Traffic Congestion and Blocking Probability Improvement Using Weighted Dynamic RWA

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ABSTRACT:
Given the needs of today's world,quick, high-volume, and high quality communication of information is performed in a variety of ways.Studies conducted by the researchers in the field of routing and wavelength allocation algorithms in previous years show that these algorithms have greatly improved the performance of communication and information transmission.However, these topics have been largely investigated, but in particular, in the optical networks WDM, is one of the goals of the routing problem investigation, wavelength allocation, and maximizing useful communication. In other words, becausethe optical route in the WDM optical network is the connection between the receiver node and the transmitter node, the best route for the network should be considered.As we mentioned, these issues have largely been investigatedover the past years, but still the issue of RWAis presented and examined as a major and challenging issue.In this article, we offer a new way for weighting-based routing for all the optical channels.This selective weighting method dramatically reduces the possibility of blocking communications.Another issue we have addressed in this article is conditions where traffic is dynamic.According to the results obtained, it is shown that performance has been improved compared to the previous modes.

KEYWORDS: Routing Algorithm, Wavelength Allocation,Optical Route, Communication Blocking, All-optical network

1. INTRODUCTION

To respond to the needs of the community, which is the establishment and sending of information, there are many choices.One of the best answers to request for sending and receiving information fast is optical fiber. Optical fiber has been taken into consideration because of its high power output.

Introduction of WDM

It is one of the optical networks thathave a signal split mechanism at different wavelengths.Due to the simultaneous transmission of fiber in the form of multi wavelengths, WDM optical networks provide high-speed data transfer.According to the description, it can be said that in WDM optical networks, all cases of sending and receiving information is done optically and no optical conversion to electric and the opposite is not done.As we mentioned, in all-optical networks, sending and receiving data is done optically, that is, the routing between the receiver and transmitter nodesis through the middle passageway, which is absolutely optical.The routing mission represents that optical connection between the two nodes (transmitter and receiver)is started and ended without any intermediate electrical appliances.

Normally, to create an optical route in the WDM optical network, a wavelength is allocatedfor all links (routes).RWA is the search and allocationof wavelengths and routes with the least network resources and its purpose is to connect more connections, taking into account the best route.During different times, several requests are sentto the networkdemanding for optical routes.One of the main goals of WDM's all-optical networks is minimizing the possibility of blocking communication. Therefore, essential challenges in WDM optical network routing techniques are optical route request and resource allocation.

2. BASIC CONCEPTS

2.1. Routing

In the description above, we mentioned that optical route is the connection established between the receiver node and the sender's node but for communication establishment it is necessary that network allocate a route for the request for route allocation.In this context, routing algorithms-based algorithms are available and according to the networkconditions and target set beforehand, the best route is chosen between existing routes between the origin and destination.In WDM optical networks, when the request for communication reaches the source node, the task of the RWA protocol is establishing or allocating an appropriate optical route[1].

2.2. Wavelength allocation

After allocating the route in the network, the proper wavelength should be allocated.Wavelength allocation is done in a variety of ways, which will be explained in the following sections[2].

3. ROUTE SELECTION METHODS

Based on the rules of existing algorithms, there are several ways to select a route which can be expressed as follows.It is possible that directions that are allocated be always fixed, which this type of algorithm is called fixed routing algorithm, or a fixed route is used with multiple alternative routes, or it is determined at the time of receiving the request for allocation of the route depending on the network status.In routing algorithms, fixed routing is the first route sample and the easiest way to choose a route,and to connect and set up that specified route for the origin and destination pairs, provided thatthere is a free wavelength of that route[1].

Fixed-alternative routing has several conditions, whichshould be considered. While it is like fixed routing, but there are several other routes.In the fixed-alternative routing,as explained, an appropriate route is chosen for the request for communication, due to network status.Frist we check the first free route and if it is not possible to communicate, we choose the alternative route which leads to reduced risk of blockage[1][3].Routes are preset and do not know about network information.Therefore, routing is donebased on the empty wavelengths in the route.

In comparative routing, the route is determined dynamically between the nodes of the specified origin and destination and it depends on the network status.Various algorithms such as minimum load routing, minimum traffic routing, and weighted minimum load routing can be named.Among the existing routing algorithms, In minimum load routing, the lowest load rout between nodes of origin and destination is allocated to the request call. An example of comparative routing, is the least costly routing.In this type of routing, every route we use has a value of 1 and any unused route is worth ∞. This method is very efficient for networks that have wavelength transducers[3][4].

4. WAVELENGTH ALLOCATION METHODS

On issues where traffic is consideed dynamically and generally instead of reducing the number of wavelengths used or employed, it is assumed that the wavelengths have a fixed number and the goal is to reduce the number of calls, whichare blocked[4].However, to specify wavelength plays an important role in determining the performance of each algorithm.Here are some ways to allocate wavelengths[5]:

4.1. Randomly Assigned Wavelength (R)

This method initially searches for wavelengths to find a ready wavelength sets.Then it randomly selects one among these wavelengths[5].

4.2. First-Fit Wavelength (FF)

In this method, all wavelengths have special numbers. When searching for ready wavelengths, wavelength with lower numberis selected before the wavelength with higher number and this way the first wavelength is selected.Compared to the random method, the cost of this method is lower, because there is no need to search for all the wavelengths of each route.This method has less complexity and does not create overhead[5][6].

4.3. Least-used Wavelength (LU)

This method selects a wavelength method that is less used in the network to establish the balance of the load between wavelengths.The function of this method is better than random method and creates overhead.In practice, it is not used much[6][7].

5. REVIEWING THE HYPOTHESES OF THE PROBLEM ACCORDING TO PAST RESEARCH

We used Eon's topology to simulate the proposed work in MATLAB.This topology has 19 nodes with $L = 35$ that is the number of two-way links in all connections.The network contains N nodes and j fiber link and each link has a wavelength, which is represented by w.In addition,they are shown with 1 to w.A route $R$is a subset of the links $\{j, ..., 2.1\}$.The length of each route $R$is represented by $L(R)$.We show number of free wavelengths on j link with mj[8].

5.1. Requesting New Connection

To request a new connection, a route with a maximum value of the following function is used[8]:

$$W = \frac{\lambda}{h} \tag{1}$$

1.λ is the number of free wavelengths of the route.
2.$h$is The number of hops in the route
If more than two routes have the same values, In this case, the least degree of the node, which ignores the node with accumulation, is selected[9].

5.2. Traffic Production

The process of requesting calls is a Poisson process with the mean of λ with uniform distribution B and nominal waiting time with an average length of $\frac{1}{\mu}$.Therefore, it is probably calculated through the Erlang process (birth and death). We assume$W$is the maximum wavelength for each fiber and C is also active wavelength.Traffic behavior is dependent on the Erlang function.Erlang's behavior is as following function[10][11][12]:

$$P_C(c) = \left(\frac{\lambda}{\mu}\right)^C \frac{p(0)}{c!}$$
$$C = 0,1,\ldots c \tag{2}$$
$$\sum_{C=0}^{w} P_C(c) = 1$$

1) For C, C = 0, 1, 2
2) $P_c(C)$ is the normalizing density function under C.
P(0) is obtained as follows:

$$P(0) = \left[\sum_{c=0}^{C} \frac{1}{c!}\left(\frac{\lambda}{\mu}\right)^C\right]^{-1} \tag{3}$$

5.3. Weight Function

The weight function is calculated as the following equation.

$$\text{argmax}_k = \quad 1 \text{ to} 18$$
$$\left[\frac{\left(W_a^k\right)(T_e)\left(\sum_{i=1}^{P_L} C_s(i)\right)}{\left[\left(\sum_{i=1}^{P_L} C_s(i)\right)+\left(\sum_{i=1}^{P_L} C_b(i)\right)\right]\left(\sum_{i=1}^{P_L} h_t(i)\right)}\right] \tag{4}$$

The route with the highest weight is considered.If the free wavelength is not available, $W_a^k = 0$, communication request is blocked.

5.4. Calculating the Connection Blockage

The calculation of the probability of blocking is as follows:

1- A_N^C Traffic intended for the network

2- S_N^C Total traffic carried on the network

$$P_N^b = \frac{A_N^C - S_N^C}{A_N^C} \tag{5}$$

6. PROPOSED PLAN

In this article, we propose a suitable spatial algorithm and we choose the first appropriate wavelength method among different wavelength allocation methods. In addition, within the network we assume that a fiber is between each pair of nodes of origin and destination.As explained in the previous sections, in wavelength allocation by the first appropriate wavelength method, all wavelengths availableare listedin ascending order. When we want to choose one of the wavelengthsamong the sets of wavelength, we choose the wavelength with the smallest index and in this method, there is no need to have the entire network information and has little complexity.The technique described in this article is WLCR that we propose to improve communication-blocking performance.In this method, load trafficand also the length of the route are taken into consideration.We calculate and apply weight for each pair of nodes of origin and destination.In the proposed WLCR algorithm, routes with highest free wavelength and the lowest leap (hop) are selected.
Among the routing algorithms and wavelength allocationas mentioned in chapter two, we useLCR methodas the closest known algorithm to proposed WLCR algorithm for comparison and we will measure the performance of these two algorithms with the various parameters.The results of these comparisonswill be used as a benchmark for assessing the quality of the proposed algorithm or understanding its bugs and trying to improve or fixing the defects of this algorithm in the following algorithms.

7. SELECTED TOPOLOGY AND SIMULATION SOFTWARE

There are various software for simulating the optical network topology, among whichthe Java-based NET2PLAN software and MATLAB-based WDMsoftware, named MATPLAN, can be mentioned.Considering the use of simulated topology in evaluating the proposed algorithm in MATLAB program,the WDM MATLAB software is used to design topology configuration.In the proposal, we review the topology performance of the European Optical Network (EON).This topology consists of 19 main nodes, which collects information centrally, and in this network, data exchange occurs.

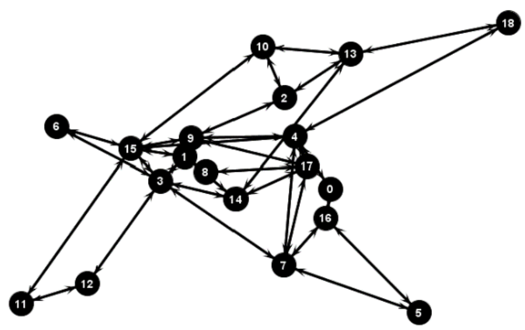

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Fig.1.EON Optical Network Topology simulated in MATLAB WDM.

8. RESULTS AND COMPARISON

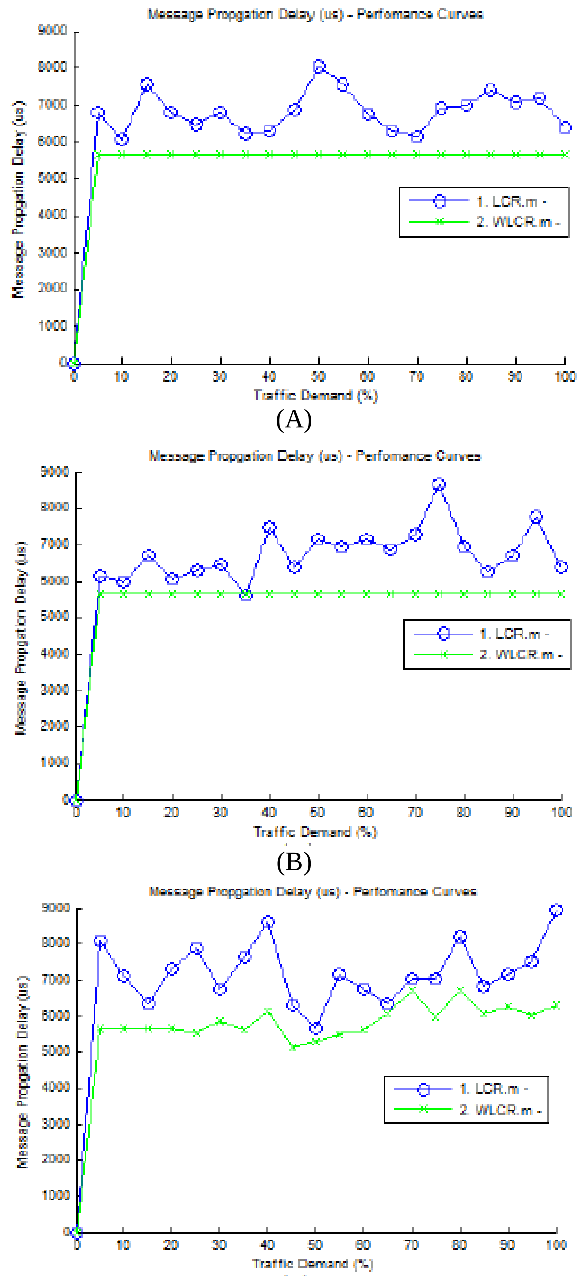
There are 35 double links or 70 fiberin this topology, allowing double-sided optical transmission.In the simulation of the proposed algorithm, 32 wavelength per link is considered.The route is selected with the highest weight.If there is no common free wavelengthin none of the *k*routes, the route is blocked and it can not be used and the traffic will not be sent.

Table 1. Main parameters for the proposed algorithm and LCR in EON Optical Network Traffic Types

	Light traffic		Semi-heavy traffic		Heavy traffic	
	LCR	WLCR	LCR	WLCR	LCR	WLCR
Number of hops	1.97	1.95	1.97	1.95	2.03	2.01
Occupied wavelength of the link	1.06	0.76	1.12	0.88	2.27	1.84
Routed traffic of the link	1.92	2.47	9.75	13.01	54.09	67.66

9. SIMULATION RESULTS OF PROPOSED ALGORITHM ON REQUESTED TRAFFIC

The requested traffic is considered as the largest simulation parameter in the optical network, which by changes in its value, the size of the request to send in the optical network and as a result of accumulation (congestion) is determined.The more traffic is requested from optical network users, the amount of link accumulation increases. Given the occupation of some of the links,alternative routes with longer lengths and consequently a further delayshould be usedto send message.In simulation, the effort was on that the effects of changing this parameter on the performance of the proposed algorithm and the LCR algorithm are shown, and performance improvementis fixed in the proposed algorithm.

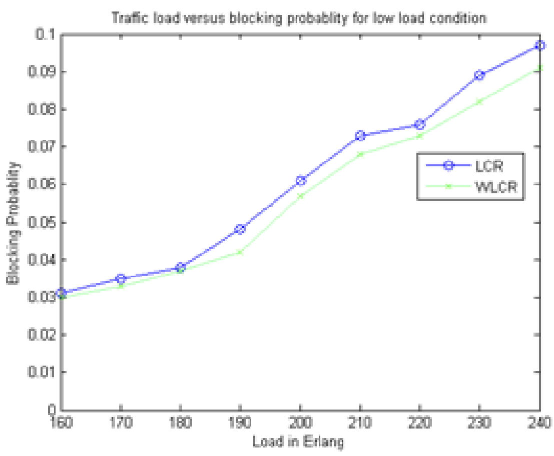


(A) (B) (C)

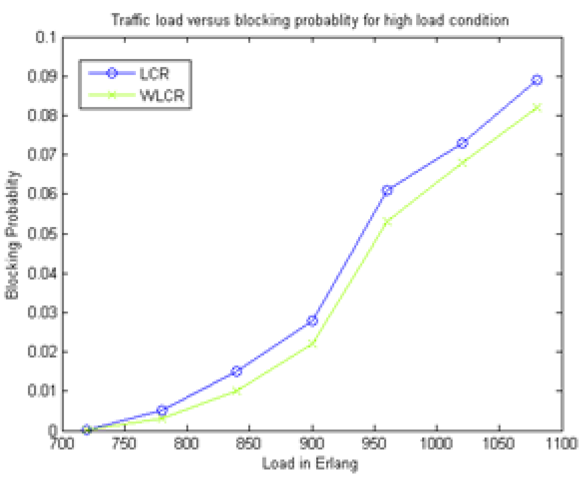
Fig.2. The yield curve of the message propagation delay based on requested traffic:(A) Optical traffic (B) Semi-heavy traffic (C) Heavy traffic.

10. LIKELIHOOD OF BLOCKING THE PROPOSED ALGORITHM

The possibility of blocking in optical networks with dynamic trafficare usually measuredbased on the Erlang function.The Erlang function represents in principlea process of birth and death or start and end of an event such as using the channel.The larger the process of the Erlang process, the moredata will be imposed on the optical network.In any optical network, it is tried to reduce blocked mode in sending data, therefore, one of the methods of measuring the performance of an algorithm, compared to other algorithms, is using the parameter of the possibility of blocking.The probability of blocking is equal to the number of blocked data per number of sent data.



(A)



(B)

Fig.3. (A),(B) The yield curve of the possibility of blocking.

11. CONCUSION

It seems that considering the network load, especially with increasing network size, has clearer effect on improving network performance. In EON topology, in most cases, evaluation of the existence of network load in the weight factor or during an update leads to improvement.This improvement sometimes occurs with increasing network load.Simulation results based on effective parameters such as the requested traffic, the possibility of blocking the connection is well illustrate dramatically improved performance of the WLCR algorithm relative to the LCR algorithm in a variety of traffic.The algorithm results support this hypothesis that given the effective parameters, assigning weighs on each link improves the performance of the LCR algorithm.

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