WHITE PAPER

Optical Switching: Implementing a Future-Ready Infrastructure

Overview

Communications technology is a critical engine that drives today's global economy – and it keeps getting faster. No matter what our device, the speed at which it connects defines the application experience. Cloud networks need faster internet access speeds; corporate networks need faster download speeds; and financial networks need faster trading speeds – all to have a "better" application experience.

- Scalable, high-speed connectivity and monitoring technology is fundamental to many high-performance applications.
- Test Automation needs switching across a wide variety of speeds as new network elements are introduced.
- Network Monitoring needs connectivity across a wide variety of protocols and speeds as they grow with increased network transport.
- Cloud Networking needs connectivity that is very cost effective and grows as the users and applications expand.
- CyberSecurity applications need to span across a broad range of past and future protocols, including proprietary formats.

From a business perspective, the application experience drives revenue and profitability. However, constantly upgrading networks for the higher speeds, new protocols, and a "better" application experience can cost significant capital and operational expense that directly reduces the profit objectives. Communications technologies that can scale with the speeds and protocols are critical for long-term success.

Physical layer switching, also known as Layer 1 switching or matrix switching, provides the unique benefit of supporting scalable high-speed connectivity and monitoring across applications ranging from under 1 Mbit/s to over 100 Gbit/sec. While electrical switching fabrics have been the heart of the systems in the past, new all-optical switching technology has evolved as the perfect complement when higher-speed and highly proprietary optical signals are needed.

All-optical switching is a technology originally developed in the 1990's for small switch sizes and has been significantly expanded in size and performance over the past decade. Using the Micro-Electro-Mechanical Systems (MEMS) technology with mirrors and collimating lenses, optical switching fabrics are now available to support virtually any speed, protocol, or application supported over singlemode fiber. Figure 1 shows a MEMS core optical switching architecture example.

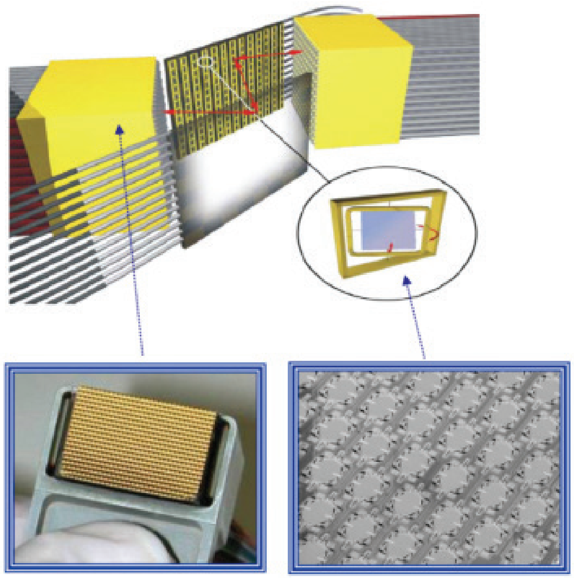

Figure 1. 320 x 320 3D MEMS Optical Switching.

Benefits of Optical Switching

There are three core advantages that create numerous benefits for all-optical switching in high-performance networks.

Speed

Fast speed comes in many forms for all optical switching:

- Multi-terabit line speeds are supported across every port of an all-optical switch. As applications continue to drive the need for more and more bandwidth, all optical switching is the only technology that can scale with the growth effectively. Figure 2 shows a cost comparison of all-optical switching compared to electrical switching, highlighting the economic benefits as speeds increase over 10Gbit/s and the stability of the cost across all data rates. This makes optical switching the obvious choice for the most speed-scalable core infrastructures.

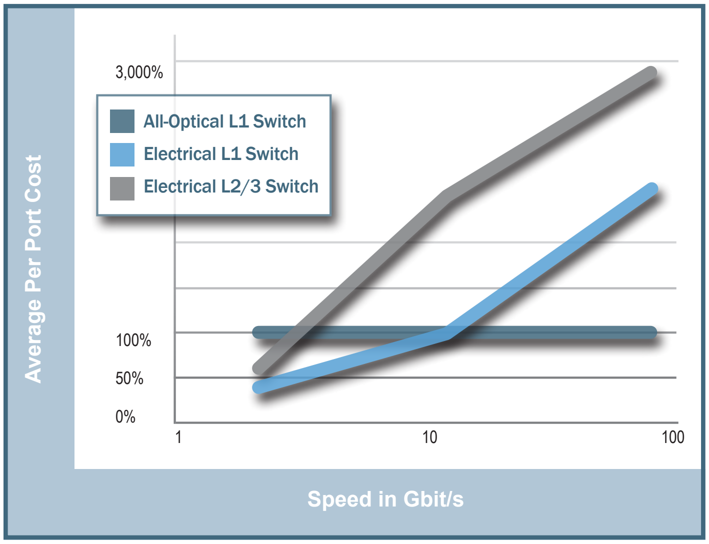

Figure 2. Average cost based on increase in speed.

- Latency is incredibly low with all-optical switching since everything happens at the speed of light. The typical latency is 5 ns, which is 500-1000x lower than most L2/3 switches. This proves especially important for financial transactions and special RF applications.
- Ultra-fast switching times below 50 ms are supported for any application on any port. This speed enables fast reconfiguration at the application level as well as the transport lines, such as protection switching.

Network Communication Speed Comparison

Maximum Throughput Speed	Protocol/Service
64 kbps	DS0/ Integrated Services Digital Network (ISDN)
1.5 Mbps	DS1/T1
10 Mbps	10Base-T Ethernet/RS-422
45 Mbps	DS3/T3
100 Mbps	100Base-T Ethernet (Fast Ethernet) /FDDI
155 Mbps	OC-3/STM-1 Synchronous Optical Network (SONET)/Asynchronous Transfer Mode(ATM)
200 Mbps	ESCON(Enterprise Systems Connectivity)
622 Mbps	OC-12/STM-4
1 Gbps	Gigabit Ethernet and Fibre Channel
2 Gbps	Fibre Channel
2.5 Gbps	OC-48/STM-16/OTU1(Optical Transport Unit)/
4/8 Gbps	Fibre Channel/Infiniband
10 Gbps	10G Ethernet/OC-192/STM-64/OTU-2/Fibre Channel (Serial and Parallel)
16 Gbps	Fibre Channel/Infiniband
40/43 Gbps	OC-768/OTU3
100/112Gbps	100GE/OTU4
Various	Video and proprietary protocols
>1Tbps	Wavelength Division Multiplex

Figure 3. Network communication speed comparison.

Protocol Independence

In addition to being data-rate independent, an all-optical switch is also protocol independent. This enables the switch to interconnect different types of networks running different protocols over a single system. Adding the capabilities of low-speed copper interfaces with all-optical switching in the same platform, physical layer switching systems can be used to switch the following types of traffic simultaneously:

Since the optical switch contains no SFP transceivers, there is also no additional cost or configuration required to support one or all of the above protocols. Likewise, as networks continue to evolve and new protocols emerge, they can be supported without requiring any changes.

Future Ready

Since all-optical switching can support the future speeds and protocols without any changes to the existing hardware, they represent a fundamental solution to future-proofing the network. The overall switching capacity of optical switching is on the order of Petabits. For example, a 320-port all optical switch growing to 100 Gbit/s per port would result in a 32 Terabit switch fabric. A similar sized system with 80 DWDM channels of 40 Gbit/s each scales to a Petabit switch without any system changes.

An all-optical switch also consumes extremely low-power, especially when compared to Layer 2/3 alternatives. An all-optical switch uses approximately 1 watt per port, regardless of the data rate running through it. As shown in Figure 3, the power benefit is over 100 times better than L2/3 switching and is uniform throughout the future speed upgrades that will be required.

Conclusion

Networks will continue to increase in speed and in efficiency. Physical layer switches are vital to supporting this growth in key application areas such as test automation, network monitoring, cloud networking, and CyberSecurity. While electrical switches can meet many of these needs for networks that operate at speeds up to 10 Gbps, all-optical switches are the only choice for networks that go beyond the 10 Gbps data rate. In addition, optical switches are the ideal choice for switching bi-directional, multi-wavelength traffic, and proprietary optical traffic. Optical switches are also ideal for areas where a multitude of network types come to a central point to provide access into each network for monitoring and CyberSecurity resulting in increased visibility into the network. In short, deploying all-optical switches enables the network to scale to much higher speeds, support current and future protocols, and future proof the network, ultimately saving time and money while increasing utilization.

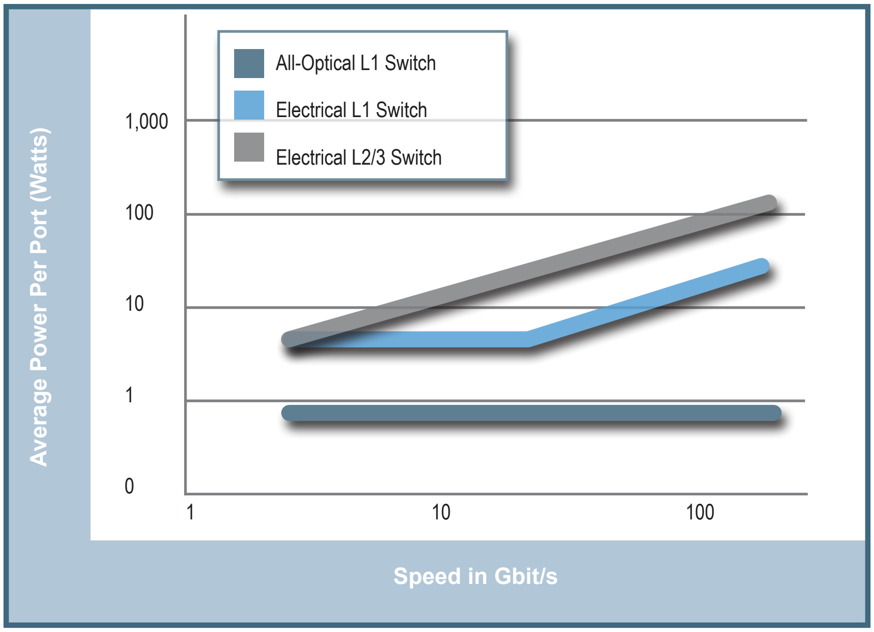

Figure 4. Average power based on increase in speed.

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