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Max-Weighted Routing and Wavelength Assignment Algorithm in Optical Networks

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Abstract—Wavelength routed network is capable of carrying the traffic grooming situations. The assigning of wavelength to routed path is one of the major facts that affect the blocking probability. This paper proposes a novel idea for assigning of wavelength called Max-Weighted Routing and Wavelength assignment algorithm for reducing the blocking probability and better performance. This algorithm focuses on weight factor which is calculated from number of total available wavelength, free wavelength and hop count along with load balancing factor. The results are compared with first fit, random, least used wavelength assignment with fixed, fixed alternate, adaptive routing, adaptive alternate routing.

Keywords—Routing, Wavelength, WDM, Weight Factor

I. INTRODUCTION

A. Wavelength Division Multiplexing (WDM)

In optical networks, Wavelength division multiplexing (WDM) is emerging technology for next generation. In WDM, many optical light signals share the single fiber using many wavelengths [1] [2]. The utilization of fiber link can be increased with wavelength routed channel operating at high speed. The lightpath is established, when connection request arise between source(s) and destination (d), s-d pair. Lightpath is the set of links between the internet nodes from s to d, where the each links are assigned to wavelength. This is how the wavelength routed optical network (WRON) is linked with nodes. For every connection request, a wavelength is determined and assigned to a physical links for creating the lightpaths. This issue is called as routing and wavelength assignment problem [3] [4].

B. Routing and Wavelength Assignment (RWA) Algorithm

RWA problem is divided into two sessions. First is assigning routes and second is assigning wavelength to links between s to d nodes.

a) Routing Algorithms:

Fixed routing, fixed alternative routing for static lightpath establishment (SLE) and adaptive routing adaptive alternate routing for dynamic lightpath establishment (DLE) are some the routing algorithms used in optical WDM network. In fixed routing, s to d path is fixed previously and assigned to the physical links [5]. In fixed alternate routing [6], s and d have more than one alternate path which is predicted and fixed in advance. An alternate route is chosen, if there is any failure in the previous assigned links.

In Adaptive Routing, the link state information is taken from routing table for assigning routes from s to d in dynamic manner [7]. The routes are chosen on basic of hop-by-hop instead of end-to-end. Information of every node is taken on routing table which is classified in local information, global information and neighborhood information [8] [9]. Adaptive alternate routing (AAR) is for circuit switched network which is dynamic alternate routing [10] base. AAR is to distribute the traffic among two pre-predicted links, where links are chosen with the amount of traffic load on path. The alternate path is finding by crankback mechanism to check the given network periodically for available bandwidth in the network link.

b) Wavelength Assignment Problem:

Wavelength Assignment problem is further subdivided in to search and selection method. Search method used to assign the available wavelength; soon the routes are identified like first-fit and random wavelength assignment. In selection method, the wavelength is chosen with some criteria and the assigned to the set of routes like least used and most used wavelength assignment.

In First-fit (FF) wavelength assignment method, all the available wavelengths are arranged in increasing order. Then from lowest position, the wavelength is selected for assigning the route. This method doesn't need global information and very less computation cost. In random wavelength (RW) assignment, the wavelength is selected randomly from the set of available wavelengths [11-13]. This method doesn't have communication overhead but high cost compare to first-fit wavelength method. Least used and most used wavelengths are identified and then assigned to a chosen route for load balancing in least used (LU) and most used (MU) wavelength

assignment method respectively. This method mostly preferred in the centralized control systems, where it has high storage cost [14].

II. RELATED STUDY

G.Ramesh et all [15], considered two constraints for selecting the best path which are based on the available free load and the number of wavelength used in the link, to provide a reliable path for the data transmission. Here, combined cost function, load and wavelength are used to reduce the blocking probability. The path for s to d is chosen with the minimum combined cost function which is selected as the primary path for data transmission.

D.K.Kothari et al [16], proposed the WDM Aware Adaptive Weight Function by considering the factors total available wavelengths, Number of available free wavelengths and the hop length. The weight function is kept on changing according to the number of free wavelength. So the adaptive method helps in reducing the blocking probability.

Shilpa S. Patil, et al [17], defined the route with maximum weight is selected. By considering maximum free available wavelengths along with the offered traffic, number of served calls, number of blocked calls and total holding time of the served calls for that entire route. The routes are assigned to a wavelength which has maximum weight value.

Xiaowen Chu et al [18], proposed weighted least congested routing (WLCR) with route length and current traffic load considered jointly. Soon the connection request arrives; the weight value is calculated and then assigned to set of routes from s to d that previously decided. The factors that taken for calculating the weight is number of free wavelengths and number of hops. Maximum weight is assigned to routes with large number of free wavelength and less number of hop counts

X. Masip-Bruin et al [19], Minimum coincidence routing (MCR) selects the path with low number of hop lengt and high number of free wavelengths in the network. MCR selects the shortest path between the source and destination node from the pre-computed routes with minimum value of parameter called minimum shared link (MSL),

III. PROPOSED WORK

Routing assignment is done on the bases of the weight (W) function to reduce the blocking probability and to increase preference.

A. Weight Function Calculation:

The weight function (W) is calculated on basis of total available wavelength, free wavelength, number of hop counts and load balancing factor. Set of links are selected from s to d. Wavelength are assign to the link, which have maximum weight. So that there is a maximum number of free wavelength and less number of hop count.

$$W= (f(b)*L) / ((A(w)-f(b))*h(c))$$

Where W is weight function, f(b) is free wavelength, A(w) is the total available wavelength, h(c) is the hop count and L is the load balancing factor.

B. Load Balancing Factor Calculation:

Load balancing factor (L) is depending upon links and data flow in the network. The links contains channels. The free channel is defined that the channel without data flows.

L=number of free channels / total number of channels

Let L is the ratio of the number of free channel and the total number of channel decided between source and destination.

C. Blocking Probability:

The major objective of this algorithm is to reduce the rejection of connection request (Con_{req}) which is called as call blocking and is measured in team of blocking probability (B_p).

B_p= (Total number of Con_{req} rejected / Total number of Con_{req} $_{arrives}$)

B_p is ratio of connection request is rejected to the total number of connection request arrives.

IV. RESULTS AND DISCUSSIONS

NSFnet are consider for simulations to find the blocking probability depend upon the proposed weight factor. The decided set of routes is assigned to wavelength which has maximum calculated weight. The results are compared with FR, FAR, AR, and AAR along with FF, RW and LU. The following table I-III shows the comparison results. Since LU and MU having same advantages and disadvantages, MU is ignored for comparison.

WAVE LENGTH	LOAD	FR	FAR	AR	AAR	MWR
60	230E	0.04633	0.04661	0.04582	0.04432	0.03921
	250E	0.05641	0.05652	0.04933	0.0486	0.04233
70	280E	0.04542	0.02602	0.01042	0.01132	0.00512
	310E	0.04568	0.02836	0.02984	0.01058	0.00501
130	860E	0.00754	0.00652	0.00431	0.00422	0.00301
	970E	0.00761	0.00667	0.00409	0.00401	0.00391
150	1050E	0.00692	0.00674	0.00592	0.00512	0.00435
	1090E	0.00532	0.00478	0.00455	0.00369	0.00215

Table 1: MWR vs. FF Wavelength with FR, FAR, AR, AAR

WAVE LENGTH	LOAD	FR	FAR	AR	AAR	MWR
60	230E	0.05456	0.04458	0.0433	0.03561	0.03012
	250E	0.06945	0.06532	0.05641	0.05952	0.04333
70	280E	0.04545	0.04042	0.01842	0.01602	0.00542
	310E	0.05264	0.06932	0.06832	0.06523	0.00601
130	860E	0.00756	0.00742	0.00654	0.00554	0.00331
	970E	0.00797	0.00747	0.00661	0.00567	0.00399
150	1050E	0.00772	0.00722	0.00699	0.00664	0.00515
	1090E	0.00775	0.00769	0.00672	0.00632	0.00592

Table 2: MWR vs. RW Wavelength with FR, FAR, AR, AAR

WAVE LENGTH	LOAD	FR	FAR	AR	AAR	MWR
60	230E	0.04761	0.04682	0.04532	0.04021	0.03881
	250E	0.05652	0.04933	0.0476	0.04243	0.04203
70	280E	0.04602	0.02142	0.02032	0.01642	0.00642
	310E	0.04836	0.02284	0.01858	0.00901	0.00701
130	860E	0.00612	0.00451	0.00428	0.00411	0.00391
	970E	0.00697	0.00467	0.00431	0.00391	0.00291
150	1050E	0.00732	0.00609	0.00564	0.00515	0.00505
	1090E	0.00759	0.00692	0.00532	0.00541	0.00492

Table 3: MWR vs. LU wavelength with FR, FAR, AR, and AAR

V. CONCLUSION

The propose weight factor which depends on number of total free wavelength, number of free wavelength, number of hop counts and load factor is to reduce the blocking probability. The performance of proposed MWR algorithm is compared with existing FR, FAR, AR, AAR combined with wavelength assignment FF, RW and LU. The blocking probability is very less for MWR while comparing to existing algorithm. Since the Bp is less, the performance will increase due to less call request rejection.

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