Experiment - 5: To simulate Fiber optics Wavelength Division Multiplexing and Demultiplexing using Optisystem 22

Date: -

1. **Aim:** To simulate Fiber optics Wavelength Division Multiplexing and Demultiplexing using Optisystem 22

2. **Requirements:** Optisystem 22

3. **Pre Experiment Exercise:**
   Brief Theory

Wavelength Division Multiplexing (WDM) is an optical networking technology that allows you to expand the capacity of optical fibre by adding a multiplexer and a demultiplexer at each end of the fibre. This enables multiple data streams to be transmitted over different light wavelengths through a single fibre.

How WDM works?

- WDM uses different wavelengths of light to separate signals on optical fibers.
- WDM allows multiple data streams to be transmitted simultaneously over a single optical fiber.
- WDM increases the bandwidth and maximizes the usefulness of fiber.
- WDM reduces the number of fibers used in the main transmission line.

Benefits of WDM

- WDM increases the transmission capacity.
- WDM adds flexibility to complex communication systems.
- WDM expands capacity without building new infrastructure.
- WDM can generate substantial savings by using an existing fiber to transport multiple traffic channels.

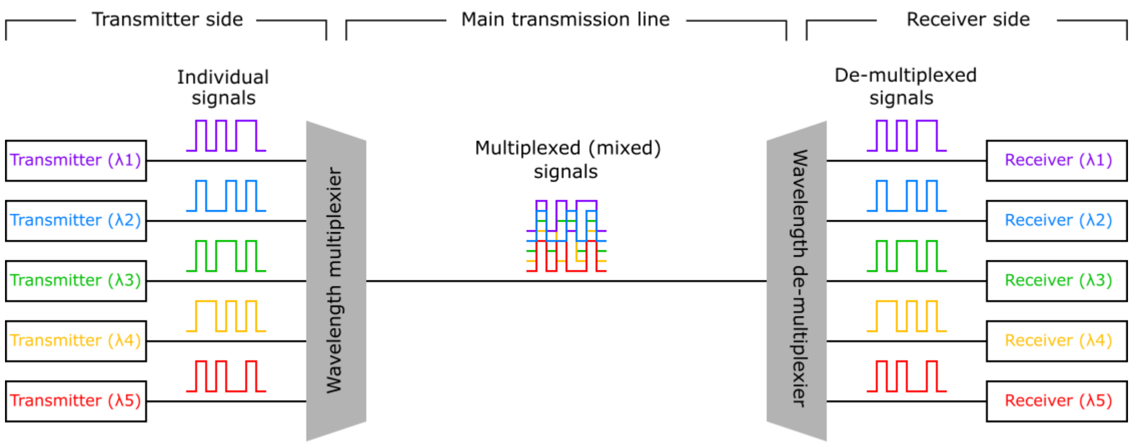

Fig. 1: Schematic of WDM transmission system

Dense WDM (DWDM)

In order to transmit optical signals over a long distance (> 100 km), optical fiber amplifiers are needed to compensate the loss of an optical fiber. As the gain bandwidth of an optical fiber amplifier is rather limited, a tight wavelength spacing is needed to put a large number of channels into the gain bandwidth.

The dense WDM (DWDM) technology has been developed for a long distance transmission systems, fully utilizing the gain bandwidth of erbium-doped fiber amplifier (EDFA). EDFA has optical gain in the C-band and L-band, and for example, a total of 115 wavelength channels are transmitted in one fiber with 100-GHz (~0.8 nm) frequency spacing, as shown in Figure 2. Several different frequency spacings for DWDM applications are defined in ITU-T G.694.1, and an appropriate spacing is chosen depending on system requirements (total capacity, bit rate per channel, distance, etc.).

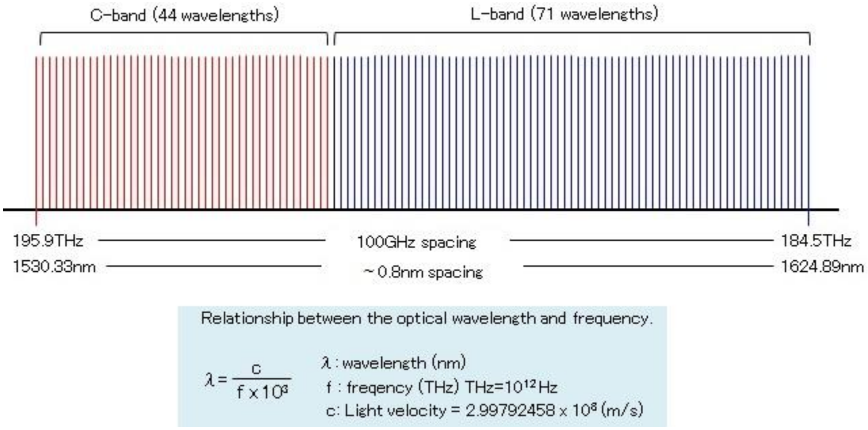

Fig. 2: Center wavelengths of DWDM.

CWDM (Coarse WDM)

The need for a tight channel spacing in DWDM technology mainly arises from the relatively narrow gain bandwidth of EDFA (compared to the entire optical telecommunication bands). On the other hand, if the transmission distance is less than 100 km and no amplifiers are needed, a wider channel spacing can be an option. A wider channel spacing allows the use of inexpensive components such as:

- Uncooled transmitter laser diode (LD) with a large wavelength variation,
- MUX and DEMUX with a relaxed channel spacing;

and as a result, the total cost for installation and operation becomes less expensive. Such WDM systems are called coarse WDM (CWDM), and ITU-T G.694.2 defines one wavelengths allocation for CWDM systems, as shown in Figure 3. There are 18 center wavelengths with 20 nm spacing from 1271 nm to 1611 nm, covering the O-, E-, S-, C- and L-bands. All the 18 wavelengths are not necessarily be used, and in fact, it is very common to use:

- 4 wavelengths from 1531 to 1591 nm, or
- 8 wavelengths from 1471 to 1611 nm.

This is mainly because many optical components (e.g. MUX/DEMUX and CWDM add-drop filters) are mass produced and widely available in the above wavelength ranges.

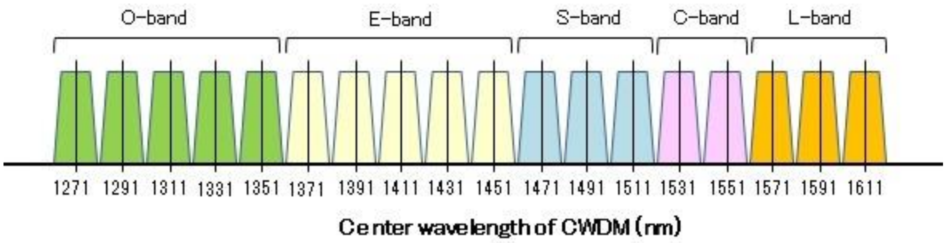

Fig. 3: Center wavelengths of CWDM.

Use of WDM technology in telecom network

Telecom networks are roughly classified into three categories, the core, metro, and access networks (see Figure 4). The core network connects major cities (>100 km) and DWDM technology is often used. The metro network is used inside a metropolitan area, typically 50~80 km, and CWDM may be used. The access network rarely uses WDM technology at present, as the requirement for transmission capacity is much less than the core and metro networks.

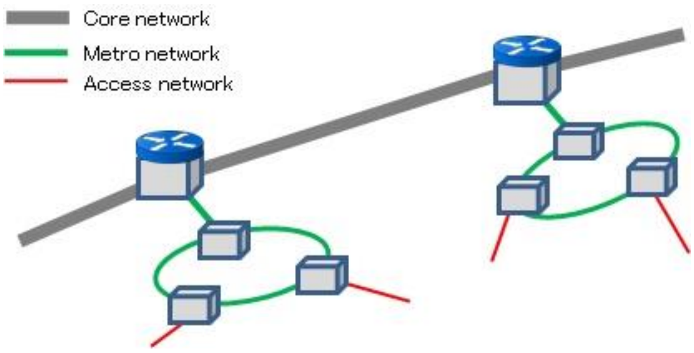

Figure 4: Schematic of telecom network.

4. Procedure

For this simulation we will use default parameters for the Bit rate, Bit sequence length, and Sample rate. The default global parameters used for this simulation are:

•Bit rate: 2.5 Gbits/s

•Sequence length: 128 bits

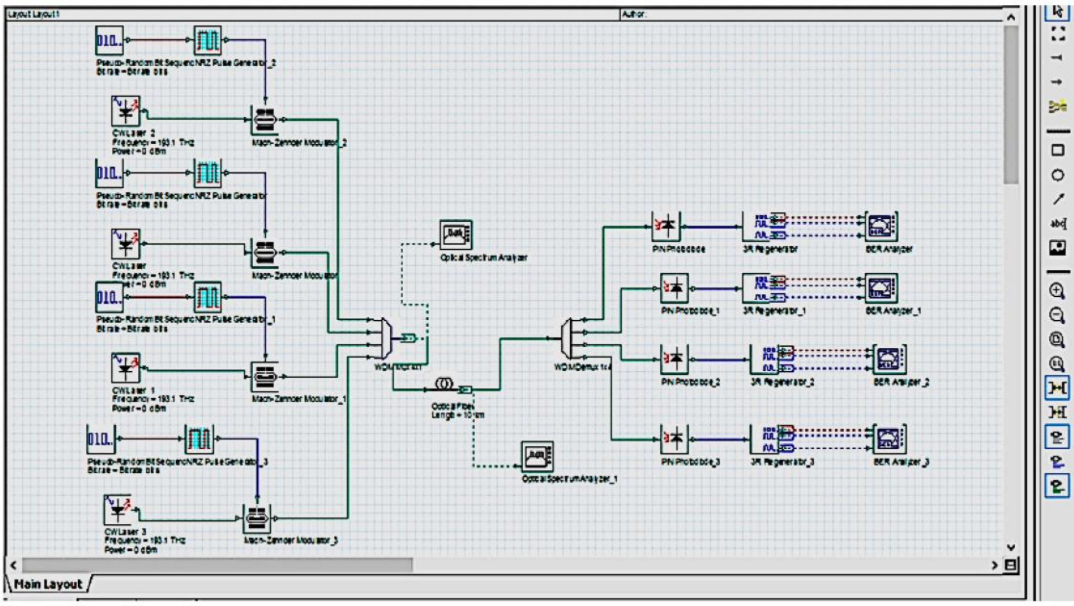

Fig. 5: Layout to demonstrate WDM and Demultiplexing

5. Observations:

Attach the simulated block diagram and graphical observations

6. Conclusion/Comments:

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7. Questions

1. Explain WDM network elements and Architectures.
2. Explain WDM Long Haul Networks.