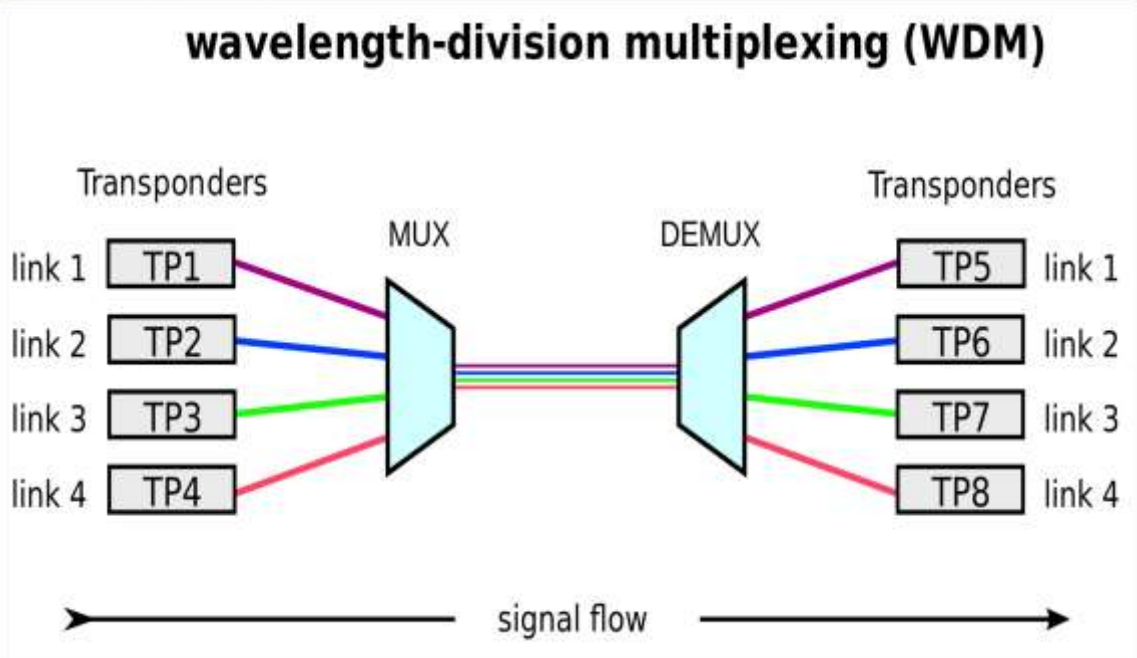
WDM

Introduction:

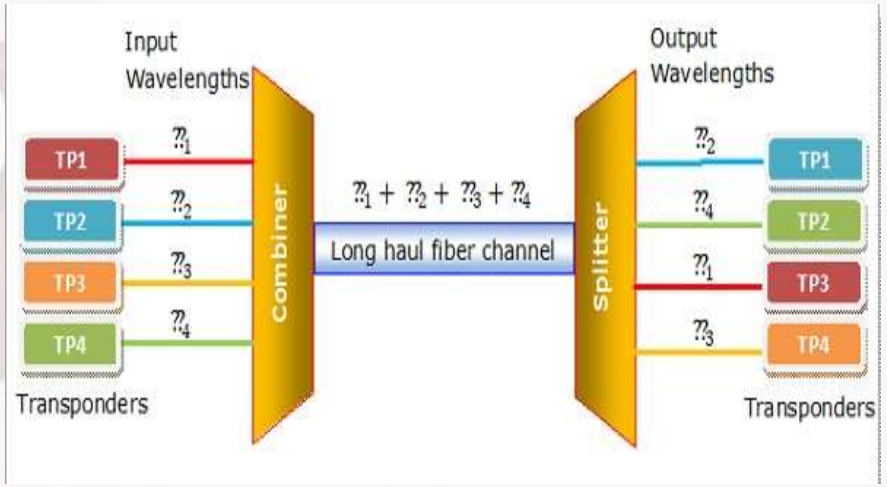
In fiber-optic communications, wavelength-division multiplexing (WDM) is a technology which multiplexes a number of optical carrier signals onto a single optical fiber by using different wavelengths (i.e., colors) of laser light. This technique enables bidirectional communications over one strand of fiber, as well as multiplication of capacity.



Concept and Process

In WDM, the optical signals from different sources or (transponders) are combined by a multiplexer, which is essentially an optical combiner. They are combined so that their wavelengths are different.

The combined signal is transmitted via a single optical fiber strand. At the receiving end, a demultiplexer splits the incoming beam into its components and each of the beams is send to the corresponding receivers



Advantages and Disadvantages of WDM

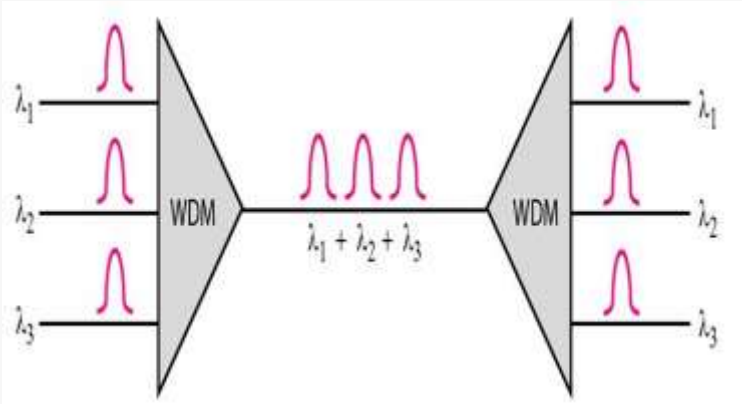
Advantages of WDM	Disadvantages of WDM
➡Optical components are similar and more reliable.	➡Signals can not be very close.
➡It provides higher bandwidth.	➡Light wave carrying WDM are limited to 2-point circuit.
➡High security	➡Cost of system increases with addition of optical components.
➡This could be the best approach as it is simple to implement.	➡Inefficiency in BW utilization, difficulty in wavelength tuning, difficulty in cascaded topology

WDM systems are divided into three different wavelength patterns:

- **Normal** (WDM)
- **Coarse** (CWDM)
- **Dense** (DWDM)

(WDM)

Normal Wavelength division multiplexing (WDM) is a technique of multiplexing multiple optical carrier signals through a single optical fiber channel by varying the wavelengths of laser lights. WDM allows communication in both the directions in the fiber cable. Normal WDM (sometimes called BWDM) uses the two normal wavelengths 1310 and 1550 on one fiber.

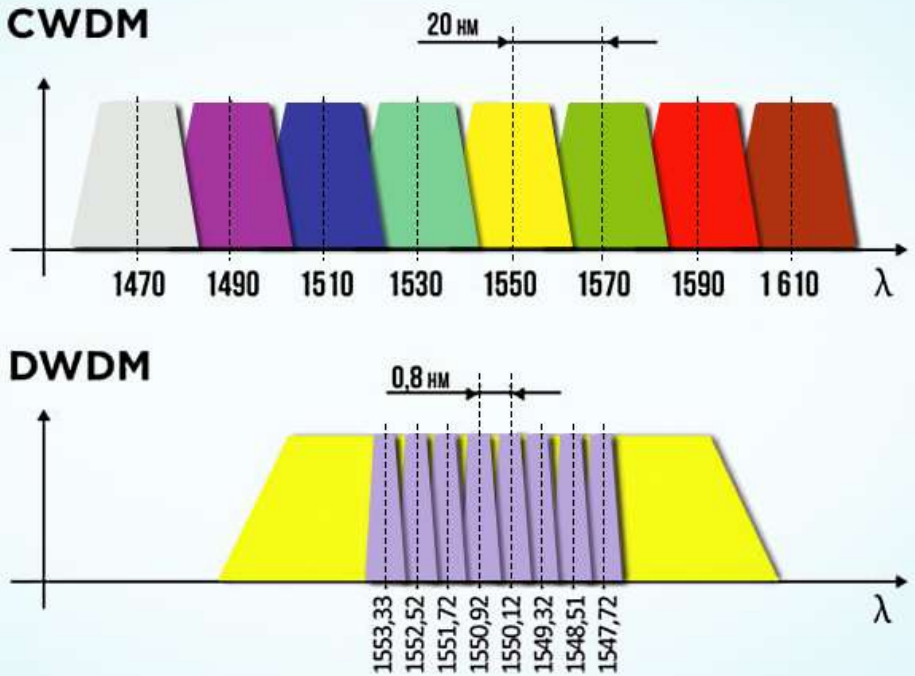


Applications of WDM

●WDM has been used by the telecommunications industry to increase the digital information carrying capacity of optical fibers.

●WDM network supporting four analog RF channels has been demonstrated as a successful application that meets the demands of the avionics environment.

CWDM vs DWDM: Channel Spacing
The channel spacing is defined to be the nominal difference in frequency or wavelength between two adjacent optical channels. CWDM has a wider spacing than DWDM. It is able to transport up to 18 CWDM wavelengths with a channel spacing of 20nm in the spectrum. DWDM can carry 40, 80, or up to 160 wavelengths with a narrower spacing of 0.8/0.4nm (100 GHz/50 GHz grid). Its wavelengths are from 1525nm to 1565nm (C band) and 1570nm to 1610nm (L band).



Coarse (CWDM)

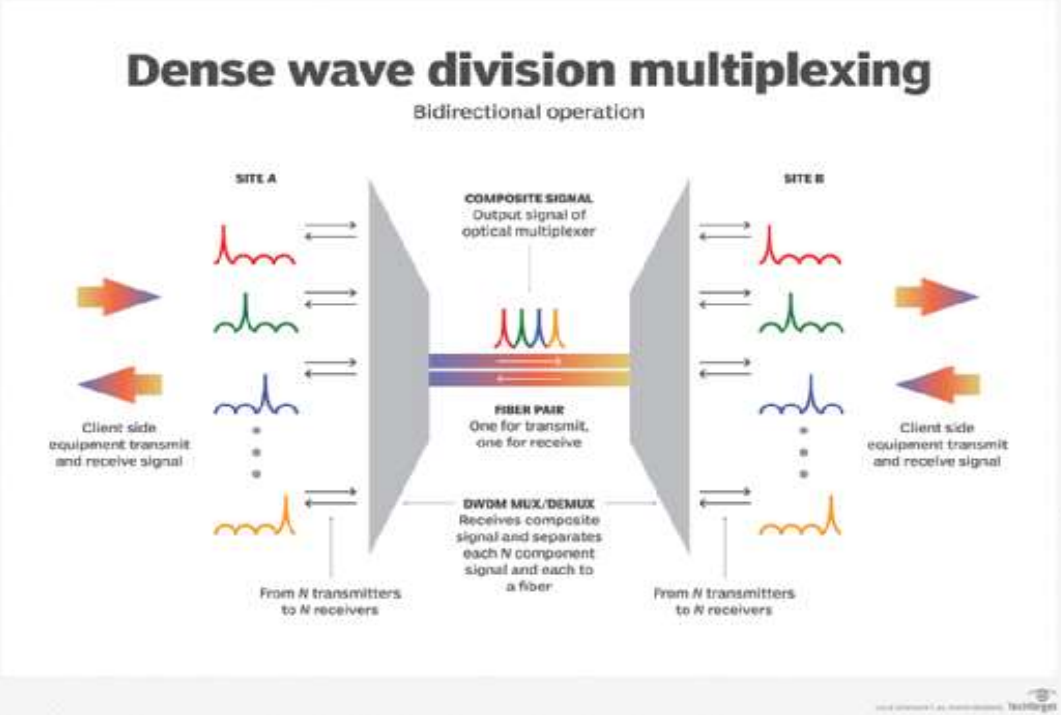
- CWDM generally operates with 18 channels where the spacing between the channels is 20 nm (nanometers) apart. It consumes less energy than DWDM and is less expensive. However, the capacity of the links, as well as the distance supported, is lesser.
- As many as 16 CWDM wavelengths over a single pair of fiber
- Distances as high as 120 km
- Scalable by hybrid CWDM/DWDM
- A highly cost-effective WDM solution
- In 2004, IEEE standardized CWDM for 10-Gb Ethernet

CWDM Application's

- Fiber exhaust relief
- In LAN and SAN connections
- Cost-effective WDM deployments in metro networks
- Main office to client-premise interconnection
- used in cable television networks, where different wavelengths are used for the *downstream* and *upstream* signals

Advantages	Disadvantages
Lower power consumption	Less range
Smaller space requirements	less capacity than DWDM
Cost savings on start-up and expansion	O, A and M functions are not carrier-class
Can use LED's or Laser's for power	Regeneration vs amplification
Larger individual payloads per channel	

Dense WDM (DWDM) : In DWDM, the number of multiplexed channels much larger than CWDM. It is either 40 at 100GHz spacing or 80 with 50GHz spacing. Due to this, they can transmit the huge quantity of data through a single fiber link. DWDM is generally applied in core networks of telecommunications and cable networks. It is also used in cloud data centers for their IaaS services.



APPLICATION OF DWMD

- In order to meet the demand in fast-growing industrial base, DWDM system can be used for existing thin fiber plants as these plants cannot support high bit rates.

- DWDM can also be used in various networks like Sensor Networks, Remote Radar Networks, Tele spectroscopic process control network, and many more networks.

- DWDM can be used to remove an entire class of equipment, the SONET ADMs.

- DWDM has the capability to expand capacity and can serve as backup bandwidth without a need to install new fibers, thus it is ready-made for long distance telecommunication services.

Advantages	Disadvantage
Maximum capacity system available	Complex technology requires
Greater fiber capacity	More power
Easier network expansion	More space
Improve scalability	Startup cost more than equivalent CWDM
Permits multiple logical topological over single physical MAN	High accuracy laser and wave filter

❖ CWDM vs DWDM: Channel Spacing

CWDM has a wider spacing than DWDM. It is able to transport up to 18 CWDM wavelengths with a channel spacing of 20nm in the spectrum grid from 1271nm to 1611nm. DWDM can carry 40, 80, or up to 160 wavelengths with a narrower spacing of 0.8/0.4nm (100 GHz/50 GHz grid). Its wavelengths are from 1525nm to 1565nm (C band) and 1570nm to 1610nm (L band).

❖ CWDM vs DWDM: Transmission Distance

DWDM wavelengths are highly integrated with the fiber during light transmission, DWDM is able to reach a longer distance than CWDM. Unlike the DWDM system, CWDM is unable to travel unlimited distances. The maximum reach of CWDM is about 160 km. While an amplified DWDM system can go much further.

❖ CWDM vs DWDM: Modulation Laser

CWDM system uses the uncooled laser while the DWDM system uses the cooling laser. Cooling laser adopts temperature tuning which ensures better performance, higher safety, and longer lifespan of the DWDM system. But it also consumes more power than the electronic tuning uncooled laser used by a CWDM system