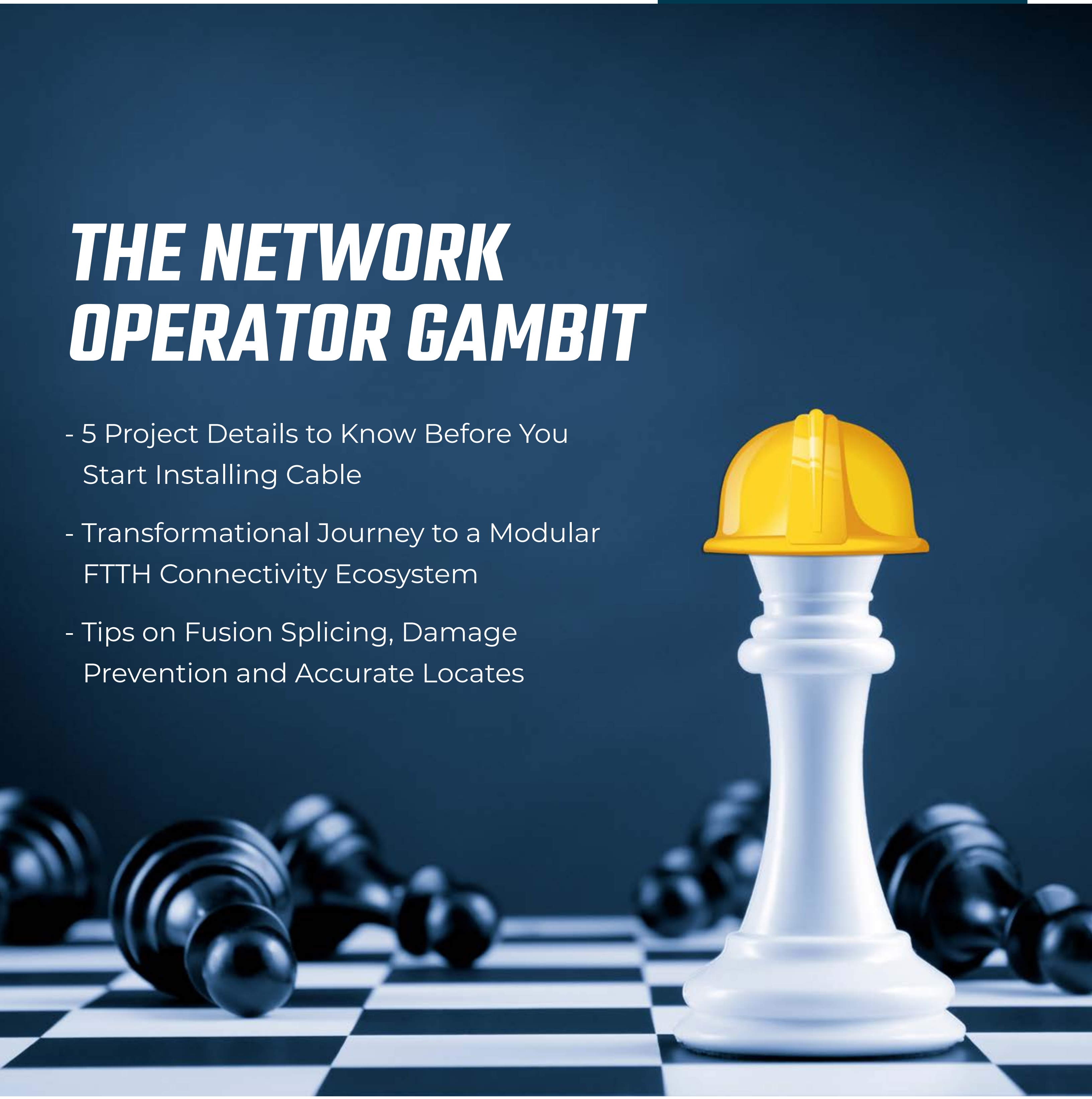
CONTRACTOR CHRONICLES

AN EXCLUSIVE PUBLICATION FOR NETWORK CONTRACTORS

VOLUME 1 | ISSUE 1 | DECEMBER 2022

THE NETWORK OPERATOR GAMBIT

- 5 Project Details to Know Before You Start Installing Cable
- Transformational Journey to a Modular FTTH Connectivity Ecosystem
- Tips on Fusion Splicing, Damage Prevention and Accurate Locates



Netceed

WELCOME TO THE CONTRACTOR CHRONICLES

IN THIS ISSUE

Welcome to the inaugural issue of **The Contractor Chronicles**, our new publication solely focused on the telecom/broadband market.

Our goal in creating this publication is to build a publication that becomes a recurring educational repository bringing together the contractor, distribution, and manufacturing communities, by publishing relevant information about products and issues impacting this specific market.

As many of you know, the challenges facing us as an industry continue to apply pressure on the ability to obtain material for your fiber network builds:

- **The government/federal investment** in broadband is simply staggering. From the Infrastructure Investment and Jobs Act of 2021 to other programs such as the Consolidated Appropriations Act, 2021 Passed in December 2020, the Rural Digital Opportunity Fund, and Broadband ReConnect Program, are just the federal dollars flooding our industry. And this doesn't even include things like private builds, organic network expansion, wireless and data center connectivity, and other network construction projects that are all pushing this industry towards hyper-scale growth.

- **Supply chain disruption** from various bottlenecks won't be resolved soon. From a lack of shipping containers to port congestion, to a shortage of vessels and space, average lead times are at its highest point since 1987.

- **Logistics costs** are also rapidly rising. Carriers have increased pricing 15-25% in the past 24-months due to rising fuel, repair and maintenance, and insurance jumping an average of 15% across the board. In fact, sending a container from Asia to Europe is about 10 times higher than in May 2020, while the cost from Shanghai to Los Angeles has grown more than sixfold, according to the Drewry World Container Index.

- **Lead times** for A-list products continue to push out well into 2023 – depending on the product/material. Consider that fiber cable is practically limited to allocation buys, then think about ordering other material and equipment necessary to complete builds – on top of the fact that the stopwatch on the delay doesn't even begin until a purchase order is placed. We're in the middle of a perfect storm between manufacturing, logistics, and supply chain restraints, that will create mayhem on a network operator's ability to deliver infrastructure in a timely manner.

- **Limited storage** space is also quickly becoming a bottleneck rivaling workforce and material bottlenecks. Warehouses across the country, whether through a distribution partner, a network contractor or the service provider yards for customer-owned inventory and stock is putting additional pressure on all parties.

In building our inaugural publication for The Contractor Chronicle, we're hoping to push information sharing out to our customers as we believe our strength comes from the ability to be seen as a true compliment to customers, acknowledged by the critical conversations we have to help combat some of the challenges just listed. In this issue, you can learn from Rhino about Five Components For Fast And Accurate Locates, Condux explains Five Project Details to Know Before You Start Installing Cable, and Matt Brice explains how to leverage IOT for damage prevention of your network, among other articles.

Again, it's important to share information like this because today, maybe more than ever, precipitates the need for greater communication between customers, manufacturers, and business partners. When thinking about federal assistance and broadband funding impacting our industry, when learning about the operational and financial efficiencies associated with a broadband network, and when experiencing the disruption being experienced in manufacturing and the supply chain, information sharing is critical and at the forefront of our value proposition.

At Netceed, it's our goal to understand market conditions at both a macro and micro level, while at the same time future-planning our stock and product portfolio to be able to limit any negative exposure to your fiber builds and revenue streams. We feel that providing this value-added service helps us stay positioned as a valued resource and true partner to your business.

It has long been a goal of ours to create a publication entirely focused on contractors to support their network construction projects. We hope you enjoy our inaugural issue!

5 PROJECT DETAILS TO KNOW BEFORE YOU START INSTALLING CABLE

BY: CONDUX

Because every duct run is unique, every project you take on will be unique. So no matter if you're on your first cable installation project or your five hundredth, we believe there are five details you need to know <u>before</u> you get on the job site to start installing cable.

Why? Knowing this information will set you and your crew up to work the most efficiently and effectively, ultimately maximizing your time, safety, and profit. Here they are:

1. Fiber OD

The OD (outer diameter) of your fiber is important on so many levels. The first question it helps calculate is: What is your duct fill ratio? For best blowing performance, your fill ratio should not exceed 60%. Secondly, this detail informs what equipment (i.e., blower, cable packs, etc.) you'll need to execute the install successfully.

Note that we did not say "fiber count." This is because the OD (outer diameter) varies by manufacturer; while your fiber count from Manufacturer A matches one from Manufacturer B, the fiber OD may not match.

2. Duct OD/ID + Type of Duct

Similarly, the outer diameter (OD), inner diameter (ID), and type of duct you're installing into completes your fill ratio calculation above and indicates which duct packs you'll need to connect your fiber blower to the conduit.

As an example, if your fiber OD is 1" and you're installing into a 2" duct, the Condux Gulfstream™ 400 fiber blower is the best suited for the job at hand, along with the right sized Cable and Duct Packs.

3. Length of Run + Hand-Hole-to-Hand-Hole Distances

Starting with the big picture in mind helps create efficiencies as you tackle the whole project, one run at a time. The total length of your run plus the hand hole locations help you identify where the best and safest locations are for loops, where couplers are needed to bridge the gap, and potentially also where the best starting point may be. Without knowing where you're going, it's more difficult to get started with your best foot forward.

4. Locations of 90s + Loops

The more information you know about your pathway, the more you can plan, and the better equipped you'll be. Piggybacking off of #3, knowing how many 90s and loops you'll encounter, will help you devise a plan that is safe and efficient, and you'll know what tools and equipment you'll need on hand to execute. For example, when doing a loop we suggest you connect ~15 feet of extra duct from the exit point to the new entry point with couplers to set up for a seamless install.

5. Compressor Size Needed

For most traditional duct and fiber we recommend a 375 cfm compressor, with 100 PSI – but your answers to #2 (duct details) and 3 (distance) above will help guide this recommendation as well. With all that being said, it is important here to point out that your blowing distance and performance is very dependent on the integrity of your duct. Bad duct equates to low performance (more on this in a minute).

While it is still possible to install cable without this information up front, we guarantee you will have better luck and a more productive install if you take the time to plan and prep accordingly. And, we'd be remiss if we didn't take it a step further and make a final recommendation. When you get to the job site, all tools and equipment in hand, always do a pressure test, a proofing test, and a crash test.

Why? One of the most important variables to know when installing fiber is the integrity of the duct. Each of these tests will give you insight into the integrity of the duct you're installing into and what, if any, challenges you might encounter (or could avoid with additional pre-install work).

PUSH FIT HDPE COUPLERS

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GULFSTREAM 400 FIBER OPTIC CABLE BLOWER

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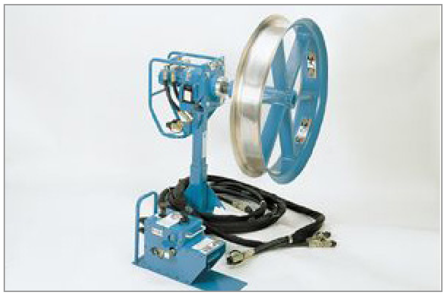
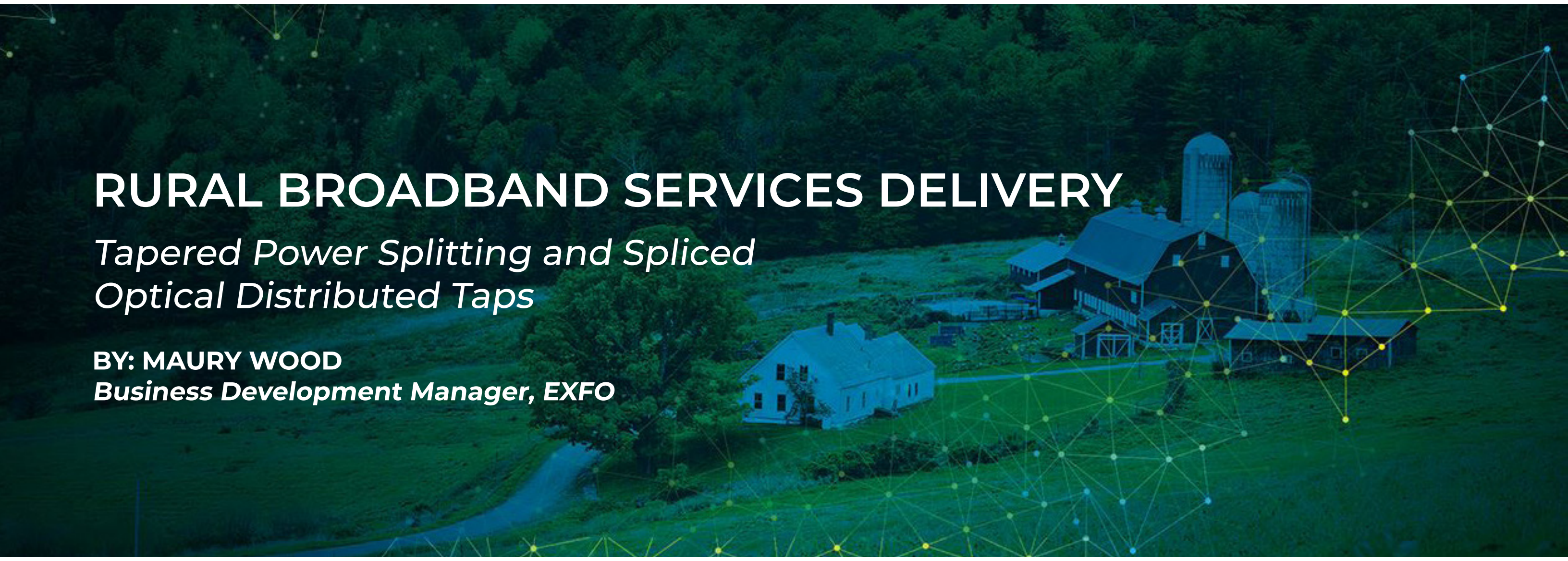


FIBER OPTIC CABLE PULLER PACKAGE 1

LEARN MORE ›



RURAL BROADBAND SERVICES DELIVERY

Tapered Power Splitting and Spliced Optical Distributed Taps

BY: MAURY WOOD
Business Development Manager, EXFO

When ISPs deploy fiber broadband service to rural areas, the biggest challenges they face are economic. Like any business, and in the absence of government regulations or mandates, ISPs will offer services first to those dwellings and businesses with the lowest total cost of deployment. (The resulting lower capital and operating costs yield higher returns.)

This reality is in flux since broadband Internet access is increasingly recognized as a basic utility and an important public good. During the pandemic, skyrocketing needs for remote learning and remote work capability combined with fickle political fortunes to accelerate this shift in perspective. Political and industrial leaders in the US and abroad have even suggested broadband access be considered a fundamental human right.

Over the past several years, the US Federal Communications Commission (FCC) has shown impressive resolve to close the so-called digital divide separating urban and rural citizens. The Emergency Broadband Benefit Program (EBBP), the Connect America Fund (CAF) and the Rural Digital Opportunity Fund (RDOF) call to mind the massive push for electrification across the rural US, propelled by Franklin Roosevelt's New Deal. Subsidized broadband deployment to rural areas may soon benefit from the huge Biden administration infrastructure spending program.

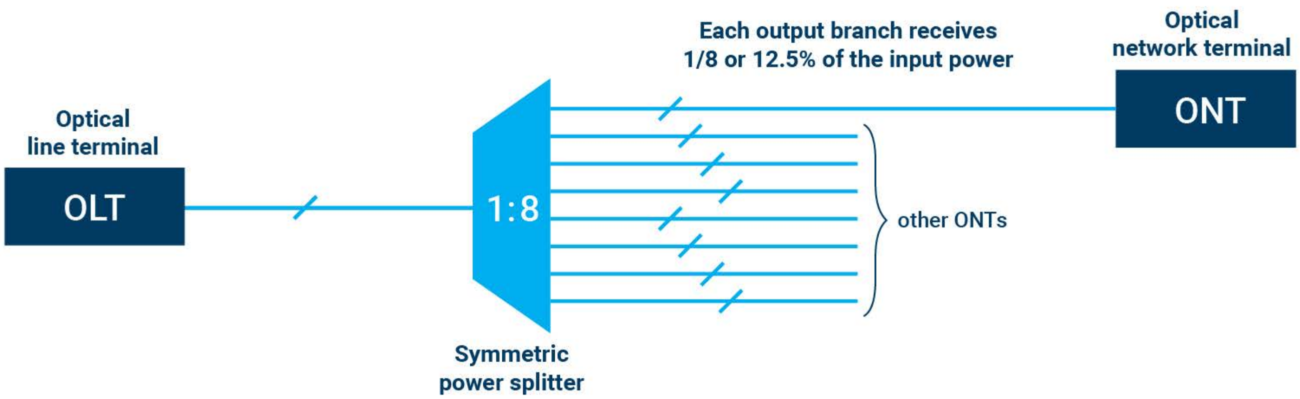
Fiber-to-the-home services in urban areas overwhelmingly utilize a passive point-to-multipoint downstream content distribution model, in which symmetric power splitters ensure all endpoints receive sufficient laser light energy and IP addresses filter that content to ensure accurate delivery of packets to their proper destination. Upstream packets also share a single channel, typically using time division multiple access methods. A key benefit of passive networks is that they avoid the need for optical repeaters and signal amplifiers to extend reach.

FTTH PON architecture has been wildly successful in serving the needs of urban (at least 1,000 people per square mile) and suburban residents (between 1,000 and 500 people per square mile), but not when deployed to rural areas (fewer than 500 people per square mile). Rural areas require longer, costlier fiber cable run lengths, and passive symmetric power splitting is not always optimal for signal distribution, particularly in sparsely populated remote villages.

Suppliers of outside plant optical components have innovated two approaches to adapt FTTH PON technology to rural applications: asymmetric unbalanced (or tapered) splitters and distributed taps.

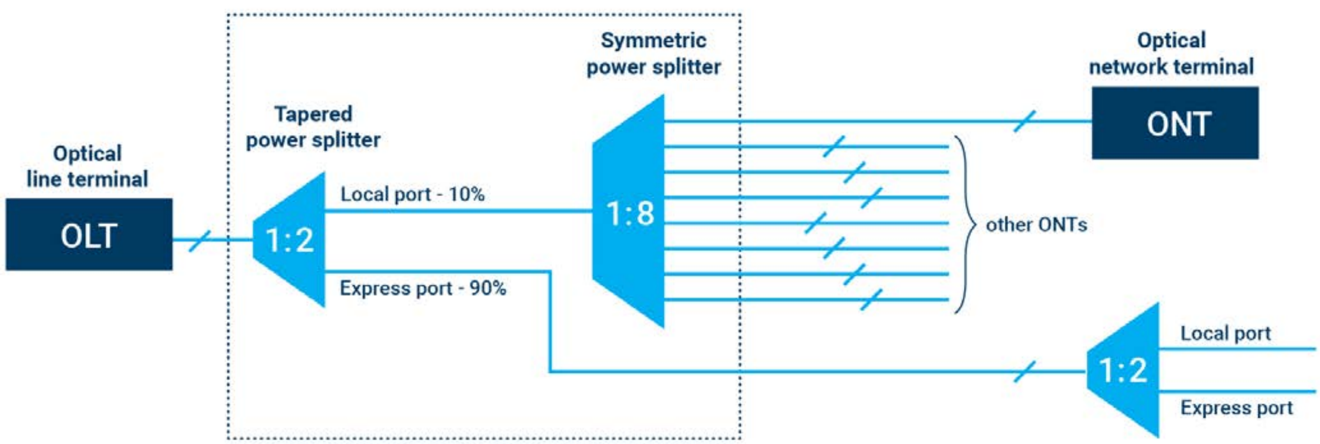
Tapered Power Splitting

Symmetric splitters generally offer a “power of 2” number of power splits (typically 4, 8, 16, 32 or 64) where each output branch receives an equal (symmetric) share of the input power from the optical line terminal (OLT).



This equal allocation of light from the OLT among optical network terminals (ONTs) is appropriate in densely populated areas, as the distance of each dwelling or business from the centrally located symmetric splitter is roughly the same. However, in rural areas, subscribers are generally not clustered geographically. In these situations, asymmetric power splitting can help maximize reach.

Often tapered power splitters are 1:2, with one output branch being the lower insertion loss “express port” and the other output branch a higher insertion loss “local port” that connects directly to a subscriber ONT, or to a symmetric power splitter to serve a cluster of homes or businesses.



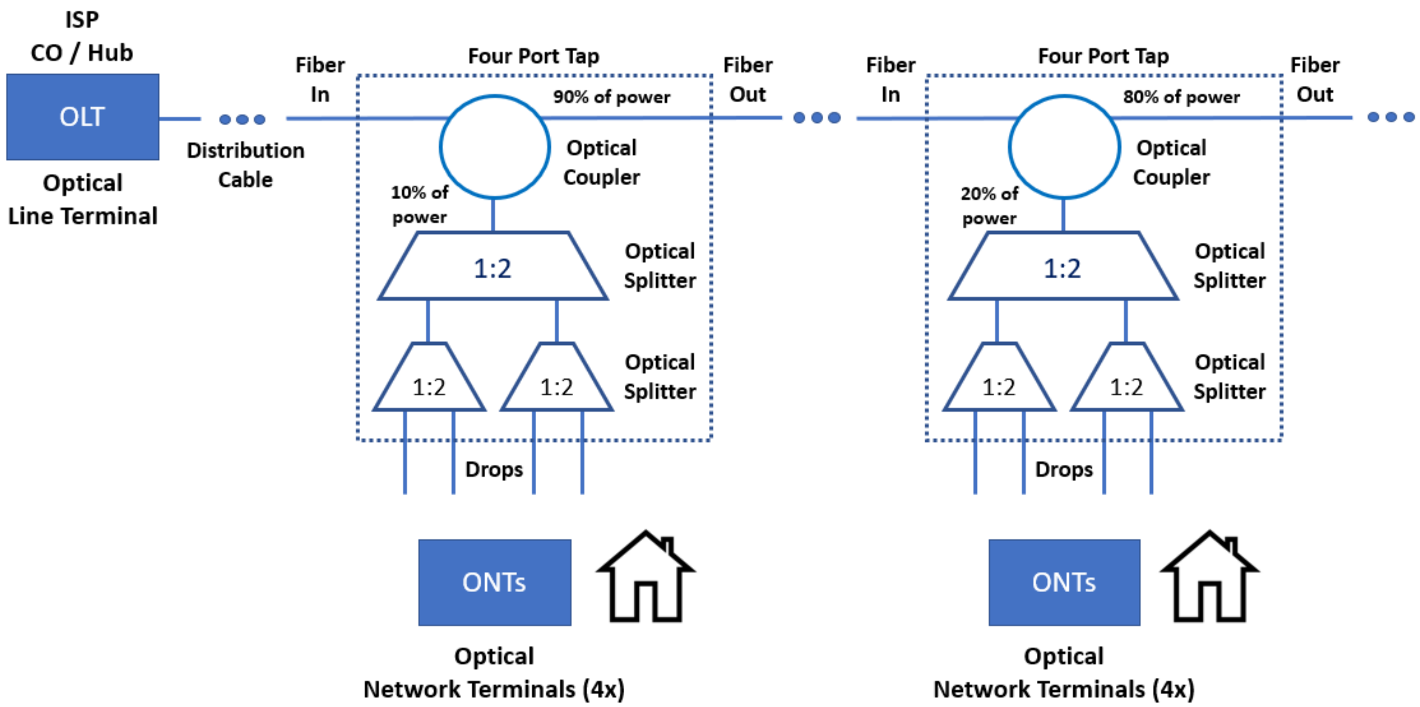
In the example shown, the local port receives 10% of the transmitted light from the OLT, while the express port receives 90% of the input power, preserving as much power as possible for the downstream tapered splitter to maximize reach out to more remote subscribers.

Tapered splitters are passive optical components and have several characteristics—insertion loss, reflective loss, polarization dependent loss, and directivity—that network designers must bear in mind when determining overall PON system performance.

Spliced Optical Distributed Taps

One key to the cost savings associated with distributed taps, as claimed by their suppliers, relates to the reduced amount of fiber cabling (distribution and drop cables) required as compared with centralized symmetric power splitter network configurations. Passive distributed taps, as shown below, implement a linear or serial daisy-chain architecture that will be familiar to engineers and technicians with experience in hybrid fiber cable (HFC) topologies. While coaxial cable taps work in the electrical domain, and the distributed taps under discussion here work in the optical domain, the basic signal tapping theory of operation is similar. This functional similarity translates into lower training costs for network operators whose technicians are familiar with electrical coaxial components and technology.

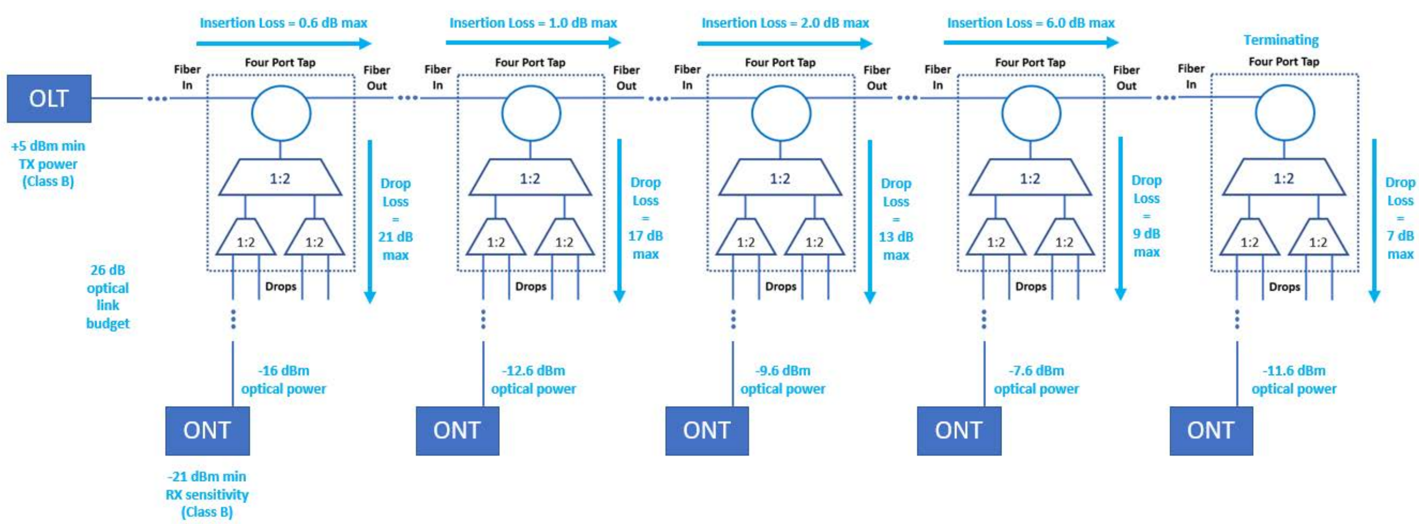
Distributed taps comprise optical couplers, which divert a portion of the input light power, and optical splitters, which equally split this diverted light into the drop outputs. The example below shows two cascaded 1:2 splitters to create four drop outputs. Note that the first tap extracts 10% of the light power, and the second tap extracts 20% of the remaining light power in this simplified example.



Another advantage of distributed taps is reduced splicing overhead, with only one fiber cut and two splices required to add each tap. The small physical size of tap terminals allows them to be mounted aerially, avoiding the need for equipment cabinets, mounting pads, labor costs and the associated local government approvals for this infrastructure.

Distributed taps have two important optical performance parameters that impact end-to-end optical loss budgeting. The first is the tap value or drop loss, and specifies the optical power extracted by the tap, between the input distribution fiber and the output drop fibers (the remaining optical power passes to the next tap in the PON). All the drop ports in each tap along the link (four in the example above) have the same drop loss. Taps closer to the optical line terminal (OLT) extract less optical power from the trunk than taps further from the OLT, in order to allow these PONs to have maximum reach; this is particularly important in dispersed rural areas. The second performance characteristic is tap insertion loss, the amount of light power (both typical and maximum) diverted from the input distribution fiber to the output distribution fiber. The final tap in the PON is the terminating tap, and it has no output fiber port, as all the light energy passes to the drop ports.

Here is a simplified illustration of the downstream path using typical loss values to help make these parameters clearer. Note that the attenuation of all connectors (below 0.75 dB for SC APC per IEC standards), fusion splices (below 0.3 dB per IEC standards), and the fiber itself (about 0.2 dB per km at 1490 nm) must be included in an actual engineering optical loss budget accounting.



A key takeaway here is the available range of tap values (drop losses) from their suppliers allows the network engineer to manage the optical link budget so that ONTs near and far from the OLT receive adequate transmit light signal power. This design methodology also manages the 1310 nm upstream signal power from the ONTs back to the OLT.

With distributed tap PON architecture, along with tapered splitter PON architecture, service providers have two options to deliver fiber broadband services to underserved rural areas cost effectively. EXFO's broad portfolio of fiber test tools, including PON power meters, optical fiber multimeters, inspection scopes, and OTDRs with iOLM, are perfectly suited to validate and maintain all types of passive optical networks.

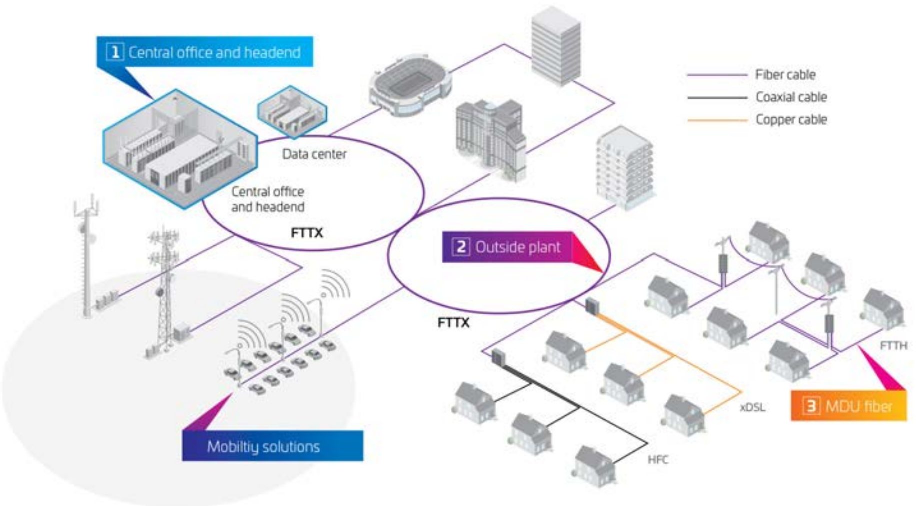
THE TRANSFORMATIONAL JOURNEY TO A MODULAR FTTH CONNECTIVITY ECOSYSTEM

BY: COMMSCOPE

Service providers are accelerating the deployment of fiber-based network solutions that help them provide highly competitive connected experiences while preparing for a future of expanded capacity. But the fiber connectivity evolution has also resulted in several challenges for service providers. With fiber going deeper into the network, there is so much variation among enclosures and terminals that sourcing these critical connectivity devices, training technicians on their use, and deploying fiber quickly have become increasingly complex and difficult.

Fiber to the home (FTTH) deployments, for example, rely on a seemingly infinite number of configuration permutations that account for variations among network segments and physical locations. Enclosures, terminals, closures, hubs, cabinets, and other connectivity devices must all be tailored for the fiber capacity, technologies, cable gauges, splice counts, connector types, mounting requirements, and environmental protection needs of their unique application.

The numbers are staggering. In its fiber connectivity portfolio, CommScope had approximately 2,500 different options for its hardened fiber terminals, including 206 types of fiber trays, 224 mounting brackets, and 155 closure domes or top covers. It's not atypical for large service providers to have tens of thousands of fiber SKUs in inventory. And satisfying each new application required a lengthy development time and added even more unique product variations to the portfolio. This rapidly expanding product set created a natural conflict between volume and variation that stifled CommScope's ability to meet customer needs quickly, created rigidity and complexity in its development processes, and made it difficult to scale production. These challenges presented the opportunity for a fresh approach and a better way to what's next in FTTH connectivity.



That's when CommScope embarked on a transformational journey, resulting in a multidisciplinary approach that is revolutionizing how CommScope brings its fiber connectivity products to market—from design to operations, ordering, and field installations. To begin this process, the company conducted a deep dive into customer needs, gathering input from over 25 global service providers and conducting multiple concept testing sessions including third party installers to also understand how CommScope's products were not only being used—but pushed beyond their intended use. CommScope wanted to know how service providers were stretching components to their limits and adapting its connectivity products to solve problems.

Internally, CommScope turned the development process into a company-wide, global initiative that involved employees from nearly every department: R&D, product management, field application engineering, operations, supply chain, sales, manufacturing, marketing, and customer service. This overhaul of design, production, and supply chain resulted in the creation of a modular end-to-end fiber connectivity ecosystem that CommScope calls NOVUX™. With it, CommScope has reduced components by at least 75 percent, while allowing for 50 times the configurations than are available today.

This paper details the key considerations that formed the creation of the industry's first modular FTTH ecosystem and reviews the path CommScope followed as it transformed its fiber connectivity portfolio around the principle of modularity—and redefined its company culture in the process.

INDUSTRY TRENDS AND CHALLENGES

Three principles emerged as the foundation for a new FTTH design approach: configurability, scalability, and simplicity. These values help guide CommScope's development while ensuring service providers can navigate current and future industry challenges and trends in an era of burgeoning demand for broadband capacity. The COVID-19 pandemic has heightened the urgency for the industry to deliver on broadband's potential and shined a spotlight on the hurdles preventing a clear path to fiber network rollouts.

Fiber Deeper in the Network

Fiber's march deeper into the network is undeniable. A November 2020 Cable Fiber Outlook Survey from Heavy Reading showed that 53.5 percent of respondents say they will deploy fiber deep over the next five years and 44.1 percent said they would deploy FTTH over the same period to meet the growing bandwidth demand. The magnitude of the investment required is demonstrated by findings from the Broadband Communities 2021 Fiber Trends report: fiber passes 53.8 million U.S. homes, but only connects 22.5 million. In Europe, fiber passes 182.6 million homes, connecting only 81.9 million, according to the FTTH Council Europe.

But as fiber goes deeper, the challenges increase. Diverse architectures (DAA, FTTX, FTTH, 5G and hybrids) and applications (residential, business, backhaul) require many connectivity product configurations, components, spares, and associated training and operational complexities—putting pressure on service providers' business cases and challenging equipment vendors to create more configurable solutions.

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Shortage of Skilled Labor

Deploying fiber for FTTH requires a skilled labor force, but experienced technicians are difficult to find and expensive to train. The same Heavy Reading survey showed two of the top three challenges to installing FTTH are training staff and contractors.

Currently, specialized technicians work in different parts of the network: trunk, feeder, and drop. The FTTH last mile is particularly complicated, with multiple variations that include spliced, connectorized, and hardened drops. With few technicians available and a trend toward a younger demographic, the opportunity to simplify fiber connectivity has never been greater.

Rapid Technology Evolution

Any solution chosen and installed today must be prepared to address not only today's technologies, but also those of the future to come. Innovations are hitting the market more quickly than ever. Consider that since APON first entered the market around 2000, there have been over 20 new versions of PON released—essentially one new PON version per year. The older iterations are still in use, while new variations continue to be proposed. Fiber connectivity advancements such as rollable ribbon cables, multifiber connectivity, WDM, and fiber flex foils require that closures and terminals are designed to serve the present, as well as anticipate the future.

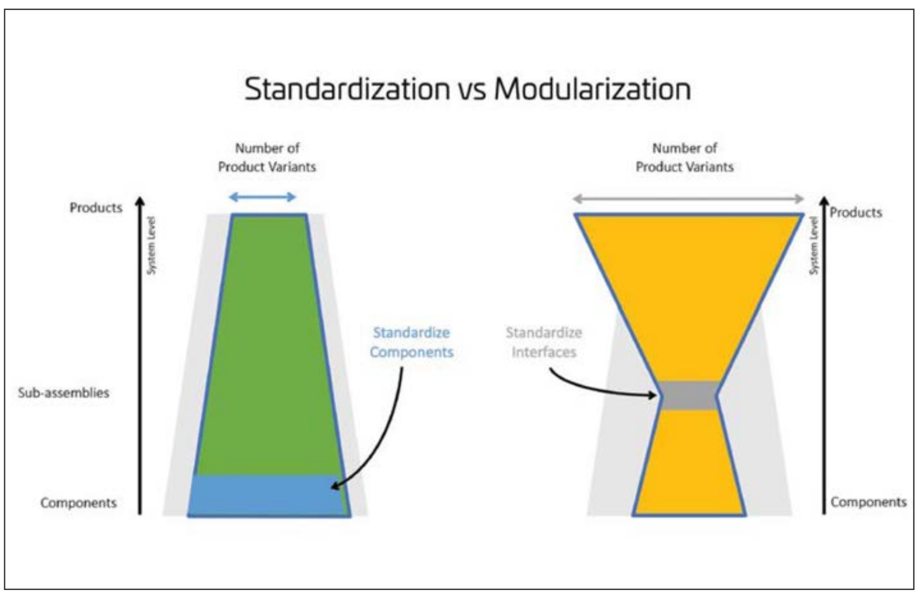
Changes in the Competitive Environment

The need to respond faster to market demand is increasingly important for service providers who are facing increased competition. This trend is expected to continue as service providers prioritize broadband investments and public funding for broadband increases.

This highly competitive environment is creating a sense of urgency for service providers who want to retain existing customers, while attracting new ones. There is room for growth in both the U.S. and Europe. A recent study by USTelecom showed that 46% of areas in Europe have two or more competing facilities-based broadband providers. In the US, the areas in which subscribers benefit from competition between two or more broadband providers jumps to 94%. For service providers, winning subscribers in these contested markets requires a network with the highest broadband capacity, fastest speed, and highest reliability. FTTH provides these advantages, assuming its deployment complexity can be mitigated so that a service provider can quickly respond to customer demands.

MODULAR DESIGN: A NEW BUT WELL-PROVEN METHOD

CommScope examined these trends and challenges and found a common thread in their solution: the ability to offer the most configurations for connectivity with the fewest components. The company first surveyed other industries to see how they accomplished this goal, and as a result, studied "platforming"—the standardization of components—as a potential solution. In the auto industry, for example, a manufacturer might use the same undercarriage or chassis for many models of cars. Here, platforming reduces the number of unique parts but also limits the potential for product variations. In broadband, platforming raises a similar issue since certain components that particular customers depend upon would need to be eliminated with this approach.



CommScope then examined the principle of modularity. The key to modularity is that interfaces are standardized. Therefore, components with these interfaces can be connected in any configuration that suits a service provider's technology and architectural requirements. This presents an elegant solution for product sets that must keep volume and variation in balance. Looking at FTTH through the lens of modular design, CommScope that knew it would have to rethink and retool all its processes.

VISION OF A MODULAR FTTH ECOSYSTEM

Returning to the trends and challenges, let's review exactly how modularity can benefit an FTTH deployment.

Enable fiber deeper in the network

Using common building blocks with standardized interfaces reduces the number of modules needed to produce more connectivity configurations to address the many unique locations and applications associated with getting fiber deeper into the network.

Deploy fiber with less skilled labor

With a modular approach to fiber connectivity, installers only need to be trained one time on the installation and assembly process, which is common across the modular system. Regardless of the configuration an installer encounters in the field, the installation process will be easy to recognize, making the work more efficient, while simplifying training and improving quality. Additionally, there is plug-and-play connectivity thanks to the interfaces but also because once a hardened technology module is tested in the factory, it is considered reliable in the field.

Where Modularity Helps Most

What do the best candidates for modularity have in common?

- Accelerate innovation acceptance
- Have large product portfolios with overlapping functionality and performance
- Require customer-specific configurations
- Have a need to reduce time to market
- Require increased flexibility in adjusting to changing demands (volume, types of products)
- Focused on increased customer satisfaction

Keep up with rapid technology evolution

When technology changes occur, updated modules can be easily designed and produced to accommodate them. This reduces the need to replace products in the field or to redesign entire products to address a technological advancement, while making it easier to upgrade the installed base to new technologies. In addition, tested modules and interfaces do not need to be retested when used in another configuration or network segment.

Address changes in competitive environments

Increased competition requires service providers to be agile and seize new opportunities. Since there is no "one size fits all" when it comes to fiber deployments, especially in brownfield and greenfield situations, service providers need the right products in the right volume, and with enough simplicity to deploy them quickly.

Discover why NOVUX is the future of FTTX

Explore how NOVUX helps you accelerate fiber rollouts and respond quickly in a rapidly changing and competitive network environment.

DOWNLOAD WHITE PAPER

TOP TIPS: INVESTING IN FUSION SPLICING

BY: CORNING OPTICAL COMMUNICATIONS AND CABLING INSTALLATION & MAINTENANCE

In 1970, the innovation of optical fiber entered the telecommunications scene. Fusion splicing shortly followed as the most reliable means of permanently joining two optical fibers via electric arc. This technology creates a continuous optical path for signal transmission and provides the strongest connection with the lowest loss and reflectance of all fiber termination methods, with splices typically measuring less than 0.1dB of loss.

Fortunately, what was once an expensive and labor-intensive process with heavy, cumbersome equipment has significantly evolved. Several improvements in fusion splicing technologies now make it easier to invest in what has become an increasingly popular fiber termination method to meet today's increasing network demands. Consider the following tips:

1. Only Use Active Clad Alignment for Same-Era Fiber

Fiber consists of a central core, cladding that surround s the core, and a protective coating. A single-mode fiber has a coating that typically measures 250 microns, a cladding of 125 microns, and a core of 8 microns. An active clad alignment splicer aligns the outer edges of the cladding by holding the fibers in a v-groove using electrodes as they move along an x- and y-axis, using cameras to assist with analyzing the alignment. Clad alignment is not recommended when splicing modern-day fiber with previous generations of fiber. Over time, fiber manufacturers have succeeded in improving fiber geometry, and the core concentricity will likely differ. When fiber cores are not the same concentricity, alignment can be off and the signal will not have an optimum path, resulting in signal loss at the splice location, degrading or preventing transmission.

2. Achieve Greater Accuracy with Core Alignment

Instead of focusing on aligning the outer edges of the fiber's cladding, core alignment promotes light moving uninterrupted through the fiber core based on its properties. For example, because light moves differently through the core than the cladding, it glows brighter at the core. Core alignment solutions provide greater accuracy when splicing single fibers, especially when splicing two fibers that may not have the same core concentricity.

3. Choose a Mass Fusion Splicer for Ribbon Fiber

With increasing bandwidth demands, fiber counts have increased. To fit more fibers into a small footprint, manufacturers use ribbon fiber where 12 color-coded fibers are grouped together. A fiber cable can contain multiple tubes packed with ribbon fibers, arranged either flat and stacked or rolled, enabling fiber counts in a single cable to reach as high as

6912! Mass fusion splicers should be used for splicing ribbon fiber as they allow all 12 fibers to be fused simultaneously, significantly saving time and money. These splicers use clad alignment technology with multiple v-grooves to align all 12 fibers, but advancements in mass fusion splicing have increased accuracy closer to that of core alignment solutions.

4. Embrace the Variety of Applications

To meet bandwidth demands and high-speed application loss requirements, fusion splicing has significantly grown in popularity. The industry has catapulted away from simple cable-to-cable splicing long employed for restoration and repairs in outside plant single-mode applications to now encompass a diverse application portfolio across a multitude of environments.

Cable-to-pigtail splicing has become increasingly popular in inside plant applications for repairs, adds, moves, or changes. Used with both single- and multimode fiber and either single or ribbon fiber, pigtail splicing has become the de facto choice for terminating incoming outside plant fiber to indoor fiber at the building entrance or demarcation point with splices typically residing in rack- or wall-mounted enclosures. Depending on the type of fiber, core or active clad alignment solutions are both effective for pigtail splicing.

Also used in inside plant applications, splice-on connectors have become increasingly popular for use with both singlemode and multimode fiber, and either single or ribbon fiber. They offer a reliable, low-loss method for easily terminating tight-buffered indoor fiber to single-fiber, duplex-fiber, or multi-fiber connectors.

5. Easily Justify Your Investment

Early fusion splicing equipment was expensive and cumbersome, costing anywhere from $12K to $40K and weighing and average of 30 pounds. Fusion splicing was also labor intensive, often requiring a team of two or three people to manually splice in a protected environment, qualify with an OTDR, and oversee the process.

Today’s splicing equipment is far less expensive, ranging between $4K and $18K, depending on the application and features. They can be easily run by one employee, feature intuitive touchscreen interfaces, and are highly portable with splicers from Sumitomo Electric and UCL Swift weighing less than 5 pounds. Fusion splicers have also advanced to deliver a very close loss estimation during the splicing process and incorporate a pull test after the fibers are fused, eliminating the need for continuous testing during the splicing process. Per industry standards, it is however recommended to test the overall end-to-end loss of the link once splicing is complete.

With its ability to support growing bandwidth demand and enable higher transmission speeds, the number of applications requiring fiber is on the rise. Manufacturers are working to make fiber optic cables easier to install, repair, and update. At the same time, the cost of electronics and splicing technologies continues to drop. Fusion splicing is now crucial for contractors to meet the network demands of today. Thankfully advancements in fusion splicing technology make justifying the investment easier than ever.

ACTIVE FUSION CONTROL AND OTHER AUTOMATIC LOW-LOSS ENABLING FEATURES OF THE 90S+ FUSION SPLICER

BY: AFL

With the introduction of the 90S+, Fujikura has also introduced the new Active Fusion Control (AFC) technology to further improve the dependability and consistent performance of core alignment fusion splicers. With each generation of fusion splicer development, Fujikura has continued to innovate and improve the state of the art in fusion splicing, and AFC in the 90S+ is the latest example.

Splicers incorporating the Profile Alignment System (PAS) core alignment system have long been recognized as providing the most consistent and reliably low-loss splicing results. AFC further enhances the consistency of splicing performance by providing a sophisticated algorithm to alter the splicing parameters to mitigate against increased loss due to a poorly cleaved fiber end.

A less than ideal cleaved fiber end may result in core deformation at the splice point (micro-bending) and therefore higher loss. AFC uses the cleave quality monitoring system to consider when the cleave quality is such that the fusion parameters should be altered to avoid an elevated splice loss. To avoid the higher loss, more fusion heating time or power is required to create greater diffusion in the fiber core and lessen loss due to micro-bending. It should be noted however that a PAS core alignment splicer generally employs a relatively short, two second arc time to ensure ultra-precise core alignment. If the arc time or power is too great, the cladding of the two fibers will self-center due to surface tension of the molten glass during the fusion arc, and core alignment will not be maintained unless the cores are already perfectly in the center of the cladding. Therefore, sophistication is required in the proprietary analysis and algorithms of AFC to ensure it is used to the best advantage.

In Figure 1 below, splice loss results with poor cleave quality are shown with and without AFC. In this case, cleaves with angles in the range of 3° to 5° were deliberately created to illustrate the benefits of AFC.

Splice Loss Distribution, G.652-G.652 Fiber

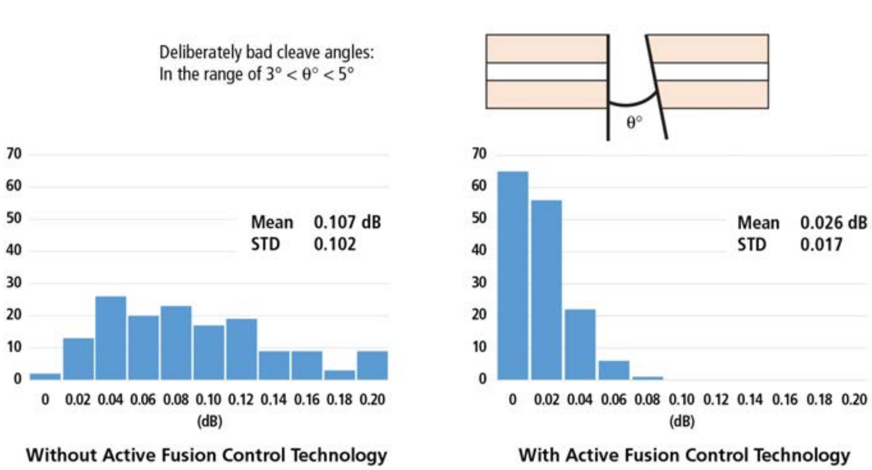


Figure 1 — Improvement in splice loss by the new Active Fusion Control Technology

The introduction of AFC in the 90S+ is only the latest in a series of innovations and features that Fujikura has introduced to ensure consistent low-loss splicing results with PAS core alignment fusion splicers. The previous Fujikura introduction of Active Blade Management technology was another such innovation and is still unmatched by any other fusion splicer manufacturer. Active Blade Management utilizes Bluetooth® communications between the splicer and CT50 cleaver to monitor cleaving performance and automatically rotate the cleaver blade when cleaving consistency begins to degrade. With the combination of Active Blade Management technology (to prevent poor cleaving results as much as possible) and now AFC (to prevent high loss when a poor cleave is encountered), the 90S+ Splicer provides near-perfect immunity to cleaving related issues.

The automated opening and closing of both the wind protector and the splice sleeve heat shrink oven is another example of Fujikura innovation. This provides an obvious boost to splicing productivity since it frees up the operator to concentrate on fiber preparation, wrapping completed splices into the splice tray, etc. However, the benefits go far beyond improvements in splicing operational time. In a dusty a splicing environment, the automation of the wind protector and heat shrink oven can also be utilized to minimize risk of dust getting into the splicer V-grooves (which might result in unstable core alignment) and to avoid contamination issues with the splice sleeve heat shrink process. These capabilities are also exclusive Fujikura fusion splicer features.

In a core alignment splicer, as noted above, a controlled arc time at the correct arc power is essential in order to ensure consistent and precise core alignment. Fujikura previously introduced Auto Arc Calibration to monitor the brightness of the glowing fibers during the arc, and thereby self-correct and fine-tune the arc power splice-by-splice, making small adjustments to the arc power as the electrode condition changes. While we still recommend a manual Arc Calibration at the start of daily splicing activities (especially if there has been a change in weather), the Auto Arc Calibration can also compensate for changes in atmospheric pressure which could otherwise result in a stronger or weaker arc intensity.

Fujikura also previously introduced Automatic Fiber Discrimination which can use image analysis to identify the fiber type being spliced in order to automatically ensure that the proper splice mode and arc parameters are used for that category of fiber. This is very helpful when the operator has some uncertainty in fiber type, and it works in conjunction with Auto Arc Calibration to ensure proper arc conditions and heating of the fibers during splicing.

It should be noted that all of these innovations function automatically and are therefore not dependent on operator habits or skill, or operator attention to routine maintenance guidelines.

Table 1 summarizes these Fujikura innovations.

Table 1 — Sources of splice loss inconsistency and automated countermeasures

FACTORS CAUSING OCCASIONAL ELEVATED SPLICE LOSS	AUTOMATED COUNTERMEASURE
Failure to consistently achieve low-loss due to occasional poor cleave	Active Fusion Control Technology (compensates for poor cleave by arc parameter adjustment)
Inconsistent or poor cleaver performance	Active Blade Management (automatically manages blade rotation)
Problems with splicer contamination in a dusty environment	Automated Opening/Closing of Wind Protector and Heat Shrink Sleeve Oven
Electrode condition or wear Incorrect electrode heat output due to weather change	Auto Arc Calibration
Incorrect splicing parameters	Automatic Fiber Discrimination (identifies fiber type and selects proper splicing parameters)

Fusion splicers using the Profile Alignment System (PAS) can align single-mode fiber cores to a sub-micron accuracy, eliminating core-clad eccentricity as an issue. Purchasing a core alignment splicer is a significant investment, and the end user has a justifiable expectation of the best and most reliable low-loss fusion splicing. The Fujikura 90S+ is the only splicer to offer all of the automated features above to ensure consistent and repeatable low-loss splicing performance.

THE PERILS OF USING A BROADBAND POWER METER IN A MULTI-SERVICE PON WORLD

BY: SCOTT PETTYGROVE AND NIKI KIRSCHENMANN
VIAVI SOLUTIONS

Test Challenge

For single-technology, single-wavelength PON deployments, the simple broadband power meter has been an excellent and sufficient tool for PON activation and troubleshooting. However, the existing PON fiber infrastructure can carry light power across many wavelengths simultaneously and—for all practical purposes—without interference. Based on this concept, new, next-generation PON technologies are being deployed on the same fiber plant as current-generation technologies but using independent wavelengths. Powerful new PON capabilities can thus be quickly rolled out to customers over the existing infrastructure by simply changing the equipment at the ends of the fiber.

However, the presence of multiple wavelengths on the same fiber or within the same PON infrastructure presents significant problems for those engaged with PON activation and troubleshooting and who are equipped with only broadband (unfiltered) optical power meters. There are two primary use cases where these problems will surface:

- In coexistent PON service structures where two PON services at different wavelengths are carried on the same fiber simultaneously, use of a broadband power meter will result in erroneous and misleading power measurement as explained in more detail below.
- In parallel PON service structures where two services at different wavelengths exist in the same footprint, the network will be constructed such that a given fiber will carry either one service (wavelength) or the other but not both. In this use case, it is very easy to accidentally connect a customer to the wrong service through patching or provisioning errors. Use of a broadband power meter in this scenario runs the risk that power measured in the PON may seem good, but in reality, the wrong wavelength is being delivered. Unnecessary customer-premises equipment (CPE) swapping, long troubleshooting sessions, and needless escalations can result if you can't immediately identify the simple fact that the wrong wavelength is present at the customer premise.

Inside an Optical Power Meter

Optical power meters employ photodiodes that detect the number of photons striking the photodiode surface per unit time and convert that photonic rate into a measured light power. The photodiodes in most broadband power meters can detect light energy across a broad spectrum of wavelengths, normally between 780 nm and 1650 nm. Power meters constructed in this way will measure photonic energy from any and all wavelengths of light within the photodiode's wavelength range and will produce a single power measurement proportional to the sum of all photons from all wavelengths per unit time. (See Figure 1.)

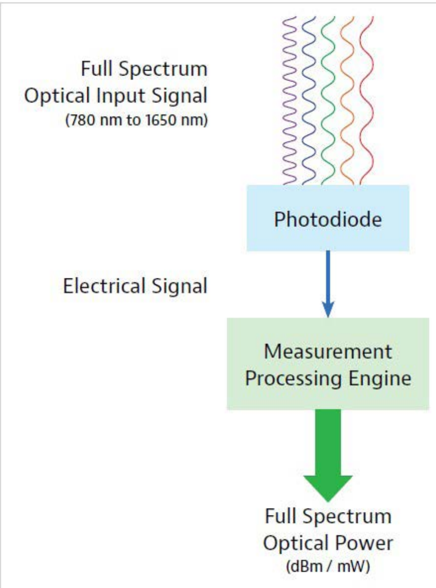


Figure 1: Broadband Optical Power Meter Schematic

As a specific example, if a broadband power meter is used to measure a PON with coexistent GPON (1490 nm) and XGSPON (1577 nm) services, the output of the broadband power meter will be the sum of the powers of both the GPON and XGS-PON wavelengths. The user will have no idea what the actual power and margin are for either of the two PON services on the link. Also important is the fact that even in networks that are intended to have a single service on the fiber at a time, a broadband power meter cannot tell you which service (wavelength) it is currently measuring. Errored provisioning and connection/patching will go undetected until the CPE fails to activate service.

For these reasons, PON power meters designed for use in multi-service environments include optical filters in front of their internal photodiodes to ensure that only the power for a specific wavelength of interest is measured. In the case of PON power meters that are designed for GPON and XGS-PON (both coexistent and parallel networks), two filtered photodiodes are normally used. More specifically, the light from the measured fiber is split inside the power meter to two independent photodiodes, passing through two selective filters in front of those photodiodes. One filter is for GPON wavelength of 1490 nm, and the second filter is for XGS-PON, at 1577 nm. (See Figure 2.)

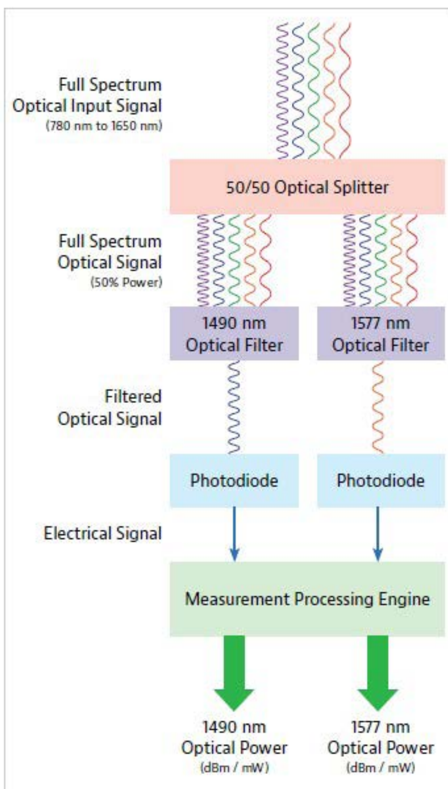


Figure 2: Selective Optical Power Meter Schematic

PON power meters constructed as such can instantly and simultaneously measure the optical power for the filtered wavelengths accurately and independently, preventing the misleading measurements delivered by broadband power meters in a coexistent environment, and identifying the specific wavelengths associated with those power measurements for both coexistent and parallel PONs.

Consequences of Applying the Wrong Tool in a Multi-Service PON

As discussed above, when using a broadband power meter in a coexistent GPON / XGS-PON network, the measured power will appear artificially high when both GPON and XGS-PON signals are present on the fiber at the same time. This can have two types of impacts during service activation:

- Power measurement could look good, but the actual power of the individual GPON and XGS-PON signals are too low to operate equipment, causing a false pass and driving:
  - Unnecessary CPE swap-outs
  - Troubleshooting complications, increasing the amount of time required to complete the installation
  - Needless escalations
- Power measurement could measure too high, causing a false failure and driving:
  - Unnecessary call-backs to the central office for incorrect requests for provisioning checks or changes

- Extensive time spent troubleshooting a problem that does not exist
- Unnecessary escalations and truck-rolls

In parallel GPON / XGS-PON where network design intentionally routes either GPON or XGS-PON to the premise (but not both), using a broadband power meter could result in measuring good power at the end of the drop fiber without realizing that the wavelength associated with the power measurement is wrong. Something as simple as connecting to the wrong type of splitter in the splitter cabinet or connecting the drop fiber to the wrong drop terminal port can easily create such a scenario.

More recently, mis-provisioned optical line terminal (OLT) ports are an increasing cause for the wrong wavelength appearing at the end of a customer's drop. As PON OLT equipment has matured, there has been a natural migration from dedicated, single service OLT ports to dual-function OLT ports (configurable as one service type or another), to multi-service OLT ports (providing simultaneous PON services and internal coexistence functions within the same OLT port).

Both provisioning and connection/patching errors will once again drive:

- Unnecessary CPE swap-outs
- Troubleshooting complications, increasing the amount of time required to complete the installation
- Unnecessary escalations and truck-rolls

Avoiding Cross-connection Issues

When a new customer signs up with a service provider they trigger several activities. The first steps include scheduling an installation date along with ordering the ONT and any other CPE. However, simply connecting any ONT to a live PON network does not ensure activation of services. If that were the case anyone could purchase an ONU and connect it to get service for free.

The other step that happens is telling an OLT that it will be responsible for and approved to deliver services to a specific ONT device. This is referred to as provisioning the service, meaning that a specific OLT port is assigned to provide support (data) to a specific ONT serial number.

If you connect the ONT to the correct drop terminal port, which routes back to the OLT port where the service has been provisioned, then the service will turn up as it should. However, if you connect to the wrong drop terminal port and therefore an OLT port where the service has not been provisioned, the ONT may boot up but the service itself will not activate. This is because the OLT is expecting the ONT to appear or communicate on a different port, so it won't deliver service to that ONT. Wrong light, i.e., a downstream wavelength from an OLT port where the service was not provisioned, is a fairly common problem with FTTx deployments.

The drop terminal enclosure typically includes labeling to show which port is which, but in the real world it's all too easy for labels to be illegible, missing, or wrong, often because the distribution fiber routing has been altered by a previous tech. To ensure the right fiber cable is connected to the right OLT port and to enable easy handling of installation error tickets, it requires a device that identifies the type of OLT and the OLT-ID at any network location.

This device must be able to evaluate the PON-ID, a unique identifier that is standardized by ITU-T and is a frame in PLOAMd carrying PON specific information, such as OLT-ID, ODN class, and the transmitted optical level from the OLT. If you can extract and read it, you can compare the provisioning information and state for certain that the OLT port a customer is connected to is the right one or not.

Addressing the Challenge

Field technicians need to quickly and accurately:

- Confirm that there is sufficient power to operate a resilient PON service
- Confirm that the measured power is on the correct wavelength for the desired service
- Segment problems down to a specific portion of the fiber plant, avoiding unnecessary CPE or drop fiber replacements, and increasing the accuracy of escalation calls

Conclusion

Next-generation PONs deliver many business-critical advantages to providers compared to current PON technologies, including higher service-rate offerings, improved service rate symmetry, increased split ratios, and the convergence of multiple applications into a single optical distribution network (ODN). As many providers transition from BPON, GPON, or EPON to next-generation technologies like XGS-PON or NG-PON2, a new test paradigm is required, as the potential for negative business impacts associated with continued use of broadband power meters in a multiservice PON environment is a real and immediate concern.

However, by deploying selective PON power meters and TruePON testers for activation and repair of multi-service PONs, providers will improve the efficiency of service activation and repair groups, and avoid the increased costs associated with longer installation and troubleshooting times and unnecessary escalations and truck rolls.

LEVERAGING THE IoT FOR DAMAGE PREVENTION

BY: MATT BRICE
Product Sales Manager, Comstar Supply

Most of the applications for the Internet of Things (IoT) are still in the incubation stage. Whether we want to solve challenges in modern medicine, make our cities easier to navigate, or increase the efficiency of our farmers, there's still a long road ahead.

As network operators and those involved in the trade, the onus is on us to think about the latest products and tools that not only enable the technologies of the future, but also allow us to protect the vital infrastructure in ways we haven't before.

There are three technologies I suggest network operators in the private and public sectors consider implementing to aid with damage prevention:

- Line Power to Remote Monitoring Devices
- Fiber Optic Acoustic Detection
- Remote Fiber Test Systems

None of these technologies are new, but recent developments further increase the value for service providers. Cloud-based visibility is one trait these systems have in common that truly allow for measurable reductions in operating expenses – the holy grail of cost-cutting.

Line Power for Monitoring

Until recently, delivering power and communications to a device more than 300 meters from the switch was a complicated and costly endeavor. Locating a device on someone's property, such as a wireless access point or camera, usually meant you were trying to negotiate using power from their building or requesting a meter dropped from the utility nearby.

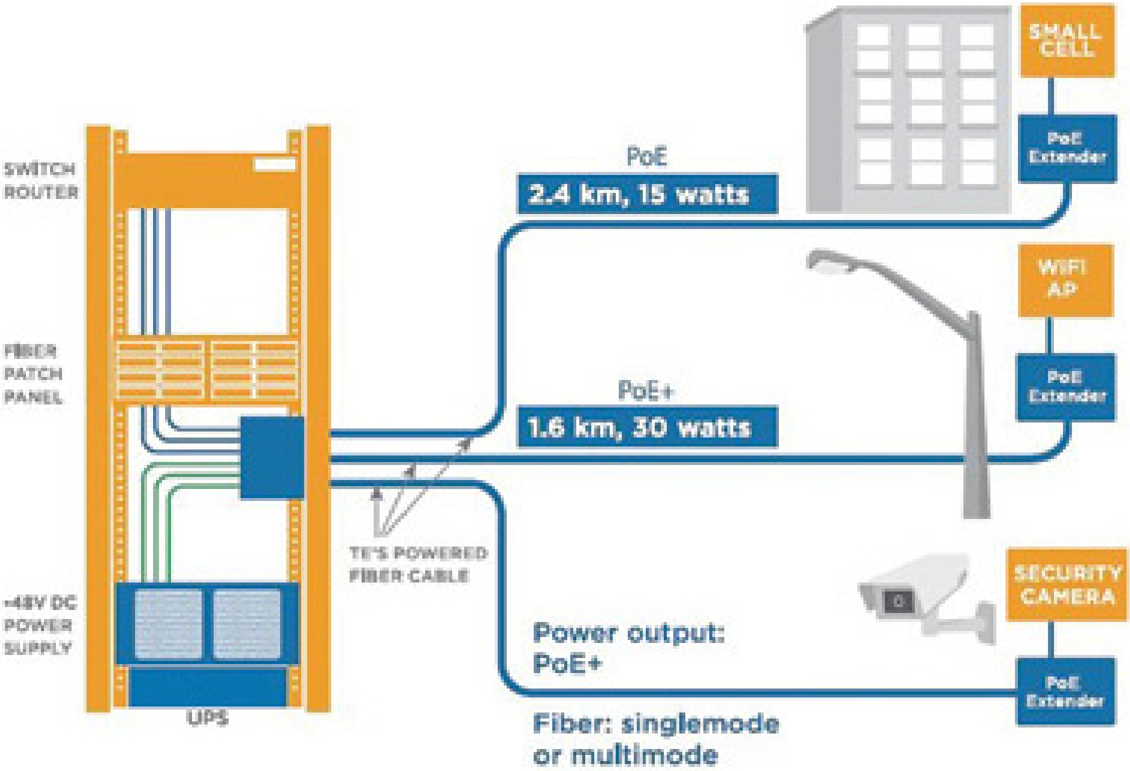
A new, powered fiber cable design featuring a pair of conductors flanking strands of fiber was developed in tandem with a system solution that is inexpensive and easy to deploy. This system uses Class II SELV power supplies that do not require a certified electrician to install. The compact cable design requires only one tool to strip and access the conductors and fiber. The powered fiber hybrid cable can be supported by traditional telephone "P-Clamps" or installed in a microduct pathway for reduced installation costs.

The power system is capable of balancing power between multiple devices that require different wattages. The distances you can reach with the system vary by the size of conductor and the power required at the device, but it is possible to reach up to 3km from the power supply while delivering 15 watts of power. This would accommodate a typical WiFi access point.

While airports, industrial sites, and campus environments already make use of the powered fiber solution, it could also be used by service providers to monitor critical facilities. Camera systems could be deployed using powered fiber around perimeters of secure data centers, earth stations or colocation facilities. Additional devices such as site access controllers or smart lighting could be run off the same shelf at distances beyond the current capabilities of PoE. All of the aforementioned devices are available to be accessed from the cloud, which could allow for reduced staffing requirements or truck rolls at those facilities.

Fiber Optic Acoustic Detection

A remarkable technology, Fiber Optic Acoustic Detection (FOAD) uses algorithms to decipher sound vibrations impacting a single optical fiber strand. The system is able to detect these sounds based on the backscatter of light pulses the vibrations create. This technology is capable of interpreting sounds created by someone walking by, passing trains or vehicles, gun shots, and more. Developers are constantly analyzing the backscatter modulations to further increase the system's ability to interpret sounds.



FOAD systems detect sounds that are three meters from the fiber being monitored. The conditions of the cable as well as the type of pathway are two key factors that impact the ability of the system to operate optimally. Believe it or not, older optical fiber and cable designs are typically preferred, which makes using degraded fiber more attractive. These fibers may have been previously removed from service due to their degradation that limits their ability to support current capacity and data rates.

While the government and railroads are early adopters of this technology, network operators can certainly use it for their own security and analysis. Imagine that a backhoe pierces the soil near your cable, and your records don't show a completed dig ticket for that location. The system might generate an alarm to notify your OSP manager via text message to further investigate the situation. Even if you can't prevent the potential damage done to the cable, the ability to pinpoint the location practically eliminates the mean-time-to-understand (MTTU) a break in the fiber.

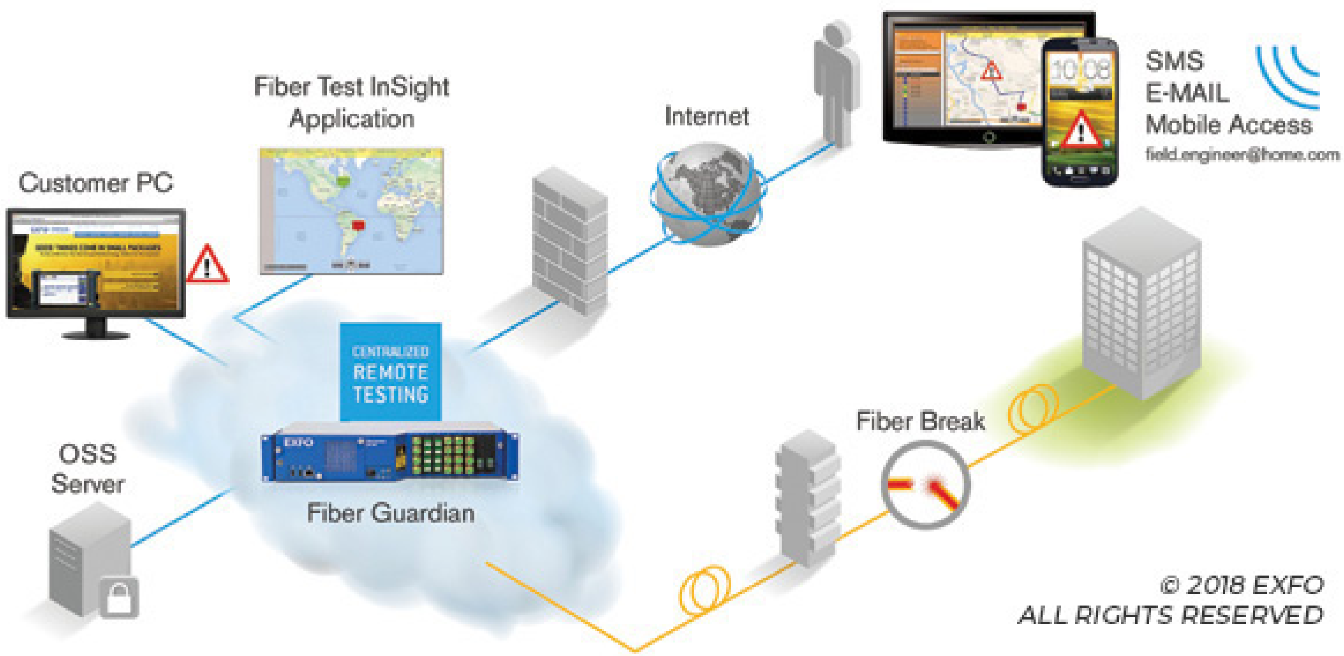
Remote Fiber Test Systems

Shelf-mounted OTDRs are already a staple in central offices, but they typically don't offer visibility to the outside plant (OSP) staff that enable them to resolve events as quickly as they would like. Information derived from these systems is often incomplete, and they require excellent records to understand exactly where a break might occur based on the OTDR trace. Fiber versus cabled length, slack loops, and risers are just a few reasons why OTDR traces might not pinpoint the exact geographical location of the event.

There is a Remote Fiber Test System (RFTS) today that supports integration with multiple GIS and reporting software that are 100% web-based. Alerts can be generated by the system to immediately notify the appropriate parties that there is an issue. These notifications may be transmitted via text message (SMS), email or SNMP notifications. Furthermore, if the RFTS system is integrated to a GIS or if it uses its own mapping tool, the GIS tool can give and display accurate geographical location based on GIS documentation. The software logging the events can prioritize by severity (i.e. macrobends versus a break) allowing technicians and their managers greater efficiency repairing the network.

These systems can run as standalone units or combined to monitor multiple fiber routes to get a complete view of the network operations. The ability to build-as-you-grow allows for flexibility in capital expenditures with options to layer advanced software suites with in-depth analytics to better suit a wide range of budgets and reporting requirements.

The predictions for connected devices in the IoT realm range from extraordinary to unbelievable. If the invention of the smartphone was any indication, who would have predicted the number of applications that would develop for any conceivable purpose? With these three connected technologies, you could gain invaluable insight into the network for security, damage prevention, and efficiency. Network operators are already in the driver seat for the Internet of Things… the time has come to take advantage of it.



5 COMPONENTS FOR FAST AND ACCURATE LOCATES

BY: TRIDENT SOLUTIONS

Accurately locating buried utilities will help prevent costly damages as well as prevent needless hassle. These five components can help ensure the locate is done accurately and efficiently.

1. The Wire

Using an extra high-strength copper clad steel tracer wire can provide locators an accurate read on the location and depth of the buried cable. Wire with a high carbon steel core, metallurgically bonded with a copper cladding, that is uniform and continuous, creates a bi-metal conductor that acts as one and is corrosion resistant.

Not only are these systems easy to install and necessary for accurate underground pipe detection, but they are also:

- Corrosion, moisture, chemical, oil, impact, crush, and abrasion-resistant
- Carry a much lower theft value than copper wiring systems
- Comes in sizes ranging from 14 through 6 AWG
- When grounded with a magnesium ground rod, corrosion is redirected to the ground rod, thus preserving the integrity of your tracer wire system
- Depending on the type of tracer wire you use, the break strength FAR exceeds typical copper applications:
  - HF-CCS (High Flex)- 43% higher in strength than copper tracer wire
  - HS-CCS (High Strength)- 227% the break load of copper tracer wire
  - HDD-CCS (Directional Drilling)- 700% the break load of copper
- Considerably lower in cost and excellent price stability compared to copper counterpart

2. Test Station

Test station marker posts are essentially a two-for one: they provide easy access to tracer wire for locate technicians, as well as provide a highly visible and effective warning message to potential excavators.

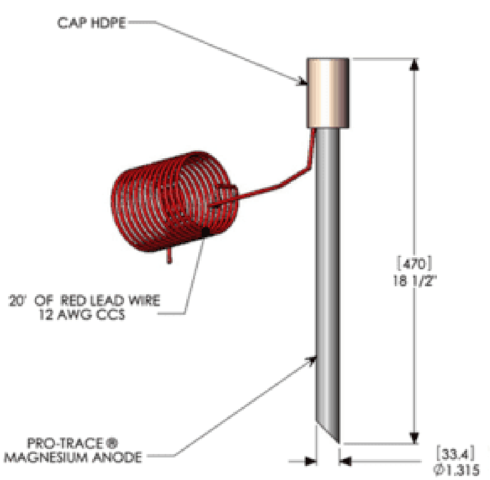
Often times, tracer wire is poorly maintained or exposed to the elements. An above ground test station like the Rhino TriView™ Test Station and its friction fit cap protect both the tracer wire and access terminals from severe weather and vandalism.

In areas where upright marker posts are not practical, the Rhino HideOut™ Test Station is an ideal choice. The flush mounted test station can be mowed over while still providing a visible warning. It has a telescoping terminal board for quick access to the tracer wire.

3. Hardware

Locating multiple utility lines can become a tedious task for the locator – having to locate lines separately and continuously reconnect to the different terminals.

Innovative hardware like the Iso-Switch, can significantly speed up the locating process as it allows the locator to connect to all the facilities at once.



4. Ground

Grounding anodes should be installed at all dead ends of the tracer wire system to complete the electrical circuit needed to enhance signal for locating purposes. Grounded tracer wire allows for the locator to use a lower frequency which provide the most accurate results for locating. Higher frequency has a tendency to bleed-over into other buried utilities, making the locate inaccurate.

The best way to ground a tracer wire system is to install a 1.5 lb. drive-in magnesium ground rod and an access point at each tracer wire dead end. An access point will protect the wire and provide a direct connection point for a utility locate transmitter to connect to the tracer wire. It also provides a connection point for the ground rod wire and allows the ground connection to be turned on and off, allowing you to control the signal on the target line.

5. Connectors

A tracer wire system is only as good as its weakest connection. Connectors with superior strength that are water and corrosion-proof protect vulnerable wire splices and keep the locate signal flowing across connections.

Using cheap alternatives like electrical tape will result in corrosion. A corroded connection point can cause the locate signal to stop at the connection point, making the rest of the buried utility unlocatable, which could end in disaster for the excavator.

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