Throughput Improvement in Dense Wavelength Division Multiplexing Optical Networks

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ABSTRACT-Dense wavelength division multiplexing (DWDM) is an optical technology that allows transmission across a fiber with many wavelengths; these wavelengths can be added and dropped by means of passive optical components. When the information is transmitted over the network there are various reasons which disrupt the information. So a need of an intellectual algorithm or process is necessary which can be applied to the network so that the network could overcome the problems of congestion and the faults occurring in the network. In this paper, a work is being proposed in the DWDM optical network to overcome the problems of congestion and faults occurring in the network so that the network can achieve better performance in transmission of information. The reliability of the network is presented in the terms of reduced packet loss and improved throughput. The intellectual process is applied to reduce congestion and various faults. In the first process the network will transmit the information with more information loss but after applying the intellectual approach to the same network there will be improvement in the networks performance as it is the main requirement in the information transmission.

I. INTRODUCTION

In optical networks based on wavelength division multiplexing (WDM), each wavelength can carry high-bit rate data originating from different users. These networks are promising candidate to meet the bandwidth demands from various emerging multimedia applications such that web applications, video on demand, multimedia conference, image access and distribution, home broadband services etc. Optical wavelength division multiplexing (WDM) networking technology has been identified as a suitable candidate for future wide area network (WAN) environments, due to its potential ability to meet rising demands of high bandwidth and low latency communication. Networking protocols and algorithms are being developed to meet the changing operational requirements in future optical networks. Simulation is used in the study and evaluation of such new protocols, and is considered a critical component of protocol design. Our goal in this paper is to incorporate the key characteristics of DWDM networks in the simulator, such as optical switching nodes, multi-wavelength links, virtual topology constructions, related switching schemes and routing algorithms. This paper presents the simulation model for the architecture and design of DWDM and a representative performance analyzer to demonstrate how the simulator can be used. This paper is structured as follows. In the section 2 we define the concept of traffic grooming, in section 3, we define the review related work on the analysis of DWDM network. In section 4, we define the methodology of the proposed work; result & discussion of the proposed work is presented in section 5.

II. CONCEPT OF TRAFFIC GROOMING

Given a set of connection requests, the problem of setting up light paths by routing and assigning a wavelength to each connection is called routing and wavelength assignment (RWA) problem. This problem is also defined as the traffic grooming. If we cannot setup a light path for a connection request, then it is blocked. A well designed RWA algorithm is critically important to improve the performance of DWDM networks. RWA problem can be classified into static and dynamic problems. In the static problem, the connection requests are given in advance. The objective is to minimize the total blocking probability or to have the maximum number of setting up connections. In contrast, the dynamic RWA considers the case where connection requests arrive dynamically. The dynamic RWA is performed online, it is much more challenging; therefore,
heuristic algorithms are usually employed in resolving this problem.

III. RELATED WORKS

In this paper we are trying to reduce the congestion and fault problem in the Dense Wavelength Division Multiplexing (DWDM). DWDM is one of the widely used optical networks used for the Metropolitan Area Network (MAN). With the tremendous growth in traffic in Ethernet and internet, there is the congestion that takes place in the network. This traffic arrives randomly, so it is very necessary to tolerate otherwise the throughput of the network is reduced. So any intellectual approach is needed to apply on the network which can overcome the problem of traffic grooming. Samy Ghoniemy et. al. [1] presented modeling and simulation, characterization and performance evaluation of high data rate and high capacity long-haul DWMD light wave systems as well, a methodology for finding the optimum modulation format that can effectively enhance the system performance without major changes in the existing infrastructure. The performance of the exemplary system is examined using four different modulation formats: NRZ-OOK, optical duo binary, differential binary phase shift keying (NRZDBPSK), and differential quadrature phase shift keying (RZDQPSK). Simulation results show that the overall system’s performance using a combination RZ-DQPSK with the LEAF based on reduced channel spacing provides a remarkable improvement over implementations based on other fiber and modulation format combinations.

Vladimir Tejkal et. al. [2] performed analysis of binary modulation formats in passive optical networks based on wavelength division multiplexing (WDM-PON). The simulations showed that CRZ is not suitable for optical link based on wavelength division multiplexing because of the broader central lobe compared with other modulation formats; also NRZ modulation gives the lowest BER in the investigated network.

Alberto Aloisio et. al. [3] presented and discussed the performance of a complex DWDM network data transmission system that will find an application in the NEMO underwater neutrino telescope. The results showed a high optical power budget for values of optical power at the receiver close to the LOS state, the introduction of optical filters increased the system performance due to the reduced amount of optical noise fed to the receiver.

Benyang Chen et. al. [4] proposed a wavelength optimization model according to the topology of wavelength-shared WDM-PON. With the application of this model, optimum allocation of wavelength resources can be realized and balance between performance and costs can be achieved under some conditions. Furthermore, average delay characteristics of wavelength-shared WDM-PON are simulated and analyzed. The results showed that not only the operation of network is stable but also simulation analysis is consistent with theoretical analysis and actual network situation.

T.L Vinh et. al. [5] worked on the problem of dynamic survivable routing in WDM networks with single link failure model. The model generated was to find the ways to dynamically determine a protection cycle (i.e. two link disjoint paths between a node pair) to establish a dependable light path with back up path sharing. The authors used a genetic algorithm (GA) based survivable routing algorithm; which allowed to improve the blocking performances.

Ge Nong et. al. [6] proposed an efficient Medium Access Control (MAC) protocol called iCSMA/CD for improving the efficiencies of optical Wavelength Division Multiplexing (WDM) networks. The proposed protocol for an optical WDM ring network with each node equipped with a wavelength tunable transmitter and a wavelength fixed receiver is more intelligent in predicting the occupation status of each individual channel, which in turn yields a better system performance in terms of delay and throughput. The simulation results showed that the protocol has significant impacts on improving the system performance.

Weifa Liang et. al. [7] proposed an algorithm for realizing all-to-all routing such that the routing is fault tolerant and both node load and link load are well balanced. The results showed that the proposed approach produces clear routing paths, requires fewer wavelengths, and can easily incorporate load balancing. In this paper we analyze the throughput improvement in DWDM network in simulation mode using the Network Simulator-2.

Chungsheng et.al. [8] proposed a work which discussed an integer linear programming problem. The proposed work minimized the used network resource, and traffic blocking probability and thus, maximize the by-pass traffic.

Kungmeng et. al. [9] investigated a class of adaptive routing called Dynamic Wavelength Routing (DWR). The objective of routing is to reduce the blocking
probability in an arbitrary network. The approach contains two sub algorithms: least congestion with least nodal-degree routing algorithm (LCLNR) and dynamic two end wavelength routing algorithm (DTWR).

IV. RESEARCH METHODOLOGY

To represent the complete DWDM system, line based architecture with a number of nodes is used as shown in figure 1. There are basically three types of nodes in the network. The first node is server of the network and is the source of information in the network. The second node acts as the controller node of the information flow in the network; it controls the flow of data in such a way that there is reduction of congestion and faults in the networks. The controller node works on the acknowledgements received from the third node which acts as the destination node. The third node is the destination node which sends the acknowledgment of the information received by it.

![Figure 1: Topological Architecture of DWDM network used for simulation](image1.png)

In the scenario-1, the transmission protocols i.e. transmission control protocol (TCP), constant bit rate (CBR), user data protocol (UDP), file transmission protocol (FTP), null agent, are used to transmit the information packets over the network. In the first scenario, the controller node does not change the data which means it doesn’t modulate the data packets according to the acknowledgements received by it and sends the data as it is received from the server node while in the second case the controller node works according to the acknowledgements received by it from the destination node. The destination node reports the loss of packets and the problem of congestion in the transmission to the controller node which helps it to modulate the data packets in such a way that there is increase in throughput. There are various cases which are studied in this paper. In the first case there is congestion in the network as shown in figure 2. In the second case there is problem of fault in the network as shown in figure 3 and in the third case there is problem of both congestion and fault in the network.

![Figure 2: Dropping of packets due to congestion](image2.png)

![Figure 3: Dropping of packets due to congestion](image3.png)

V. SIMULATION RESULTS AND DISCUSSION

The proposed analysis is showing the comparison of existing and proposed approach as the parameters of
packets delay, window size and throughput. Figure 4 shows the comparison of transmission window in both the cases defined and the graph shows that the probability of transmission window to be successfully transmitted is more in the proposed work hence increasing the throughput of the network.

Figure 4: Optimization of Transmission Window (Existing Vs. Proposed)

Figure 5 shows the probability of successful transmission during congestion is more in the case of proposed work then in the case of existing work. Figure 6 shows that the probability of successful transmission during fault is more in the case of proposed work then the existing work. Both these graphs show that the throughput of the network has improved with the application of the proposed work.

Figure 5: Probabilistic analysis of successful Transmission in congestion (Existing Vs. Proposed)

Figure 6: Probabilistic analysis of successful Transmission in fault (Existing Vs. Proposed)

Figure 7 shows that the size of the window carrying information during congestion has decreased during the proposed work and hence more data packets can be transferred during the same time frame and thus improves the efficiency of the network. Figure 8 shows that the size of the window carrying information during fault has decreased during the proposed work and hence more data packets can be transferred during the same time frame and hence improves the efficiency of the network.
VI. CONCLUSION

We have proposed a comprehensive approach to reduce the problem of congestion and fault in the DWDM networks. The proposed approach improves the network throughput and efficiency and thus gives the network reliability for further future works.

REFERENCES


