WHITE PAPER

The Next Data Center

Understanding and Preparing
for Tomorrow's Technologies

ADC®

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What many in the IT industry thought would never come is now knocking on the data center door. Technologies like 40 and 100 Gigabit Ethernet, Fibre Channel over Ethernet, IP convergence and server virtualization are no longer just aspirations—they are real, and the time to prepare is now.

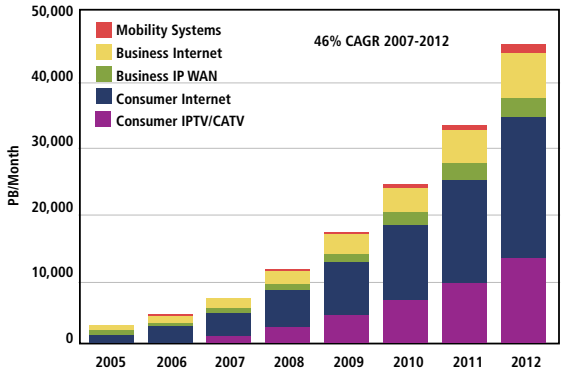
While these emerging technologies offer benefits abound, understanding how they work, the implications for the data center, and the strategies and solutions that will best support them can enable data center managers to ensure that their infrastructures are ready and able. Compounding the onset of these technologies is the need to lower total cost of ownership (TCO). This white paper will cover:

- New and imminent data center technologies, applications and objectives
- Optimum strategies and solutions for preparing the infrastructure
- Why getting ready today makes good business sense

Introduction

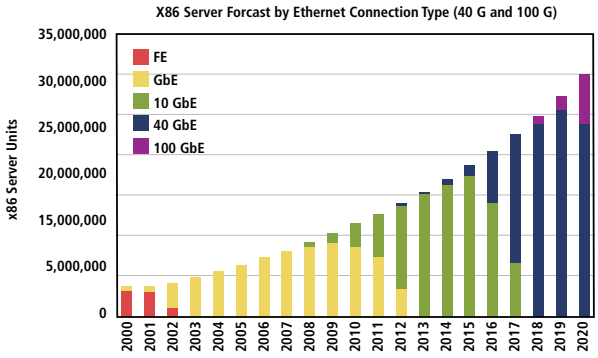
As global enterprise requirements continue to evolve, the amount of data needing to be transmitted and stored is growing exponentially. Technological advancements in transmitting information via Internet protocol (IP) also means that more devices and applications reside on the network, further increasing the amount of data transmission.

Once deployed primarily for backbone cabling between core switches, high-speed links in the data center are becoming more vital than ever for transmitting the increased amount of information to and from a greater number of sources. Data transmission is growing so significantly that it is expected to be six times larger in 2012 than it was in 2007. As shown in Figure 1, overall IP traffic is expected to grow to over 45,000 petabytes (PB) per month by 2012—that's more than 46 billion gigabytes of information.



Cisco Forecasts Over 45 Petabytes per Month of IP Traffic in 2012

To keep pace with growing data transmission and application needs, data centers today are experiencing increased bandwidth and server requirements. The annual server growth of 11% is climbing, and server bandwidth requirements are forecasted to move quickly from 10 gigabit per second (Gbps) to 40 Gbps in the next five years, and reach 100 Gbps within the next decade.

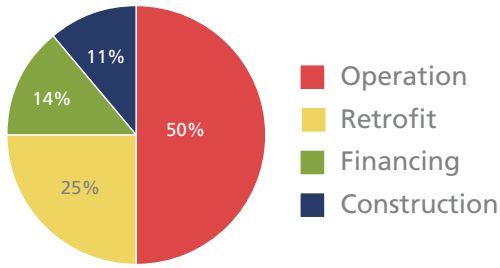


Source: Intel and Broadcom, April 2007

Server Forecast by Ethernet Connection Type
(40G and 100G)

All data—everything from email and company information to customer accounts, transactions and medical records—must also be properly stored and archived by storage area networks (SANs). SANs enable sharing, moving and recovering information during daily operations and disaster recovery. The ever-increasing amount of data demands larger capacity storage devices and high-bandwidth SAN switches for faster backup and retrieval.

The need to reduce TCO is also at the forefront of concern among today's enterprise businesses. Over the life cycle of a typical enterprise, operation costs alone can account for 50% of total costs. By making operations more efficient, that cost can be significantly reduced. Retrofit costs take up another 25% of life cycle costs. Therefore having solutions in place today that enable easier upgrades tomorrow can also significantly reduce TCO.



A Building's Life cycle Costs over 40 Years
Source: ASHRAE

The industry is responding to these needs with advancements like 40 and 100 Gbps Ethernet (GbE), Fibre Channel over Ethernet (FCoE), server virtualization and IP convergence. These new technologies also have implications for the data center infrastructure, including new cabling and connector solutions, higher fiber densities, higher bandwidth performance, and the need for enhanced reliability, flexibility and scalability. Fortunately, many solutions and strategies are available today that can help data centers managers prepare while simultaneously lowering TCO.

40 and 100 GbE

Standards for 10 GbE over both fiber and copper already exist, and many data centers today are running the application in their backbone cabling where large numbers of gigabit links aggregate. High-speed applications, emerging server technologies and enhanced aggregation are now calling for even faster connections. In response, the Institute of Electrical and Electronics Engineers (IEEE) is developing standard 802.3ba that will support data rates for 40 and 100 GbE and is slated for ratification in 2010.

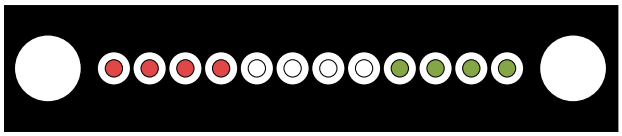
The 40 and 100 GbE standards will address multimode and singlemode optical fiber cabling, as well as very short distances over four lanes of shielded balanced copper cabling. Both 40 and 100 GbE will likely be initially deployed in high-bandwidth switching, routing and aggregation points for service provider backbones, interconnections in server and SAN devices and high-performance computing in research, university and medical facilities.

Copper

Transmitting 40 or 100 GbE over short distances of shielded copper cabling will require 10 Gbps over each lane (4 lanes for 40 GbE and 10 lanes for 100 GbE). This will likely be limited to very short distances of approximately 10 meters for equipment-to-equipment connections and will likely not be intended for backbone and horizontal cabling.

Multimode Fiber

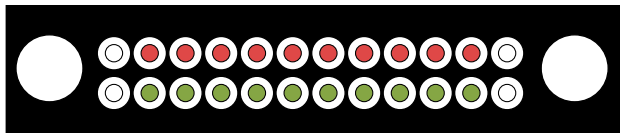
To run 40 GbE over at least 100 meters of multimode fiber, the standard will require parallel optics with 8 multimode fibers transmitting and receiving at 10 Gbps using an MPO style connector. The MPO connector is a high-density, multi-fiber connector that terminates up to 12 fibers in one connector. Because only 8 fibers are required for 40 GbE, the other 4 fibers of the connector will not be used in this scenario.



Represents 10 Gbps Transmit Channel
Represents 10 Gbps Receive Channel

40 GbE over Multimode Fibers using MPO Style Connector (40GBASE-SR4)

Running 100 GbE over multimode fiber will require 20 fibers transmitting and receiving at 10 Gbps within a single 24-fiber MPO style connector or two 12-fiber MPO style connectors, with 4 fibers unused.



Represents 10 Gbps Transmit Channel
Represents 10 Gbps Receive Channel

100 GbE over Multimode Fibers using 24-fiber MPO Style Connector (100GBASE-SR10)

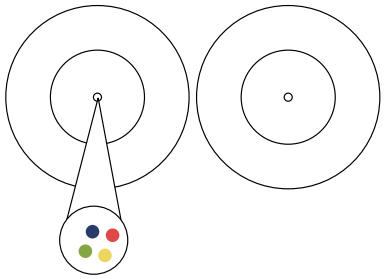
Within the data center, 40 and 100 GbE over multimode fiber will require MPO-style connectors, very precise performance, and a significant increase in the amount of fiber—six times more for 40 GbE and twelve times more for 100 GbE.

- **MPO Connectors.** MPO connectors will be required to support 40 and 100 GbE over multimode fiber. MPO connectors are typically preterminated in the factory to multi-fiber cables that are purchased in predetermined lengths. This requires more careful planning to ensure exact measurements, or the use of proper slack management. Some are already installing MPO connector solutions for better management and density in the data center, and doing so will better prepare them for 40 and 100 GbE tomorrow.
- **Higher Bandwidth and Performance.** To run 40 and 100 GbE per the proposed standard, the cabling infrastructure will also require optimum performance. Bandwidth performance will require a minimum of OM3 laser-optimized 50 µm multimode fiber. Lower performing optical fiber cables are not part of the proposed standard. Reduced insertion loss and minimal delay skew will also be a key consideration for 40 and 100 GbE. Installing high-performance optical fiber cable and components today is therefore vital to supporting 40 and 100 GbE tomorrow.
- **Higher Density.** With up to 12 times the amount of fiber needed to support 40 and 100 GbE, managing fiber density will be a key consideration for the next data center. In addition to physical space and proper planning, 40 and 100 GbE will require properly managing and routing large amounts of fiber in and above racks. It's also imperative to consider the overall diameter of the cable—smaller diameter solutions can go a long way in saving space and enabling higher density.

Singlemode Fiber

Running 40 GbE over singlemode fiber will require 2 fibers transmitting 10 Gbps over 4 channels using wavelength division multiplexing (WDM) technology. Running 100 GbE with singlemode fiber will require 2 fibers transmitting at 25 Gbps over 4 channels using WDM.

WDM combines multiple signals on a single optical fiber using different color wavelengths of light. Multiple signals, each with its own wavelength, are transmitted on the optical fiber and combined by a multiplexer at the source end, then separated (de-multiplexed) at the destination end. This provides a scalable way to increase the capacity of existing singlemode fiber infrastructure.

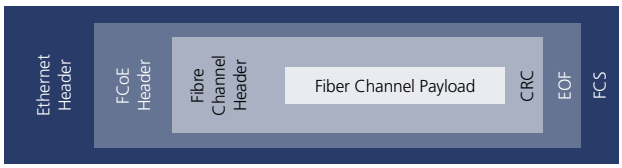


WDM technology using different color wavelengths of light on a single fiber (40GBASE-LR4, 100GBASE-LR4, and 100GBASE-ER4)

While WDM technology for running 40 and 100 GbE over singlemode fiber will be ideal for long reach (up to 10 km) and extended reach (up to 30 km) distances, it will likely not be the most cost-effective option for shorter 100-meter distances like those in a campus or data center environment. However, as the standards are finalized and equipment is introduced, data center managers would be wise to examine the cost differences between singlemode, multimode and copper cabling solutions for both 40 GbE and 100 GbE.

Fibre Channel over Ethernet (FCoE)

Over the past decade, most data center managers and storage equipment manufacturers have adopted Fibre Channel as a means of transmitting data for SANs. This highly reliable, low-latency technology allows simultaneous high-speed communications among servers and data storage systems via optical fiber cabling. On the other hand, most data centers use Ethernet for transmitting data from client to server or from server to server. To support both Fibre Channel and Ethernet, data center managers have had to deploy parallel infrastructures and interfaces, which increases cost and manageability concerns.

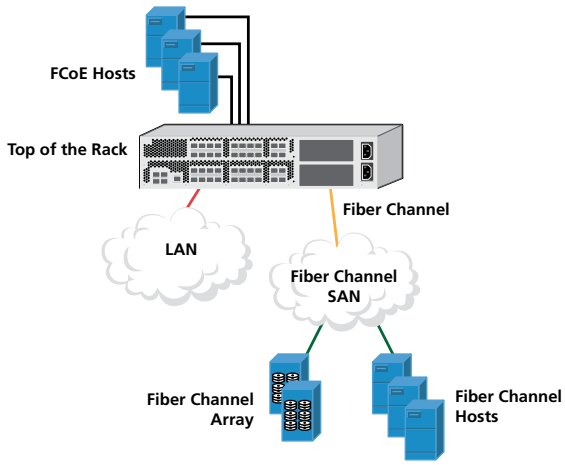


Encapsulation of Fibre Channel Frame in an Ethernet Packet

FCoE is a new standard that aims to consolidate both SAN and Ethernet data transmission onto one common network interface, enabling the use of the same cable for both purposes, improving server utilization, reducing the number of required ports, reducing power consumption and improving cable management. FCoE works by encapsulating Fibre Channel frames within Ethernet data packets.

To support FCoE, higher bandwidth solutions will be required, as well as flexibility to support uncommon data center configurations that will likely be deployed.

- **Higher Bandwidth and Performance.** FCoE requires 10 GbE at a very minimum, which means that anyone upgrading their infrastructure and planning for FCoE now or in the future must deploy cabling capable of supporting 10 GbE.
- **Flexibility and Management.** FCoE will likely be deployed using top-of-rack switches that provide access to the existing Ethernet LAN and Fibre Channel SANs. This is different than the centralized approach that most data center managers are comfortable using. While top-of-rack reduces the amount of cabling, it also requires flexibility and manageability because reconfigurations need to be made within each rack vs. a centralized location.



IP Convergence

Voice, data, video, security, and building management systems that once operated as separate analog systems have now become digitally based, allowing all forms of communication traffic to converge over a common infrastructure using IP technology. Voice and data are now commonly converged using voice over Internet protocol (VoIP) technology, and many are beginning to deploy additional IP-based applications like video over IP, access control systems, industrial applications and building automation systems. IP converged networks offer several advantages, including eliminating the need to build and maintain separate networks and enabling more efficient operations and management.

As IP convergence and the number of networked devices continues to grow, data centers will see a rapid increase in the amount of cabling and equipment to support new applications, as well as the need for increased reliability.

- **Higher Density.** IP converged networks will see a rapid increase in the amount of cabling both in horizontal pathways and in the data center. Cable pathways must be properly sized to accommodate more cabling while also enabling adequate cable management and room for growth. Smaller cabling diameters can go a long way in saving costly pathway space for IP converged networks.
- **More Equipment.** With IP convergence, the network is making its way into other areas of a facility to support security, building automation and industrial applications. The data center must also support more applications like video surveillance and building automation, requiring more equipment, space and management in the data center.
- **Increased Reliability.** With IP convergence, network downtime no longer means that employees just lose access to email, data and the Internet. Because data centers now support mission-critical systems like physical security and building automation, downtime can cause a life safety situation and simply cannot be tolerated. The IP converged network therefore requires extremely reliable components and design strategies like redundancy that ensure availability.

Server Virtualization

Server virtualization involves running multiple virtual operating systems on one physical server. This practice is increasingly being deployed to address the issue of more equipment and space constraints in the data center. Server virtualization reduces capital expenditure because fewer servers need to be purchased. It also maximizes resources and space availability, improves server utilization and reduces power and cooling.

Most enterprises deploying server virtualization are consolidating applications on one physical server at a ratio of 4:1. As data centers become more comfortable with the technology, experts predict that the ratio could grow to as much as 20:1. With so many applications running on one physical server, the need for availability and bandwidth also increases significantly.

- **Increased Availability.** In the past if a server experienced downtime, access to one application was compromised. With server virtualization, downtime could limit access to several applications. Redundancy is now needed to maintain server availability, which requires a second set of cables running to a back-up network interface card.
- **Higher Bandwidth and Performance.** With multiple applications running on one server, higher bandwidth capacity is required to support increased data transmission to and from the servers. Increased services such as firewalls are also required with server virtualization, which places additional demands on capacity.
- **Higher Density.** While server virtualization theoretically should reduce the number of servers and cabling in a data center, required redundancy and greater bandwidth to support server virtualization actually requires more cabling. Furthermore, the demand for capacity is outpacing the gains provided by virtualization so the rate of growth in the number of servers and associated cabling continues to increase.

Lower TCO

While technologies like FCoE, server virtualization and IP convergence are aimed at reducing TCO, the reality is that the overall increase in data transmission and equipment is putting strain on the data center's power, cooling and space. Today's enterprise is struggling to find a balance between implementing new technologies and ensuring lower TCO through more efficient operations, reduced energy consumption and lower life cycle costs.

- **More Efficient Operations.** With more cabling, more ports and more equipment, data center managers are faced with the need for solutions that better facilitate management and reconfiguration as needs change.
- **Reduced Energy Consumption.** Utility cost is a key portion of a data center's operational expenses. Energy consumption in the data center has doubled in the past five years and is expected to rise as the amount of equipment and power requirements increase steadily, driving yet another culprit for increased energy use—cooling. Global environmental initiatives are also putting pressure on data centers to further reduce energy consumption.

- **Lower Life cycle Costs.** The longer the data center infrastructure can support changing technology needs, the lower the life cycle cost of the components. Ensuring scalability and reliability across all components in the data center is therefore becoming paramount.

Key Strategies and solutions

With several imminent technologies either being deployed or on the horizon, data center managers would be wise to consider available solutions and strategies that will better support next data center technologies when they are needed. Fiber infrastructure will be greatly impacted by future technologies, and the right structured cabling components can support MPO solutions, high density cabling and connectivity, high bandwidth and performance, and enhanced reliability, flexibility and scalability—all of which ultimately lower TCO.

- **MPO Solutions.** MPO solutions will be a must-have for 40 and 100 GbE. Thankfully, data center managers have become increasingly comfortable purchasing predetermined lengths of multi-fiber cables preterminated with MPO connectors. ADC offers several MPO solutions including trunk cables, array cables, and plug-and-play cassettes. ADCs TrueNet® Fiber Panel and high-density Optical Distribution Frame (ODF) are also designed to easily accommodate MPO connectors at interconnects and crossconnects in the main distribution area (MDA) and equipment distribution area (EDA) in the data center, enabling a variety of cabling configurations like top-of-rack that will likely be deployed for FCoE. MPO connectors are also factory terminated and tested in a clean environment to ensure precise performance for 40 and 100 GbE. MPO connectors also ensure lower TCO because they offer significantly reduced labor costs vs. field termination or splicing and are fast and easy to install.
- **High Density Solutions.** Several technologies will result in more optical fiber links throughout the data center, creating a demand for high-density solutions that properly manage high optical fiber counts and provide scalability to support more optical fiber cabling.

  Because MPO connectors terminate up to 12 fibers in one connector approximately the same size as a one SC-style fiber connector, they offer the highest density for maximizing space savings and managing higher port counts that come with IP convergence and the increasing number of network devices and equipment. In addition to supporting MPO connectors, ADC's TrueNet ODF is the highest density fiber distribution frame available. Extremely scalable, a single ODF can efficiently manage up to 1,728 fiber terminations using 144-position blocks or 2,304 using 192-position blocks (LC style only). This is significantly higher density than can be supported by typical fiber patch panels.

  Smaller cable diameters can also play a critical role in facilitating higher densities in cable management and pathways. Preterminated MPO multi-fiber cables are a small round loose-tube configuration that includes 12-fibers in a 3mm jacket, which is only slightly larger than traditional 2-fiber cables in a 1.7 to 2mm jacket. Round loose-tube cable is also easier to manage and route through pathways than traditional multi-fiber ribbon cables. ADC's AirES® conductor insulation technology makes our copper cable 28 to 32 percent smaller than others on the market. Smaller cables help reduce cable blockage in cabinets, allowing improved airflow in and around equipment for optimum cooling and less energy consumption.
- **High Bandwidth Solutions.** Several imminent technologies call for higher bandwidth cabling and precise performance. ADC offers TrueNet Ultra 550, an enhanced grade of OM3 laser-optimized multimode fiber, which is the required minimum for 40 and 100 GbE. Because optical fiber cabling is backwards compatible, not forwards, it's critical to choose fiber today that will support future bandwidth requirements. If singlemode becomes a viable and cost-effective option for 100 GbE, ADC offers a variety of high-performance singlemode optical fiber cabling components. ADC also offers 10 GbE copper and fiber cabling solutions, which is the minimum required for FCoE.

  40 and 100 GbE will require reduced insertion loss and delay skew to ensure that signals in each optical fiber arrive at a very precise time relative to each other. ADC's patented fiber technology ensures minimal loss and delay skew for precise performance. All of ADC's TrueNet products and cabling systems are designed and engineered to maximize uptime and ensure reliability and throughput to support multiple generations of equipment and technology.
- **Cable Management.** Proper cable management is required to maintain reliability, flexibility and scalability of cabling and connections in the data center and ultimately lower TCO. Cabling and connectivity needs to be deployed with proper bend radius protection to reduce signal attenuation, maintain fiber performance, well-defined cable routing paths, accessibility to work on connectors and cables without affecting adjacent circuits or ports, and physical protection for cables, patch cords, and jumpers. Without end-to-end cable management, cables can pile-up in raceways, maximum bend radius can be exceeded, connector access can be difficult, and it can take hours to trace cables—all which impacts the ability to support and deploy new technologies in the data center.

ADC's TrueNet ODF and fiber panels incorporate the fundamentals of cable management with built-in bend radius protection, intuitive cable and jumper routing, easy access to connectors, physical protection, and built-in slack management. Ample vertical and horizontal cable management in the ODF also reduces fiber congestion and potential damage while enabling scalability for more cabling and connections.

Cable management is also critical within the pathways going to and from the various areas of the data center, especially with the increased amount of fiber cabling that is needed to support the latest technologies. ADC's FiberGuide® Management System physically separates, protects, and routes fiber while ensuring that a two-inch minimum bend radius is maintained throughout, even as more cables are added in the future. FiberGuide also facilitates moving fiber cable overhead to remove blockages under the raised floor for improved airflow and reduced energy consumption.

Optimized management is available with our TrueNet TracerLight® system, which identifies termination points of optical patch cords. Each end of a TracerLight patch cord features a flashing LED to visually trace individual patch cords from one end to the other without pulling or fishing through troughs.

Proper cable management also lowers TCO by enabling proper flow of cool air into and out of the cabinet, improving the life cycle of equipment and reducing the need for fans and additional cooling that increases energy consumption. Cable management that provides accessibility to cables and connectors also makes it easier and quicker to locate components during network reconfiguration, saving a signification amount of time and reducing operation costs.

Summary

Preparing the data center for imminent technologies like 40 and 100 GbE, FCoE, IP convergence and server virtualization is much more cost effective than trying to unsystematically and randomly deploy solutions at a later date to accommodate a new technology. IT professionals upgrading or deploying their data centers today should therefore consider MPO solutions, high-density solutions, higher bandwidth cabling, and cable management that ensures reliability, flexibility and scalability. With lower TCO as a top concern, many of the solutions available today not only prepare for the next data center, but they also enable more efficient operations, reduced power consumption and lower life cycle costs.

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Website: www.adc.com

From North America, Call Toll Free: 1-800-366-3891 • Outside of North America: +1-952-938-8080

Fax: +1-952-917-3237 • For a listing of ADC's global sales office locations, please refer to our website.

ADC Telecommunications, Inc., P.O. Box 1101, Minneapolis, Minnesota USA 55440-1101

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