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A Novel Approach for Fault Detection for Wavelength Assignment Problem

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Abstract

Now a day's optical communication is a major technology that meets end user demands. In fiber optical communication Wavelength Division Multiplexing (WDM) technique is introduced and it supports adequate bandwidth for the end users. The route assignment of WDM is an important in case of optical routing networks. Here in this paper we provide the solution for the problem of fault detection for routing and wavelength assignment that meets the end user requirements for increasing the efficiency of wavelength routed All-optical network traffic.

***Keywords**: Fault detection, intelligent systems, Routing and Wavelength, Routing optimization*

I. Introduction

In 20th century the internet users demand increases day by day. It is difficult to meet all the requirements of end users. We need some powerful techniques that satisfy user demands. One of the major technology to support all the user needs is optical fiber cables.Because of its unique properties in real world. In real time we use different types of techniques that meet user needs for quick browsing internet for various applications. One of the powerful technique is wavelength division multiplexing (WDM) which serve for the future all-optical networks [7]. Wavelength Division Multiplexing (WDM) offers the capability to handle the increasing demand of network traffic in a manner that takes the advantage of already deployed optical fibers. A lightpath is an all optical communication path between end-to-end over a same wavelength used on each intermediate link. Wavelengths are the main resources in WDM optical networks. A generalized model for wavelength division multiplexing is shown in Figure 1.231.

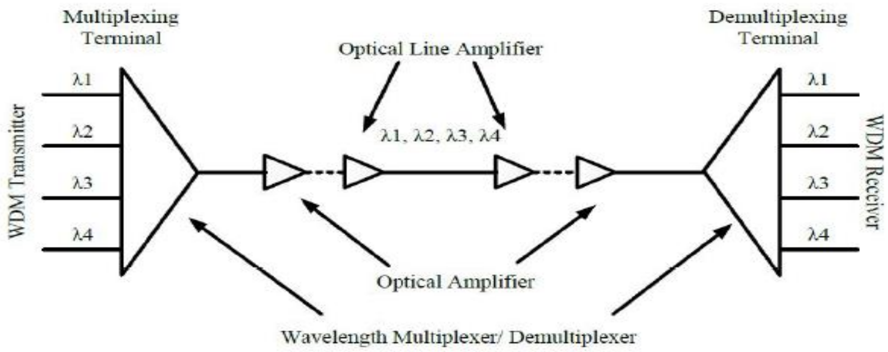

Figure 1.1: Wavelength Division Multiplexing

Wavelength division multiplexing and wavelength routing are rapidly becoming the technologies-of-choice in network infrastructure to meet the tremendous bandwidth demand of the new millennium. They are also receiving increasing attention from the telecommunications industry. In WDM an optical fiber link carries several optical signals using different wavelengths. By allowing many independent signals with different wavelength to be transmitted simultaneously on one fiber, WDM enables the employment of a substantial portion of the available fiber bandwidth. Since the wavelength determines the communication path by acting as the signature address of the origin, destination or routing, the routing and detection of these signals can be achieved independently. Therefore the wavelength selective components are required, allowing for the transmission, recovery or routing of specific wavelengths. The capacity of such fiber links is huge in terabits per second.

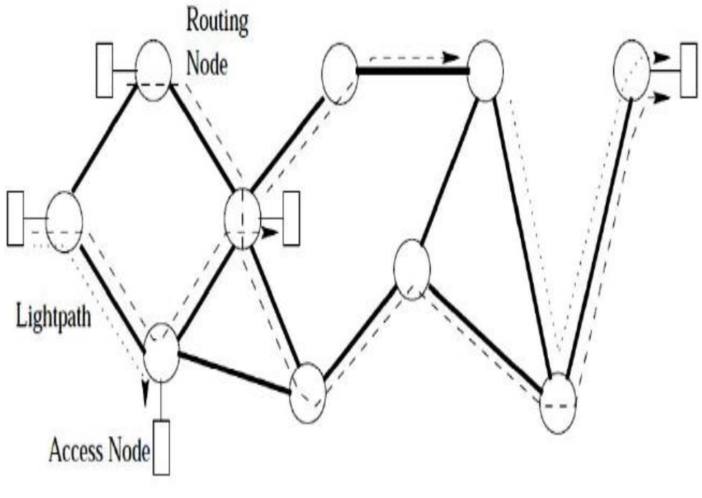

Figure 1.2. Wavelength Division Multiplexing Network

Figure 1.2, shows the communication by a clear channel between different nodes in simple physical networks. The dotted lines indicate the light paths. With the use of different wavelengths two light paths can share a common physical link. The updation from point-to-point fibers to WDM and then virtual topologies can be in an incremental manner. The virtual topology provides a certain measure of independence from the physical topology, because different virtual topologies can be set up on the same physical topology, though the set of all virtual topologies that can be set up is constrained by the physical topology. In setting up a virtual topology, the usual considerations are delay, throughput, equipment cost and reconfigurability.

The physical limitations of the optical medium and the cost and complexity of the optical switching need to be accounted for in this design. A particularly important consideration in this context is number of wavelengths associated with an optical link *i.e.*, the number of separate wavelengths that can be supported in that link. The network is wavelength continuous such that the same wavelength must be used throughout the lightpath [5-6].It can be solved by fault tolerance schemes. Now a day in WDM routing to provide the solution for over traffic in usage of internet for telecommunications. Also security issues and attack management in transparent wavelength division multiplexing (WDM) optical networks have become of prime importance to network operators due to the high data rates involved and the vulnerabilities associated with transparency. Deliberate physical-layer attacks, such as high-powered jamming, can seriously degrade network performance and must be dealt with efficiently[11].While most approaches are focused on the developing fast detection and reaction mechanisms triggered in case of an attack, we propose a novel approach to help deal with these issues in the network planning and provisioning process as a prevention mechanism. Fault detection and routing optimization is serious issues in now a day. The traffic assumptions generally fall into one of two categories: static or dynamic. In static RWA models we assume that the demand is fixed and known, *i.e.*, all the lightpaths that are to be set up in the network are known beforehand. The objective is typically to accommodate the demand while minimizing the number of wavelengths used on all links[1] Wavelength-Division Multiplexing (WDM) in optical fiber networks has been rapidly gaining acceptance as a means to handle the ever-increasing bandwidth demands of network users[2]. In a wavelength-routed WDM network, end users communicate with one another via all-optical WDM channels, which are referred to as lightpaths[3]. Emerging wavelength-routed WDM systems, which utilize photonic cross connects (PXCs), are capable of switching data entirely in the optical domain. Configuring these optical devices across a network enables one to establish all-optical connections, or lightpaths[1],between source nodes and destination nodes is shown below.

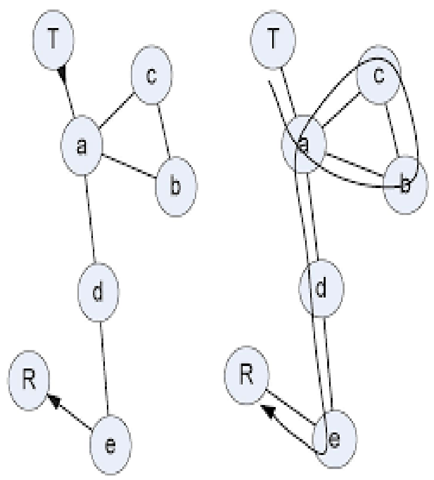

Figure 1.3. Wavelength-Routed WDM Network with Lightpaths Established between Nodes

Data carried on these lightpaths avoid electronic conversion and processing at intermediate nodes, thereby alleviating the electronic bottleneck. The integer linear programming (ILP) models have been successfully employed for solving RAW problem for small size optical networks. Therefore, different heuristic and intelligent algorithms [4-5] have been developed for solving RWA problem for large scale networks. The aim of this paper is to introduce a genetic algorithm for solving RWA problem. In this paper providing a compatible and practical model of genetic algorithm for RWA in optical networks is the main concern which could be extended and improved more in future for different applications. Given a set of connections, the problem of setting up lightpaths by routing and assigning a wavelength to each connection is called the Routing and Wavelength-Assignment (RWA) problem. Typically, connection requests may be of three types: static, incremental, and dynamic [4]. For the routing sub problem, there are three basic approaches that can be found in the literature: fixed routing, fixed-alternate routing, and adaptive routing [6-10]. Among these approaches, fixed routing is the simplest while adaptive routing yields the best performance.

2. Fault Tolerance Approach For Genetic Algorithm

The key new aspect of our formulation that sets it apart from other approaches, is that mainly because of the structure of the cost function, the resulting formulation tends to have an integer optimal solution even when the integrality constraints are relaxed, thereby allowing the problem to be solved optimally by fast and highly efficient linear programming methods [1]. Because of the optimality of the solution produced, our methodology is not subject to the performance degradation that is inherent in the alternative heuristic approaches. We prove the optimality of the resulting solutions in a special but widely used in the practice topologies, such as ring networks under some assumptions. For the case when our approaches fails to find the integer optimal solution for arbitrary network topologies that has full wavelength conversion for that we provide the efficient rounding method.

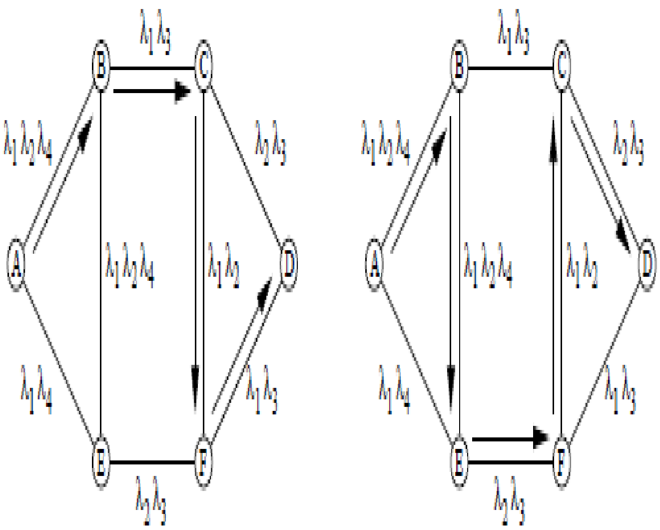

Figure 2.1. Deflection Routing. Available Wavelengths are Shown on Each Link

This method takes into account the structure of the cost function, and starting from an optimal non integer solution, produces a possibly sub-optimal integer solution. It may also be used to construct efficient methods that find optimal or near-optimal solutions for the no wavelength conversion case. However, based on our ring network analysis, as well as extensive computational experimentation, it is likely that an integer optimal solution can be found by our methodology for the most optical networks and traffic patterns encountered in the practice. The genetic algorithm used to solve the formulated ILP is explained below. The reproduction in simple genetic algorithm (SGA) is considered for determining which chromosomes will be chosen as the basis of the next generation. Generating populations from only two parents may cause loss of the best chromosome from the last population. Reached good solution may be destroyed by either crossover or mutation or both operations.

Thereby, the best solution in SGA popped up from the new population may be inferior to the old generations. The aim of the modified genetic algorithm is to prevent this demerit. MGA possesses a structure similar to SGA. However, the MGA has been distinguished from the SGA in that the reproduction is processed after both the crossover and mutation have been performed. Thus the deterioration problem never happens since the best solution from the current generation will be superior to or at least the same with the past. In the beginning the modified genetic algorithm creates an initial population. In the next step the algorithm evaluate the objective values (cost values) of the individuals in the current population. After that individuals are reproduced. During the reproduction, recombination (or crossover) first occurs. Genes from parents combine to form a whole new chromosome. The newly created offspring then mutates. Mutation means that the elements of chromosome are a bit changed. These changes are mainly caused by errors in copying genes from parents. Then MGA ranked individuals represented by their associated cost, to be "minimized", and returns the corresponding individual fatnesses. Next the most fitted individuals from offspring are selected. Here the objective values of the individuals in the offspring are evaluated and re-insertion of offspring in population replacing parents is done. The MGA is terminated when some criteria are satisfied, *e.g.,* a certain number of generations, a mean deviation in the population, or when a particular point in the search space is encountered. The outline of the modified genetic algorithm is show below

Algorithm:

Step1: Generate random population of *n* chromosomes for given lighpaths in a network

Step2: Evaluate the object function of each chromosome in the populations

Step3: Evaluate the fitness function of each chromosome in the populations

Step4: Create a new population by repeating following steps for optimum routing

Step5: Select parent chromosomes from the population according to their fitness function

Step6: Cross over the parents to form new offspring with a crossover probability

Step7: Mutate new offspring at each locus with a mutation probability

Step8: Use new generated loop in an old population for a further run of the algorithm

Step9: once finding the object function, fitness function, produces the new optimum route for given light path.

In the selected generation, a chromosome is mutated with a fixed mutation rate. According to a mutation ratio, the number of lightpaths is calculated that will be modified. For each such lightpath p_i= [n_{i0},n_{i1}.....,$n_i h_i$], randomly pick two adjacent nodes n_{ij} and $n_{i(j+1)}$. Disconnect the fiber link among two nodes and then remove all the nodes n_{il} such that $l<j$ and $l>j+1$. Then calculate the minimum cost path between n_{ij} and $n_{i(j+1)}$ and substitute the corresponding portion in p_i using the new path. Selection schemes mainly predict the convergence characteristics of a Genetic Algorithm within a deterministic environment. The following effect of different genetic operators explains the convergence characteristics of the GA used to solve the formulated ILP. RWA problem can be formulated as Integer linear programming (ILP) problem. This type of problem focuses on optimizing a single objective. Here objectives may be minimizing the number of amplifiers or maximizing the number of connections or minimizing the number of wavelength used. But our primary objective in RWA problem is to establish a loop free path which minimizes the crosstalk. To achieve this objective we are taking the help of genetic algorithm (GA). Congestion among the individual lightpath request will be the parameter for the application of genetic algorithm.

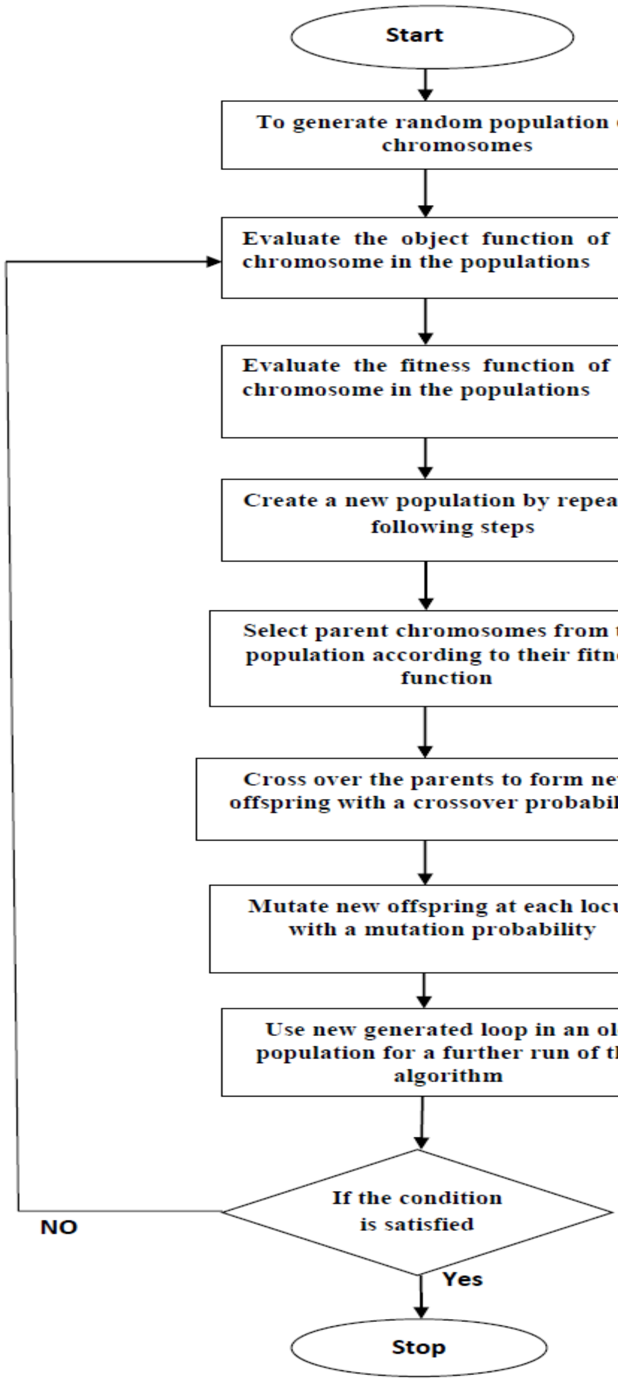

Figure 2.2. Flow Chart for Modified Genetic Algorithm

3. Experimental Results

According to the observations, the simulation results show that the robustness of modified algorithm presented below results. It shows the modified algorithm routs wavelength packets to the sender as minimum number of routes without faults. In order to analyses results it can be observed that the GA-1 and GA-2 algorithms take almost same time for executing the routing decision for less number of lightpath requests. But GA-2 is performing better than that of GA-1when there are many number of lightpath requests are present for ARPANET. From the results, it has also shown that the GA-1 and GA-2 take unstable costs of the paths for the less number of lightpath requests for ARPANET. The total cost of paths calculated under modified approach is performing better than the original one, when there are more number of lightpath requests are present. This algorithm is found very effective in solving small to medium sized generalized assignment problems. The proposed approach could be extended for dynamic RWA schemes in real-time applications and employed by network resilience architectures. The total cost of paths calculated under modified approach is performing better than the original one, when there are more number of lightpath requests is present.

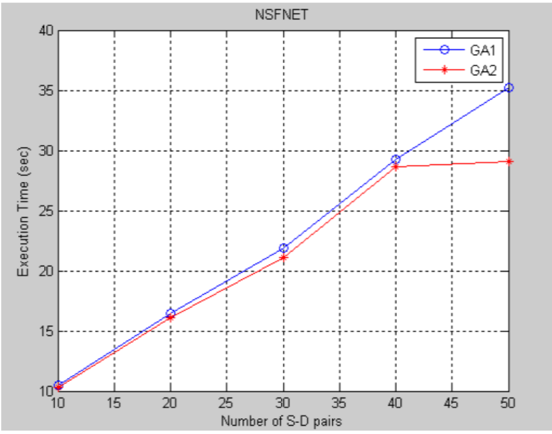

Figure 3.1. Simulation Results on the Performance of Original Algorithm and Modified Algorithm: Execution Time of the Routing Vs Number of S-D Node Pairs. We Can Observe that the GA1 has Better Performance Over GA2 Shown in Results

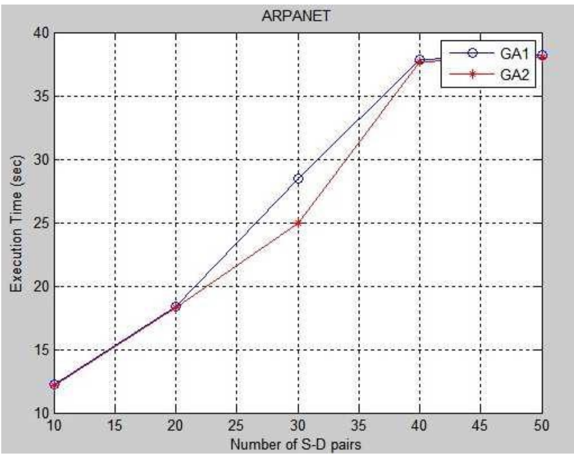

Figure 3.2. Execution Time of the Routing Vs Number of S-D Node Pairs (Lightpath Requests)

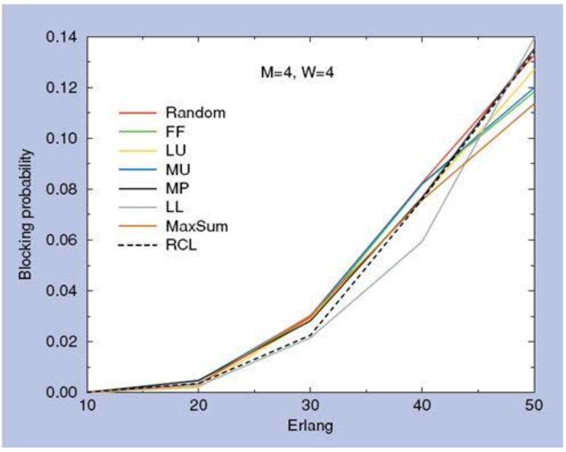

Figure 3.3. Simulation Results on the Performance of Original Algorithm and Modified Algorithms in Case of M=4, W4

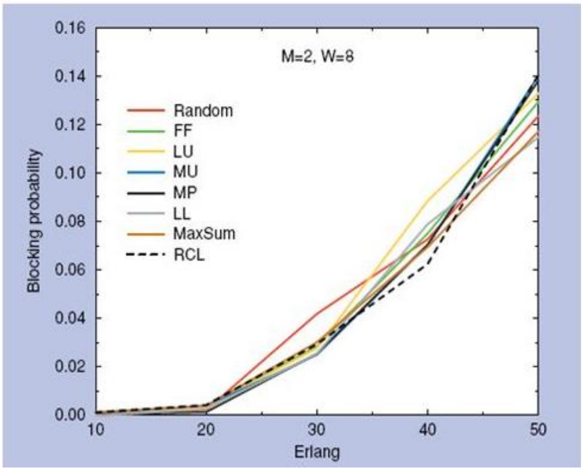

Figure 3.4. Simulation Results on the Performance of Original Algorithm and Modified Algorithms in Case of M=2,W=8

	Blocking probability			
Traffic	10	20	30	40
Approach				
Random	16.1	16.4	16.9	16.8
FF	11.0	11.4	14.5	11.9
LU	13.6	15.4	15.0	14.5
MU	12.1	14.0	11.2	10.4
MP	10.7	15.1	14.2	13.1
LL	13.1	1302	12.5	15.4
Max sum	14.9	10.7	10.4	12.8
RCL	14.2	10.4	14.1	10.1

Figure 3.5. Table Shows Blocking Probability vs Erlang

4. Conclusion

In this paper we discussed a novel approach for fault detection for minimizing the routing and wavelength assignment problem. The performance of proposed and existing algorithms are studied with respect to the time taken for making routing decision, number of wavelengths required and cost of the requested lightpaths. The modified algorithm performed better than the existing algorithm with respect to the time and cost parameters. The simulation results shows different population sizes on speed convergence and link state variables after routing and wavelength assignment.

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