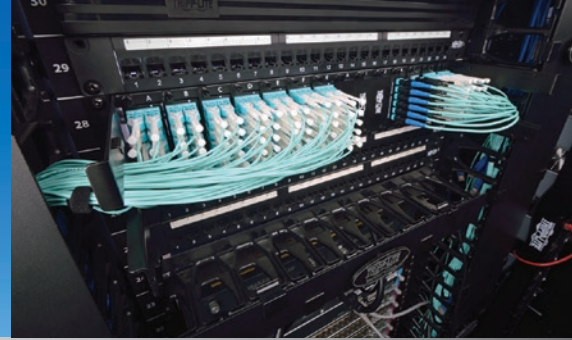




W H I T E P A P E R



Integrate 10 Gb, 40 Gb and 100 Gb Equipment More Efficiently While Future-Proofing Your Fiber and Copper Network Infrastructure

Executive Summary

Growing demand for faster access to larger volumes of data, coupled with emerging high-speed network standards and rapidly advancing technology, is having a profound impact on network infrastructure. As 40 Gb fiber becomes a standard option in data centers, the challenge of connecting 40 Gb switches to existing 10 Gb equipment moves front and center. Adding further complexity, it's clear that organizations of all sizes also need to be prepared to integrate speeds of 100/120 Gb and beyond. Custom breakout cables filled a pressing need when there were no other options available, but they also increase costs, delay projects and present an unpleasant scenario for upgrades and repairs. The emergence of modular patch panels provides a mature and highly scalable alternative to custom breakout cables. Modular patch panels conveniently integrate equipment of different network speeds to meet your connectivity needs today and cost-effectively future-proof your network for tomorrow.

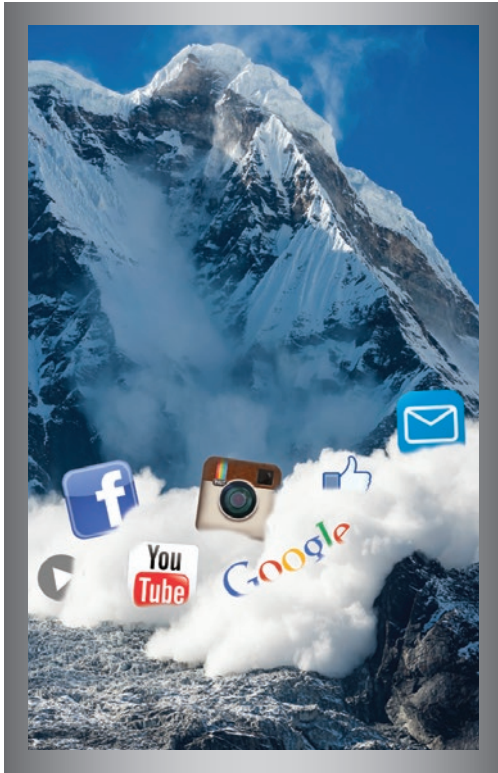
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The Data Avalanche

Every minute of every day:¹

- Facebook® users share **2,460,000 posts**
- Instagram® users post **216,000 new photos**
- Email users send **204,000,000 messages**
- Google® receives **4,000,000 search queries**
- YouTube® users upload **72 hours of video**



The Limitless Demand for Bandwidth

Technology is part of nearly everything we do today, so it's no surprise that the volume of digital data continues to expand exponentially. The size of the digital universe is predicted to double every two years, climbing from 4.4 trillion gigabytes in 2013 to 44 trillion gigabytes in 2020.²

Numerous factors on the consumer and business fronts fuel this staggering data growth. These include video streaming, cloud computing, big data, server virtualization, social media, mobile computing, video streaming and the proliferation of network-connected objects, also known as the Internet of Things (IoT).

At the same time, user demand for faster access to all this data is also increasing, further contributing to the seemingly insatiable appetite for bandwidth. Not all that long ago, Ethernet networks that supported 10 Mb (Megabit) speeds were considered amazingly fast. 10 Gb (Gigabit)³ fiber – 1,000 times faster than 10 Mb – is the norm in most data centers today, and 40 Gb fiber is becoming commonplace. In next-generation data centers, 100/120 Gb will become standard, and 400 Gb is most certainly on the horizon.

¹ Source: www.domo.com/learn/data-never-sleeps-2.

² Source: *7th Annual EMC Digital Universe Study*, IDC, 2014.

³ Gigabit (Gb) network speeds are referenced in different ways by different sources. For example, 40 Gb may be called 40 GbE, 40 Gbps, 40G, 40GE, 40GBASE, 40 Gbit, 40 Gbit/s, 40 Gigabit or 40 Gigabit Ethernet, with or without spaces or hyphens.

The Connectivity Challenge

It took 15 years for 10 Gb to replace 1 Gb as the norm, but only five years after the approval of the IEEE 802.3ba-2010 standard, 40 Gb fiber is already gaining ground on 10 Gb. With the rate of change accelerating, it's no longer a question of if, but when, organizations of all sizes will need to integrate higher network speeds.

As you start to mix 10 Gb and 40 Gb equipment in your data center, you need to make sure you can connect your existing network of 10 Gb servers and other devices with your new 40 Gb switches. You also need to consider connectivity with future network standards, as speeds inevitably climb to 100/120 Gb and beyond.

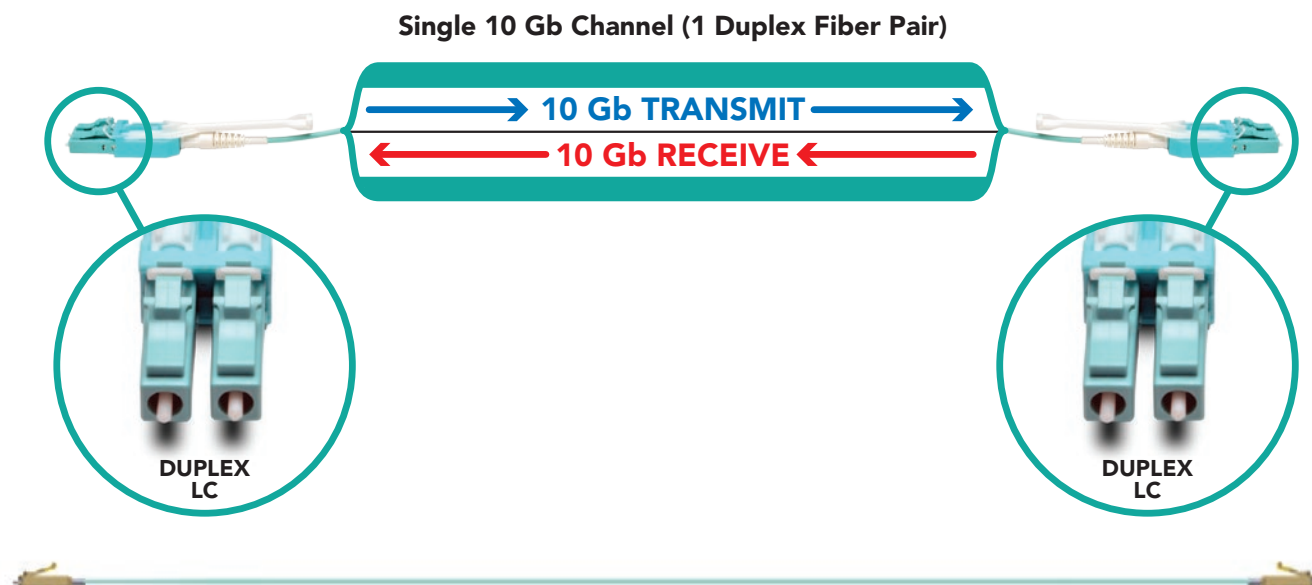
Having multiple speeds coexist within the same data center is nothing new, but the parallel optics cabling used for data transmission speeds of 40 Gb and beyond presents a brand-new set of connectivity challenges.

The Nuts and Bolts of Connectivity

By taking a closer look at the two primary types of digital data transmission – serial and parallel – we can shed some light on why connectivity has become more complex.

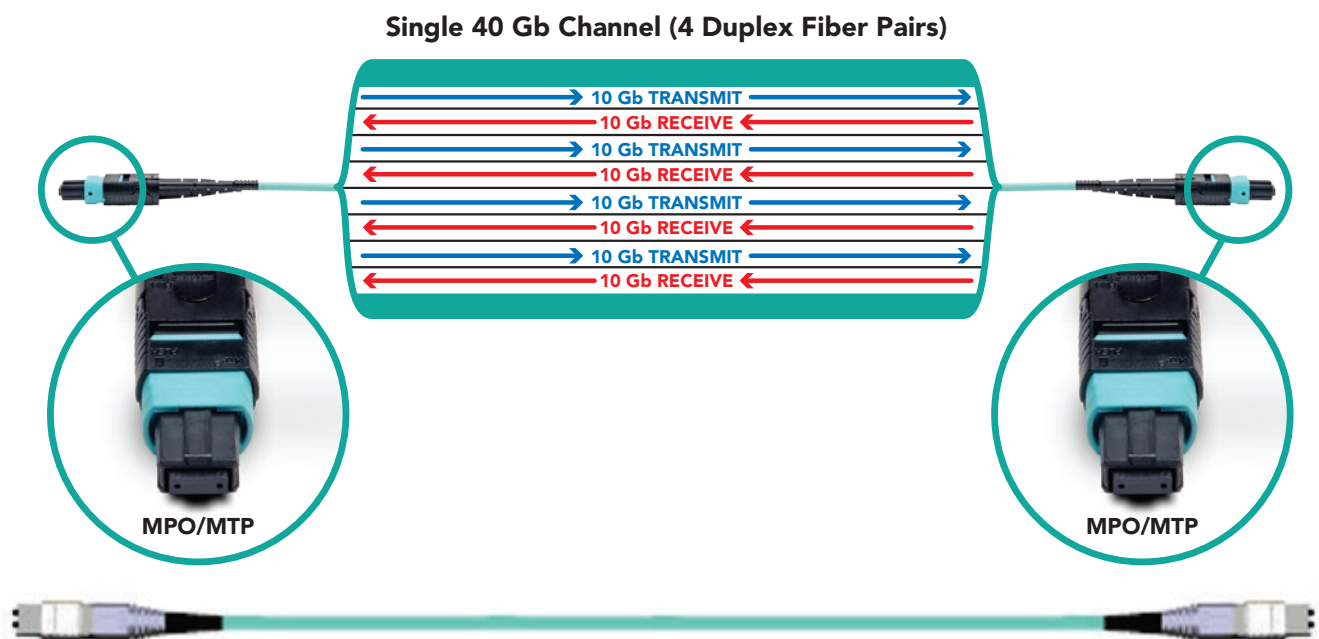
Serial Transmission

10 Gb fiber uses a serial transmission approach where the data is sent sequentially, one bit at a time. One dedicated transmission fiber and one dedicated reception fiber, together known as a duplex fiber pair, create the 10 Gb channel used to complete the data circuit. Typically, serial connectivity is achieved using a duplex LC connector. The LC connector is the most commonly deployed interconnect in data centers, especially for high-density network applications.



Parallel Optics Transmission

Until recently, it wasn't possible to achieve speeds beyond 10 Gb using a single duplex fiber cable. Improvements in serial transmission have raised the limit to 25 Gb, but speeds of 40 Gb and beyond require an alternative approach called parallel optics transmission. Parallel optics transmission employs multiple duplex fiber pairs to transport more data and achieve higher speeds. For example, parallel optics transmission achieves the 40 Gb speed by combining four 10 Gb duplex fiber pairs to create a 40 Gb channel. The same principle applies for speeds of 100 Gb, 120 Gb and higher. A 100 Gb channel would include ten 10 Gb duplex fiber pairs, and so on. (We concentrate on 10 Gb duplex fiber pairs in this document because they best represent today's most common data center applications. However, parallel optics transmission principles can also be applied to 25 Gb duplex fiber pairs to reach even higher speeds or reduce the number of fibers required. For example, a 100 Gb channel would require four 25 Gb duplex fiber pairs instead of ten 10 Gb duplex fiber pairs.)



In parallel optics transmission, connectivity is achieved using MPO (multi-fiber push-on) connectors, also known as MTP® connectors. (MTP is a high-performance MPO connector manufactured and trademarked by US Conec, Ltd.) They house 8, 12 or 24 fibers (4, 6 or 12 duplex fiber pairs). This connectivity option lends itself well to data centers because it can take advantage of low-cost lasers and multimode cables.

Devices designed for speeds of 10 Gb or less have two-strand, duplex fiber ports for serial transmission, while 40 Gb and 100/120 Gb devices have 8-, 12- or 24-strand MPO/MTP fiber ports for parallel optics transmission. Given the different numbers of strands involved, connecting the existing 10 Gb devices designed for serial transmission with newer, higher-speed switches and devices requiring parallel optics transmission becomes more complicated, requiring new solutions that were not available before 40 Gb switches entered the picture.

Solutions for the Connectivity Challenge

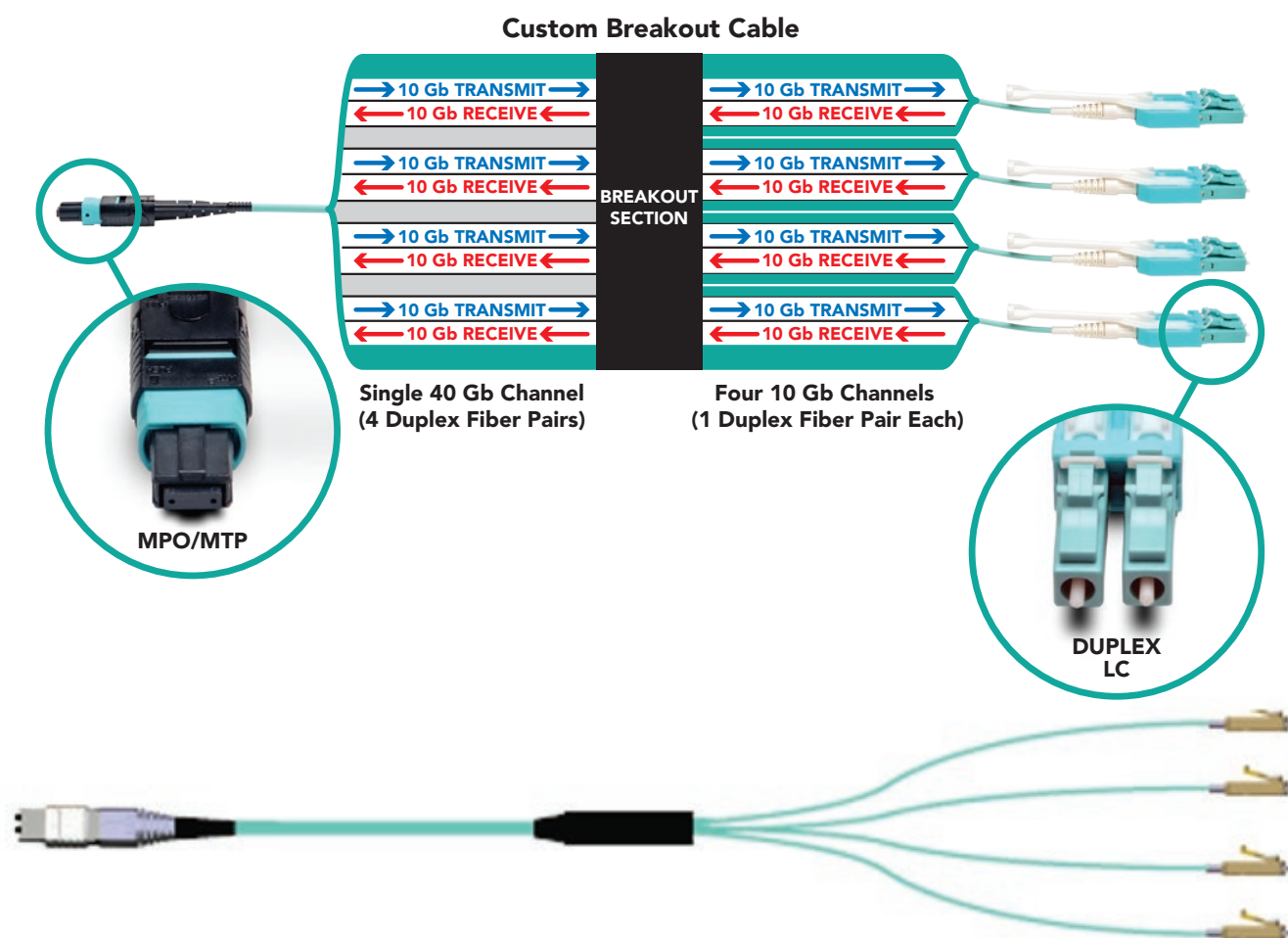
Two different types of solutions have been developed to connect 10 Gb equipment with higher-speed equipment in the same data center: breakout cabling and modular patch panels. It is important to understand the benefits and challenges of each type of solution in order to select the one that meets your current and future connectivity needs more effectively.

Breakout Cabling Solutions

A breakout cable is a multi-strand cable, typically custom-made, which is divided into multiple duplex cables. For example, a 40 Gb breakout cable has four 10 Gb duplex cables totaling eight strands, while a 100 Gb breakout cable has 10 duplex cables and 20 strands. A breakout cable has duplex LC connectors at one end and an MPO/MTP connector at the other.

How They Work

To understand how breakout cabling solutions work, let's assume you want to integrate 10 Gb servers into a 40 Gb network. For each port on the switch, you will need a breakout cable with an MPO/MTP connector on one end and four duplex LC connectors on the other end. The MPO/MTP connector plugs into the 40 Gb switch port and each duplex LC connector plugs into a 10 Gb port on each server. Each switch could have 32 or more ports.



The Benefits

When 40 Gb switches first entered the marketplace, simply being able to connect the equipment was the overriding concern. A breakout cabling solution allows slower equipment to be connected to higher-speed equipment successfully, such as the 10 Gb servers and 40 Gb switch in our example. Up to 128 10 Gb devices can be connected to a 32-port, 40 Gb switch.

The Challenges

Breakout cabling solutions present several challenges. These include:

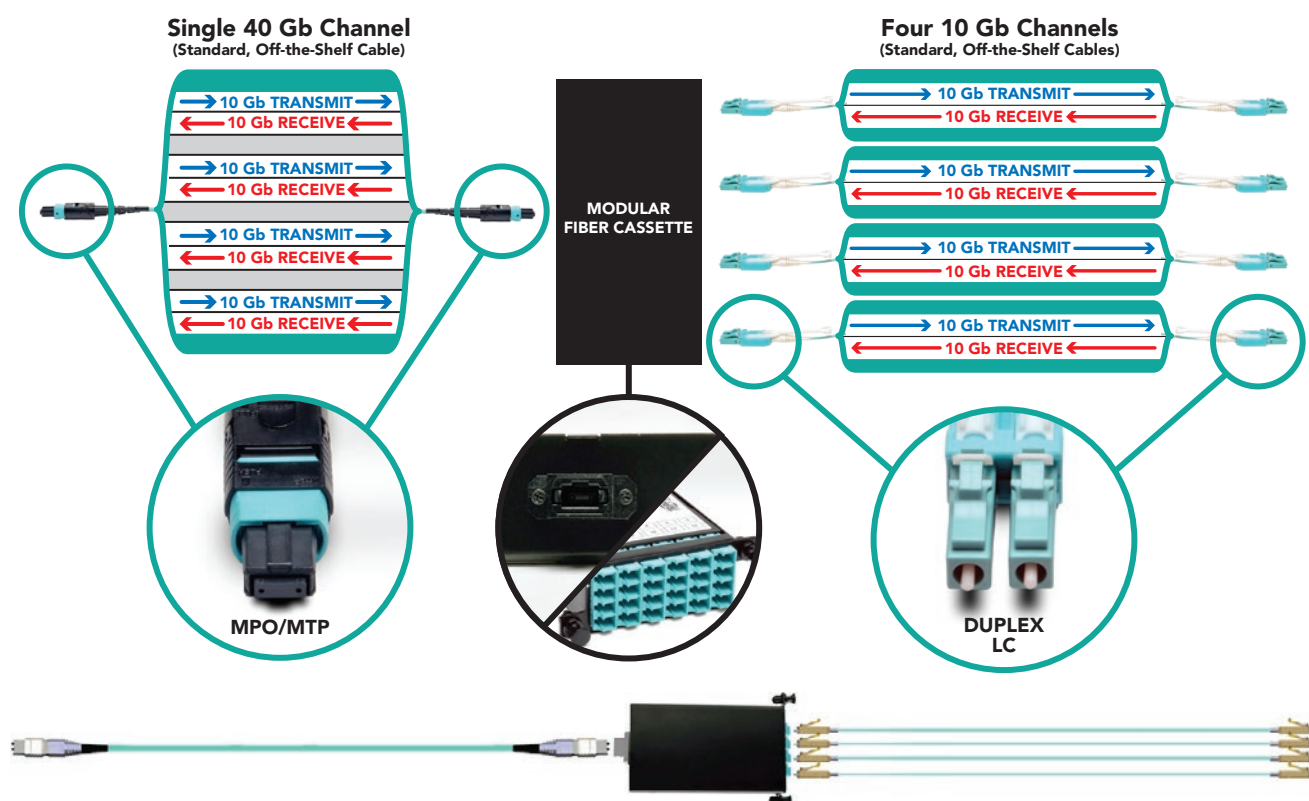
- **Assessing requirements.** Most breakout cables are custom-made. However, it can be difficult to accurately determine the optimum length for breakout cables in advance. The tendency to overestimate so cables won't be too short inevitably leads to excess cable slack.
- **Cable congestion.** If you picture a 1U network switch connected to 32 or more breakout cables, each with 4 duplex cables at the server end, it's easy to see how breakout cable solutions can increase congestion, clutter, tangling and confusion. This "spaghetti syndrome" reduces efficiency and makes cable management much more difficult.
- **Delivery time and cost.** Since most breakout cables are custom-made, they're more expensive than off-the-shelf cables and require longer lead times between order and delivery. This delays network projects and inflates costs, especially when considering large, high-density projects with extensive cabling requirements.
- **Labeling.** When using so many breakout cables, labeling is absolutely essential. The profusion of cables makes it difficult to label them clearly and accurately, interfering with your ability to troubleshoot effectively and efficiently.
- **Repair.** An issue with a single strand or connector can render an entire custom-made breakout cable non-functional. Since they're not available off the shelf for immediate delivery, this adds to network disruption and downtime. And when the new breakout cable is finally in place, you must remember to relabel everything.
- **Flexibility and scalability.** Breakout cables are difficult to reconfigure when you add or upgrade equipment, requiring frequent overhauls of cabling infrastructure. Not only is this approach costly and time-consuming, it limits your ability to plan properly for future growth. This is especially problematic given that future port and bandwidth growth will inevitably require integrating new network cabling standards.

Modular Patch Panel Solutions

Modular patch panels are comprised of rack-mountable enclosures designed to house a range of modular, removable media cassettes. Supporting various network cabling standards, the cassettes are easy to mix, match, add and replace as your connectivity needs grow and change.

How They Work

The modular cassettes are the key to modular patch panel solutions. Available in multiple variations, the cassettes allow you to interconnect different fiber speeds simply by plugging standard, off-the-shelf duplex LC cables into one side of the cassette and one or more standard, off-the-shelf MPO/MTP cables into the other side.



Note: This example has been simplified. In a typical high-density application, Two 12-strand or three 8-strand MPO/MTP cables will be mated with 12 2-strand duplex LC cables.

The Benefits

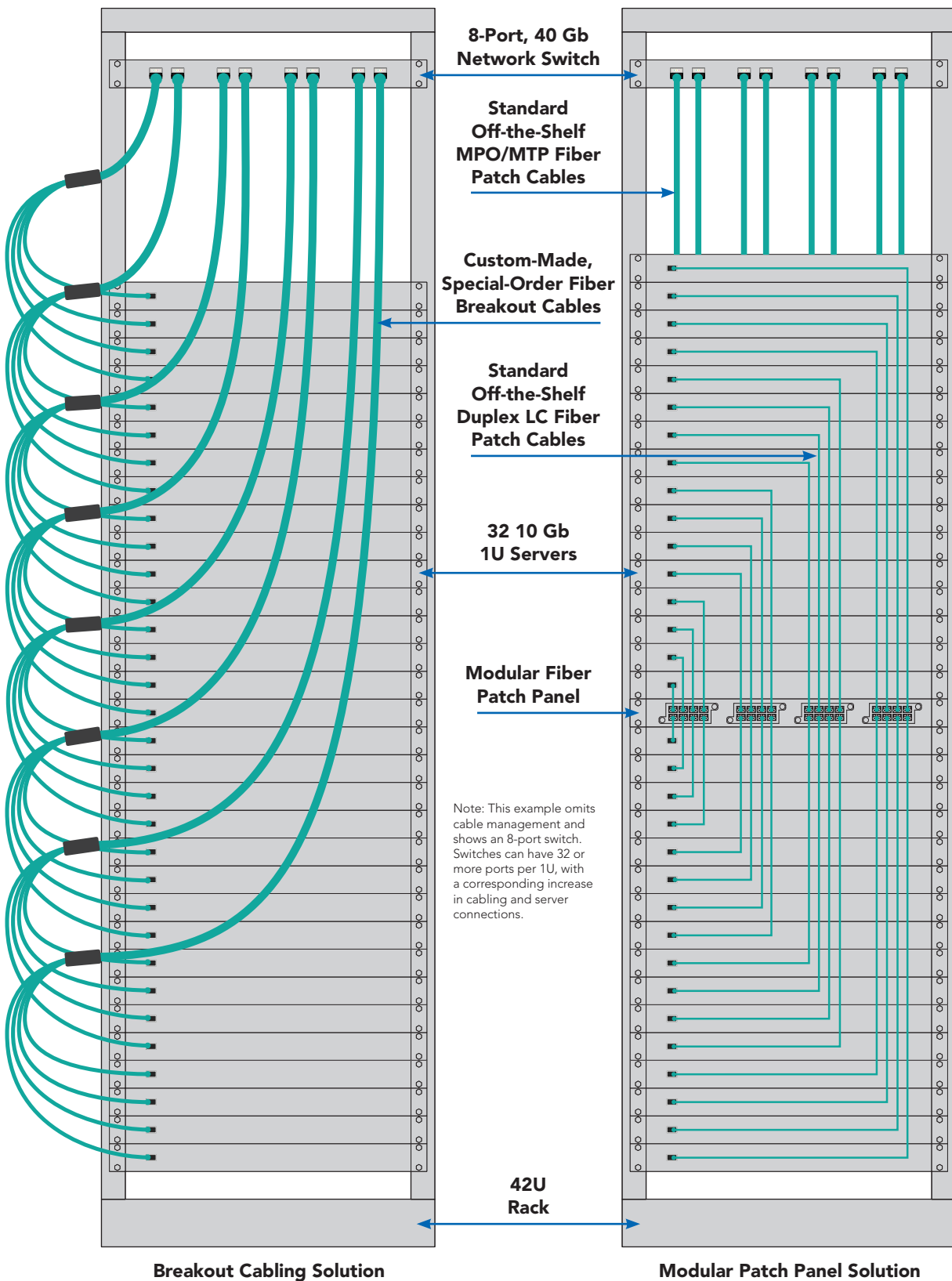
Modular patch panel solutions offer a range of benefits:

- **Integrate diverse cabling standards.** Modular patch panel solutions allow you to connect diverse network cabling standards seamlessly, including 10/10 Gb, 10/40 Gb, 40/40 Gb, 10/100/120 Gb and 40/100/120 Gb, as well as future standards.
- **Use standard patch cords.** Since connections use standard, off-the-shelf patch cords that are readily available, you can make changes and repairs without the delays and added expense associated with custom cabling.
- **Provide flexibility and scalability.** As you integrate new cabling standards to support higher network speeds, you can simply swap existing cassettes with new cassettes that support the new standards. Your network can grow and change on demand, without the costly, labor-intensive hassle of replacing channels end-to-end.
- **Reduce cable congestion.** Less cable slack means less clutter, less confusion and an easily organized, better-labeled cabling infrastructure. You can also manage cables in any direction – horizontal or vertical, front or back.
- **Support standards.** Modular patch panel solutions support structured network cabling standards for data centers.
- **Save space.** By managing varying port densities and speeds in a single high-density patch panel, you save valuable rack space, helping to lower data center costs. A single panel can manage as many as 168 10 Gb ports.
- **Right-size investments.** With a modular solution, you can buy and load only the cassettes you need now, while leaving room for future expansion.

The Challenges

The biggest challenge is selecting a modular patch panel solution with the features and capacity to meet your current needs, as well as the flexibility and scalability to adapt and grow with your future needs. Because you expect the solution to provide connectivity for the foreseeable future, you should work with a well-established manufacturer that will be around to provide new modular cassettes to support new standards in years to come.

Comparison of Breakout Cabling Solution and Modular Patch Panel Solution



Pre-Assembled Solutions

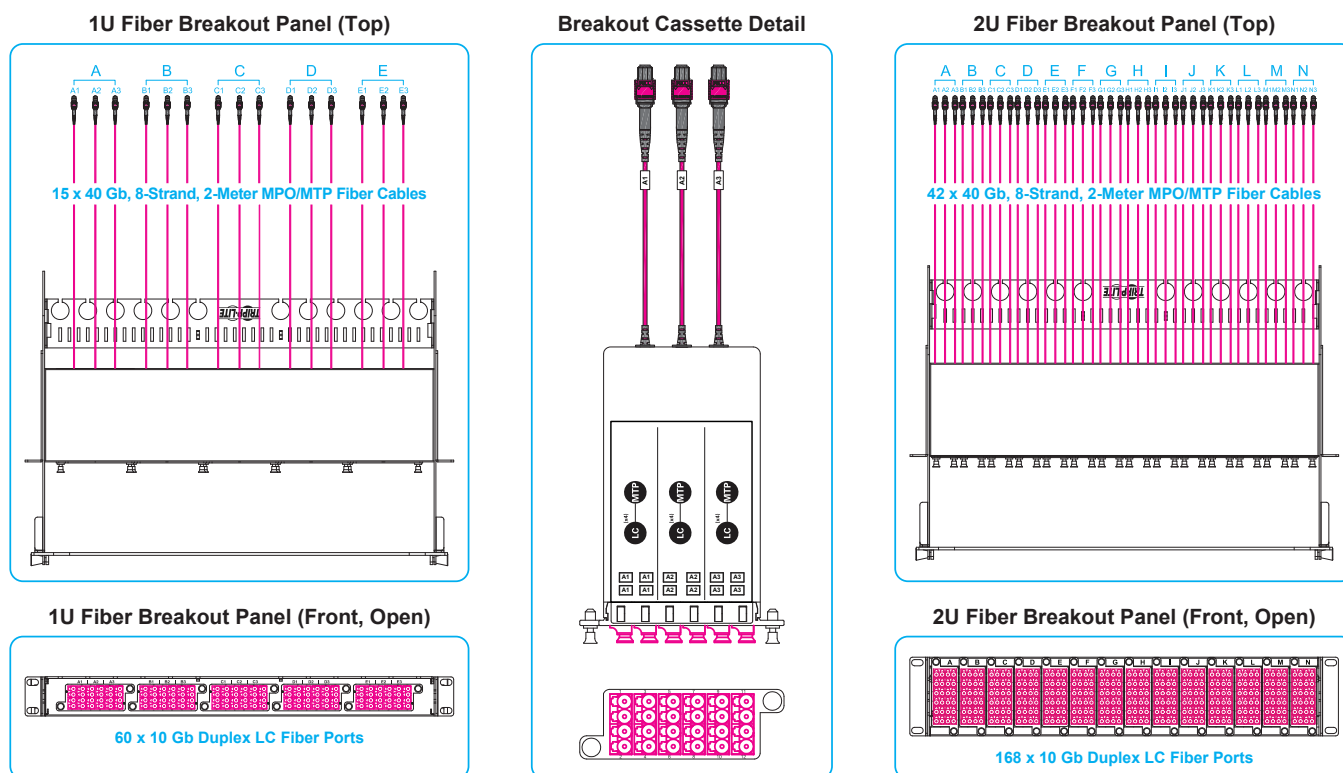
Experience shows that the typical 40 Gb switch will have about half its ports connected to 10 Gb devices. Pre-assembled fiber breakout panels make these connections much more convenient.

Fiber Breakout Panels

Fiber breakout panels are ready for plug-and-play deployment out of the box. OM4 multimode and singlemode versions are available with panels pre-populated with pre-terminated, pre-labeled fiber cassettes. Each cassette supports Base-8 connectivity with three 8-fiber MPO/MTP cables connected at the rear and 12 duplex LC ports facing forward. The MPO/MTP cables are each 2 meters, which is an optimal length to reach switches installed in any part of a rack. The 1U panel holds 5 pre-installed cassettes for a total of 60 10 Gb duplex LC ports and the 2U panel holds 14 cassettes for a total of 168 10 Gb ports. The fiber breakout panels can also divide 100 Gb switch ports into 25 Gb connections. Although the fiber cassettes are pre-installed, they are still removable and replaceable for repairs, reconfiguration and upgrades.

How They Work

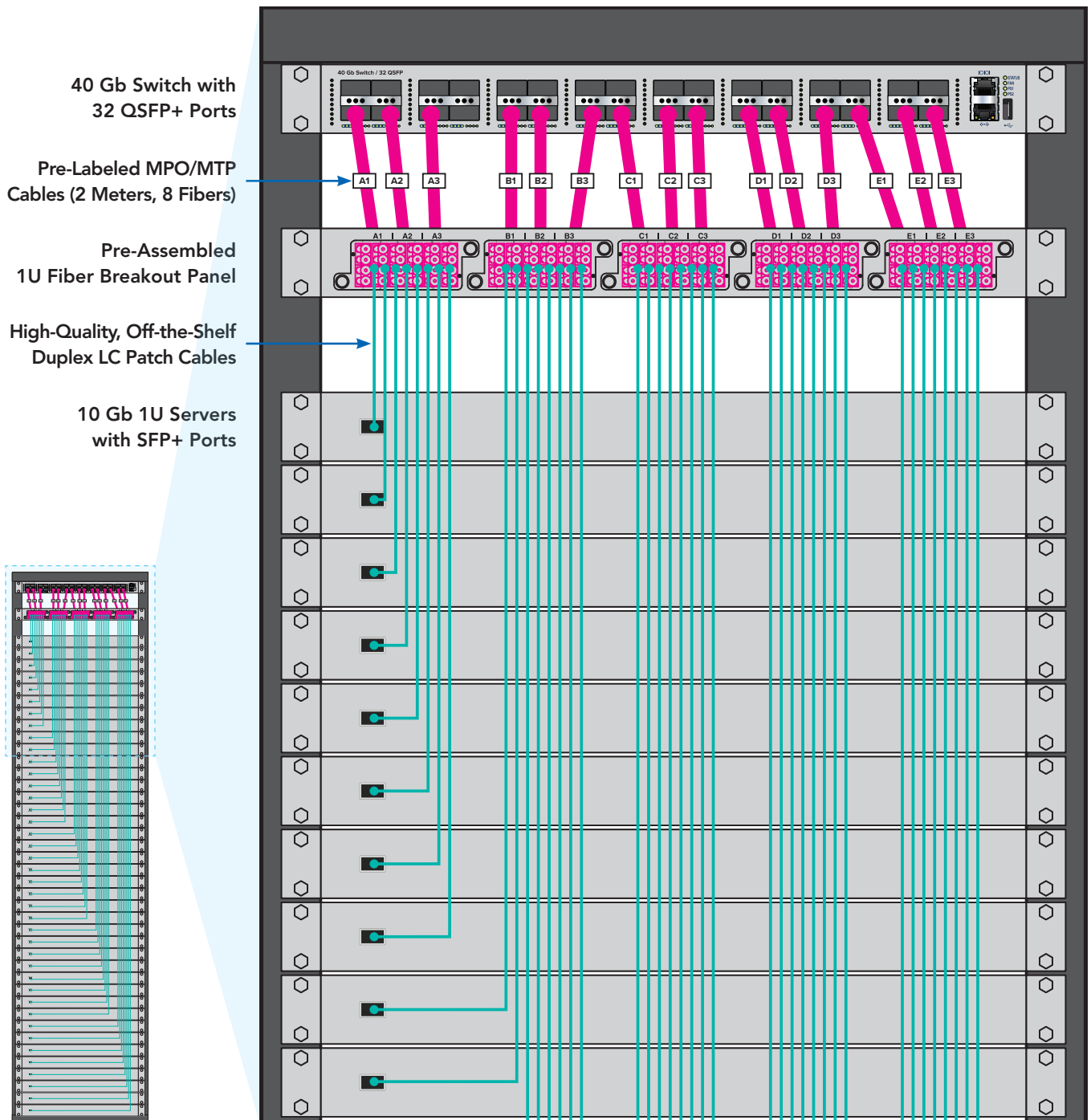
As with modular patch panels, the modular fiber cassettes are the key. With the fiber breakout panels, however, the cassettes are pre-installed and the MPO/MTP cables are pre-connected and pre-labeled. Assuming the appropriate optical transceivers are in place, the installer simply needs to connect the MPO/MTP cables to the switch's 40 Gb ports and connect high-quality off-the-shelf duplex LC patch cables between the cassettes' front-facing ports and the 10 Gb devices.



Fiber Breakout Panel Connection Example

Connect 10 Gb devices to a 40 Gb switch.

Server Rack with 32-Port 40 Gb Network Switch, 1U Fiber Breakout Panel and 10 Gb 1U Servers (Detail View of Top of Rack)



Note: This example omits cable management and assumes appropriate transceivers are in place.

Low-Stress Solutions for High-Density Applications

Inserting and removing fiber cables in high-density applications can be extremely challenging. Because cables are packed so closely together, there's no room for fingers. Inserting and removing cables typically requires special tools. However, some manufacturers now offer LC and MPO/MTP cables with push/pull tab connectors that you can easily insert and remove without tools, maximizing convenience and accessibility.



Copper vs. Fiber

It's true that fiber seems to be winning the popularity contest over copper in new high-speed cabling installations and upgrades. Lightweight, thin and durable, fiber can reliably transmit data at higher speeds and greater distances with minimal signal loss. However, copper will continue to play an important role in network infrastructure, particularly at the edge of a structured network.



With fiber and copper cabling likely to coexist in data centers for years to come, especially as manufacturers of both types of cabling develop new products with greater capacity and flexibility, innovative solutions will be necessary to provide connectivity. For example, you can equip some modular patch panel solutions with cassettes that provide Cat6a and SFP+ ports. This allows you to mix and interconnect copper and fiber cables from 1 Gb to 120 Gb in a single high-density panel.

Choosing Wisely for Today and Tomorrow

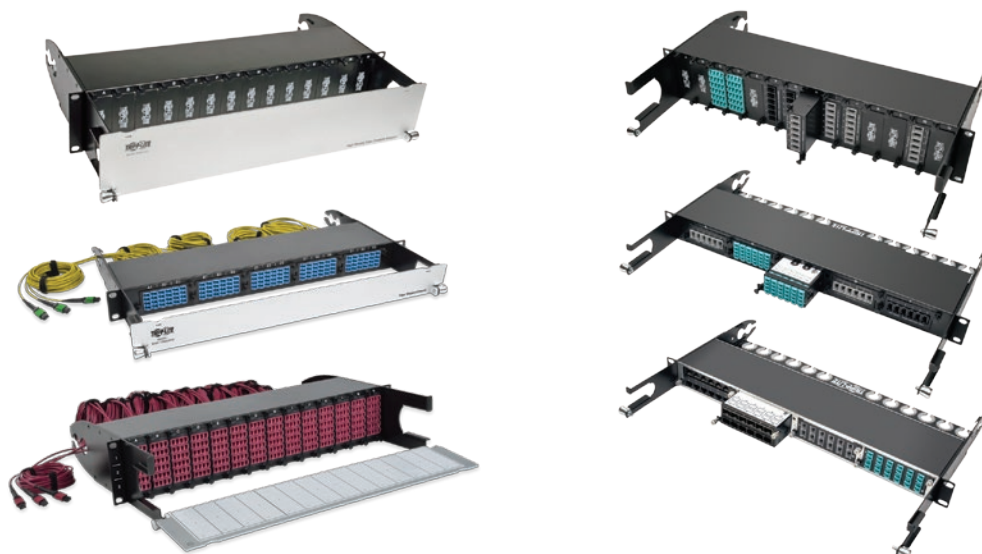
You should consider several factors when determining the best connectivity solution for your data center's needs. These include:

- **Speed and bandwidth.** What types of equipment do you need to connect at which speeds?
What are your current port-density requirements?
- **Convenience.** How easily can you insert, remove and label cables?
- **Manageability.** Will the solution help you avoid excessive cable slack and congestion?
Can you choose to manage cables in any direction – horizontal or vertical, front or back?
- **Flexibility.** How easy is it to add and connect new servers and other equipment? How easy will it be to modify your installation when you need to integrate new equipment that supports higher network speeds?
- **Scalability and future-proofing.** What are your needs likely to be five years down the road? 10 years?
Is the solution designed to grow along with you?
- **Cost.** Which solution is most cost-effective? Be sure to consider the total cost of ownership, including the cost of the cables and any necessary replacements, labor time and expense for installation and modification, rack space savings and the cost of downtime if cables can't be replaced quickly.

Future-Proofing Your Data Center

With increasingly higher network speeds always just around the corner, you want to make sure your investment in upgrading and building out your network infrastructure is a solid one. Breakout cabling solutions served an important purpose when 40 Gb switches first entered the marketplace and required immediate connectivity solutions. Breakout cables have always been a makeshift solution, however, requiring end-to-end replacement every time you upgrade equipment. They were a necessary placeholder waiting for a more mature solution to emerge.

The development of modular patch panel solutions has been a game-changer. Designed for maximum connection density, flexibility, scalability and compatibility with both existing and emerging high-speed network standards, they allow you to meet your current connectivity needs while simultaneously investing in your future. Modular patch panel solutions support your ability to plan, deploy and upgrade your network to meet the growing demand for additional bandwidth and higher speed. By selecting the right modular patch solution for your data center, as well as a dependable manufacturer that will support the solution in years to come, you can be confident that all the components of your cabling infrastructure will continue to work together seamlessly as speeds climb from 10 Gb to 40 Gb to 100/120 Gb and beyond.



About Tripp Lite

Customers in the IT, telecom, industrial, commercial, corporate, healthcare, government and education sectors choose Tripp Lite for complete solutions to power, protect, connect and manage servers, network hardware and other equipment in data centers and related facilities. Tripp Lite makes more than 3,500 products, including UPS systems, battery packs, PDUs, rack enclosures, cooling solutions, surge protectors, KVM switches, cables, power strips, charging stations and inverters. For more information about Tripp Lite's full line of data center solutions, visit www.tripplite.com.

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