated from 258 MHz (channel 30), and the total downstream spectrum available and bandwidth achievable is a function of the number of channels offered to subscribers. The more channels, the less spectrum remains for the downstream traffic. For instance, 20 CATV channels, each using 6 MHz of spectrum, reduce the downstream bandwidth of DOCSIS by about 1 Gbps.

Like the DOCSIS High-Split, G.hn allows CATV channels starting at 258 MHz. **The very important difference and benefit of G.hn is that it does not use any spectrum that overlaps with the CATV content.** Therefore, the total available bandwidth of G.hn is not impacted by the number of channels offered to the subscribers.

When deploying a GAM in environments such as an MDU or a hotel, it is very easy to overlay the G.hn and CATV signals over the same coaxial cabling using standard splitters-combiners as shown in Figure 3.

Looking at Figure 3, we see that the CATV signal needs to be overlaid with G.hn for each port of a GAM device. This combined G.hn + CATV signal can then feed up to 16 subscribers per GAM port using standard splitter devices that are typically already in place. A single coaxial drop per apartment or guest room is then used to bring the G.hn signal to a G.hn endpoint (Ethernet bridge) and to a set-top-box or TV.

> “With G.hn, operators deliver advanced services, such as gigabit high-speed residential Internet and 4K IPTV without the high capital and operational expenses associated with a fiber retrofit.”

Adding Pay-Per-View

Pay-per-View services rely on return channels located below the 50 MHz range. The specific channel(s) may vary depending on the Pay-per-View solution in use. To make room for such signals, a G.hn signal can be “notched” to begin at a higher frequency than the default 5 MHz defined by the G.hn standard (ITU-T G.9660). This is achieved via a simple

> Like the DOCSIS high-split, G.hn allows CATV channels starting at 258 MHz. **The very important difference and benefit of G.hn is that it does not use any spectrum that overlaps with the CATV content.** Therefore, the total available bandwidth of G.hn is not impacted by the number of channels offered to the subscribers.

configuration setting in the GAM. While this reduces the available spectrum, it does not prevent G.hn from delivering peak bandwidth of 1 Gbps in any direction.

For example, a GAM can configure the G.hn signal to begin at 60 MHz. Looking at Figure 4, we clearly see that the Power Spectral Density (PSD) for the G.hn signal is from 60 MHz to 200 MHz on the G.hn port using the coaxial cable.

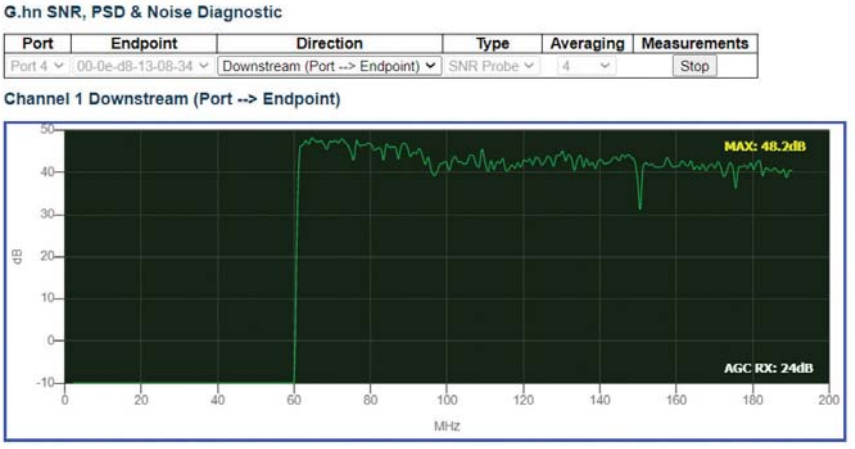

Figure 4. PSD of G.hn to make room for CATV and Pay-per-View.

Simple Migration to IPTV

The migration to IPTV is gaining momentum, even for traditional cable operators. G.hn offers a seamless migration to IPTV, and does not require all subscribers to switch at the same time; this is achieved via a simple 2-step approach.

Step 1. Inject the IPTV feed via the uplink port of a GAM. The GAM provides full support for Internet Group Management Protocol (IGMP) Multicasting, allowing multiple subscribers to share the same IPTV feed, which is very convenient for serial TV. At the same time, the GAM supports unicast IPTV which allows for more advanced user experiences (pause, rewind) without additional complexity.

Step 2. Whenever a subscriber is ready to migrate to IPTV, use the second Gigabit Ethernet port of the G.hn endpoint and connect it to the set-top-box or smart TV. You can then disconnect the coax cable from that previously used for the CATV signal.

Once there are no remaining CATV subscribers on a coaxial segment, remove the spectrum notch (5-60 MHz in the example earlier) to reclaim the full G.hn spectrum to deliver the full 1.7 Gbps of aggregate bandwidth of G.hn.

Conclusion

G.hn optimizes the spectrum use on coaxial cabling to achieve superior bandwidth to DOCSIS in the upstream and downstream directions. G.hn is an ideal fiber extension. (See the Broadband Forum *TR-419 document* for more information about the concept of Fiber to the Extension point.) It further shares the coaxial cabling with legacy cable TV (CATV), and facilitates a simple and efficient migration to IPTV. ■

ABOUT THE AUTHOR

Pierre Trudeau is President and CTO of Positron Access Solutions Corp. He revolutionized Wi-Fi in 2005 with Colubris' Distributed Data Plane architecture. Pierre is doing it again with Positron's carrier grade G.hn Access Multiplexer (GAM) that extends fiber / FWA virtually symmetrical Gigabit services over the existing in-building wiring to all underserved subscribers in MDU/MTU in hours @20% of the cost. Pierre was selected on the 2021 list of "Top 50 Broadband Influencers, Innovators and Disrupters who are Connecting the World" (Informa Tech). For more information, please email ptrudeau@positronaccess.com and visit https://www.positronaccess.com/. Follow us on Twitter at https://twitter.com/PositronAccess. Social media handles: #ghn #GAM #telecoms #fiberextension #MDU.

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G.hn optimizes the spectrum use on coaxial cabling to achieve superior bandwidth to DOCSIS in the upstream and downstream directions. G.hn is an ideal fiber extension. It shares the coaxial cabling with legacy cable TV (CATV) and facilitates a simple and efficient migration to IPTV.

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It's All About Your Reaction

Create an Effective Disaster Prevention and Recovery Flow Before Disaster Strikes

By Ernie Gallo

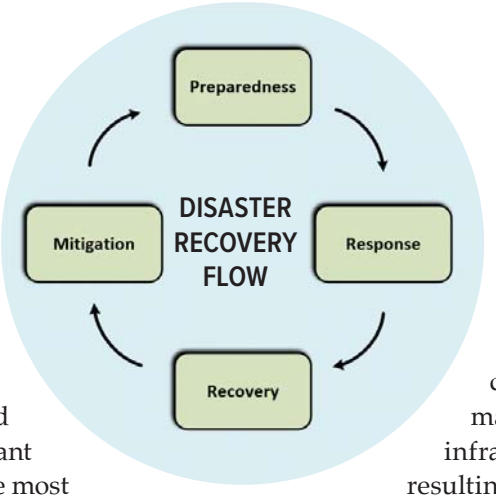

Figure 1

Disasters often arrive unannounced, but that doesn't mean we can't plan for them. Consider the tornados that occurred in December of 2021. At the time of this writing, network service providers are facing damage to buildings and outside plant facilities. While aerial plant and tower mounted equipment are the most affected, flooding of underground installations is also a concern. High winds damage roofs, allowing for water ingress and flooding damaging both equipment and services. Having regional response teams is critical to service restoration.

An unplanned interruption of network services can range from performance degradation to a complete network outage. Natural events, human error, cyberattacks, design flaws, or a combination of these factors can all cause an unplanned interruption. To effectively respond to a disaster, planning is needed to mitigate the effects on health and safety, facility risk exposure, service disruptions, economic loss, potential liability, corporate reputation, public relations and to reduce the possibility of future regulatory requirements.

Disasters can occur when communications service providers are faced with constraints to their budgets and resources. While providers need to maximize the reliability of their network infrastructure, they are also often faced with converged traditional communications and IT-based networks with differing installation procedures and environments. Thus, major outages related to physical infrastructure continue to occur, resulting in lost revenue from service outages and direct damage costs. These outages can be caused by service losses from power outages and backup power failures; facility fires, A/C switch gear fires and hydrogen gas concerns; and water leaks and floods.

The key elements to disaster prevention and recovery:

1. First and foremost, the disaster prevention and recovery plan should be tested to ensure that it can be effectively executed.
2. In the event of a disaster, evacuate staff if needed.
3. Determine usable and unusable equipment.
4. Maintain critical systems and infrastructure needed to keep service available before anything else.
5. Determine how to maintain service until final repairs can be made.

6. For large-scale disasters, find replacement equipment and staff available as quickly as possible.
7. Once final repairs are made, fully restore service.
8. Prepare necessary insurance claims.
9. Discuss lessons learned and areas for improvement.

Review building and network equipment in the following areas:

- Geographic and local building risks and site security
- Power and back-up power availability
- Fire protection (detection, suppression, safety)
- Equipment selection and installation quality
- HVAC systems and environment
- Cabling, bonding, and grounding
- Facility operations: Operating procedures, safety hazards, building conditions
- Disaster recovery planning and procedures

Disaster Recovery Plan

Because this plan becomes the reference for all managers and employees during a critical time, the disaster recovery plan should define the process of resuming normal business operations and repairing or salvaging critical equipment. (See Figure 1.) It's also critical to include representatives from all critical organizations across the company.

- It must provide for major and minor disasters, and prepare for natural disasters, such as tornados and general flooding; and both accidental and purposeful man-made disasters, including cyberattacks.
- The plan must provide for initial and ongoing employee training as well as the skills needed during the recovery process.
- The plan must not only spell out which functions are vital, but also in which order they are restored.
- And remember: no 2 disasters are the same.

Your disaster recovery plan should include information related to:

- Minimizing interruptions to the normal operations.
- Notifying those affected.
- Limiting the extent of disruption and damage.
- Minimizing the economic impact of the interruption.
- Establishing alternative means of operation in advance.
- Training personnel with emergency procedures.
- Planning for contingencies.
- Providing for smooth and rapid restoration of service.

A good reference to review is NIST Special Publication 800-34 *Contingency Planning Guide for Federal Information Systems*.[1]

> "In response to a disaster, we must also determine which equipment can remain in use temporarily, which equipment needs to be deactivated or decommissioned and replaced, and which equipment can be left in service."

Figures 2a and 2b. Equipment Backplane and Connector Damage

Proactive Response

Let's focus on the actions needed to respond to specific disasters and to determine the level of damage. In response to a disaster, we must also determine which equipment can remain in use temporarily, which equipment needs to be deactivated or decommissioned and replaced, and which equipment can be left in service.

The most common disaster scenarios encountered include:

- **Water Damage:** Flooding or overhead ingress from pipe breaks and roof failures
- **Fire and Smoke:** Direct thermal damage, corrosive smoke, or corrosive fire suppression
- **Contamination** from indoor- or outdoor-generated particulate or chemical releases
- **Critical Equipment Failure:** Generator, air conditioning, ATS, switch gear, etc.

A. Evaluation of Water Damage

Direct contact with water will rapidly cause electrolytic corrosive damage to electronics. (See Figures 2a and 2b.) However, electrical systems such as switch gear and distribution panels often can be restored. Thermal damage from electrical arcing and short-circuits may also occur, causing additional damage to electronics.

If the electronics are not energized at the time of wetting, returning to service is much easier through cleaning and testing. In addition to detailed visual inspections of equipment, sample collection for chemical and elemental analysis is critical to determining the type of corrosion and impact of contaminants in the water and to differentiating types of metals impacted for superficial surface oxidation to corrosion of underlying metals. This is needed to determine replace, restore, and cleaning recommendations and ensure long-term reliability. Additional testing considerations may be found in NEMA and NETA guidelines.[2]

Recommended analytical testing routinely performed includes:

- **Ion Chromatography Analysis** is used to quantify anionic and cationic contamination levels in micrograms per square. These can be compared to industry standards for electronics to aid in restoration or replacement decisions.
- **Environmental Scanning Electron Microscope with Energy Dispersive Spectroscopy (ESEM/EDS)** provides analysis for the elemental composition of corrosion Elemental Analysis.
- **pH or Halogen Paper** spot tests determine corrosivity of residues when hydrated.
- **Thermography (Infrared Camera)** for use on water-impacted electrical panels.
- **Insulation Resistance or Dielectric Breakdown testing** for electrical cabling and panels.

B. Evaluation of Fire and Smoke Damage on Electrical Cards

While direct thermal damage and combustion in a fire are devastating, the impacts from the corrosive smoke and fire gasses generated typically are far-reaching and may cause extensive damage to electronics well away from the fire event or throughout an entire building if not quickly remediated. The combustion or thermal decomposition of common halogenated plastics, cable insulation, and polymers used throughout communications and IT facilities, See Figure 3, release corrosive halogenated chemicals that may attack metallic surfaces.

Figure 3. Equipment Fire Damage

“While direct thermal damage and combustion in a fire are devastating, the impacts from the corrosive smoke and fire gasses generated typically are far-reaching and may cause extensive damage to electronics well away from the fire event or throughout an entire building if not quickly remediated.”

It is critical to perform chemical analysis throughout impacted areas and surrounding areas to map out the deposited concentrations of these anionic contaminants. Once the contamination levels are

> While providers need to maximize the reliability of their network infrastructure, they are also often faced with converged traditional communications and IT-based networks with differing installation procedures and environments. Thus, major outages related to physical infrastructure continue to occur, resulting in lost revenue from service outages and direct damage costs.

known, the decisions for equipment replacement, restoration, basic cleaning, or no cleaning necessary, can be developed and refined throughout different areas within a facility.

The chemical analysis also determines irreparable corrosion or other damages or chemicals of concern. Many of the same analytical tests described for water residues should be used, including:

- **Ion Chromatography Analysis** is used to quantify anionic and cationic contamination levels in micrograms per square. These can be compared to industry standards for electronics to aid in restoration or replacement decisions.
- **Environmental Scanning Electron Microscope with Energy Dispersive Spectroscopy (ESEM/EDS)** provides analysis for the elemental composition of corrosion Elemental Analysis.
- **pH or Halogen Paper** spot tests determine corrosivity of residues when hydrated.

C. Evaluation of Contamination

In addition to water and fire events, other contamination events include renovation activities. Construction or demolition debris, zinc or tin whisker contamination, hygroscopic (moisture-absorbing) pollutant ingress, chemical spills, virus or bacteria decontamination byproducts, refrigerant leaks, diesel spill, and electrolyte leaks, are all possible contaminants affecting critical facility equipment.

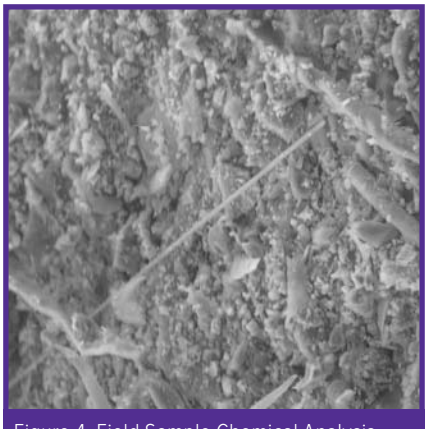

Figure 4. Field Sample Chemical Analysis

(See Figure 4.) In addition to a detailed visual evaluation and review of chemical data sheet information, several of the same analytical tests should be employed:

- **Optical Microscopy** of affected components characterizes the contaminants.
- **Ion Chromatography Analysis** is used to quantify anionic and cationic contamination levels in micrograms per square. These can be compared to industry standards for electronics to aid in restoration or replacement decisions.
- **Environmental Scanning Electron Microscope with Energy Dispersive Spectroscopy (ESEM/EDS)** provides analysis for the elemental composition of corrosion elemental analysis.
- **pH or Halogen Paper** spot tests determine corrosivity of residues when hydrated.

Now you can see WHY it's important to have a plan and preparation for all phases, from being ready to react to a disaster, actions to analyze the damage, and steps to minimize service interruptions and recovery efforts.

While you can't plan for disasters, a well-planned and rehearsed Disaster Recover Flow plan (as illustrated in Figure 1), can help your facilities, team members and customers, recover more effectively. ■

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ABOUT THE AUTHOR

Ernie Gallo is Director at Network Infrastructure Solutions, a division of Ericsson, Inc. He has more than 40 years of experience in outside plant products, requirements, deployment, and electrical safety codes and standards such as the NEC and NESC. For more information, please email ernest.gallo@ericsson.com or visit https://www.ericsson.com/en. Follow Ericsson on Twitter @ericsson.

Are You Meeting These Critical Fiber Deployment Objectives?

Technologies and Tactics to Help

By David Tanis

One of the few bright spots that emerged from the pandemic is the recognition of just how critical broadband Internet access is to our everyday lives. It's hard to imagine what it would have been like over the past year+ without broadband infrastructure in place to support activities like remote learning, work-from-home, and streaming entertainment.

And for those of us in the IT/telecom industry, this acknowledgement is long overdue. The job, however, is far from done.

Recent studies have estimated that between 18 million to 42 million people in the US lack broadband Internet access. Fortunately, initiatives like the Rural Digital Opportunity Fund (RDOF), the recently passed Infrastructure Bill, and others, have earmarked over $85 billion to close this gap.

These ambitious projects will require innovative approaches and new technology development to ensure that broadband service can be rolled out in a timely and cost-effective manner.

> "And while funds have been allocated for broadband projects, there are other headwinds, such as the well-documented shortage of skilled fiber optic installers, which threaten to slow it down."

And while funds have been allocated for broadband projects, there are other headwinds, such as the well-documented shortage of skilled fiber optic installers, which threaten to slow it down.

Fortunately, there have been a myriad of new developments in the fiber optic industry that make much better use of scarce resources, including labor, that are impeding broadband deployment.

3 Objectives

Here we share 3 objectives service providers aim to achieve along with fiber technologies and their impact through all stages of fiber deployment and activation:

Objective #1:
Simplify Fiber Installation
Objective #2:
Facilitate Plug-and-Play Connectivity to the Home
Objective #3:
Improve Time to Service with Improved Testing Strategies

Objective #1: Simplify Fiber Installation

Innovative fiber cable designs are significantly smaller than traditional fiber cables. This allows service providers to maximize use of already crowded duct space, and, in some cases, defer the need for additional civil works to add duct banks.

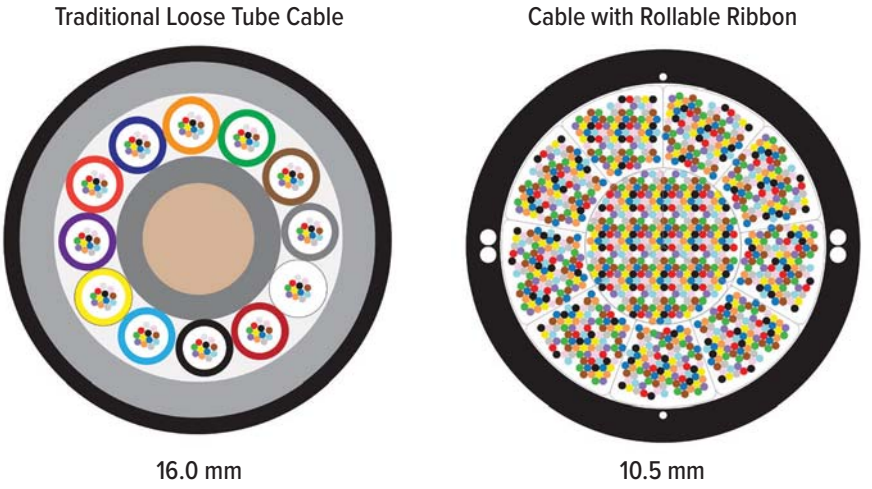

Figure 1. Comparison of Traditional Loose Tube Fiber Cable and Collapsible Ribbon Fiber Cable.

A comparison of traditional loose-tube duct cable with 144 fibers vs duct cable with collapsible ribbon fiber shows a 52% reduction in size. Similar size advantages are seen in higher fiber count cables. One example of this type of fiber cable design is SpiderWeb Ribbon®. (See Figure 1.)

And with continuing improvements in mass fusion splicing and splice-on connector technology, cable installation and termination can achieve the efficiencies needed to support the massive rollout of fiber-to-the-home. The combination of collapsible ribbon fiber and mass-fusion splicing can provide up to an 89% reduction in installation and termination time compared with conventional cable and single-fiber splicing methods.[1]

Objective #2: Facilitate Plug-And-Play Connectivity to the Home

With the sheer magnitude of fiber to be installed, terminated, and tested, conventional fiber deployment methods can become a bottleneck. Using pre-terminated cabling greatly speeds up fiber deployment by creating a plug-and-play environment for adding new services and customers.

Hardened single-fiber and MPO connectors, designed to withstand outdoor environments, are becoming commonplace for FTTx and 5G networks. These connectors are terminated in the factory, thus ensuring low loss termination. Examples of a pre-terminated port terminal and single fiber hardened connectorized cable are shown in Figure 2.

As with all fiber connectors, these hardened connectors must be inspected and kept clean to guarantee that the link loss is within acceptable limits. Clean connectors are essential, since additional truck rolls to perform remedial inspection and cleaning can impact fiber activation times.

Advanced digital fiber inspection scopes have on-board pass/fail analysis which provide installers with rapid, objective results, thus minimizing inspection time while taking the guesswork out of deciding whether fiber connectors are clean or dirty. Hardened MPO connectors can be inspected with pass/fail analysis in under 15 seconds, greatly speeding up fiber verification.

Fiber cleaning tools have also been developed specifically for several of the more common hardened fiber connectors.

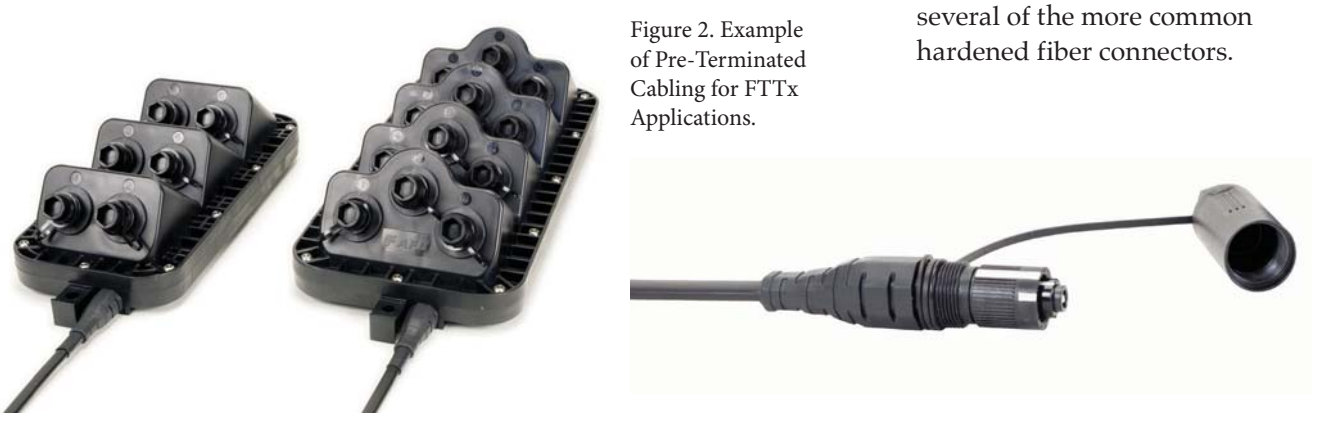

Figure 2. Example of Pre-Terminated Cabling for FTTx Applications.

Pre-Terminated Multi-Port Terminal and hardened fiber drop cable

Objective #3: Improve Time to Service With Improved Testing Strategies

The shortage of experienced fiber optic installers has driven the need for manufacturers to rethink the design and operation of fiber test equipment. Complex, multi-purpose test equipment is being replaced by intuitive, easy-to-operate, purpose-build instruments that require minimal training for technicians new to the fiber optic industry.

Office, as well as upstream from the Optical Network Unit (ONT) based at the customer premises. (See Figure 3.)

These power meters have the advantage of being able to test in both directions, thus verifying that both the OLT and ONT are delivering sufficient signal power levels. Figure 3 shows how Through-PON power meters can be used at the fiber distribution hub or at the customer premises.

This service activation tool is a critical part in provisioning

> “Many service providers that deployed GPON services in the past are in the process of upgrading their networks to 10G PON, which is needed to deliver the bandwidth that their customers demand.”

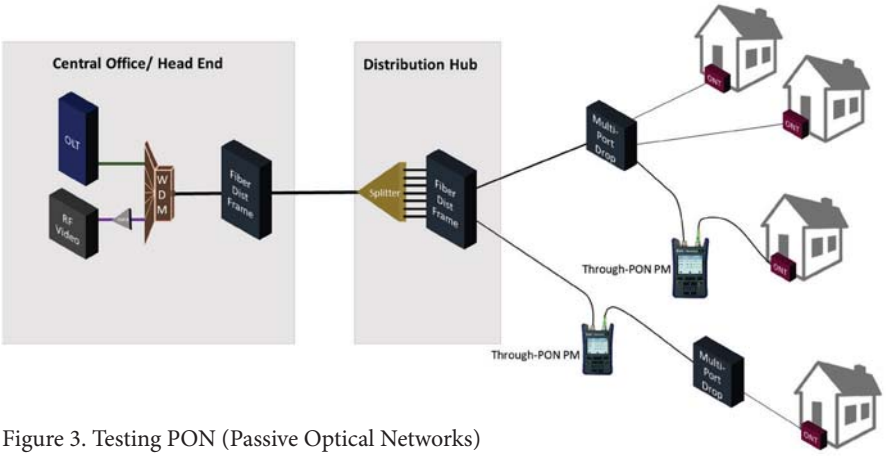

Figure 3. Testing PON (Passive Optical Networks) With Through-PON Power Meters

A perfect example of this is fiber testing for PON service activation. Verification of the presence of all required wavelengths is a requisite step in the provisioning of new PON services.

To accomplish this, next-generation PON power meters known as *Through-PON Power Meters* can test PON networks in both directions, downstream from the OLT (Optical Line Terminal) based in the Central

PON services in a greenfield environment, and in brownfield environments that are migrating from GPON to one of the different types of 10G PON. Many service providers that deployed GPON services in the past are in the process of upgrading their networks to 10G PON, which is needed to deliver the bandwidth that their customers demand.

A well-designed Through-PON power meter detects

presence of legacy as well as next-gen PON signals, and correctly establishes power limits based on where in the network testing is performed. For example, downstream power level limits at the customer premises will be lower than power level limits at the distribution hub.

Focus on the Fiber

The importance of the telecom network is only increasing, as most workers continue to follow a hybrid work model. And as many service providers are converging their wireline and wireless networks as part of 5G rollouts, the need for innovation technology to simplify and speed up deployments is becoming more critical. Fortunately, the fiber industry is responding with creative solutions to simplify deployment in all phases, from installation, to termination, to activation. ■

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ABOUT THE AUTHOR

David Tanis is a Senior Product Line Manager at AFL. He has more than 30 years of experience in telecommunications, primarily in fiber optic networking and cabling for service providers and enterprises. He has published multiple papers and spoken at numerous industry conferences on fiber-related topics. For more information, please email David.tanis@aflglobal.com or visit https://www.aflglobal.com/Products/Test-and-Inspection.aspx. Follow David on Twitter @DavidT28641531. Follow AFL on: Twitter @AFLglobal, Facebook: AFLcorp, LinkedIn: afl-2, Instagram: photos.afl, and YouTube: AFLglobal.

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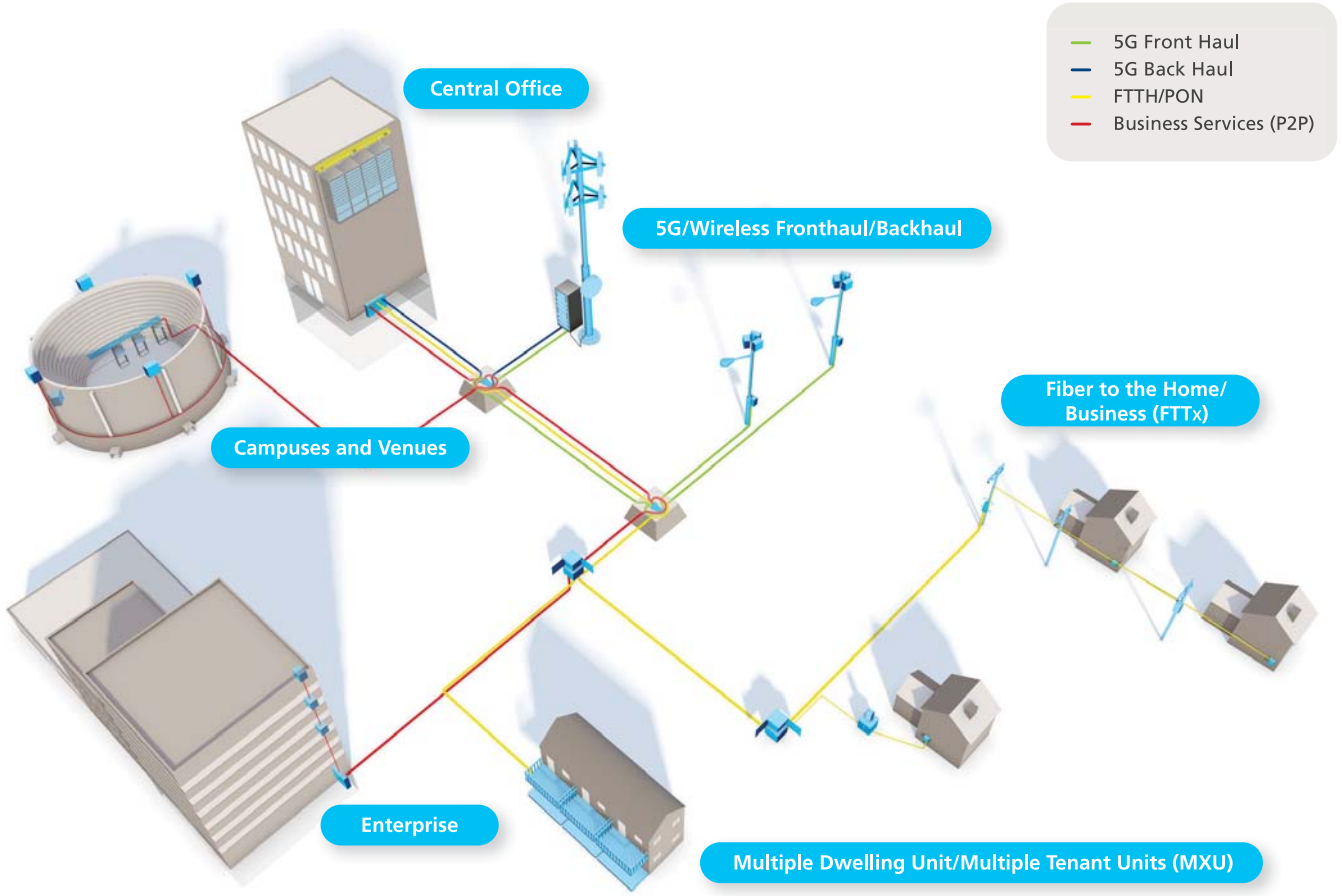

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Cell tower in San Francisco. *(Image: Nearmap)*

Level the 5G Playing Field

Leverage Different and Powerful Partnerships

By Tony Agresta

If you want to understand the significance of the approaching 5G revolution, just consider the numbers. Over the next decade, 5G deployment could contribute up to $1.7 trillion to the US GDP and create about 4 million jobs, according to consulting firm BCG.[1]

In telecom, 5G isn't just going to change the rules of the game, it's going to take it to an entirely different playing field. Those who make the right investments now will realize an outsized share of future gains. But it takes a willingness to embrace a new mindset, new partners, and new technology.

GIS data, for example, has historically enabled telecom providers to plan routes and fiber networks. It's an accurate way to map their above-ground and in-ground assets to make sure they have up-to-date information and unobstructed pathways. But in an era defined by 5G, telecom companies need to reimagine their networks to densify to the necessary degree. And that creates an even bigger opportunity for

those who use GIS data—in the right ways.

5 Questions

As telecom leaders navigate this dynamic moment, a strong GIS strategy can help them grow. If you're looking for a GIS partner, these 5 questions can help you find your match.

1. How Can You Help Me Succeed in a 5G World?

Think of it this way: in the mobile era of yesteryear, data traveled like sound waves. But in a 5G environment, data travels more like a light wave. That means line-of-sight matters more than building materials. It also means networks are in a race to deploy 100 times the number of 5G towers because 5G waves don't travel as far and can't pass through obstructions. To ensure both coverage *and* capacity, those towers need to go up all over, including in congested downtown areas.

Old-school RF propagation tools may have been effective enough at planning networks in 3G and 4G environments. But newer GIS technology that offers aerial imagery and data insights is needed to meet the kind of density 5G demands.

2. Just How Fresh and Accurate is Your Imagery?

In a 5G universe, data that isn't constantly updated and 99% accurate is irrelevant. Especially in an increasingly dense environment, providers need to know exactly what's surrounding their assets—or potential assets—at all times. The only way to achieve that level of freshness is through a subscription GIS service that's uploading new data all the time. The ideal GIS partner publishes fresh imagery of our coverage areas in the cloud multiple times a year, so customers always have an up-to-date view of what's truly on the ground.

One company, Nearmap, ensures that data is accurate within ⅛ of a cm, which ensures telecom companies know exactly which poles have space to mount gear and where exactly those poles are located.

3. Can You Support Me Through a Crisis?

Getting a network up and running is just the first step. **What makes the difference between winners and losers is *maintenance*.** As savvy telecom leaders know, customers who can't get service in a hurricane or natural disaster switch to someone else. And in a 5G-dominated world, even a single wet leaf can disrupt a signal.

In a disaster, continually updated and highly accurate GIS data ensures that telecom providers can swiftly deploy crews to make necessary repairs and fortify the network.

4. How Intelligent are Your Insights?

As the role for GIS evolves, so must its intelligence. Artificial intelligence (AI) can enhance datasets with oblique images from different angles to see obstacles or support planning for routing. AI datasets can also provide supplementary information, from identifying information for poles and buildings to the site of buildings, square footage, and other key details. With AI, GIS partners can get key insights to you faster and in a format that automatically augments and complements your existing data.

5. How do You Ensure Safety and Compliance?

Finally, as companies continue to grapple with pandemic-induced disruption, any partner that can't help you adhere to the highest public health and compliance standards is remiss. For the foreseeable future, sending feet into the field isn't just inefficient—it can be unsafe.

New GIS technologies make it easier than ever to get high-resolution data virtually. Remote options not only help you stay on top of the data you need in a less time- and labor-intensive way. They also ensure safety, which helps attract and retain the best talent.

Making the most of a rapidly changing opportunity is never easy—and in the midst of an ongoing global crisis, no less—but those who lean into transformation now will define the telecom landscape of tomorrow. GIS technology can be a powerful driver of future success—as long as you pick the right partner. ■

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ABOUT THE AUTHOR

Tony Agresta is the Executive Vice President and General Manager of North America, at Nearmap, a global technology GIS company. He has more than 30 years of extensive technology experience in sales, marketing, product management, and operations for technology companies focused on analytics, marketing automation and mapping. For more information, visit https://www.nearmap.com/us/en. You can also follow us on Twitter: https://twitter.com/nearmap.

Construction Without Disruption

Dig Once Best Practices Pay Off

By Jim Hayes

The COVID-19 pandemic has helped spotlight the need for speeding broadband deployment to rural and other unserved areas. And now that the Bipartisan Infrastructure Law has passed, it includes $65 billion for broadband buildouts to bring broadband to those in need.

Department of Transportation Secretary Pete Buttigieg hopes that Dig Once legislation will facilitate that. The Dig Once Act would require that conduit for fiber optic cable be included in the construction of any road being built with federal funds in areas without broadband. The intent of the bill is to accelerate the deployment of broadband (and reduce its cost) by minimizing the number and scale of repeated excavations for the installation and maintenance of broadband conduit or broadband infrastructure in rights-of-way.

Politics aside, this idea of digging once reaches much farther than roads.

Figure 1. Microtrenching can be almost invisible when done properly.

Figure 2. A technician tracks a boring installation down Santa Monica Blvd.

> "The Dig Once Act would require that conduit for fiber optic cable be included in the construction of any road being built with federal funds in areas without broadband. The intent of the bill is to accelerate the deployment of broadband (and reduce its cost) by minimizing the number and scale of repeated excavations for the installation and maintenance of broadband conduit or broadband infrastructure in rights-of-way."

Some municipalities have adopted a policy of installing fiber duct anytime they do underground construction. If there is construction required for water, sewers, gas, electricity or anything else, they will install some fiber ducts for future use. It's cheap insurance.

Dig Once solves problems for the future, but what about today? What are the alternatives to underground trenching? Of course, there are aerial cables, but they're becoming less common in urban areas for aesthetic reasons.

Underground Fiber Installation Techniques

Following are descriptions of 2 sound underground fiber installation techniques.

Technique #1: DIRECTIONAL BORING

This technique does a good job of installing cables without disruption if used properly. But when something goes wrong, it often creates a big problem.

In fact, we regularly hear about contractors boring into gas lines, often with tragic consequences. Last year, that very thing happened near where I live. The puncture occurred in a 16-inch-high pressure gas line. Thankfully, the gas and electrical service was quickly shut off before fires or explosions resulted. This is not unique. One fiber contractor in Nashville managed to puncture 7

water mains in 1 year—flooding neighborhoods and causing substantive damages.

An expert in damage prevention recently told me that damage from directional boring can go unnoticed at the time of installation. Sewer lines are often the victims because they are not well-marked in underground utility maps.

Unfortunately, the damage occurs when the boring tool punches through the sewer pipe. The contractor then goes ahead and installs ducts or other pipes with no signs of damage to the sewer. Later, when a backup in the sewer occurs, the cleaning process may cut the cable or pipe that actually caused the sewer pipe blockage.

Situations like this illustrate the importance for contractors doing directional boring to be extremely careful. They should start by contacting *Call Before You Dig* and the appropriate local authorities. They should also secure maps of the buried utilities, and use underground locating equipment to double-check the locations where the boring is being done.

Technique #2: MICROTRENCHING

This may be the best development in construction to minimize disruption.

Figure 3. Microtrenching in rural British Columbia, Canada.

The field team saws a groove in a roadway or sidewalk, installs a small plastic microduct, and blows fiber optic microcable into the duct. The whole process is built around fiber optic microcables that reduce the diameter of a 144-fiber cable to the size of a pencil.

That microcable is then blown into a plastic duct less than a half-inch in diameter. This process floats the cable via high-speed air flow in the duct to reduce friction, and enables the cable to be pushed down the duct for distances of a mile or more.

Microtrenching can be done so neatly that it becomes almost invisible in the street.

Figure 1 shows this type of fiber installation in Southern California. You can see the groove cut along the edge of the pavement and the curb. The microduct with 6 ducts is placed in the groove. Then, the groove is backfilled with a special filler that closely matches the color of the pavement. In this case, one 288-count-fiber cable was blown in one of the ducts. Future projects could add 5 more microcables to the empty ducts for a total of 1,728 fibers to be turned up when needed.

Smart contractors do the right things each time they are installing fiber. A time ago we witnessed an installation in downtown Santa Monica where a tech followed the boring tool down the street with a locator to ensure that it stayed on the proper path. (See Figure 2.) That's an example others should follow.

Microtrenching is not only for urban areas. Figure 3 shows a contractor who installed hundreds of miles of fiber optic cables using this strategy in rural

British Columbia. Aerial cable was not possible due to the area's harsh winter weather, so an underground cable was required.

Rather than trenching alongside the road, the contractor convinced the customer that microtrenching was better, and he proved it. The installation went much faster and cost much less than conventional trenching.

Underground Installation Alternatives?

Other techniques like using robots to install cables in sewers or removing the insides of CATV coax cable and blowing in fiber optics have been proposed and trialed. But none have gained traction, and some have proven useless.

The worst idea (in our opinion) was called *nanotrenching*. This technique cut a shallow groove in the roadway, and a fiber optic cable was laid in the groove. It was then covered by rubber cement. Unofficial reports shared how the cable was ripped out in just a few days from the traffic driving over it.

Best Training = Least Disruption

In order to minimize the disruption from construction, municipalities need to understand fiber optic construction practices. Cities like Santa Monica, which started its own fiber network 20 years ago, have staff members who are trained in fiber installation practices and believe in the idea of digging once. That best practice is worth the investment.

You see, Santa Monica figured out long ago that having their own high-fiber-count cables allowed them to become a commercial ISP and lease dark fiber. That generated revenue for the city, and offset the costs of building and operating their own network.

Figure 4. Technicians install 3 fiber ducts and 6 additional ducts for future use.

Now, when a contractor does a project in the city, it may include installing multiple fiber ducts for both current and future projects. (See Figure 4).

Remember, training is not frivolous. When service providers hire contractors to install fiber, those contracted engineers and field techs should be trained on which fiber installation techniques suit specific applications.

Unfortunately, contractors complain about the cost of training, or the equipment needed for processes like microtrenching and blowing in microcables. That's extremely short-sighted, because being able to bid these new techniques gives them a big competitive advantage—especially if they promote their services as "construction without disruption." ■

ABOUT THE AUTHOR

Jim Hayes is President of The Fiber Optic Association (FOA) with over 40 years of experience in fiber optics as an entrepreneur, trainer, and writer. The FOA is the international non-profit professional organization and widely recognized certifying body in fiber optics. FOA has certified over 80,000 CFOTs through more than 200 training organizations in 40 countries worldwide. For more information, email info@foa.org, visit https://foa.org/ and follow on Facebook and LinkedIn.

Guiding Clients as They Upgrade Their Legacy WAN

Help Your Clients Find the Right Legacy Network Upgrade Strategy

By Noah Drake

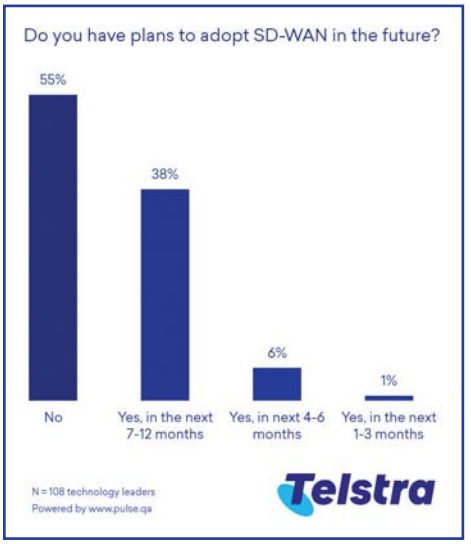
As your enterprise clients prepare for their future successes, they should look to the past when it comes to their legacy network infrastructure.

Organizations are scrambling to adopt ambitious new technology initiatives related to cloud computing, IoT, artificial intelligence, 5G, or unified communications—all to remain relevant and retain top talent in today's hyper-competitive environment.

Network user behavior is also changing. Gone are the days of everyone logging on only at the office at the same times. Today, demands on a network occur at different times from different regions making scalable network optimization a priority.

However, one commonly overlooked resource is the fundamental infrastructure necessary to achieve most business objectives: a reliable, stable, and scalable, network. Without upgrading, or at least maintaining, legacy network infrastructures, your clients may face outages, latency, faulty performance, and low customer adoption.

While many companies realize the need to move on from their legacy wide area network (WAN) infrastructure, common barriers include cost, resources and administrative logistics. However, there are bright spots in the form of new software-based networking technologies more suited to the adaptive networking needs of today's flexible and agile business environments.



The WAN Evolution

The most common infrastructure in place is some flavor of WAN. These types of networks use dedicated private links and include such technologies as Multi-protocol Label Switching (MPLS). A WAN-MPLS model, for example, is based on physical network connections among centralized data hubs, data centers, and sites.

Legacy networks are often contracted through a service provider like you—with set terms based on bandwidth or number of sites.

And while your customers are YOURS right now, don't assume that will always be the case. Keeping them for the long-term requires that you become their consultative partner, looking out for their future after you fully understand their past. You can do that by helping them see both the pros and cons of their legacy network and the benefits/pitfalls of the future strategy they're considering.

Education Is Transformative

They may be realizing their lofty goals to build-out a whole new network and team to manage it and maintain it requires significant changes in skills and resources. They may not realize that the new network approach could take fewer people, but also has the potential to create conflicts of interest as they end up fighting their own internal headwinds.

The bottom line is this: switching equipment and vendors can also be costly battles.

In today's high-pressure, always-on environments, companies need constant network status updates, which are often difficult to obtain with a WAN-based model. Plus, legacy WAN technology can be expensive to maintain. Upgrading is often marketed as a cost saving. However, a company usually won't see any of that return until much later from a total cost of ownership perspective.

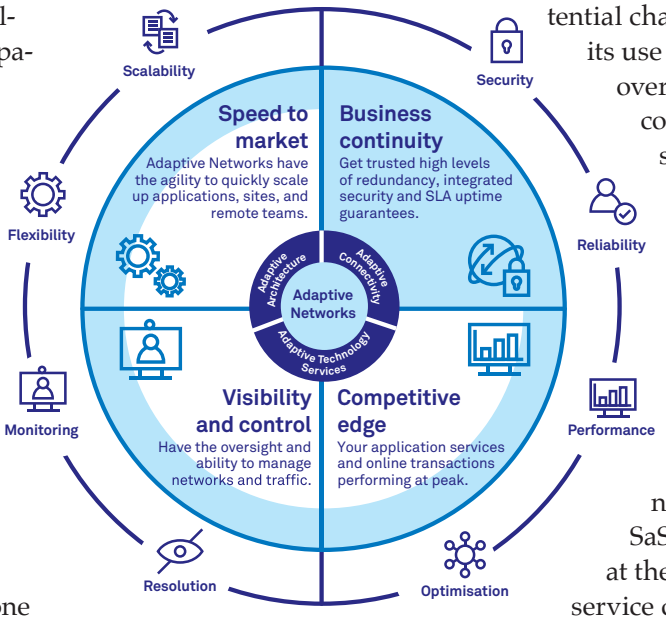
As you guide your clients, explaining that cost is only one factor to consider when planning a network upgrade. Among the many key elements, they should look for in a new network are security, flexibility, and performance.

Share why the option for Software-Defined Wide Area Networking (SD-WAN) has emerged as an attractive solution for provisioning and optimizing distributed IT networks. Quite simply, SD-WAN uses the Internet to send traffic between networks, controlled by centralized software, or to provision new networks at the edge. This coincides with the trend of more organizations moving to cloud-based models and becoming less reliant on data centers.

You can also cite research that shares how more enterprises are realizing the benefits of SD-WAN. According to the TeleGeography SD-WAN Research Service, the number of enterprises they surveyed deploying SD-WAN increased from 18% in 2018 to 43% of respondents in 2020.

SD-WAN addresses the issue of network "forklifting"—in other words, converting a network all at once, an incredibly massive undertaking especially in a WAN environment. With SD-WAN systems, your client can combine different underlay networks to approach an upgrade at their own pace. This makes sense for global organizations, for example, as they can adopt a regionalized model, which is much more obtainable and less intimidating. They can do their Asia region first, then move on to European regions and then North America, instead of having to do it all in one go.

You can't talk about SD-WAN without talking about Secure Access Service Edge (SaSE). One potential challenge with SD-WAN is its use of a software networking overlay, which is efficient for connectivity but can lack sufficient security and access controls. SaSE is a networking model that can augment SD-WAN networks with enhanced security provided as a service.



In the case of SaSE, the edge may refer to points of presence (PoPs) close to network endpoints. With SaSE, security is performed at the point where Internet service comes onto the network at each location before the traffic reaches a centrally orchestrated network. Security at the edge is much more effective, and the fact it's decentralized gives organizations more options for managing their own unique security requirements.

SD-WAN is also provider-agnostic. The underlying components of an SD-WAN may likely be from multiple providers. Being provider-agnostic frees your clients from the limits of having a single provider or an incredibly sophisticated network engineering team.

The Future Is Bright

A legacy network upgrade at the right pace with the right technologies can deliver flexibility, enhanced security and increased performance across every area of your client's operations.

Organizations of all sizes are focusing their resources on digital investments that make a real difference for employees, customers, and partners—with the common goal of being faster, more agile, and adaptable to change. Looking ahead, we can expect to see more companies approaching legacy network upgrades with a heightened sense of urgency as they realize the importance of network infrastructures for enabling true enterprise transformations. ■

ABOUT THE AUTHOR

Noah Drake is Vice President, Customer Solutions and Architecture, Americas, Telstra. For more information, please visit https://www.telstra.com/americas. You can follow us on Twitter @TelstraEnt, and on LinkedIn at https://www.linkedin.com/showcase/telstra-enterprise/.

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