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Wavelength Assignment in Optical WDM Optical Network

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ABSTRACT

This paper analyses the wavelength assignment problem in case of WDM optical networks. The random wavelength assignment algorithm is compared with the first – fit wavelength assignment algorithm .These two assignment strategies are also compared with wavelength conversion case. These comparisons are made on the basis of blocking probability, keeping the number of channels and number of links constant and the response is calculated by varying load per link (in erlangs). Blocking probability on a link is calculated by using famous Erlang B formula. It is seen that blocking probability in case of random wavelength assignment is always greater than first –fit wavelength assignment algorithm. The blocking probability in case of WDM networks employing wavelength converters is minimum but it increases the overall cost of the optical network.

1. INTRODUCTION

Wavelength assignment problem is one of the important problems in optical networks as on the first stage route of the optical network is to be decided and after selecting the route , the wavelength must be assigned to the route. Wavelength division multiplexing (WDM) technology in optical fiber networks has been gaining a great acceptance as a means to full fill the ever increasing bandwidth demands of network users. WDM technology has been improving with a steady pace since few years. WDM systems are currently being employed in long distance telecommunication networks on a point to point basis , with optical signals converted back to their electronic format at each node.

The great challenge faced in designing wavelength routed networks is to devise efficient algorithms for establishing light paths in the optical network. These algorithms must have capability to select routes and assign wavelengths to selected routes in such a way that uses network resources efficiently and which increases the number of established paths.

1.1 ROUTING AND WAVELENGTH ASSIGNMENT

RWA is the unique feature of WDM networks in which light path is implemented by selecting the path of a physical link between source and destination dgenodes and reserving a particular wave length on each of these links for the light path. Thus for establishment of an optical connection, one must deal with these lection of the path (Routing problem) as well as allocating the available wave lengths forth econnections (Wave length Assignment problem). This resulting problem is known as routing and wave length assignment problem [1].Wecan divide this problem in two problems namely ;routing problem and wavelength assignment problem and then we can propose different solutions to this problem.

- Findar out efrom the source the destination.
- Assign a wavelength to the selected route.

Anend-to-end light path has to be established prior to the communication between any two nodes. To establish a light path, it is required that the same wave length be allocated on all the links along the path. This limitationis known as the wave length continuity constraint [2]

1.2WAVELENGTH ROUTED CONSTRAINTS

There are two constraints that have to be kept in mind by the approaches when trying to solver wa. The first distinct wave length assignment constrain tholds for solving wavelength assignment problem in any wave length routing network. These cond wave length continuity constrain tapplies only to the simple case of wave length routing networks that have no wave length conversion capability inside their nodes[3].so brief introit the miss following: A) distinct wave length assignment constraint :all light paths sharing common fiber must be assigned distinct wave lengths to avoid interference. This applies ot only with in the all-optical network but in access links as well.

B) wave length continuity constraint: the wave length assigned to each lightpath remains the same on all the links it traverses froms ourceend-node to destination end- node[4].

1.3 WAVELENGTH ASSIGNMENT ALGORITHM

Wave length assignment is a unique feature in wave length routed networks that disting uis hes them from conventional networks. Based on the order in which the wavelengths researched, wavelength assignment methods are classifiedin to most-used, first-fit ,rando mand
Wavelength conversion algorithm. Sobriefint roof wavelength assignment algorithms are following:-

- Random wavelength assignment [8]: In this algorithm as et of wavelengths that can be used to establish the connection is determined. After that wavelength is randomly select with uniform probability distribution from the set.
- Most- used wave length assignment [8]: The most-used algorithm selects the wave length most often used in the network. The objective of this policy is to keep more wavelengths available for calls traveling over long paths. This algorithm requires communication over head and storage requirements.
- Wavelength conversion wavelength assignment [5] :Any incoming light-path can be assigned to any wavelength on the out put side.This eliminates wavelength-continuity constraints.
- First-Fit wave length assignment [7]:This algorithm numbers all wavelengths, so that when there is ademand for wavelengths available, those of a small ernumberare

Considered first. The first available wavelength is then selected. This algorithm does not require global information system. Its computational cost is lower because no storage is needed to keep the network states. It works well interms of blocking probability and fairness so fallocation. This algorithm is preferred for it ssmall over head and low computational complexity. The objective of this allocation scheme is to minimize wavelength fragmentation [6].

2. METHODOLOGY

Our research focused on the prevention of congestion in Wavelength division multiplexing optical networks by developing an adaptive dynamic natured algorithm which is tested in Network simulator version 2 (NS2). The basic implementation started with creation of optical network with ten nodes and high speed links for connectivity and communication. Research has been divided into three phases. In the first phase i.e. Random algorithm, the blocking probability was much higher. Then we switched to the second phase i.e. First fit algorithm which has lesser blocking probability than the previous one. Finally there is development of dynamic conversion algorithm which has the best results out of all three. Comparison has been done with variation of load per links for various nodes in the network.

In this research, we have developed and implemented a dynamic routing algorithm for wavelength division multiplexing which use to fetch information in early state of communication and sort the wavelengths according to the channels available with same frequencies on the further nodes in optical network. Dynamic algorithm finds the available paths with clearance from further nodes with information of load and availability of the same frequency as on base node.

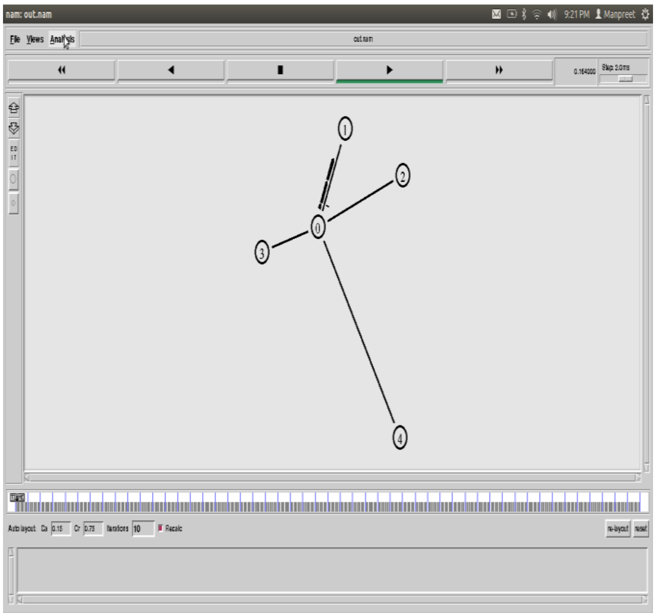


Figure 1.1: Simulation scenario for dynamic routing

The simulation study has been done for dynamic algorithm along with first fit and random routing scheme in network simulator version 2. In simulation setup we have considered optical communication with ten optical nodes for representing routing process. The base simulation scenario for dynamic routing is shown above in figure 1.1.

The simulation scenario for dynamic routing contains 5 subnets and traffic start after finding load and frequency value on all nodes. For different nodes, we have considered blocking probability with variation of load on nodes.

The blocking probability is good parameters for deciding the efficiency of the optical routing process. If the intermediate node doesn't have same frequency as carried by wavelength at starting then packets will be dropped and converters are required for conversion of the frequency to suitable value. Below figure 1.2 shows the blocking and packet drop in simulation.

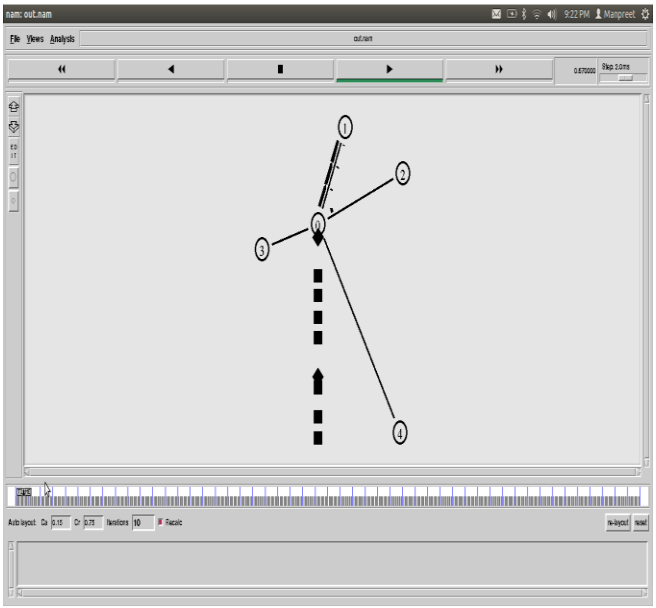


Figure 1.2 Simulation scenario for blocking and packet drop

2.1ALGORITHM FOR DYNAMIC CONVERSION

The proposed algorithm is to reduce the cost factor and to improve the performance of the optical fiber network. Here the steps from 1 to 3 are for source node, step 4 is for intermediate node , step 5 for destination node and steps 6,7 are for control operation. The algorithm is given below:-

1. Find the routes from source node having one or more free wavelengths and list them
2. Choose first two routes R_1 and R_2 from the list through shortest route algorithm and put $R_P \leftarrow R_1$ and $R_s \leftarrow R_2$.
3. Send the request R_Q on R_1 and R_2 with the information about destination node, route, wavelength status for outgoing route, route cost, load per link and route time
4. If the next node is not the destination node then

   i. Get the request R_Q and find out the information on signal

   ii. List the free wavelengths on route to next node

   iii. If no free wavelength is there, then R_Q fails otherwise compare the wavelength of R_Q with the available wavelengths. If wavelength matches then X_R is not required and select that wavelength otherwise X_R will be required

   iv. Add on R_Q the information about the requirement of X_R, Load and wavelength status of outgoing route.

   v. Forward R_Q to next node

otherwise go to 6

5. Go to 4
6. do

   i. Find out the information with R_Q for R.

   ii. Calculate N_R, $L_{R,}$ $L^R{}_A$, V_R, X_R, T_R

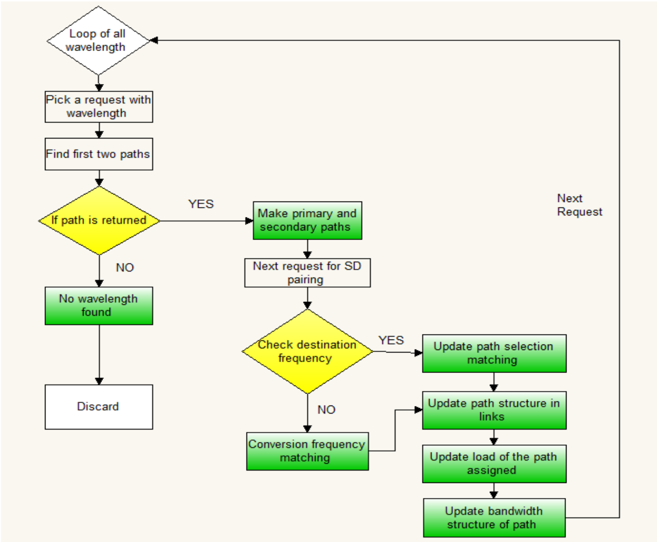
7. Calculate Integrated route cost ($C_I(R)$) of route R through

$$C_I(R) = \varepsilon(N_R) + \lambda(L_R) + \zeta(L^R{}_A) + \eta(V_R) + \kappa(X_R)$$

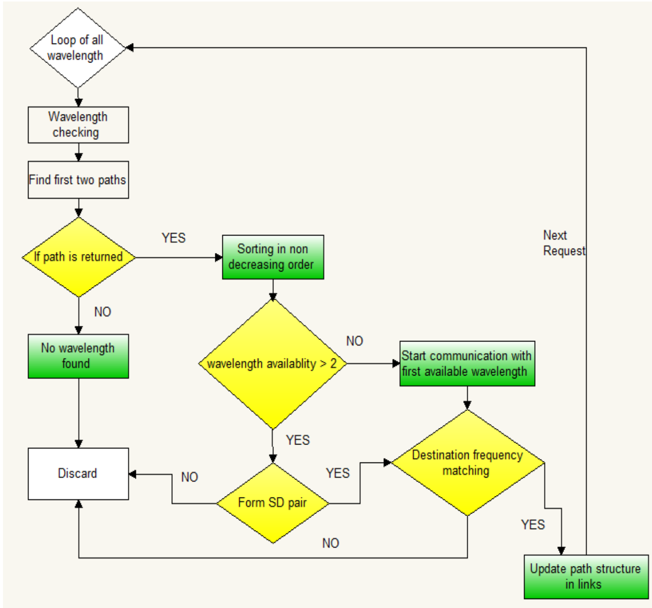
where ε, ζ, η, κ are the parameters having value from 0 to 1 and λ is the parameter having value to be considered as the ratio between the rate of wavelength converters and optical fibers.

8. Compare $C_I(R)$ of both routes and fix the primary and backup route by using compare algorithm.

Choose next two routes from the list and go to (3) till the list ends



(a) Algorithm of proposed dynamic wavelength assignment



(b)First fit algorithm

2.2 ALGORITHM FOR FIRST FIT STRATEGY

- ✓ Initially number of wavelength is calculated which is given by W = {n/k} in given communication.
- ✓ If the wavelengths are available at source is more than two.

Begin the process with sorting SD pairs of the wavelength

Non Decreasing Order selection If Two or more sequence of wavelength available Then put highest value of wavelength as initial stage of communication else start communication with first available wavelength

- ✓ Path is searched for the first wavelength selected.
- ✓ Connect the pairs for communication. If Combination is not formed

Then discard the wavelength combination end

2.3 ALGORITHM FOR RANDOM ASSIGNMENT

- ✓ Store the number of wavelengths calculated and available. Check each possible wavelength available with cost of wavelength.
- ✓ If the wavelengths are available at source is more than two.

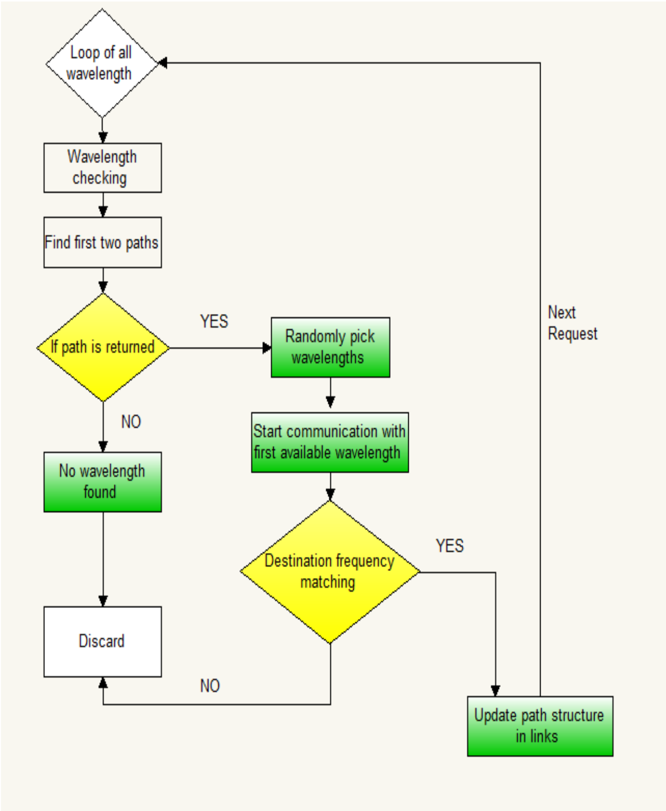
Begin the process with sorting SD pairs of the wavelength

Random Order selection
if
Two or more sequence of same frequency wavelength available
then
put randomly the value of wavelength as initial stage of communication
else
start communication with first available wavelength

- ✓ Start matching communication frequency.

If Frequency of wavelength found Then Connect it with wavelength value Else Discard wavelength at particular source

✓ Output is *W* which is the number of wavelengths.



3.

(c)Random assignment algorithm

3. RESULTS AND DISCUSSION

The following graphes clearly shows comparison of first fit , random and conversion wavelength assignment strategies. These show blocking probability variation for loads 10, 20 and 30 erlangs respectively. Moreover, it is also evident from these plots that blocking probability is maximum in case of Random wavelength assignment algorithm and is minimum in wavelength conversion strategy.

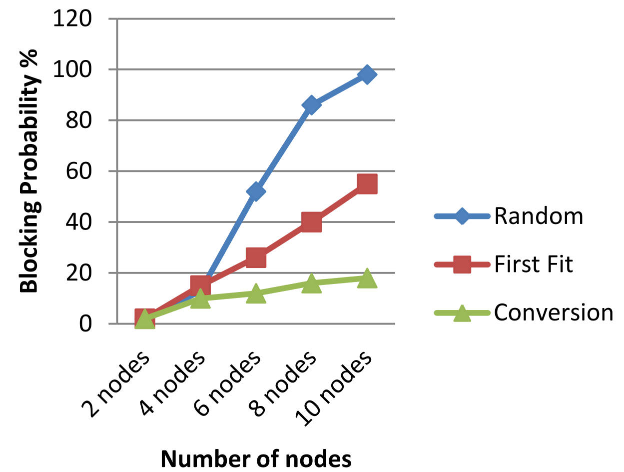


Figure 1

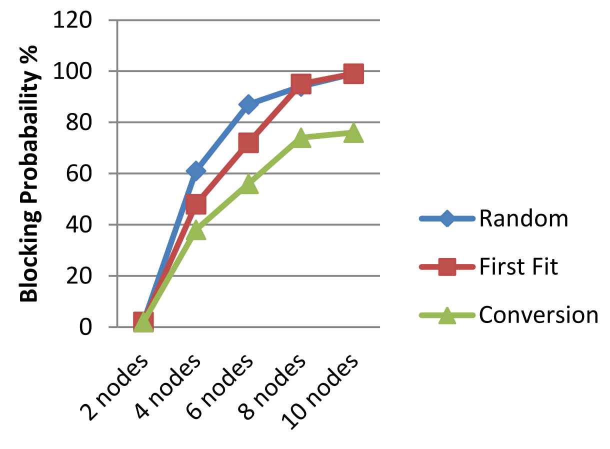


Fig 2

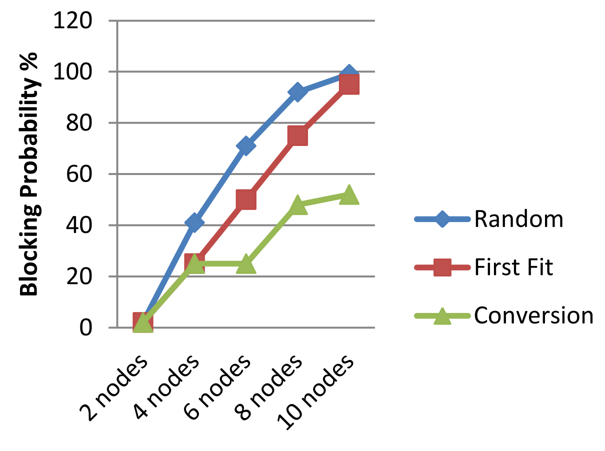


Fig 3

4.CONCLUSION

Optical wavelength routed network offer huge capacity with highs calability which makes them a very attractive choice for then ext generation optical networks. The wavelength division multiplexing technique is considered to be one of the best possible techniques in optical network to enhance the capacity of optical fiber. Wave length assignment problems are the major problems of WDM networks. Wavelength assignmentisa unique feature in wavelength routed networks that distinguishes them from conventional networks. So we analyze the performance of First-fit, Random, Most-used and Wavelength conversion Algorithms for wavelength assignment in WDM unidirectional opticalring network. We compare the blocking probability of various algorithms with the variationinnum berof events.

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