A REVIEW OF CHALLENGES IN WDM OPTICAL NETWORKS

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Abstract: The ever expanding traffic demand in next generation networks has been supported by Wavelength Division Multiplexing (WDM) optical networks. In this paper, basics of WDM have been summarized. Various issues and challenges involved in design and implementation of next generation optical networks have been addressed. This paper has reviewed some of the solutions presented to the challenges in order to meet ever increasing capacity demands from communication networks. Comparison of few of the implementation approaches and corresponding limitations have been presented.

Index Terms **- Optical network, Bandwidth, WDM, Multiplexing..**

1. INTRODUCTION

Ever increasing demands from communication systems require larger bandwidth, high data rate increases and less cost. Communication systems implementing optical fibers provide high bandwidth and low cost. Fig.1 [21] illustrates the basic construction of optical fiber.

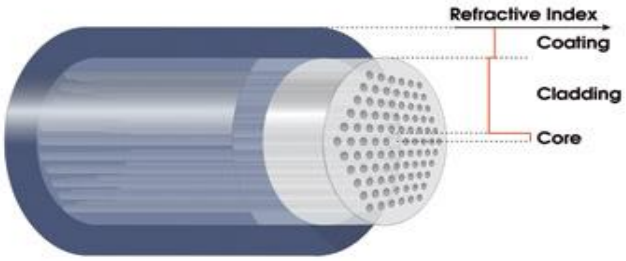

fig.1 optical fibre [21]

In an optical fibre, the chances of degradation of signal increases asreallythe distance increases. This limitation can be overcome by repeaters and amplifiers. To remove the complexity involved with implementation of repeater, optical amplifiers are used. They can boost up the energy of the signals. Multiplexing is an important part of communication system in which large number of users sends data at the same time through a single communication link. Multiplexing is widely used in communication systems due to its potential to increase the channel utilization or transmission capacity and decrease system cost.

Wavelength division multiplexing (WDM) is a scheme in which multiple signals are carried on same optical fibre and at the receiving end, demultiplexer separates all the signals (illustrated in Fig. 2). WDM is basically of two types. Coarse wavelength division multiplexing (CWDM) and Dense wavelength division multiplexing (DWDM). In CWDM, separation between the wavelengths is wide. **DWDM** is that in which a wide range of channels are used and channel spacing is very less. It is about 1nm or less.

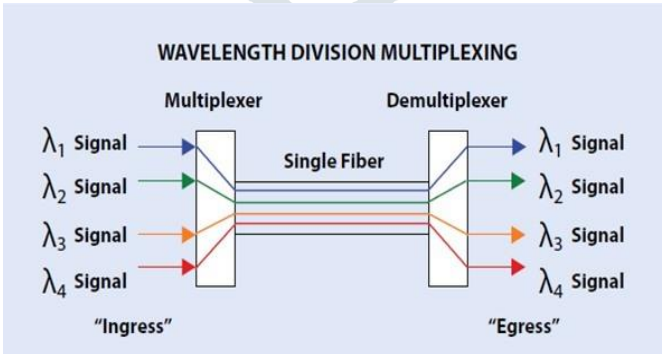

fig. 2 wdm [22]

2. LITRATURE SURVAY

WDM concepts, issues, challenges, implementation and future scope have been investigated by number of researchers. Few of the related work have been presented as follows:

Siddharth Bhatt et.al [1] have introduced about the explosive growth of internet activities, full utilization of signal by which the overall capacity of the system increases. For increasing the capacity three methods are used, installing more cables, WDM and increasing system bit rate. Installing more cables is not a good method because it will be very costly and the other major problem is the integrity of the system. The transmission of signal over photonic layer is governed by various parameters and these are

channel spacing, signal direction and signal trace. Optical amplifier EDFA is the most popular amplifier, it is a silicon based amplifier and doped with erbium, it amplifies the signal at regular intervals. Bandwidth of EDFA is 1530 nm-1560 nm. Basically in this paper new and existing transmission technologies are described.

Laurent Begin et.al [2] have introduced about the challenges in DWDM system. Differentiation between platforms and current application of DWDM is also introduced in this paper. DWDM basically focus on three areas for increasing bandwidth and these areas are high data rate, high channel count system and full utilization of spectrum. All these have their advantages and disadvantages but because of economical things we select only a specific approach. If used L-band system then there will be additional cost of deploying L-band amplifier and attenuation and chromatic dispersions will be very high in case L-band. Its operating speed is also greater than 10 GB/sec and it is challenging due to dispersion, cost will increase if structure got more complex. In DWDM, the operating channel spacing is 12.5 GHZ or less. Spectral resolutions, Wavelength, Dynamic range, Polarization sensitivity, Channel selection are the major characteristics which are used to realize the system performance.

N.Victor Jaya et.al[3] have discussed about the performance of DWDM systems. The presented work relates to the performance of 48 channels DWDM using EDFA over long distance. During the transmission of signal some losses also occur and that will depend on the number of channel. For increasing the strength of signal, optical amplifiers are used. Optical amplifier directly amplifies the signal, there is no need to first convert the signal in electrical signal. Signal also faces scattering losses such as Rayleigh, Mie, Raman scattering. Scattering loses are inversely proportional to fourth power of the wavelength. As the length increase the signal gets attenuated. Attenuation is the ratio of input power to the output power. In the simulation set up, there are 32 channel of DWDM network, Return to Zero (RZ) modulation technique is used resulting in increase of quality factor.

Jia-Ning Niu et.al[4] have discussed about Quantum Key Distribution and introduced its practical applications. It tells about the suppression of four-wave mixing and the RAMAN noise. Joint optimized channel allocation scheme is also discussed. Joint optimized channel allocation scheme increase the security rate. Targets are effective for specific application. By Joint optimized channel allocation scheme almost all FMW noise and about 23% of RAMAN noise can be reduced.

Simon C.M Lidgate et.al[5] have introduced about the array waveguide grating that provide high performance and are the important components for realization of DWDM networks.

Mei Yang et.al [6] have introduced major challenges involved with optical burst switching technology. In DWDM, three switching technology are implemented i.e. Circuit switching, Packet switching and Burst switching. An Optical burst DWDM network consist edges and core router. The edge router is placed at the edge of the network of optical link, consisting of many channels having different wavelength. Basically optical link is divided into two groups one is Data channel group and other is Control channel group. This paper introduced LAUC-VF algorithm which improves Quality of Service (QOS). It can be done by prioritizing data burst, maintaining multiple queues and utilizing limited optical buffers. In future, the QoS may be improved by assigning burst of different classes with different length.

Chiranjit Ghosh et.al[7] have discussed about the dispersion compensation scheme having minimum number of cascaded fibre Bragg grating. Optical communication work on high speed and for larger capacities means transmission of data is on high rated WDM technology because they used narrower channel spacing. In this work, two techniques are proposed and these techniques are related to Dispersion compensation fibre and Chirped fibre grating system. Chirped fibre grating system is the fruitful solution of Dispersion compensation, that is more attractive then Dispersion compensation fibre because of its size, potential cost, ability to compensate, less insertion losses, absence of linear effects. Basically it tells about the variation in Q- factor with different grating lengths. In this optimum grating length is about 500 mm and that give the maximum Q-factor.

Antonio Manzalini [8] discussed about the TDM based metropolitan networks to transport the data efficiently. Automatic switching in metropolitans area network is used for high capacity links.

Abu Jahid et.al [9] have presented a system with high gain with optimum number of amplifiers. Signal to noise ratio and Bit Error rate (BER) are the parameters used for measuring the performance. The performance can be changed by varying amplifier gain, number of optical amplifiers and number of hopes. The result shows that the system performance increase or decrease with channel spacing. And this can be improved by adding optimum number of amplifiers.

Md. Shipon Ali [10] introduced DWDM as a key component for communication. A lot of improvement has been done for high speed. DWDM increases the bandwidth per fibre and bit rate increases. Mostly DWDM operates on 40, 80 and 120 wavelength and the maximum bandwidth is 4Tbps, 8Tbps and 12 Tbps. Demand for optical fibre is increasing per year. The result shows about the tremendous increase in spectral efficiency. Transport capacity of optical communication increasing beyond 100 Gbps.

Jin Seek Choi et.al [11] have introduced about the routing and wavelength assignment algorithm in WDM routing network. Different solutions are compared based on their observation. These algorithms are basically for off-line models.

Rastislav Rbka [12] introduced the principle of WDM and some characteristics of WDM in metro/access telecommunication network. The goal is to increase the transmission rate. The DWDM satisfies the requirement of long-haul networks. DWDM and CWDM combination will provide a huge potential for solving challenges for future development.

Geoffrey A. Cranch et.al[13] have presented the multiplexing schemes for the interferometer fibre sensor that are based upon Time Division Multiplexing (TDM) and WDM using add and drop multiplexer and presented various architectures and demonstrated a practical implementation of one of the architectures. It is shown that if sensors are designed as underwater hydrophones in a sonar array, the low-frequency pressure resolution in water become limited; and the maximum effective dynamic range is between 110 and 135 dB.

Parul [14] presented an overview about WDM technology followed by review of recent developments. It is also presented that how utilization of WDM technology helps in increasing the overall capacity of the communication network.

Ross Saunders[15] introduced about the coherent digital optical transmission. This provide high speed data transmission. Initially 40 GB/sec coherent system was used. Now new systems are based on 100 GB/sec DP-QPSK data rate. Some potential area of future studies also discussed.

P. Ferreira et.al [16] have introduced about DWDM techniques. It allows number of channel in same fibre, multiplexed on different frequency to increase the capacity. Scalability of network is highlighted and it is shown that DWDM network operates on terabytes levels at reasonable cost. It increases the capacity of fibre and allows more and more user at low cost.

Reena Antil [17] introduced about DWDM networks with respect to attenuation, dispersion, signal to noise ratio, quality factor, different types of multiplexing techniques and channel spacing.

Shaowen Song [18] introduced architectures of Synchronous Optical Networking (SONET) and TCP/IP. For full optical network, SONET will be the first framework because of its switching simplicity and bandwidth availability. DWDM is basically used for point-to-point and this will increase the bandwidth capability of fibre. Basically protocols are used to avoid collision and managed about network bandwidth.

Milan Cucka et.al [19] have introduced about the phase sensitive optical time duration. High power pulse cause degradation in the signal strength. It is verified that data transmission will be effective if power of pulse is exceed from 13 dbm.

3. Comparative analysis

Table 1 shows comparison of some of the investigations in WDM optical networks as presented in section 2.

Table 1: Comparison of Investigations in WDM Optical Networks.

Reference No.	Survey/Investigation Approach	Result	Limitations
[2]	by ber tester introduced challenges in dwdm.	study about challenges in dwdm.	choice of the instruments must be accurate.
[3]	performance analysis of 48 channels dwdm using edfa.	quality factor is improved by 11.4327.	scattering losses
[7]	use of cascaded fiber bragg grating systems.	optimum grating length is about 500 mm and that give the maximum q-factor.	only used for distance up to 100 km.
[9]	for the performance analysis of dwdm, intensity and direct modulation techniques are used.	system performance increase or decrease with channel spacing.	cost is high because for increasing performance optical amplifiers will be added.
[11]	implementation of routing and wavelength assignment algorithm in wdm	study about routing and wavelength assignment algorithm.	used only for off- line models.
[19]	optical time domain reflectometer (otdr) for high speed data transmission.	data transmission will be effective if power of pulse is exceed from 13 dbm.	highly sensitive in nature.

4. CONCLUSION

It is imperative to work on solutions to various issues and challenges of WDM optical networks because of the ever rising traffic demands from future networks. Survey and comparison of research in direction of WDM networks implementation and challenges has been presented in this paper. Demand from future transport networks is scalability, speed, resilience, capacity and all the expectations can be attained only if solutions are proposed to challenges in current deployed network architectures. This work presents WDM optical network basics and few of the associated challenges which are addressed by researchers. Future scope of the presented work is implementation of resilient and high capacity network taking into consideration each challenge observed at high data rate.

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