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Effect of Placement of Grooming Nodes Along With Wavelength Convertor on Blocking Probability

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ABSTRACT-- Traffic grooming has become important issue in optical networks because optical networks provide high speed data transmission. Wavelength Division Multiplexed switching networks are important for the future transport networks. This paper analyzes the performance of different wavelength assignment algorithms and effective placement of grooming nodes along with wavelength convertors with their effect on the blocking probability of the connection request in the optical network. The wavelength assignment is a unique feature in wavelength routed network that distinguish them from the conventional networks. The wavelength assignment algorithms are classified as First fit, Random fit, Most used, Least used and wavelength conversion algorithms. Simulation is done for the 20 node optical ring network. because of effective placement of grooming nodes The experimentation results indicate that the first fit , least loaded , most loaded offers least Overall blocking blocking Probability rate. Effective grooming requires consideration of the topology of the network and the different routes in use.

Index Terms - WDM Networks, Blocking Probability, Traffic grooming.

I. INTRODUCTION

TRAFFIC Grooming is a term used to describe the optimization of capacity utilization in data transmission systems by use of cross connections of conversions between different transmission systems or layers within the same system. Major advantages of traffic grooming are reduced network cost improved network performance.

Traffic grooming is the process of grouping small telecommunications flows into one larger units,. For example, if a network using both time-division multiplexing (TDM) and wavelength-division multiplexing (WDM), two flows which are destined for a common node can be placed on the same wavelength, that allowing them to be dropped by a single optical add-drop multiplexer. the aim of grooming is minimizing the cost of the network. The cost of line terminating equipment (LTE) (also called add/drop multiplexers or ADMs) is the most dominant component in an optical WDM network's cost. The grooming typically involves minimizing the usage of ADMs. This is similar to the use of virtual channels and virtual paths in ATM networks.

Effective grooming requires consideration of the topology of the network and the different routes in use. Thus it is especially useful when dealing with mesh networks. An add-drop multiplexer (ADM) is an important element of an optical fiber network. A multiplexer combines and multiplexes, several lower-bandwidth streams of data into a single beam of light. A add-drop multiplexer also has the quality to add one or more lower-bandwidth signals to an existing high-bandwidth data stream, and also can extract or drop other low-bandwidth signals, removing that signals from the stream and redirecting them to other network

ADMs can be used both in long-haul core networks and in shorter-distance networks, although the former are much higher expensive due to the difficulty of scaling the technology to the high data rates and dense wavelength division multiplexing (DWDM) used for long-haul communications. This optical filtering technology used in add-drop multiplexers is the Fabry–Pérot etalon.

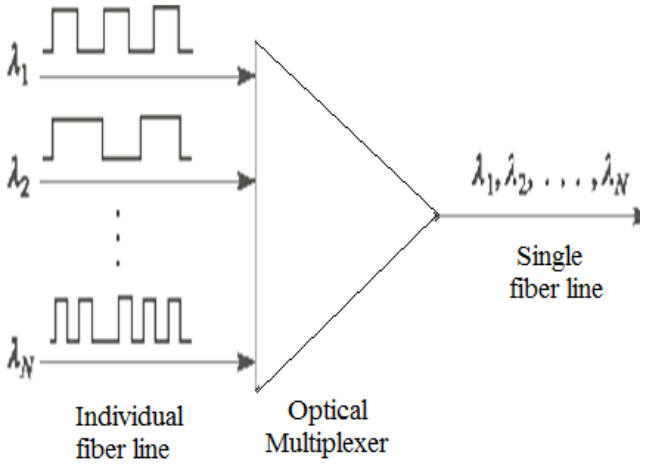
A recent shift in ADM technology has introduced so-called "multi-service SONET/SDH" (also known as a multi-service provisioning platform or MSPP) equipment which has all the capabilities of legacy ADMs and also include cross-connect functionality to manage multiple fiber rings in a single chassis. That new devices can replace multiple legacy ADMs and also allow connections directly from Ethernet LANs to a service provider's optical backbone network. An emerging variety of ADMs that is becoming popular as the carriers continue to invest in metro optical networks are reconfigurable optical add-drop multiplexers (ROADMs). Different multiplexing techniques can be used for traffic grooming in different domains of optical WDM networks .

• Space Division Multiplexing (SDM): It partitions the physical space to increase transport bandwidth, e.g. grouping a set of fibers into a single cable or using several cables within a network link.

• Frequency Division Multiplexing (FDM): It partitions the available frequency spectrum into a set of independent channels. The function of FDM within an optical network is termed (dense) wavelength-division multiplexing (DWDM or WDM) which enables a given fiber to carry traffic on many distinct wavelengths.WDM divides the optical spectrum into coarser units called wavebands, which are further divided into wavelength channels [2].

• Time Division Multiplexing (TDM): It divides the bandwidth's time domain into repeated time-slots of fixed length. By the application of TDM, multiple signals can share a given bandwidth.

• Wavelength Division Multiplexing (WDM): WDM is used to increase at rapid rate of 40% to 70% per year.



WDM (wavelength division multiplexing) based optical networks proposes the solution to meet the demands of high bit rate in order to meet efficiently utilize the fiber capacity. Wavelength Division Multiplexing (WDM) enables the efficient utilization of optical fibers by dividing its tremendous bandwidth into a set of disjoint wavelength bands,it is referred to as wavelengths. Every one of the given wavelengths supports one communication channel which corresponds to an end user operating at an arbitrary speed. This helps to overcome the opto-electronic mismatch between the multiple terabit-per-second bandwidth of optical fibers and the gigabit-per-second electronic processing speeds at end users.

In WDM optical networks multiple channels have assigned different wavelengths and transmitted over the same fiber simultaneously, enabling the fiber to provide the large throughput. Because of this reasons different network service providers and telecommunication communities are playing close attention to WDM based optical networks. Theoretically, the full data transmission capacity of a fiber could be exploited with a single data channel of high data rate . However, this is given the better available bandwidth (tens of terahertz) of the low-loss transmission window of silica single-mode fibers, that would lead to a data rate which is far higher than what can be handled by optoelectronic senders and receivers. Also, different types of dispersion in the transmission fiber would have very detrimental effects on such wide-bandwidth channels, so the transmission distance would be strongly restricted. Wavelength division multiplexing gives solution of these problems by keeping the transmission rates of each channel at reasonably low levels (e.g. 10Gbit/s) and achieving a high total data rate by combining several or many channels. WDM networks possess different wavelength patterns that include conventional or coarse WDM and dense WDM . Conventional WDM system provide up to 16 channels whereas dense WDM provide denser channel spacing on same transmission window. In all WDM networks a connection is assigned a wavelength on each of the links along the routing path for the connection. In case that the connection has to be assigned two or more wavelengths on different links one or more nodes along its routing path must have the capability of converting the signal from one wavelength to another wavelength if a connection is assigned same wavelength on all links along its routing path, is known as wavelength continuity constraint.. These techniques are evaluated in terms of call blocking probability in network. Wavelength conversion increases the routing choices for a given light path, that gives good result and better performance in terms of less blocking probability. This will also reduces the bandwidth loss that result in better bandwidth utilization. However such converters are likely to b expensive. Therefore there is a compromise between performance gain and cost. The RWA can be split up into two parts first choosing the rout then assigning the wavelength/channel to that rout. In the routing process, the routes are chosen based on shortest path sets.

II. VARIOUS WAVELENGTH ASSIGNMENT ALGORITHMS ARE AS FOLLOWS:

first fit (FF) wavelength algorithm

In this method first the free wavelengths of traffic matrix are sorted in non decreasing order. FF strategy always chooses the lowest indexed wavelength from the list of free wavelengths and assigns it to the connection request. When this request is completed the wavelength is added back to the free wavelength set.

Random fit (RF) wavelength algorithm

In this method, a set of free wavelengths on particular path is to be determined. RF algorithm determines which wavelengths are available and then choose the wavelength randomly amongst the available set of free wavelengths.

Most used (MU) and least used (LU) wavelength algorithm
In most used algorithm, when the connection request is made it get to be allocated by the wavelength which is using on the greatest number of fibers in the network.
Least used (LU) wavelength assignment is similar to the most used algorithm except in LU algorithm the least used wavelength in the wavelength is assigned.

III. LITERATURE SURVEY

Barry and Pierre (1995) [1] introduced a traffic model for circuit-switched all-optical networks which we then use to calculate the blocking probability along a path for networks with and without wavelength changers. The author investigate the effects of path length, switch size, and interference length (the expected number of hops shared by two sessions which share at least one hop) on blocking probability and the ability of wavelength changers to improve performance.

Bianco et al. (mar,2000) [2] devise and validate by simulation an analytical model to study the performance of TDM/WDM networks using a three-stage switching architecture as an abstract model. Here We consider this transparency property as a constraint: a new incoming call can be accepted only without modifying the routing of previously accepted calls. The author concentrate on the analysis of the call blocking probability by varying the traffic pattern and the configuration of the switching architecture. The author shows that a very good agreement is obtained between simulation and analytical results.

Tushar Tripathi , Kumar N. Sivarajan (oct,2000)
[3] Proposed a method to calculate the average Blocking Probability in all optical networks using limited range wavelength conversion , Previous works have shown that there is a remarkable improvement in blocking probability while using limited-range wavelength conversion , but these analytical models were either for a path or for a mesh network. The author extend birman's model for no Wavelength conversion and derive an analytical expression to compute the blocking probability in networks for fixed routing. the given model is applicable to any network topology.

Ding Zemin , Mournir Hamdi (2002) [4] Consider the Routing and Wavelength Assignment Problem as well as the placement of Wavelength Converters in wavelength routed all Optical network, Used a Clustering technique Called blocking Island , The author propose a simple and Intelligent RWA. Algorithm:BI_RWA and a converter placement Algorithm . these Algorithm can be used in arbitrarily connected networks and with some simple changes , this can also be applied on various networking scenarios. The author have evaluated our algorithm through extensive simulations. The Simulations are carried out in two parts : Static traffic and Dynamic Traffic. The result will demonstrate that Rwa algorithm performs Better than other Previously Proposed Algorithms.

Rolland Mewanou and Pierre (2003) [5] considered dynamic routing in all optical networks without wavelength converters which are very expensive and always not effective. The author proposed two new heuristic algorithms to manage optical routing based on link-state and reduce blocking probability of request arriving in the network. The first uses a technique similar to 'fixed paths least congested" (FPLC) routing by analyzing the first k link on each path whereas the second is based on an estimation of the link-congestion in the network. Both algorithms achieve excellent performance, for different types of network topo
logies, when compared to methods like FPLC, and FPLC-k.

Ghose et al. (2005) [6] considered the problem of designing virtual topologies for multihop optical WDM networks when the traffic is self-similar in nature.The Studies of years suggest that the network traffic is bursty and can be much better modeled using self similar process instead of Poisson process. The Author examine buffer sizes of a network and observe that with reasonably low buffer overflow probability, the buffer size requirement for self-similar traffic can be very large. A self-similar traffic model has an impact on the queuing delay which is usually much higher than that obtained with the Poisson model. The author investigate the problem of constructing the virtual topology with these two types of traffic and solve it with two algorithmic approaches: Greedy (Heuristic) algorithm and Evolutionary algorithm. the greedy algorithm performs a least cost search on the total delay along paths for routing traffic in a multihop fashion, the evolutionary algorithm uses other methods to optimize the average delay in a network. The author analyze and compare our proposed algorithms with an existing algorithm via different performance parameters , with both the proposed algorithms the difference in the queuing delays, caused by Poisson traffic, that results in different multihop virtual topologies.

Suresh Subranmaniam (2007) [7] : In all optical networks with no Wavelength convertors signals are switched optically inside the nodes and therefore Propagate over Hundreds of thousands of Kilometers with no electrical Regeneration This is lead to serious signal degradation ,resulting poor quality of transmission. RWA Algorithm block calls if a continues Wavelength from source to Destination can not be found (Wavelength Blocking) or when the QOT of the calls is not acceptable. The author Present an analytical method to evaluate blocking probability in all optical networks accounting for several physical layer impairment: intersymbol interference, amplifier noise, node crosstalk.

Garg and Agrawal (2008) [8] While a session request is assigned to a wavelength-routed optical WDM networks, that are circuit-switched in nature, the target of routing and wavelength assignment (RWA) is to calculate the optimal path between two nodes, and assign an avaliable set of wavelengths with this path. An algorithm called Total wavelengths and Expected available wavelengths (TEW) proposed by Pavarangkoon in order to achieve effective routing and wavelength assignment formulates a link weight function and considers this as the main factor for route selection. That function is calculated by determination factor of the number of wavelengths that are being used currently and are supposed to be available after a certain time period. However, this algorithm tends to overload paths with smaller weights and higher utilization while lightly loaded paths with slightly lower capacities may remain unused. In this paper, proposed an improvement to the TEW algorithm by incorporating the frequency of use of the paths in the weight function and running Dijkstra's shortest path algorithm to choose paths that have more total and expected available wavelengths and less frequency of usage. That proposed algorithm is called as Countered Total wavelengths and Expected available wavelengths (CTEW) algorithm. The effect of the proposed algorithm on blocking probability is investigated by means of computer simulation and by comparing it with TEW algorithm. The results show that the given algorithm can achieve better performance in terms of blocking probability.

He et al. (2009) [9] reviewed that The quality of an optical signal degrades due to physical layer impairments as it propagates from a transmitter to a receiver. this results, the signal quality at the receiver of a light path may not be sufficiently high, leading to increased call blocking.thus in all-optical network's routing and wavelength assignment algorithm must verify the quality of the light path before accepting it. So the, analytical expressions for the total blocking probability are derived for first-fit wavelength assignment for networks suffering from transmission impairments. The new technique effectively predicts the performance of wavelength selection techniques that consider either a single candidate channel or all channels for quality of transmission . The analysis is also applicable to first-fit algorithms with different static channel orderings.

Aditya Goel (2009) [10] Consider that in Various wideband applications in wired and wireless network demand of bandwidth is growing exponential . the existing network is not capable to meet the requirement of vast bandwidth. These requirement can be meet by all optical network which is capable of transmitting enormous data at very high speed, around 50 tera bits per second (Tbps) A Wavelength conversion technique is addressed in this paper to reduced the blocking probability in wavelength routed networks. It is observed that the blocking probability of traffic request decreases as the Wavelength Conversion factor increases also. The Author concluded the Possibility for network with Different sizes Comprising of 25,50 and 100 nodes with variation in wavelength per link in this work the effect of varying number of wavelength converters , Different traffic types on fibre link utilization and network blocking probability are evaluated and results are shown that the blocking probability is minimum with wavelength conversion Factor of 0.5 . Thus Propose a network With 32 and 64 Wavelength and 50% Wavelength convertible nodes

S.LI.,M. Wang ,E.W.M Wang (2011) [11] Consider an optical Network That uses Various circuit switching based technologies such as OCS and OFS, The author model it as two-priority circuit-Switched network with non-hierarchal alternate routing . The author evaluate the Blocking Probability using Algorithms Based on the Erlang Fixed-Point Approximation (EFPA) and the Overflow priority classification Approxification (OPCA) , For a particular Example of a-node fully meshed network with alternate routing we compute numerically between OPCA and EFPA and discuss Traffic implications.

Lei Gong , Jie Zang , Yongli zhao (2011) [12] consider that OFDM has recently been proposed a modulation technique for optical network, because of its good spectral efficiency , flexibility and tolerance to impairements optical Ofdm is much more Flexible compare to traditional WDM system,enablingelastic bandwidth transmissions and optical networking is the future trend of development in OFDM- based optical network the research of blocking rate has very much important significance for network assessment current research for WDM network is basically based on a fixed bandwidth,inorder to accommodate the future business and the fast changing development of optical network,The author study is based on variable banwidth OFDM- based optical network. The author apply the mathematical analysis and theoretical derivation, based on the existing theory and algorithm , research blocking probability of the variable bandwidth of optical network ,and buikd a model for blocking probability.

Onur al.,masayuki murata (2012) [13] consider the optimization of the traffic splitting parameters by some metrics is vital to maximize the benefit by the hybrid architecture. Blocking rate is the most important Performance Metrics in a path switching network. In this paper , The author propose an analytical method to compute both forward and backward blocking rates in path switching optical WDM networks with destination-Intiated reservation. On mesh topology The author show that results of our analytical method and simulations are close to each other.

Singal and Kaler (2012) [14] proposed a new simulation technique for the performance analysis of First-fit Most-used, Random, and Wavelength conversion Algorithms for wavelength assignment in WDM unidirectional optical ring network.

The blocking probability of different algorithms with the variation in number of events has been compared. The capabilities of the wavelength conversion algorithms technique is good but there is burden of using expensive hardware. Without the need of wavelength converter the Most-used algorithm performs better than the Random and First-fit algorithms. These approaches are most effective for the minimization of blocking probability of optical.

Vikas Kaushik (2013) [15] Wavelength Division Multiplexed Switching Networks are important for the Future Transport networks. That Paper analyzes the Performance of Various Wavelength assignment algorithm and their effect on the blocking Probability of the connection request in the optical network with Traffic Grooming . The Wavelength routed Network that Distinguish them From the Conventional Networks. The Wavelength assignment is a Unique Features in Wavelength routed network that distinguish them from the conventional networks. The Wavelength assignment algorithm are Classified as First fit, Random Fit , Most used , Least used and Wavelength conversion algorithm Simulation is done for the 16 node optical ring network . The Experimentation results indicate that most used algorithm achievers reduced network blocking rate with and Without traffic grooming.

IV. SIMULATION:

The experiment is carried out to analyze the performance of various wavelength assignment algorithms with and without convertors with its effective placement to reduced blocking probability. The parameter used for simulation is variable traffic and fixed wavelength. The ring topology with twenty nodes is shown in fig:4.1.

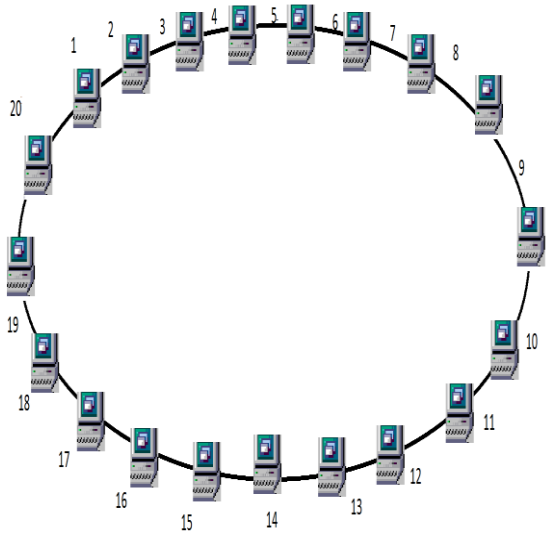


Fig: 4.1 Optical ring network with 20 nodes

The simulation is done on the optical ring network models in hegons simulator which is having 20 nodes with the fixed wavelength 20 and the variable offered traffic on each of the link between the nodes. The nodes used in the model are of grooming and non grooming type. The link capacities matrix and the arrival rate matrix of order [20][20] is used in the proposed model.

V. RESULTS:

The blocking probability of network depends on length of the route, free wavelengths, number of channels. We have fixed the wavelength as 20 and traffic load varies from 0 to 9. Here the total traffic blocked, average blocking probability, overall blocking probability and average of average blocking probability of algorithms such as first fit, random fit, least used, most used, , least loaded and most loaded is compared with each other as shown in fig 5.1 to fig: 5.3

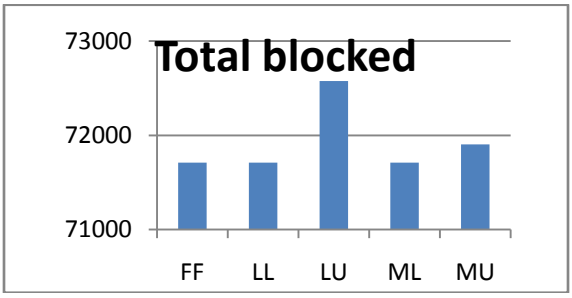


Fig:5.1. Total Blocked.

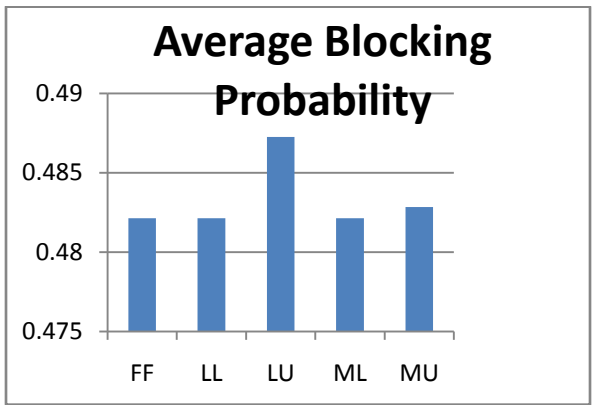


Fig:5.2. Average Blocking Probability

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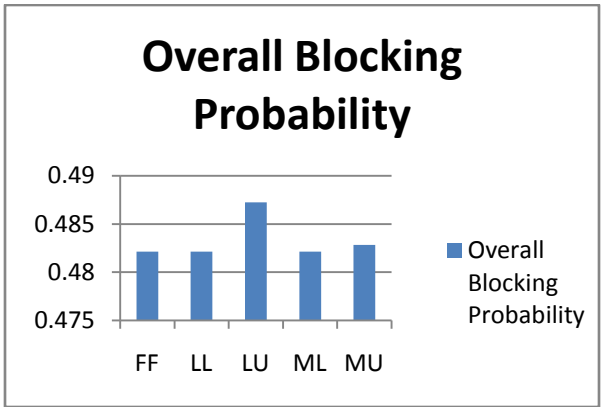

Fig:5.3. Overall Blocking Probability.

VI. CONCLUSION:

The blocking probability in an optical network depends on the Network hierarchy as well as offered Traffic to a network. The wavelength assignment problems are the major problems of WDM networks. Hegons simulator is used for performance analysis of optical network using first fit, random fit, most used, least used, least loaded and most loaded wavelength assignment algorithms. The simulation results obtained for calculating the blocking probability for each of the algorithms has been compared. The firstfit,least loaded,Most loaded algorithm performs better than all other algorithms with effective placement of grooming nodes. The blocking performance of WDM network was analyzed for optical ring network having 20 nodes with fixed wavelength. Simulation results obtained for calculating the total blocking probability, average blocking probability, and overall blocking probability for each of the algorithm are compared and it is analyzed that the first fit , least loaded , most loaded offers least Overall blocking probability which is 0.482145.

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