ACCESS™

Communications Offers & Insights

January 2017

Building the Foundation for the Next **Wireless Boom**

KGP Logistics


MAKE THE
RIGHT CONNECTION
WITH WAVETRAX
RUN YOUR FIBER CABLE THE TELECT WAY
The WaveTrax optical raceway system is designed for flexibility, durability and ease of installation. WaveTrax components adapt to your legacy architecture and are designed to suit any application in central offices, data centers or mobile switching centers. WaveTrax saves critical time, because you don't need tools for our snap-together system, and our competitive adapters allow for easy expansion on your legacy systems.
Telect engineers are available to custom configure your solution now.
CONTACT THE TELECT TEAM
509.926.6000 // getinfo@telect.com // www.telect.com
Telect

ACCESS™
January 2017

Advertisers

Inside View

Page 4

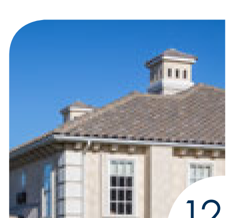
Ordering Guide

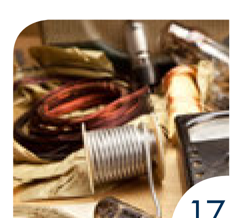
Pages 40-41

Upcoming Events

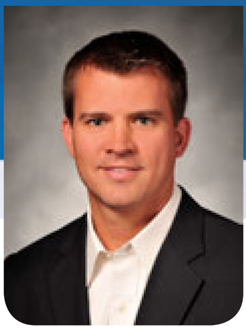
Pages 24, 42, 44

Features





INSIDE VIEW



Customers, Suppliers, Colleagues and Friends:

I hope your 2017 is off to a strong and healthy start.

With the pace of change today across our industry, there is no shortage of initiatives to work on, changes to initiate and investments to make. KGP Companies has grown and evolved to the company it is today through more than forty years of organic investment and growth, along with a collection of targeted acquisitions, while always anchored by the uncompromised core values embedded in the very essence of who we are by our founders.

This cherished journey has brought us to today, where KGP Companies is comprised of two companies; KGP Logistics and BlueStream. With large regional Distribution Centers and local staging facilities across the country, combined with the latest systems architecture, KGP Logistics is the industry leader in advanced supply chain solutions, value-added distribution, and product/software integration services. BlueStream is a premier solutions provider with a comprehensive suite of communication network management, engineering, and implementation services. Together, our business' objective is to build, optimize, and transform our customer's networks. Since our acquisition of BlueStream, we have operated the businesses autonomously, within the framework of our values and the way we do business at KGP. At the same time, however, our industry and customers have also continued to evolve. Increasingly, we are engaged in opportunities that can benefit from, or require, the value both companies can deliver. This is true whether our customers are converting a central office or headend to a data center to enable a SDN deployment, building fiber networks, or expanding and densifying existing mobility networks through small cell or macro site deployments.

Recognizing that trend, in the near future you will see our company continue to enhance our go-to-market approach into a single, powerful brand that enables a value proposition focused on delivering advanced supply chain and distribution, solutions based professional network engineering and installation, and software integration services. We are excited about the formal merging of our capabilities, what it means to our customers and partners, and the solutions it will allow us to deliver. We are confident our recent preparation and investment will successfully lead us through this time of transformation. While we are by no means complete, nor will we ever be, we promise to continue our daily drive to challenge ourselves to think about things differently, to develop new relationships, create new capabilities, and ensure that we remain a relevant and reliable partner to our valued customers.

The approach to our continued evolution will continue to be deliberate, while opportunistic. Thank you for the opportunity to continue to move through this fascinating time of change with you. Our goal remains to be your true and trusted partner, and we deeply appreciate your continued trust and confidence in the KGP team. We look forward to working with you to make 2017 a successful year for your company.

Gratefully,

Trevor Putrah
President, KGP Companies

Gigabit and MDUs: Capturing Generation Y

Michael Sumitra
Strategic Solutions Marketing Manager, ADTRAN

Multi-Dwelling Units (MDUs) consisting primarily of apartments, condos and mixed use multi-family housing, are experiencing occupancy rates at an all-time high. Providing premium broadband to the MDU market is a major opportunity for service providers, with over 80 million MDU households in the Americas, constituting over 35 percent of all homes in the United States. New multi-family housing grew by 10 percent in 2015, exceeding 390,000 (the greatest increase since 2000), and is expected to remain at high levels through the end of 2017.

Generation Y is now over 90 million strong with an annual buying power exceeding $600 billion. Millennials represent a major target market for service providers, as they currently comprise over half of all MDU residents. They are the first generation to have grown up with the internet and are therefore digital natives. According to a Goldman Sachs report, millenials are always connected: 80 percent have mobile phones, 75 percent are active on social media, and a growing number consume audio/video content online (38 percent watch TV online; over 44 percent download music/videos). This makes millennials a prime target for service providers with a focus on MDUs.

The Case for Gigabit Broadband in MDUs

Positioning Gigabit services in the MDU market requires not only convincing the tenant that they need higher-speed service, but also the building owner. For MDU owners, their primary interest lies with the economics of a Gigabit deployment. They want to see a return for their investment, such as increased property values on owned property and increased rental rates on leases, as well as a positive effect on occupancy levels with decreased tenant turnover.

So how does Gigabit broadband translate to MDU economics? A recent study by the Fiber to the Home (FTTH) Council showed that Gigabit service results in an 8 percent growth in apartment rent and a 2.8 percent increase in condo value (owned). So there's a clear case for Gigabit in MDUs.

Gigabit Architectures for MDUs

The unique nature of MDUs drives the need for a toolkit approach to delivering Gigabit broadband. Fiber connectivity is key, but service providers need to consider multiple Fiber-to-the-“x” (FTTx) architectures and technologies to deliver on the Gigabit promise.

- Fiber-to-the-Living Unit (FTTLU) – A: This architecture involves extending fiber directly to each living unit in the MDU, where it is then terminated by a single ONT or residential gateway. This is a complete future-proofed solution allowing upgrades to multi-gigabit speeds. However, this is a high-cost solution, requiring re-cabling with fiber, and causes tenant disruption.
- FTTLU–B: For low density garden-style apartments, an alternate option involves deploying nested GPON ONTs (up to 16-ports) with CAT5 cabling into each unit. The resident simply plugs their wireless router into a wall-jack to activate service. It also enables instant activation for the next-resident with no truck-rolls, elimination of vandalism (no equipment in the living unit), and increased ROI from each ONT.
- Fiber-to-the-Floor (FTTF): In this architecture, fiber is extended to each floor, and living units are connected over copper (CAT3 or CAT5) or coax cabling, using a medium-density ONT (eight to16 ports). This is a medium-cost solution and reduces tenant disruption.
- Fiber-to-the-Building (FTTB): FTTB extends fiber to the basement or interior wall of building. Using a high-port count (24 to 48 ports) ONT or DPU, service providers can connect multiple living units cost-effectively over existing copper riser-bundles or coax.

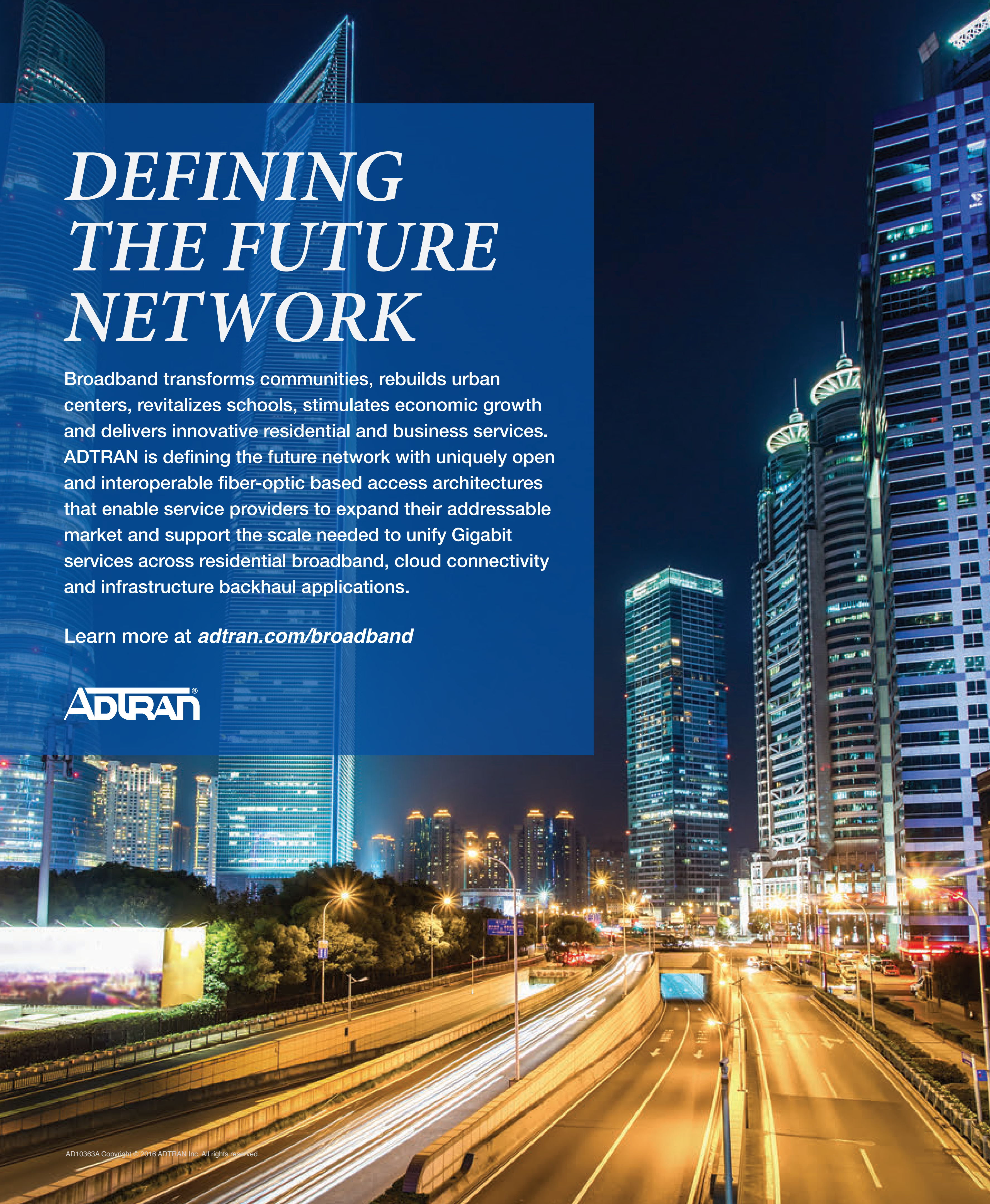
In addition, there are a number of different technologies that can be used to deliver Gigabit services in the MDU market. The following matrix shows a comparison of these technologies and the FTTx architecture best suited for each technology:

Technologies to Deliver Gigabit Services in the MDU Market

	GPON	NG-PON2	G.fast	G.hn	10G EPON	DOCSIS 3.1
Deployment Model	FTTLU	FTTLU	FTTB/F	FTTB/F	FTTLU	Fiber Deep
Physical Medium	Fiber	Fiber	Copper, Coax	Copper, Coax, Powerline	Coax/Fiber	Coax
Downstream Rates	2.5 Gbps	40 Gbps	Up to 1 Gbps*	1 Gbps	10 Gbps	10 Gbps
Upstream rates	1.25 Gbps	40 Gbps	Up to 1 Gbps*	1 Gbps	10 Gbps	2 Gbps

* Throughput rates assume DTA and coax medium

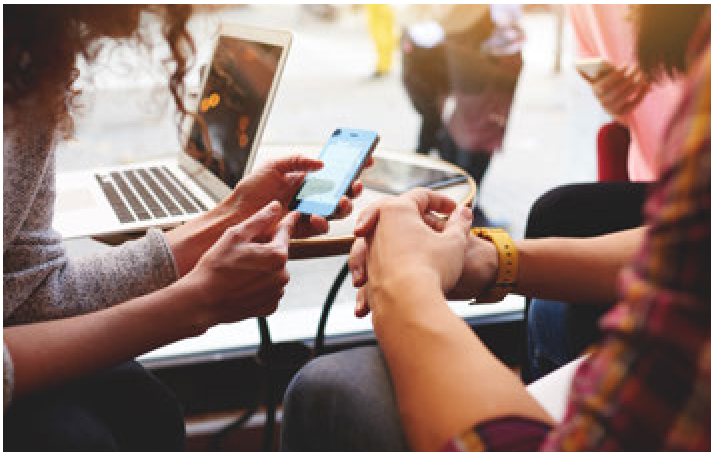
Generation Y is now over 90 million strong with an annual buying power exceeding $600 billion


DEFINING THE FUTURE NETWORK
Broadband transforms communities, rebuilds urban centers, revitalizes schools, stimulates economic growth and delivers innovative residential and business services. ADTRAN is defining the future network with uniquely open and interoperable fiber-optic based access architectures that enable service providers to expand their addressable market and support the scale needed to unify Gigabit services across residential broadband, cloud connectivity and infrastructure backhaul applications.
Learn more at adtran.com/broadband
ADTRAN®
AD10363A Copyright © 2016 ADTRAN Inc. All rights reserved.

App-Driven Services Delivery

Tenant turnover is a key challenge that service providers must address with respect to broadband services in MDUs. The average apartment lease is 12-14 months, while the average payback period per subscriber is between 18-24 months, making serving an MDU subscriber a costly proposition. Service providers need to transition their business model from, turning up individual subscribers to, Gigabit-enabling the living unit and enabling self-service activation.

Millennials have grown up in an instantaneous, on-demand economy where everything is an "app". They want to be in control of their experience and they want the ability to choose the services they value. To succeed in capturing this generation, service providers must deploy highly programmable SD-Access networks, which enable network automation and service orchestration, and support extending self-service capabilities via a mobile app. For millennials, a self-service app allows them to select and activate services on-demand, eliminating truck rolls and delivering a user-driven customer experience.



Universal Wi-Fi

Wi-Fi access in MDUs is perhaps the most critical extension of broadband service delivery. For millennials, Wi-Fi is their primary means of accessing the Internet with smartphones, tablets, laptops and other devices. However, Wi-Fi in MDUs presents a major challenge for service providers. Signal bleed from Wi-Fi routers or residential gateways (RGs) in neighboring living units can cause interference and slow Internet connections. Wireless interference results in poor signal quality, slow network speeds and a poor customer experience. A next-generation wireless architecture is required for MDUs.

Adopting wireless RGs and APs with built-in radio resource management (RRF) is key to delivering Wi-Fi in MDUs. RRF is an enterprise-grade self-optimizing network (SON) technology that automatically selects the right Wi-Fi channel setting and transmit power of each RG or AP, to maximize coverage across the MDU, while eliminating interference from neighboring APs.

Seamless roaming is another requirement, as residents expect connectivity whether in the living units, hallways, or common areas, without having to login multiple times to access the network. Instead of deploying additional APs for coverage, utilizing the existing RGs and enabling an additional public SSID and L2 roaming between the RGs can be an effective solution. Seamless roaming can be provided for all residents, significantly reducing CAPEX.

Summary

The MDU market presents a great opportunity for service providers equipped to offer Gigabit services. It is important to remember that MDU owners and property managers see Gigabit broadband as a means to charge higher rent, higher occupancy and increased property values. Service providers must translate the benefits of Gigabit broadband into how it can improve business for the owner/management company. To succeed, service providers need to adopt a broadband toolkit approach that not only addresses the optimal deployment strategy for different MDU types, but also adopts a next-generation SDN network architecture service and enables flawless Wi-Fi. By doing so operators can offer increased service flexibility and innovations, vital for millenials' lifestyles.

The Art of STEALTH®

There are thousands upon thousands of cellular antennas scattered across the landscape of this planet, from cell sites, to Small/Metro Cell, to DAS, encompassing Macro, Micro, Pico and so much more. The widespread deployment of communication equipment is as wide reaching as the connectivity that they provide consumers.

With the proliferation of in-building antenna systems and the need for pleasing aesthetics within these venues, design and concealment have become increasingly more necessary. Function still takes priority over form; however, companies have begun to develop concealment options with little impact on functionality, cost or speed of deployment. Concealment design and engineering has now stepped outside to larger scale antenna systems, stadiums, buildings, signs and posts, offering the functionality and coverage of a traditional cell tower, while retaining the character and aesthetics of the location.

The aptly named company, STEALTH® Concealment Solutions, Inc., has been at the forefront of concealment solutions for almost 25 years. STEALTH® created the country's first ever RF-transparent antenna concealment system in 1992, and with it, the concept of concealment was born. The science behind their design is the use of the highest-grade radio-frequency (RF) transparent materials on the market, along with hours of design and testing to balance signal strength, structural integrity, and cost efficiency.

*All photos are the exclusive property of STEALTH® Concealment Solutions, used under licence.

Hidden in Plain Sight

The primary challenge of delivering wireless service has, and will likely always be, delivering capacity and coverage in dense areas. The advancement of distributed antenna systems (DAS) throughout the early 2000s dramatically improved capacity and extended coverage into previously uncharted territories.

One such area has been the growth of DAS capabilities in sporting and entertainment venues. For most of the 21st century, the density of wireless devices used within entertainment venues led to a virtual traffic jam of data. Bringing DAS systems into these locations drastically enhanced the experience for event-goers and boosted the attendance and capabilities for the promoters. Building these systems, however, was not without its own set of challenges. First, antenna alignment, calibration and networking must serve its intended purpose. Second, stadiums and venues are designed to be aesthetically pleasing – and should remain that way. Concealment and antenna systems are paramount to creating an atmosphere where coverage and capacity operate together and go unnoticed.

Armed with an arsenal of options, STEALTH® covers the entire wireless industry with rooftop, tower, pole, DAS and custom concealment structures. When considering concealment options, STEALTH® must manage coverage of the hardware, public interaction, aesthetics, and most importantly, the ability to grow or change with time. In his article, 'Insatiable Hunger Feeds DAS', Trey Nemeth, Vice President of Operations for STEALTH®, points out that, *"Forward thinking owners have already installed DAS to future proof their sites, but change comes fast to the wireless world. Any site more than two years old is probably already obsolete, and is not delivering the coverage in which owners expected."* In this regard Nemeth points out that, *"Upgrading means bringing in more antennas; and that means multiplied aesthetic challenges."*

STEALTH® continues to remain at the forefront of concealment solutions, a paradigm shift has occurred, but they're ready for it. The concept of concealment has changed from providing the smallest possible concealment structure to minimize the total footprint to larger structures with a pleasing aesthetic design, giving the engineers room to grow with less impact on the look of the venue or the cost of concealment.

Advancements like STEALTH® RadomeFlex™, are a deceptively simple solution to a costly concealment problem. Using revolutionary strap connection technology, RadomeFlex enhances the maintenance process while making it significantly safer.

Go to www.stealthconcealment.com/ for more information

Keeping the "Metro" in Metro Cell

Buildings are tall. Cities are full of people. This is not earth shattering news. It's quite remedial in fact, but these simple facts point to the struggle of wireless connectivity and cell tower usage in metropolitan areas.

Upon close inspection we see that the issues with connectivity in crowded metro areas goes much deeper than sight lines and cell phones. Internet of Things (IoT) devices, Wi-Fi over LAN, and signal interference create a symphony of chaos within the world around us. With all of these challenges, careful planning and design of Small/Metro Cell systems allow for capacity and coverage that cut through the clutter below the towering skyline of the city. Placement is a key element to success, but managing virtual noise by adding visual clutter is not a viable option.

There are two popular tactics for concealment in metropolitan areas. One is to conceal or hide the antenna systems completely, using high-grade radio-frequency (RF) transparent materials. The other option is to camouflage. That is, to integrate the antenna design into objects that appear to be normal everyday pieces of the landscape.

Conceal

Innovations like StealthSkin™ and RadomeFlex™ have allowed STEALTH® to integrate and hide communications components in plain sight behind signs, billboards, steeples, silos and more. Through careful design and engineering these concealments not only work at an optimal level, but they also provide room for future growth.

Camouflage

Sight lines and the directional layout of antennas are essential to effective coverage in a Small Cell/ Metro Cell system. To allow for greater coverage and more control of antenna placement, incorporating the antennas into the landscape of a given area can be the key. Small Cell antennas are often inconspicuously installed on existing right-of-way street signs, telephone poles, or streetlights. Where concealment uses the architecture to hide communication hardware, camouflage simply incorporates the hardware into the landscape that we see.

Pittsburgh is the "Steel City", known for being raw and hard working. Seattle is the "Emerald City", with lush green landscapes and clean air. New York City is the "City that Never Sleeps". Tourism boards spend extensive time and funding building the "brand" of metropolitan areas. Nobody wants to be known as the "City of Cell Towers".

Concealment is the solution to aesthetically deploy Metro Cell solutions in an area without muddying up a landscape with plain gray boxes.

PREMIER

800.328.5142

CONNECTED

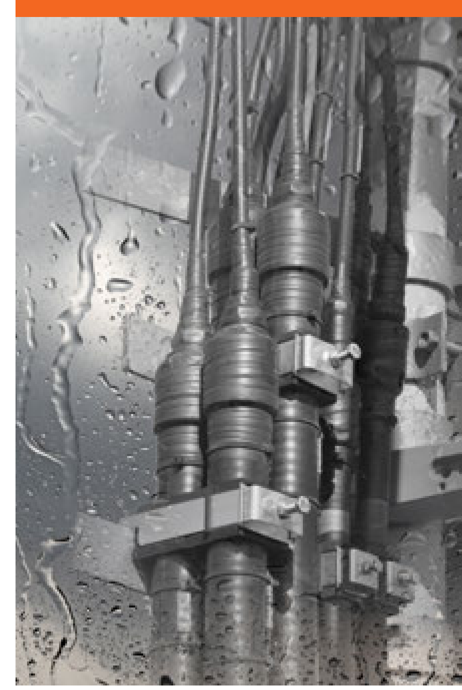
PROTECTED

RESPECTED

- 30+ years sourcing carrier quality products
- Average 20+ years' experience with Product Managers
- Products backed by a 5 year warranty
- 25 year warranty on structured wiring system products
- 80%+ Domestic suppliers
- TL 9000 Certified Quality Management Systems
- Sourced under ISO 9001:2008 Registered
- RUS approved

www.DependonPREMIER.com

Filling the Gaps of the Ever-expanding Communications Network



PREMIER has been involved with the communications industry a while. Not since the days of smoke signals and drums, but we have been there to see many firsts. The first Fiber-to-the-Home (FTTH) deployment; the expansion of the cellular network and its growth from 1G to 4G with 5G on the horizon; the invention of the World Wide Web; the advent of ADSL and VDSL, VoIP; and now we are seeing G.fast, GPON, MoCA, among others. We have seen speeds go from 2400 bps to 10 Gbps.

Through all of these advances, plus the many speed and bandwidth improvements, PREMIER has played a part in providing quality cost effective products to Carriers for use in their networks.

In essence, every network, from the smoke signals of the Stone Age to today's billions of connected devices, consists of three primary components – a transmitter, a receiver and a transmitting medium (the channel that carries the signal). But a network is not that simple. There are many supporting products needed to support a network. That is where PREMIER comes in.

Network operators don't have the capacity to worry about every item in the network. PREMIER has been there for over 33 years reducing that list of worries. Our purpose has been to remove the pain points for our customers; starting with reliability, quality, cost reduction and improved availability.

PREMIER was born from within a carrier, so when it comes to carrier grade, we have lived it. We run first article inspection tests, audit factories and suppliers, drive field trials, reject off-quality samples, and investigate corrective action requests. We were TL9000 certified before most knew what it was. Quality and reliability are who we are. It is in our DNA.

Today's networks evolve more quickly with every year. Legacy products and solutions have been reduced to a smaller scope, while new technologies and supporting product needs are emerging. As the product landscape shifts, PREMIER continues to be a reliable source for high quality, cost effective products. New networks, new technologies and cutting edge components are demanding more of the network engineer's time and attention. Let PREMIER be your resource to worry about the needed but less critical components.

Tell us what pains you have. Where do you see holes in the product supply landscape? What components do you want to take off that worry list? Help us help you

Allow PREMIER to do what we do best: manage the specifications and standards process; ensure quality is front and center in the product development; handle the prototyping and production phase to keep project timelines on track; provide the on-going technical and application support as well as the customer service to make getting the products you need as painless as possible.

Bottom line: we'll make sure your needs are met. Depend on PREMIER.

PREMIER®

www.DependonPREMIER.com

Communication Trends 2020

In a recent article, Christopher Surdak, JD, a global subject matter expert in Analytics, Governance and eDiscovery with HP Software studied hundreds of predictions from telecommunications industry observers, and distilled them into a list of six external factors that are predicted to drive the most change in telecommunications by the year 2020. His list includes:

1. Integration–The Content Contest

Being connected continues to become cheaper and cheaper for consumers, driven by falling costs of providing the service, as well as continued competition. As a result, connectivity is capturing an ever-smaller proportion of the information value chain, while content, service, and product deliverers capture ever-more. By 2020, it is likely that one or more major telecom companies will be acquired by a content company.

A mere nine months after the initial publication of this article, we see the once hard lines between carriers, content producers and manufacturers blend. AT&T is a telecommunications company, an ISP, a security company and now, with DirecTV, a satellite broadcasting company.

Google is an ISP, a fiber company, a content provider (YouTube), a ubiquitous OS (Android), a smartphone manufacturer (Pixel), a smart home hub (Google Home), and on and on. Look at Verizon and Amazon for similar examples of convergence and the reformulation of how and where to compete in a highly connected world.

2. IoT–The Traffic Explosion

The next major trend that Surdak predicts will impact telecommunications is the explosion of connected devices. This internet of things, or Thingification, will add billions if not trillions of new connected data sources globally by 2020.

His prediction is that the upswing of all of these devices will be an astronomical growth in data volumes; we will quickly push through exabyte volumes and enter the world of zettabytes per year.

3. Mobility–The Great Wireless Migration

Global growth of mobile connectivity is far outpacing hardline connectivity. This makes sense, as most growth is occurring in the developing world and amongst poorer populations. Such consumers may not even own a home, let alone a FiOS connection. For these people, mobile is cheaper, more convenient, and more useful, even when landline connectivity is an option.

4. Saturation–The Search For Growth

As they retire, boomers will enter retirement communities and assisted living facilities which are fully digitized in order to be as efficient as possible. Older Americans will be forced into using these technologies by the world around them and will likely consume vastly more bandwidth than they, or their carriers, ever imagined. As this occurs, the last remaining percentages of market penetration will be achieved, and the market will be thoroughly saturated.

5. Security–Threats to the Network

As custodians of the networks, carriers play a pivotal role in fighting the new threats that are emerging. Customers will begin to expect, then demand, more proactive protection from the entire internet value chain, and carriers will be expected to support these expectations with a range of technical and operational innovations. The desire for greater security may be a boon for carriers, if they embrace the need. Remember number two on this list? Imagine a fully connected Smart Home without adequate security measures to ensure privacy or defend against hackers.

6. Ascension–Skynet Finally Gets Real

Finally, Surdak predicts that Skynet 2.0 is about to reappear. These space, balloon, or drone-based systems will provide high-quality broadband access to anywhere and everywhere in the world, they'll do it affordably, and they'll likely start arriving around 2020. And this time, they'll be wildly successful.

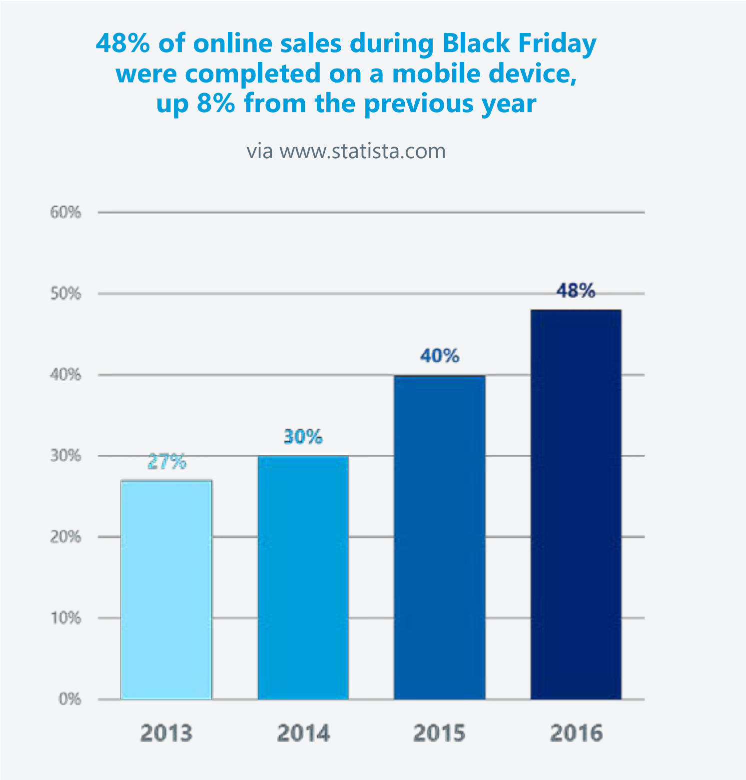
Of course, one of the common threads among all of Surdak's prediction, even the last sci-fi'ish one, is that somehow all of these trends must be supported by an infrastructure services company.

As content devours bandwidth, more must be supplied.

The most practical potential of IoT at the moment may well be connected home technology. Implementing home automation, security and communications is a real business, and may well be a significant part of an industry that is projected to be worth over $78 billion by 2022.

Globally, the migration to wireless and complete market saturation is merely the culmination of the inevitable march of progress and the adoption of technology that has rapidly become efficient, effective and cheap. And as market demand and acceptance becomes universal, so too will the continual need for delivery infrastructure.

While meeting all of the infrastructure demands of today, BlueStream continues to keep an eye on the needs of the future. Through an ever-expanding list of infrastructure deployment services, expertise and strategic partnerships, BlueStream will remain a premier provider of infrastructure solutions to carriers, OEMs and consumers alike.



This statistic highlights a number of items:

1. The number of smartphones and other connected devices able to complete transactions continues to increase;
2. People are becoming more and more comfortable conducting transactions on their mobile devices;
3. The importance of device and information security cannot be overstated as the depth and breadth of connectivity continuously expands.

Sources:
http://qz.com/354164/these-six-forces-will-disrupt-the-telecommunications-industry-by-2020/. Surdak, Christopher. "These Six Forces Will Disrupt the Telecommunications Industry by 2020." Quartz. N.p., 06 Mar. 2015. Web. 19 Dec. 2016.

https://www.statista.com/statistics/247195/percentage-of-mobile-black-friday-sales/ "Black Friday: Percentage of Mobile Orders 2016 | Statistic." Statista. N.p., n.d. Web. 19 Dec. 2016.

BLUESTREAM Driving Transformative Networks End-to-End

Access

More than 20,000 Cell Sites Constructed / Upgraded

Over 1,000 DAS & Small Cell Projects Completed

Densification of the network to meet the growing data demands are resulting in a multitude of wireless and wireline access technologies being deployed. BlueStream's comprehensive offerings are well suited to support the resulting heterogeneous environment including edge networks.

Transport

National Presence in FTTX, Cell Site Services, & Central Office

In-house Optical Lab Test Facilities

IOT and Broadband is fueling the load on the network and newer transport and backhaul technologies hold the key to providing ubiquitous connectivity across the network. BlueStream is well positioned to support these needs with solutions including Fiber and Microwave offerings.

Core

Over 3,000 Data Center Projects Completed

Over a Quarter of a Million Central Office / MSC / MTSO Projects Complet

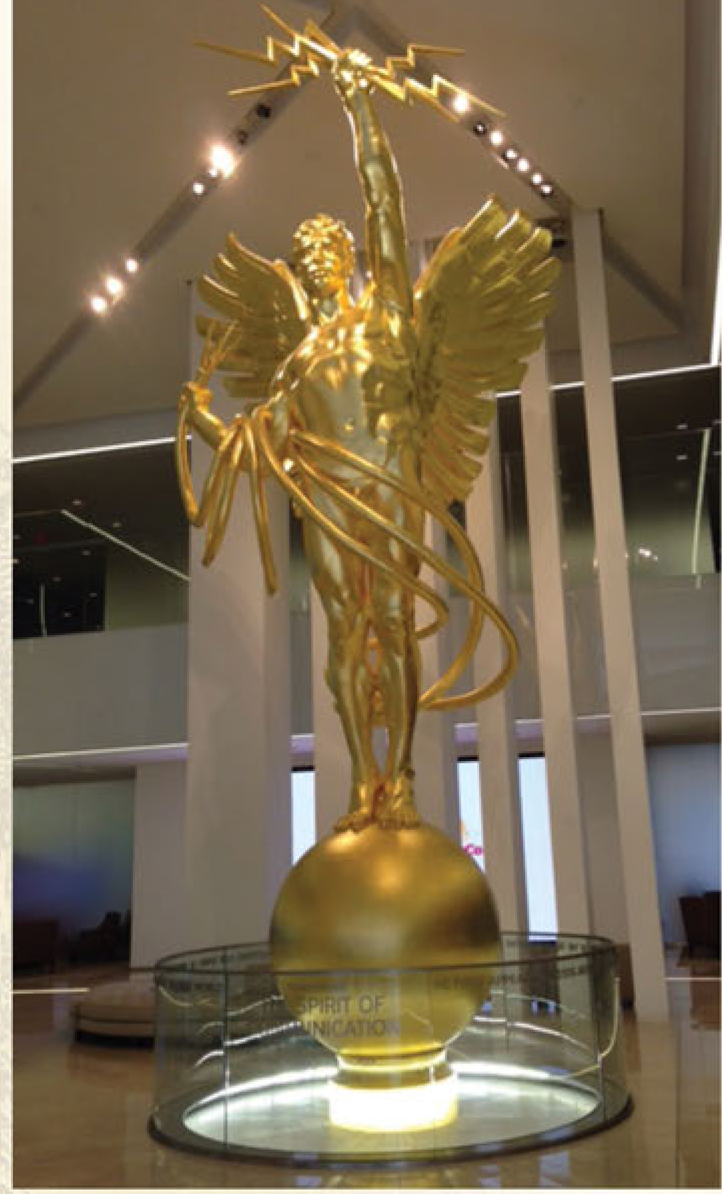
BlueStream core services offerings include hardware-optimized platforms or cloud-native virtualized network functions to support NFV evolution. Big Data Analytics and in house IT/IP expertise brings value added business intelligence.

BLUESTREAM

www.BlueStreamPro.com

678-355-6200

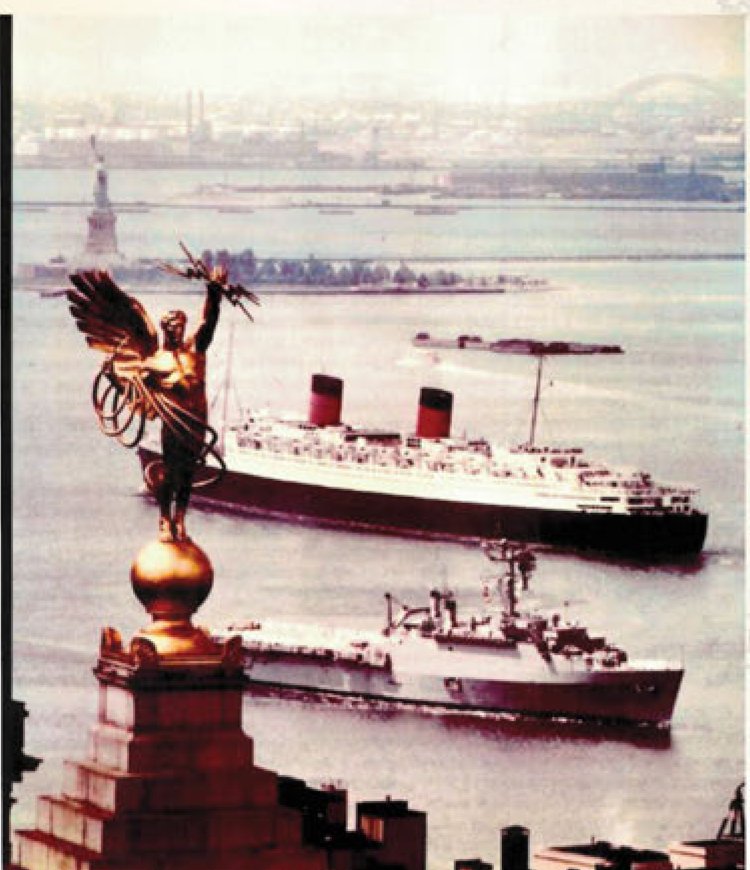
AT&T's Golden Boy



The official name of the image commissioned by Western Electric, to be fashioned into a statue, was originally The Genius of Electricity. Commissioned in 1914, it was sculpted by Evelyn Beatrice Longman. The work was completed in 1916 and hoisted to the roof of AT&T Corporate Headquarters at 195 Broadway in the Lower Manhattan area of New York City. It weighs over 16 tons and is 24 feet in height with wings that extend nine feet from the body. It is cast in bronze and covered with over 40,000 pieces of gold leaf.

The Genius of Electricity appeared on the cover of the Bell System telephone directories for about a decade beginning in the early 1930s and became a very well-known symbol for the Bell System and its affiliated companies.

In the mid-1930s, AT&T changed the name of the statue (and the image) to The Spirit of Telecommunications. It continued to stand atop the 195 Broadway building until 1984. That year marked the opening of a new postmodern headquarters building for AT&T located at 550 Madison Avenue in midtown Manhattan. The roof of the new building was a sloping inverted V with a notch in the center. There was no place for the statue on the roof, but AT&T created a seven-story lobby that contained a specific alcove to host its well-known statue and "Golden Boy" took up residence there.

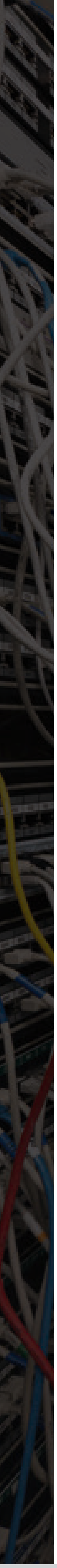


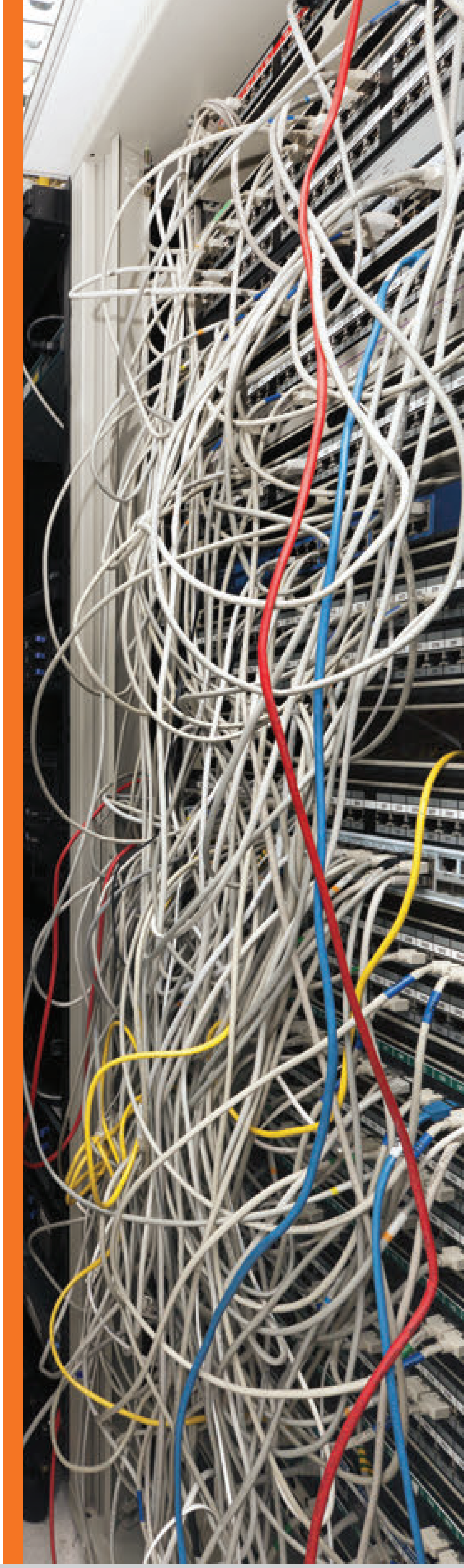
By coincidence, 1984 also marked the end of the Bell System. During the 1990s, the telecommunications industry experienced significant changes. The New York City headquarters building was sold in 1992 to Sony and the company relocated its headquarters across the Hudson River and forty miles west to a 140-acre campus in Basking Ridge, New Jersey.

Golden Boy made the trip and was installed in front of the main entrance of the building in 1992. There it stood for a decade until 2002, when AT&T sold its Basking Ridge property and moved down the road to Bedminster Township, which had been the headquarters of the AT&T Long Lines division and home to the company's national network operations center. Once again, Golden Boy also made the move.

In 2009, AT&T moved Golden Boy to the company's new and current global headquarters in Dallas, Texas, where it stands in the Dallas lobby of the Whitacre Tower at 208 S. Akard Street.


COMTREND
WifiXtend™
SSID
PW
SSID
PW
Just plug it in.
No pairing.
Now, go play.
A Comtrend to Comtrend Innovation
For more information please visit http://us.comtrend.com/wifixtend/





Meeting the Unique Test Challenges of FTTx Deployment

Michael Scholten, Sr. Product Marketing Manager, AFL

Synopsis

Passive optical networks are being deployed worldwide to more cost-effectively deliver high-bandwidth broadband services to subscribers. FTTx PONs present unique installation verification and maintenance troubleshooting challenges. These challenges are effectively overcome when technicians understand FTTx PON architecture and are equipped with test tools designed to address the unique test requirements of FTTx PONs.

Introduction

Rapid growth of fiber optic networks has resulted in an explosion of improved services to the residential consumer. Fiber to the home (FTTH or FTTx) passes more than 262 million homes globally, 20 million of which are in the United States[1]. As telecommunications companies replace old copper technologies with fiber, they are able to deliver more bandwidth, reliability, flexibility and security to end-users.

While many carriers with deployed twisted-pair copper networks utilize increasingly complex DSL technology to deliver broadband services, bandwidth demand will ultimately exceed the capacity which can be delivered over those networks.

With nearly unlimited bandwidth, FTTH fiber networks are becoming the go-to technology for next-generation communications worldwide, including distance learning, cloud computing, tele-medicine and more. Additionally, many governments have sponsored broadband plans to install and improve this critical fiber infrastructure in remote and rural areas.

FTTH passive optical networks (PONs) are increasingly being deployed to provide optical fiber's bandwidth advantages at a lower cost than point-to-point architecture affords. However, PONs present unique test challenges when installing and maintaining the FTTH network. This white paper provides an overview of FTTx PON architectures, identifies test challenges unique to FTTx PONs, and describes optical tests recommended to verify or troubleshoot FTTx PONs, including in-service (live) PONs.

FTTH Network Architectures

FTTH networks may be deployed using either point-to-point or point-to-multipoint network architecture.

Point-to-point architectures include active Ethernet, and offer a dedicated fiber connection from the operator's local exchange—either a central office (CO) or powered, environmentally-controlled vault (EV)—to each subscriber's premise. A point-to-point architecture also requires electro-optics for each subscriber at both CO or EV and the customer premise.

Gigabit-capable passive optical network (GPON) and Ethernet passive optical network (EPON) are two PON technologies commonly deployed in point-to-multipoint networks. In both GPON and EPON networks, active electronics are located only at the end-points of the PON, reducing network cost and increasing network reliability. An optical line terminal (OLT) residing in the carrier's CO communicates across the passive optical distribution network (ODN) to optical network terminals (ONTs) located at subscribers' premises (see Fig. 1).

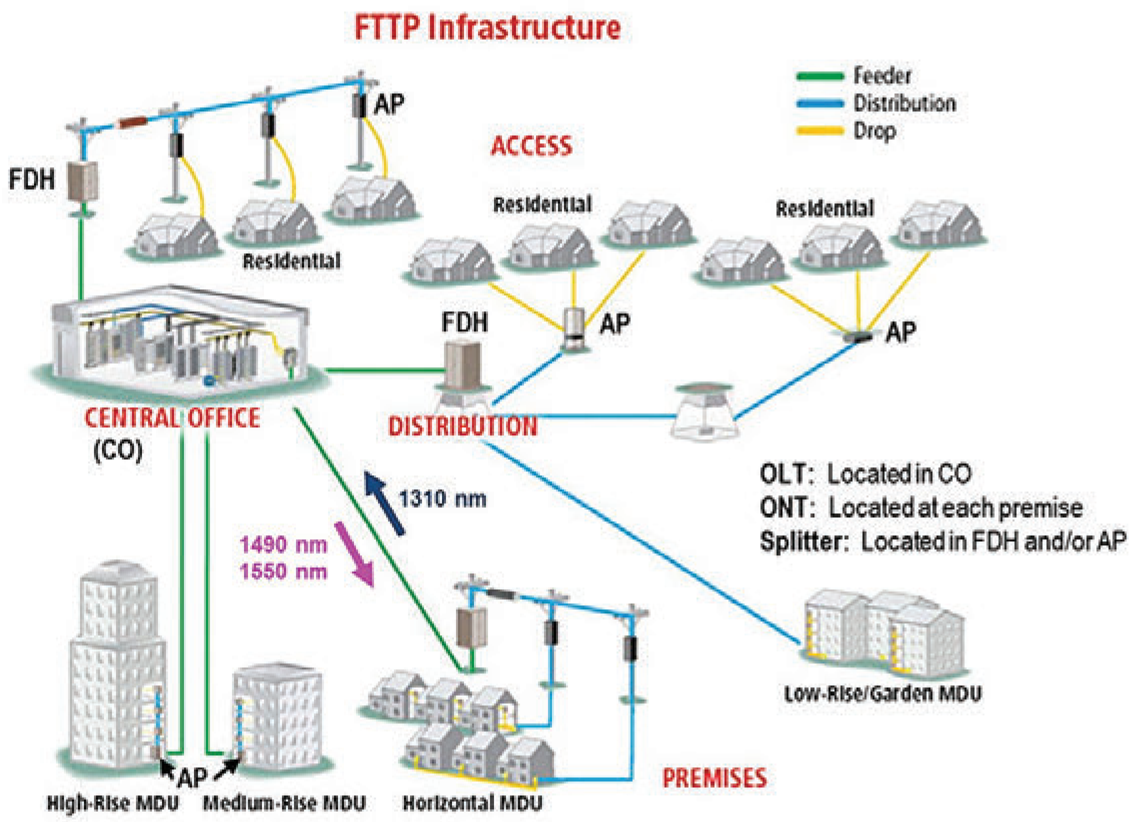


Fig. 1—FTTH PON Architecture using GPON or EPON

In the ODN, a single feeder fiber connects the CO to a pedestal- or pole-mounted fiber distribution hub (FDH). The FDH may be located in a neighborhood or the entry level of a multi-dwelling unit (MDU).

In single splitter PON architectures, a single 1x32, 1x64 or 1x128 splitter is installed at the FDH. A feeder fiber connects the central office to the splitter at the FDH. This splitter separates the downstream signal into 32, 64, or 128 copies. Each of the many splitter ports are then connected through a distribution fiber to a pedestal- or pole-mounted Access Point (AP) terminal. A drop fiber connects each AP terminal to an ONT installed at each subscriber's premise. The ONT may be installed either inside or outside the customer premise.

In a distributed PON, two lower split ratio splitters are installed, one at the FDH followed by a second splitter at the multi-port access terminal. The effective split ratio in a distributed PON is the multiple of the distributed splitters (e.g. 1x4 followed by 1x8 results in an effective split ratio of 1x32). This configuration may be used in rural applications to save fiber, or in dense applications, such as MDUs or apartment buildings. For example, drop fibers from a secondary splitter located in the entry level of an MDU would connect to each subscriber's apartment.

A PON's trunk-and-branch architecture reduces the amount of fiber required. Additionally, the downstream signal is broadcast to all attached subscribers, so a single downstream transmitter serves multiple customers. In the upstream direction, subscribers are assigned unique time slots in which to transmit, with the signals from the subscribers combined at the passive splitter and sent to the CO over the single feeder fiber. Consequently, a single CO receiver also serves multiple customers.

Traffic on the network

Both GPON and EPON deliver voice, data, and IP video signals downstream using 1490 nm wavelength. An optional video overlay may be transmitted downstream at 1550 nm. Voice and data is communicated upstream from the ONT on the same fiber using 1310 nm wavelength.

Downstream signals are optically divided at the splitter into multiple identical signals. The optical power of each signal is reduced by the split ratio plus some additional insertion loss. For example, the optical power level through a 1x32 splitter is reduced by approximately 16 dB, which is slightly more than a factor of 32. While each ONT sees the same downstream signal, downstream data is encrypted and addressed to specific ONTs, so each ONT can only access data addressed to it.

In the upstream direction, multiple subscribers may simultaneously wish to send data upstream to the CO. Since all ONTs use the same 1310 nm upstream wavelength, time division multiple access (TDMA) is used to prevent multiple ONTs from sending signals at the same time. With TDMA, the OLT assigns each ONT unique time slots during which it can send data in the upstream direction, preventing multiple ONTs from transmitting simultaneously.

FTTH PON Testing Overview

Proper testing is a critical part of installing, activating and maintaining a PON. While most components are tested during the manufacturing process, they are tested again after splicing and installation of splitters and access terminals. Field testing is required to ensure no excess loss or reflectance has been introduced due to micro-bends in installed fiber, poor splices, macro-bends in splice closures or access terminals, or dirty, damaged, or improperly seated connectors. If not detected and corrected, excess loss or reflectance often results in poor network performance. Performance may initially seem acceptable, but over time, transmission errors may begin to increase long before the need for any maintenance activity would normally be expected.
Tests commonly used to verify optical links include the following:

- Connector inspection
- Insertion loss test
- Optical return loss test
- Optical time domain reflectometry (OTDR)

Connector inspection and cleaning during installation and maintenance are among the most effective methods for ensuring an optical network will deliver expected performance. Connector inspection is typically performed using an optical microscope. To prevent accidental eye damage when inspecting fibers potentially carrying live traffic, a video microscope images the connector end-face and displays the magnified image on a handheld display. Dirt, debris, or damage are easily detected. Images may be captured before and after cleaning, then compared for any variation. Connector contamination and damage are the most common causes of poor optical network performance, according to a recent study by NTT-Advanced Technology[2].

An **insertion loss test** measures the end-to-end loss of the installed link by injecting light with a known power level and wavelength at one end, and measuring the received power level output from the other end. The measured difference between the transmitted and received power levels indicates the optical loss through the network. Insertion loss is considered acceptable when the measured loss level is lower than the budgeted loss level.

An **optical return loss test** injects light with known wavelength and power level into one end and measures the power level returned to that same end. The difference between the injected power level and the measured return level is the return loss. Return loss is considered acceptable when it is higher than the budgeted return loss target. A low return loss value (below 35 dB) is often an indication of one or more sources of excess reflection in the network under test, typically due to dirty or damaged connectors or a fiber break.

Since optical network loss is wavelength-dependent, insertion and return loss testing is typically performed using wavelengths at or near those which will be used during network operation. In the case of FTTx PONs, downstream wavelengths of 1490 nm and 1550 nm may be used, while 1310 nm is used in the upstream direction. Consequently, insertion and return loss testing at 1310 nm, 1490 nm, and 1550 nm may be required. In practice, testing is often performed only at 1310 nm and 1550 nm, reasonably expecting loss and return loss at 1490 nm to be between the levels measured at 1310 nm and 1550 nm.

If the loss and return loss measured at each wavelength are within the levels budgeted for the link, the optical network may be considered ready for activation. However, in many cases, the network operator requires the network to be more fully documented using an optical time domain reflectometer (OTDR).

An **OTDR** scans a fiber from one end to measure the length, loss and optical return loss of an optical network. It also locates and measures reflective and non-reflective events in the network due to splices, connectors, micro- or macro-bends, splitters or faults.

Operating like a radar, an OTDR injects narrow pulses of light into the fiber-under-test. As each pulse travels down the fiber, imperfections in the fiber scatter some of the light, with some of this Rayleigh-scattered light being guided back up the fiber.

Optical pulses and backscatter experience some loss as they traverse a mated connector pair, mostly due to imperfect alignment between the two connectors. By measuring the difference between backscatter levels before and after the connection, the OTDR is able to measure the loss across each connection.

A Fresnel reflection is generated whenever the pulse encounters a mismatch in the index-of-refraction, usually at a mated connector. An air gap at a poorly mated connector or an open connector end will generate a strong reflection. This reflected energy is also guided back up the fiber. (Note: The ends of APC connectors are angled to ensure that light is reflected off the end-face at such an angle that it is not captured and guided back up the fiber.)

The OTDR measures the level of returned backscatter and reflections vs. time. Since the speed of light through the optical fiber is known, the OTDR is able to convert time-of-flight into distance, creating a trace which plots changes in backscattered and reflected light levels vs. fiber length. Losses due to connectors or macro-bends appear as abrupt changes in the backscatter signal level. Reflections due to connectors, air gaps and open ends appear as spikes in the OTDR trace, as shown in Fig. 2.

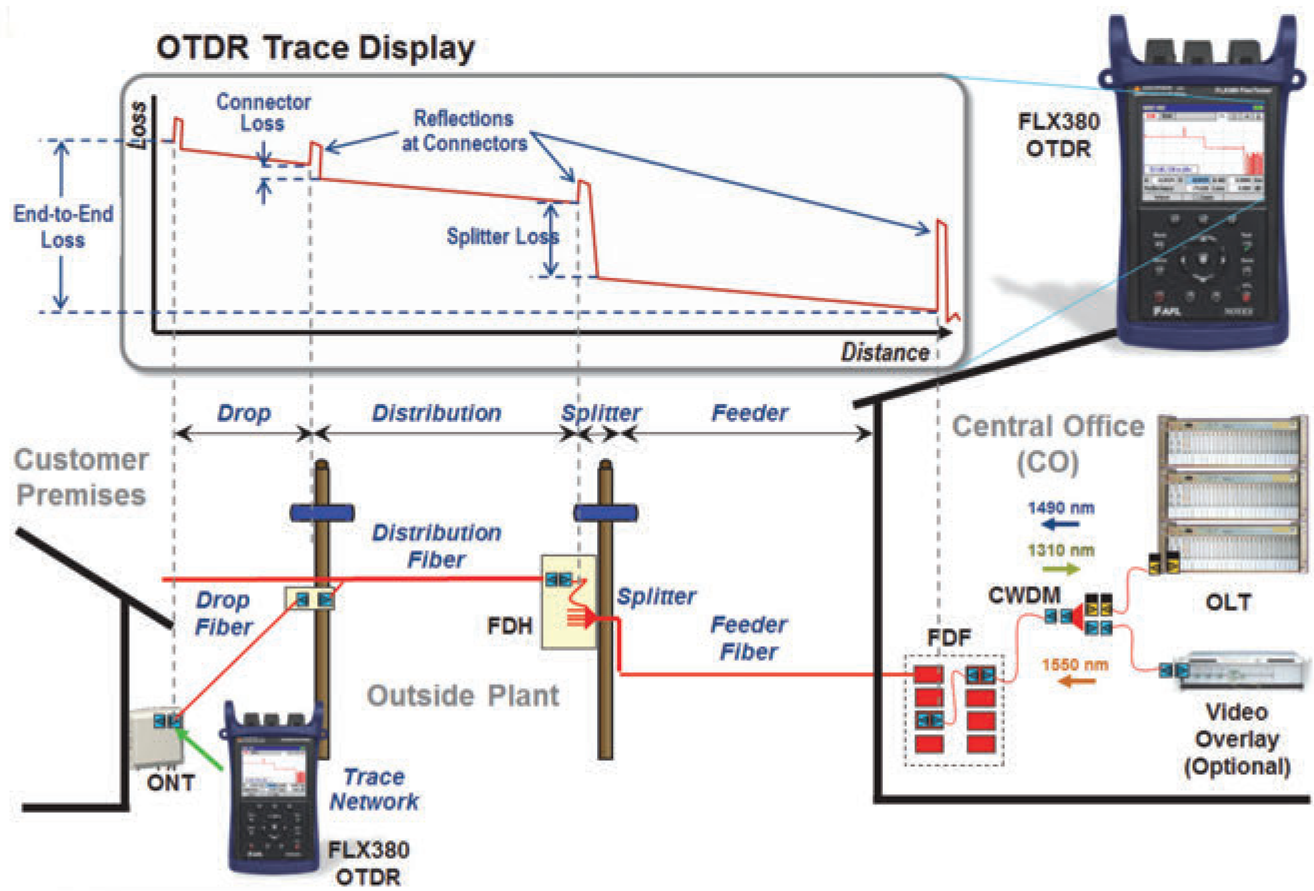


Fig. 2— Example OTDR trace showing backscatter, reflections, and loss events

End-to-end loss is measured by comparing backscatter level at the beginning of the fiber to backscatter level at the end of the fiber. Reflectance levels are determined by comparing the backscatter level just before a connector to its reflective spike level. Optical return loss can be computed by summing end-to-end backscatter and reflection levels and comparing them to the transmitted pulse power level.

For more accurate connector or end-to-end loss measurements, OTDR traces from opposite ends of a point-to-point network are often averaged using PC-based trace analysis software. Note: Insertion and return loss tests each provide a single numeric value which can be compared to network-specific limits to determine if the optical plant is within acceptable performance values. However, when unacceptable or marginal values are found, insertion or return loss tests cannot locate the source of the problem. An OTDR also measures loss and return loss, but can additionally locate the sources of excess loss and reflections, reporting the distance to high loss or highly reflective events.

Which Tests, When and Where?

Optical testing is typically performed at various points in a network's lifetime:

Installation verification testing occurs as the network is being constructed or after network installation is complete, but before the network is activated. This is usually when the most complete testing is performed, and may include insertion and return loss testing as well as OTDR testing. Pass/fail criteria may be applied to end-to-end length, loss and ORL results, as well as to individual event loss and reflectance measurements for splices, connectors, and splitters. Formal reports may be generated, including all of the measurements, OTDR traces, pass/fail criteria and pass/fail results.

Maintenance troubleshooting is performed when service outages occur, and typically requires rapid response to restore service as quickly as possible. This is done through reroute restoration and/or fault location, repair, and verification before restoring active service. Troubleshooting may also require nondisruptive fiber identification to ensure in-service fibers are not disconnected. Maintenance personnel may require a visual fault locator (VFL) to precisely pinpoint the location of breaks or macro-bends in splice or access enclosures.

Table 1 summarizes installation and maintenance tests which may be performed, indicates the equipment required for each test, when the test is most likely to be performed (e.g. during installation or troubleshooting), typical test wavelengths, and where the test is performed.

Table 1— FTTx PON Installation Verification and Maintenance Troubleshooting Tests

TEST	DESCRIPTION	WHEN USED		REQUIRED EQUIPMENT	WAVELENGTHS (NM)	TEST FROM	NOTES
		INSTALLATION	TROUBLESHOOT				
Out-of-Service Feeder Fiber Test	Test insertion loss of feeder fiber before splitter installed (OLT <--> FDH)	Yes	No	OLS & OPM	1310/1550 or 1310/1490/1550	OLT to FDH, or FDH to OLT, or Both (bidirectional)	Does not verify connection to splitter; Either test requires equipment at both ends; Wave ID shortens test time and eliminates setup errors
	Test insertion loss of feeder fiber after splitter installed (OLT <--> FDH)	Yes	No	OLS & OPM	1310/1550 or 1310/1490/1550	OLT to FDH, or FDH to OLT, or Both (bidirectional)	Test through any splitter port verifies feeder fiber and splitter connection; Must test through all splitter ports to verify each splitter port is OK
	OTDR test of feeder fiber before splitter installed (OLT <--> FDH)	Yes	No	OTDR	1310/1550 or 1310/1490/1550	OLT to FDH, or FDH to OLT, or Both (bidirectional)	Locate all splices and connectors; Verify no excess losses or reflections, or locate any excess losses and reflections for repair
	OTDR test of feeder fiber after splitter installed (OLT --> Splitter)	Yes	No	OTDR	1310/1550 or 1310/1490/1550	OLT	Locate all splices and connectors; Verify no excess losses or reflections, or locate any excess losses and reflections for repair; Does not test individual splitter ports
	OTDR test of feeder fiber after splitter installed (Splitter --> OLT)	Not recommended	Possibly	OTDR	1310/1550 or 1310/1490/1550	Splitter ports	Not recommended for verifying feeder fiber splices since wide pulse width (low resolution) required to see through splitter to detect & verify low-loss splices; May be used to verify loss through each splitter port.

table ccontinued →

Table 1— FTTx PON Installation Verification and Maintenance Troubleshooting Tests

TEST	DESCRIPTION	WHEN USED		REQUIRED EQUIPMENT	WAVELENGTHS (NM)	TEST FROM	NOTES
		INSTALLATION	TROUBLESHOOT				
Out-of-Service Splitter, Distribution & Drop Fiber Tests	Test insertion loss of feeder fiber, splitter and distribution fiber (drop fiber not installed)	Yes	No	OLS & OPM	1310/1550 or 1310/1490/1550	OLT to AP, or AP to OLT, or Both (bidirectional)	Verify loss of feeder fiber, splitter and distribution fiber; Requires equipment at both ends; Use Wave ID to shorten test time and eliminate setup errors
	Test insertion loss of feeder fiber, splitter, distribution, and drop fibers	Yes	Possibly	OLS & OPM	1310/1550 or 1310/1490/1550	OLT to ONT, or ONT to OLT, or Both (bidirectional)	Verify loss of feeder fiber, splitter and distribution fiber; Requires equipment at both ends; Use Wave ID to shorten test time and eliminate setup errors
	OTDR test of splitter plus distribution fiber (drop fiber not installed) (PON out-of-service)	Yes	Possibly	OTDR	1310/1550 or 1310/1490/1550	AP toward OLT	Test from AP downstream from splitter; PON must be out-of-service to test at 1310/1490/1550 nm; High-resolution test possible on distribution fiber (from AP to splitter); Can measure splitter loss and end-to-end loss
	OTDR test of splitter, distribution and drop fibers (PON out-of-service)	Yes	Possibly	OTDR	1310/1550 or 1310/1490/1550	ONT toward OLT	Test from ONT (end of drop fiber); PON must be out-of-service to test at 1310/1490/1550 nm; High-resolution test possible on drop & distribution fibers; Can measure splitter loss and end-to-end loss
In-service Distribution & Drop Fiber Tests	Test end-to-end insertion loss of PON	Not typical	Possibly	OLS & OPM	1625 or 1650	OLT to ONT, or ONT to OLT, or Both (bidirectional)	Requires WDM test port at OLT; Requires unused or out-of-service ONT port; Only measures end-to-end loss through single splitter port
	OTDR test of splitter, distribution and drop fibers (PON in-service)	No	Yes	OTDR	1625 or 1650	ONT toward OLT	Test in-service PON from unused or out-of-service drop fiber; Must use out-of-band OTDR wavelength (e.g. 1625 or 1650 nm); High-resolution test possible on drop & distribution fibers; Can measure splitter loss and end-to-end loss
	Measure downstream power level	No	Yes	PON OPM	1490, 1550	ONT	Detect and measure downstream power level at ONT; Verify received power ≥ minimum acceptable power level.
	Pinpoint faults in AP, FDH or splice closure	Yes	Yes	VFL	635 or 650	ONT toward AP, FDH	Connect VFL (visible red laser) at ONT end of drop fiber; Visually inspect fiber in fault region for red glow pinpointing fault location.
Active ONT detection	Non-intrusively detect active ONT	No	Yes	Active ONT Identifier	1310 nm	900 µm, 2 or 3 mm fiber between splitter and ONT	Clamp onto accessible buffered or jackected fiber; Indicates if ONT actively responding to OLT
Fiber Identification	Non-intrusively detect live fiber	Possibly	Yes	OFI	1310/1490/1550	900 µm, 2 or 3 mm fiber between splitter and ONT	Use OLS to inject tone into one end of out-of-service fiber;
	Non-intrusively detect out-of-service fiber carrying test tone	Possibly	Yes	OLS & OFI	1310/1490/1550	900 µm, 2 or 3 mm fiber between splitter and ONT	Clamp onto accessible buffered or jackected fibers in a bundle of fibers (some active, some out-ofservice, one carrying identifying tone); OFI Indicates if no signal, live fiber, or test tone (270, 1k, 2k Hz) present

FTTx PON Insertion Loss Tests

Insertion loss tests are primarily used to test FTTx PONs during installation. Insertion loss testing may be performed on individual fiber segments as they're installed (e.g. test feeder fiber from CO to FDH, test distribution fiber from FDH to AP, or test drop fiber from AP to subscriber's premise). An end-to-end insertion loss test may also be performed on the FTTx PON after it is partially or fully installed (from CO through feeder fiber, splitter, distribution and drop fibers to the AP or customer's premise).

A stable optical light source and an optical power meter are required to measure insertion loss. Access to both ends of the fiber-under-test is required. Consequently, this is typically an out-of-service test.

To measure loss, received power at the far end of the fiber-under-test must be compared to transmit power injected into the fiber at the near end of the fiber under-test. To simplify loss measurements, the power meter is initially connected to the source with a short jumper cable and the source power level is measured and stored as the 0 dB reference level for that wavelength. Since the source's output power levels and the power meter's detector response are different at each wavelength, the power meter must be referenced to the source at each test wavelength.

Once the source and power meter have been referenced at each of the test wavelengths, the source—with the reference jumper still attached—is connected to one end of the fiber under test. The power meter is connected to the other end of the fiber-under-test. Received power level is measured and displayed. More conveniently, the power meter can compare the received power level to the stored reference, directly displaying optical loss in dB.

Simple power meters measure power at only one wavelength at a time. To make loss measurements at multiple wavelengths, the source must be configured for each test wavelength in turn. At the same time, the power meter operator must select the appropriate wavelength at the power meter so the correct detector calibration factor and reference level are applied. This is both time-consuming and error prone, as it requires coordination between the source operator on one end and the power meter user at the other end of the fiber-under-test.

To reduce test time and eliminate this potential for errors, AFL's FLX380 FlexTester includes Wave ID. A Wave ID source alternately transmits light at each wavelength. A Wave ID power meter automatically synchronizes to the received wavelengths, eliminating the need for source and power meter to be manually switched between wavelengths (see Fig. 3).

Test Steps Without Wave ID	Test Steps With Wave ID
Store references: 1. Connect OLS to OPM at one location. 2. Set OLS to 1310 nm. 3. Set OPM to 1310 nm. 4. Store reference. 5. Set OLS to 1550 nm. 6. Set OPM to 1550 nm. 7. Store reference.	Store references: 1. Connect OLS to OPM at one location. 2. Set OLS to Wave ID, 1310 / 1550 nm. 3. OPM detects Wave ID (< 2 sec) 4. Store reference (stores refs at both λ).
Measure network loss: 1. Connect OLS & OPM to network ends. 2. Set OLS to 1310 nm. 3. Tell OPM user to set OPM to 1310. 4. Wait for OPM user to measure loss @ 1310. 5. OPM user sets OPM to 1550 nm. 6. Tell OLS user to set OLS to 1550 nm. 7. Wait for OLS user to switch to 1550 nm. 8. Measure loss @ 1550 nm.	Measure network loss: 1. Connect OLS & OPM to network ends. 2. Set OLS to Wave ID, 1310 / 1550 nm. 3. OPM detects Wave ID, simultaneously measures loss at *both* 1310 & 1550 nm.

Fig. 3— Store reference and measure loss using Source and Power Meter with Wave ID

FTTx PON Out-of-Service OTDR Tests

OTDR testing is typically completed as the FTTx PON is being deployed. The feeder fibers connecting CO to FDH are typically the longest links in the PON, are usually the first fibers installed, and may include multiple splices. These may be tested as point-to-point links before the splitter is installed at the FDH.

If a splitter is spliced to the feeder fiber before testing, the loss through each of the splitter legs may be verified. However, this requires testing from each of the multiple splitter outputs, and requires a launch fiber (1000 m recommended) to allow the splitter loss to be clearly seen and measured. Splitter losses through each of the legs cannot be easily verified by testing from the CO end of the feeder fiber.

Using an OTDR, distribution fibers are typically tested after installation and connection to the splitter. Once attached to the splitter, these fibers may only be tested from the downstream access point or subscriber premise (if the drop fiber is also installed and connected). High-resolution of the distribution and drop fibers may be obtained using narrow pulses, but the OTDR may not be able to measure the splitter loss using narrow pulses. Wider pulses improve the OTDR's dynamic range, enabling it to more accurately measure the loss of the attached splitter.

OTDR testing during FTTx PON installation testing is usually performed only at 1310 and 1550 nm. During operation, the FTTx PON always utilizes 1490 nm in the downstream direction and 1310 nm in the upstream direction. It may additionally utilize 1550 nm as a second downstream wavelength. Fiber loss is highest at 1310 nm and lowest at 1550 nm, while bending-induced loss is highest at 1550 nm. If end-to-end loss is within acceptable limits at both 1310 and 1550 nm, it is nearly certain to be acceptable at 1490 nm. If no excess losses or reflections are found at 1310 or 1550, none are likely to be found at 1490 nm. Even if the PON will initially be operated using only 1490 and 1310, testing at 1310 and 1550 nm can detect any micro- or macro-bends, and ensures the FTTx PON is capable of adding 1550 nm operation in the future.

Troubleshooting an In-Service FTTx PON

Because of its point-to-multi-point architecture, it is possible for one or only a few subscribers to lose service while other subscribers on the same PON continue to receive service. There are several possible causes:

- Equipment or connection problem inside the customer's premise;
- Failed ONT at the customer's premise;
- Fault in the distribution or drop fiber from the splitter to the subscriber;
- Fault introduced at the splitter connection to the subscriber's distribution or drop fiber (e.g. macro-bend introduced while adding another subscriber, or inadvertently disconnecting the distribution or drop fiber to an active subscriber).

If some, but not all subscribers are affected in an FTTx PON built using distributed splitter architecture, it is possible that all of the affected customers are served from a single secondary splitter. In this case, likely causes include:

- Fault in the distribution fiber serving the secondary splitter;
- Fault in the secondary splitter itself.

In either case, a fault in the feeder fiber or a failure within the OLT is not likely, since the feeder fiber and OLT are also shared by subscribers who are still receiving service.

Troubleshooting normally requires a visit to the subscriber's premise. A recommended troubleshooting process is illustrated in Fig. 4 and described on pages 11 and 12.

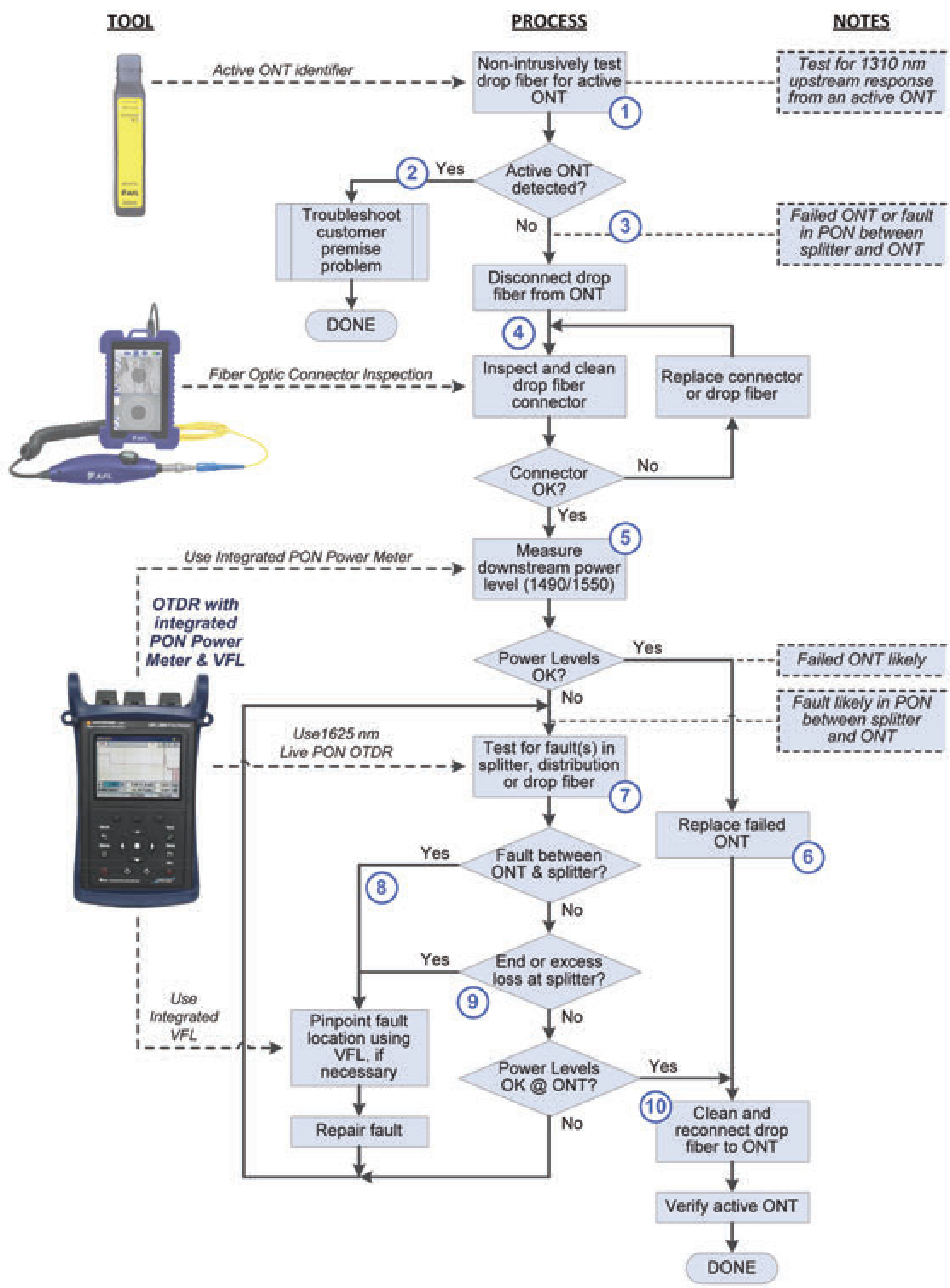


Fig. 4— Troubleshooting a Live PON

Test Procedure when Troubleshooting an In-Service (Live) PON

1. Use an Active ONT Identifier to determine if the ONT at the subscriber's premise is responding to downstream signals from the OLT. The Active ONT identifier clamps on to 900 µm buffered fiber, or 2 or 3 mm jacketed fiber, senses and reports the presence or absence of the 1310 nm upstream response from an active ONT.

2. If an active ONT is detected, the fault is either an equipment or connection problem inside the customer's premise (most likely), or the ONT itself (less likely). Optical tests at the ONT are unlikely to resolve the problem.

3. If an active ONT is not detected, the fault may either be a failed ONT or a fault in the splitter, distribution or drop fiber connecting the feeder fiber to the subscriber.

4. In this case, disconnect the drop fiber from the ONT, inspect and clean the optical connectors on the drop fiber and the ONT. If a damaged optical connector is found on the drop fiber, replace, clean and inspect the new connector before proceeding. If a damaged optical connector is found on the ONT, the ONT likely will have to be swapped out.

5. If connectors are clean and undamaged, check the downstream power level at the ONT using a PON Power Meter. Some OTDRs include a PON Power Meter integrated into their OTDR port, enabling immediate detection and measurement of downstream power levels at both 1490 and 1550 nm.

6. If the measured downstream power levels are acceptable, the problem is likely a failed ONT. Swap out the ONT, clean and reconnect the drop fiber, and verify the ONT synchronizes to the upstream OLT.

7. If the measured downstream power level(s) are not acceptable, the problem is likely a fault in the distribution or drop fiber, or a fault introduced at the splitter in the FDH. In this case, connect a live PON OTDR to the drop fiber and initiate an upstream OTDR test using the out-of-band 1625 nm wavelength. To prevent disrupting service on the live PON, select an OTDR which prevents the user from initiating 1310, 1490, or 1550 nm OTDR tests when live traffic is present.

8. Some OTDRs also allow the operator to test only the customer fiber (distribution and drop), or to test through the splitter. Unless multiple customers are affected, the problem is most likely in the distribution and drop fiber, so testing only the distribution and drop fiber is a good bet.

9. Review the 1625 nm trace and event table to determine if there is a break or any excess losses or reflections in the distribution and drop fibers. If so, locate the problem location, repair the fault, then verify the fix by rescanning the fiber using the same 1625 nm test. To precisely pinpoint macrobends or breaks within a splice enclosure or access point, disconnect the OTDR and connect a Visual Fault Locator (VFL, a visible red laser). Enable the VFL and look for the point where the fault causes red light to escape from the fiber.

10. If no excess losses or reflections were identified in the OTDR trace, rescan the FTTx PON from the same location at 1625 nm using the "Test through Splitter" setup. This will provide a trace of the distribution and drop fibers with sufficient dynamic range to see through the splitter and measure the splitter loss. Since other probable causes have been eliminated, likely problems are a break or macrobend at the splitter, or the splitter has been disconnected from the distribution fiber. These will manifest themselves either as excess loss at the splitter, or as the fiber end being detected at the splitter. Repair the fault, then verify the fix by rescanning the fiber using the same setup.

11. Once fiber restoration is complete, verify the proper downstream power levels are available at the end of the drop fiber, clean and reconnect the drop fiber to the ONT, and verify the ONT synchronizes to the upstream OLT.

Summary

Passive optical networks are being deployed worldwide to more cost-effectively deliver higher bandwidth broadband services to subscribers. FTTx PONs present unique installation verification and maintenance troubleshooting challenges. These challenges are effectively overcome when technicians understand FTTx PON architecture and are equipped with test tools designed to address the unique test requirements of FTTx PONs.

Notes:

[1] "Telecom Cable Market Outlook 2012 Executive Summary," CRU International, August 2012.

[2] NTT—Advanced Technology; http://www.bicsi.org/uploadedFiles/PDFs/Presentations/Fibre%20Optic%20Connector.pdf

About Michael Scholten

Michael is Sr. Product Marketing Manager at AFL, one of the world's leading manufacturers of fiber optic cable. The company's diverse product portfolio includes fibre optic cable, transmission and substation accessories, outside plant equipment, connectors, fusion splicers, test equipment and training. AFL's service portfolio includes market-leading positions with the foremost communications companies supporting inside plant central office, EF&I, outside plant, enterprise and wireless areas.

3M

Item No.	Vendor No.	Description
0000418437	80611387558	SFFW-J-1/2 SLIM LOCK CLOSURE FOR 1/2" DIN 7/16 CONNECTOR
0000434896	80611495971	Slim Lock Closure, SLC-A-MINI
Contact KGP Logistics	80611495989	SLC-B-NANO SLIM LOCK CLOSURE 0.51-0.62 CONN NECK 1/2IN CABLE

ADTRAN

Item No.	Vendor No.	Description
0000407753	1287703G1	TA374 4 POTS + 4 GE MDU
0000436104	1287703G1S	TA374 4 POTS + 4 GE MDU(S)
0000432913	1287733F1	TA480 OUTDOOR MDU ENCLOSURE

AFL

Item No.	Vendor No.	Description
8800003153	FLX380-303-CMP2	Flextester3 CMP2 Kit(Hard Case,FOCISFlex,One-Click),Mod303(41/41/38@1310/1550/1625),APC Ferrule,TRM &LM, English, ASC Bulkhead;2.5 APC Ferrule;2.5 Cleaning, FR1-SM-150-ASC-ASC, 400-Jacketed & Buffered Fiber;Power & Tone Display
8800002925	FLX380-303A-ENG-STD	Flextester3 Standard Kit(Soft case,Oneclick),Mod 303(41/41/38@1310/1550/1625),APCFerrule,TRM only, English
0000420642	FLX380-303A	FlexTester3 Kit, FLX380-303A, 1310/1550/1625, APC
0000408219	S015671	Fujikura 70R Fusion Splicer Kit w/CT-30,BTR-09,DC-18
0000397667	S015591	70S Fusion Splicer Kit w/ CT30A
0000087449	VFI2-00-0900PR	Visual Fault Identifier FDA & IEC Class II Laser 650NM Wavelength 1MW Output 2HZ or CW Selected Modulation Universal Adapter 2.5mm Battery Powered AA Alkaline 5.5" X 2.4" X 1.3" 7.06oz

APC by Schneider Electric

Item No.	Vendor No.	Description
0000354106	SMT1500RM2U	APC Smart-UPS, 1000 Watts / 1500 VA,Input 120V / Output 120V, Interface Port SmartSlot, USB, Rack Height 2 U

CommScope

Item No.	Vendor No.	Description
0000427343	L4A-DMDM-10-P-SGW	10' Din Male-Din Male LDF4 SureGuard Jumper - PIM Rated
0000387380	L4A-DMDM-8-P	8' Din Male-Din Male LDF4 SureFlex Jumper - PIM Rated
0000417117	158EZNF	1-5/8" N-Female Connector
0000413371	SSH-114	1-1/4" Stackable Snap In Hangers
0000417361	SSHAK-3812	3/8" Stackable Snap In Hangers
0000408373	FT-TB	Black Silicone Weatherproofing Tape
0000417387	UGBKIT-0412-T	1/4"X4"X12" Tinned Copper Ground Bar With Universal Hardware
0000416817	SBNH-1D6565A	Quad Port Antenna 698-896/1710-2180MHZ
0000391093	SF-SU12-B	12'-6" Sector Frame - Purchase Antenna Pipes Separately
0000417405	SF-QV12-B	12'-6" QV Folding Sector Frame - Purchase Antenna Pipes Separately
0000433108	VSR-TS-B	Stabilizer Kit For QV Folding Sector Frame
0000391081	MC-PA12L-B	12' Monopole Co-Location Platform For 30-30" Monopole - Purchase Pipes Separately
0000409907	WB-K210-B	24" x 10' 2 Post Direct Burial Waveguide Bridge Kit
0000387437	SM-U2080	Universal Saddle Mount
0000387452	XP-2020	Crossover Plate For 2-3/8" Pipe
0000387411	MT-651-96	2-3/8" x 96" HDG Antenna Pipe
0000368963	CMAX-DM60-CPUSEi	MIMO DAS Antenna 698-960/1710-2700 Mhz
0000369031	T-2-DM	2 Watt DIN Male Termination

Comtrend

Item No.	Vendor No.	Description
0000439773	WAP-PC1750W	AC1750 Dual Band Wireless Access Point, (560mW) High Power, High Sensitivity, Gigabit Pass-Through Port, Wall Mount
0000462066	WAP-PC1200C	AC1200 Dual Band Wireless Access Point, (400mW) High Power, High Sensitivity, Ceiling Mount
0000462067	WAP-EN1750W	AC1750 Managed Dual Band Wireless Access Point, (560mW) High Power, High Sensitivity, Gigabit Pass-Through Port Wall Mount
8800003966	WAP-EN1200C	AC1200 Managed Dual Band Wireless Access Point, (400mW) High Power, High Sensitivity, Ceiling Mount

Preformed Line Products

Item No.	Vendor No.	Description
Contact KGP Logistics for more information		

PREMIER		
Item No.	Vendor No.	Description
HDMI Cable		
0000439302	PT-HDMI-1.4V-6FT	HDMI Cable, Male to Male, 6', High Speed with Ethernet Version 1.4
0000439303	PT-HDMI-1.4V-10FT	HDMI Cable, Male to Male, 10', High Speed with Ethernet Version 1.4
0000439304	PT-HDMI-1.4V-12FT	HDMI Cable, Male to Male, 12', High Speed with Ethernet Version 1.4
Station Wire		
2010827500	SW-C3X-2P22BG-P1000	2 Pair 22 Gauge CMX Category 3 1000 Foot Pop Box Beige
3043867500	SW-C3X-2P24BG-P1000	2 Pair 24 Gauge CMX Category 3 1000 Foot Pop Box Beige
3043887500	2137142	4 Pair 24 Gauge CMX Category 3 1000 Foot Pop Box Beige
0000014266	2137146E	4 Pair 24 Gauge CMX Category 5e 1000 Foot Pop Box Gray
0000185515	2137144E	4 Pair 24 Gauge CMX Category 5e 1000 Foot Pop Box Beige
0000282004	2137113E	4 Pair 24 Gauge CMX Category 5e 600 Foot Pop Box Ivory
0000031726	51-240-31	4 Pair 24 Gauge CMX Category 5e 1000 Ft Pop Box Gray-Superior Essex
0000101639	51-240-21	4 Pair 24 Gauge CMX Category 5e 1000 Ft Pop Box Blue-Superior Essex
0000295425	51-240-11	4 Pair 24 Gauge CMX Category 5e 1000 Ft Pop Box Beige-Superior Essex
Coax Cable		
0000108097	C5775.31.01	RG6 Coax General Purpose CM 60% Braid 1000 Foot Pop Box Black
0000233798	C5775.31.02	RG6 Coax General Purpose CM 60% Braid 1000 Foot Pop Box White
0000196741	C5775.41.01	RG6 Coax General Purpose CM 60% Braid 1000 Foot Reel Black

Telect		
Item No.	Vendor No.	Description
0377330217	027-2000-4099	WaveTrax FastLock Couplers 4"
0011580000	027-2000-6499	WaveTrax FastLock Couplers 6"
Contact KGP Logistics	027-2000-12499	WaveTrax FastLock Couplers 12"
0000438619	027-2000-6412	WaveTrax Express T's 6"
Contact KGP Logistics	027-2000-12412	WaveTrax Express T's 12"
0000420636	027-2000-4262	WaveTrax Express Off-Ramps 2"
0000420635	027-2000-4062	WaveTrax Express Off-Ramps 4"
5132730217	027-0000-4200	WaveTrax CableLinks 2"
0257150217	027-0000-4000	WaveTrax CableLinks 4"
0257190217	027-0000-6400	WaveTrax CableLinks 6"

Viavi		
Item No.	Vendor No.	Description
0000477167	FIT-FC-KIT1	FiberChek probe, case, FBPT-U25M, tip case
0000477168	FIT-FC-KIT2	Kit: FiberChek probe, case, FBPT-LC, FBPT-SC, FBPT-U12M, FBPT-U25M, tip case
0000477169	FIT-FC-KIT3	Kit: FiberChek probe, case, FBPT-LC, FBPT-SC, FBPT-U12M, FBPT-U25M, tip case FBPT-U25MA , tip case
0000477170	FCPP-SCASE3	FiberChek case
0000477171	FBPP-DPAC7	Locking MicroUSB cable
0000477172	FBPP-DPAC8	OTG cable
0000477173	FCPP-CHP1	FiberChek holster
0000477106	FIT-FC-KIT4C	FiberChek Probe wireless fiber inspection probe, a/c charger, soft carry case; SW-FCM-A1; SC/UPC, SC/APC and LC/UPC patchcord and bulkhead inspection tips (6 tips total), MP-60A PM
0000477107	FIT-SD103C	FBP-P5000I w/Fibercheckpro SW, Case, Tips, & Adapters; SW-FCM-A1; MP-60A
0000477108	HST3000-CUDSL-SILVERC	HST3000-CUDSL-SILVER;Advanced DSL Copper Package
0000477109	ONX580-DSL-BONDED-P1C	ONX-580 DSL Bonded Standard Package
0000477110	ONX580-DSL-HOME-P4C	ONX-580 DSL Bonded Home Standard Package
0000477111	SmartOTDR126A-P1C	SMARTOTDR CONTRACTOR OTDR PACKAGE, Singlemode, SmartOTDR 1310/1550nm (34/33dB) w/5 Inch Color Touchscreen, Wifi, VFL and PM ports, Light Source, SLM, SmartTEST and ExpertOTDR Modes, Lithium Polymer battery, hands-free carry case, soft carry case
0000477112	TB2-FCOMP-TK1C	T-BERD 2000 FiberComplete Test Kit, T-BERD 2000 1310/1550nm w/ 5 Inch touchscreen color display, power meter, VFL, built-in WiFi module 1310/1550nm, FTTH-SLM Pass/Fail connector inspection software w/P5000i digital inspection probe
0000477113	TB2-OTDR-TK3C	T-BERD 2000 FTTA/FTTH CONTRACTOR OTDR Test kit, T-BERD2000 w/5 Inch touchscreen color display, built-in power meter, WiFi function, UPC connector, LC connector adapter, light source, cell tower, PON, soft carrying case, hands-free bag
0000477114	TB2-QUAD-TK2C	T-BERD 2000 QUAD FTTA/ENTERPRISE OTDR PACKAGE, T-BERD2000 platform w/5 Inch touchscreen color display, built-in power meter, VFL,
		Dual port MM-SM, UPC connector, SC/LC connector adapters, soft carrying case, hands-free bag, AC/DC adapter/charger
0000477115	TB5800-CPRI-ETH-OTDRC	TB5811P w/ WiFi; CPRI/BERT test options (614M-9.8G); E1/ E3/ E4/ STM-1e/ GE and 10GE LAN/WAN/ incl optics; E4126MA OTDR module w/ LS; FTTA-SLM; FFL-050-2; MP-60A, P5000i No optics
0000477116	TB5800-DS3-10GE-C	MTS5811P-PDH-10GE;MTS5800 with E1/ E3/ E4/ STM-1e/ GE and 10GE LAN/WAN/ incl optics

KGP Logistics

600 New Century Parkway
New Century, Kansas
66031-8000

Upcoming Events

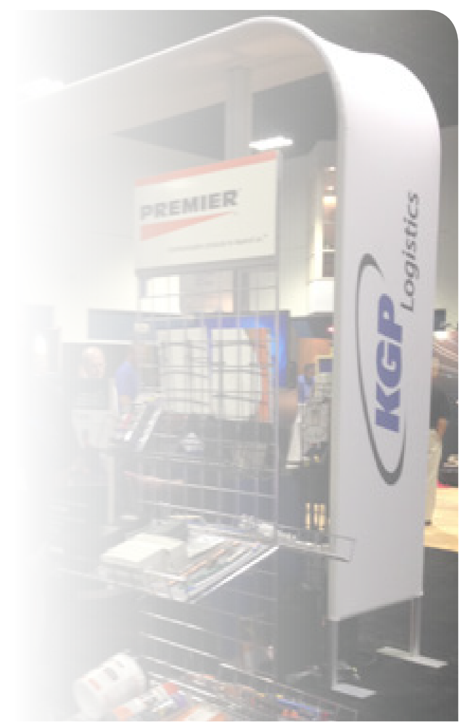
ACCESS™

Verizon IBTUF XI
January 22-25, 2017
Austin, TX

TechAdvantage 2017
February 27 - March 1, 2017
San Diego, CA

NATE Unite 2017
February 27 - March 2, 2017
Fort Worth, TX

FTTH - Fiber Connect 2017
June 12-14
Orlando, FL



For a complete list of upcoming events visit www.kgplogistics.com/events.html

Follow us on:

Facebook - https://www.facebook.com/KGPLogistics | Twitter - https://twitter.com/KGPLogistics | LinkedIn - http://www.linkedin.com/company/1004151

KGP Logistics is one of the country's largest single-source, value-added providers of supply chain services, communications equipment and integrated solutions to the telecommunications industry. We have a diverse and valued customer base, a national logistics network, and a portfolio of manufacturer partnerships that is second to none.

KGP Logistics • 3305 Hwy 60 West • Faribault, MN 55021
www.kgplogistics.com • 800-328-5142

KGP Logistics

www.kgplogistics.com