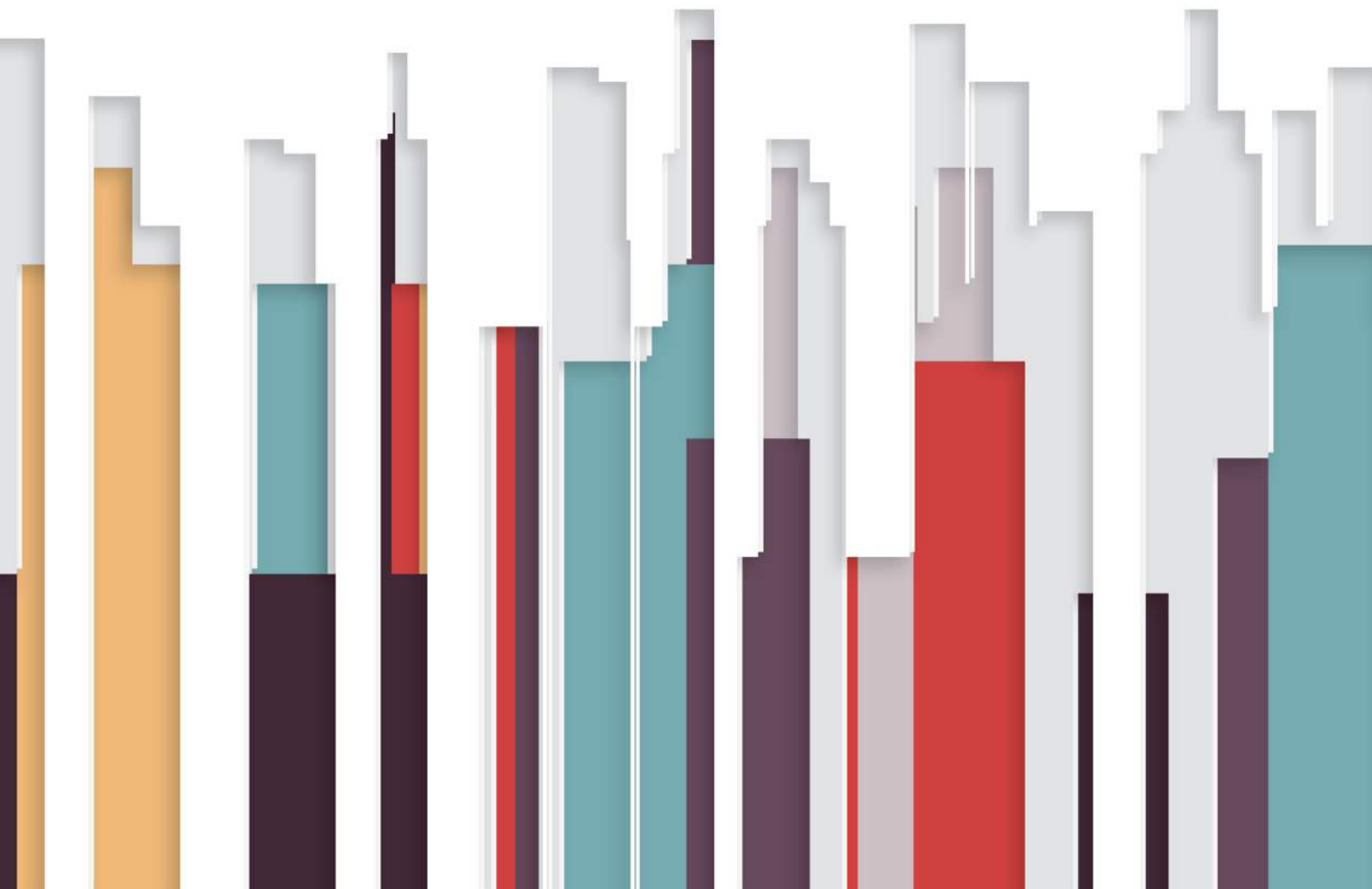
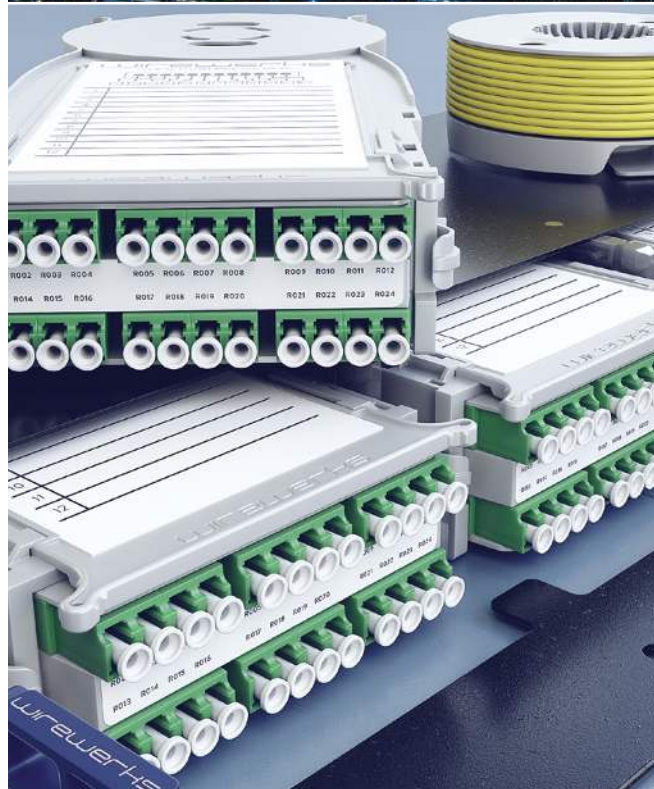


Wired *Insights.*



Contents

4	Agile Network Deployment Amid Supply Chain Disruptions: A Success Story
6	400G is here. 800G is coming. Are You Ready?
8	Game Changer: Wirewerks' Hybrid Fiber+Power Solution Transforms Old Stadium into 5G Arena
10	Add More Bandwidth, Not More Fiber
12	Leveraging NextSTEP™ for Global Data Center Expansion
14	The Rise of Hybrid Fiber+Power DAS: Optimizing In-Building Connectivity for Next-Generation Wireless Networks
16	PONdering the Best Options for 5G Fronthaul?
18	NextSTEP – System Overview Advanced Fiber Management System
20	LGXtra – System Overview Fiber Management System
22	Fiber+Power – Solution Overview Powered Fiber Solution
24	KEYWERKS – System Overview Copper & Fiber Structured Cabling System
26	High-Performance Cable Assemblies Product Overview



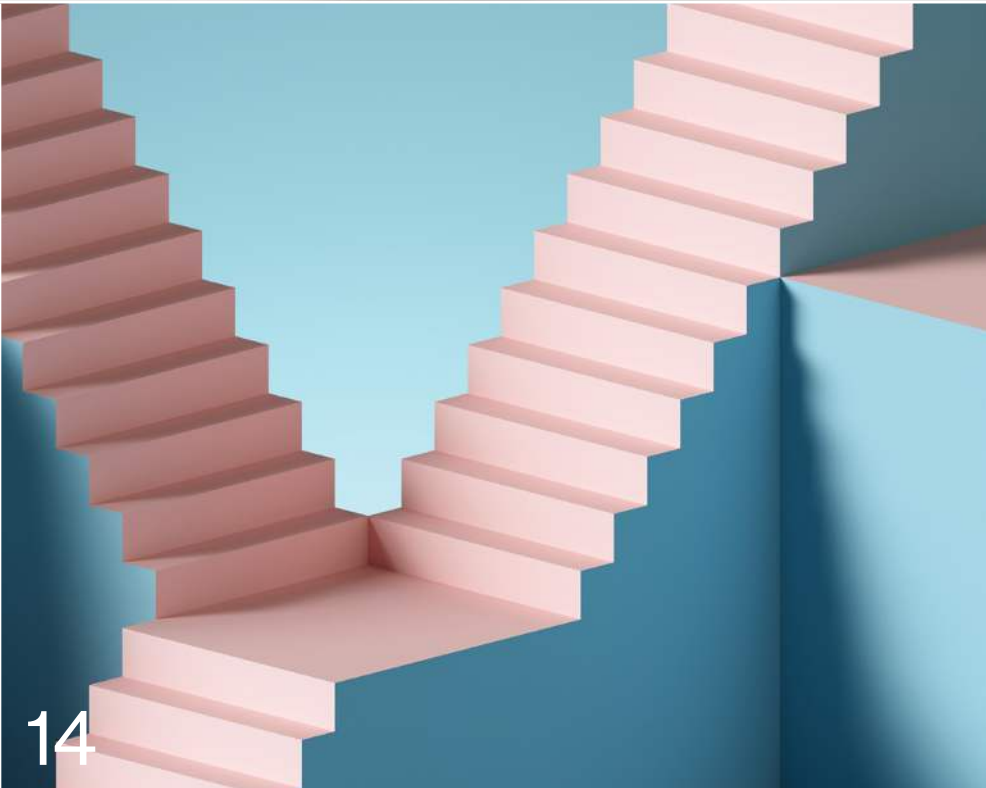


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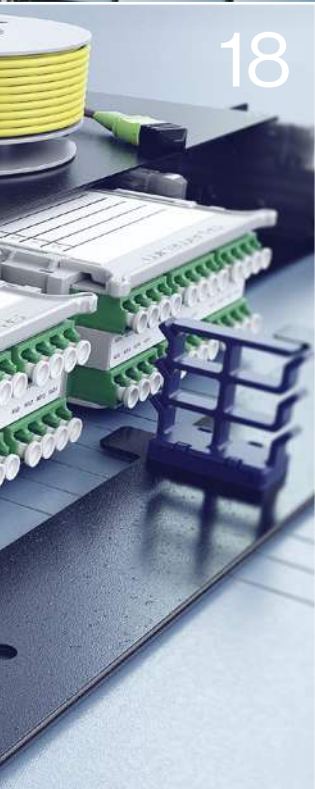
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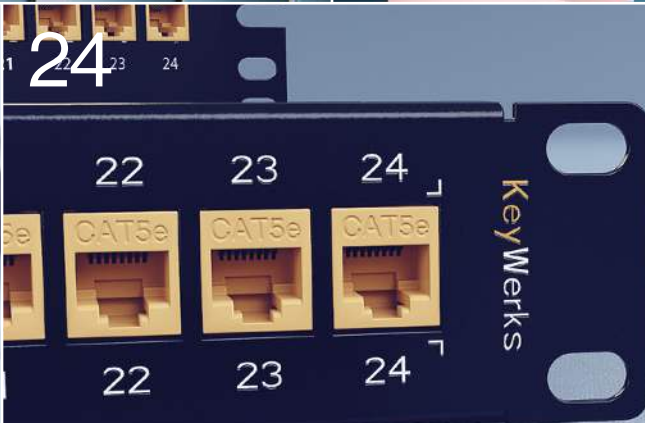


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24



Agile Network Deployment Amid Supply Chain Disruptions: A Success Story

Network operators today are looking for technology innovations that solve *their* specific issues; in products that can be easily installed in *their* production networks; with reliable delivery to facilitate *their* network expansion plans.

As a leading manufacturer of fiber and copper networking solutions for broadband, wireline and wireless networks, we recently applied our 3-Step Process to define, develop and deliver a new fiber network management product for one of the largest cable operators in the United States **connecting 30+ million subscribers in nearly all 50 states.**



**Steven Nesbitt,
Director of Sales,
North America
Wirewerks**

Steven is a business professional with a decade of experience in the telecommunications Industry. Each of those years has been in a variety of professional capacities ranging from managing small regional territories and now directing the Sales operations for North America. He has worked with leading telecommunications companies and has extensive knowledge of the latest trends and technologies in the market. Steven's expertise includes network architecture, infrastructure design, and project management. He is passionate about developing long-term business relationships to connect people and transform businesses.

The Need for Network Expansion Agility

The pandemic fueled the massive growth of work/school-from-home users and their need for broadband network connectivity. Network operators who could quickly expand their networks were well positioned, however the same phenomenon that created the increased demand also created supply chain issues that made it increasingly difficult for operators to keep their network expansion projects on pace with demand.

For our customer, wide-scale supply chain and delivery issues required them to look for alternative rapid/flexible deployment solutions and partners to support and ensure product availability to keep their network expansion plans on track.

Collaboration

In our approach, Collaboration is the interactive process we follow to go beyond product procurement specs to uncover *and understand* the underlying technical, operational, and commercial factors driving the customer's product needs. In this case, we came to understand that in addition to the obvious second-source supply issue, the customer was also facing fiber density issues in their networks and would benefit from a re-designed rapid-deployment fiber management module that also contributed to increased fiber density in their headends and distribution hubs.



Innovation

Instead of simply producing a product clone to address the supply issue, we acted on the knowledge gained through collaboration to add new customer-specific features to our NextSTEP™ 3S-FLEX rapid-deployment module. High-value innovations included design modifications producing a **two-fold increase in fiber density** compared to the incumbent product, and a re-dimensioned rack mount panel fully compatible with the customer's wide variety of telecom racks. The re-engineered panels also added enhanced fiber slack management and cable attachment features supporting the customer's installation and operations best practices.

Implementation

As important as product innovations are, they are meaningless if they can't be deployed efficiently in the customer's network. To transform product innovations into value-added installed solutions, we pursued a two-pronged strategy addressing **product supply** and **product deployment** as related, yet different challenges.

For the product supply challenges, we engaged with distribution partner TVC Communications, well known for their supply chain solutions for the broadband and telecom markets. Working collaboratively with the customer, TVC and Wirewerks created a customer-specific Ordering & Application Guide, and simplified

ordering and material management by packaging the four component P/Ns used in the customer's standardized product configuration under a single SKU. The customer, TVC and Wirewerks continue to work closely to coordinate purchasing forecasts, inventory levels, and production planning to ensure on-schedule project rollouts.

This collaborative, innovative, and implementation-focused approach allowed us to create a tailored solution for a major cable operator, addressing both supply chain and network expansion challenges. This successful alliance showcases the immense value of combining broadband operator needs with a manufacturer's expertise to deliver effective, industry-leading solutions.



The Power of **We.**
With **Wirewerks.**

400G is here. 800G is coming. Are You Ready?

Learn how the hyperscalers are using new features in a new generation of Fiber Management Systems to smooth their 200G/400G and four-lane quad/eight-lane octal transceiver migrations over their existing fiber cabling plants.

Fiber Managers -- more accurately Fiber Management Systems; are fiber connectivity systems designed to facilitate splicing, breakout, termination, distribution and centralized management of large populations of fiber cables in headend, CO, and data center environments.

Not surprisingly, Data Centers are leading the next great migration in speed, with the hyperscalers currently implementing 400G applications and already planning the jump to 800G.

In the context of Fiber Management Systems, these next gen speeds are significant in three ways:

1. 400G marks the first use of eight-lane octal transceiver technologies that will lead to 800G and eventually 1.6T and 3.2T speeds.
2. These speeds and technologies in the Data Center will migrate out to Broadband and MSO networks as they re-imagine their COs and headends as data centers and pursue network virtualization with Software-defined Networking (SDN) and Network Functions Virtualization (NFV).
3. Migrating from four-lane quad designs that provide 50G, 100G and 200G, to eight-lane octal designs for 400G and beyond will require new capabilities in the Fiber Management System.



As a Result

Fiber Management Systems in 400G/800G networks will indeed operate under a “**new job description**”, adding new functionality specifically for four-lane quad and eight-lane octal migrations and operation, while continuing to provide classic Fiber Manager capabilities.

What Are The Next Steps In Fiber Management Systems?

- Path to 400G/800G and beyond
- Support for QSFP, QSFP-DD, and OSFP switch ports
- Support for 8F and 16F applications
- Support for legacy 12F and 24F applications
- Ultra-low loss performance
- Modular design
- Compact footprint
- Manageable high-fiber density
- Easily scalable
- Quick to deploy
- Simple to manage

Meet Wirewerks' NextSTEP™ Fiber Management System

Wirewerks' NextSTEP System is a modular fiber management system designed to support your fiber network through multiple growth, upgrade, and migration cycles.



Panels

NextSTEP (NS) high-density Panels are designed to adapt and grow as your needs change. NS Panels are available in 1RU, 2RU, and 4RU rack-mount configurations, with a compact model available for wall-mount applications.

Optical Distribution Frame (ODF)

The NextSTEP ODF is industry-unique with its modular, building-block design that allows customers to create high-density, feature-rich ODFs in the racks or cabinets of their choice.

Modules

More than twenty models of NextSTEP Modules are available, allowing customers to customize the functionality of each NS Panel to their specific needs, at the slot level, for virtually any fiber management application:



- **Splice Tray Modules**
- **Patch Modules** (easy field termination)
- **Distribution Modules** (factory terminated, plug-and-play)
- **Adapter Modules** (SC, LC, MPO adapters, plug-and-play)
- **Splitter Modules**
- **xWDM Modules** (C/D/S-WDM)
- **FLEX Modules** (self-contained, connectorized, fiber-on-a-spool for instantaneous, pull-to-length fiber deployment)

Fiber Assemblies

Wirewerks' offers a complete line of superior quality, low-loss fiber cable assemblies for the NS System. Choose from ready-to-ship standard connector/cable/fiber configurations, or order custom assemblies built to your preferred specifications.

Fiber Management Accessories

NextSTEP's innovative Management Accessories simplify installation and maintenance operations. Routing, bend-radius control and strain-relief features protect fibers throughout the NS System, assuring performance, reliability and up-time in customer networks.

“ Broadband and MSO operators are re-imagining their COs and headends as data centers, and pursuing network virtualization. ”

Game Changer: Wirewerks' Hybrid Fiber+Power™ Solution Transforms Old Stadium into 5G Arena

In this era of 70"-plus UHD TVs and immersive surround-sound systems, sports venue operators are constantly searching for new ways to entice fans into the seats and increase attendance. Providing new in-venue services that enhance the fan experience and create additional revenue opportunities are proven strategies for venue operators. Offering high-performance 5G wireless service with reliable connectivity *everywhere* throughout the venue -- for tens of thousands of simultaneous users -- is the latest opportunity for venue operators and their 5G service providers.

This Case Study documents an innovative Wirewerks' cabling solution for the many challenges encountered in deploying a new 5G DAS network in a 56,000 seat, forty-five year-old, multi-purpose open-air stadium complex located in the northern Great Plains.

Customer's Challenges

In this study, Wirewerks' direct customer was the mobility division of a major national communications services provider (CSP) offering wireline and wireless telecom and broadband services to the stadium operator.

For the CSP and the stadium operator, the goal was to provide reliable 5G wireless connectivity throughout the entire stadium complex, from the parking lots to the retail concourses and outbuildings, and to every seat in the stadium bowl. Their plan called for a new 5G Distributed Antenna System (DAS), operating over a new, high-performance cabling infrastructure.

Retrofitting the classic open-air stadium complex with a 5G DAS network presented *many* site-specific cabling challenges. This Case Study will focus on a notable few, including:

1. Single CSP PoP for entire Stadium Complex

- One PoP (CSP's secure point-of-presence room), on the extreme perimeter of the complex, supporting 300+ RRU (remote radio unit) locations, with RRUs typically >100m distant
- No usable telecom rooms across the complex; no protected, powered locations for RHUBs

2. No Power at Antenna Locations

- Existing power grid did not reach the RRU/antenna locations, chosen for optimal RF coverage

3. No Pathways/Conduits to RRU/Antenna Locations

- RF-optimized RRU/antenna locations were not served by the existing pathways and conduits for the legacy telecom or power cabling infrastructures



Wirewerks' Fiber+Power™ Solution

DAS cabling applications are often good candidates for traditional PoE (Power-over-Ethernet) systems that deliver data and power over twisted-pair copper cables. PoE systems have inherent distance, bandwidth and power limitations that left them unsuitable for the unique requirements of this project.

To solve the stadium's atypical DAS cabling challenges, Wirewerks developed our new Fiber+Power™ cabling solution. The solution features hybrid cables that combine optical fiber for communications with copper power conductors in the same cable -- greatly increasing distance, bandwidth and power capacity versus twisted-pair PoE systems. These gains in distance, bandwidth and power allow the Fiber+Power cabling solution to reach, connect and power every new RRU/antenna in the stadium complex, with all the bandwidth necessary for an uncompromised 5G user experience.

How It Works: In the CSP's PoP

In typical DAS networks, BBUs (baseband units) are deployed in a centralized location, connected over cabling to RHUBs (remote radio unit hubs) installed in telecom rooms (TRs) distributed throughout the service area. RHUBs are then cabled

to RRUs installed at locations selected for optimal RF coverage. RF-optimized RRU locations are often isolated and not easily connected to the existing power grid, making power delivery over the data cabling critical for RRU power.

With no usable TRs for the RHUBs, the thinking turned to co-locating the RHUBs with the BBUs in the CSP's PoP, and then cabling out from the PoP to each RRU. The roadblock in that strategy was that the perimeter location of the CSP's PoP meant that virtually every RRU cabling run was well beyond the distance limitations of twisted-pair PoE cabling.

Wirewerks' Fiber+Power solution collocates BBUs and RHUBs in the CSP's secure PoP and then connects every RRU location in the stadium complex with fiber bandwidth and electrical power over one hybrid cable deployed with a single cable-pull.

How It Works: At the RRU/ Antenna Locations

Hybrid fiber-copper cables originating in the PoP are routed to RRU/antenna sites where they terminate in Fiber+Power Hybrid Distribution Enclosures (HDEs), or Fiber+Power Hybrid Terminal Enclosures (HTEs).

Fiber+Power HDEs support multiple RRUs and feature a 12F fusion splice-tray and 12-Port LC Adapter

Strip along with a 12-Pole 24-12AWG 300V/20A Terminal Strip.

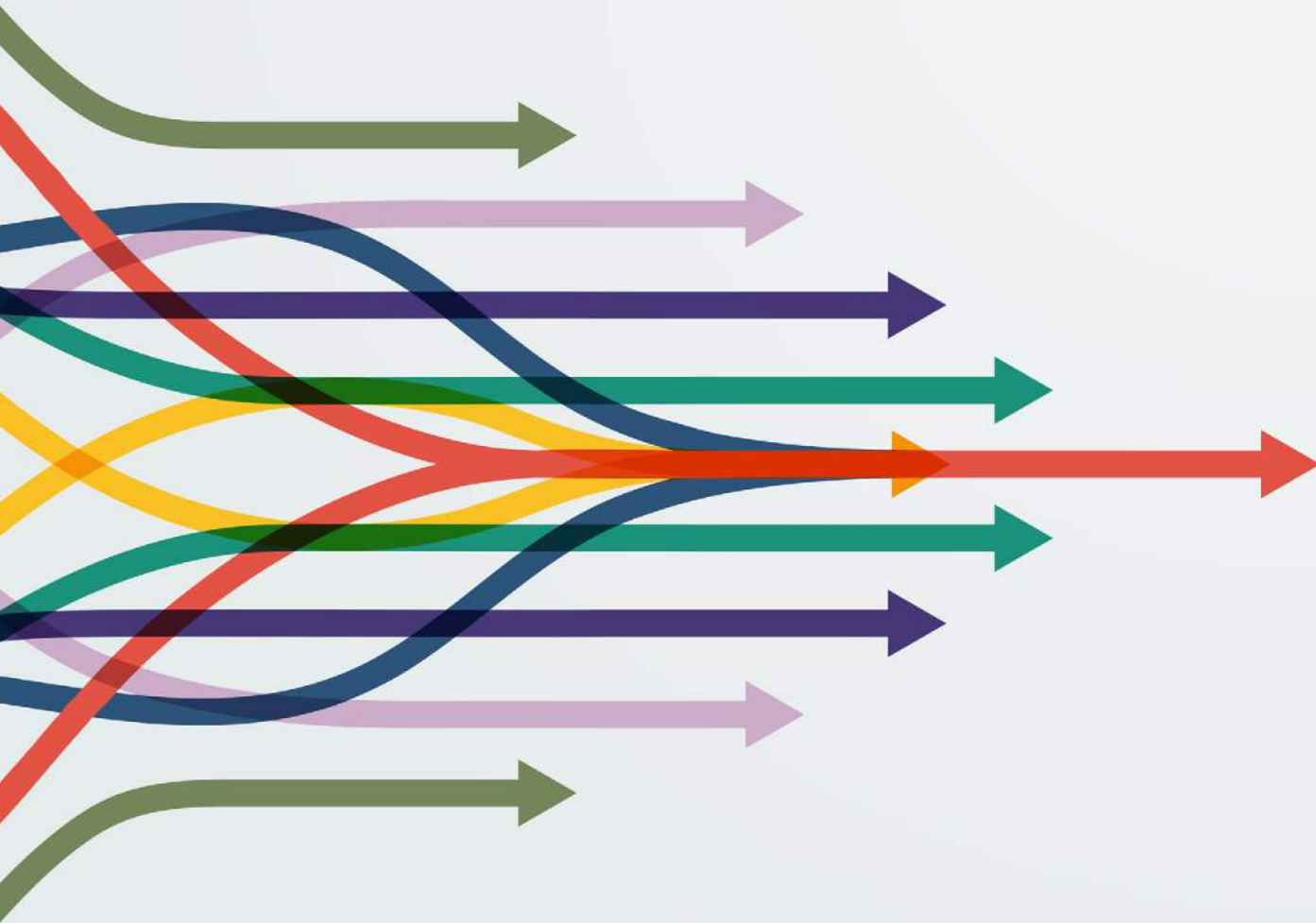
Fiber+Power HTEs support single RRUs and feature an integrated fusion splice-tray and LC Duplex Adapter along with a 2-conductor 600V/20A Splicing Connector for solid or stranded 24-12AWG wires.

Key Fiber+Power™ Benefits

Wirewerks' Fiber+Power system solved the project's most significant cabling challenges and provided the CSP and the stadium operator with many additional benefits, including:

1. Fiber bandwidth and DC power over one cable reduces material and labour costs, and avoids additional costs/delays for power grid or conduit modifications
2. One repeatable cabling solution connects any RRU anywhere in the facility, simplifying installation and operations
3. Centralizing the BBUs and RHUBs and in the CSP's PoP simplifies installation, operations and maintenance, and increases security
4. Solution meets CSP's network performance and reliability objectives, and SLAs with stadium operator
5. Fiber+Power meets applicable TIA, IEEE and BICSI standards and best practices

Add More Bandwidth, Not More Fiber



**Edouard Tabet, VP, Engineering
Wirewerks**

Edouard Tabet, B.ME, P. Eng., is the VP of Engineering at Wirewerks; a manufacturer of advanced optical fiber and copper structured cabling solutions. He earned his degree in Mechanical Engineering at the Université Polytechnique de Montréal and has over 20 years of industry experience.

Many industry analysts predict that new fiber deployment in Canada and the U.S. over the next five years may actually exceed the total fiber installed to-date.

Closing the digital divide in rural areas is one factor driving new fiber deployment. Other drivers include cloud computing, 5G, IoT and smart cities; with many network operators laying new fiber to meet the additional bandwidth requirements of these and other applications.

But *more fiber* isn't necessarily the best solution for *more bandwidth*. Since the 1990s, Tier-1 operators have used wavelength division multiplexing (WDM) technologies to add more bandwidth without adding more fiber.

Today, technical advances and reduced costs make WDM solutions attractive and accessible to virtually all network operators, regardless of their size and resources.

Two types of WDM are commonly used today:

- Coarse Wavelength Division Multiplexing (CWDM) creates up to 18 widely spaced optical channels in a single fiber; driven by less sophisticated, lower cost transceivers.
- Dense Wavelength Division Multiplexing (DWDM) creates up to 96 narrowly spaced channels in a single fiber; driven by more sophisticated, higher cost transceivers.

What's Next? Ultra-Wideband WDM (UW-WDM) will utilize an expanded range of wavelengths across the C, L and S-bands to create up to 192 channels in a single fiber, with potential throughput exceeding 100Tbps.

Top Six Reasons for WDM

1. Multiply the Bandwidth and Capacity of existing Fiber

WDM transforms a single physical fiber into multiple virtual fibers. With DWDM, for example, it's possible to multiplex ninety-six (96) 100Gbps channels onto one fiber, increasing the capacity of each fiber from 100Gbps to 9.6Tbps and beyond.

2. Protocol and Data Rate Transparency

WDM channels are transparent to transmission protocols and data rates, allowing simultaneous operation of multiple services and data rates over a single fiber pair.

3. Coexistence of PON standards: GPON, XGS-PON and NG-PON2

WDM enables simultaneous upstream and downstream traffic on a single fiber strand. WDM works with coexisting modules to support multiple services on a single fiber, allowing concurrent operation of GPON, XGS-PON and NG-PON2 over the existing PON infrastructure without changing the outside plant.

4. 5G Small Cell connectivity and C-RAN optimization

Proper 5G coverage requires a massive number of small cells operating in a centralized RAN (C-RAN) architecture, typically connected over a fiber fronthaul network. WDM supports the transition to C-RAN and replaces multiple dedicated fiber runs at each small cell site with multiple WDM channels in a single fiber span.

5. Simplified Operations & Service Provisioning, Faster Time-to-Revenue

WDM works with network management and provisioning systems to support centralized service provisioning, network reconfiguration and network operations.

6. Capital Efficiency and ROI

WDM technologies allow network operators to start small and scale economically. Adding capacity and bandwidth in the existing fiber plant, without adding more fiber, maximizes network ROI.

The Bottom Line

WDM allows operators to add *more bandwidth* without adding *more fiber* -- saving time and money while simplifying network operations at the same time.

In a June 2022 proof-of-concept, Nokia demonstrated how to increase fiber capacity from GPON to XGS-PON to 25G and beyond by simply adding wavelengths to a single strand of glass.

CASE STUDY

Leveraging NextSTEP™ Fiber Management System for Global Data Center Expansion

Our customer is a hybrid multi-cloud managed service provider delivering high-performance cloud computing solutions and professional services to clients in the United States, Canada, Latin America, the United Kingdom and Europe. Currently operating 14 data centers in North America and the UK, our customer recently initiated a comprehensive migration program to increase network speeds and capacities in all data centers.

This study examines the customer's network migration project, and describes how Wirewerks' fiber management solutions helped expedite network deployments, reduce costs, and create solid foundations for efficient network operations and future growth in all data center.

Customer's Challenges

The customer's network migration program was designed to achieve two strategic objectives. First, increase network bandwidth and capacity to provide higher speeds and throughput for their customers. Second, ensure their fiber networks were optimized to provide the many inherent benefits of spine-leaf architecture in cloud data center operations.

The migration program began with a pilot project to validate design assumptions and identify implementation challenges. The pilot demonstrated that their **legacy fiber solution was heavily dependent on field fusion splicing** -- a technique that requires specialized techs, drives up costs, introduces the potential for optical performance impairments, and extends project completion times.

The pilot also identified fill/congestion issues in cable trays and fiber managers when adding new fiber media for the network migration, and exposed **inefficient use of existing fiber assets when migrating from Base-12 to Base-8 MPO cabling** for 10G/25G/40G/100G parallel optic transmission.

AT A GLANCE

Customer: Cloud Computing Service Provider

Industry: Cloud Data Center Operator

Location: 14 Data Centers in US, Canada, UK

Application: Fiber Management in spine-leaf DC network

Project: Increase data center fiber bandwidth, capacity, speeds

Challenges:

- Standardize on a fiber management system across all company DCs
- Simplify fiber deployment, management and operations
- Repeatable in both existing and new DCs

Wirewerks Solution: NextSTEP™ Fiber Management System (FMS)

Benefits:

- NextSTEP System establishes company-wide standard for FMS, yet configures easily for the specific requirements of each DC
- Modular FMS with plug-and-play pre-term fiber modules simplifies deployment, maintenance and operations
- Pre-term fiber ensures superior optical performance and network reliability
- High fiber capacity/high-density NextSTEP System saves space and maximizes ROI
- Significant CAPEX and OPEX savings



Finally, the pilot reinforced the need for a scalable fiber management system to leverage the inherent scalability of spine-leaf data center architecture, and clearly established the economic and operational benefits of standardizing on an advanced fiber management solution across all company data centers.

Wirewerks' NextSTEP™ Solution for Cloud Data Centers

To maximize network connectivity, availability and scalability while minimizing latency in their cloud data centers, the customer adopted a two-tier spine-leaf architecture with top-of-rack (ToR) network access switches connected to aggregation switches for routing and network core functions.

To optimize the spine-leaf architecture in each of their 14 data centers, the customer selected Wirewerks' NextSTEP™ Fiber

Management Systems. The wide selection of NextSTEP patch panels and fiber modules provided the functionality and flexibility needed in each data center, and allowed the customer to realize the financial and operational benefits of a standardized fiber management solution.

To simplify network operations and reduce costs, the customer deployed NextSTEP factory-terminated fiber modules and fiber cable assemblies to create 'plug-and-play' connections whenever possible. NextSTEP 'plug-and-play' products reduce installation and maintenance times while increasing optical performance and reliability; all without the need for specialized fiber technicians.

The star of the NextSTEP 'plug-and-play' solution was the 3S-FLEX Module. By combining 12/24F LC distribution cassette with an MPO fiber trunk cable stored on an onboard spool, the 3S-FLEX Module allowed technicians to complete

multi-fiber trunk connections by simply pulling the spooled MPO trunk cable to the exact length required and plugging the MPO connector.

The Outcome

Spine-leaf architecture in cloud data centers optimizes server-to-server communications, reduces latency, and scales efficiently. The meshed connections between switches enable any-to-any connectivity with predictable performance and inherent redundancy.

Wirewerks' NextSTEP System provides a high-density, plug-and-play fiber management solution that deploys faster, simplifies operations, scales easily and reduces costs.

**The Power of We.
With Wirewerks.**

The Rise of Hybrid Fiber+Power DAS: Optimizing In-Building Connectivity for Next-Generation Wireless Networks

5G networks promise significantly faster data speeds, lower latency, and higher network capacity. But 5G's benefits are limited if users can't access the network reliably indoors. The problem: high-frequency 5G signals are more easily blocked by obstacles such as walls and buildings, reducing signal strength and coverage.



**Artem
Andreychik**

Artem holds a degree in International Economics and has over 12 years industry experience with advanced fiber optic solutions. He has made significant contributions to wireless innovations by developing cutting-edge hybrid distributed antenna systems, which have been widely adopted by major carriers and enterprises. Artem is known for his technical expertise, leadership skills, and entrepreneurial spirit.

The solution – a distributed antenna system (DAS) improves signal coverage and network performance, transmitting wireless signals throughout a facility where 5G signals are weaker. Increased capacity ensures users can access 5G networks reliably to take advantage of highly demanding applications such as video streaming, augmented and virtual reality.

A DAS network's antennas, connected to a central controller that manages signal distribution, overcomes weak signals and accommodates high traffic volume in large office buildings, stadiums, airports, and shopping centers. This improves the user experience, reducing dropped calls and increasing data transfer speeds.

DAS Architectures

DAS comes in passive, active, and hybrid architectures. Passive DAS uses components such as coaxial cables and splitters to distribute the signal, while active DAS uses signal boosters and amplifiers to enhance the signal. Hybrid DAS combines passive and active components for optimal performance.

Passive DAS, better in small to medium-sized locations, doesn't amplify or boost signal strength. It divides and distributes it. Its advantages are simplicity and cost-effectiveness, with no need for additional power sources or equipment. Installation and maintenance are simple and inexpensive. However, Passive DAS does not offer an optimal area coverage, as building internal structures become the obstacles for dissipating signals.



Active DAS connects antennas and radio units to a central hub, or head-end, that manages signal distribution. Its enhanced coverage and capacity, signal quality, extensibility, and reliability work well in larger buildings and campuses. But it is more expensive to install, maintain, and upgrade than passive DAS.

A hybrid fiber cable DAS system delivers the advantages of passive and active networks. It combines fiber optic and copper conductors in a single cable to cost-effectively transmit signals and power and provide multiple services between the central hub and remote antennas over longer distances.

- **High bandwidth**, allowing fast and reliable transmission of wireless signals.
- **Longer distances**, so signals travel farther without losing strength.
- **Flexibility** in installation, enabling a customized architecture with power always present.

- **Reduced installation costs**, since a single cable pull to each antenna location can be done by one communications contractor with no conduit required.
- **Multiple carrier support**, including 2G, 3G, 4G LTE, and 5G, as well as Wi-Fi and public safety communications.
- **Improved signal quality** for a better user experience.

Powering the Hybrid DAS

Small cells in distributed antenna systems, depending on size and technology and number of users, typically consume up to 100watts of AC, DC, or battery power. The advantage of hybrid fiber cable is the cable construction itself, using fiber components for signal transfer and copper strands to carry power from any class 2 (low voltage) distribution power system. This complies with all National Electrical Code requirements and safety standards.

The Smart Choice

A hybrid fiber-based DAS represents a significant advancement in deployment of next-generation communication networks in large buildings or outdoor areas. It offers enhanced scalability, flexibility, ease of design, reliability, and cost-effectiveness. As demand for high-speed connectivity and data-intensive applications grows, hybrid fiber DAS provides the solution.

PONdering the Best Options for 5G Fronthaul?

The expectations for massively increased capacity and instantaneous network performance are now well established in the minds of the burgeoning 5G-user community. The challenge for 5G operators lies in rolling out their networks to reach the most subscribers, over the broadest geography, economically and as quickly as possible.

With these challenges in mind, this article looks at the potential of PON (Passive Optical Network) solutions in 5G fronthaul applications.

“ 5G requires from 20 to 50 times more antennas than 4G to provide equivalent coverage in a given geographic area. ”

5G Fronthaul Challenges

For wireless connectivity, 5G networks use millimeter-wave radio to achieve higher capacity and throughput at the expense of reduced signal radius -- decreasing from 1 km in 4G radio to **100 m or less in 5G**. This means that 5G requires from **20 to 50 times more antennas** than 4G to provide equivalent coverage in a given geographic area.

Networking this massive population of antennas with the necessary bandwidth -- quickly, reliably, and economically presents significant design challenges, namely:

- To reduce the size and cost of base stations, 5G systems physically separate the radio unit (RU) and the distributed unit (DU) into discrete components, allowing DUs to be deployed more efficiently and economically at the edge of the access network, configured to support multiple remote RUs.
- The discrete RUs and DUs require 10- to 25-Gbps fiber connections to support 5G's **twenty-fold increase in bandwidth** compared to 4G LTE, with a **ten-fold reduction in delay** to meet 5G's strict latency objectives.



The PONtential in 5G Fronthaul Applications

ROI is one of several important considerations influencing 5G network expansion, making cost reduction in the towers, base stations, and their connecting network infrastructure a key design objective for network engineers. Using PON technologies to leverage existing fiber assets and/or reduce new fiber deployment is a powerful design strategy that reduces costs, improves ROI, accelerates network rollout, and maximizes capacity in the RAN.

A PrePONderance of Choices

Many versions of PON have been developed and deployed over the years, and several provide viable options for 5G fronthaul infrastructure:

- **GPON** is well understood and widely used in current FTTP/H networks, however its 2.4-Gbps downstream and 1.2-Gbps upstream speeds are insufficient for 5G fronthaul applications.
- **XGS-PON** is suitable for 5G fronthaul, providing 10-Gbps upstream and downstream, with a path to 25G PON.

- **WDM-PON** (Wavelength-Division Multiplexing) technology overlays new wavelengths onto legacy PON networks, allowing uncompromised simultaneous operation of GPON for fixed broadband FTTP/H service and XGS-PON for 5G fronthaul on the same fiber.
- The latest **TWDM-PON** (Time-and-Wavelength-Division Multiplexing) development is **NG-PON2**, providing up to 40-Gbps in both directions using eight wavelengths of XGS-PON. With this tremendous transport capacity, NG-PON2 has the potential to support both RU/DU fronthaul and DU/CU (central unit) midhaul over the same PON, thereby reducing costs while increasing capacity in the RAN.

The PROs and CONS of PONs

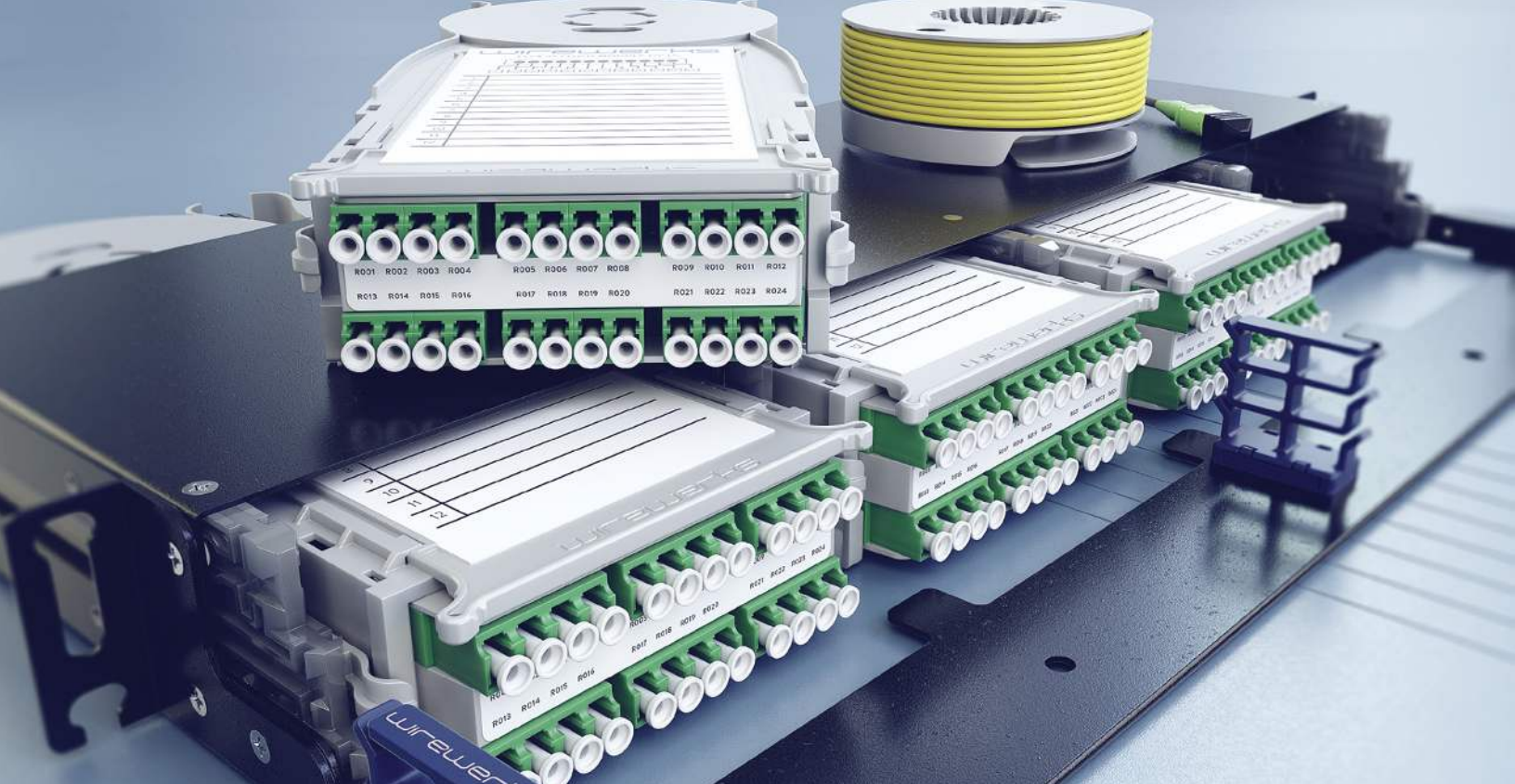
As with all things, PON as a design strategy for 5G fronthaul has both pro and con attributes that must be considered and weighed in the design process.

Notably, PON utilizes TDMA protocols with inherent overheads that may add as much as a millisecond of delay in transmission, depending on network conditions.

This can be significant in terms of 5G network performance and should be carefully considered by network designers. Importantly, continuing developments in higher-layer resource allocation mechanisms between the DUs and CUs are mitigating this issue, and TWDM-PON (NG-PON2) is proving to be an attractive design choice for low-latency fronthaul (and midhaul) transport.

PON as a 5G fronthaul design strategy offers many well-defined benefits to service providers, including:

- Single distribution network for both fixed broadband and cellular data transport
- Interoperable with other deployed networking architectures
- Leverages existing fiber, reduces new fiber and reduces active devices, lowering CAPEX
- Fewer active devices reduces maintenance and energy costs, lowering OPEX
- Reduced CAPEX and OPEX allows network operators to expand their 5G service areas, more quickly, to more revenue-generating subscribers



NEXTSTEP™

ADVANCED FIBER MANAGEMENT SYSTEM

Take the **NextSTEP** to advanced, high-performance, high-density fiber management solutions in Broadband, Data Center and Enterprise networks.

NextSTEP™ is a high-performance, high-density Fiber Management System (FMS) designed to provide the flexibility, scalability, ease-of-use, and ultra-reliability needed to manage fiber and connectivity in Broadband, MSO, Data Center and Enterprise networks.

NextSTEP's modular design and comprehensive selection of feature-rich, fully integrated components allow every NextSTEP System to be custom configured and right-sized for the specific requirements of each project. NextSTEP solutions maximize functionality and control costs while simplifying deployment and operations at the same.

AT A GLANCE

- High-performance, high-density Fiber Management System (FMS)
- Complete product line including panels, modules and cable assemblies
- Modular design customizes to the required size and functionality of each project
- Exceptional reliability with superior quality materials and stringent manufacturing processes
- Guaranteed performance with low-loss optical components and premium fiber media
- Scales to suit network size, capacity, performance and deployed technologies
- Technician-friendly features accelerate installations and simplify operations
- Fully supported from concept to cut-over by Wirewerks engineering resources

Present-Positioned and Future-Ready

NextSTEP's range of high-density panels, wide selection of interchangeable modules, and choice of connectors provide high-performance solutions for current fiber network applications, and offer an effective migration path to next generation applications and beyond.

- NextSTEP modules with MPO, LC and SN adapter/connector options support current 8/12/16/24F network configurations and offer the 96/144/192/1,152F per 1RU density options preferred in MSO, Broadband, Data Center, and Enterprise networks.
- Coming developments will provide ultra-low loss 16F configurations to support eight-lane octal designs for an open path to 400G/800G and beyond.

Reliability And Uptime Engineered In

Precision engineering, superior quality materials and stringent manufacturing processes assure the performance and reliability of all NextSTEP products.

Plug-and-play cable assemblies, front and rear panel access, slide-in modules, easier fiber access and technician-friendly, intuitive fiber management features make NextSTEP significantly faster to deploy and easier to manage than previous generation fiber managers.

The result is faster installation and maintenance routines, lower operational costs, less downtime, improved ROI, and the ultimate benefit of satisfied users/customers.

Scalability In 4D

NextSTEP scales efficiently across four key dimensions to accommodate the *certainty* of changes that will impact your fiber network infrastructure: 1) Network Size; 2) Network Capacity; 3) Network Performance; and, 4) Technology Evolution in areas like PON, WDM, and in the transceiver technologies that directly affect how the network's fiber infrastructure is utilized. NextSTEP's inherent scalability and design flexibility helps to mitigate the impact of inevitable change.

SOLUTION SUITE

NextSTEP's complete line-up of fully integrated panels, modules, fiber assemblies and accessories combine to maximize design options and optimize functionality in fiber management applications.

NextSTEP High-Density Panels

- 1U, 2U, 4U Rack Mount Panels
- Wall-Mount Panels

NextSTEP ODF (Optical Distribution Frame)

- High-capacity, high-density ODF for CSP networks

NextSTEP High-Performance Modules

Plug-and-Play

- Distribution Modules (factory-terminated MPO to LC/SC/SN)
- Adapter Modules (LC-LC, SC-SC, MPO-MPO)
- FLEX Modules (LC/SC to on-board MPO trunk)

Field Terminated

- Patch Modules (integrated fusion splice tray)
- Fusion Splice Trays (ribbon, tight-buffered, loose-tube)

Special Function

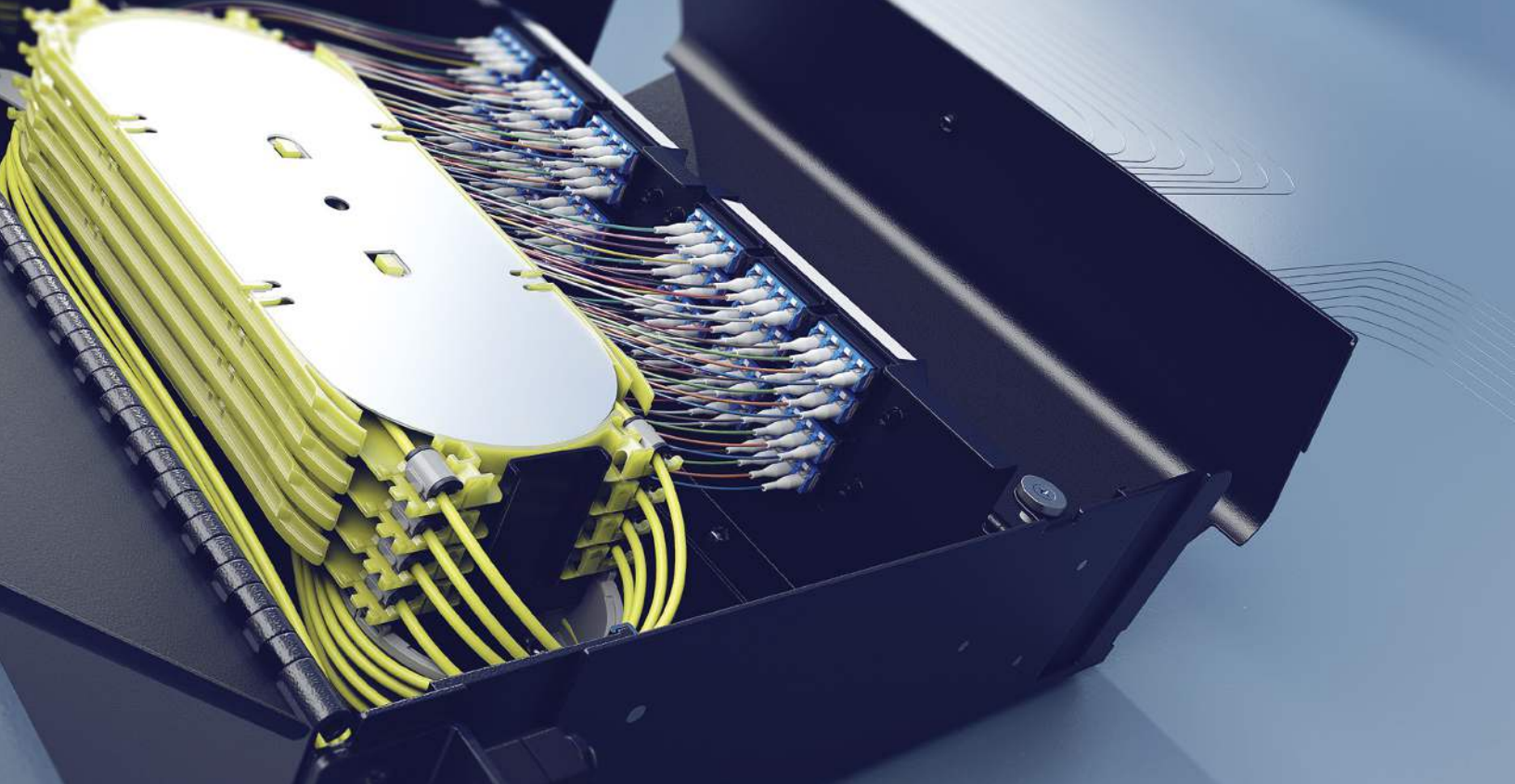
- C/D/S-WDM Modules
- Splitter Modules

NextSTEP Low-Loss Cable Assemblies

- Patch Cords & Pigtailed (LC, SC, SN), MPO trunks, Multi-fiber Cable Assemblies

NextSTEP Accessories

- CableTREE™ and CableBUNDLE™ magnetic cable management accessories
- CableGRIP™ cable attachment and strain-relief accessory



LGXtra™

FIBER MANAGEMENT SYSTEM

LGXtra brings Wirewerks innovation to the classic industry workhorse for fiber management in Headends, COs and other high fiber count applications.

LGXtra™ is a high-performance Fiber Management System (FMS) designed to provide the flexibility, scalability, ease-of-use, and ultra-reliability needed to manage high fiber count concentrations typically found in Headends and COs.

LGXtra components are typically compatible and interoperable with installed-base LGX-style fiber management systems and LGX-style products from numerous manufacturers.

AT A GLANCE

- High fiber count Fiber Management System (FMS) optimized for Base-2/8/12 fiber architecture and 96F/RU density preferred in Headends and COs
- LGX-style form factor for compatibility and interoperability with legacy systems and other LGX-style products from many manufacturers
- Optimized for OAMPTR (Operations, Administration, Management, Provisioning, Trouble-shooting & Repair) Best Practices in Headend and CO environments
- Complete product line including panels, modules, adapter strips, splitters and drop cassettes
- LGXtra products feature innovations that add new capabilities, enhance manageability, and simplify deployment and operations
- Engineered and manufactured to provide carrier-class reliability
- Guaranteed performance with low-loss optical components and premium fiber media

Listen to the LGX® Experts

Nobody knows more about operating LGX-style fiber management systems in your networks than ... *you!* Our LGXtra product line reflects years of our customers' real-world experience and input, defining a comprehensive line-up of components ready to maintain, grow and optimize LGX-style fiber management systems in headend and CO environments.

Practical Innovation

To add value to the LGXtra product line, Wirewerks engineers collaborate with customer experts to define and develop 'practical' innovations that solve real fiber management challenges in real production networks, always with the goals of simplifying operations, increasing reliability and reducing costs.

Different Differentiation

Continuing to invest in the development of beneficial new features and capabilities for a classic, de facto standard product line is a different way for a manufacturer to differentiate their solutions. By continuing to advance the LGXtra product line with new features that may be deployed in both new projects and across the massive installed-base, Wirewerks keeps our LGXtra system efficient and effective in headend and CO fiber management applications. This approach extends the operational lifespan of the LGXtra solution, increasing ROI and protecting literally decades of our customers' investments.

LGXtra™ is a trademark of Wirewerks.
LGX® is a registered trademark of OFS FITEL, LLC.

SOLUTION SUITE

LGXtra's extensive selection of LGX-style panels, modules and adapter strips maintain and expand classic LGX-style fiber management systems.

LGXtra Rack Mount Panels

- 1U Swing-Out Model
- 1U Lean Model
- 1U Sliding Drawer Model
- 1U/2U/4U Models

LGXtra Wall-Mount Panels

- Compact Model (1 Adapter Strip)
- Low Profile Models (2/4 Adapter Strips)
- Vertical 4U Model

LGXtra Adapter Strips

- LC, SC, MTRJ, ST, FC, MPO
- 6-96F SM/MM

LGXtra Distribution Modules

- LC, SC 6-24F SM/MM

LGXtra Optical Splitters

- FBT Optical Splitter
- PLC Optical Splitter

LGXtra Drop Cassette

- LC, SC
- 6/12/24F - Left/Middle/Right Outlet

LGXtra Low-Loss Cable Assemblies

- Patch Cords & Pigtails, MPO trunks, Multi-fiber Cable Assemblies



Fiber+Power™ Powered Fiber Solution

SIGNAL AND POWER TRANSMISSION OVER HYBRID FIBER CABLING

Wirewerks powered fiber cabling solutions save time and money by delivering bandwidth and power over a hybrid fiber/copper cable installed in one pull without the need for licensed electricians.

Digital transformation is driving the explosive growth of DAS, Small Cell, Wi-Fi, Smart City and Smart Building applications and devices in cities, campuses and buildings everywhere.

The challenge in deploying the remote devices used in these applications lies in providing high-performance, low-latency data connectivity along with higher wattage power over a cost-effective, easy-to-deploy cabling solution.

Wirewerks' Fiber+Power™ products deliver fiber bandwidth and DC power over hybrid fiber/copper cables to remote devices. Fiber+Power solutions are ideal for use in campus, smart city, airports and large venue applications where longer circuits are required to connect and power remote devices.

AT A GLANCE

- **Fiber+Power™** products deliver fiber bandwidth and DC power over hybrid fiber/copper cables to remote devices
- Fully compliant with the requirements and specifications of applicable ANSI/TIA and IEEE industry standards, and low-voltage SELV/NEC Class 2 circuits
- Reduce labour and material costs by eliminating the need for separate power and communications cabling infrastructure
- Relieve conduit cable fill issues and reduce/eliminate new conduit costs
- Precision engineered and manufactured to provide exceptional reliability with guaranteed optical and electrical performance
- Fully supported from concept to cut-over by Wirewerks engineering resources

Longer Reach, More Bandwidth, More Power

Fiber+Power solutions operate over hybrid fiber/copper cables that combine the reach and bandwidth of SM/MM optical fiber with copper power conductors in the same cable. Hybrid cables are available with different types and counts of optical fibers and copper conductors to support the longer distances, higher bandwidth and greater voltage requirements often found in the targeted applications.

Faster Deployments And Reduced Costs

Fiber+Power solutions eliminate the need for separate communications and power cables, substantially reducing material costs. Hybrid cables simplify installation, saving both time and money; and hybrid cables reduce conduit fill, avoiding the costs and delays of new conduit installations. The low-voltage SELV/NEC Class 2 power circuits in the hybrid solution typically do not require installation by licensed electricians, further reducing costs.

Proven Solutions for Central and Remote Locations

Fiber+Power rack-mount products are precision engineered to simplify installation and save space in central equipment locations. For remote device connectivity and power, Fiber+Power enclosures are available in a range of sizes to support single and multiple devices. Fiber+Power products feature technician-friendly integrated fiber splice trays, fiber adapter strips, and quick-splice copper power connectors to simplify installations while providing superior quality results at lower costs.

SOLUTION SUITE

Wirewerks Fiber+Power solutions deliver high-performance fiber connectivity and low-voltage power over hybrid fiber/copper cables, substantially reducing material and labor costs. Fiber+Power solutions are ideal for use in applications where longer circuits are required to connect remote devices with higher bandwidth and higher wattage power requirements.

In central Equipment locations:

Wirewerks NextSTEP™ Fiber+Power Kits

- Factory-assembled kits of 3 x NextSTEP 12F LC Patch Modules and 3 x NextSTEP 12-Pole Copper Terminal Strip Modules for NextSTEP 1U or 4U Rack-Mount Panels. Each kit connects up to 36 switch ports and power ports to 36 remote powered devices over hybrid fiber/copper cables.

Wirewerks LGXtra™ Fiber+Power Module

- Each module includes a 12F LC LGXtra adapter strip, an integrated splice tray, and 8 quick-splice copper connectors. LGXtra modules are compatible with all LGX-style panels and enclosures.

At Remote Device locations:

Wirewerks Fiber+Power Enclosures

- Hybrid Distribution Enclosure (HDE) supports clusters of up to 6 remote devices; includes splice tray, 12F LC duplex connector strip and 12-pole power strip.
- Hybrid Terminal Enclosure (HTE) supports a single remote device with an integrated splice tray, LC duplex connector and quick-splice copper connectors.
- IP65 Enclosure (F+P IP65) is a weather-resistant, lockable enclosure supporting up to 4 remote devices; includes splice tray, 8F LC duplex connector strip and 8 quick-splice copper connectors.

Wirewerks LGXtra™ Fiber+Power Enclosure

- Compact wall-mount enclosure supports up to 12 remote devices; includes splice tray, LGX-style 12F LC adapter strip and 12 quick-splice copper connectors.



KEYWERKS™

STRUCTURED CABLING SYSTEM

Unlock the full potential and value of your networks with **KEYWERKS** high-performance structured cabling systems.

According to industry analyst Gartner, an inadequate or underperforming structuring cabling system can be the source of *chronic* reliability and performance problems that may prevent your ICT networks from ever reaching their full potential and value.

KEYWERKS™ is a high-performance structured cabling system engineered to provide the critical physical foundation for the ICT networks that empower your people and drive your business. KEYWERKS offers a complete range of copper and fiber components that integrate seamlessly into end-to-end, standards-compliant structured cabling system solutions for applications in Enterprise, Data Center and Communications Service Provider (CSP) networks.

AT A GLANCE

- High-performance, superior quality, end-to-end structured cabling system
- Comprehensive portfolio of copper and fiber cables and connectivity products
- Fully compliant with applicable ANSI/TIA, IEEE, SCTE and BICSI standards and performance specifications
- Available nationwide from Wirewerks Authorized Distributors (ADs)
- Value-added design, installation and maintenance services from qualified Wirewerks Certified Installers (WCIs)
- Guaranteed performance and no-nonsense 25-Year Warranty Program

Green Lights Don't Always Mean 'Go'

Remember, a 'green' network status LED on switches and routers only confirms a basic link level connection, and is not an indicator of actual network performance or throughput.

KEYWERKS systems are guaranteed to provide the full bandwidth and superior noise performance necessary for your network equipment to operate at peak performance with maximum throughput, ensuring that green status LEDs signify 'Really Good To Go And Do Business'.

Deploy KEYWERKS With Confidence

Precision engineering, superior quality materials and stringent manufacturing processes assure the performance and reliability of KEYWERKS products both as individual components and when installed together as end-to-end structured cabling solutions.

Guaranteed compliance with the requirements of the most demanding industry standards means that KEYWERKS components may be deployed with confidence in:

- TIA-568 Cat5e/6/6A UTP and SM/MM networks
- TIA-942 Data Centers
- TIA-1179 Healthcare Facilities
- TIA-4966 Educational Facilities
- IEEE 802 standards for Power-over-Ethernet (PoE), WiFi, PON, WDM
- SCTE standards for data cabling applications in cable broadband networks
- BICSI standards for design and installation best practices for ICT networks

SOLUTION SUITE

KEYWERKS' complete line-up of patch panels, modular jacks, cables, patch cords, cable assemblies and accessories means greater design flexibility and more precisely configured cabling solutions.

KEYWERKS Patch Panels

- 1U, 2U, 4U Rack Mount Panels
- Standard & High-Density style, LGX-style
- Flush and Angled designs
- UTP, FTP models
- Wall-Mount Panels

KEYWERKS Modules

- Cat5e/6/6A UTP/FTP Modular Jacks and Couplers
- LC/SC/MPO Connectors and Couplers
- Coax, Multimedia modules

KEYWERKS Patch Cords & Cable Assemblies

- Cat5e/6/6A RJ45 patch cords
- LC/SC fiber patch cords
- MPO trunks and custom cable assemblies

KEYWERKS Twisted-Pair Cables

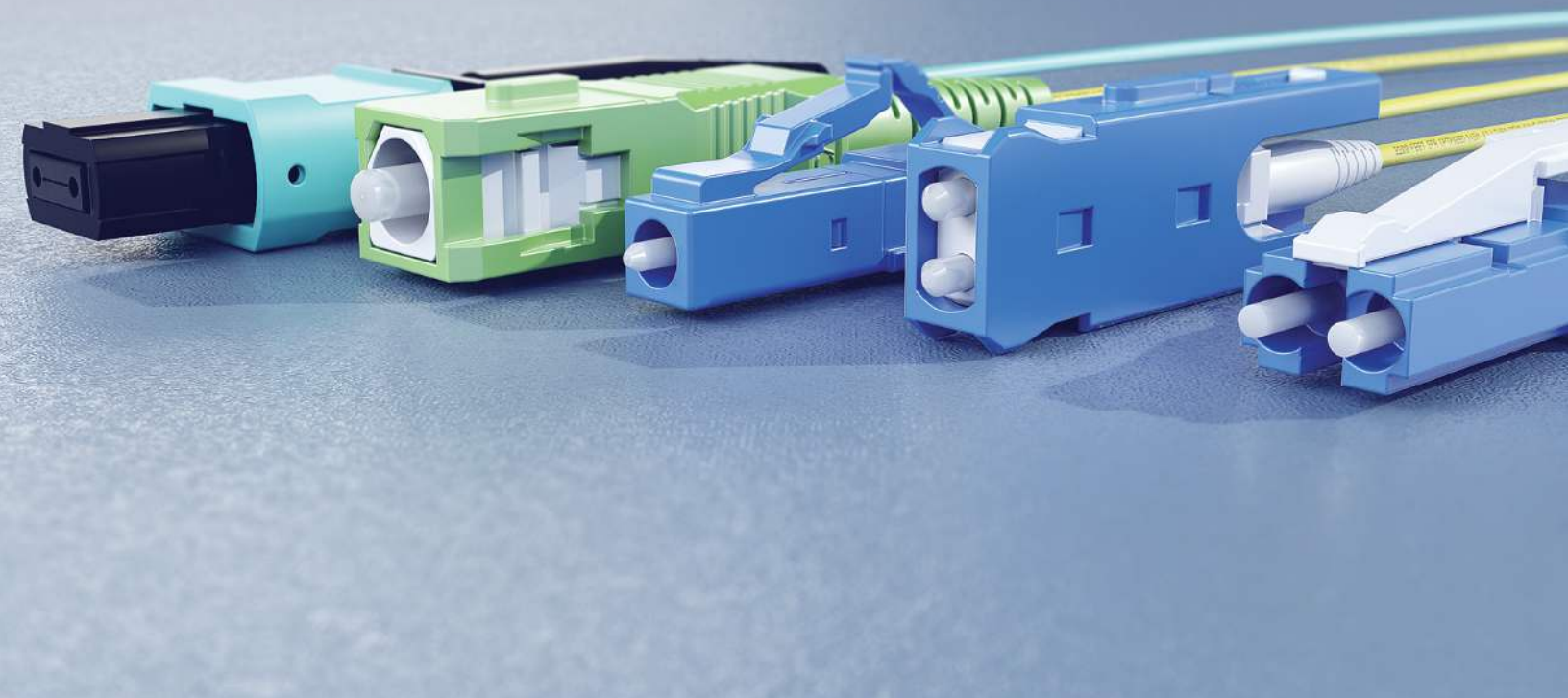
- Cat5e/6/6A certified
- U/UTP, F/UTP, F/FTP designs
- Plenum/Riser/General Purpose applications
- CMP/CMR/CM, FT6/FT4/FT1 flammability ratings

KEYWERKS Faceplates, Bezels, Boxes

- PVC, stainless steel
- Decora faceplates & bezels
- Surface-mount boxes
- Industrial Ethernet IP67 connectors, faceplates, boxes

KEYWERKS Field Term Products & Accessories

- Cat6A UTP/FTP RJ45 Field Term Plug
- LC/SC Splice-on Connectors
- Punch-down tools, fiber splice tools, accessories



High-Performance Cable Assemblies

FIBER AND TWISTED-PAIR PLUG-AND-PLAY CONNECTIVITY SOLUTIONS

Make outstanding network connections with **Wirewerks** ultra-reliable, high-performance fiber and twisted-pair cable assemblies.

Wirewerks engineers and manufactures a complete line of optical fiber and twisted-pair cable assemblies, available in popular standard configurations or custom-manufactured to customer specifications. Fiber products include patch cords, pigtails, MPO cable assemblies, node service cable assemblies and multi-fiber distribution assemblies. Twisted-pair products include patch cords, pigtails and trunk assemblies. “Pre-term” solutions are available in both fiber and copper media.

It's In Our DNA

Cable Assembly manufacturing has been a Wirewerks core competency since the company was founded more than 30-years ago. Today, our Cable Assembly product line continues to be an important element of our over-all product mix, fueled by supply agreements with major communications service providers and data center operators, and by wide use in virtually every enterprise network application.

AT A GLANCE

- Complete line of fiber and twisted pair cable assemblies
- Step-by-step product configurators simplify ordering and eliminate order errors
- Precision fabrication in Wirewerks facilities under stringent quality control procedures
- Factory-terminated connectors by skilled specialists assures highest quality and performance with little unit-to-unit variability
- 100% testing means zero out-of-the-box failures
- Guaranteed performance and comprehensive Product Warranty Program

The Trend Today Is Plug-and-Play

Many network operators are moving away from field terminated connectivity in favour of factory-built Cable Assemblies whenever possible.

- Avoiding field terminations expedites installation and operations, reduces tech time and costs, improves termination quality and network reliability & performance.
- Technician skill levels vary, resulting in variable productivity rates, variable quality of workmanship, and variable performance that can negatively impact network performance and reliability.
- These variable factors increase cost, impact network performance and reliability, and may complicate manpower/project scheduling and cost control.

As a result, network designers are opting for plug-and-play connectivity strategies throughout their networks and turning to trusted suppliers like Wirewerks for the high-performance Cable Assemblies that simplify deployments, maximize performance and reliability, and reduce costs.

Proven Process Yields Virtually Perfect Results

Over thirty-years of experience has taught us that an effective Total Quality Program must reach beyond the factory floor. Our program starts with expert technical assistance to ensure proper cable assembly design, and uses step-by-step product configurators to virtually eliminate ordering errors. Orders then move on to our purpose-built, dedicated cable assembly manufacturing facility where experienced technicians use state-of-the-art equipment and processes to build each assembly precisely to customer specifications. Finally, we perform 100% testing of all assemblies and package carefully, ensuring that all Wirewerks Cable Assemblies arrive on-site exactly as-ordered, performance certified, and ready for installation.



SOLUTION SUITE

Wirewerks manufactures a complete line of optical fiber and twisted-pair **Cable Assemblies**. Choose from a massive selection of standard types, lengths, media and connector combinations, or order custom products built to your exact specifications in our dedicated production facility. Our virtually error-proof ordering process, precision manufacturing, 100% testing, and certified performance means 'ready to plug-and-play' Cable Assemblies with zero out-of-the-box failures.

Wirewerks Fiber Cable Assemblies

- Fiber Patch Cords & Pigtailed
- MPO Cable Assemblies
- Node Service Cable Assemblies
- "Pre-Term" SM/MM Fiber Solutions

Wirewerks Twisted Pair Cable Assemblies

- Cat5e/6/6A UTP/FTP Patch Cords
- Cat5e/6/6A UTP/FTP Pigtailed
- Cat5e/6/6A UTP/FTP Trunk Assemblies
- "Pre-Term" Cat5e/6/6A UTP/FTP Solutions



Enabling Agile Network Expansion

For 30+ years, Wirewerks has delivered award-winning advanced fiber and copper connectivity solutions, enabling agile network expansion across the Broadband, Enterprise and Data Center markets.

We Know the complexities you face in transitioning to new network technologies.

We Understand the need to upgrade efficiently and sustainably to meet the demands of higher throughput and lower latency.

We Provide structured cabling solutions that integrate smoothly today, and prepare you for the network expansions of tomorrow.

The Power of **We.**
With **Wirewerks.**