White Paper

Cisco EtherChannel Technology

Introduction

The increasing deployment of switched Ethernet to the desktop can be attributed to the proliferation of bandwidth-intensive intranet applications. Any-to-any communications of new intranet applications such as video to the desktop, interactive messaging, and collaborative white-boarding are increasing the need for scalable bandwidth within the core and at the edge of campus networks. At the same time, mission-critical applications call for resilient network designs. With the wide deployment of faster switched Ethernet links in the campus, users need to either aggregate their existing resources or upgrade the speed in their uplinks and core to scale performance across the network backbone.

Cisco EtherChannel® technology builds upon standards-based 802.3 full-duplex Fast Ethernet to provide network managers with a reliable, high-speed solution for the campus network backbone. EtherChannel technology provides bandwidth scalability within the campus by providing up to 800 Mbps, 8 Gbps, or 80 Gbps of aggregate bandwidth for a Fast EtherChannel, Gigabit EtherChannel, or 10 Gigabit EtherChannel connection, respectively. Each of these connection speeds can vary in amounts equal to the speed of the links used (100 Mbps, 1 Gbps, or 10 Gbps). Even in the most bandwidth-demanding situations, EtherChannel technology helps aggregate traffic and keep oversubscription to a minimum, while providing effective link-resiliency mechanisms.

Cisco EtherChannel Benefits

Cisco EtherChannel technology provides a solution for network managers who require higher bandwidth between servers, routers, and switches than single-link Ethernet technology can provide.

Cisco EtherChannel technology provides incremental scalable bandwidth and the following benefits:

- *Standards-based*—Cisco EtherChannel technology builds upon IEEE 802.3-compliant Ethernet by grouping multiple, full-duplex point-to-point links together. EtherChannel technology uses IEEE 802.3 mechanisms for full-duplex autonegotiation and autosensing, when applicable.
- *Multiple platforms*—Cisco EtherChannel technology is flexible and can be used anywhere in the network that bottlenecks are likely to occur. It can be used in network designs to increase bandwidth between switches and between routers and switches—as well as providing scalable bandwidth for network servers, such as large UNIX servers or PC-based Web servers.
- *Flexible incremental bandwidth*—Cisco EtherChannel technology provides bandwidth aggregation in multiples of 100 Mbps, 1 Gbps, or 10 Gbps, depending on the speed of the

aggregated links. For example, network managers can deploy EtherChannel technology that consists of pairs of full-duplex Fast Ethernet links to provide more than 400 Mbps between the wiring closet and the data center. In the data center, bandwidths of up to 800 Mbps can be provided between servers and the network backbone to provide large amounts of scalable incremental bandwidth.

- *Load balancing*—Cisco EtherChannel technology is composed of several Fast Ethernet links and is capable of load balancing traffic across those links. Unicast, broadcast, and multicast traffic is evenly distributed across the links, providing higher performance and redundant parallel paths. When a link fails, traffic is redirected to the remaining links within the channel without user intervention and with minimal packet loss.
- *Resiliency and fast convergence*—When a link fails, Cisco EtherChannel technology provides automatic recovery by redistributing the load across the remaining links. When a link fails, Cisco EtherChannel technology redirects traffic from the failed link to the remaining links in less than one second. This convergence is transparent to the end user—no host protocol timers expire, so no sessions are dropped.
- *Ease of management*—Cisco EtherChannel technology takes advantage of Cisco experience developed over the years in troubleshooting and maintaining Ethernet networks. Existing network probes can be used for traffic management and troubleshooting, and management applications such as CiscoWorks and third-party management applications are now EtherChannel-aware.
- *Transparent to network applications*—Cisco EtherChannel technology does not require changes to networked applications. When EtherChannel technology is used within the campus, switches and routers provide load balancing across multiple links transparently to network users. To support EtherChannel technology on enterprise-class servers and network interface cards, smart software drivers can coordinate distribution of loads across multiple network interfaces.
- *Compatible with Cisco IOS® Software*—Cisco EtherChannel connections are fully compatible with Cisco IOS virtual LAN (VLAN) and routing technologies. The Inter-Switch Link (ISL) VLAN Trunking Protocol (VTP) can carry multiple VLANs across an EtherChannel link, and routers attached to EtherChannel trunks can provide full multiprotocol routing with support for hot standby using the Hot Standby Router Protocol (HSRP).
- *100 Megabit, 1 Gigabit, and 10 Gigabit Ethernet-ready*—Cisco EtherChannel technology is available in all Ethernet link speeds. EtherChannel technology allows network managers to deploy networks that will scale smoothly with the availability of next-generation, standards-based Ethernet link speeds.
- *Interoperability with Coarse Wavelength Division Multiplexing (CWDM) Gigabit Interface Converters (GBICs)*—By simultaneously implementing Gigabit EtherChannel and CWDM technologies, network managers can increase the bandwidth of their links without having to invest in new long runs of fiber. CWDM technologies allow the traffic aggregated by the Cisco EtherChannel link to be multiplexed on to a single strand of fiber.

Cisco EtherChannel Components

Cisco EtherChannel technology is a trunking technology based on grouping several full-duplex 802.3 Ethernet links to provide fault-tolerant, high-speed links between switches, routers, and servers. It is based on proven industry-standard technology—it has been extended from the EtherChannel technology offered by Kalpana in its switches in the early 1990s, and provides load sharing across multiple Fast Ethernet links while providing redundancy and subsecond convergence times.

Cisco EtherChannel technology consists of the following key elements:

- *Fast Ethernet links*—Cisco EtherChannel connections can consist of one to eight industry-standard Fast Ethernet links to load share traffic with up to 80 Gbps of usable bandwidth. EtherChannel connections can interconnect LAN switches, routers, servers, and clients. Because load balancing is integrated with Cisco Catalyst® LAN switch architectures, there is no performance degradation for adding links to a channel—high throughput and low latencies can be maintained while gaining more available bandwidth. EtherChannel technology provides link resiliency within a channel—if links fail, the traffic is immediately directed to the remaining links. Finally, EtherChannel technology is not dependent on any type of media—it can be used with Ethernet running on existing unshielded twisted pair (UTP) wiring, or single-mode and multimode fiber.
- Cisco EtherChannel technology is a standard feature across the entire Cisco Catalyst series of switches and Cisco IOS® Software-based routers. The load-sharing algorithms used vary between platforms, allowing for decisions based on source or destination Media Access Control (MAC) addresses, IP addresses, or Transmission Control Protocol/User Datagram Protocol (TCP/UDP) port numbers.
- *Redundancy*—Cisco EtherChannel technology does not require the use of 802.1D Spanning-Tree Protocol to maintain a topology state within the channel. Rather, it uses a peer-to-peer control protocol that provides autoconfiguration and subsecond convergence times for parallel links, yet allows higher-level protocols (such as Spanning-Tree Protocol) or existing routing protocols to maintain topology. This approach allows EtherChannel technology to use the recovery features of the network without adding complexity or creating incompatibilities with third-party equipment or software. Because the Spanning-Tree Protocol operation is completely standards-based, network managers can use their existing network topologies, augmenting bandwidth by installing EtherChannel technology where single Ethernet links were previously installed.
- *Management*—Cisco EtherChannel technology is easily configured by a command-line interface (CLI) or by Simple Network Management Protocol (SNMP) applications such as CiscoWorks. A network manager needs to identify and define the number of ports that will make up the channel, and then connect the devices. CiscoWorks for Switched Internetworks will graphically display EtherChannel connections between devices, collect statistics for both individual Ethernet links within the channel, and aggregate statistics for the EtherChannel connection. An integral benefit of EtherChannel technology is the ability to detect, report, and prevent the use of incorrectly paired interfaces within the channel. These may include interfaces that are not configured for full-duplex operation, have mismatched link speeds, or are incorrectly wired. Consistency checks are completed before the activation of a channel to help ensure network integrity.

Cisco EtherChannel Topologies

The following diagrams show some common applications of Cisco EtherChannel technology and how they solve the bandwidth requirements of today's networks. Fast EtherChannel and Fast Ethernet links will be used throughout these examples.

Figure 1 shows a network using Cisco EtherChannel connections. The bandwidth between the wiring closets and the data center has been doubled, from 200 Mbps to 400 Mbps. In addition to the increased bandwidth, the resiliency within the channel provides for subsecond convergence if one of the links fails.

Figure 1
Scaling Performance Between Wiring Closets and the Data Center

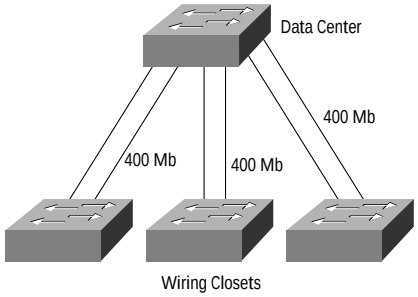


Figure 2 shows a topology where the network manager has increased bandwidth between the data center and the wiring closet to an aggregate of 800 Mbps, but has also used the physical diversity of the fiber plant to decrease the chances of a network outage. Using a Cisco EtherChannel connection consisting of four Fast Ethernet links, two fiber runs on the east side of the building provide 400 Mbps, and the west side of the building provides the remaining 400 Mbps. In this example, in the event of a fiber cut on one side of the building, the remaining side will pick up the traffic in less than one second, without wiring closet clients losing sessions.

Figure 2
Scaling Bandwidth with Resilience

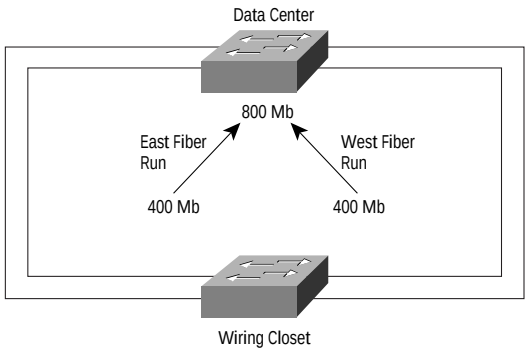


Figure 3 shows a configuration where a switch has been configured with two Cisco EtherChannel connections consisting of two links each. Because these are separate channels, Spanning-Tree Protocol will block the second channel to avoid the looped topology. This design is applicable where EtherChannel connections are resident on separate line cards within the switch for resiliency.

Figure 3
Resilience with Cisco EtherChannel Technology Using Spanning-Tree Protocol

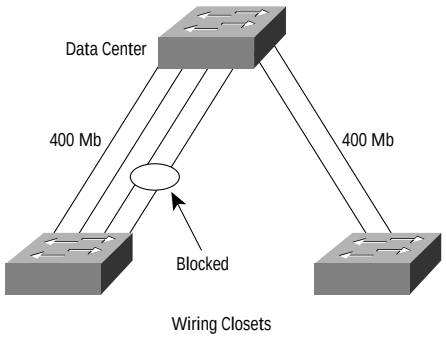


Figure 4 shows a complete network design based on Cisco EtherChannel technology. As in the previous examples, links from the wiring closets are brought into the data center using 400 Mbps channels, providing bandwidth and resiliency. In the data center, routers are interconnected with EtherChannel connections, providing improved performance by having more bandwidth available to route between subnets. Here the router is configured with two dual-link EtherChannel connections to provide 400 Mbps of bandwidth on each subnet. The EtherChannel technology provides load balancing across two links within the channel based on IP addresses, and the links within the channel can use ISL encapsulation to support multiple subnets per link. The last component in this network design is a server attached via a four-link EtherChannel connection, which provides 800 Mbps of bandwidth to the network. Typical platforms that would require such bandwidth would be high-end Pentium Pro servers, enterprise servers, and high-end graphics imaging and rendering servers. As shown in Figure 4, the server is connected via a multiple-link EtherChannel connection—an excellent match for the bandwidth needs of locally attached users and the users serviced via the router.

Figure 4
Cisco EtherChannel Technology Interconnecting Servers, Switches, and Routers Across the Campus

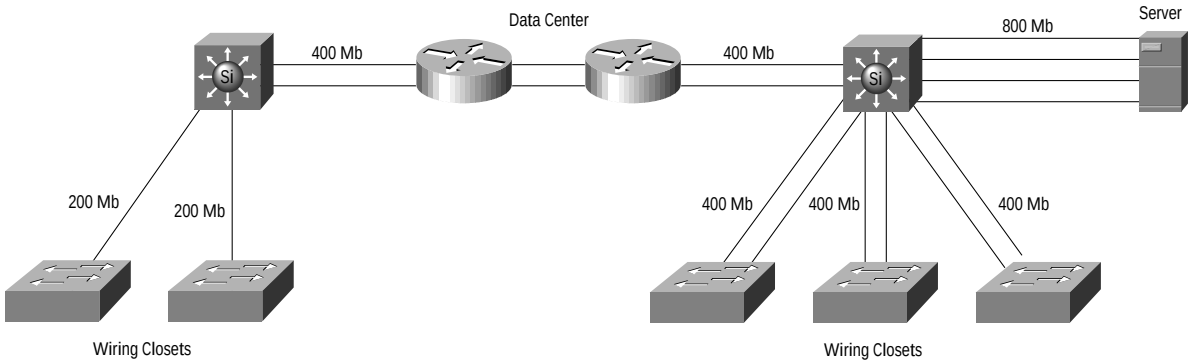
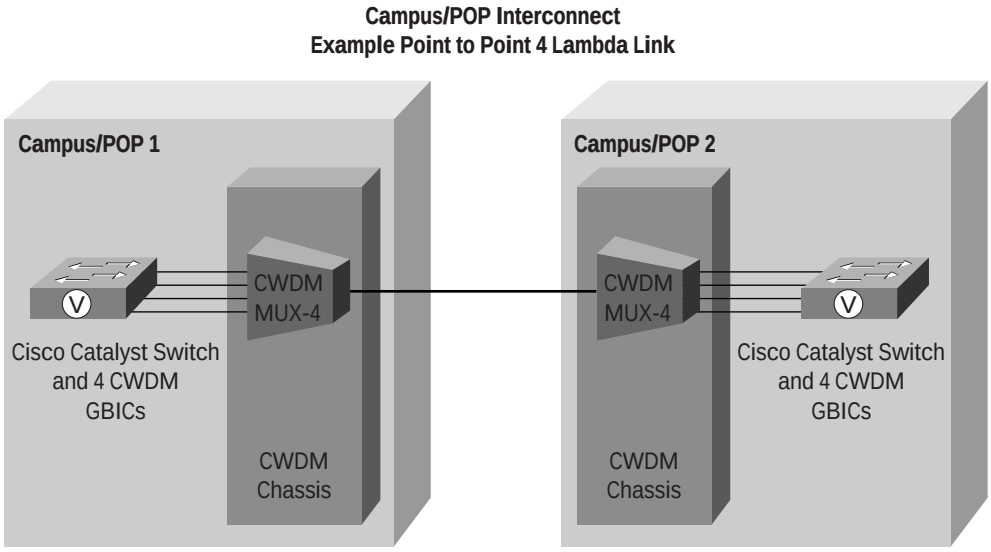


Figure 5 shows a sample network where Gigabit links are used with Gigabit EtherChannel and CWDM technologies. In Figure 5, four gigabit links have been combined to obtain a total aggregated bandwidth of 4 gigabits. Without incorporating CWDM technologies into the solution, four runs of fiber need to be installed between the two campus points of presence (POPs). By employing CWDM GBICs and two CWDM add/drop multiplexers, the number of runs of fiber can be reduced to one. This translates into significant savings depending on the distance to be spanned by the EtherChannel connection.

Figure 5
Cisco EtherChannel Technology over CWDM



Summary

Cisco EtherChannel technology leverages standards-based Ethernet links used in a parallel topology, taking advantage of existing technology to provide the additional bandwidth that network backbones require. EtherChannel technology provides flexible, scalable bandwidth with resiliency and load sharing across links for switches, router interfaces, and servers. EtherChannel technology provides the tools for network managers to build high-speed solutions for their campus network backbones, while using the existing cabling and network device infrastructure. EtherChannel technology can aggregate all available Ethernet link speeds, from 10 Mbps to 10 Gbps.

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