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Routing and Wavelength Assignment Strategies in Optical WDM Network

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Abstract: ***Advances in communication field require large number of bandwidth in which WDM is one of the technologies. Today with the growth of internet Wavelength Division Multiplexing has prime importance. WDM is the system in which at the same time on the same fiber link the data can be transmitted and received simultaneously. In WDM the main problem is Routing and Wavelength Assignment (RWA) is the challenging problem. Routing is the concept to find the available path in the network. And also re-routing is one in which to find best alternative path if available in the network without changing the traffic. In this paper we gave the survey on routing algorithm and re-routing algorithm in Wavelength Division Multiplexing network with the comparisons in different parameters like Network Congestion (NC), Network Converter Requirement (NCR), and Network Wavelength Requirement (NWR) etc.***

Keywords: WDM, Re-routing algorithm, Routing & Wavelength assignment problem (RWA), Routing algorithm, Network Converter Requirement etc.

I. INTRODUCTION

WDM optical networks have gained prime importance due to the rapid growth of internet and the ever increasing demand for voice and video transmission [10]. In optical networks Wavelength-Division Multiplexing (WDM) is used large amount of available bandwidth of fiber [2]. That means WDM is used in optical network for transmission of data, which allocates different wavelength to the signals and also helps in reducing the bandwidth. WDM enables different connections are established by using a common set of fibers [1]. In a wavelength routed WDM network, communication between end users with one another using optical WDM channels that means light paths. A light path is the path that is established between source node and destination node for transmission of data [4]. In the absence of wavelength converter, a light path must assign the same wavelength on all the fiber links through which it traverses; this property is known as the wavelength-continuity constraint. The below figure.1 depict Wavelength Division Multiplexing (WDM),

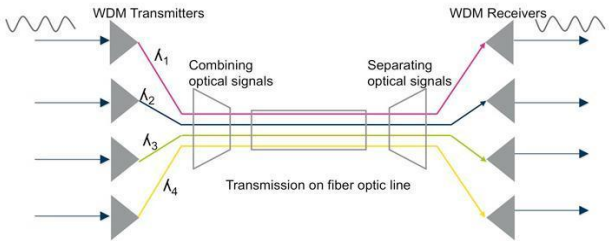

Fig. 1 Wavelength Division Multiplexing (WDM)

In this we have to use Bi-directional WDM optical network in which at the same time on the same fiber link, signals can be transmitted & received simultaneously. The routing is of two types that are static routing and dynamic routing. In Dynamic routing type, protocol on one router communicates with the same protocol running on its neighboring routers. Then router itself updates information about location and places it into routing table. The important one main problem of WDM optical network is RWA (Routing and Wavelength assignment) problem, which deals with light path to be setting up with the optimal use of network resources [6]. An algorithm which is used for finding out solution for a given problem, in which its result sometimes may not be accurate, is called a Heuristic Algorithm. For many solutions now a day, heuristic algorithms are used, as its results are close to optimum.

In this paper we have to use a heuristic algorithm for minimizing different parameters in RWA problem which is in wavelength routed WDM network. There are mainly three architectures of WDM network, like as Wavelength routed network (WRN), Broadcast and select network and Linear light phase network [16]. But out of these three architectures by considering Wavelength Routed Network because of its advantages than that of other two types like as lack of wavelength, low power splitting losses and scalability to WAN. That shows the performance of WRN is better than other architectures.

On this WRN network we have implemented heuristic algorithm mainly in two phases. In First phase routing and wavelength assignment is performed and in second phase rerouting is performed. The remaining of the paper is organized as follow. Now in section 2 brief overview of routing and re-routing is given, we have to explain the routing and wavelength assignment in section 3 and we have to explain in section 4 proposed algorithm. In section 5 we have to explain performance evaluation for a 5 Node, 8 Links WDM network and in section 6 conclusions is given with in section 7 the future scope of this work.

II. LITERATURE SURVEY

In this section we have to give overview of various papers as listed in below table,

Sr. No.	Year of Publication	Paper Title	Author's Name	Abstract
1	NOV-2003	An Efficient algorithm for Virtual-wavelength Path Routing Minimizing Average Number of Hops	Harsha V. Madhyastha and N.Balakrishnan	Presents a novel heuristic algorithm for routing and wavelength assignment in virtual-wavelength-path (VWP) routed wavelength-division multiplexed optical networks. The algorithm not only minimizes the number of wavelengths required for supporting the given traffic demand on any given topology, but also aims to minimize the mean hop length of all the lightpath which in turn maximizes the resource utilization
2	2004	Rerouting schemes for dynamic traffic grooming in optical WDM networks	Wang Yeo, Byrav Ramamurthy	Traffic grooming in optical WDM mesh networks is a two-layer routing problem to effectively pack low-rate connections onto high-rate lightpath, which, in turn, are established on wavelength links. The objective of traffic grooming is to improve resource efficiency. However, resource contention between lightpath and connections may result in inefficient resource usage or even the blocking of some connections. He proposed two rerouting schemes, rerouting at light-path level (RRLP) and rerouting at connection level (RRCON) and a qualitative comparison is made between the two.
3	APR-2008	Heuristic Algorithms for Routing and Wavelength Assignment in WDM Optical Networks	Keqin Li	Evaluate the average-case performance of eight offline heuristic algorithms to solve the routing and wavelength assignment problem and the related throughput maximization problem in wavelength division multiplexing optical networks.
4	JAN-2010	Rerouting technique with dynamic traffic in WDM optical networks	Amit Wason, R.S.Kaler	Discuss wavelength rerouting algorithm for dynamic provisioning of lightpath. In wavelength division multiplexed (WDM) networks rerouting of lightpath can be used to improve throughput and to reduce blocking probability. We have proposed a shortest path wavelength rerouting (SPWRR) algorithm for dynamic traffic in WDM optical networks. The results show that it can improve blocking performance of the network. The pro-posed algorithm has been applied on the realistic network like as NSFNet.
5	AUG-2011	Routing and wavelength assignment algorithms for multiclass WDM optical networks	Uma Rathore Bhatt, Sanjiv Tokekar	In this paper dynamic routing and wavelength assignment strategies have been proposed for multiclass WDM optical networks. Multiclass optical networks provide multiple classes of services to the subscriber according to the requirement, which in turn increase operational profitability.

				Each class of service could be characterized by parameters like number of wavelengths, expected call holding time and average arrival rate of request. The proposed strategies have been analyzed and compared with existing strategies on the basis of blocking probabilities for multiclass traffic scenarios.
6	NOV-2011	A Heuristic algorithm for reducing wavelength number of optical WDM networks	V. Mishra, Vinay Verma, Abhilash mandloi , P.N.Patel	In this paper a Heuristic algorithm is proposed in order to reduce the total number of wavelengths required to accommodate light-paths in a WDM networks with static traffic loading. Proposed algorithm is compared with Dijkstra's algorithm for average light-path length and wavelength number of network. To evaluate efficiency of this algorithm, reduced wavelength cost (RC) has been defined.
7	MAR-2013	Path length based wavelength assignment strategy: An algorithm for efficient system performance in wavelength routed WDM networks	Uma Rathore Bhatt, Sanjiv Tokekar	In this paper, proposed path length based wavelength assignment strategy in terms of blocking performance is compared with existing strategies. The strategy applied on the different networks like NSFNET and US network. Then simulation Results shows that in minimizing the blocking probability the proposed strategy is very effective. The results also represents that proposed strategy improves blocking performance for heavy loaded WDM networks

III. ROUTING & WAVELENGTH ASSIGNMENT ALGORITHM

The different steps of routing and wavelength assignment algorithm are as follows,

[a] Let us consider a network with distance between each node of network.

[b] Then enter of source & destination pairs.

[c] Now consider first source-destination pair.

[d] After that all number of nodes store in variable.

Let length of nodes to infinity.
& length of source as zero.

[g] For calculating minimum path we have to use the formula,

$$L(i) = \min \{Old(i), L(a) + w(a, i)\}$$

Where, i = Total number of nodes 1 to N.
a = Source of link
W (a, i) = Weight (distance) between a & i.

[h] Calculated the Number of Hops required for each route using formula,

No. of Hops of individual SD pair = (Total No. Of Nodes in Route – 1)

[i]Then calculate Network Congestion on each link by using,

$$Lmax = \max (i, j) Li, j$$

Where,
Lmax = Maximum used link,
i = Source node of link,
j = Destination node of link

[j] Assign wavelength to 1.

[k] Assignment of wavelength to source-destination pair by considering each link.

[l] Consider first link, check network congestion of that link

[i] If NC is one, then applying same wavelength to the source destination pair as previous one.

[ii] If NC is greater than one, then apply different wavelengths to the source destination pairs, where that particular link is used.

[m] Apply same process up to the end of all source destination pairs.

[n] Also find out maximum number of wavelength assigned for network traffic as,

NWR (max) = Max (no. of wavelengths in the network)

[o] Consider first link and check network congestion of link.

[i] If network congestion is greater than one then network converter is required at either of the nodes.

[ii] If network congestion is one, then Network converter is not required.

[p] Else repeat the steps for all of the physical links in the network.

IV. PROPOSED ALGORITHM

[a] Considered route whose Network congestion is greater than one stored it in reroute array. Find out Source, Destination and number of intermediate nodes in the Route as S1, D1 and K respectively. Set intermediate nodes number to i.

[b] Consider first K as N_{iK} add all neighboring nodes of N_{iK} to NHBRS list, Where k should not equal to Destination.(the neighboring node should not equal to (N_{ik}-1) and N_{ik}+1)

[c] Check NHBRS is empty or not

i. If not empty go to step [i]

ii. If empty go to step [h]

[d] Considered the first node of NHBRS list as a source and destination is same as original route, with this source and destination find out again the shortest path. And add the change the path to the original path and display the message 'Rerouting is Possible.'

[e] Display the message that 'Rerouting is not possible.' Consider next node of NHBRS up to NHBRS get empty. Go to step 9.

[f] Then consider the next intermediate node (N_{ik}+1) repeat the same process up to i = 0;

[g] If reroute array is not empty, repeat the step 2 to 8 till reroute array become empty.

V. PERFORMANCE EVALUATION

- **For a 5 Nodes, 8 Physical Links WDM Network:** the proposed algorithm evaluated for the 5 Nodes and 8 Links of WDM network,

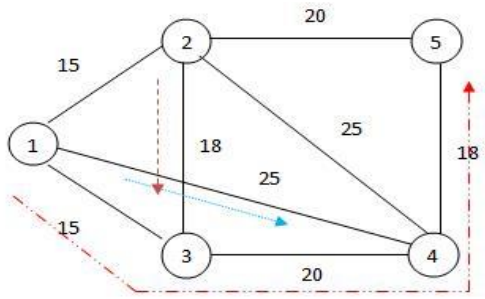

Fig. 2 Nodes WRN before Applying Re-routing Algorithm

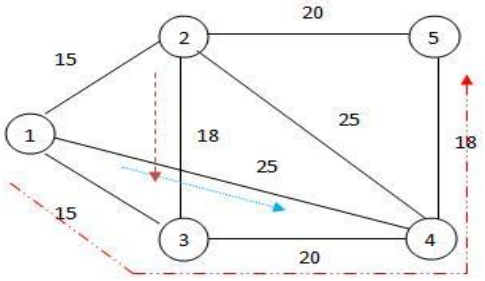

Fig. 3 Nodes WRN before Applying Re-routing Algorithm

CONCLUSION

Research work presented in this paper can be summarized in following points as:

1. Various parameters of Wavelength Division Multiplexing network have been studied.

2. The technique presented in the work is implemented according to the proposed design.

3. Finally, the experimental outcomes are analysed and compared.

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