A BRIEF OVERVIEW OF 10 GIGABIT ETHERNET

025

TECHNICAL NOTE

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Since its inception in 1970, Ethernet has steadily gained dominance as the networking protocol of choice. As Ethernet's adoption increased to the 95% level it enjoys today in local-area network deployments, the standards have evolved to satisfy the need for higher bandwidth, optical fiber installations, and geographically larger networks.

The 10 Gigabit Ethernet (10 GigE) 802.3ae standard was ratified by the IEEE in June 2002 and is now entering mass deployment in a variety of applications. 10 Gigabit Ethernet is equally valuable as a core technology for server room switching, metro access and backhaul networks, and long-haul installations leveraging legacy SONET/SDH equipment.

In the evolution from Gigabit Ethernet to 10 Gigabit Ethernet, a number of changes were made to accommodate this broad range of possible applications. The most important of these changes relate to how data is encoded and the types of physical connections 10 Gigabit Ethernet can run over. The frame size and format remain the same so that Layer 3 and higher protocols remain fully compatible.

Mode of Operation

10 Gigabit Ethernet is designed to run only over point-point (switched) links, in full-duplex mode. This reflects its role as a backbone (as opposed to a workgroup) technology. 10 Gigabit Ethernet does not currently support auto-negotiation since it is assumed to be used only in pure 10 Gigabit Ethernet installations. Currently, 10 Gigabit Ethernet is ratified for use over fiber; a copper specification is under review by the IEEE.

Data Encoding

Ethernet has typically been encoded with what is known as 8B/10B encoding. This means that each 8 bits of data are converted to 10 bits before transmission, with the additional information used to ensure data integrity. This technique requires transmitting encoded data 25% faster than the desired throughput–1 Gb/s of encoded data is transmitted at 1.25 Gb/s between terminals. At Gigabit Ethernet rates, 8B/10B encoding is reasonable, but it is not efficient at 10 Gb/s transmission, in which an encoded signal would have to travel at an impractically fast 12.5 Gb/s. To ensure that Ethernet remained a cost-effective technology, the 10 Gigabit Ethernet standard introduced a new 64B/66B encoding scheme to keep transmission rates near 10 Gb/s. This allowed system manufacturers to leverage mature 10 Gb/s technology originally developed for SONET/SDH applications.

Physical Interfaces

Depending on the application, LAN or WAN physical interfaces are used. LAN PHY is used to carry native Ethernet over wavelengths in WDM systems, whereas WAN PHY was developed to allow 10 Gigabit Ethernet data to be carried directly over native SONET/SDH transport equipment, facilitating Ethernet integration into existing long-haul networks.

LAN PHY Specifications

This interface comes in two different versions: a serial version using 64B/66B encoding, operating at a data rate of 10.000 Gb/s allows for transmission over a fiber or single WDM wavelength, and a CWDM version–10Base-LX4–using 8B/10B encoding on four channels, each running at 3.125 Gb/s.

WAN PHY Specifications

WAN PHY is designed to bridge the asynchronous world of Ethernet data with synchronous SONET/SDH transport, allowing 10 Gigabit Ethernet to be transparently carried over current DWDM networks. As a result, this interface runs at a data rate compatible with SONET OC-192c/SDH VC-4-64c (9.5846 Gb/s). WAN PHY supports a direct connection to SONET/SDH circuit-switched networks. In the WAN PHY standard, a WAN interface sublayer (WIS) is added, which encapsulates the data payload into a simplified SONET OC-192c (concatenated) frame.

WAN PHY has some SONET/SDH features but does not support the full SONET/SDH standard.

SONET/SDH Features

Supported:

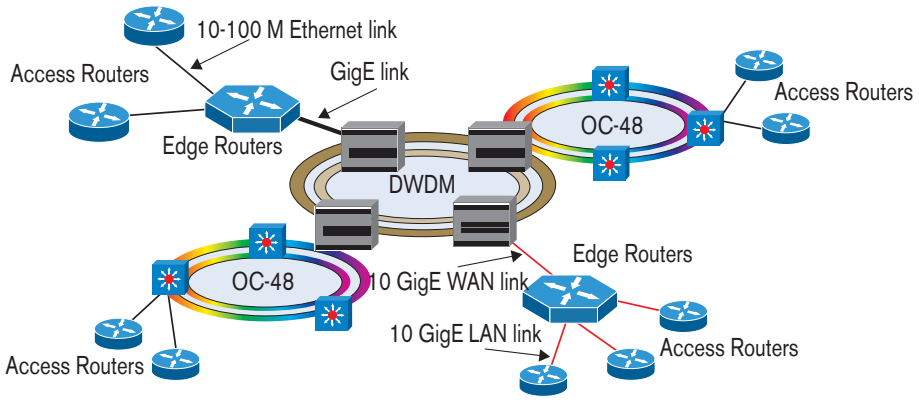
- SONET/SDH overhead features required for fault isolation
- Pointer-processing to allow carriage over future OC-768/STM-256 backbones

Not Supported:

- Line and section DCC
- Local and express orderwire

The WAN PHY standard also defines some telco-like features, reflecting its possible use as a long-haul protocol. These include facility-loopback capabilities, threshold for severely errored seconds, and embedded test pattern generation/detection capabilities (PRBS-31).

Figure 1 . A Typical 10 GigE Implementation using LAN and WAN PHY



With its interface flexibility, integration with existing SONET/SDH transport technology, and full backward compatibility with lower-rate Ethernet standards, 10 Gigabit Ethernet is positioned to be a key technology in LAN, access, metro, and long-haul network deployments.

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