International Journal of Emerging Technology in Computer Science & Electronics (IJETCSE) ISSN: 0976-1353 Volume 25 Issue 5 – APRIL 2018 (SPECIAL ISSUE).

IMPLEMENTING WDM BASED FIBRE OPTIC METRO NETWORK AND ENHANCING BANDWIDTH EFFICIENCY THROUGH OXC

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***Abstract* ---To provide a high speed and long-distance communication OFC's are used. In this WDM and OXC are the concepts. This depends on BER and OSNR ratios. To increase the bit rates and efficiency OXC's (Optical Cross Connects) are used. Number of intermediate stations can be introduced by using OXC. The communication depends upon the quality of the system required by the customer according to his or her requirement. The cross connects are used here to decrease even the cross talks during a telephone talk. These are used in HD TV's, Internet and telephone communications.**

Index Terms --- WDM, OXC, BER, High speed

I. INTRODUCTION

Fiber optic cable is made up of glass or silica which carries optical signals. Here WDM (Wavelength Division Multiplexing) is used. The concept used in optical fiber is Snell's law. There are 5 processes involved in the transmission of the data, let it be P1, P2, P3, P4, P5. P1- User information encoding. P2 - Modulation (conversion of electrical signal into optical signal) P3 - Optical fiber (Medium)P4 - Demodulation (conversion of optical signal into electrical signal) P5 – Decoding the user data. These 5 processes are involved in the optical signal transmission. Total Internal Reflection is the concept used in the transmission of the optical signal (Snell's Law). *The modulation used here is CWDM (Course Wavelength Division Modulation) which is having IR range of 1270nm–1610nm*.The total wavelengths used here is 16. The OTM is used as the end stations of the metro network, one acts as transmitter containing mux other as receiver containing demux. OADM acts as the intermediate device which can be both mux and demux where there is drop of 4 wavelengths. The optical amplifier(OA) used here is EDFA (Erbium Doped Fiber Amplifier). Amplifier is used to boost the optical signal. OXC is used near the OADM where the drop occurs. When the availability of wavelength is free then they can be dropped at OADM with the help of OXC. Total Internal Reflection is the concept used in the transmission of the optical signal (Snell's Law). The modulation used here is CWDM(Course Wavelength Division Modulation) which is having IR range of 1270nm - 1610nm. The total wavelengths used here is 16. The OTM is used as the end stations of the metro network, one acts as transmitter containing mux other as receiver containing demux . OADM acts as the intermediate device which can be both mux and demux where there is drop of 4. The optical amplifier(OA) used here is EDFA (Erbium Doped Fiber Amplifier*). Amplifier is used to boost the optical signal*, is used near the OADM where the drop occurs. When the availability of is free then they can be dropped at OADM with the help of OXC. If there are no then maximum drop is 4 here drop is nothing but the amount of usage by the consumers. One can implement an OXC in the electronic domain all the input optical signals are converted into electronic signals after they are demultiplexed by demultiplexers. The electronic signals are then switched by an electronic switch module. *Finally, the switched electronic signals are converted back into optical signals by using them to modulate lasers and then the resulting optical signals are multiplexed and converted by optical multiplexers onto the outlet optical fibers. This is known as an "OEO" (Optical-Electrical-Optical) design*. Cross-connects based on an OEO switching process generally have a key limitation the electronic circuits and limit the maximum bandwidth of the signal. Such an architecture prevents an OXC from performing with the same speed as an all-optical cross-connect and is not transparent to the network protocols used. On the other hand, it is easy to monitor signal quality in a device, since everything is converted back to the electronic format at the switch node. An additional advantage is that the optical signals are regenerated, so they leave the node free of dispersion and attenuation. In fiber optic communications, wavelength-division multiplexing (WDM) is a technology and which multiplexes a number of optical carrier signals onto a single optical fiber by using different wavelengths (i.e., colors) of laser light. The term wavelength-division multiplexing is commonly applied to an optical carrier, which is typically described by its wavelength, whereas frequency-division multiplexing typically applies to a radio carrier which is more often described by frequency. This is purely convention because wavelength and frequency communicate the same information. *Coarse wavelength division multiplexing (CWDM) is a method of combining multiple signals on laser beams at various wavelengths for transmission along fiber optic cables, such that the number of channels is fewer than in dense wavelength division multiplexing (DWDM) but more than in standard wavelength division multiplexing (WDM).*

II. UNITS

The units used are dB, nm. dB is used to measure the power loss and nm is used to measure the wavelength of the IR spectrum range of CWDM.

III. BLOCK DIAGRAM

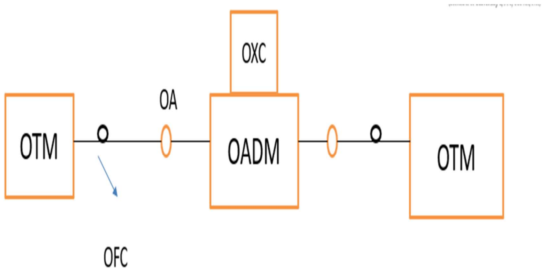

Fig-1.1

IV. COMPONENTS

A. Hardware Components**:**

1. Optical Terminal Multiplexer(OTM) or Demultiplexer

2. Optical Add/Drop Multiplexer(OADM)

3. Optical Amplifier(OA)

4.Optical Cross Connect(OXC)

5.Optical Fiber cable

B.Software Components**:**

1.Optisystem

1.Optical Terminal Multiplexer(OTM) or Demultiplexer**:**

In , a multiplexer (or mux) is a device that selects one of several analog or digital input signals and forwards the selected input into a single line. A multiplexer of inputs has select lines, which are used to select which input line to send to the output. Multiplexers are mainly used to increase the amount of data that can be sent over the network within a certain amount of time and bandwidth. A multiplexer is also called a data selector. Because DWDM systems send signals from several sources over a single fiber, they must include some means to combine the Incoming signals. This is done with a multiplexer, which takes optical wavelengths from multiple fibers and converges them into one beam. At the receiving end the system must be able to separate out the components of the light so that they can be discreetly detected. De-Multiplexers perform this function by separating the received beam into its wavelength components and coupling them to individual fibers. De-Multiplexing must be done before the light is detected, because photo detectors are inherently broadband devices that cannot selectively detect a single wavelength. *Multiplexers and De-Multiplexers can be either passive or active in design.* Passive designs are based on prisms, diffraction gratings, or filters, while active designs combine passive devices with tunable filters. The primary challenges in these devices are to minimize cross-talk and maximize channel separation. Refer Fig-1.2,

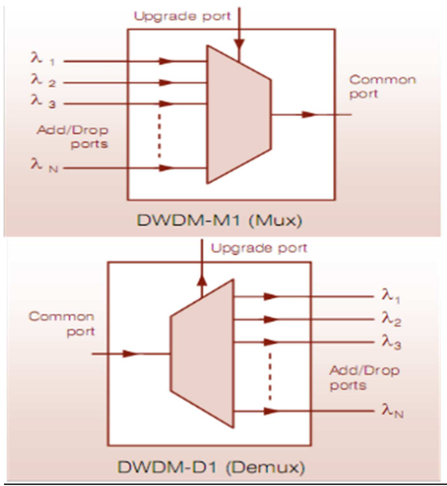

Fig-1.2

2. Optical Add/Drop Multiplexer (OADM):

From the Fig-1.3 the add or drop signals in between the communication ,this optical add/drop multiplexer is used. Between multiplexing and de-multiplexing points in a DWDM system, as shown in there is an area in which multiple wavelengths exist. It is often desirable to be able to remove or insert one or more wavelengths at some point along this span. An optical add/drop multiplexer (OADM) performs this function. Rather than combining or separating all wavelengths, the OADM can remove some while passing others on. OADMs are a key part of moving toward the goal of all - optical networks. OADMs are similar in many respects to SONET ADM, except that only optical wavelengths are added and dropped, and no conversion of the signal from optical to electrical takes place. There are two general types of OADMs. The first generation is a fixed device that is physically configured to drop specific predetermined wavelengths while adding others. The second generation is reconfigurable.

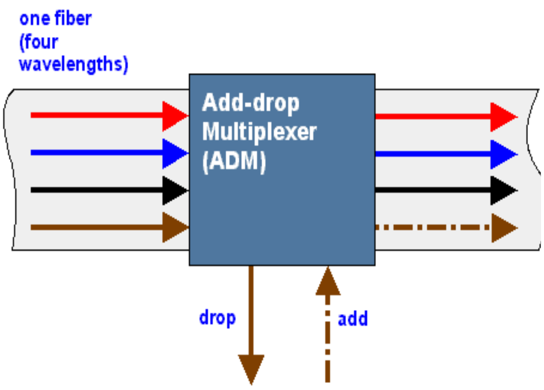

Fig-1.3

3.Optical Amplifier (OA):

Amplifier is used to boost up the signal. As the signals are optical this amplifier is called Optical Amplifier. Here the amplifier used is EDFA (Erbium Doped Fiber Amplifier). By making it possible to carry the large loads that DWDM is capable of transmitting over long distances, the EDFA was a key enabling technology. At the same time, it has been a driving force in the development of other network elements and technologies .From Fig-1.4,we can see the internal construction of the amplifier . Erbium is a rare-earth element that, when excited, emits light around 1.54 micrometers—the low-loss wavelength for optical fibers used in DWDM. weak signal enters the erbium-doped fiber, into which light at 980 nm or 1480 nm is injected using a pump laser. This injected light stimulates the erbium atoms to release their stored energy as additional 1550nm light. As this process continues down the fiber, the signal grows stronger. The spontaneous emissions in the EDFA also add noise to the signal; this determines the noise figure of an EDFA. The key performance parameters of optical amplifiers are gain, gain flatness, noise level, and output power. Gain should be flat because all signals must be amplified uniformly. So addition of noise and limited wavelength makes it difficult to use in the ultra high speed optical system.

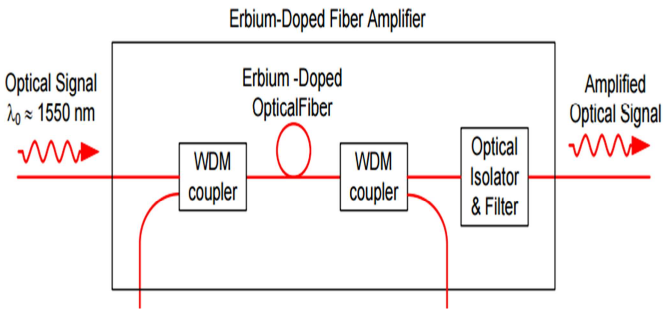

Fig-1.4

Due to attenuation, there are limits to how long a fiber segment can propagate a signal with integrity before it has to be regenerated. Before the arrival of optical amplifiers (OAs), there had to be a repeater for every signal transmitted, as discussed earlier. The OA has made it possible to amplify all the wavelengths at once and without optical-electrical-optical (OEO) conversion. Besides being used on optical links, optical amplifiers also can be used to boost signal power after multiplexing or before de-multiplexing. Current systems are limited by the erbium doped fiber amplifier (EDFA) bands, i.e., about 32 nm. To use larger bandwidths, it is, therefore, necessary to investigate other amplifier types. Fiber optical parametric amplifiers (OPAs) offer prospects for amplification over large bandwidths and outside the EDFA bands, which could be useful for future communication systems. However, the nonlinearity of the amplifying medium, coupled with the fact that good phase matching is necessary for parametric amplification, may lead to detrimental nonlinear crosstalk in wavelength-division multiplexing (WDM) systems. This crosstalk can be greatly reduced by using highly uniform fibers, low signal power, polarization multiplexing, or short fibers.

4. Optical Cross connect (OXC):

Channel cross-connecting is a key function in most communications systems. In electronic systems, the electronic cross-connecting fabric is constructed with massively integrated circuitry and is capable of interconnecting thousands of inputs with thousands of outputs. The same interconnection function is also required in many optical communications systems. Optical (channel) cross-connection may be accomplished in two ways.

1)Convert optical data streams into electronic data, use electronic cross-connection technology, and then convert electronic data streams into optical. This is hybrid approach.

2)Cross-connect optical channels directly in the photonic domain. This is known as all-optical switching.

3)Cross connect can be used to connect more number of stations and also used to reduce the cross talk that are recently a big problem that are being faced in the telecommunication . So, they are being reduced by using OXC.

5.Optical Fiber:

Fiber optic cable is made up of glass or silica which carries optical signals. The transmitting medium for fast and long-lasting through light signal is known as Optical Fiber . *For a Metro network the distance between stations using OF cable is maximum of 80 kms.*

Refer Fig-1.5 and 1.6

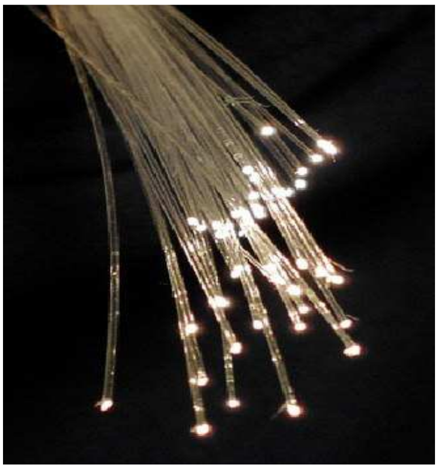

Fig-1.5

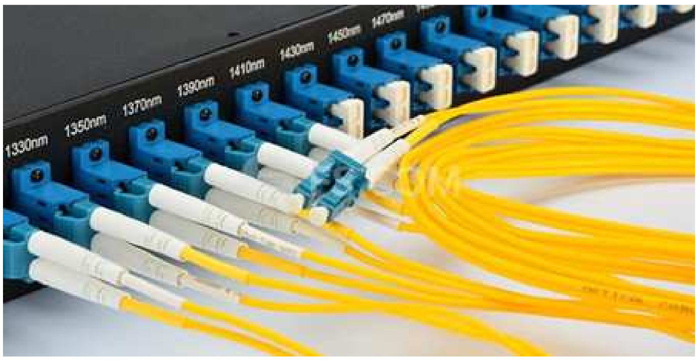

Fig-1.6

1.Opti System:

Opti System is a software that is used to design the required circuit that is used to transmit the data and check the errors and also eliminate them. BER and OSNR can be found out with the help of the components that are present in the components list. The output can also be modified using attenuators and amplifiers by increasing or decreasing the attenuation or the gain. The source used here is laser though LED is having more life time compared to laser , laser is more efficient and monochromatic. As this is a Metro Network the length of the optical fiber between each station can be up to 80 kms which can be adjusted in the component properties. At each point after connecting the components the power and the frequency that is sent can be checked by power meter , spectral analyzer , WDM analyzer. To reduce the complexity the set of components can be reduced and made into a sub system.

V. SIMULATION

Design is made as per the connections that are required at each station so that the adding and dropping can be done easily by taking this as the reference. From the below figures we can understand the BER ratio , power and attenuation at every point of the connection.

Fig 1.7 describes the bit error ratio i.e., the errors that are formed for each bit that is being transmitted.

Fig 1.8 describes about the power that is present at each point of the design and can be adjusted using amplifiers and attenuators.

Fig 1.9 tells about the wavelengths that are being sent

Fig 1.10 gives the graph details about the wavelengths that are being sent during the process.

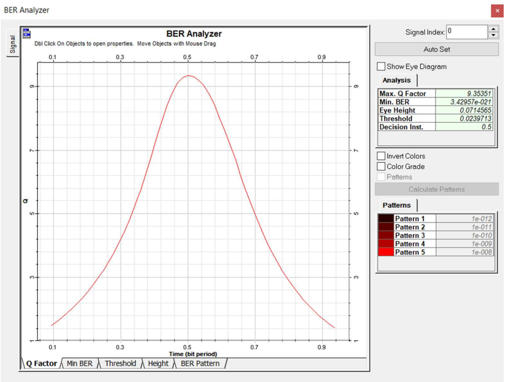

Fig-1.7

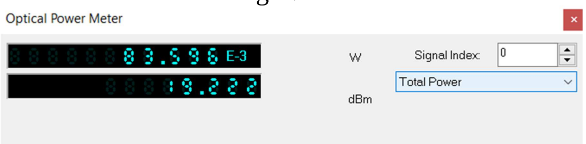

Fig-1.8

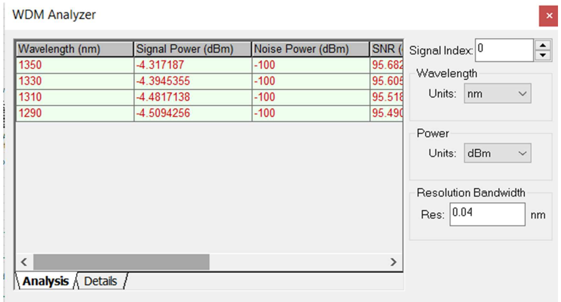

Fig-1.9

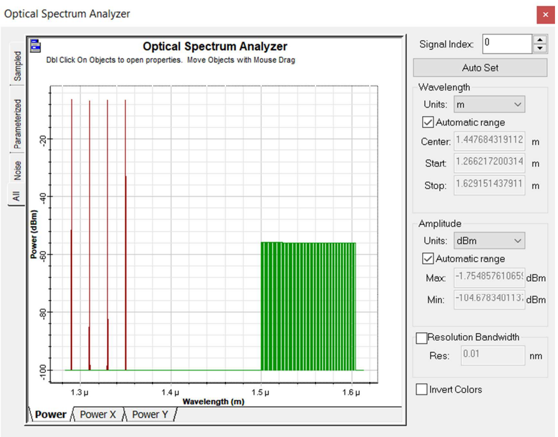

Fig-1.10

VI. CONCLUSION

Using Opti system software the designs are made and simulated which is later implemented in real time. Thus, the power dissipation can be examined and can be modified as per the requirement. This can be the concept for the future fast fiber communication.

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