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PLI IN WDM/DWDM RECEIVER

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ABSTRACT

In this paper we basically discuss about the PLI occur in transferring the information between the sender and receiver in optical networks. Physical layer impairment (PLI) depends upon the network type, access and the number of network element. The purpose of this article is to provide a survey of different types of PLIs, the effects of PLI's, and the presently available modeling and mitigation techniques. We will also study about PLI-aware network design techniques, regenerator placement algorithms, routing and wavelength assignment algorithms, and PLI-aware failure recovery algorithms. In transparent optical network PLI basically occurred because of non-ideal transmission and this effect the feasibility of light path. If the received signal quality is not good then the receiver may not be able to detect the signal and it gives high BER. Optical transparency improves the quality of signal and flexibility of optical network. Transparency reduces the collision of client layer and optical layer.PLI efficiently compute feasible routes and wavelength. A connection is set up to carry a data signal via light path from source to destination. The selection of light path is also an important feature in optical network.

Keywords: PLI, BER, light path.

I. INTRODUCTION

Optical fiber communication transmits data at very high rate and also gives large bandwidth. The optical fiber channel is capable of transmitting signal having data rate in tera bit per-second, but through a single communication system we are unable to get the high speed[1]. In WDM systems the bandwidth of the fiber is divided into different channels with each channel consist of one signal, due to this there is a increase in the overall data rate without the increment in the number of fibers. The data rate of different channel is limited, but when we consider so many channels the total data rate is higher [2]. At the receiver of the WDM, a de-multiplexer separates the wavelengths and routes them into different fibers, which all conclude at separate receivers. The wavelength spacing transmitted through the same fiber provides the services for defining Dense WDM and Coarse WDM. Coarse WDM is more cost-effective then the Dense WDM and Coarse WDM is widely accepted as important transport architecture. Optical network utilizes dense wavelength division multiplexing (DWDM) and wavelength routing for future wide-area backbone networks[2]. These network gives high order of throughputs that is, terabits per second, low error rate, low delays, and also satisfy emerging applications.

WDM network gives higher bandwidth than copper cable and is less susceptible to different kinds of electromagnetic interferences and other undesirable effects. The history of WDM started with opaque network.

In opaque network there is a presence of O-E-O conversion at each node and it shows that the optical signal carrying traffic terminates at each node to undergo O-E-O conversion.

The O-E-O approach occurs between the network and physical layer. The O-E-O conversion devices increases the network cost and energy consumption. In transparent optical networks, no O-E-O conversion is involved and the optical signal at the source node reaches the destination through the various nodes. This approach reduces the cost of the system and it also considers that physical layer must support end-to-end communication. The transmission of the data is also affected by the impairments that occurs in the physical layer. These impairments cause the transmitted data not to be received correctly at the destination. The data is transmitted for the entire light path, remains in optical domain, the signal is decreases due to the accumulation of noise and signal distortions. Due to the presence of these impairments at the destination the received signal quality become poor and BER is high and the light path is not usable.

In first generation optical fiber is replaced copper cable and used as a transmission medium. These networks give point to point transmission service. The switching and processing of the data in these networks handled by electronics. The main advantage of DWDM techniques for example amplifiers, lasers, filters and optical switches is to provide large capacity of bandwidth over a single mode fiber (SMF). In the second generation of optical networks we consider switching, routing and restoration of the signals. DWDM technology gives transmission rates up to 10 Gb/s per channel × 40 channels @ 100 GHz (50 GHz) spacing and standard link distances up to 600 km with optical amplifiers placed every 80 km. A DWDM network basically consists of optical cross-connects (OXCs) interconnected by point-to-point fiber links in the form of mesh topology. In these optical networks the connection is establish in the form of light path and is establish between two nodes having same wavelength. The requirement of the same wavelength along the all links known as *wavelength continuity constraints* [1].

Because of the presence of transparency in all-optical network. The elimination of OEO conversion gives the loss in the potential and it gives a signal degradations will be cleaned up when the signal is regenerated at intermediate nodes. The transmitted data signal remains in the optical domain for the entire light path, noise and signal distortions due to impairment effects accumulate while the signal travels through the light path, and they may cause significant signal degradation. The received signal quality at the destination node may be so poor that the bit-error rate (BER) can reach an high value, and thus the light path is not usable [10]–[11].

II. PHYSICAL LAYER IMPAIRMENT

The PLIs depend upon the network type, network access, reach, and the type of network applications. The network type could be non-transparent that is, an optical signal undergoes OEO conversion at all intermediate nodes along its path can be translucent, transparent and the light paths are switched completely in the optical domain. The PLI reach basically consist of access, or core/long-haul network and the type of network applications consist of real-time, non-real time, mission-critical, etc. In WDM as shown in the Fig.1, impairments are present in the signal path and also determine the maximum transparency length and it is also helpful to determine the maximum distance or number of hops an optical signal can travel and received by a receiver without requiring OEO conversion. The transparency of an optical path depend on the following parameters: 1) the signal power of optical fiber, 2) the distance of fiber, 3) type of fiber and link design 4) the

number of wavelengths on a single fiber, 5) the bit-rate 6) the mechanism of amplifier and the number of amplifiers, 7) the number and type of nodes[1].

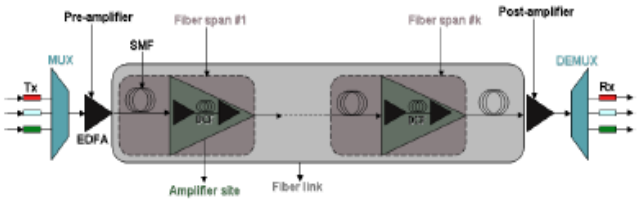

Fig. 1. Typical configuration of a WDM point-to-point system.

The effect of PLIs basically determines the feasibility of an optical path and the received bit-error rate (BER) at the receiver node become unacceptably high. In optical networks, OEO converters are present in the path, and they can be used to eliminate the impairments. The transparency in the physical layer of the optical networks gives flexibility and dynamic nature in the optical layer and the transparency also decreases the possibility of electrical layer interaction with the optical layer at intermediate nodes in the path[3,4]. The impairment effect on the network design, network planning and network management and control plane.

2.1 Linear Impairments

A) Power loss- Power loss is defined as the optical loss that is present between the source and destination along fiber- links and it is generally made up of intrinsic fiber losses.

$$P_{out} = P_{in} e^{-\alpha l}$$

Where, P_{out} is output power of the fiber, P_{in} is the input power of the fiber having length l and α is the fiber attenuation coefficient.

B) Crosstalk- Linear crosstalk occur due to incomplete isolation of WDM channels by the components of optical fiber such as OADMs, OXCs, multiplexers/demultiplexers, and optical switches, that is, the effect of signal power leakage from other WDM channels on the desired channel.

Linear crosstalk is very much different from the non-linear crosstalk that is, non-linear crosstalk deals with the non-linear fiber interaction. The linear crosstalk depends on the ratio of the powers of two channels, whereas non-linear crosstalk depends on absolute powers[7].

Optical cross-connect node (OXC) is an important network element in WDM optical networks. Crosstalk occurs between the input and the output fiber. OXC occur in the WDM network, having same wavelength as the signal and degrades the transmission performance.

2.2. Non-Linear Impairments

The main reason for non-linear impairments are fiber attenuation and fiber dispersion, it also involve variety of dispersion compensation techniques. The Non-linear impairments is helpful in determining the data transmission rates, transmission lengths, number of wavelengths, and optical power levels increase in addition to reduction in channel spacing [5]. It basically consist of Cross-Phase Modulation(CPM) and Four Wave Mixing (FWM).

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III.OUT-OF BAND AND IN BAND CROSSTALK

3.1.Out-of Band- These are generally occur in optical fiber having high power condition and for large distances. It can

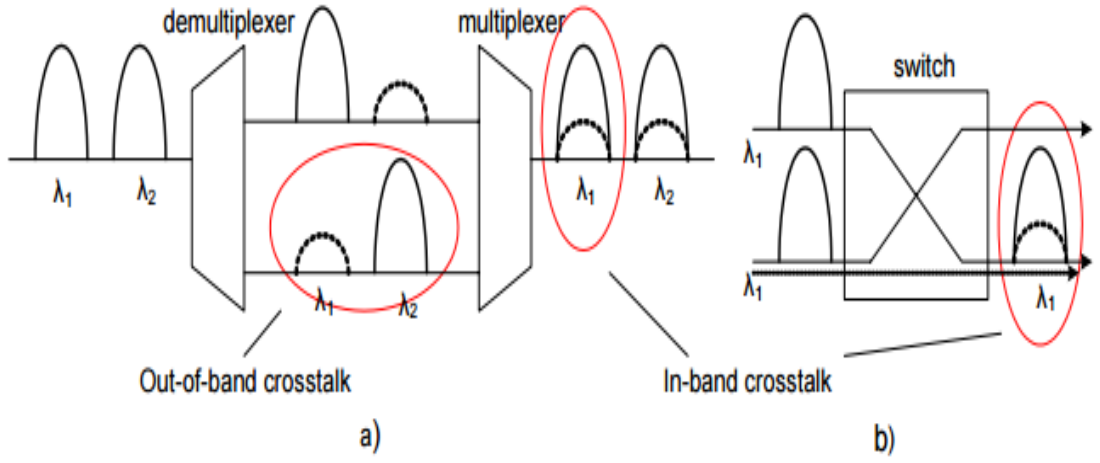

Fig. 2. Optical multiplexer/demultiplexer (a) as a optical switch (b) as sources of out-of-band and in-band crosstalk

also occur due to non-ideal demultiplexing where one channel is selected and other channel is not perfectly rejected. Optical switches are also source of out-of band crosstalk which is arises due to imperfect isolation in different output ports.

3.2.In-Band Crosstalk-In-band crosstalk is more hazardous than the out-of band crosstalk that is, the damage signal at the same wavelength cannot be removed by the demultiplexers. Both the multiplexers and demultiplexers are the sources of In-band crosstalk as shown in the Fig.3.In-band crosstalk inherent to optical switches can also be used for tapping. This can be reduced by individually amplifying only signals , it means that the crosstalk would not be amplified. However, an attacker can still request a data channel and not send any information over the channel, but use it to tap other signals at the same wavelength.

IV. LITERATURE SURVEY

Chava Vijay Saradhi and Suresh Subramaniam, Optical WDM/DWDM networks have the capacity to satisfy emerging applications such as video services, medical imaging and distributed CPU interconnects. In a transparent optical network, if a light path is established between any two nodes, traffic present between these nodes can be routed without requiring any intermediate optical-electrical-optical (OEO) conversion and buffering [1].

Avizit Basa k, Md. Zargis Talukder & M d. Rakibul Islam, In WDM systems the bandwidth of the fiber is divided into different channels with each channel consist of one signal, due to this there is a increase in the overall data rate without increasing the number of fibers. The data rate of different channel is limited, but when we consider so many channels the total data rate is higher [2]. At the receiver of the WDM, a de-multiplexer isolates the wavelengths and routes them into different fibers, which all conclude at separate receivers.

J. Strand, The transparency in the physical layer of the optical networks gives flexibility and dynamic nature in the optical layer and the transparency also decreases the possibility of electrical layer interaction with the optical layer at intermediate nodes in the path.

G. P. Agrawal , The Effects of non-linear impairments determining the data transmission rates, transmission lengths, number of wavelengths & optical power levels increase in addition to reduction in channel spacing [5].

Yurong Huang, The WDM networks present in the optical network.

Yunfeng Shen, Kejie Lu and Wanyi Gu, There are basically consists of two types of crosstalk that are, out-of band crosstalk and In-band crosstalk.

Aneek Adhya and Debasish Datta , PLI occur when there is a transmission between the sender and the receiver.

V. CONCLUSION

The physical layer impairments present in the transmission are of two types- linear and non-linear impairments. Linear impairments are static, independent of signal power and affect each wavelength individually whereas non -linear impairments are dynamic, depends on signal power and it not only affects the individual channel but also causes disturbances in between the channel. In this paper we study about the transparent optical networks, PLIs occur due to a non- ideal optical transmission medium present in the optical path and also determine the feasibility or transmission quality of the light paths. If the quality of the signal is not good, the receiver is not be able to correctly detect the optical signal at the receiver, and hence the light path become useless and the BER become high.

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