International Journal of Innovative Technology and Exploring Engineering (IJITEE)
ISSN: 2278-3075 (Online), Volume-9 Issue-1, November 2019

An Efficient Scheme on Adaptable Priority-Based Routing and Wavelength Assignment Algorithm for Enhanced Quality of Service

Tarun Gupta, Amit Kumar Garg

Abstract: ***Current research interests have diverted towards the efficient priority-based routing and wavelength assignment strategy in order to enhance the quality of service in the distributed optical networks. The traditional RWA techniques such as Adaptive Routing (AR), Non priority based RWA schemes etc. are lacking of capability to reduce both the blocking probability and average end to end delay simultaneously during the transmission of networks. In this paper, an Adaptable Priority-based RWA (APRWA) schemes for optical network has been demonstrated and evaluated by utilizing the performance enhancing metric such as reduction in hop count while simultaneously handling distinguishable traffic volume. The simulation result shows considerable reduction both in the blocking probability (approx. 25%) as well as in average end to end delay near around (15 msec.) in comparison to conventional RWA techniques.***

Keywords: ***Alternate path routing, QoS, Lightpath, Wavelength assignment strategy, Blocking probability.***

I. INTRODUCTION

Routing and Wavelength Assignment schemes are the challenging and critical issues in optical WDM network owing to wavelength reuse characteristics as well as information transparency. In the wavelength routed communication network, dispersion not only increases with respect to fiber length but also results in signaled distortion i.e. performance of network degraded w.r.t to signal quality. To overcome this challenging issue, Routing and Wavelength Assignment (RWA) schemes are utilize to lessen the overall dispersion, blocking probability as well as average setup time for the requested route. In all optical networks where optical path is established between the wavelength routing nodes on all the available links is generally referred as Lightpath which is primarily essential for any network architecture and their constructive establishment is valuable to assign routes to the requested lightpath and to provide wavelengths on all available connections in order to maximize the performance metrics. This is basically the concept of RWA issues [2].

Revised Manuscript Received on November 30, 2019.
Tarun Gupta,
Amit Kumar Garg

This problem enhances the efficiency of wavelength-routed optical networks where number of users can be adjusted and only a few users require to be rejected during congestion periods by the designed network.

Additionally, efficient assignment of wavelength is equally important in any communication model and it must be allocated in such a manner that any two lightpaths which shares common optical link are not supposed to use the same wavelength at any cost [1]. Additionally, in networks where conversion of wavelength [9] is absent or ignore, the concept of wavelength continuity constraint comes into the picture where same wavelength must be used for the available connections of the requested lightpaths.

In the current work, Adaptable Priority based RWA algorithm is used which considers all the best possible paths and then prioritize the request accordingly and allocating the required wavelength to the link request by utilizing the optimal adaptable shortest path algorithm which in results reduced the overall dispersion of the designed system and hence the QoS is increased without increasing the network setup cost [3]. The calculation of the priority order of requested lightpath is evaluated depending upon the type of the path and the volume of traffic which implies the better blocking probability, throughput and average setup time. By varying the values of wavelength, traffic load and the connection request, the performance measure would be designed.

This research work focusses on most of the possible scenarios of prioritizing the link requests to improve the system performance and in order to achieve, requested lightpath is categorized in several groups based on priority which depends on number of hops count a request requires and capacity of the traffic [4-5]. This research proposed adaptable priority-based RWA algorithm to minimize the blocking ratio, average setup time in the designed topology. The output of the discussed adaptable PRWA approach than differentiate with the existing conventional schemes.

The remaining work is categorized as follows. Related work outlines in section 2. Section 3 proposed Adaptable PRWA approach and discussed in more detail on the successive sub parts. In section 4, outcomes of discussed scheme have been demonstrated. Lastly, concludes the research paper in section 5.

II. RELATED WORK

Y. Dong et al. [16] modeled a path length-based optimization algorithm assuming physical impairments,

traffic grooming functionality and using the metaheuristic approach. Furthermore, Y. Dong et al. [19] discussed routing, wavelength assignment problem by introducing the dynamic functions which highlights path length based optimization for all optical networks. Y.S. Kavian et al. [20] presented a logical approach where issues related to hop count and RWA propagation delay can be optimized. Further, D. Sousa [17-18] discussed other associated RWA problem by using evolutionary, IL programing algorithms. There are several suggested approaches which have been acquired such as greedy, evolutionary, fuzzy logic to solve the routing and wavelength assignment problem. D. Mishra presented various dynamic routing problems and differentiate it with the outcomes of the existing or similar algorithms where different approaches such as metaheuristic, fuzzy [11] showcase the grade of transmission aware algorithm.

P. Rajalakshmi et al. [15] proposed a dynamic wavelength based reassignment algorithms to reduce the blocking ratio in all optical network, where continuous wavelength route is demanding and in order to fulfill, already established path needs to be reassigned to the other wavelengths which results to serves more new lightpaths for the same network configuration by considering minimal overlap schemes. In the proposed scheme, route for each established lightpath remains the same which means only the wavelength reassignment is performed.

N. Charbonneau [12] proposed static routing assignment issues by using some heuristics approach. A.G. Rahbar [13] studied a literature review where the more focus given on dynamic impairment schemes. Additionally, the method associated with link characteristic is suggested by ignoring the statistical multiplexing effects which leads to face some crucial application limitations. A.N. Khan [14] studied a routing-based strategy to design or construct the large size networks where more s-d pairs are active parallelly.

In current research, concept of hybrid prioritization has been integrated with RWA scheme for minimizing the blocking problems on WDM networks. D.M. Shanan et al. [10] proposed an offline wavelength assignment based on priority where each traffic connection has been evaluated at source nodes in respect of the volume of the traffic enters and based on that prioritization of the wavelength can be accomplished. However, this proposed scheme not considering the other parameters like which type of traffic enters and number of hops count it requires and due to this the proposed scheme not met the expectation after a specific threshold.

The noticeable work achieved on the available researches but still few RWA related research seen where one can improve the blocking probability as well as setup time of the requested route simultaneously with dynamic network state [6]. This paper researches an adaptable priority based RWA approach by introducing a factor which depends on number of hops count a connection needs to require and volume of the traffic of the requested connection for distributed optical networks.

III. PROPOSED ADAPTABLE PRIORITY-BASED RWA APPROACH

The performance of Adaptable priority-based routing (APR) algorithm is better among other existing routing algorithms with respect to blocking probability and average setup time of the requested connection. The proposed algorithm always keeps a track on the latest update happens on the network link-state information which varies dynamically depending upon the establishment of each new requested connection and then opt the best optimal link among all the available connections.

A. Model Assumptions and Notations

National Science Foundation network topology is examined for the simulation purpose by using OptiSystem simulator. It consists of N nodes, L fibre links and W represents total available wavelengths in the designed topology and assuming all the links are bidirectional in nature.

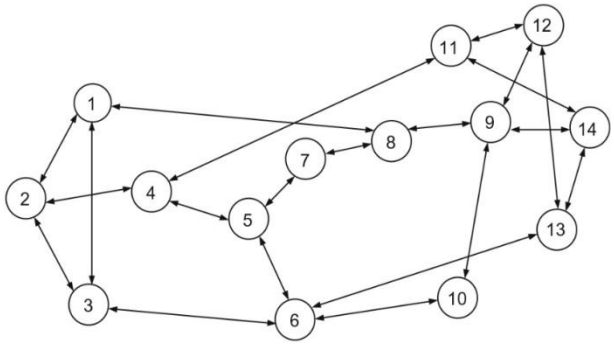

Fig. 1. NSFnet Network

B. Traffic Generation

The call arrival process is Poisson with mean rate λ uniformly distributed and holding time is exponential with mean length $1/\mu$, then state probabilities are determined by the birth and death process. Considering W as maximum wavelengths per fiber and C as active wavelengths. The behavior of the traffic enters into the network can be calculated based upon the Erlang's model [16].

$$P_c(C)=\left(\frac{\lambda}{\mu}\right)^c \frac{P(0)}{c!}, c=0,1,\ldots,C$$

where, $P_c(C)$ is probability density function of C under the normalized condition

$$\sum_{C=0}^{W} P_c(C)=1, P(0), \text{is obtained as}$$

$$P(0)=\left[\sum_{c=0}^{C}\frac{1}{c!}\left(\frac{\lambda}{\mu}\right)^c\right]^{-1}$$

C. Computing Blocking Probability

The total blocking probability is evaluated for proposed routing and wavelength assignment algorithm as ratio of number of requests blocked to the total number of offered traffic to the designed NSFnet network as,

$$P_N^b = \frac{A_N^C - S_N^C}{A_N^C}$$

where, A_N^C is offered traffic to the network and S_N^C is total carried traffic by the network.

IV. PERFORMANCE ANALYSIS

To examine the outcomes of RWA algorithms in respect of BP, considers First-Fit (FF) WA approach as its offers lesser blocking probability and lower evaluation complexity among all existing schemes [1].

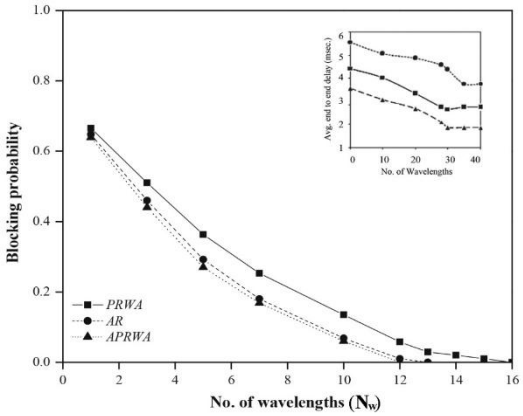

Fig. 2. Blocking probability vs N_W on various RWA algorithms in NSFNET topology.

Table.1. Blocking probability vs N_W on various RWA algorithms at various traffic load.

Wavelengths	Load	PRWA	AR	APRWA
W=4	24E	0.004346	0.003919	0.003821
W=6	36E	0.003132	0.002543	0.002165
W=8	48E	0.002165	0.001518	0.001322
W=10	60E	0.001342	0.001032	0.000584
W=12	72E	0.000548	0.000284	0.000002

Fig. 2 demonstrates blocking probability vs number of wavelengths for various RWA algorithms like APRWA, PRWA, AR (Adaptive Routing) [7-8]. The result reveals that the BP reduces when there is increase in available wavelengths because of more lightpaths have been setup, but in all available algorithms rate of reduction in BP in case of APRWA is more than other existing routing algorithms and its due to the fact that in this routing algorithm all the best possible paths are considered between s-d pair based upon the link-state information. Furthermore, simulation result reveals that BP for proposed APRWA is (approx. 25%) less than the other discussed routing algorithms [5]. On the other hand, it can also be observed on APRWA lesser average setup time near around (15 msec.) requires as compared to AR and other existing algorithms (which is shown in the inner graph of above figure).

In Fig. 3, simulates the average BP of the discussed adaptable and priority based RWA and compared with the priority, non-priority based RWA respectively w.r.t to network load. According to the performance results shown in the figure, it concludes that the discussed adaptable priority-based RWA algorithm can efficiently minimizes the BP and hence improves the performance of the simulated network in comparison with the other mostly used algorithms like PRWA and NPRWA even at higher network loads.

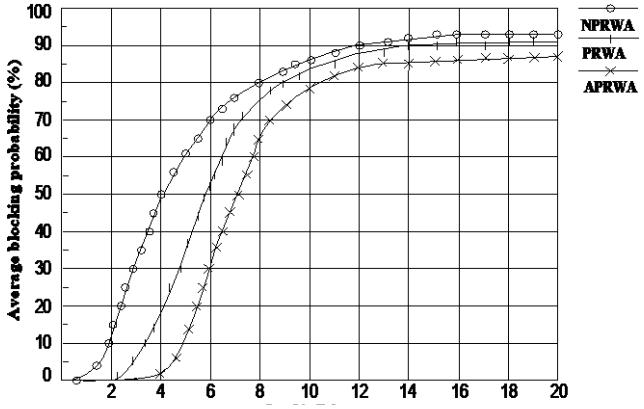

Fig. 3. Blocking probability vs traffic load for different algorithms

V. CONCLUSION

This paper introduced an adaptable priority-based RWA (APRWA) algorithm which lowers the blocking probability and improves the performance of the designed system. The proposed strategy support the priority-based connection requests where establishment of lightpath request is evaluated depending upon the fact whether the requested path in between source-destination pair is the single hop link or multi-hop path and secondly the capacity of the requested traffic. Once the priority is assigned, the discussed scheme serves the optical path requests accordingly. The simulation result shows that BP using the proposed approach is less than that of using the priority and non-priority based RWA approach. Adaptable priority-based RWA (APRWA) using First-Fit approach provides the better results in respect of BP and also its average setup time requires for APRWA is much lower in comparison with the existing schemes. The proposed scheme enhances the overall system productivity in respect of blocking probability as well as for the average end to end delay of the requested route.

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