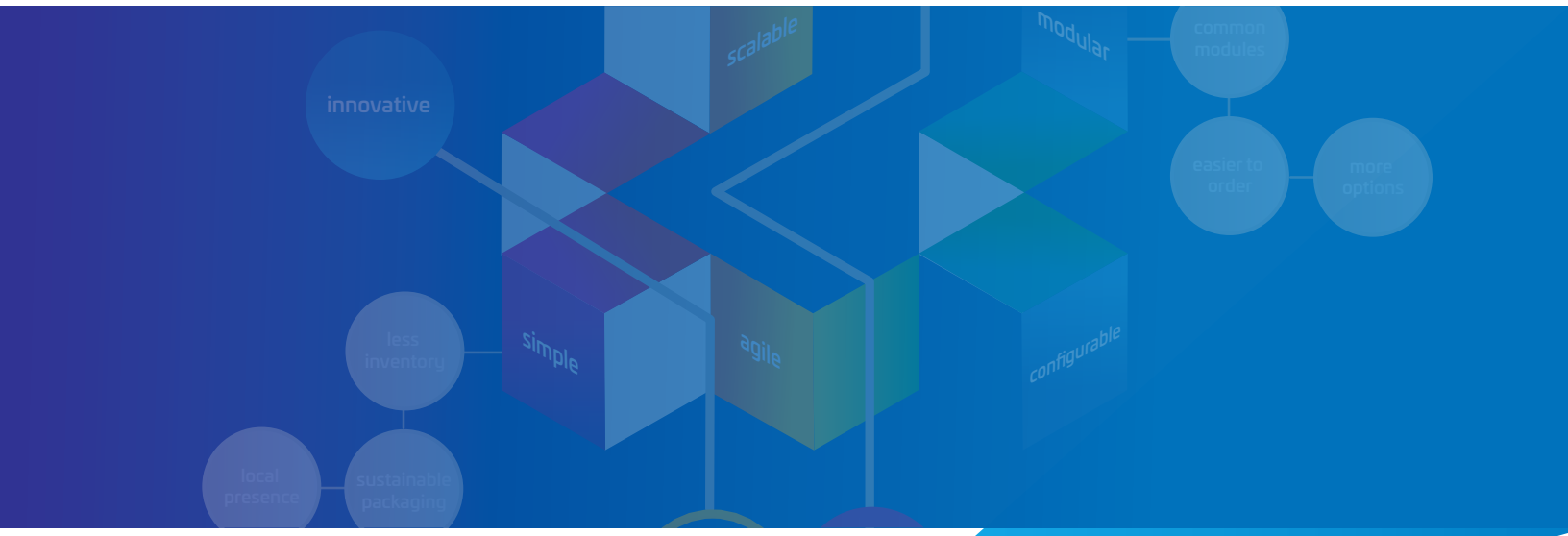
COMMSCOPE®

The Transformational Journey to a Modular FTTH Connectivity Ecosystem

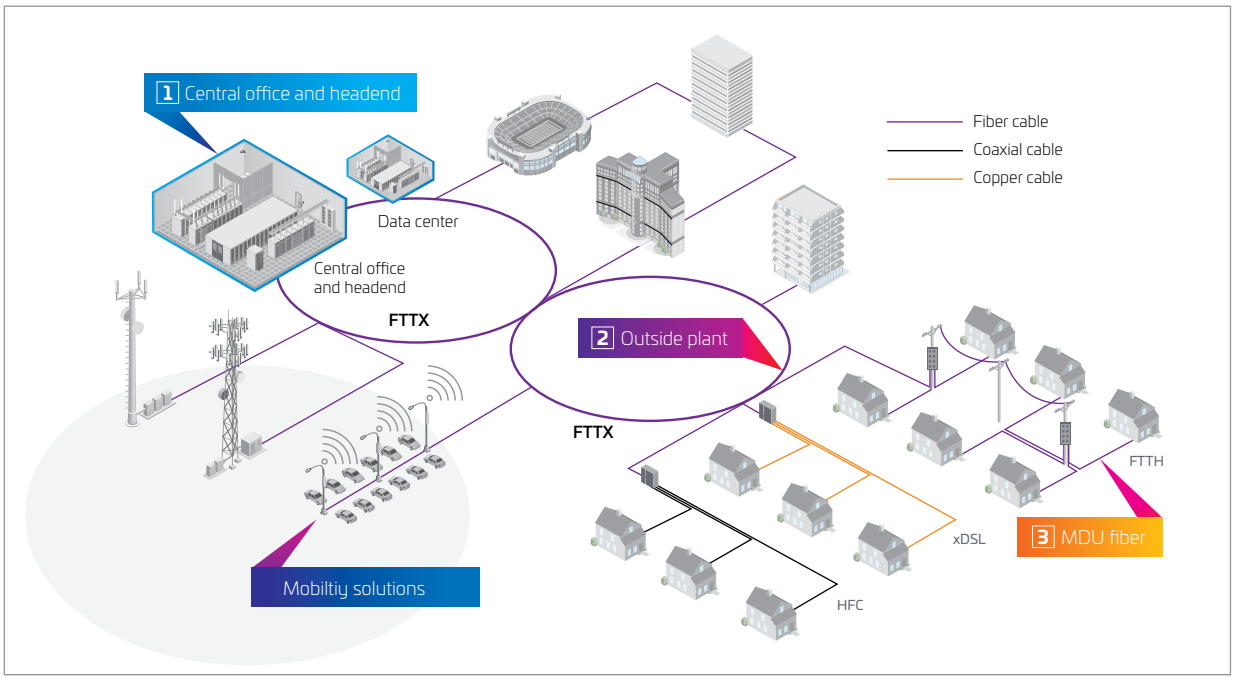
How CommScope reimagined connectivity around configurability, scalability and simplicity



Introduction

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

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



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

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

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

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

Industry Trends and Challenges

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

Fiber Deeper in the Network

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

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

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Shortage of Skilled Labor

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

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

Rapid Technology Evolution

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

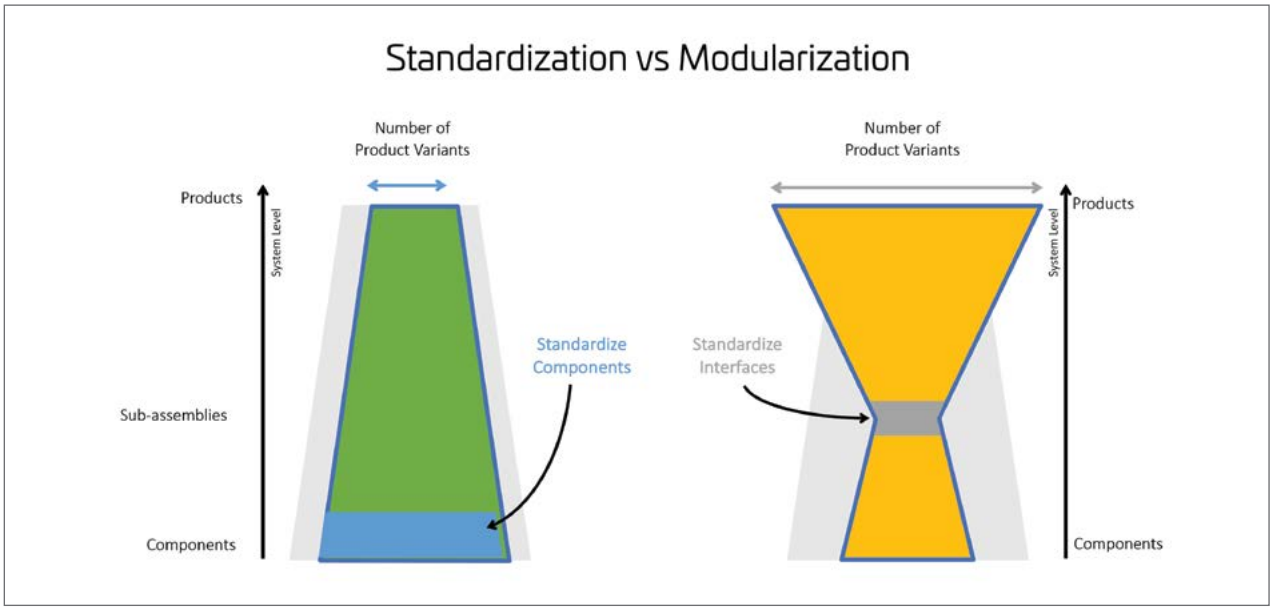
Changes in the Competitive Environment

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

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

Modular Design: A New but Well-Proven Method

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

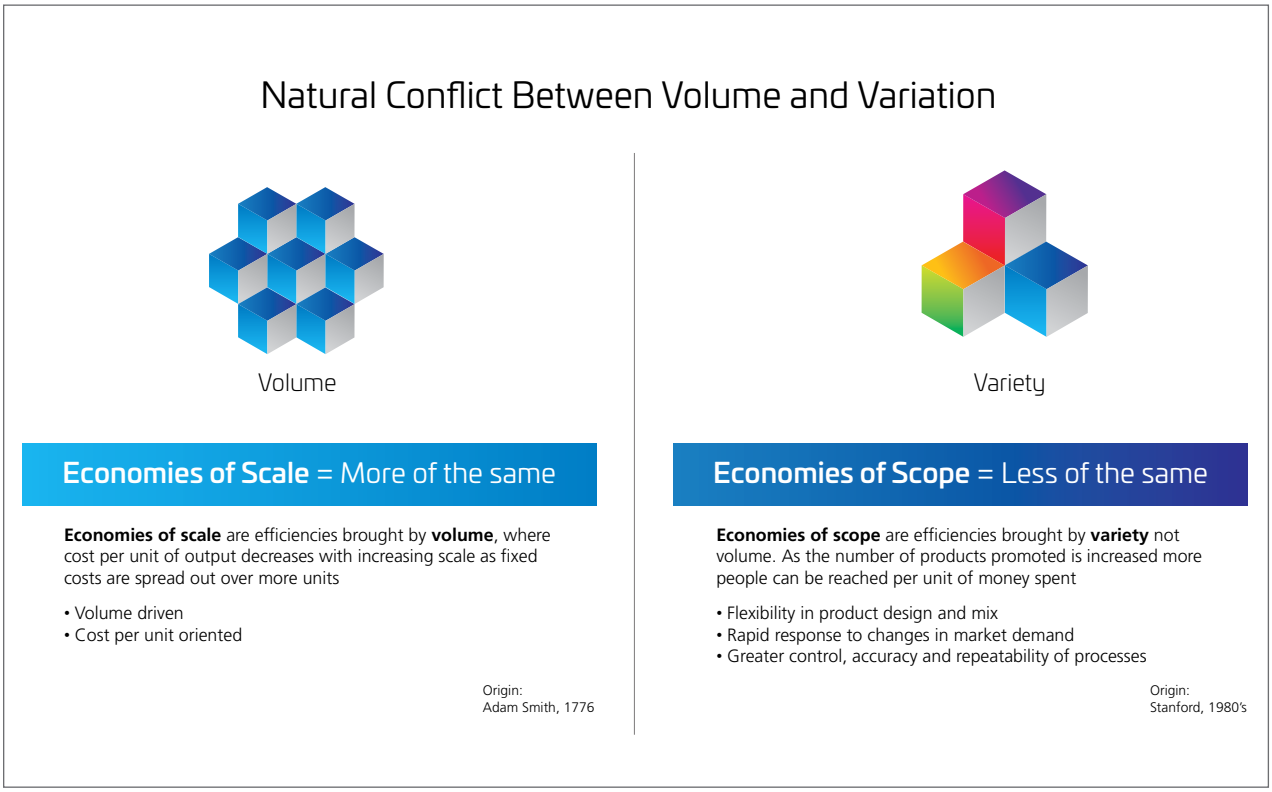


CommScope then examined the principle of modularity. The key to modularity is that interfaces are standardized. Therefore, components with these interfaces can be connected in any configuration that suits a service provider's technology and architectural requirements. This presents an elegant solution for product sets that must keep volume and variation in balance. Looking at FTTH through the lens of modular design, CommScope that knew it would have to rethink and retool all its processes. This would require the help of an expert: Modular Management, an organization that has helped numerous companies across a variety of industries undergo similar transformations to modularity.

Modular Management quickly noted the similarities between the principle of modularity that applies to fiber connectivity and a familiar childhood toy. Lego® bricks provide an endless source of entertainment because the same set of building blocks can be used to build a race car, a train, or even a spaceship. No matter the shape or purpose of the pieces, they all

have the same "studs" that connect them to one another; the interfaces are standardized. The result is high customer satisfaction and hours of fun, with interfaces that make Lego products extremely configurable, scalable, and simple.

Modular Management had helped one of its customers, Whirlpool, with a similar challenge. The world's leading appliance company sought to expand its line of high-end microwave ovens to address a wider range of customers and keep up with evolving technologies and trends. The challenge for Whirlpool had to do with the knob and display configurations of its existing products, where every change in functionality required a new printed circuit board. By applying the principle of modularity and standardizing interfaces, Whirlpool reduced the number of unique parts that go into its microwaves by 35 percent.



Graph courtesy of Modular Management

In this example, it's clear that modularity, unlike platforming, provides both scale and scope. Scale refers to volume and the ability to turn up production capacity to meet market demand and scope refers to the ability to provide a wide variety of products such that the exact configuration needed for any project is available. As more unique solutions are needed in the future, products can be easily configured from the common, modularly designed interface and manufactured at a scale that meets the required demand.

As with Whirlpool, Modular Management helped Bosch Thermotechnology achieve significant efficiencies when it implemented a modularity program across its heat pump product line. This resulted in 60 percent fewer part numbers, a 40 percent reduction in inventory, a 50 percent reduction in assembly time, and required 66 percent less floor space.

Where Modularity Helps Most

What do the best candidates for modularity have in common?

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

Vision of a Modular FTTH Ecosystem

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

NOVUX™

Configurable Scalable Simple

Enable fiber deeper in the network

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

Deploy fiber with less skilled labor

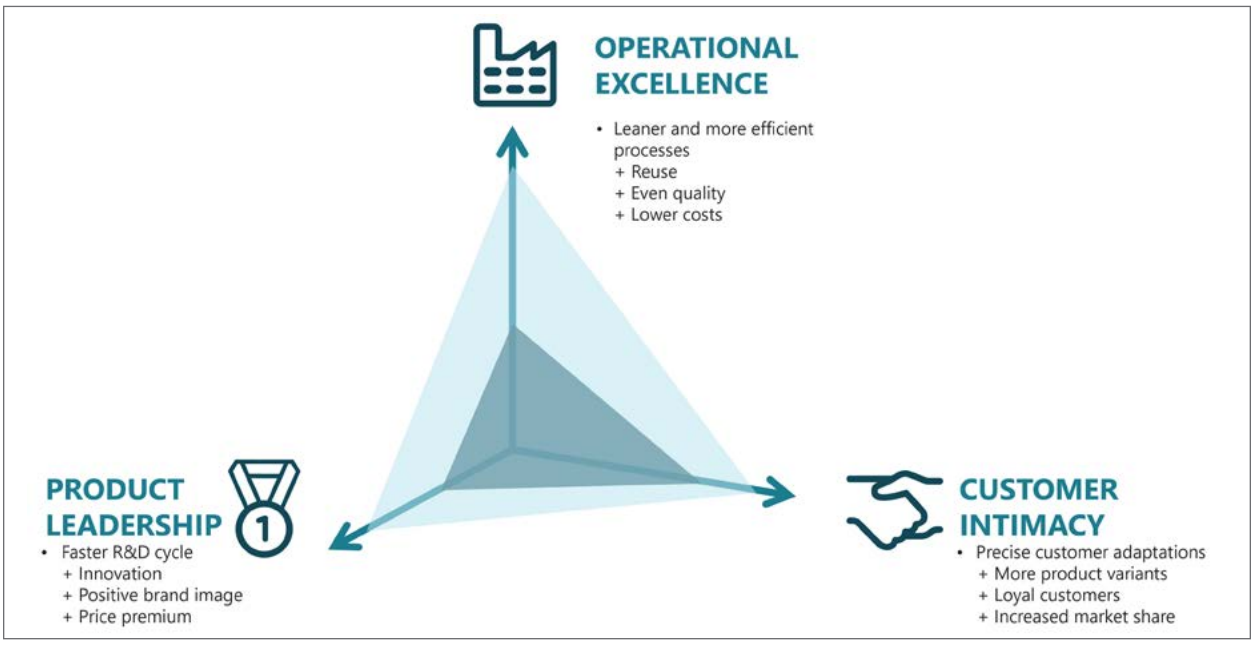
With a modular approach to fiber connectivity, installers only need to be trained one time on the installation and assembly process, which is common across the modular system. Regardless of the configuration an installer encounters in the field, the installation process will be easy to recognize, making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

Keep up with rapid technology evolution

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

Address changes in competitive environments

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



Graph courtesy of Modular Management

New System Architecture Design from the Ground Up—Years in the Making and Transformative in Nature

CommScope embarked on a multi-year transformational journey not only toward modularity, but toward a new multi-discipline approach to product development. Traditionally, product design had been reactionary and focused on meeting a specific customer need as it arose, with little or no consideration on how the product fits into the total network layout. But CommScope's new methodology calls for anticipating the configurations that will serve the needs of many customers and building solutions with commonalities in mind. The goal for the company is to create a market-oriented product architecture that can deliver both the scale and scope required to serve its customer's needs for FTTH connectivity.

Much like when an architect designs a new house, the goal is to meet the needs of various occupants for decades to come. Rather than designing for one customer, this approach required designing for 90% of the customer base. CommScope had to first develop a complete understanding of all FTTH applications and make upfront choices to lay a solid foundation. To do this, the company underwent an unprecedented process of market assessment to understand critical industry and technology drivers; features and functions for specific segments and customer needs; and—equally important—specific preferences, which were gathered in sessions with dozens of large and small service providers and third party installers around the world.

CommScope considered the similarities and differences in the various segments of the network. For example, the trunk, usually at the plant or central office, requires many connections, but once they are installed, they rarely have to be touched unless there is a problem. At the drop, however, there are fewer connections inside each enclosure so the size can be smaller. In addition, continued access is necessary and less-skilled technicians are common, so plug-and-play connectivity is preferable to fiber splicing in these devices. Because every customer has its own way of planning and organizing fiber in the network, CommScope had to look at the network topologies of each customer and review their needs thoroughly to find commonalities.

CommScope encountered several challenges along the way and overcame them through a careful design optimization process. Product size is one of the regional preferences. In North America, service providers prefer slightly larger products because that has a benefit for installation. The bigger the product, the easier it will be for the installer, who can reach all the components and perform the fiber splicing, cabling, and installation. In Europe, smaller products are preferred because of the space limitation and the requirement to fit them into smaller pedestals, handholes, etc.

With a solid foundational architecture map in place and a selected "philosophy", CommScope started creating the individual products. Execution began with 10 projects, 14 configurations in scope that fit the end-to-end outside plant portfolio. This new modular design methodology required a new R&D organizational structure, which CommScope put in place not only to perform the work but to ensure adherence to this architecture for future decades. CommScope now has a system architecture team that owns the direction and can maintain it going forward. Today, each request from a customer for a new product is immediately routed to the architecture team to fulfill it with CommScope's existing modules and interfaces.

Raising the Bar: Key Design Areas for Functionality Improvements

One important design requirement given to the R&D team was to improve the application range of the portfolio with the new modular design and, where applicable, to maintain backwards compatibility to help customers easily adopt the new products.

Fiber Closure Sealing Redefined

CommScope's product line includes 50 different gel blocks to protect fiber within the split enclosures, and each enclosure model has its own sealing methods. There isn't any family resemblance within the closure sealing products, and sometimes there are wide variances among sealing products.

The characteristics differ based on whether the enclosures are to be used in the trunk, feeder, or drop portion of the network. Each of these areas has different requirements for sealants based on its needs for reliability, installability, flexibility, and speed. For example, reliability takes precedence in the trunk, but once a fiber closure is fitted it rarely needs adjustment. At the drop, however, flexibility is important because technicians need to regularly access to the enclosure.

Fiber sealing closures need to accommodate a variety of cable sizes. But, historically they have been specific to a narrow range of cable diameters, meaning installers have to be trained to use many closure sealing types and to make sure that they stock the truck with the right products for the job. And when a cable is removed, the hole it leaves needs to be filled with a series of blank plugs, which are often misplaced.

One innovation CommScope brought to bear throughout its transformational journey is a new silicone gel. The hyper-elastic behavior of this material allows a single sealant to cover a wide diameter range of cables and jacket thicknesses. It can be deformed extensively and still return to its original shape, and, in many cases, it is activated by simply latching the closure. This means that a less-skilled workforce can achieve the proper results and the gel can be used in a wide variety of applications. Technicians can be trained once to use the family of gel block products since the installation method is common across closures.

The size issue also has been mitigated. One gel block covers cables ranging between 0-18 mm (0-0.7 inches) in diameter. The same closure that once required seven to eight different gel blocks based on varying cable diameters now requires only three. Another benefit is that the new gel blocks are optimized to increase the surface contact and, in some cases, are flat making it easy for technicians to slide new cables into an enclosure, and eliminate the need for technicians to carry blanks to plug empty holes when a cable is removed.

Universal Mounting System

Because fiber closures and terminals need to be installed in various locations and affixed using different methods, CommScope's line of mounting products grew to at least 224 options to accommodate this diversity. There are mounting products for underground, cabinet, pedestal, and strand deployment, many of which have four to five different metal mounting brackets associated with it depending on the installation type.

Pole mounting

Universal cable bracket with overlength

Strand mounting

Pedestal mounting

Flat surface mounting

The tools required for installation also differ; with one mounting system requiring a standard screwdriver, and another using a hexagon shaped tool. Installers face the challenge of making sure they have the correct mounting product, bracket, and tool in the truck for every job. This also creates unnecessary costs for service providers, who need to keep a large assortment of mounting products and brackets on-hand.

CommScope simplified its mounting system by making it modular and universal. The same mounting product can be used across every installation location, with the only variation being the unit's size. The brackets, which are now made of plastic and less expensive, all use the same "snap-in" interface to connect—no tools are required. With this shift to a modular design, CommScope has not only simplified installation substantially, but it has also reduced the number of mounting products that it manufacturers to five. This is a 98 percent reduction when compared to the original 224 product variations.

Field Identification and Customization

In many of the information gathering sessions with customers, they said that they like to see their own logo on the outside of their products for branding and differentiation. They also want the option to place their logos internally, particularly where a closure or terminal is shared by multiple service providers. To accommodate this desire in the past, CommScope created a series of mold inserts that inscribed each customer's logo directly onto the product. While this traditional method this was not expensive for a single product mold, the cost added up since multiple molds are used to create each product variation. Each time a customer went through a merger, acquisition, or name change, new mold inserts needed to be created. Not only did this make logo changes expensive, but it was also time-consuming. Updating a customer's name or logo on a mold took approximately two to three months.

With modularity as a guiding force, every product in CommScope's NOVUX product line will have a designated area with an interface that can hold a branded ID plate. If the customer wants to add or change a logo, a new ID plate can be printed within an hour. The same plate can be used for the entire range of products, both externally and internally, for example, on the outside of a closure or the inside of a cable tray.

Today, these ID plates carry a QR code that is linked to a product's installation instructions or any other information the customer wishes, including specifications, videos, schematics, and test results. All product information is now available to the installer with one-click on a smart phone app. In the future, these ID plates can hold an RFID tag, which can speed identification, improve monitoring, and provide additional information to technicians. Modularity has transformed customer branding from a time intensive project to an easy to implement and competitive edge.

Cable Termination Units (CTUs) All-in-One

At CommScope, a CTU is the interface that holds the cable in place. Traditionally, every product had its own type of cable attachment, which resulted in a product line that comprised 134 CTUs. They differed based on cable size and whether the cable was being installed inside or outside of a closure.

CommScope took the opportunity to simplify things by moving the cable attachment point to the outside of its products and standardizing the CTU interface. To provide service providers with flexibility, multiple cable attachment options are available using the same CTU, including Kevlar® wraps, metal clips, and screw-in strong metal fixation. This means that installation is the same no matter how large or small the closure and that the service provider can attach any size cable without using a wide variety of CTUs.

In the CTU space, the company has reduced the number of attachments by 85-90 percent to 12-13 modules.

Delivering all FTTH-Viable Configurations with a Phased Rollout Based on Market Needs

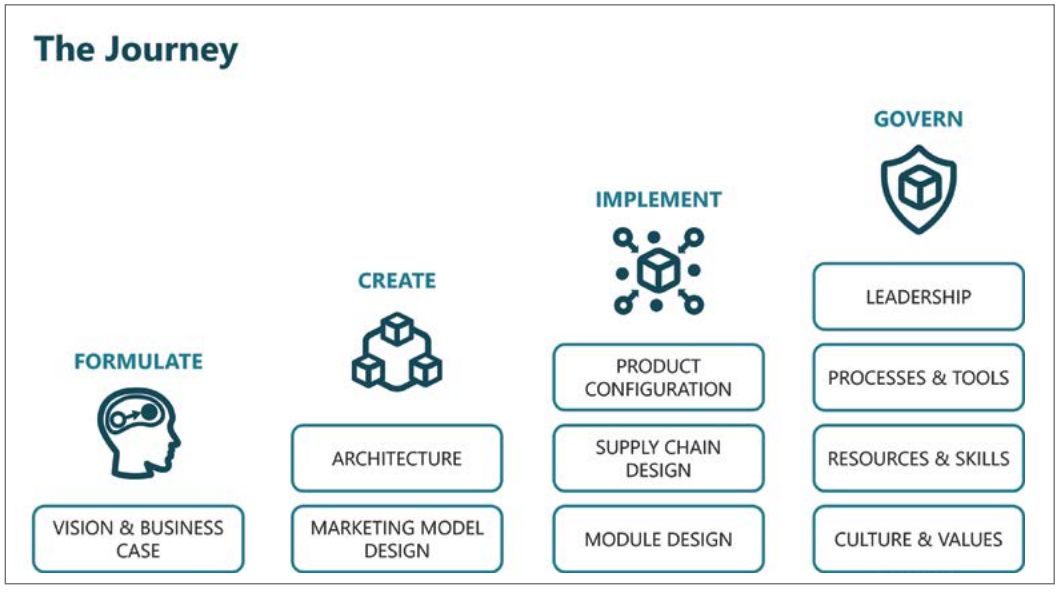
CommScope's modular FTTX ecosystem now provides a platform from which all FTTH-viable network architectures and applications for new builds and upgrades can be built today—and for decades to come. Several closures and terminals are available today and more are in development.

NOVUX closures and terminals*					
Technologies	**Dome closures**	**Inline closures**	**Compact closures**	**Hardened closures**	**Hardened terminals**
Standard	●	●	●	●	●
Optical tap	●	●	●	●	●
WDM	●	●	●	●	●
Multi-fiber		●	●	●	●
Fiber indexing			●		●
Pre-cabled	●		●		●
Multiple sizes	●	●	●	●	●
Other	Specialty closures and terminals				
*Development for specific NOVUX components is ongoing. This chart represents CommScope's road map for prospective future releases.					

CommScope determined that the best place to begin the new modular architecture product roadmap was in the drop and distribution part of the network—an area of growing market demand and a need for many product configurations. Also, with the growing interest in plug-and-play connectivity, the focus was placed on the company's hardened terminals. Within this segment, CommScope had solution gaps that needed to be filled first and then the task turned to reducing the existing portfolio by implementing a modular approach.

In addition, this modular ecosystem allows CommScope to offer new products for increasingly diverse distribution and drop network applications. These solutions, which include specialty closures, allow fiber to go deeper into the network, serving evolving needs for broadband connectivity with agility and flexibility.

CommScope is in the early days of new product releases, and the company is holding ongoing discussions with service providers and installers to chart a course to what's next. CommScope is combining its powerful vision for modular FTTH connectivity together with its industry-leading expertise to usher in a new era of modular connectivity.



Graph courtesy of Modular Management

Conclusion

Solving today's FTTH challenges with an eye on the future by anticipating industry evolution and needs gave CommScope the opportunity to think differently and take a completely new approach to product design. Modular design, a proven methodology in other industries with similar challenges required the team to create a new end-to-end operational framework from R&D, Operations, Marketing, Sales, Field Applications Engineering and Customer Service.

While the undertaking is a massive one, which presented many challenges along the way, the results of this transformational journey are extremely encouraging. For example, one target of this modular architecture design was a 75 percent reduction in components. CommScope more than met this goal in the hardened terminal market, while increasing the number of configurations from 2,500 key variants before modularization to 162,000 configurations after. Another goal the company set early on was a reduction in time to market for new products. Using modular components and standardized interfaces, CommScope has reduced the time to create new configurations from four to six weeks to one day.

By building its modular FTTH connectivity portfolio around the three core principals of configurability, scalability, and simplicity, CommScope is helping its customers solve some of the most important issues in optical networking. Service providers can reduce the variety and volume of products they need to stock significantly. They are finding it easier to train technicians and seeing an improvement in the quality and success of their installations. They are also moving faster through reduced product delivery times and the ability to quickly configure the solutions they need.

CommScope's journey of evolving its fiber connectivity solutions continues, with new products scheduled to enter the market in the next years. And, with the foundation in place, the new system architecture built on modular design makes it easy for customers to provide input on the focus and priorities for new product introductions. The company's ongoing product design remains guided by the principle of modularity and the collaboration of an experienced, extended team.

To learn more about CommScope's modular FTTH connectivity solutions, visit our NOVUX web page

CommScope pushes the boundaries of communications technology with game-changing ideas and ground-breaking discoveries that spark profound human achievement. We collaborate with our customers and partners to design, create and build the world's most advanced networks. It is our passion and commitment to identify the next opportunity and realize a better tomorrow. Discover more at commscope.com.

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Visit our website or contact your local CommScope representative for more information.

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