The 40 Gigabit Ethernet Era in the Enterprise: Applying Lessons Learned from the Transition to 10 Gigabit Ethernet

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***Abstract*— With the ratification of the IEEE 802.3ab in 2010, 40GbE has displaced 10GbE as the next network speed evolution in the enterprise. As was the case with the migration to 10GbE, the two main hurdles to widespread deployment of 40GbE are high deployment costs and lagging availability of supporting technologies and tools. In the 10G era, the network monitoring switch emerged as one of the technologies that helped enterprises clear the two main hurdles to High-Speed Ethernet deployment. The network monitoring switch is poised to play an even greater role in the 40GbE era. In addition to providing a bridge to High-Speed Ethernet, the network monitoring switch delivers higher network visibility and monitoring efficiency.**

***Keywords*—** *IEEE 802.3ab, 40GbE,10GbE, Ethernet.*

1. Introduction

With the ratification of the IEEE 802.3ab in 2010, 40GbE has displaced 10GbE as the next network speed evolution in the enterprise. What drives the need for 40GbE today is the same force that drove the need for 10GbE beginning in 2006: increasing bandwidth demand. In the modern enterprise, bandwidth demand is driven by the changing nature of applications and advances in server and storage technologies.

As was the case with the migration to 10GbE, the two main hurdles to widespread adoption of 40GbE are high deployment costs and the lagging availability of supporting technologies and tools. While the cost per switch port is not as high of a hurdle for 40GbE as it was in the 10GbE era, the cost of upgrading the supporting tools is significant. Also, there is concern that the ecosystem of supporting technologies and tools needed for the transition to 40GbE is not keeping up.

In the 10GbE era, the network monitoring switch emerged as one of the technologies that helped enterprises clear the two main hurdles of High-Speed Ethernet deployment. By enabling enterprises to monitor the new high-speed network with the monitoring tools they already owned, the network monitoring switch reduced the 10GbE deployment cost and addressed tool availability and performance concerns.

The network monitoring switch is poised to play an even greater role in the 40GbE era. In addition to providing a bridge for High-Speed Ethernet, the network monitoring switch delivers benefits every modern data center needs:

- Increased network visibility
- Improved monitoring tool utilization

2. Statistical Approach

The next network speed evolution in the enterprise is 40 gigabits per second. On June 17, 2010, the IEEE Standards Association Standards Board approved the IEEE Std. 802.3ba™ 2010 40Gbps and 100Gbps Ethernet amendment to the IEEE Std 802.3™ 2008 Ethernet standard. This is the first time the IEEE has determined that two new speeds are needed (J. D'Ambrosia et al, 2010).

Until now, Ethernet speed has increased by a factor of 10; from 10Mbps to 100Mbps, to 1000Mbps and eventually to 10Gbps. However, this time around the 802.3 Higher Speed Study Group (HSSG) found that computing and network aggregation applications were growing at different rates and determined that two new rates were needed:

- •100Gbps for network aggregation applications

- •40Gbps for server and computing applications

See Figure 1. In practical terms, this means that 100GbE is targeted primarily at service provider and telecommunication applications, and that 40GbE is targeted at medium to large enterprise applications.

*Source: IEEE 802.3 Higher Speed Study Group ¶

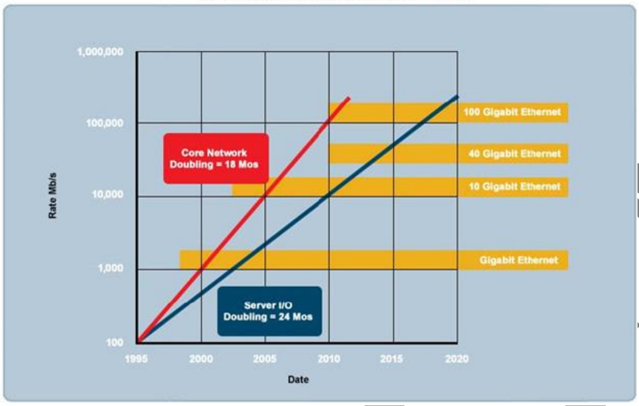

Figure 1. 40GbE and 100GbE - computing and networking

As was the case with 10GbE (A. Reichman, 2008), the need for 40GbE is driven by increasing bandwidth demand. In modern enterprise, bandwidth demand is driven by the changing nature of the data center, notably:

- Wide adoption of media-rich, cloud-based applications

- Growing adoption of virtualization

- Advances in both virtualization and server technology

- Convergence of storage area and local area networks (SAN and LAN)

To meet this bandwidth demand, some data center network administrators have turned to bundling multiple10GbE links in link aggregations (LAG). However, this solution has complexity and performance issues (H. Liu et al, 2010) that limit its usefulness.

3. Media-Rich Cloud Based Applications

Wide adoption of media-rich, cloud-based applications has resulted in data center network bandwidth requirements that outpace Moore's Law (H. Liu et al, 2010). For example, a cloud-based Customer Relationship Management (CRM) application vendor was among the top 5 fastest-growing companies in 2010. In 2010 the vendor reported an increase of 17,000 customers, a 31 percent year-over-year growth. Each such customer expects desktop-like performance from their cloud-based application, and delivering on this expectation puts new bandwidth demands on the network.

4. Growing Adoption of Virtualization

Server virtualization refers to the technology that enables the consolidation of multiple server workloads onto a single physical server. Enterprises embrace virtualization primarily to reduce IT costs. One cost saving is in lowered power consumption because fewer physical servers are needed to run a given number of server workloads. Other benefits of virtualization in the enterprise include simplified IT infrastructures and a more dynamic and flexible data center.

5. Extended in Virtualization and Server Technology

However, virtualization also poses some challenges. One challenge is the increased bandwidth requirements due to the consolidation of multiple workloads onto a single physical server with a limited set of network interfaces. Before virtualization, each workload ran on its own dedicated hardware with a dedicated network interface. With virtualization, as more workloads are added to the physical server, the network interfaces on the server need to provide more bandwidth.

This issue is exacerbated by the use of blade servers, which increase the density of servers in an equipment rack. It is common to see a blade enclosure using an active, eight-port link aggregation to provide upstream bandwidth to all of the virtual machines (VMs) running on it.

Figure 2 illustrates the impact of a higher density of 1Gbps and 10Gbps server interfaces and server density on the aggregation link speed requirements in the data center. As the server density increases, so do the aggregation link speed requirements.

*Source: Cisco IEEE – 40G SMF Ad Hoc Summary ¶

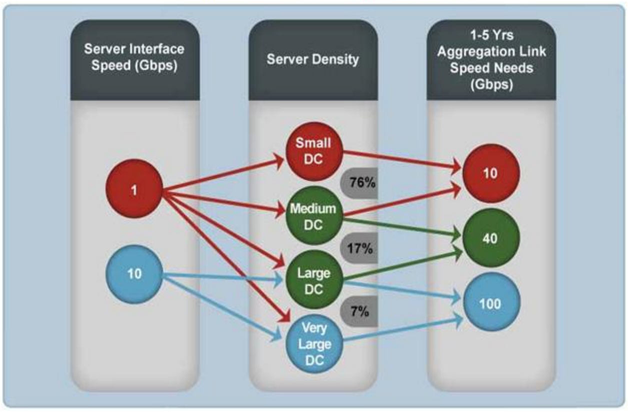

Figure 2: Different classes of data centers have different link aggregation speed needs

6. Convergence of Storage and Regular Networks

Another change in the data center that drives bandwidth requirements is the convergence of storage and regular networks. Enterprises are replacing server hard disks with networked storage to improve data access and reliability and lower maintenance costs (M. Nowell et al, 2010). However, the convergence of SAN and LAN traffic onto the same physical network infrastructure, also known as I/O convergence, increases the bandwidth demand on the converged network. Disk I/O is one of the primary bandwidth consumers in servers, and moving the disks out of the local chassis to a remote network drive increases the network I/O bandwidth requirements (M. Nowell et al, 2010). Network storage solutions utilizing Ethernet include most Network Attached Storage (NAS) devices, iSCSI, and Fibre Channel over Ethernet (FCoE).

7. The Main Hurdles to 40GbE Deployment

In 2010, 40GbE switch ports were priced at about $1000 per port, which was only $85 more than the average price for 10GbE ports (J. Duffy, 2010). This makes 40GbE more affordable than 10GbE was in 2008 when its per-port premium was 5 to 10 times the average 1GbE price (A. Reichman et al, 2008). However, deployment costs also include the cost of upgrading the ecosystem of supporting tools.

For example, modern data centers rely on a variety of network monitoring tools to meet regulatory compliance, provide network security and troubleshoot network performance (A. Kindness, 2011). Since most tools were not designed to work at 40Gbps, most will need to be upgraded or replaced as part of the migration to 40GbE (D. Newman, 2011). The cost of upgrading the ecosystem of supporting tools will be the bulk of the 40GbE deployment cost. For example, the first 40Gbps-capable Intrusion Detection System (IDS) to market costs $760K ($19 per Mbps of protection).

The second obstacle to widespread adoption of 40GbE in the enterprise is the lagging availability of supporting technologies and tools. While a handful of 40Gbps network monitoring tools have been announced, the new 40Gbps data rate pushes the performance envelope on monitoring tools, especially on tools that need to capture and analyze packets in near real-time. There is a concern that the ecosystem of tools needed for the transition to 40GbE is not keeping up (D. Newman, 2011).

8. The Network Monitoring Switch

During the transition to 10GbE, the network monitoring switch emerged as one of the technologies that helped enterprises overcome the two main obstacles to High-Speed Ethernet deployment: high deployment cost and lagging tool availability. The network monitoring switch will play the same role in the transition to 40GbE. It enables enterprises to monitor its new high-speed networks using the monitoring tools they already own.

In doing so, the network monitoring switch reduces the 40GbE deployment cost and addresses the monitoring tool availability and performance concerns. A network monitoring switch is deployed between network (SPAN ports and

TAPs) and the monitoring tools, as illustrated in Figure 3. In this configuration, the network monitoring switch can "downshift" the speed of network data to match the speed of the attached monitoring tools. The network monitoring switch uses several techniques to achieve this interface speed matching, including packet filtering. With filtering, 40Gbps network traffic can be reduced to the data rate the attached monitoring tools can manage.

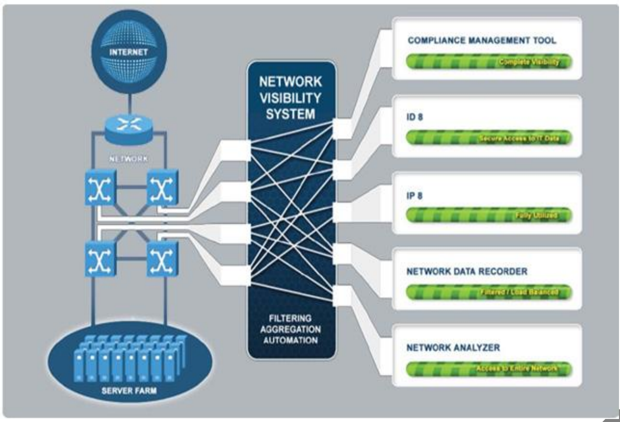

Figure 3: Network monitoring switch

This capability not only resolves the speed difference, it also boosts tool performance. Since the network monitoring switch removes irrelevant data from the network traffic before it is delivered to the monitoring tools, the tools are able to dedicate all computing resources to processing relevant data.

However, the network monitoring switch is more than a bridge to High-Speed Ethernet. It also solves a common network visibility problem, and for this it is recognized as one of the three core network tools every modern data center needs (A. Kindness, 2011). Enterprises commonly need to connect an increasing number of monitoring tools to the network, but the number of access points is fixed. As illustrated in Figure 3, the network monitoring switch can be configured so that all monitoring tools can have access to data from all access points. As a result, every tool gets a complete view of the network traffic. In addition, as business needs dictate more monitoring tools can be attached to the network with the same level of visibility.

9. Conclusion

The IEEE 802.3ba standard was developed to help meet the bandwidth demand driven by modern network applications. The network monitoring switch will be an important tool for medium to large enterprise data centers as they transition to 40GbE. It lowers the transition cost by enabling IT organizations to use their existing monitoring tools to monitor their new 40GbE links. In addition, the network monitoring switch delivers higher network visibility and monitoring efficiency.

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