A Practical Guide for Moving to 10GbE

A Dell Networking White Paper

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2   Introduction

The data center landscape for many organizations is constantly changing with the introduction of new technologies and economic drivers. One technology, virtualization, has been at the forefront of the planning and implementation efforts of many IT professionals. Initially driven by the widespread adoption of server virtualization across enterprises, IT departments are embracing the significant cost savings from virtualization technologies for other platforms like desktops, storage and even applications themselves. On the economic side, fluctuations in the economy and tighter restrictions on spending has led to additional constraints on IT organizations such as showing a measureable return on investment (ROI) and combating dwindling space, power, and cooling resources in data centers.

This paper provides a brief overview of key changes occurring within data centers and the challenges they present to IT organizations. It then takes a closer look at 10 Gigabit Ethernet (10GbE) technology, how it can help overcome some of these challenges, and provides some practical guidelines on introducing it into your data center.   Finally the paper will discuss of some Dell's 10GbE switch solutions and their benefits.

This paper is intended to help CIOs, IT and network directors, and managers to gain a better perspective when planning for a shift to 10GbE within their data center infrastructure, realize the importance of a high-performance network infrastructure, and understand the types of 10GbE solutions that are available to help ensure an effective and efficient network environment.

3   Changes and Challenges in the Data Center Environment

Virtualization technology is pervasive within many data centers and is fundamentally changing the way people utilize computing resources. A common type of virtualization called server virtualization allows users to run multiple virtual machines on a single physical server, thereby sharing the resources of that single computer across multiple environments. The main incentive for organizations to use this type of technology is to make better use of the commonly underutilized servers which now feature multiple processors, and extensive memory. By consolidating multiple servers into a single physical server and optimizing the resources of that one server, IT organizations can reduce the number of physical servers within their data centers and increase resource utilizations. (see Figure 1).

Figure 1   Server Virtualization

Another virtualization technology is desktop virtualization where one or more servers can be in a centralized location hosting the end user enterprise desktop environment. One type of desktop virtualization is a virtual desktop infrastructure (VDI), where a virtual desktop connects to a centralized server and thin clients sends all user input (keystrokes, mouse clicks, etc.) across the network to the server, which processes the input and sends the user interface back across the network to the user.

Many data centers are implementing storage virtualization which helps make multiple physical resources like storage devices appear as a single virtual resource. Here a new layer of software and/or hardware is added between storage systems and servers, so that applications no longer need to determine on which

specific drives, partitions, or storage subsystems their data resides. Servers detect this virtualization layer as a single storage device, and the storage devices determine the virtualization layer as their only server.

While implementation of these virtualization technologies provides great cost savings and enhanced efficiencies of resources, they also require the infrastructure to rapidly transport large amounts of data and necessitate the real-time remapping of network resources. For example, each virtualized operating system (OS) in a server expects exclusive use of the physical resources including the network adaptor, resulting in oversubscription of I/O resources.

An often unseen impact to the network from the implementation of virtualization services is the increased number of network connections within a virtualized device (e.g. server.) and among different virtualized devices. Virtual machines running within a single virtualized server and across multiple virtualized devices must connect to each other in real time to ensure continuous service to applications and end users. For example, an application may be interacting with multiple virtualized servers or between multiple application servers. Widespread implementation of virtualization across an enterprise can sometimes result in poor quality of service (QOS) for applications and end users depending on how congested or taxed a network infrastructure may already be.

In addition to implementing new technologies, many IT organizations are tasked with decreasing their CAPEX and OPEX expenditures and resources. IT departments are taking a hard look at making their data centers more efficient and simplifying operational and maintenance activities across the board. The push behind these mandated reductions vary from changing economic conditions to federal requirements for green initiatives. The first step for many IT departments is taking inventory of expensive stand-alone systems such as networking or storage devices and then investigate how smaller, denser and converged platforms might help reduce costs, footprint and management. At the same time organizations are assessing their Local Area Network (LAN) and Storage Area Networks (SAN) infrastructures and evaluating how they can consolidate the two into one multi-functional network.

In the next section, we will take a high-level look at a promising technology called 10 Gigabit Ethernet that has proven capable of reducing many of the data center challenges we've just discussed.

4   Quick primer on 10GbE

From its introduction in the 1970s, Ethernet technology has been in continuous evolution driven by the demand for faster rates of data transmission on LANs. Starting at 10Mbps we have watched Ethernet technology move to Fast Ethernet (100Mbps) to Gigabit Ethernet (1000Mbps) and 10Gbps Ethernet and beyond.

Under the International Standards Organization's Open System Interconnection (OSI) model, Ethernet is fundamentally a Layer 2 protocol. 10GbE uses the IEEE 802.3 Ethernet Media Access Control (MAC) protocol, the IEEE 802.3 Ethernet frame format, and the minimum and maximum IEEE 802.3 frame size. The purpose of the 10GbE standard, IEEE 802.3ae, was to extend the Ethernet 802.3 protocols to an operating speed of 10 Gbps. Some of the guiding principles of this standard were to affect a significant increase in bandwidth while maintaining maximum compatibility with the installed base of 802.3 interfaces and to protect previous investment in research and development.
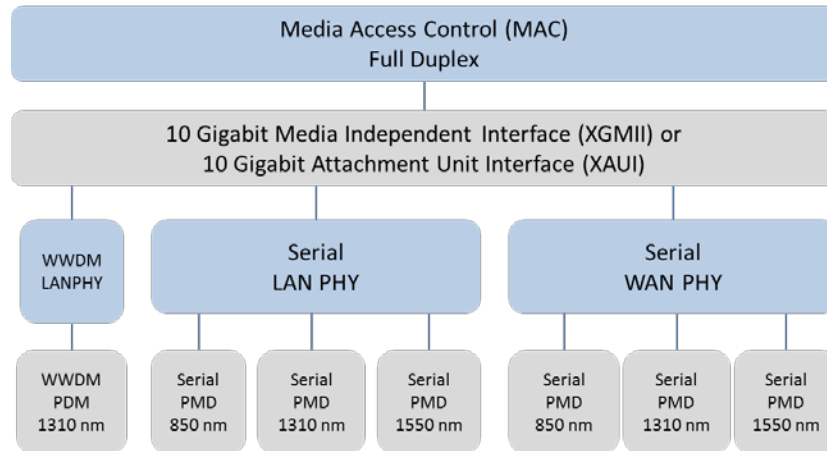
Figure 2   IEEE 802.3ae Standard

An Ethernet Physical layer device (PHY), which corresponds to Layer 1 of the OSI model, connects the media (optical or copper) to the MAC layer, which corresponds to the OSI Layer 2. Ethernet architecture divides the PHY into a Physical Media Dependent (PMD) and a Physical Coding Sublayer (PCS). For example, optical transceivers are PMDs. The 802.3ae specification defines two PHY types: the LAN PHY and the WAN PHY (see Figure 2).   The WAN PHY has an extended feature set added onto the functions of the LAN PHY.

Most 10GbE switches offered today use the Small Form-Factor Pluggable (SPF+) connectors to fiber optic cables. However, the 1GbE connectors on many existing servers, storage platforms and switches use

standardized Category 6 cables which use four pair of copper wire and a RJ-45 connector (See Figure 3). This is an important consideration when planning for a migration to 10GbE and ensuring backward compatibility with existing data center systems.
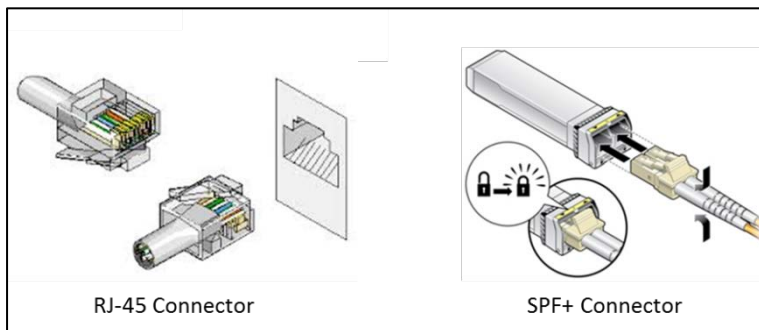
Figure 3   802.3 Connector Types

The next section of this paper will cover some important considerations when moving your data center infrastructure to 10GbE and how you may want to manage the migration.

5   Moving to a 10GbE Infrastructure

This section outlines some simple steps to follow when migrating to 10GbE within your data center. It starts with taking a good look at your current data center infrastructure, then goes into a discussion on the various types of 10GbE switches available on the market today, and wraps up with some important considerations to help ensure a successful migration.

For this paper, we will assume you are running a 1GbE infrastructure connecting servers and storage platforms within your data center. You may or may not be running a data center fabric core that is running at 10GbE or possibly 40GbE.

5.1   Inventory your infrastructure

The first step of moving to a 10GbE infrastructure involves taking a look at the equipment you are currently running within your data center. For this exercise we'll organize the inventory activities into four main categories: (1) platforms, (2) virtualization, (3) redundancy, and (4) management.

5.1.1   Platforms

Both the technology and processing capabilities embedded in today's server and storage platforms are advancing quickly. It's not uncommon to find organizations utilizing servers with multi-core processors which can overwhelm 1GbE I/O interfaces. As a result, many manufacturers are now shipping servers and Internet SCSI (iSCSI) storage platforms that include 10GbE I/O natively. Fibre channel (FC) platforms run network interfaces that are measured in Giga bits per second (Gbps).

The first step of your inventory should be to list the current platforms that you are using within your data center and their respective network I/O ports. This will help you to better understand what you're running today, if there are I/O bottlenecks, and how you will handle the migration to 10GbE. Based upon your preference, platforms can generally be categorized as stand-alone (rack mounted) or converged (blade chassis)

Table 1   Platforms

Style	Platform	Type	Network I/O Port Speed
Stand-alone (Rack Mounted)	Servers	Web, email, application, other	10MB, 100MB, 1GbE, 10GbE
	Storage	Direct attached, iSCSI SAN, FC SAN	iSCSI - 10MB, 100MB, 1GbE, 10GbE FC – 2, 4, 8, 10, 16 Gbps
Converged (Blade Chassis)	Blades	Server, storage	10MB, 100MB, 1GbE, 10GbE

5.1.2   Virtualization

IT departments everywhere are implementing server virtualization to better leverage server processors and increase efficiency. It's probably a safe assumption that you've been implementing virtualization within your data center for a while now.

The next step in compiling your inventory will be to list out the types and breadth of virtualization being implemented within your data center. This will help you better understand how much of an impact virtualization and resulting virtual connections may have on your current network infrastructure. The key types of virtualization in most organizations include server or desktop virtualization.

Table 2   Virtualization

Platforms	Virtualization Type	Extent of Virtualization
Server	VMware virtualization, Microsoft virtualization, other	# VMs (10/100/1000+)
Desktops	Remote server-based VDI, local client-based VDI	# virtual desktops (10/100/1000+)

5.1.3   Redundancy

As you continue this inventory, it's also a good time to review how your organization may have implemented multiple, discrete networks within your data center to serve specific needs. In most cases, Gigabit Ethernet technology is used for the data center LAN, while FC and iSCSI are being used to meet SAN performance levels.

The emergence of affordable 10GbE LAN technology and standards-based technologies like Data Center Bridging (DCB) are making it possible for organizations to converge these separate LAN and SAN networks into a single, multi-purpose infrastructure.

Table 3   Redundant Networks

Network Type	Technology	Types and # of I/O's
LAN	Ethernet	# Ethernet NICs on servers # Ethernet Switches
Storage	FC iSCSI	# FC NICs on servers, # of FC switches, # Ethernet NICs on servers, # of Ethernet switches

5.1.4   Management

The final part of your inventory should be to take a look at the types of device and network management tools that are being used within your data center. While there may be a variety of embedded device management tools in place for servers or storage devices, how are you managing your current switching environment? Do you have multiple or a single version network operating system? Are you able to manage all of your switching devices under one console-based network management tool? What type of enterprise management system are you using to keep track of all devices including servers, storage, and networking platforms?

There may be opportunities to implement management tools that can cover a wider spectrum of platforms that will help simplify operations and maintenance activities.

Table 4   Management

Platform	Embedded Management	Console-based Management

Server	Server management tool(s)	
Storage	Storage management tool(s)	Cross-platform management tool(s)
Networking	Networking management tool(s)	

After completing this inventory you should have a better understanding of the I/O connectors, bandwidth requirements, and management tools within your data center. If several of these areas show potential bottlenecks, redundant networks, or complex management tools then it's an opportune time to evaluate the capabilities of the leading 10GbE switches.

5.2   Evaluate and Select 10GbE switches

The next step of your move to a 10GbE infrastructure involves taking a look at the various switches available, comparing their features and making a selection. Fortunately, 10GbE technology, price, and performance are now within reach for organizations of all sizes through a wide variety of offerings. This section will provide some details on types of switches and features to look for.

5.2.1   Top-of-Rack Switches

If your data center uses a rack-based environment for their servers, there are many 1/10/40GbE Top of Rack (TOR) Ethernet aggregation switches available. These high-performance switches help aggregate many 1/10GbE interconnects within the rack while also providing a 40GbE uplink to the data center fabric.

When looking for a TOR switch, be sure to choose one that provides port density, oversubscription values, and CPU processing to insure maximum network performance for your data center environment. Some key attributes to look for during the evaluation include:

Table 5   Key TOR Switch Features

Category	Feature	Benefit
Physical	1RU high density TOR switch with • 48 to 96 ports of 1/10GbE • 4 to 32 ports of 40GbE	Conserve rack space while enabling denser footprints and simplifying migration
Redundancy	Hot swappable redundant power Hot swappable redundant fans	Optimize data center network efficiency and availability
Switching bandwidth	From 1,28Tbps to 2,56Tbps (full duplex) non-blocking, cut-through switching fabric	Delivers line-rate L2 and L3 forwarding capacity with ultra-low latency to maximize network performance
Software	Scalable L2 and L3 Ethernet switching with QoS and a full complement of standards-based IPv4 and IPv6 features	Optimizing network flexibility and efficiency

	Automated configuration and provisioning capabilities including VM-awareness	Simplify the management of virtual network environments
	Single network operating system	Simplify management and maintenance of networking devices

5.2.2 Blade Switches

You can be using infrastructure convergence technology like a blade chassis to help reduce capital and operational costs. These chassis provide extremely reliable, flexible and efficient platforms to help combat data center sprawl and IT complexity. Network connectivity within these chassis are provided by 1/10/40GbE blade switches that support internal 1/10GbE ports as well as 1 or 2 fixed 40GbE uplink ports.

When evaluating blade switches look for solutions that have the enhanced bandwidth, performance and flexibility to satisfy the changing demands of mid-market data centers. Some key attributes to look for include:

Table 6   Key Blade Switch Features

Category	Feature	Benefit
Physical	Chassis blade switch with • Up to 32 internal 1/10GbE ports • 2 fixed 40GbE ports	Delivers performance and flexibility in a flexible package to help meet the shifting demands of your data center
	Ethernet stacking	Enables scalable network switch growth for interconnected blade switches that are managed as one logical device
	FlexIO modules for QSFP+, SFP+ and 10GBASE-T connectors	Ensures room for business to grow with options for adding or swapping connectors as needed in the future
Software	Same list of key software features listed under TOR switch section	

5.2.3 Combined LAN/SAN Switches

If you are looking to combine separate Ethernet LAN and storage SAN networks, there are multiple LAN/SAN converged switches available. These 1/10/40GbE switches provide support for a wide range of services including Ethernet, iSCSI, native FC, and Fibre Channel over Ethernet (FCoE).

Look for LAN/SAN switches that also support standards like DCB, which help deliver the ability to classify and prioritize different traffic flows, enabling the combining of Ethernet LAN traffic and high-performance demanding SAN traffic across a single infrastructure. Some of the key features to look for include:

Table 7   Key LAN/SAN Switch Features

Category	Feature	Benefit
Physical	Modular, high density 1U enclosure providing • Up to 64 10GbE ports • 4 40GbE ports • Optional modules for 1/10GbE ports and FC 2/4/8 Gbps ports	Conserve rack space while enabling denser footprints and simplifying migration Consolidate server and storage connectivity with separate networks based on different networking protocols.
Redundancy	Hot swappable redundant power Hot swappable redundant fans	Optimize data center network efficiency and availability
Switching bandwidth	1.28Tbps (full-duplex) non-blocking, cut-through switching fabric delivers line-rate performance	Delivers line-rate L2 and L3 forwarding capacity to maximize network performance
SAN Support	FCoE, iSCSI and RDMA over Converged Ethernet (RoCE) is supported on all Ethernet ports	Unified LAN/SAN switch to help converge separate, redundant networks into one
	Full Data Center Bridging (DCB) support	Provide support for lossless iSCSI SANs and converged network
Software	Scalable L2 and L3 Ethernet switching with QoS and a full complement of standards-based IPv4 and IPv6 features	Optimizing network flexibility and efficiency
	Automated configuration and provisioning capabilities including VM-awareness	Simplify the management of virtual network environments
	Single network operating system	Simplify management and maintenance of networking devices

5.2.4   Management

It is critical when looking at 10GbE switches to closely evaluate the type of management tools that are available. With a goal of simplifying management within your data center, you should be looking to run all of your networking devices on one operating system. Another good capability to look for is using a single embedded network management utility across your networking devices and a single console view across all of your enterprise platforms.

Table 8   Key Switch Management Features

Category	Feature	Benefit
Embedded	Common management functionality and common user interface across all switching products	Makes operating the network easier and protects training investments

Console-based	Integrated web-based console that functions as a single window into all network management functions	Allows the quick and efficient deployment and management of all network switches
Enterprise-wide	System management console with an easy-to-use interface that can monitor the health of all enterprise platform devices (servers, storage, networking), update drivers and firmware on servers	Single place to go for a high-level view of your datacenter and simplify and automate essential hardware management tasks

5.3 Start the migration

Once you have analyzed your data center and evaluated 10GbE switches that fit your organization's needs, it's time to map out your migration. This section will walk you through several steps that will help ensure a successful and smooth migration.

5.3.1 Defining the plan

An ongoing challenge for many IT managers is how to implement new technology into their data centers with minimum disruption of daily services. To help ensure a smooth migration you should develop a plan that documents the key objectives, team members, evaluation and selection of the 10GbE switches. It's also important to identify the critical platforms to be migrated, and develop a migration schedule.

Deployment of 10GbE within your data center should include backward compatibility with existing switches, storage, and servers in the data center that are running 1GbE I/O's and copper cabling. While many 10GbE switches use the Small Form-Factor Pluggable (SPF+) connectors and fiber cabling mentioned previously, today's 10GbE switches offer 10GBASE-T connectors that are backward compatible with 1GbE switch 1000BASE-T connectors (RJ-45 like) and copper cabling. This will allow you to keep costs down while implementing an easy migration path to 10GbE.

For data centers with parallel, redundant Ethernet LAN and storage SANs, you should consider a modular converged LAN/SAN switch that allows you to merge these networks without requiring a forklift upgrade. This will help with the migration of expensive FC SANs to a pure FCoE environment at the speed you feel comfortable with.

It's highly recommended that you enlist the aid of a recognized end-to-end systems provider like Dell to help you through this planning process.

5.3.2 Training with new 10GbE switches

After the migration plan is completed and you've chosen your 10GbE switches, it's important to have key team members responsible for their installation and operations to be thoroughly trained. This training will help members become familiar with the new switches and their respective management tools. Most switch manufacturers including Dell provide detailed training courses both on-site and at separate

facilities to help train customers on key features and how to properly install, migrate, and operate their switches in the customer's data center environment.

5.3.3   Integrating with existing management tools

As in most data centers, you've already implemented one or more management tools to help your IT staff manage not only the network switches, but the server and storage platforms as well. Now is a good time to take a close look at the management tools accompanying the new 10GbE switches and to determine how they can integrate or possibly replace your existing management tools. Do your current tools provide extensions or application programming interfaces (APIs) for multi-vendor environments? If not, do the new management tools provide this so that you can simplify your management and operations tasks within the data center?

5.3.4   Running a pilot

It's a good idea to pick a smaller subset of critical platforms or perhaps a specific non-critical application as a pilot. This pilot activity will give you a chance to "practice" the upgrade from 1GbE to 10GbE switches in a controlled environment.

5.3.5   Continuing the migration

Once you're satisfied with the overall upgrade and ongoing operations, you will be ready for upgrading the next set of platforms in your plan. Based on your schedule and resources, you can conduct this migration at a speed that fits into your business plans and budget. As with running the pilot, it's recommended you move over sections at a time to help minimize large scale migration issues should they occur.

5.3.6   Reviewing lessons learned

While its good business practice to hold a lessons learned session after the migration is completed, it might be helpful if you held a "mini" lessons learned session after the initial pilot is completed. This will help make the follow-on migrations go smoother. Be sure to pull in all team players to the meeting and also include some IS folks to get a perspective on application and end user performance impacts with the migration.

6   Dell 10GbE switches and their benefits

Now that we've taken a closer look at 10GbE switch solutions, this section will give a brief overview of Dell's 10GbE switching solutions. These solutions from Dell help provide a cost-effective and user-friendly path to a 10GbE infrastructure throughout your data center.

Table 9   Dell 10GbE Switch Offerings

Features	S4810 switch	S4820T switch	S5000 switch	S6000 switch	MXL blade switch
Best for	High-performance data center and computing environments requiring high bandwidth and ultra low-latency	Dense data center environment and helping smooth migration of installed servers, storage and switches running 1GbE	Data centers looking to consolidate separate storage SAN into a single Ethernet LAN infrastructure	Demanding data center and cloud networking environments with large connectivity and workload requirements	For customers who are bundling their infrastructure on Dell's full-featured and highly flexible M1000e chassis
Line-rate ports	48 x 10GbE SFP+ ports	48 x 10GBASE-T ports	48 x 10GbE SFP+ ports and FC/FCoE ports	96 x 10Gb ESFP+ ports in breakout mode	32 x 10GbE KR ports
QSFP ports	4 x 40GbE QSFP+ ports	4 x 40GbE QSFP+ ports	4 x 40GbE QSFP+ ports	32 x 40GbE QSFP+ ports	2-6 x 40GbE QSFP+ ports
MAC address	128,000	128,000	128,000	160,000	128,000
User traffic capacity	960Mpps	960Mpps	960Mpps	1,462Mpps	960Mpps
Management	Dell Networking Operating System (FTOS) Dell Open Automation Framework OpenManage Network Manager (OMNM) OpenManage Essentials (OME)				

By integrating Dell's 10GbE solutions you start the move towards optimizing your data center with a 10GbE infrastructure that will help increase performance, reduce cost and simplify management.

Increase performance

Dell's high density 1U 10GbE S4810, S4820T, and S6000 switches will help to aggregate 10GbE traffic and to take advantage of embedded 10GbE I/O's shipping in Dell servers and storage. They will help stay ahead of increasing I/O connectivity and bandwidth demands from virtualization sprawl and new storage caching functionality in servers. You will also be able to manage an easier migration from existing 1GbE with RJ-45 connectors with Dell S4820T switch with 10GBASE-T connectors.

Reduce costs

Dell's S5000 LAN/SAN switch will help consolidate expensive, redundant Ethernet LANs and storage SANs into a single, unified LAN/SAN infrastructure. For converged environments, you can consolidate expensive stand-alone server, networking and storage devices into Dell's powerful and flexible M1000 blade platform including the Dell MXL blade switch. All of these Dell products will help you migrate from expensive Fibre Channel SANs to Ethernet LANs. You can also start planning for Dell Active Fabric functionality in the future that will help further drive down power usage, costs and management tasks

Simplify management

All Dell switches use Dell's single network operating system FTOS across all networking devices with a command line interface (CLI) that is intuitive and familiar to Cisco certified administrators. It also includes Dell's Open Automation Framework that helps automate and orchestrate tasks like bare metal provisioning, smart scripting, virtual server networking and more. You can manage all Dell networking devices with Dell's embedded OpenManage Network Manager (OMNM). Finally you can gain a single inventory and management view across all of Dell's server, networking and storage products using Dell's console-based OpenManage Essentials (OME).
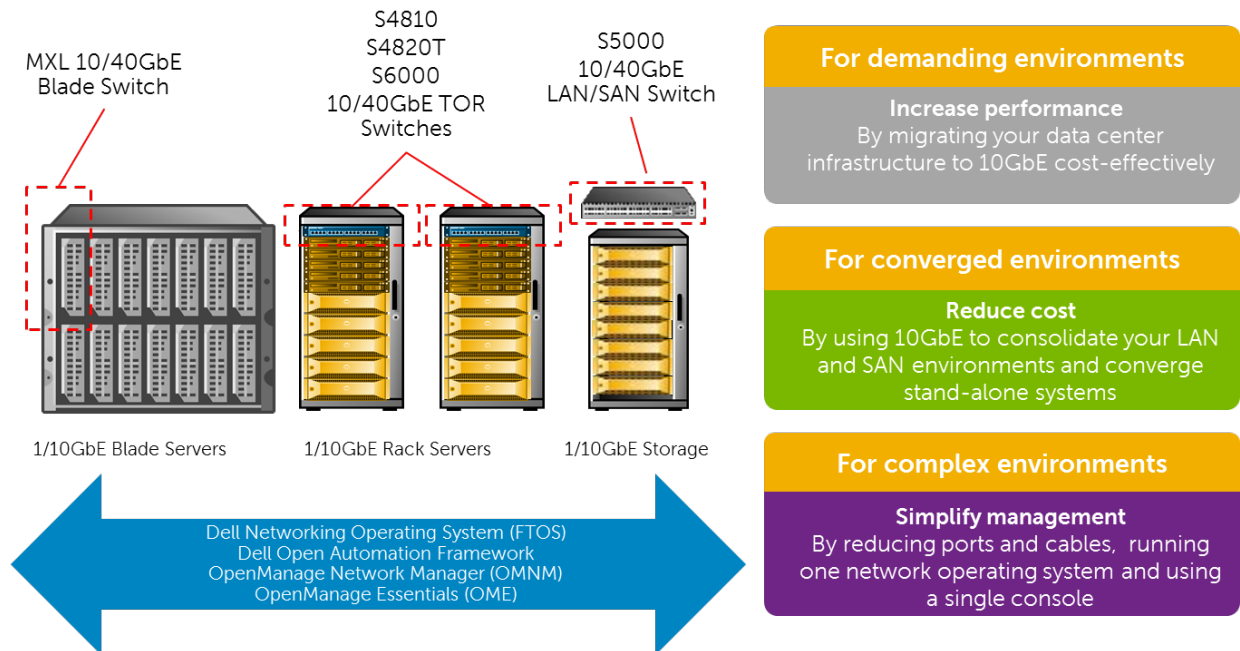
Figure 4   Dell's 10GbE Solutions

7   Summary

It's safe to assume that data center landscapes will continue to change from the constant influx of new technologies and economic drivers. Virtualization has taken a strong foothold in data centers and its use will continue to grow due to the great savings it presents. Increased performance, higher densities and convergence technologies will allow IT managers to do more with less. Ethernet will expand to become the standard highway running through the data center providing on-ramps and off-ramps for increasing network traffic both within and between servers and storage platforms.

Fortunately, improvements in 10GbE technology, price and performance is attainable by organizations of all sizes. The technology is proving to be a promising solution for many of the demanding challenges in today's data center. Now is the time for you to take a closer look at the systems within your data center environment, understand what the connectivity and convergence opportunities are, and start your careful migration toward a 10GbE infrastructure. There are a variety of choices to choose from based on your unique environment. When looking at 10GbE solutions, seek solution providers that can offer a wide selection of products, has products that help ease the 10GbE migration, and most importantly has the experience and services to provide an end-to-end solution.

At Dell, technology has always been about enabling potential for our customers. Our strategy is to help customers realize an optimized enterprise environment with an end-to-end approach that delivers superior performance and efficiency. Contact Dell to learn more about our expansive, unmatched portfolio of 10GbE networking hardware, software and services that will help accelerate positive results for your organization.