COMMSCOPE®

White paper

Fiber backbone cabling in buildings

Contents

Introduction

Until recently, the horizontal cabling in most buildings was designed to support speeds up to 1 Gbps to the desk, with 1000BASE-T considered ample bandwidth for horizontal applications in enterprise buildings. However, recent advances in wireless technologies have pushed horizontal bandwidth beyond 1 Gbps—and the broad adoption of these technologies is a herald of a broader need for faster network speeds elsewhere in the horizontal and backbone network.

Specifically, the newest generation of IEEE 802.11ac Wi-Fi access points support wireless speeds up to 6.9 Gbps. To provide sufficient backhaul bandwidth for these devices, the 2.5GBASE-T and 5GBASE-T application standards were developed as IEEE 802.3bz, defining 2.5 Gbps and 5 Gbps Ethernet interfaces over high-performance twisted-pair copper. The first commercial implementations of these new interfaces are designed to auto-negotiate up to 10 Gbps (10GBASE-T) if supported by the cabling infrastructure. Additionally, leading-edge in-building wireless (IBW) systems require fiber or copper connectivity to the access point based on 10GBASE-T technology.

As these technologies become the new normal, the greatest bandwidth impact rests on network backbones. So perhaps, unsurprisingly, emerging standards of backbone speeds are mapping a migration from 10 Gbps to 40 Gbps—and even to 100 Gbps—with the latest fiber-optic technologies. Initially developed for data center applications, these technologies are now routinely considered for building backbones.

Backbone cabling speeds

As a practical matter, building backbones have traditionally been designed to exceed the horizontal requirements by a factor of 10. To illustrate, a 100 Mbps horizontal requirement typically uses a 1 Gbps backbone, while a 1 Gbps horizontal requirement calls for 10 Gbps in the backbone. Therefore, in order to maintain this relationship, any increase
in horizontal connection speed triggers the need for a similar increase in backbone speed.

Because 1 Gbps is giving way to 2.5, 5, and even 10 Gbps horizontal standards for many networks, any new construction or retrofitted backbone infrastructure should be specified to support speeds of at least 40 Gbps—and ideally 100 Gbps.

The new king of speed and bandwidth: OM5

The newest fiber-optic infrastructure capable of these speeds is OM5 wideband multimode fiber, which supports emerging low-cost shortwave wavelength division multiplexing (SWDM) applications that increase speed and bandwidth with fewer fibers than comparable parallel fiber-optic solutions. In fact, OM5 can transmit 100 Gbps using just two fibers rather than the eight required for a typical parallel fiber application.

You can see the evolution of horizontal and backbone speeds from the earliest days of fiber infrastructure to the latest OM5 standard in Figure 1 below.

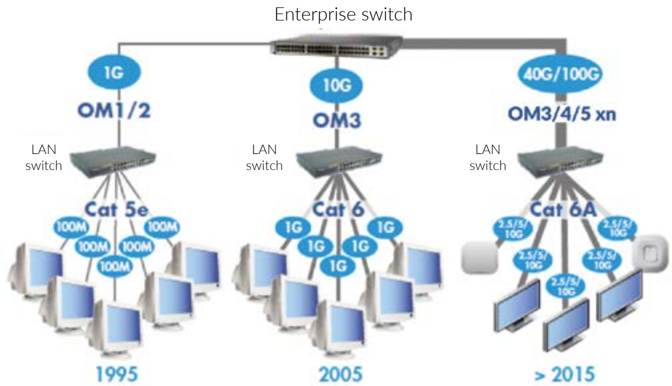

Figure 1. Enterprise LAN cabling timeline

Fiber in the backbone

First, let's map the backbone and where it connects. Backbone cabling provides interconnections between access provider (AP) space, entrance facilities (EFs), equipment rooms (ERs), telecommunication rooms (TRs), and telecommunication enclosures (TEs) (see Figure 2).

ANSI/TIA-568.3-D recommends deploying a hierarchical star topology for the backbone, with no more than two levels of cross-connections. For the simplest design, the main cross connect (MC) in the ER feeds directly to the horizontal cross connect (HC) in the TR on each floor, as shown in Figure 2. Optional intermediate cross connects (IC) may be positioned between the MC and HC.

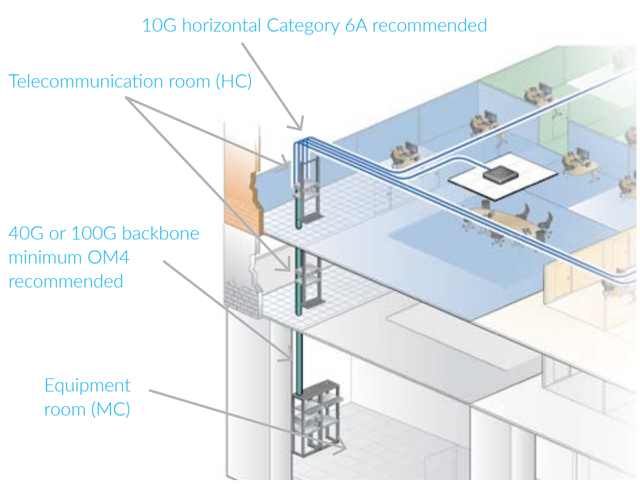

Figure 2. Building backbone cabling system

The standard recognized transmission media for backbone cabling are multimode and singlemode fiber. Laser-optimized 50/125 µm (OM3 and OM4) multimode fiber has traditionally been recommended for 10 Gbps building backbones up to 300 meters (OM3) and 550 meters (OM4), based on the lower overall total system costs when compared with singlemode fiber and optical transceivers. Singlemode fiber is typically installed where the channel lengths are expected to exceed the specified distances of multimode fiber, such as providing 10 Gbps over distances longer than OM4's 550-meter limit.

10 Gbps fiber backbone

10 Gbps backbones utilize serial transmission with standard two-fiber duplex cabling, in which one fiber transmits and one fiber receives. A 10 Gbps channel typically consists of backbone cables that are field terminated or fusion spliced using LC connectors. Duplex LC patch cords are used to connect the backbone cabling to active networking equipment, as shown in Figure 3.

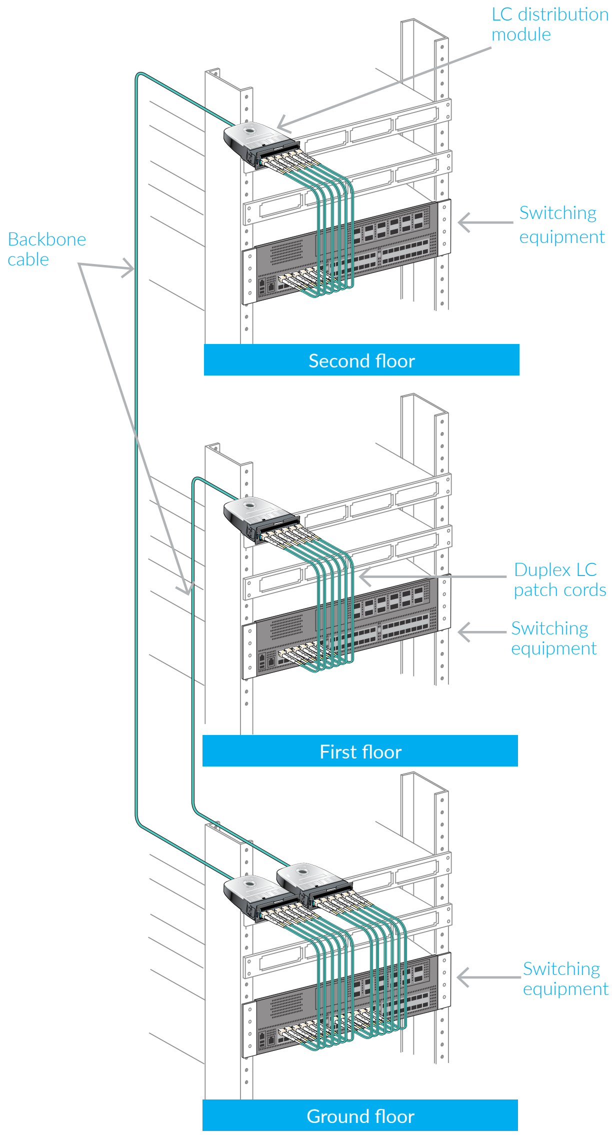

Figure 3. 10 Gbps fiber backbone channel

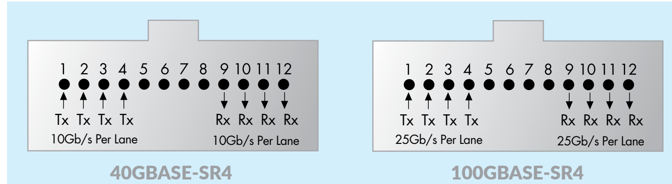

Figure 4. 40GBASE-SR4 and 100GBASE-SR4 transmission schemes

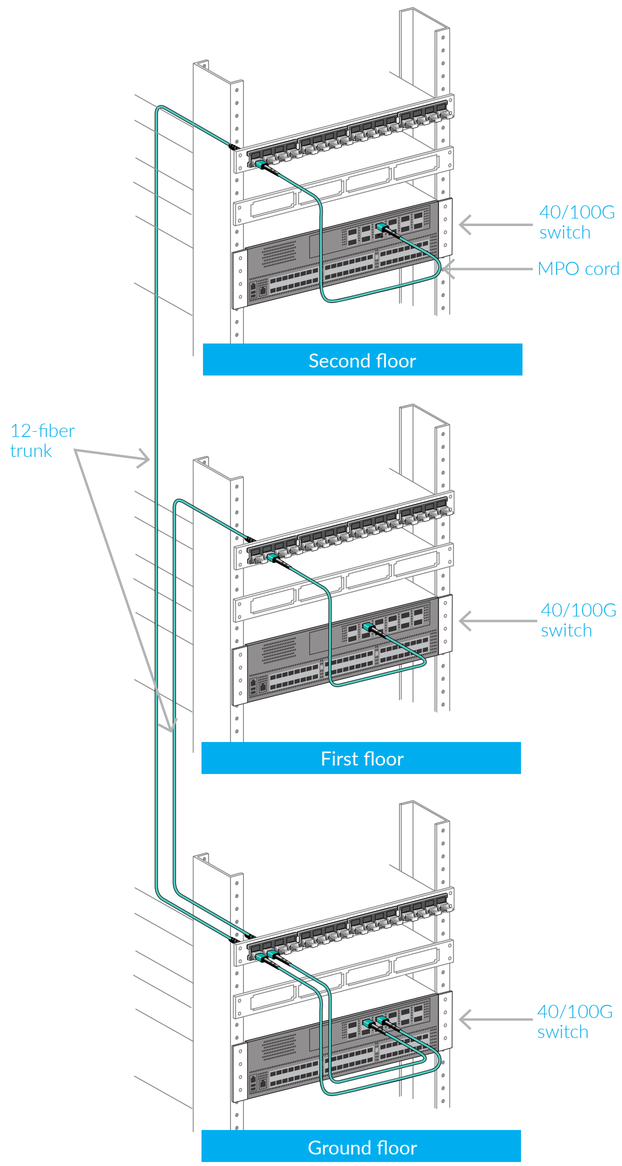

Figure 5. 40GBASE-SR4 and 100GBASE-SR4 channel

Migrating to 40 Gbps and 100 Gbps

Unlike 10 Gbps backbones, which utilize serial transmission, the latest generation 40 Gbps and 100 Gbps multimode applications utilize a parallel transmission scheme. 40GBASE-SR4 requires eight fibers, in which four transmit and four receive at 10 Gbps each lane, and 100GBASE-SR4 requires eight fibers, in which four transmit and four receive at 25 Gbps each lane (Figure 4). In contrast to 10 Gbps backbones, multimode backbone channels capable of supporting 40GBASE-SR4 and 100GBASE-SR4 are typically deployed with preterminated MPO trunks, MPO pass-through panels, and MPO cords (Figure 5).

When migrating from 40 GbE to 100 GbE, 100GBASE-SR4 is frequently deployed, as it utilizes the same eight-fiber transmission scheme as 40GBASE-SR4—therefore providing minimal network interruption and the most seamless upgrade. Emerging 24-fiber MPO trunks cab be utilized to support multiple two- and eight-fiber applications between floors. As Figure 6 illustrates, by utilizing preterminated trunk cables in the initial 10 Gbps deployment, it is possible to seamlessly migrate from 10 Gbps to 40 Gbps and 100 Gbps speeds by repurposing the trunk cables and replacing the equipment or patch cords and distribution modules.

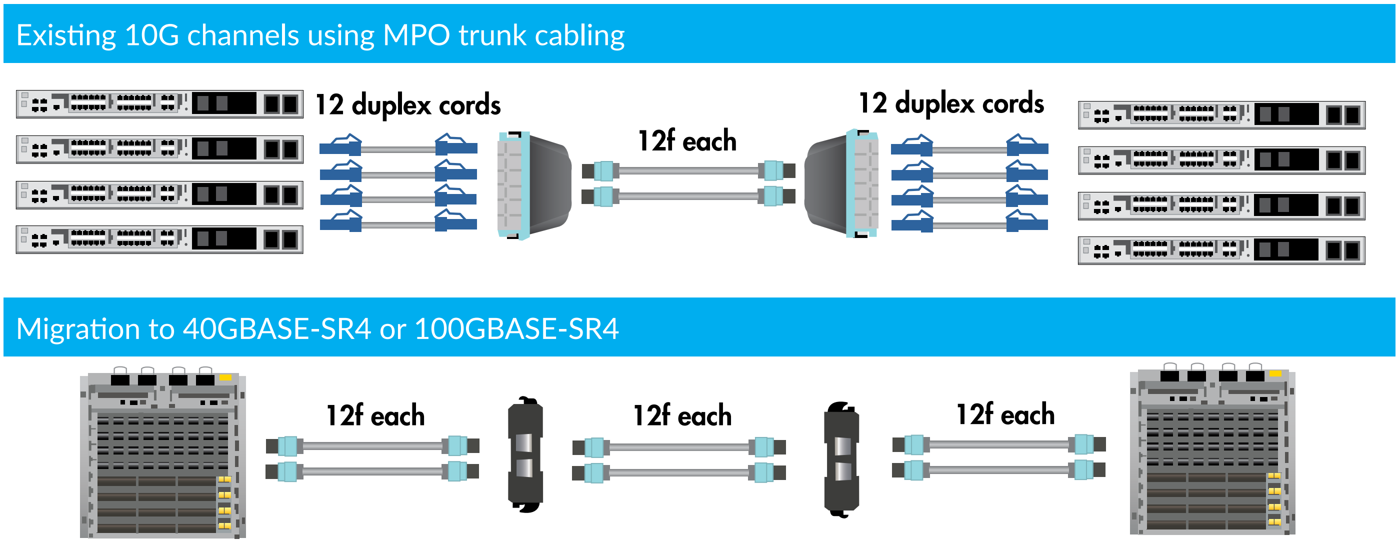

Figure 6. Migration from 10 Gbps to 100 Gbps

However, as a practical matter, preterminated MPO connectors can be a challenge to install based on the pathways and available space in conduits between floor. One of the main advantages of new OM5 wideband fiber is that it does not require the use of factory-terminated MPO connectors to support 40G and 100G applications. The fact that it uses serial transmission means it can be easily terminated in the field with LC or similar connectors after the cable itself has been installed—as is typically done today with fiber building cable supporting 10G backbone links.

Backbone distances

The IEEE 802.3ba standard defines the capabilities of OM3 and OM4 fiber to support 40G and 100G Ethernet applications.

While 10GBASE-SR has a reach of 400 meters over OM4, commercially available 40G and 100G systems are currently limited to 150 meters—or 100 meters in the case of 100GBASE-SR4. However, with extended-reach VCSELs, it is possible to reach 400 meters with 40 Gbps, facilitating a seamless migration from 10G to 40G. Similar extended-reach VCSELs are becoming available for 100G as the market develops, but—in situations where distances beyond 300 meters are expected—installing singlemode fiber alongside multimode will ensure that the backbone can accommodate speeds in excess of 40 Gbps. OM5 fiber provides extended distance support for 40G and 100G SWDM4 applications.

Backbone application	OM3		OM4		OM5	
	Standard specified max. distance	CommScope supported distance*	Standard specified max. distance	CommScope supported distance*	Standard specified max. distance	CommScope supported distance*
10GBASE-SR (850 nm)	300 meters (984 ft)	300 meters (984 ft)	400 meters (1312 ft)	550 meters (1800 ft)	400 meters (1312 ft)	550 meters (1800 ft)
40GBASE-SR4	100 meters (328 ft)	135 meters (440 ft)	150 meters (492 ft)	170 meters (560 ft)	150 meters (492 ft)	170 meters (560 ft)
40GBiDi	100 meters (328 ft)	100 meters (328 feet)	150 meters (492 ft)	150 meters (492 ft)	200 meters (656 ft)	210 meters (689 ft)
40GBASE-eSR4	300 meters (984 ft)	300 meters (984 ft)	400 meters (1312 ft)	500 meters (1640 ft)	400 meters (1312 ft)	500 meters (1640 ft)
40G SWDM4	240 meters (787 ft)	240 meters (787 ft)	350 meters (1148 ft)	350 meters (1148 ft)	440 meters (1444 ft)	470 meters (1542 ft)
100GBASE-SR10	100 meters (328 ft)	135 meters (440 ft)	150 meters (492 ft)	170 meters (560 ft)	150 meters (492 ft)	170 meters (560 ft)
100GBASE-SR4	70 meters (230 ft)	70 meters (230 ft)	100 meters (328 ft)	130 meters (427 ft)	100 meters (328 ft)	130 meters (427 ft)
100GBASE-eSR4	200 meters (656 ft)	200 meters (656 ft)	300 meters (984 ft)	300 meters (984 ft)	300 meters (984 ft)	300 meters (984 ft)
100G SWDM4	75 meters (246 ft)	75 meters (246 ft)	100 meters (328 ft)	100 meters (328 ft)	150 meters (492 ft)	150 meters (492 ft)

Table 1. Multimode fiber backbone cabling distances for 10 Gbps, 40 Gbps, and 100 Gbps applications

Note 1: Standard distances are based on two connections. For CommScope channels with more connections, please refer to "SYSTIMAX Applications Performance Specifications, Volume One".

Note 2: CommScope supported distance is applicable to installations eligible for registration for the CommScope 25 Year Extended Product Warranty and Applications Assurance

Existing installations and support for 40 Gbps and 100 Gbps

Support of 40 Gbps and 100 Gbps over existing multimode backbones may be accomplished with the use of an LC-to-MPO fanout connecting the existing LC connectors in the installed cabling to the MPO connector in the 40 Gbps or 100 Gbps equipment. As shown in Figure 7, the LC cord ends connect with the LC couplers in the shelf, while the MPO connector is inserted into the 40G or 100G transceiver. As the transceivers are always pinned, a fanout cord with an unpinned MPO connector is used.

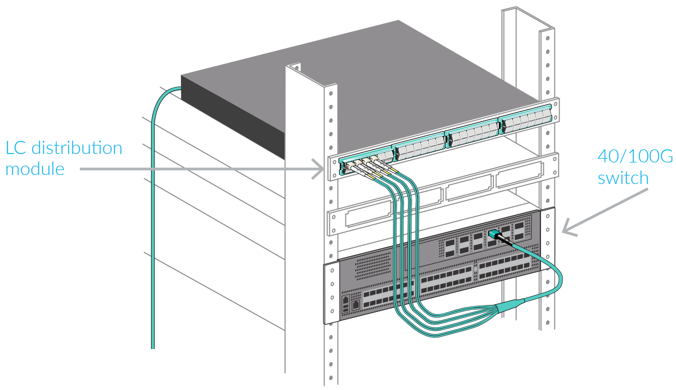

Figure 7. 40/100G switch connection with array cord

As shown in Figure 8, migration to 40 Gbps or 100 Gbps over OM5 wideband multimode fiber may provide a simpler and more cost-efficient solution as it can utilize the same two fibers used to support a 10 Gbps backbone.

Consult Table 1 for maximum distances supported, depending on the type of installed optical fiber and optical transceiver technology.

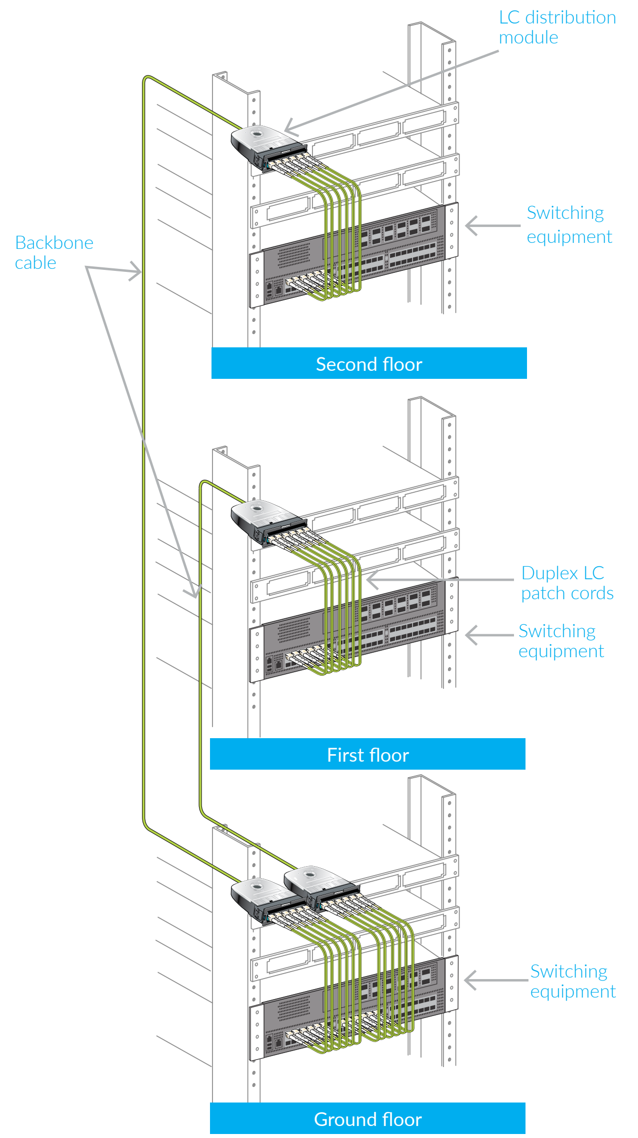

Figure 8: 40/100 Gbps fiber backbone with SWDM4 optics and OM5 fiber

Greenfield installations and support for 40 Gbps and 100 Gbps

For new installations, the use of preterminated MPO trunks offers faster installation speeds, factory-assembled performance, easier administration, and higher panel/shelf density. As shown in Figure 5, when the building backbone is deployed with preterminated MPO trunks, MPO patch cords are used to connect the MPO connectors in the installed cabling to the MPO connectors in the 40 Gbps or 100 Gbps equipment. As the transceivers and panel ports are always pinned, MPO cords with unpinned MPO connectors are used.

OM3 fiber is the minimum recommendation, with OM4 fiber strongly recommended to allow for added distance and/or connector pairs in a link. Customers requiring additional distance should consider the overall benefits of OM5. Consult Table 1 for maximum distances supported, depending on the optical fiber type and number of connectors.

When installing preterminated cabling in the buildings, care must be taken to ensure that the risk of damage to the preterminated ends is minimized during installation. Installing MPO-based preterminated fiber cabling in the riser requires that sufficient space be allocated and the IDFs on each floor are all located in line vertically. However, in cases where the IDFs are not aligned and/or sufficient space is not available in pathways, a conventional approach as described for existing installations may be appropriate. To protect the preterminated ends, the use of pulling socks is strongly recommended when installing preterminated cabling. Reusable pulling socks can be ordered to help ensure the MPO connectors are not damaged during installation.

While the use of preterminated cabling simplifies fiber management and increases panel density, one may instead opt for an OM5 wideband multimode fiber solution. As mentioned, its serial configuration permits easy field termination and smaller connectors that are easier to install. OM5 also provides better "future proofing" against emerging applications that may require speeds greater than 100 Gbps, which OM5 is capable of handling.

Conclusion

With continued growth in data rates in the horizontal driven by applications such as 802.11ac and in-building wireless solutions, the backbone must be able to accommodate speeds of 40 Gbps or 100 Gbps to maintain a comfortable tenfold differential. Planning for a seamless migration path to 100 Gbps—and beyond—ensures the backbone will be able to support high-capacity wireless and other high-bandwidth applications that may emerge. Installing the proper cabling today will extend the expected life of the structured cabling and reduce upgrade costs over time.

Everyone communicates. It's the essence of the human experience. *How* we communicate is evolving. Technology is reshaping the way we live, learn and thrive. The epicenter of this transformation is the network—our passion. Our experts are rethinking the purpose, role and usage of networks to help our customers increase bandwidth, expand capacity, enhance efficiency, speed deployment and simplify migration. From remote cell sites to massive sports arenas, from busy airports to state-of-the-art data centers—we provide the essential expertise and vital infrastructure your business needs to succeed. The world's most advanced networks rely on CommScope connectivity.

COMMSCOPE®

commscope.com

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

WP-109423.2-EN (09/17)