The SCOOP

AN EXCLUSIVE PUBLICATION
FOR ELECTRIC COOPERATIVES

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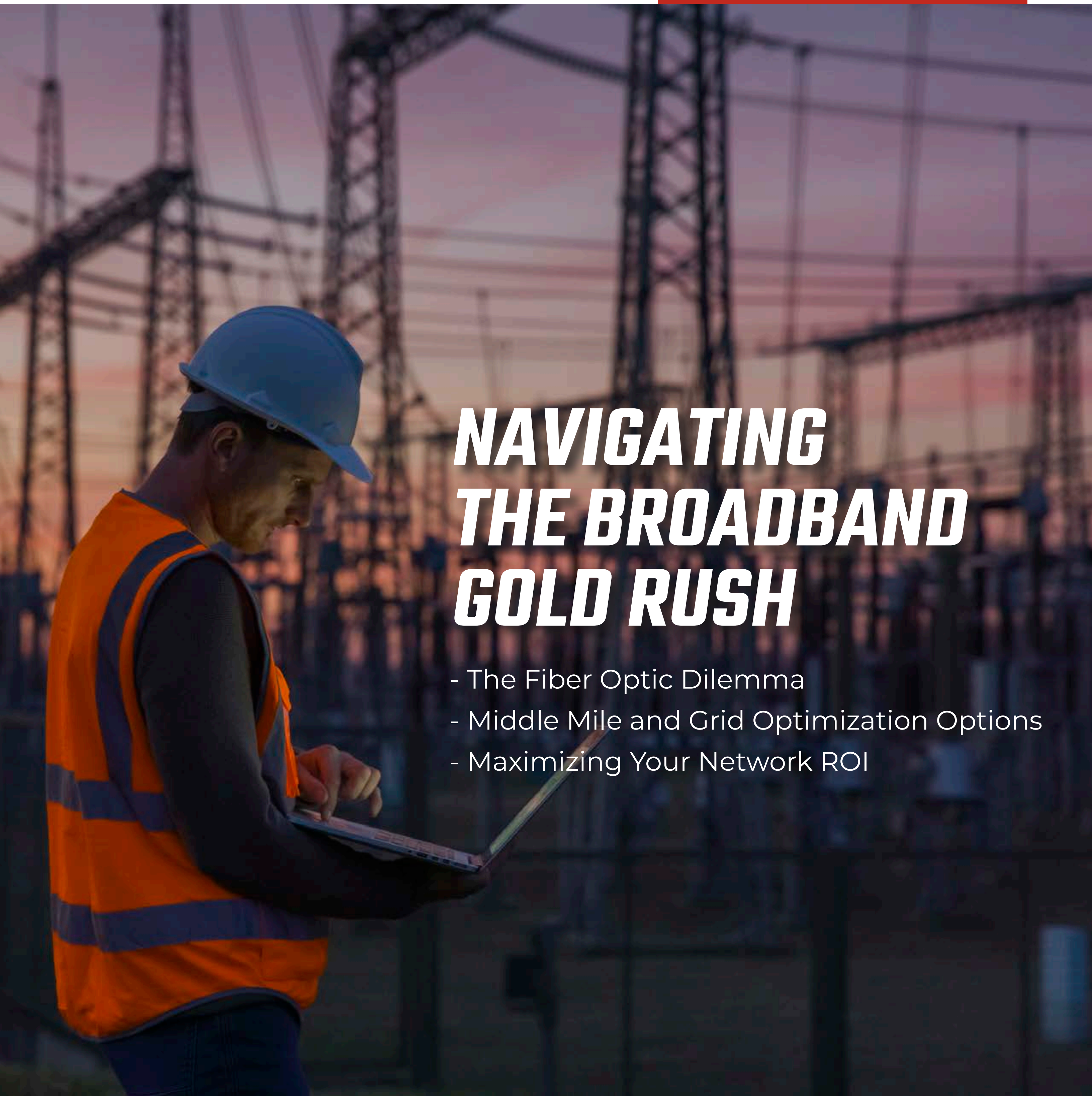

NAVIGATING THE BROADBAND GOLD RUSH

- The Fiber Optic Dilemma
- Middle Mile and Grid Optimization Options
- Maximizing Your Network ROI

WELCOME TO THE SCOOP!

Welcome to the inaugural issue of ***The SCOOP***, our new publication solely focused on the electric cooperative market. Our goal in creating ***The SCOOP*** is to bring together the electric cooperative, broadband, and manufacturing communities, and publish relevant information about products and issues impacting the market.

In our inaugural issue, you can read about the incredible federal funding opportunity available to electric cooperatives. You can also learn from some of our leading partners on new revenue streams, improving grid reliability, maximizing ROI, and future focusing your FTTH network. We hope you find the content is focused on helping you add value and purpose to your broadband goals.

We also felt it was important to compile this information 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.

IN THIS ISSUE

At Walker, Comstar Supply, Multicom, and USTC, 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 electric cooperatives to support their broadband plans and initiatives. We hope you enjoy our inaugural issue!

The SCOOP

ELECTRIC CO-OPS SHOULD ENGAGE NOW ON $42.5 BILLION BROADBAND PROGRAM

BY: CATHY CASH
Staff Writer, NRECA

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NRECA and RE Magazine, April 2022

The newest and largest federal effort to fund rural high-speed internet is getting ready to launch, and NRECA is encouraging electric cooperatives that offer broadband or are planning to do so to contact their state officials now.

The $1.2 trillion Infrastructure Investment and Jobs Act allocates $42.5 billion to the National Telecommunications and Information Administration to distribute a minimum of $100 million to each state participating in the Broadband Equity, Access and Deployment (BEAD) program to deploy internet to unserved or underserved communities.

NTIA on May 16 is expected to release a Notice of Funding Opportunity with rules for how states can disburse BEAD funds.

“As states await rules from NTIA on the program, co-ops in broadband should be engaging with state and local officials on broadband needs in their service territories and how they can be partners in connecting rural communities,” said Katie Culleton, NRECA legislative director.

“Electric co-ops have a long history of being excellent stewards of federal resources and should highlight that fact in their communications with state and BEAD program officials.”

States without a standing broadband office, or those that need to expand their current program, may request up to $5 million of their $100 million allocation to hire and train staff, do community outreach, perform research, upgrade technology and carry out other planning and pre-deployment tasks considered necessary by NTIA.

Disbursement of additional BEAD funds to states will rely on updated broadband data and service maps from the Federal Communications Commission. These maps, which may be available this fall, will show where the need for service is greatest. NRECA has been actively engaged with the FCC on efforts to improve the granularity and accuracy of broadband data and maps.

Deployment funds are expected to go toward connecting eligible homes, businesses and community anchor institutions. The money can also be used for data collection, broadband mapping and other activities approved by the NTIA administrator.

Population areas shown as unserved or underserved will be considered priority for financial aid.

BEAD defines unserved as lacking a minimum speed of 25/3 megabits per second for data download and upload and underserved as below 100/20 Mbps.

GROWING DEMAND FOR BROADBAND INTERNET IN RURAL AREAS CREATES NEW REVENUE STREAM FOR ELECTRIC COOPERATIVES

BY: ZYXEL COMMUNICATIONS

Energy-saving innovations such as LED lighting, smart home technology and energy-efficient appliances, along with the increased use of energy from renewable energy sources, has resulted in a decline in the use of electricity from electric utility companies nationwide. To address the need to generate revenue amidst the downward trend in electric consumption, electric cooperatives (co-ops) are increasingly capitalizing on the rapidly growing need for another type of service – broadband internet.

The COVID-19 pandemic has forever changed the ways in which people work and learn. According to a recent Gallup survey, 60 percent of respondents worked fully on-site in 2019, prior to the pandemic. In February 2022, the survey showed that only 19 percent of respondents worked fully on-site with 42 percent reporting that they work in a hybrid arrangement, and 39 percent working exclusively remote.

The ability to connect and interact remotely while under COVID-19 restrictions during the pandemic also brought telemedicine and even streaming church services into the mainstream. The growing demand for increased bandwidth and reliable internet connectivity among businesses and consumers will continue to create exciting new revenue opportunities for electric co-ops.

Electric co-ops often provide electric services to homes and businesses in rural areas that have few or no options for high-speed, broadband service. If broadband services are available in these areas, the consumers typically have to settle for connections using VDSL or coax, which can result in high latency and asymmetrical upload and download speeds. Poor video performance characterized by buffering and delays, can be disruptive to video conferencing for business, school and other applications.

For many electric co-ops, deployment of fiber to homes and businesses using their existing networks of electric poles, can make it relatively easy and economical to deliver broadband services to even the most remote customers. Some co-ops have found that their fiber deployments can also provide substantial value in the maintenance of the electrical grid. By connecting pole-mounted sensors to the fiber network infrastructure, some co-ops are applying advanced analytics to data received from the sensors to be able to identify shortcomings in the electrical power grid, enabling them to identify problems before they happen. These co-ops area also able to separate their SCADA for all stations and put it on a private network for added security.

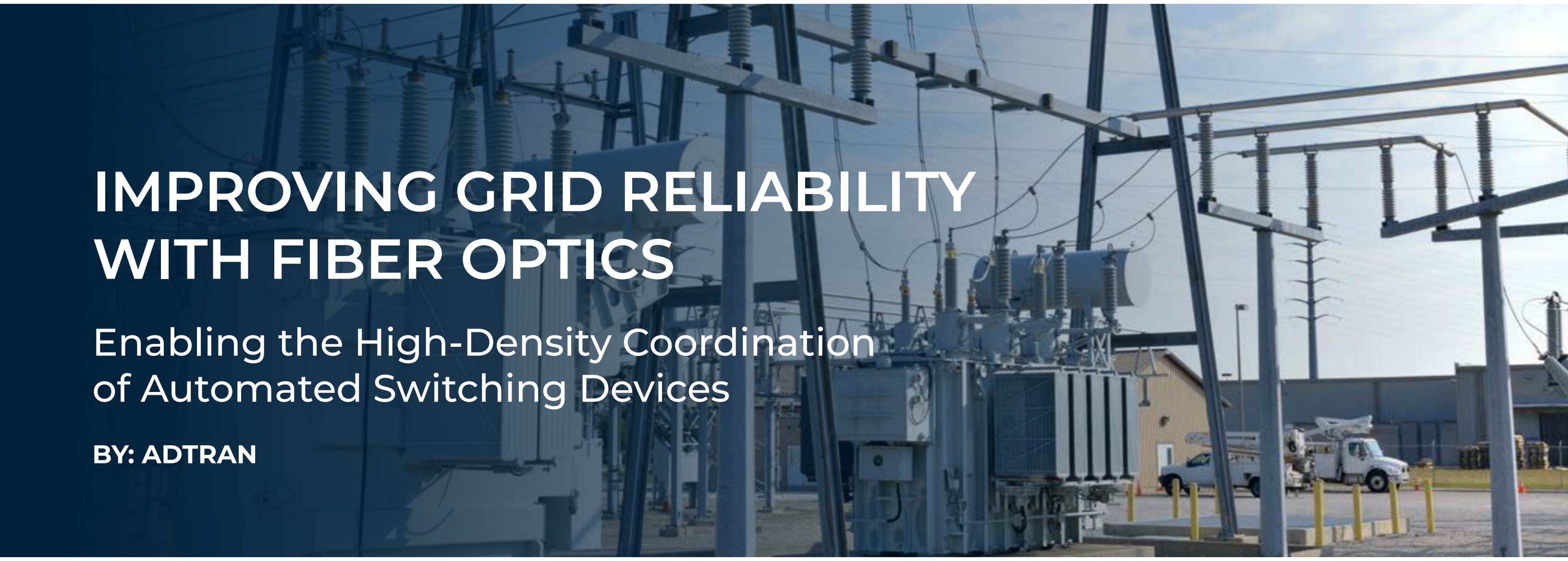
While the potential revenue generated by the deployment of fiber broadband services, and add-on content services such as digital video and telephone services, is an exciting proposition, there are significant challenges to a fiber roll-out. The service areas of many co-ops face intense competition from existing, well-known and established service providers, requiring the co-op to deliver service differentiation to overcome the mindshare and marketing resources owned by these providers. But perhaps the biggest challenge is the fact that while these co-ops have decades of expertise in the delivery of electric services, they often have no experience in telecommunications and have to quickly develop or acquire the expertise required to plan, deploy, manage, and maintain the new broadband services.

Of course, routing the fiber cable and installing the physical connection to the home or office is only the first part of the solution. The customer experience will be defined by speed, range, reliability, and manageability of the wireless network that enables the internet connectivity for a wide variety of devices including laptops, desktops, smartphones, smart TVs, smart appliances, gaming consoles, IoT devices, and more. The selection of the customer premises equipment (CPE) by the co-op can significantly impact the total customer experience. With some service providers reporting that as much as 70 percent of customers subscribe to whole-home WiFi services, the selection of the CPE is absolutely critical to maximizing the performance of high-bandwidth, internet-connected applications like video streaming, video conferencing and large file transfers.

Selection of the proper CPE to provide whole-home network access is critical not only for ensuring the delivery of a positive customer experience, but can also reduce tech support requirements and lower operating expenses for the co-op.

Whole-home WiFi solutions, such as Zyxel's WiFi 6-powered MPro Mesh solution, can provide reliable, high-speed WiFi connectivity throughout homes of all sizes, which is becoming especially important to enable and optimize the performance of a growing array of IoT devices including security cameras and smart appliances. Deploying solutions that support remote management, including standards-based TR-069 and TR-181 remote management protocols, enable the co-op to process configurations, upgrade software, run diagnostics, and provide management from the support center. Remote management enables the co-op to respond immediately to customer issues, increasing customer satisfaction, and reducing the need for truck rolls.

Perhaps just as important in the selection of the CPE solution is the pre- and post-deployment technical support that will be provided by the manufacturer. Having access to an always-available and highly-responsive engineering and technical support team from the equipment vendor can be invaluable to the co-op as they work to select and customize the ideal CPE solution that will deliver on the high expectations of an eager customer base.



IMPROVING GRID RELIABILITY WITH FIBER OPTICS

Enabling the High-Density Coordination of Automated Switching Devices

BY: ADTRAN

HIGHLIGHTS

Power Grid Management Requirements:

- Scalable Point-to-Multipoint Communication
- Enablement of High-Density Coordination
- High Reliability and Fault Resilience

Passive Optical Network (PON) Technology Attributes:

- Proven Point-to-Multipoint Fiber Optic Technology
- High Capacity, Low Latency Access
- Efficient Use of Fiber Optic Cabling

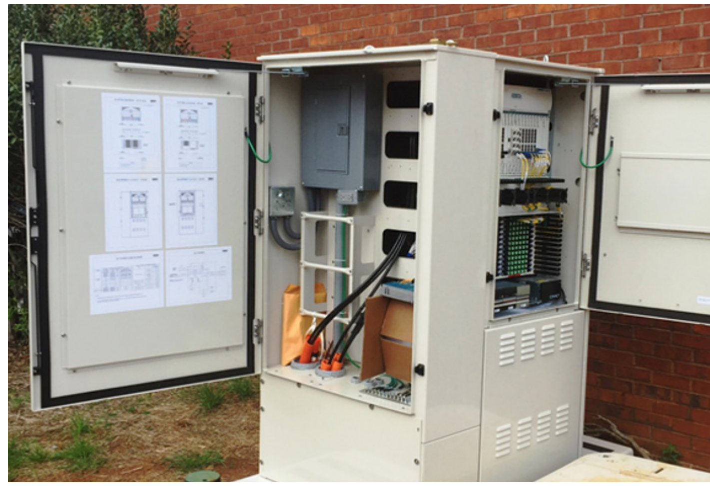
Growing Demands in Grid Management

Electric utility providers have a need to modernize their power distribution networks to increase the reliability, resiliency, and security of the power grid. Reducing the impact of a power fault is imperative. The power line fault must be quickly and accurately located to expedite repair and limit the affected area. To accomplish this, electric utilities have begun upgrading their communication networks by installing fiber alongside their distribution electric plants and leveraging passive optical network architectures.

Due to the real-time, low-latency communication needed to support high-density coordination, traditional recloser coordination methods are not effective; however, enhanced PON communication enables increased density of automated electrical switches which allows for more granular and accurate fault sensing, fault segmenting, and power redistribution via more elegant auto-transfer schemes. The combination of point-to-multipoint fiber access and high-density coordination results in a more reliable, resilient, and secure power distribution network.

Fiber Optics and PON Provide a Path Forward

With the complexity of the grid continually evolving, a robust communication backbone is essential to provide the reliability needed. Fiber access technologies continue to be the gold standard for point-to-multipoint access. By taking the highly proven, low latency fiber access network model and combining it with the speed and security of the Generic Object Oriented Substation Events (GOOSE) protocol and the reliability of a fully redundant communication architecture, electric utility providers have the opportunity to deliver high-density coordination of their power grid reclosers using GOOSE messaging.

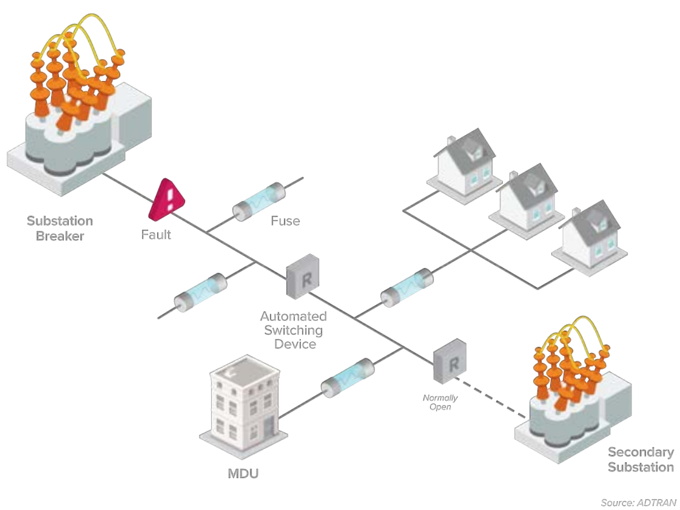


The Adtran Total Access 5000 fiber access platform installed within an environmentally hardened cabinet.

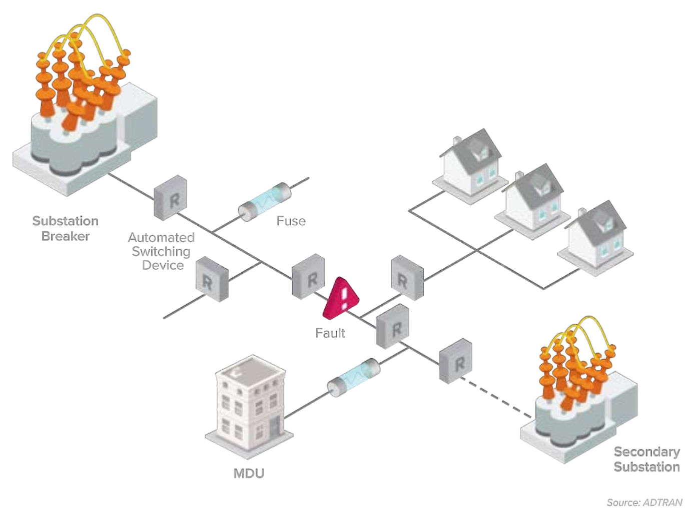
Total Access 5000 for Fiber Distribution

The Adtran Total Access 5000 (TA5000) is a fiber-access platform that has been deployed to improve the reliability and resiliency of power distribution networks. The TA5000 serves as the enhanced communication system for automated switching devices. It functions as a highly secure, high-speed, low-latency communication system that operates between power line reclosers without having to take the traffic through any equipment upstream of the OLT. It allows automated line switching devices to employ ultrafast, effective peer-to-peer coordination between switching devices via GOOSE messaging utilizing the 61850 communication protocol and enhanced high-speed wired Supervisory Control and Data Acquisition (SCADA) communication, which enables a larger and more scalable self-healing network.

As a modern fiber access platform, the TA5000 supports network redundancy via multiple methods to maintain a secure and reliable connection. The redundancy scheme supports dual-parented Type B PON redundancy, which provides redundant connections from one or more PON OLT systems to each recloser and SCADA device deployed. Combining this redundancy with a dual-path optical distribution network (ODN) architecture feeding each distribution device, electric utilities can protect the high-density coordination communication system from both an OLT equipment and a fiber optic facility failures.



Traditional recloser networks often leave many customers without power in the event of a power grid fault.

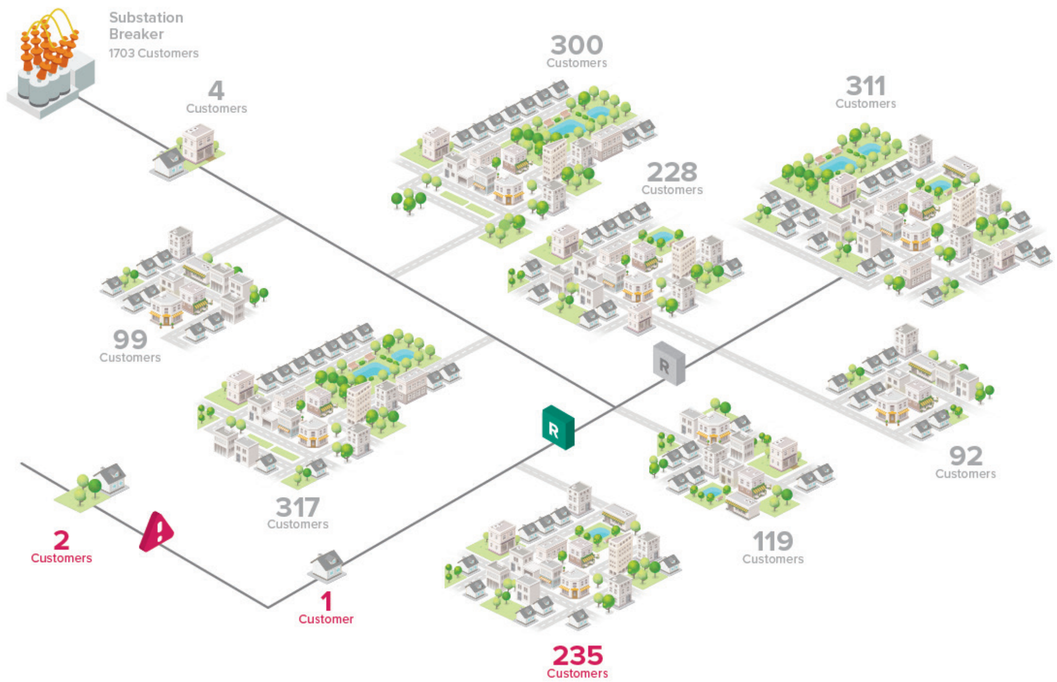


Modern recloser network using high-density coordination.

99% Reduction in Customer Minutes Interrupted (CMI)

To illustrate the case for PON management of a power grid fault event, consider a regional utility's pilot program of high-den-sity coordination of automated switching devices networked with point-to-multipoint fiber access. An outage lasting 402 minutes (6.7 hours) could have affected 237 customers under a traditional automated recloser network, resulting in a CMI of 95,274. However, due to the utility's use of an advanced automa-tion strategy underpinned by PON technology, the actual power line fault duration of 402 minutes affected only two customers resulting in a CMI of only 804 -- a reduction of greater than 99%.

R Normally Closed R Normally Open R Abnormally Open



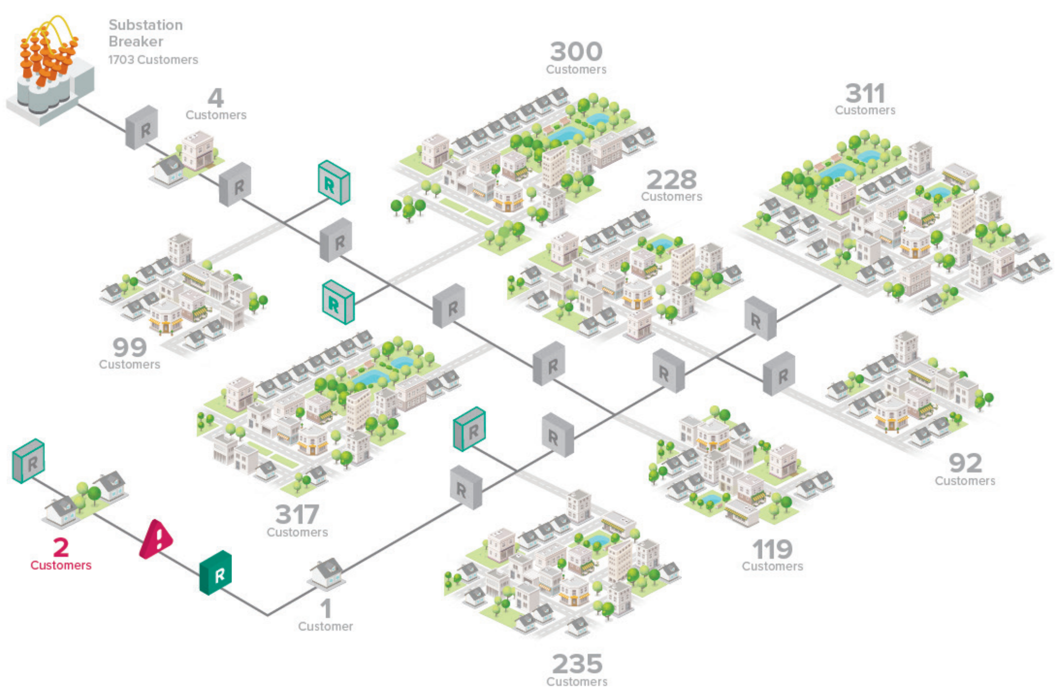
Pilot network PRIOR to high-density coordination

Assumed Duration: 402 Minutes

Customers Out: 238

Total CMIs: 95,274

Source: ADTRAN | ILL646-1C



Pilot network AFTER passive optical network deployment

Actual Duration: 402 Minutes

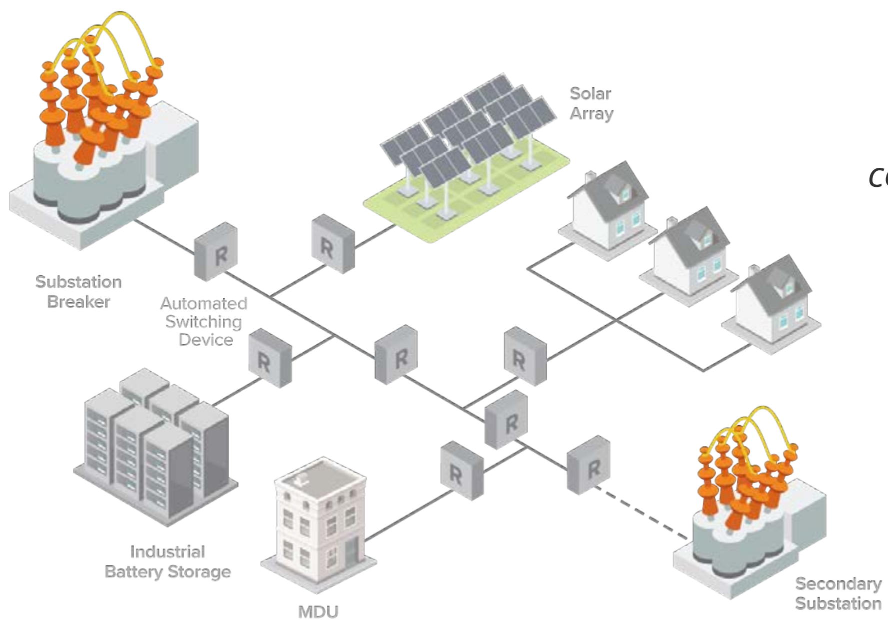
Customers Out: 2

Total CMIs: 804

Source: ADTRAN | ILL646-2C

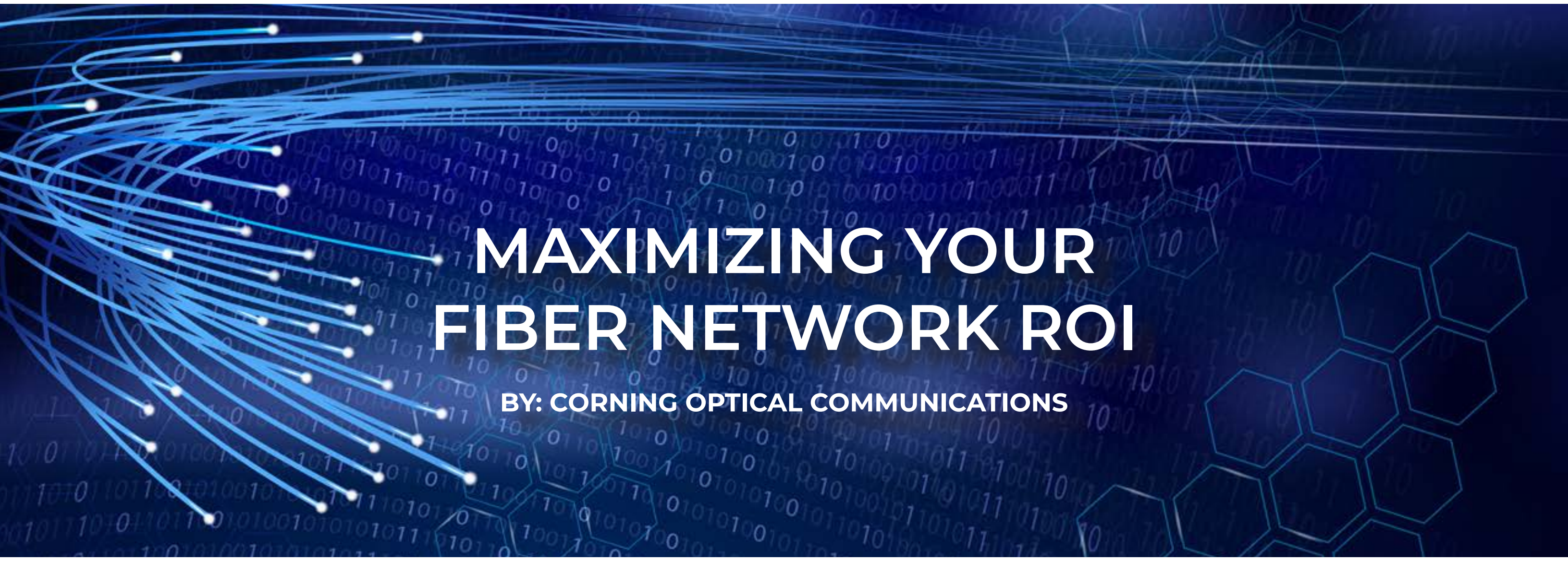
Extending Intelligent Data Collection Even Rurther

Scalable, cost-effective fiber access technology carries a host of other advantages. It can be leveraged to modernize automatic meter reading using next-generation advanced metering infrastructure, affording the network operator real-time, on-demand interrogation and data collection of metering endpoints. This will become increasingly import-ant as the power grid is asked to support emerging solar arrays, battery storage, electric vehicle applications, and power- and current-sensitive customer equipment.



Source: ADTRAN
ILL645-3B

"Electric utilities can protect the high-density coordination communication system from both OLT equipment and fiber optic facility failures."



MAXIMIZING YOUR FIBER NETWORK ROI

BY: CORNING OPTICAL COMMUNICATIONS

The questions about the critical nature and essential need for broadband everywhere have been answered. The COVID-19 pandemic has helped unify the call for universal broadband to ensure that no child, frontline worker, small business, or community is ever left behind without connectivity again.
In fact, many existing service providers have enacted free or low-cost connection options to support the radical shift to home-based learning, working, and telehealth. Although this article focuses on the financial bottom line, we acknowledge that many of you are choosing to do the right thing, even if it is counter to traditional financial goals.
The question going forward for communications service providers (CSPs) and communities is which long-term broadband network strategy ensures ubiquitous high-speed broadband is available to everyone.

Fiber broadband networks provide the best answer. No other technology matches fiber's ability to enable any bandwidth application, both now and in the future. All-fiber networks have proven their ability to scale over time and have a useful life well beyond comparable copper or wireless technologies. Before we delve into the levers one can pull to affect the ROI in total, CSPs may want to challenge their expectations with respect to the time to recoup their investment, given the lifespan of a fiber infrastructure. An underlying fiber broadband network empowers CSPs and communities to meet the challenge of bringing ultra-broadband capability for both fixed and mobile networks, leaving no one behind. Significant investment is required to achieve this goal. With proper planning, CSPs and communities can maximize the return on this investment, giving their customers and constituents the broadband network that best prepares them for whatever the future may hold.

Build it Once

As CSPs and communities plot their technology future for the next 50 years or more, a lot can be learned from the previous 50 years. A key lesson learned is to take the build-it-once approach. The last thing any CSP wants to do is make an investment in an underlying communications network, only to find out 3, 5, or 20 years later that a significant network investment is required to keep pace with innovation and customer demand.

Historically, networks were built in this way – one network was built, only to learn years later that an additional network infrastructure investment was necessary to meet the demands of different customer segments or evolving applications. The end result has often been multiple interconnected networks.

A patchwork of networks that may include copper or coax networks, feeding homes and small- to medium-size businesses (SMBs), complemented by fiber networks feeding large business/enterprise and wholesale customers. This patchwork is rounded out by mobile networks using a combination of wired and wireless transport solutions. The interconnected network or networks are incredibly complex and expensive to operate and maintain. We can do better.

Considering the total cost of a build is heavily influenced by installation labor, in some cases upwards of 60%, building a network that requires little to no new outside plant construction after initial build to expand or upgrade will minimize the total cost of ownership. To realize a better ROI, implementing a strategy to build one underlying fiber broadband network enabling various applications is prudent. As fiber technologies advance throughout, think XGS-PON or NG-PON2, the fiber infrastructure they ride on largely remains unchanged. Building an all-fiber network gives CSPs the ability to converge customer demands – residential, SMB, enterprise/wholesale, and mobile – on a single unified network. Revenue models multiply as a result, delivering an enhanced ROI.

The build-it-once approach also extends to mobile demand and smart cities. If communities want to ensure they participate in a 5G future, an underlying fiber-rich network is not just desirable, it's required. Fiber-fed small cells will power both 5G and Wi-Fi, making a wireless ultra-broadband experience possible. Tangentially, the thousands, or even millions, of sensors needed to deliver on the promise of the smart city will need fiber connectivity to function properly.

The choice is clear – one network foundation for whatever the future holds. Build it once and leverage it several times over. Whether it's utilizing wave-division multiplexing (WDM) on an optical transport network (OTN) segment for 5G transport or employing NG-PON2 to meet increasing residential, SMB, or enterprise demands, CSPs can truly maximize their revenue opportunity from a foundational fiber-based network.

Verizon outlined this very approach with its One Fiber program. Several years ago, Verizon embarked on building one fiber infrastructure that would serve all its technology needs. Launched in 2016, the program currently reaches 60 major U.S. cities. According to one report, it involves deploying 1,000 miles of fiber and spending as much as $30 million per month.[1]

Verizon's Fiber One strategy includes laying up to 1,728-count fiber strands as well as never lower than 864-count fiber strands on major routes. Although their decisions on fiber counts may not be practical for every CSP or in certain rural applications, the underlying strategy of build it once to maximize the return is sound.

Key ROI Factors

As CSPs embrace a fiber broadband strategy, there are several factors that can improve ROI. Among all key strategies, noteworthy options include leveraging existing network assets and considering all network design options. If minimizing CapEx is a primary concern, considering "lean fiber" architectures may also be an option to explore.

Leveraging Existing Network Assets

Today's modern CSP consists of a very diverse group of providers. Ranging from traditional TELCOs and cable companies, to electric cooperatives and municipalities, and even the communities themselves, these providers all have a common goal of bringing the best broadband possible to the marketplace. Regardless of type, all CSPs share a common characteristic – existing network assets that can be leveraged for fiber network builds.

Traditional TELCOs and cable companies have obvious network assets that they've learned to leverage for decades. These assets allow long-standing CSPs to bring fiber deeper into their networks, with fiber-to-the-premise (FTTP) networks now flourishing across the country. Newer CSP entrants, such as electric cooperatives and municipalities, are fortunate to have similar network assets that traditionally were used for delivering electricity. Those same assets can be easily repurposed for a fiber network. These assets go beyond the obvious poles and rights-of-way infrastructure critical to a fiber build, to include assets like huts, substations, towers, trucks, and technicians. Technology enhancements that shrink fiber terminals and drops may allow existing handholes or pedestals to be leveraged, reducing upfront costs even further.

Electric cooperatives have been particularly adept at leveraging these assets for fiber networks. A recent study by the National Rural Electric Cooperative Association (NRECA) highlighted that fiber was the overwhelming technology of choice for cooperatives who have moved into broadband.[2] The NRECA cites the amount of fiber investment made by electric cooperatives in just the last few years as "remarkable." Indeed, electric utilities, be they cooperatives or municipalities, have extensive network assets that can contribute to a better ROI for their fiber network builds.

Fiber Network Design Strategies

Important decisions made during the design phase have lasting implications for fiber network ROI. Upfront planning is necessary to maximize future revenue opportunities. That includes ensuring fiber network designs anticipate economic or real estate expansions, dark fiber demand, or other unforeseen opportunities. This is of particular interest for those who are pursuing funding through the FCC's Rural Digital Opportunity Fund (RDOF) or USDA's ReConnect program, both of which can augment investments in fiber broadband builds.

Funding programs target specific unserved and underserved territories, but through proper design and planning, CSPs can build networks that are conducive to future expansion into neighboring markets, creating additional revenue opportunities and contributing to a better ROI.

Additionally, if smart city or 5G-capable future is a part of the vision, network designs should consider higher fiber counts than what current conditions may indicate. More fiber capacity from the beginning creates potential for dark fiber leasing and other wholesale opportunities, as well as for taking advantage of unforeseen future demand to generate additional revenue opportunities. Fiber is unique in this regard because it's the underlying infrastructure that best enables expansion to address market opportunities that may present themselves. Designing a network with these factors in mind is critical for maximizing fiber broadband ROI.

Lean Fiber Architecture

For certain CSPs serving remote and very rural territories, turning to a lean fiber architecture strategy can positively impact a fiber network ROI by lowering upfront CapEx and splice labor during construction. A lean fiber strategy relies on distributed split architectures, also referred to as distributed split or optical tap. This approach puts less fiber facilities in the network, while still providing FTTP services. Ideally, all CSPs would follow a more fiber-rich home-run or centralized split architecture, both of which offer a high degree of flexibility, bandwidth capacity, and room for future network expansion. But these also require higher levels of upfront CapEx, which can be a drag on fiber network ROI – particularly in lower-density markets.

Adopting distributed split or optical tap architectures lessens feeder and distribution fiber cable requirements, thus lowering fiber management material and fiber splicing construction costs. This can improve the ROI calculations for less dense markets. However, the trade-off of these leaner architecture options limits bandwidth flexibility to discrete locations and future expansion as a result. This approach should be used in service areas where significant expansion and growth are not expected. Adding capacity for business or enterprise growth, or 5G small cells, or a new housing development, could require an expensive network overbuild.

The lean fiber approach can make sense in certain applications. Some of the downside risk can be mitigated by using a higher-capacity main distribution fiber cable that serves as surplus dark fiber. This approach takes advantage of the lower-cost lean architecture strategy, while including additional capacity in the network for future growth.

The Best ROI Path

Any good broadband business strategy should aim to utilize an underlying technology that can best enable any and all applications, regardless of bandwidth demand or latency requirement. That capability gives CSPs an ROI advantage. It allows them to maximize their revenue opportunity. This is where fiber broadband excels. No other technology can more easily handle the bandwidth and latency requirements of not only today's applications, but tomorrow's as well.

With proper planning and a build-it-once vision, CSPs are not only positioning their companies and the communities they serve for the next 50 years, they are also maximizing their ROI opportunity. By embracing some of the strategies outlined above, the investment in the network yields returns well beyond what can be found on a balance sheet.

[1] The Story Behind Verizon's 5G Secret Weapon. https://www.lightreading.com/mobile/5g/the-story-behindverizons-5g-secret-weapon/d/d-id/752625

[2] Electric Cooperatives Bring High-Speed Communications to Underserved Areas. https://www.cooperative.com/programs-services/bts/Documents/Reports/Report-Broadband-Case-Studies-Summary-Updated-Feb-2020.pdf

ACCELERATE THE PROCESS TO ENABLE BROADBAND ACCESS

BY: JUNIPER NETWORKS

The United States is on a mission to ensure that everyone has access to one of the most significant resources in today's environment—the Internet. Under the latest federal program, H.R.3684—Infrastructure Investment and Jobs Act, the funds supporting this mission have reached an unprecedented level.

This expansive funding program that reaches every corner of the U.S. will motivate most states to have a broadband office, task force, and agency to manage the process of distributing broadband funds to eligible municipal applicants. How you take control now to better prepare and accelerate the application process will shape the future. But how do you get there? The answer is simple. Get information now from trusted advisors.

Since 1996, Juniper Networks has been an industry leader — delivering equipment, providing guidance, and establishing relationships to power the Internet. Fast forward to 2022, and we are still at the forefront. As the Internet has expanded, scaled, and evolved, we have found ways to power and connect everything. Juniper has a deep understanding of the various broadband delivery models for municipalities.

Beyond public and private, other delivery models can mitigate operational risk, split asset ownership, and drive open access. Innovative broadband architectures that leverage distributed, cloudified, disaggregated, and converged models are emerging.

MUNICIPAL BROADBAND DELIVERY MODELS

Public—Own and Operate

- Use broadband as a stimulus for economic development
- Maximize citizen engagement
- Leverage public utility assets for last mile

Private—Own and Operate

- Used in states where regulations prohibit public broadband

Public-Private Model

HOW JUNIPER IS YOUR TRUSTED ADVISOR

Whether you are a state, county, city, or a private company that provides Internet services, you cannot afford to tackle this broadband effort without support and focused partnerships (i.e., consultants, managed service providers, systems integrators and value-added resellers). And your partners must have the experience and ability to create a successful outcome.

Let Juniper help accelerate your municipal broadband initiative by leveraging our ecosystem partnerships and decades of expertise to provide valuable insights on the entire broadband life cycle—including assessment, outside plant build, selecting the best technology architecture, implementation, testing, management, and ongoing automation for optimization.

We encourage you to take advantage of these government programs with success blueprints from Juniper that will power and optimize any delivery model.

WHY JUNIPER'S DISTRIBUTED BROADBAND ACCESS?

Enabling Broadband Network Transformation

Subscriber Experience

Improve latency and performance

Network Scalability

Scale out incrementally with services demand

Simplified Operations

Reduce failure domains for simplified operations and improved citizen experience

Cost Optimization

30% cost optimization in architecture, power and space requirements for better TCO

HOW TO RIGHT-SIZE YOUR MIDDLE-MILE NETWORK FOR RURAL BROADBAND GROWTH

BY: MITCH SIMCOE
Director of Global Consulting, Ciena

Ciena's Mitch Simcoe explains all the factors that you need to consider when designing your middle-mile network for rural broadband.

Have you ever purchased something where you didn't plan and anticipate your future needs correctly and you ended up needing to replace it with something larger, something that can scale with greater capacity to meet your needs? Something that leaves you with a nagging feeling, that if you had just planned better from the start it would have saved you a lot of time, money and aggravation?

For example, my son recently graduated from college and the first car he went and bought was a 2-seater red convertible with a trunk that can barely hold a suitcase. Now he wants to go mountain biking and kayaking on the weekend and realized he will need to upgrade to a truck and will reluctantly have to sell the sports car.

Well, it is not hard to fall into the same trap when it comes to planning for a Middle-Mile Network for Rural Broadband. Middle-mile networks are typically fiber rings that aggregate the traffic from service provider central offices or utility substations that connect residential customers in rural areas as shown in Figure 1. Whether it's utility co-ops, regional service providers or municipalities, all need to plan for future broadband demand on these middle-mile networks. As we have seen during the pandemic, people living in rural areas have welcomed the opportunity to work from home; they shop, consume entertainment, and access advanced education services and critical healthcare data online. The COVID-19 pandemic has only accelerated these trends: elevating high-speed reliable broadband from a "nice to have" service to an essential one, just like water or electricity.

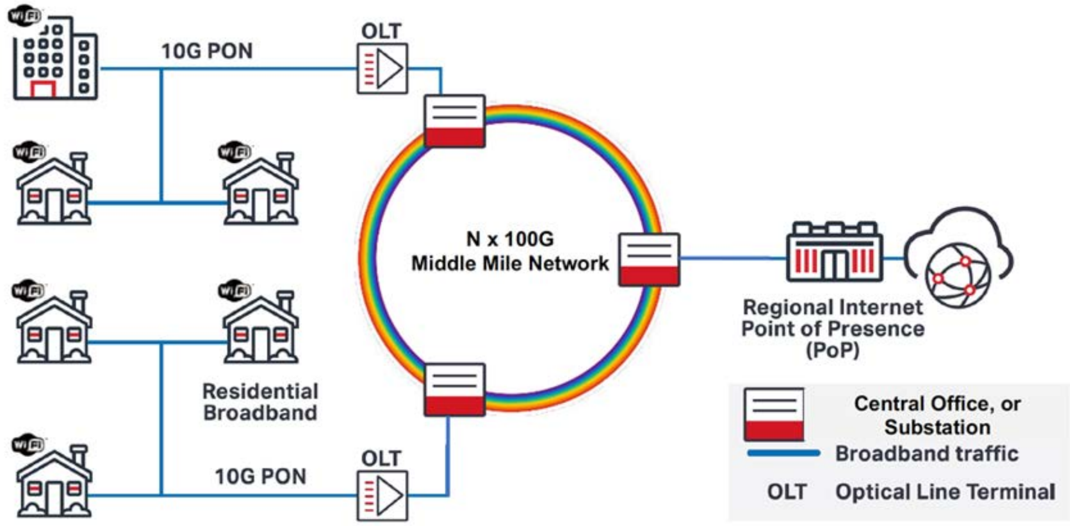


Figure 1: Middle-Mile Network Architecture

Now how should regional service providers and utilities (let's say operators for short) plan for their Middle-Mile? Well, 100G is considered the new bandwidth currency for the Middle-Mile. But is 100G sufficient for this digital future? Some access equipment vendors whose platforms are limited to 100GE Middle-Mile backhaul capacity would argue that it's right sized for future growth. But operators need to look at the factors driving broadband capacity both today and in the near future to come up with an accurate model to plan for their Middle-Mile networks.

Here are some of the key factors that operators need to consider in a model to plan for scalability in their Middle-Mile networks:

1. Broadband Customer Penetration

When operators launch a new broadband service into a community, they won't typically acquire all their potential market in the first year. Broadband penetration will grow based on how many homes are passed by fiber or fixed wireless and this will likely occur in phases as new broadband customers sign-up for service. Since rural broadband is typically being rolled up in unserved communities with no existing broadband offering in service and pent-up demand, penetration rates will likely rise faster than in urban areas. One utility co-op in Alabama recently provided me an example of pent-up demand for broadband; where an installer putting in a new broadband service for a customer was upgrading from 3 Mbps copper DSL to a 900 Mbps fiber service; and the customer was literally in tears once she saw the difference in performance!

2. Application-Specific Bandwidth Drivers

During the pandemic, consumers hunkered down to consume video content at home versus visiting their local movie theater and they started doing video calls, whether personal or for work. As a result, the biggest driver for traffic growth has been streaming video content.

Today, Netflix, Disney+, Amazon Prime, and YouTube are the leading online video services. Most of the streaming content is in high definition at 720p, 1080i and 1080p resolutions. The greatest growth however is at 4K resolutions. When we looked at this in 2014, 4K was still in its infancy both in the penetration of 4K TVs sets and the amount of 4K content. Yet today in 2021, the penetration rate of 4K TVs is 44% in the US (Source: Statista) and with this users can stream all the content from Disney+ and Amazon Prime in 4K resolution, as well as a significant amount of Netflix's content (if they subscribe to their top tier package). Analysts predict that the percentage of content streamed in 4K will continue to increase substantially as 4K becomes the de facto standard for streaming.

Newer services, still in their infancy today, promise to take the demand even further. That is the case of 8K-resolution video and cloud gaming. Cloud gaming services such as Google Stadia, Microsoft xCloud and Playstation Now offer users the ability to stream their games from the cloud with no need of a gaming console. The amount of bandwidth required for cloud gaming is effectively the same as streaming 4K content, requiring better network performance.

3. The number of devices consuming broadband in the home

While a single 4K TV can consume 30 Mbps of a broadband connection, what matters for Middle-Mile sizing is how many devices are consuming broadband simultaneously in the peak hour, typically the evenings from 8pm to 11pm. An advanced household could have a single 4K TV, an HD TV, a dongle or gaming console consuming cloud gaming (equivalent to a 4K TV) and some mobile devices on WiFi such as iPads and smartphones. A Middle-Mile bandwidth sizing model must estimate the average number of such devices to assess the effective average broadband demand per household.

4. How hot does an operator want to run their Middle-Mile network?

When an operator engineers their network, they need to maintain a certain buffer capacity to allow for special events where a higher than typical number of their subscribers will be streaming video at the same time. This could be sporting events like the World Series, Super Bowl, or the Olympics. This will drive demand beyond typical usage, so operators need to engineer in excess capacity for these situations. How much of a buffer is up to each individual operator – it is directly linked with the user experience they are committed to deliver - typically operators engineer aggregation capacity so that average demand results in no more than 75% utilization, to accommodate the additional strain of these occasional events.

So, what is the impact of these factors combined on the sizing of a Middle-Mile network? Well, we commissioned analyst firm ACG Research to create a bandwidth sizing model for Middle-Mile networks for rural broadband to help us model it. You can download the white paper on their findings here.

ACG created a base model using a network with 20,000 households which is considered the average for rural America. They used a rural penetration rate growing from 25% to 60% over 5 years (#1 above), a network engineered to 75% of capacity (#4 above); leaving 25% as a buffer. Assumptions for items two and three are included in the white paper.

The white paper uses an approach called the Average Household Data Rate. This is an average data rate in the peak hour per household that the operator can use to multiply against the number of broadband households served to estimate the required average aggregate bandwidth needed in the Middle-Mile network.

The result shown in Figure 2 provides both the Aggregate Middle-Mile capacity (Gbps) and Required Middle-Mile capacity (Gbps) for the Middle-Mile network.

	2021	2022	2023	2024	2025	CAGR
Average Household Data Rate (Mbps)	12.9	14.2	15.7	17.7	20.1	12%
Aggregate Middle-Mile BW (Gbps)	64	99	142	195	241	39%
Required Middle-Mile Capacity (Gbps)	100	200	200	300	400	32%

Figure 2: Middle-Mile Network Capacity Requirements

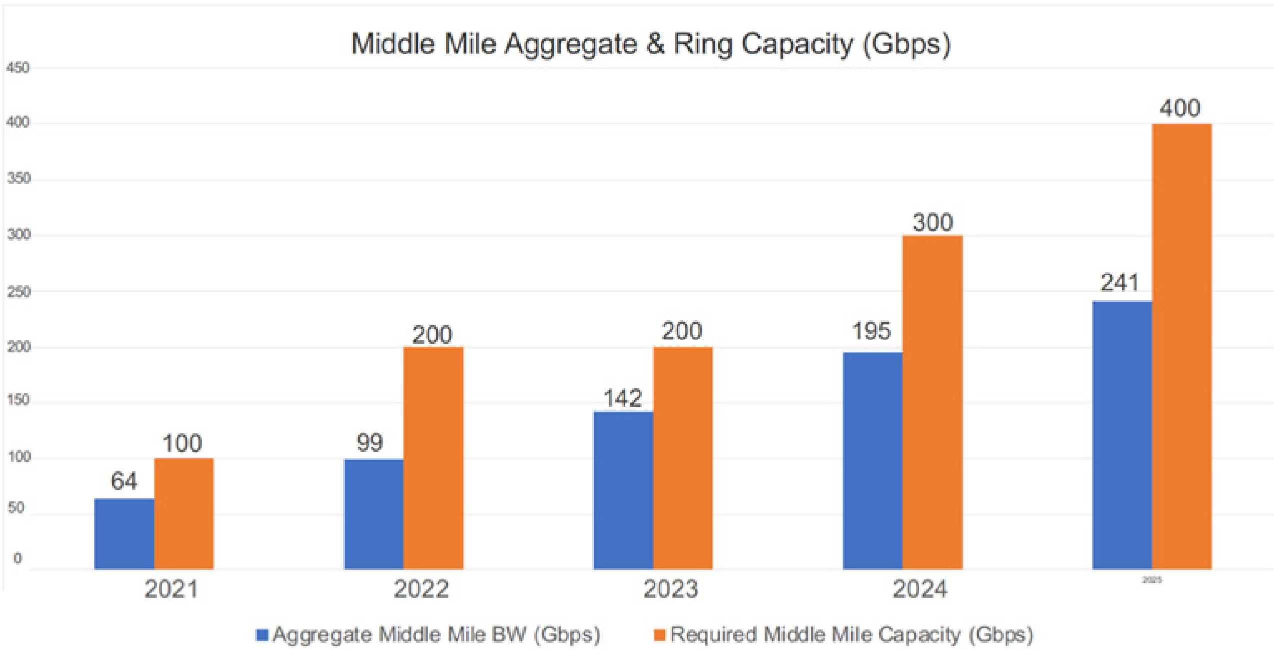


Figure 3: Middle-Mile Network Capacity Requirements

The bottom line shown in Figure 3 is that 100 Gbps is the bare minimum to keep up with bandwidth demand even for a rural network of 20,000 households. This projection shows that up to a 400 Gbps Middle-Mile ring will be required at the end of year 5. Bottom line, this proves that operators need to plan for a dedicated Middle-Mile network that can scale to support N x 100 Gbps of capacity in just a couple of years.

Ciena's Middle-Mile Network Solution

With Ciena's Routing and Switching platforms, which deliver best-in-class Middle-Mile universal aggregation, Ciena enables operators to build a scalable N x 100 Gb/s Middle-Mile backbone for internet broadband traffic in a converged solution. Ciena platforms can scale to enable operators to add broadband customers and increase bandwidth utilization per household. Ciena's N x 100 Gb/s Middle-Mile network means that broadband customers can have faith in the performance of their subscribed services and know that they have the bandwidth to simultaneously satisfy all their streaming, work-from-home, remote education, smart home, and remote healthcare needs—well into the future.

So back to our original premise of planning a Middle-Mile network to anticipate future demand. Like my son who thought it would be cool to get a convertible, had he anticipated his future needs to be able to carry his mountain bike and kayak, he would have opted for the truck or SUV – and saved himself the hassle and cost of having to upgrade his vehicle so quickly.

We want to ensure that regional service providers and utilities have the required tools to plan their Middle-Mile networks to anticipate their future growth as well and consider the best-in-class platforms for this use-case.

RURAL FIBER DISTRIBUTION TAP ARCHITECTURE

BY: COMMSCOPE

A more efficient approach for deploying a future-focused FTTH network

Bringing broadband service to rural and underserved exurban areas can pose unique challenges to providers. Deployments must cover great distances to reach just a few homes. Rural areas have higher costs per home passed, and require high subscriber take rates to make fiber deployments economically possible. Providers must invest heavily in equipment and labor, so solutions that can reduce expenditures in either of those key categories can make the difference between economic success or failure. This article will explore the tap network architecture option to create or expand rural fiber-to-the-home (FTTH) networks.

Fiber-Optic Taps

In a tap FTTH network architecture, a fiber cable is deployed throughout a service area, and fiber-optic taps divert optical signals to subscribers. It's a simple process: the cable is opened, and one of the fibers inside is carefully cut. A fiber-optic tap is spliced into the line, which siphons off a portion of the signal for a subscriber. The tap allows the signal to continue down the line to the next home or business, where the process is repeated. Multiple taps can be spliced onto the line until the signal is exhausted—usually at 32 subscribers. At this point another fiber in the cable is cut, and the process continues.

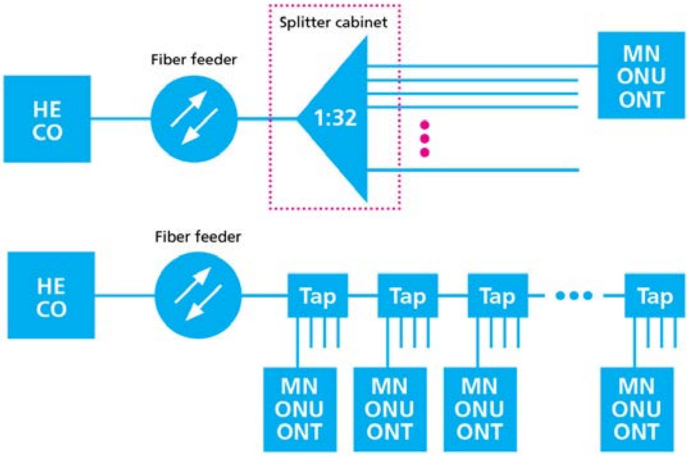


Figure A: A traditional, centralized, FTTH network architecture (top) compared to a distributed TAP network architecture (below)

A tap network design is quite different from the design of a traditional "centralized" FTTH network, which typically uses splitters installed in a cabinet configuration to distribute data to subscribers. In this splitter-based architecture, a fiberoptic feeder line runs from the central office or head-end location to a cabinet in the street or service area. The feeder line terminates on an optical splitter in the cabinet, which distributes the signal to subscribers with additional fibers. This hub-and-spoke design gives providers great flexibility, as the cabinets allow easy management of both fiber connections and central office equipment, and can also be in proximity to remote central office equipment.

Difficult Topography

Of course, network architecture is a crucial decision for providers embarking on rural installations. These deployments can cover great distances of sparsely-populated terrain, with just three or four homes per kilometer. Land can be mountainous, forested, or desert, with little existing infrastructure. Providers need solutions with design simplicity, to keep labor and equipment costs as low as possible.

Figure B: Rural terrain with little existing infrastructure

Equipment Savings

The biggest difference between tap network and splitter-based architectures is cabling requirements. For a deployment serving 256 subscribers, the minimum number of fibers required in the splitter-based architecture is 256. These 256 fibers run in several smaller cables from the equipment cabinet. The cabinet is necessary to house the eight 1x32 splitter components, which route optical signals to subscribers, as well as permit fiber access. For many rural deployments, splitter-based architecture is considerably more expensive, as it requires the use of much more fiber cable and distribution equipment.

Tap Architecture Key Benefits:

- Equipment savings
- Labor savings
- More efficient to deploy
- Easier to maintain
- Easy future expansion

Figure C: 1x32 splitter

In comparison, for a 256-subscriber deployment, tap architecture needs a minimum of eight fibers. Two four-fiber cables are run directly into the serving area, without the need of a cabinet to house splitters and connections. Cable savings would depend upon the length of the runs to the actual drop points; but, since four-fiber cable costs much less than 72-fiber cable, savings could easily run to thousands of dollars.
With tap architecture, providers have seen large reductions in the number of optical fibers used in a deployment—some as large as 87 percent. Tapped architecture also avoids the need for an equipment cabinet, splitters, mounting pad, and cabinet installation labor.

Figure D: FDH 3000 cabinet

Taper Splicing

A common practice in a splitter-based approach is for a 72-fiber cable to be initially used in the serving area. Once 24 of the fibers are used, it's cost effective to splice the larger cable to a smaller 48-fiber cable. This is called "taper-splicing." Here, tap architecture enjoys another cost savings. Because the commonly-used four-fiber cable is so small, it does not need to be taper spliced. Tap architecture eliminates the cost of splicing the larger fiber cable to the smaller fiber cable, as well as the cost to install a splice closure. An additional management benefit: an operator need only stock a single distribution fiber cable type, as they can use the same four-fiber cable throughout the serving area.

Labor Savings

Tap architecture commonly uses four-fiber cables, compared to the 72- or 48-fiber cables used in splitter architecture, which creates considerable savings in splicing and material labor. The number of splices required is further reduced because tap architecture requires no splitters at the entrance to the service area. In a typical tap deployment, just two splices will be necessary for each two to eight homes: one for the input to the module, and one for the through-leg. This compares to as many as 72 splices required with a centralized architecture.

Works with Plug-and-Play Equipment

Operators can further reduce the need for splicing by using an optical terminal enclosure, or OTE, equipped with preconnectorized adapters. These fiber enclosures eliminate the need for drop cable splices, as technicians can simply plug preterminated drop cables into ports on the outside of the terminal. Because splices at residences and businesses are eliminated, this type of OTE will save even more labor time.

Figure E: Mini-OTE 300 with eight-port taps

Figure F: FOSC 450 with TAP Trays

Splice Mapping

In most deployments, a special map must be produced to chart splice input and output locations, and to indicate which fibers are connected. This is especially true with a splitter-based architecture, as technicians need to keep careful track of which fibers are joined when working with 72-fiber cables. This information must also be created for each taper and branch point in the distribution network, as well as for splitters in serving area cabinets. Splice maps can add significant cost to system designs, as a typical service area could have hundreds of splices, and maps must be maintained and updated to show any field or customer changes.

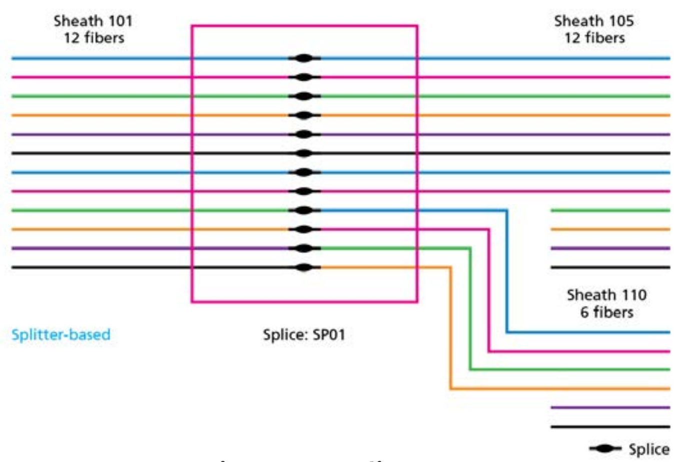


Figure G: Splice map

In tap architecture, no splice map is needed, as only a single fiber is used on each run, and the indication of which fiber is spliced is readily done on the standard design map. This simplicity helps avoid both expensive connection errors and the production time for the splice map.

Deployment Efficiencies

The high fiber-count cables used in traditional centralized architecture deployments are considerably larger than the four-fiber cables used in tap architecture. For technicians on a tap deployment, a smaller cable allows more cable to be wound onto truck reels, which further reduces the number of splices they must make when they reach the end of a reel of cable. Deploying smaller cable creates additional efficiencies, as technicians save time because fiber closures and other equipment can be smaller; and, if they must dig hand holes, they can be smaller.

Rural electric co-ops have often deployed tap architecture networks, because they already have considerable infrastructure in place. Additionally, electric co-ops often find deployment efficiencies with tap network architecture, as there are many similarities to electrical system deployments.

Maintenance Efficiencies

Troubleshooting is efficient in tap architecture, as technicians can easily check connections through fiber-optic taps with an optical time domain reflectometer, or OTDR. In splitter architecture, the OTDR signal can't pass through the distributed splitters, making it more difficult to check connections.

Future Expansion

Some operators believe that, compared to splitter architecture, tap architecture networks are difficult to expand. While it's true tap systems are often designed with minimal fiber use, to save as much upfront cost as possible, designers can use a 1:2 split at launch to increase optic use efficiency. If expansion is required later, this 1:2 split can be removed to add capacity, and additional fiber-optic taps added to change to a higher port count. And, in another expansion strategy, many operators purchase dark fibers along with the initial four-fiber cables, as the economics are best with a full buffer tube of 12 fibers. The cable size doesn't change, and the additional dark fibers provide the highest utility of all solutions, with each fiber good for another 32 homes.

Tap network architecture - simplified design with less cable, less equipment, and less splicing means faster installations at lower cost:

- Fewer fiber cables required
- Design simplicity—one type of small fiber count cable can be used
- Less splicing required, saving skilled labor
- No need for complicated splice maps
- Large equipment savings—distribution cabinets and splitters generally not needed

Summary

While several fiber architectures have been developed to support FTTH deployments, tap network architecture is optimal for rural broadband networks. A major benefit of this design is the significant reduction in fiber required to serve a rural area. With the long distances typically involved in rural FTTH deployments, this reduction in fiber count can dramatically reduce up-front network costs, and allow providers to serve areas where deploying a fiber-optic network would have been cost-prohibitive.

BETTER TIMES FOR SMART GRIDS

Mastering synchronization challenges in energy networks

BY: ADVA

From one-way energy distribution to the intelligent power grid

The way energy is generated and distributed is changing. As today's large power plants are boosted by multiple sources of energy generation from wind farms to small-scale private solar-power panels, traditional operational strategies require a major rethink. To support these changes, the one-way distribution network needs to evolve into an intelligent power grid. All active sites must be integrated into the operational control system, and sub-stations will become essential monitoring and control points. For secure and reliable operation of the power grid, we need a real-time assessment of its health and immediate notification in the event of problems. What's more, measurements need to be precisely timestamped to enable accurate analysis of network status and fast localization of any fault.

Timing at a substation

Timing at substations has historically been provided by dedicated timing systems that use separate cabling and specific protocols such as IRIG-B. Such time code protocols deliver time information from a local clock, which physically connects with each intelligent electronic device (IED). The time is coded as a digital data stream frequently supported by a 1-PPS signal for precise alignment of the time code information. In many cases, the Global Navigation Satellite System (GNSS) is used for synchronizing the local time to a global reference.

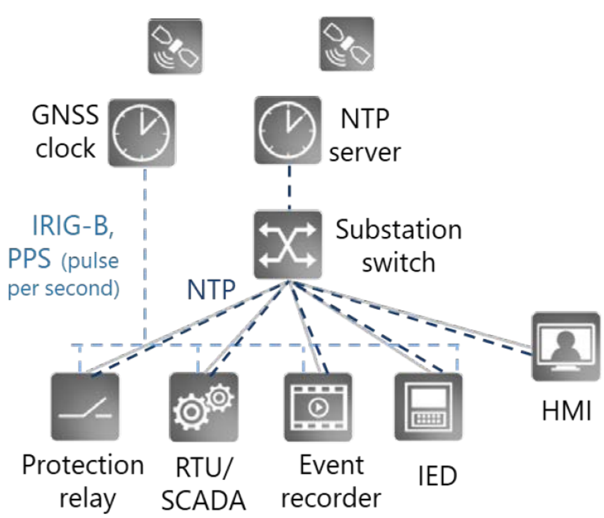


Figure 1: Legacy timing at substations

Regulators are now categorizing power networks as critical infrastructures. Using a purely satellite-based sourcing of time to substations is creating an unacceptable risk. Interference, jamming and spoofing could degrade accuracy of time, with negative impact on the operational integrity of the power grid. In the worst case, this could lead to power outages.

Timing over packet networks

Packet networks based on IP and Ethernet are now widely available. We can use these packet network technologies for delivering time to substations and remote sites in a power grid. Network Time Protocol (NTP) is frequently used for distribution of time over packet networks, mitigating the risk of GNSS outages. Figure 1 shows a substation using IRIG-B as well as NTP for synchronization in a complementary way, combining high accuracy with high availability.

Highest time accuracy is essential for efficient operations

With an increasing level of operational sophistication, greater accuracy is needed in power grid monitoring and localization of faults. Substations require microsecond accuracy with phasor measurement units as well as sample value merging units. Portable wave fault locators require a similar precision for accurate localization of any fault. Those requirements have been specified with IEC 61850, which addresses communication networks and systems for power utility automation.

While GNSS-based timing can provide this accuracy, NTP cannot. NTP needs to be replaced with the more sophisticated Precision Time Protocol (PTP).

How PTP makes a difference

PTP can be implemented with physical hardware timestamping to minimize delay and achieve very high accuracy required by these essential substation systems. This creates a significant improvement over software-based NTP solutions.

PTP is complemented by timing functions in the packet network transport equipment. Transparent clocks (TCs) compensate for packet processing delays in packet switches. Boundary clocks (BCs) combine a grandmaster (GM)-function with clock recovery to eliminate delay and packet delay variations.

With these two mechanisms, the packet network becomes time aware and improves the quality of PTP delivery. In short, the packet network needs to be built for PTP for delivering accurate frequency, phase and time services.

Operational and information technologies

Energy companies consider it good practice to separate operational technology (OT) and information technology (IT). This separation includes the highly specialized teams designing and implementing OT and IT. However, both teams must cooperate as the IT network frequently provides bearer services for the OT communication.

The introduction of PTP is creating a new field and new opportunities for close cooperation between OT and IT teams. While precise time is key to operational control, it can only be provided by IT networks specially enhanced with PTP capabilities. An IT network which is not time-aware and designed for the transport of PTP packets will most likely not be able to deliver PTP with the required accuracy.

Figure 2 highlights the best practice for migrating from legacy timing to future-proof PTP for scale, precision, and availability. A local PTP grandmaster is the source of legacy NTP and IRIG-B timing. It also delivers highly precise synchronization with PTP. The grandmaster clock is synchronized from satellites but also with PTP from a central core clock for security and vulnerability mitigation. This core clock needs to provide highly accurate frequency and time information, even in the event of extended GNSS unavailability. As outlined above, the packet network is time-aware and provides very accurate frequency, phase and time synchronization.

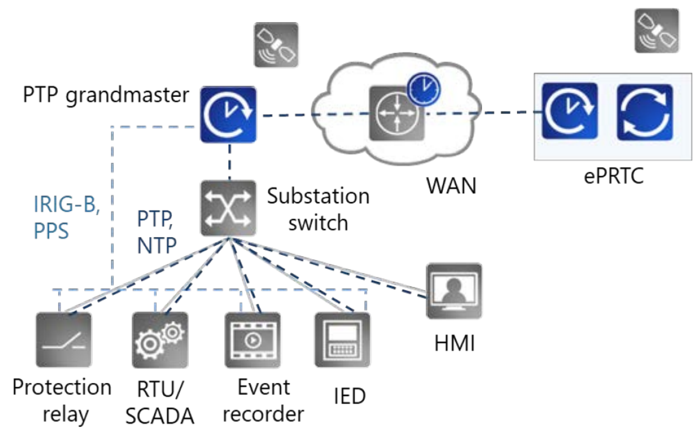
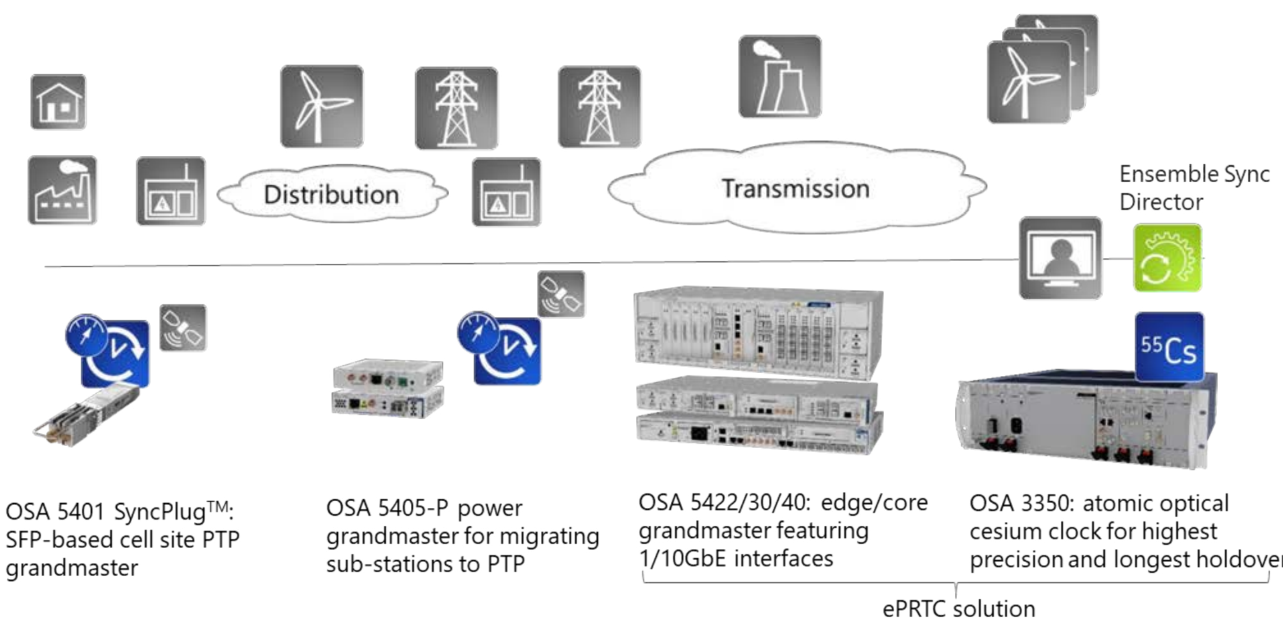


Figure 2: Seamlessly introducing highly accurate PTP timing

Oscilloquartz solution overview

Oscilloquartz, an ADVA company, offers a comprehensive portfolio of synchronization solutions for migrating substations to IP-based timing while supporting legacy timing signals. The very compact, zero-footprint, SFPbased grandmaster OSA 5401 can easily convert any non-timing-aware device into a PTP-enabled application. It is complemented with the OSA 5405-P power grandmaster, which combines NTP, PTP, Sync-E and IRIG-B interfaces with multi-constellation, multi-band GNSS receivers for migrating legacy synchronization networks to future-proof, high-performance timing solutions.



The OSA 5422 is an essential component for timing excellence in energy distribution networks at primary substations or core sites. It supports the widest range of interfaces as well as multiple PTP profiles including power profile, and can be applied as a gateway between telecom and enterprise timing networks. What's more, in the core of the network, our OSA 5430 and OSA 5440 in combination with our cesium atomic clocks provide unique standards-compliant enhanced primary reference time clock (ePRTC) accuracy. Those ultra-stable primary reference time clocks in the core of the network are the reliable foundation of any timing architecture, while providing secure mitigation of GNSS vulnerabilities such as jamming and spoofing.

Better times for power networks

IRIG-B and NTP have served our industry well in the past. But those technologies will not lead us into the future. They are not suitable to synchronize substation systems that require very high synchronization accuracy and reliability. This is what PTP was developed for. With market-specific adaptations known as PTP profiles, PTP complements and replaces legacy timing protocols in the enterprise market. Oscilloquartz has optimized its synchronization portfolio to meet the specific requirements of power utilities. Most importantly, we have integrated legacy timing and PTP interfaces in combination with gateway functions between power and telecom profiles. All these innovations make this product family a perfect solution for migrating existing power utilities timing networks to modern IP based timing aware synchronization solutions.

In order to meet stringent availability and security requirements, our timing solution is enhanced with a comprehensive set of synchronization assurance features. This includes SyncjackTM technology for continuous monitoring, testing and assurance of timing accuracy. With our solution, network elements also provide GNSS spoofing and jamming detection. In combination with AI-assisted analytics, problems in the synchronization network are detected even before services are affected. This unique capability is essential for mission-critical operations.