Finisar®

WDM REFERENCE GUIDE

WDM is a key enabling technology for any network provider, carrier, or enterprise that wishes to significantly increase the amount of data transmitted over a single fiber.

UNDERSTANDING WDM TECHNOLOGY

The concept of WDM technology is very simple. A key property of light is wavelength ("color"). Historically, optical communications operated on a single wavelength (i.e. "one color") and the amount of bandwidth that could be transmitted down a single fiber was equal to the bandwidth of that data-stream. However, by combining multiple wavelengths ("colors") and transmitting these wavelengths down a single fiber, we have the ability to drive multiple traffic streams simultaneously, each one carrying its own independent data-traffic.

Figure 1 shows one such example. If each color of light carries a data rate of 10 Gbit/s, then, combining 4 colors of light into the same fiber increases the total data rate four fold to 40 Gbit/s.

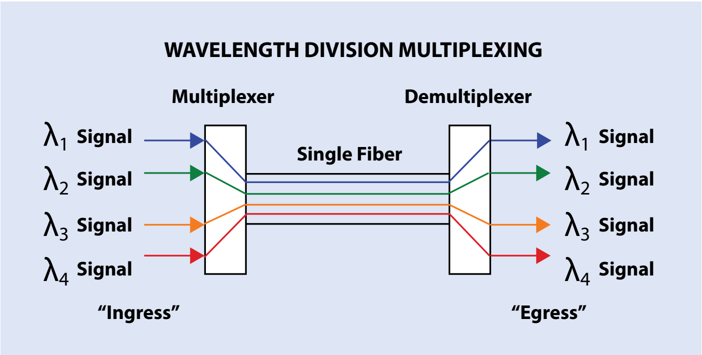
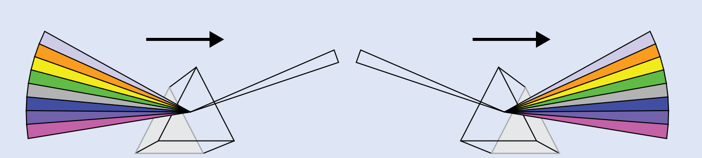


Figure 1: Basic WDM Technology Diagram

DESCRIPTION OF MUX/DEMUX

Two key components in a WDM system are the optical wavelength multiplexer (MUX), and the de-multiplexer (DEMUX). An optical prism represents a convenient way to understand a MUX/DEMUX function. When a multi-color light beam goes through an optical prism, due to its unique material property and geometry, light of different colors will exit at different angles and become, in WDM terminology, de-multiplexed. Conversely, if light of multi-colors are sent through the prism at different pre-designated angles, they will exit the prism at the same angle as a single light beam becoming, in WDM terminology, multiplexed. See Figure 2.

In general, a CWDM (coarse WDM) MUX/DEMUX deals with small numbers of wavelengths, typically eight, but with large spans between wavelengths (spaced typically at around 20nm). A DWDM (dense WDM) MUX/DEMUX deals with narrower



At Ingress: Multiple optical signals of differing wavelengths are combined to form a single optical signal.

At Egress: A single optical signal is refracted to separate multiple optical signals of differing wavelengths.

Figure 2: Ingress vs. Egress functions

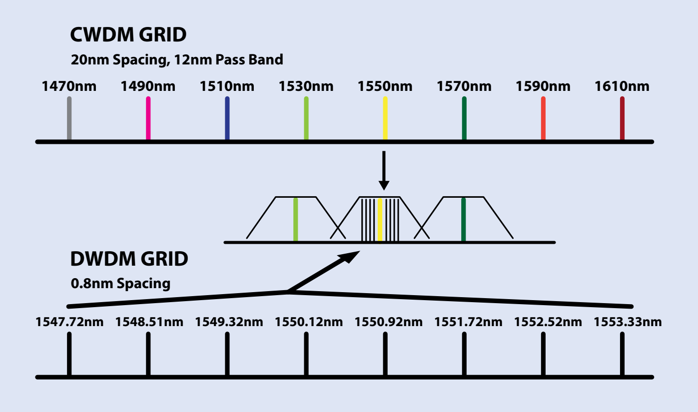


Figure 3: CWDM and DWDM technology comparison

wavelength spans (as small as 0.8nm, 0.4nm or even 0.2nm), and can accommodate 40, 80, or even 160 wavelengths. See Figure 3.

Another key enabling component for WDM networks is a WDM transmitter, which provides the function to generate the light signal of a specific wavelength and encodes the electrical data on this light signal. WDM transmitters also need to hold the wavelength of the light over the network's life span.

Finisar provides both MUX/DEMUX and WDM transmitters. Finisar's WDM transmitters are sold in the format of WDM transceivers with embedded transmitter and receiver functions in a single packaged module. With different grades of performance, these products have been adopted by carriers and enterprise customers and have been integrated into WDM networks for point to point links, metro and core networks, and storage area networks (SAN) applications such as data-center mirroring and disaster recovery. See examples in Figures 4 and 5 below.

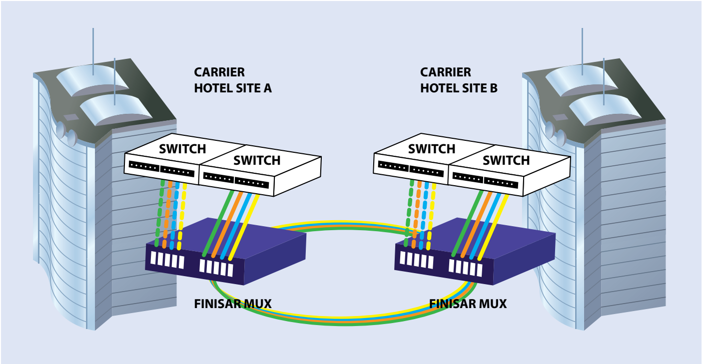


Figure 4: Point-to-Point Network

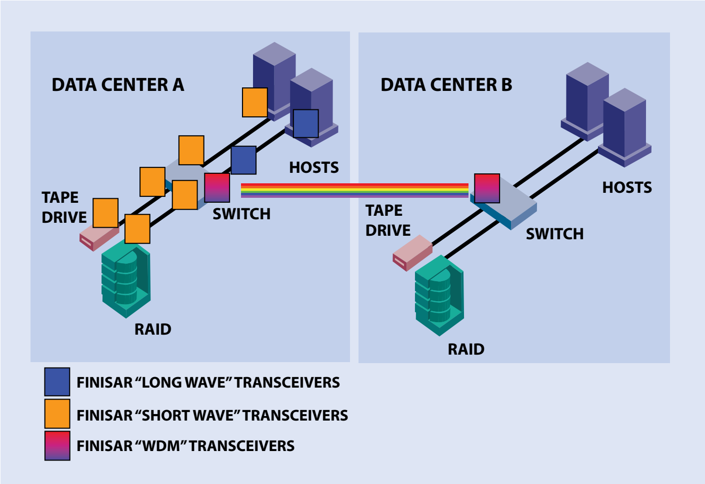


Figure 5: WDM Use in SANs

WDM VALUE PROPOSITION

- Significantly increases the amount of data transmitted over a single fiber (up to 80x)
- Expands the capacity of the network without laying additional fiber
- Allows Operators of Storage Area Networks (SANs) and Datacenters to increase bandwidth between sites without leasing additional fiber from carriers
- Flexibility: each wavelength can carry a different type of data (Ethernet, Fibre Channel, SONET/SDH, etc)
- Easy to manage

FINISAR'S OPTICAL NETWORK BUILDING BLOCKS

- CWDM & DWDM Passive OADM and MUX/DEMUXs
- CWDM & DWDM SFP and GBIC Transceivers
- DWDM XFP
- DWDM tunable 300pin transponder
- Plug and Play MUX/DEMUX

FINISAR'S WDM PRODUCTS

Finisar pioneered the use of transceivers in WDM networks. Our product solution set is tailored for either CWDM or DWDM networks; and includes GBICs and SFPs that can transmit traffic up to 180 km, and are able to accommodate speeds up to SONET/SDH OC-48/STM-16 and 4G Fibre Channel. In addition, Finisar has a suite of DWDM modules tailored for the 10Gb/s market in both XFP and 300-pin form factors.

SFP Transceiver

XFP

300pin Transponder

MUX/DEMUX

GBIC

For a complete listing of Finisar's WDM products, refer to the latest Finisar Product Guide on our website or contact us at sales@finisar.com.

WDM DEFINITIONS

CHANNEL: Wavelength or frequency of a WDM transmitter.

CWDM: Coarse Wave Division Multiplexing combines up to 16 wavelengths onto a single fiber. CWDM technology uses an ITU standard of 20 nm spacing between the wavelengths varying from 1310 nm to 1610 nm.

DATACOM: Data traffic transmitted using Fibre Channel or Ethernet protocols.

DIGITAL DIAGNOSTICS: Developed by Finisar, this functionality enables real-time monitoring of five parameters critical to transceiver operation: transmitter output power, receiver sensitivity, laser bias current, transceiver input voltage and transceiver temperature.

DWDM: Dense Wave Division Multiplexing combines up to 96 wavelengths onto a single fiber. DWDM technology uses an ITU standard of 50 GHz or 100 GHz spacing between the wavelengths, arranged in several bands at approximately 1500-1600 nm.

ETHERNET: Dominant communications protocol for networking over copper or optical fiber.

FIBRE CHANNEL: Dominant protocol for transmitting storage data over optical fiber in enterprises.

HOT-SWAPPABLE/PLUGGABLE: Modules that can be manually inserted or removed from cages or sockets in host systems that are running (i.e. powered up and in operation). These are particularly advantageous for WDM applications enabling specific channels to be easily inserted into specific sockets.

LAN: Local Area Network using Ethernet protocol, typically <500 m.

OADM: An Optical Add/Drop Multiplexer takes a single wavelength from a trunk, pulls the signal out and allows a new signal at the same wavelength to be inserted into the trunk at roughly the same spot. All other wavelengths pass through the add/drop mux with only a small loss of power (usually a few dB).

OPTICAL TRANSCEIVERS: Integrated modules incorporating optical laser transmitters and photodiode receivers. These modules convert physical signals from electrical to optical and vice-versa in a network and couple the optical signals into (and out of) optical fiber. Transceivers have serial electrical interfaces on the host board.

SAN: Storage Area Network using Fibre Channel protocol, typically <300 m.

SDH: Synchronous Digital Hierarchy. Widely used protocol for telecommunications carriers outside North America to transport data and voice traffic over optical fiber.

SONET: Synchronous Optical Network. Widely used protocol for telecommunications carriers in North America to transport data and voice traffic over optical fiber.

TELECOM: Data/telecommunications traffic transmitted using SONET/SDH protocols.

TUNABLE: WDM transmitter that can be electronically tuned to a specific channel.

WDM: Wave Division Multiplexing (WDM) enables multiple data streams of varying wavelengths ("colors") to be combined into a single fiber, significantly increasing the overall capacity of the fiber. WDM is used in applications where large amounts of traffic are required over long distance in carrier networks. There are two types of WDM architectures: Course Wave Division Multiplexing (CWDM) and Dense Wave Division Multiplexing (DWDM).

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