ANALYSIS OF R&WA IN WAVELENGTH DIVISION MULTIPLEXING NETWORK USING GENETIC ALGORITHM

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ABSTRACT: *Recently there are many deployments in the field of optical networks. Current demand of data transfer in the internet is possible only with the help of optical network. Optical network makes us to switch from end-to-end wavelength transmission system to all optical backbone networks which use all the available bandwidths. The unlimited bandwidths in optical network are the only solution for the future demand of data transfer. Wavelength routing is the major concept in the design of WDM network. Optical cross connects are connected by fiber links and form a mesh type topology in this routing network. The optical communication medium "light path" is used to communicate in optical networking. This light paths are created in the network of cross connects. So the network connection will be established between two the end nodes by selecting the appropriate paths and assigning the existing wavelength. In this paper we analyze genetic algorithm for Routing and Wavelength Assignment Problem.*

Keywords :*Routing, Cross connect, Optical networking, wavelength, light path*

1. INTRODUCTION

Wavelength Division Multiplexing is the technique in optical network to make use of multiple wavelengths to send the data in the same medium. Optical network makes us to switch from end-to-end wavelength transmission system to all optical backbone networks which use all the available bandwidths. There are several set of cross connects are connected in the form of mesh topology in the optical network. The cross connects gets a signal on a wavelength from one fiber link and can transfer it to another fiber link on the same wavelength. The cross connects may also transfer the signal received on a wavelength of one fiber link into another fiber links of different wavelength with wavelength converter. These types of transferring signal in an optical network can be done by light paths. Light paths is the medium of communications created with several fiber links in cross connect network. Light path consists of same wavelength in all end points if no wavelength converts are used. Light path may contain different wavelengths on each end points if wavelength converts are used. Hence, a lightpath is an optical network connection established between two sub-networks connected to the optical backbone. The techniques for wavelength assignment are discussed first and then we are going to analysis the routing problem using genetic algorithm.

2. WAVELENGTH ROUTING NETWORK

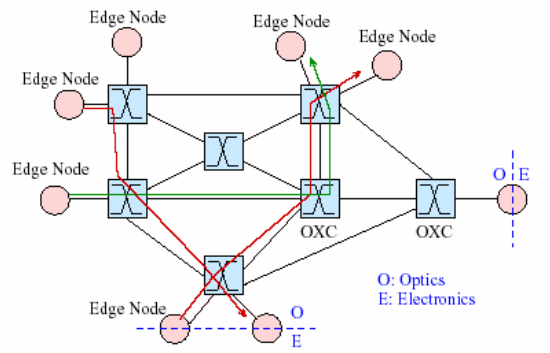

Fig. 1. Optical Network Architecture

Wavelength routing is the major concept of WDM network to build. Figure-1 shows the wavelength routing network. Edge nodes are connected by the optical cross connects. Cross connects are also interconnected with fiber links. In the figure, 'O' represents Optic mode of communications and 'E' represents Electronic mode of communications. So the edge nodes are placed between the optic and electronic modes of communications. The optical cross connects are represented as 'oxc' in the figure. These cross connects are connected with a group of fiber links and creates a network model. The light paths are the logical connection established between the WDM network with its client sub networks. These optical paths traverse through various fiber links in the optical network. The oxc's in the figure takes the responsibility for the transferring and routing functions in the network connection. The cross connects gets a signal on a wavelength from one fiber link and can transfer it to another fiber link independent of the other wavelengths.Assume an optical cross connects contains 'k' input slots or ports and 'k' output slots. Consider that 'm' wavelengths are handled by one port. Then the cross connect can be specified as 'm' independent 'k' by 'k' switches. The cross connects are implemented as mentioned below.

Wavelength demultiplexer→ Optical switches → wavelength multiplexer

In this way, demultiplexer produces various wavelengths as input to the cross connects and these wavelengths are cross connected by the switches and then transfer to the multiplexer. If oxc's are configured, then the llogical connections are created between any pair of sub-networks. Each 'oxc'consists of a control unit attached to one of its ports. The control and management functions of light-paths to tearing down and setting up, are taken care by the control unit.

3. ROUTING& WAVELENGTH ASSIGNMENT

The two problems of routing and wavelength assignment are closely interconnected. It is not possible to establish a connection if we consider these problem separately. So these two problems together place a major role in WDM Network. The two steps are used to implement light paths.

(i) Selecting a path of fiber links from one end node to another

(ii) Allocate a particular wavelength of each links

Thus an optical connection will be created with the above two processes. These two steps of process together named as the routing and wavelength assignment problem. The routing and wavelength assignment strategies are subject to the following constraints

1. Wavelength continuity constraint: a light path must use the same wavelength on all the links along its path from source to destination edge node.
2. Distinct wavelength constraint: all light paths using the same link (fiber) must be allocated distinct wavelengths

4. GENETIC ALGORITHM FOR ROUTING

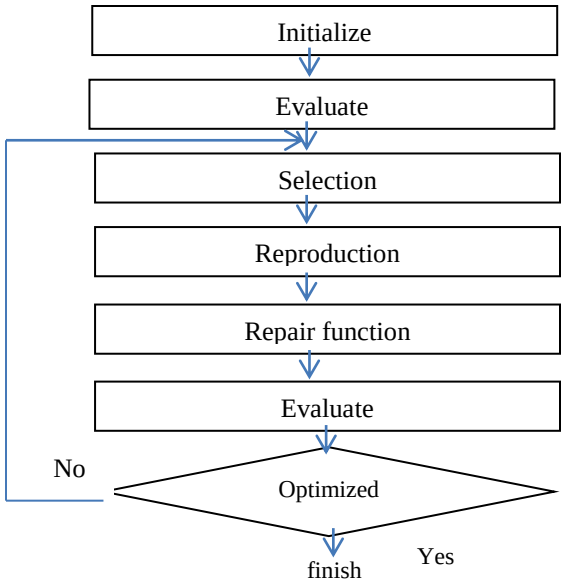

Fig. 2. Flow chart for genetic algorithm for routing

For routing we consider the lengths of the chromosomes are dynamic. Nodes are considered as Chromosome elements. Randomly initialize the population and evaluate to determine the fitness of the populations. Now we select the parents from the population and crossover to reproduction of population. Mutations introduce new partial population and now evaluate the new partial

population with fitness function. Repeat the steps from selection until we reach the complete routes.

5. ALGORITHMS FOR WAVELENGTH ASSIGNMENT

Following are the algorithms used for wavelength assignment in WDM network.

Random WL Assignment

Random WL assignment algorithm looks the set of all wavelengths available for the given route and it choose any one wavelength randomly.

First Fit Assignment

In this method, wavelengths are identified by some sequential value. Small value represents high priority. Wavelength with small number will be selected for assignment.

Least-Used

In this technique, the least used wavelength is selected. So this technique balances the load among all the wavelengths.

Most Used

Most used wavelength is selected in this technique and thus the wavelength usage will be minimum compared to other methods.

Min Product

Min product algorithm is used in multifiber networks. Min Product becomes First Fit in a single-fiber network. The purpose of Min Product is to group wavelengths into fibers and thereby the number of fibers in the network is minimized.

Least Loaded

The Least Loadedalgorithm is used for multifiber networks. Least Loaded outperforms Most Used and First Fit assignment algorithms.

MAX-SUM

If the entire traffic matrix is known in advance, then MAX-SUM technique can be used. For each request, among all possible paths, it chooses the one which maximizes the remaining path capacities after the current connection is established. The major problem of this algorithm is that it ends up blocking connections, which do not have alternate wavelengths available. This technique is expensive but outperforms MU under heavy load.

Wavelength Reservation (Rsv)

A particular wavelength is reserved for a route in "Wavelength Reservation" technique.Multihop traffic can be reduced in this method..

6. ANALYSIS AND FINDINGS

A random of twenty node network for routing has been chosen. Our objective is to find the shortest route with minimum cost.As we discussed earlier, the Genetic algorithm is used for this test. Length of chromosomes and their genes are dynamic. With mutation, partial routes are identified.Fitness function is used to evaluate the route. The initial population and the partial populations are evaluated by the fitness function.

Let 'n' be the number of nodes in the network and 'p' be the initial size of the population. We are getting the sub optimal solution when the value of 'p' is small. If we increase the population gradually then chance of getting desired solution gets increased. Desired quality of solution is almost guaranteed if 'p' is equal to 'n/2'.

Sub-optimal result comes out if the number of generations kept low. But good solution is received when the generations are increased slightly. Algorithm gives an optimal-solution after a particular generation and the same repeated in all other upcoming generations. In the beginning, this algorithm produces more new routes, but it produces very less number of new routes in later generations and perishes after a particular moment. It is advised to select the population randomly in order to get a better solution.

Figure 3 shows the network for routing. This network with thirty random nodes, is considered for wavelength assignment. It is assumed that the arrivals of requests are random. Sufficient wavelengths are assumed to be available and our objective is to calculate the number of wavelengths needed for routing. We have to use more number of wavelengths if wavelength converters are not used.

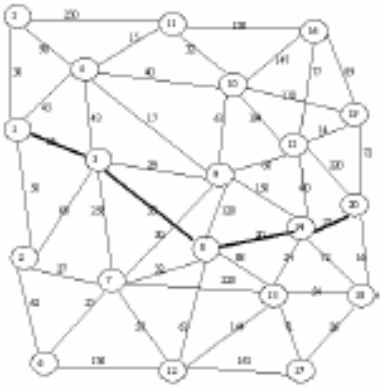

Fig. 3. Network for routing

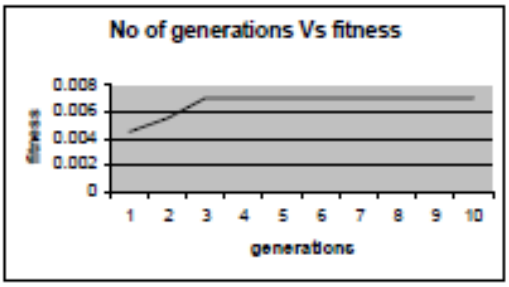

Fig. 4. Number of generations with Fitness

Fig. 5. Population size with Fitness

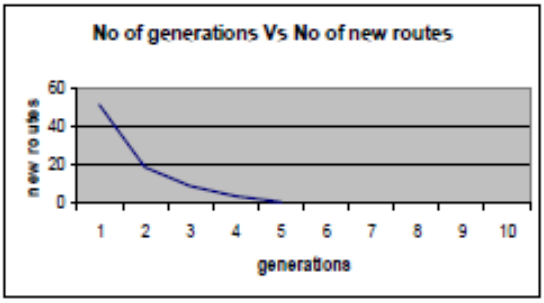

Fig. 6 Number of generations with number of new routes

No of wavelengths	Wavelength used
19	Λ1
10	Λ2
6	Λ3
6	Λ4
5	Λ5
3	Λ6
1	Λ7

Table 1. Wavelength assignment

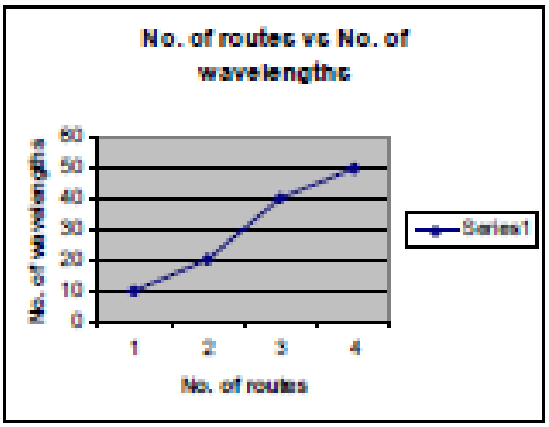

Fig. 7. No. of routes with No. of wavelengths

7. CONCLUSION

In this work routing in WDM networks is done using genetic algorithm, which is a parallel algorithm unlike others. The algorithm searches the solution space in a very effective way. This algorithm converges faster than the normally used Dijkstra's algorithm. This property is very useful in high bit rate communications like optical WDM networks. "First fit" technique is used for wavelength assignment. Major findings can be listed as follows:

- Routing using genetic algorithm finds the solution faster than traditional algorithm.
- Let 'n' be the number of nodes in the network. Thedesired quality of solution is almost guaranteed, if the initial population size is equal to 'n/2'.
- Sub optimal result comes out when number of generations kept low. But good solution arrives when the generations are increased gradually.
- If we select the population randomly, the chance of good solution gets increased.
- Integrated RWA algorithm is used to select the best strategy for routing based on the size of network

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