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Implementation of Adaptive Algorithm to Optimize the Placement of Wavelength Converters

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Abstract: ***The Wavelength Converters in WDM Optical Network, is one the essential component in today's advanced research, but at the same time they are very expensive and it should be used in limited number to make effective use of Wavelength Converters. The two main criteria to be achieved is to reduce the overall blocking probability at an affordable cost and the other performance measures are within reasonable limits. To equip the node with the Wavelength converter for any network is crucial. There should be a minimal blocking probability at those particular nodes chosen to place the Wavelength Converter. A large margin decrease in the blocking probability will be easy for the placement of Wavelength Converter. Compared with the previous method of allocation, the results of the proposed adaptive algorithm can significantly reduce the blocking probability at higher range. The implementation of Adaptive algorithm shows that it is more cost effective to optimize the blocking performance. The blocking performance improvement hence led to the comparison of performance and efficiency other conventional methods with the proposed Adaptive algorithm is done.***

Keywords: ***Wavelength Converter, blocking probability, wavelength routed network, optical Network.***

I. INTRODUCTION

In Wavelength Division Multiplexing (WDM) Network, Wavelength routed Optical Network involves Wavelength Converters are believed as latest trend for today's research, as it has potential limitless capabilities, low signal distortion, low power requirement and low cost efficient materials. Wavelength routing is considered as practical architecture and sophisticated process. This can be done by dividing the transmission bandwidth into bandwidths with which the end users can process the speed, so on single optical fibre at different wavelength the multiple channels can operate in parallel. The performance of the overall network gets degraded due to wavelength continuity constraints in terms of blocking probability. The solution to this problem is the optimal placement of Wavelength Converter.

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The one of the most important key technique in a wavelength routed Optical Network is the Wavelength Converter, that can improve the blocking performance. Optimal Placement and maximum Utilization of Wavelength Converter are the main aim with minimum hardware requirements of the Network as their cost are high. Genetic Algorithms (GA) an application of optimization tool is used to solve this problem. In this paper, an evolutionary algorithm called Differential Evolution (DE) and the use Particle Swarm Optimizer (PSO) to find the optimal placement of the wavelength converter are the conventional methods. These conventional methods are compared with the proposed Adaptive algorithm and considered to be best for the optimal placement of Wavelength Converter.

II. REVIEW

In a simple definition, optimization is to find the best solution to a determinate problem [1]. However, the problems NP-complete cannot be resolve in a deterministic way. In this work, the wavelength converter placement [2] is of paramount importance in optical networks optimization. Well known class of NP-complete problem [3] is considered, which means that the number of possible solution grows up in an exponential manner when the network gets bigger. Throughout this investigation, an evolutionary algorithm called differential evolution (DE) is applied to a problem related to optical networks, particularly the wavelength converters placement, in search for favorable results and comparing these with other methodologies in order to validate them. The DE algorithm is an algorithm developed by K. R. Price and Storn in 1995 [4] for global optimization. This algorithm performance depends on the control of a few parameters that can be applied to different problems.

Many research works are focused on the cost-effective Wavelength Converters as they are expensive to place at all nodes, should meets the target, hence two cases are taken and thoroughly reviewed. This problem has been taken as analysis for our proposed algorithm

(i) An evolutionary algorithm called Differential Evolution (DE) based algorithm is reviewed.
(ii) The use Particle Swarm Optimization (PSO) Algorithm is reviewed
The Differential Evolution (DE) Algorithm for the placement problem is used. *This* paper is investigated because it gives many well known qualities of solution through evolutionary computational approaches.

The work of this DE and the output performance of this algorithm can be used to compare with our proposed algorithm.

The Particle Swarm Optimization (PSO) Algorithm is the solution for the optimal converter placement in an optical network. PSO is a evolutionary computation technique done paralleled which is based on the social behavior metaphor [5]. PSO exhibits some evolutionary computation attributes.

III. PROBLEM DEFINITION

An easy definition of an optimization is finding the best solution to a determinate problem. This research analysis shows the outcomes of the proposed algorithm. In this paper, quick and an accurate method to compute the blocking probability in dynamic WDM networks is presented. The proposed algorithm considers different traffic loads at each link in the network connection. In heterogenous traffic, the method sees that network is in sequence with link load.

The main objectives of the adaptive algorithm are

- the blocking probability is computed
- minimizing the blocking probabilities
- Optimal placement of Converters.

So far, this problem has been optimized using the evolutionary techniques. Complete theoretical analysis of the proposed Adaptive Algorithm is compared with the previous Genetic algorithms like DE and PSO.

Both the algorithm are compared with the analytical based Adaptive algorithm and assumed to be best for the optimal placement of Wavelength Converter. The main contribution of this paper is to minimize the blocking probability, and to search out optimum solution to the converter placement problem.

IV. NETWORK MODEL AND ANALYSIS

The Analytical technique is used to evaluate the blocking probability for a NSF T1 backbone NETwork (NSFNET) topology shown in Fig 1. The analytical model for optimizing the placement is computed accurately. The NSFNET backbone network consists of 14 Node bidirectional network.

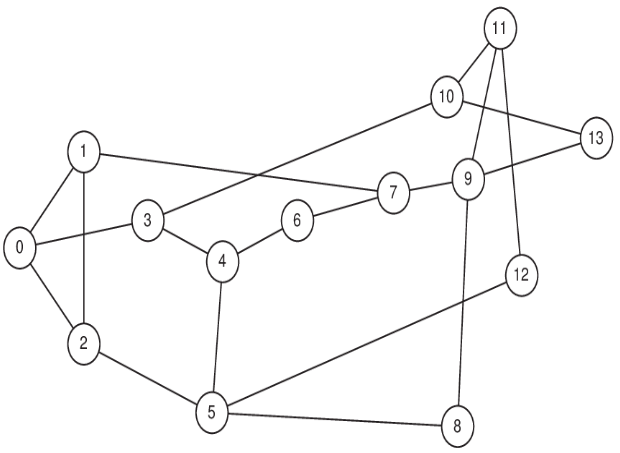

Figure1: NSF T1 backbone NETwork (NSFNET)

A WDM Network is considered with an bidirectional graph $G = (V,E)$. The nodes in the network are numbered 1, 2,...., N nodes and consists of i,j.....links, each carrying a W Wavelength on the link l_{ij}. The blocking probabilities for end to end node, when the set of wavelength-convertible nodes C is considered. The analytical model is used for computing the blocking probability. ρ_{ij} is the probability for a given wavelength on the link can be obtained from the node-pair loads by

$$\rho_{ij} = \frac{\Sigma \lambda_{sd}}{W} \quad \forall sd \qquad (1)$$

4.1 Notations

$1,2 \ldots.N$	nodes in the network
l_{ij}	links in the network
W	number of Wavelength on the link
C	number of Wavelength Convertible nodes in the network
λ_{sd}	end to end traffic rate from node s to node d
T	traffic matrix of the network
ρ_{ij}	is the probability that a given wavelength on link l_{ij}
λ^{ij}_{sd}	Amount of traffic λ_{sd} going through link l_{ij}
S_{sd}	Success probability from source to destination
P_{sd}	Blocking probability from source to destination

A single segment between the source and destination consists of

$$f(i,j) = 1 - (1 - \overline{\rho_{ii1}}, \overline{\rho_{i1i2}}, \ldots\ldots \overline{\rho_{inj}})^{W} \qquad (2)$$

Let the number of converters placed on the nodes (not including the source and destination nodes) of the path $\boldsymbol{p}$ be C is given by

$$S_{sd}(C) = \prod_{i=0}^{C} f(s_i) \qquad (3)$$

the success probability of the segment s_i between the converter nodes $d(i)$ and $d(i+1)$.

The blocking probability for the path is then obtained as

$$P_{sd}(C) = 1 - S_{sd}(C) \qquad (4)$$

Thus the blocking probability can be computed for the all the path

The traffic matrix for 14 nodes is as shown in the table below.

Table 1: Traffic Matrix for 14 node NSFNET

Nodes	Traffic Matrix					
1	0.44	0.41	0.13	0.02	0	0
2	0.41	0.38	0.16	0.03	0.02	0
3	0.52	0.44	0.03	0.01	0	0
4	0.11	0.51	0.22	0.10	0.04	0.2
5	0.64	0.25	0.07	0.04	0	0
6	0.59	0.32	0.09	0.00	0	0
7	0.12	0.54	0.22	0.07	0.03	0.2
8	0.47	0.43	0.08	0.01	0.01	0
9	0.71	0.21	0.08	0.00	0	0
10	0.21	0.57	0.12	0.04	0.03	0.3
11	0.46	0.38	0.13	0.03	0.01	0.1
12	0.39	0.51	0.09	0.01	0	0
13	0.35	0.43	0.12	0.09	0.01	0
14	0.67	0.28	0.03	0.02	0	0

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V. RESULT ANALYSIS:

The blocking probability for 14 node NSFNET is computed with the above equation (4) using the traffic matrix shown in table 1 and are tabulated in table 2.

Table 2: Blocking probability for 14 Node Network

Node	Blocking probability of an Adaptive Algorithm
1	8.61E-05
2	8.13E-05
3	0.000209
4	0.000127
5	0.000343
6	0.000229
7	0.001171
8	8.42E-05
9	0.000347
10	4.59E-05
11	3.69E-05
12	4.18E-05
13	1.28E-05

Table 3: Blocking probability of PSO, DE and proposed Adaptive Algorithm

Nodes	Blocking probability PSO	Blocking probability DE	Blocking probability Proposed algorithm
1	0.0013294	0.0086841	0.00008606
2	0.000648	0.0047884	0.00008133
3	0.0003581	0.0032	0.0002093
4	0.0002191	0.00246	0.00012688
5	0.0001624	0.00177	0.000343126
6	0.0001212	0.00143	0.00022947
7	0.0001024	0.0011	0.00117065
8	0.000084	0.00093	0.000084201
9	0.0000746	0.00091	0.000346791
10	0.0000664	0.0009	0.00004594
11	0.0000644	0.0009	0.00003694
12	0.0000636	0.0009	0.00004179
13	0.0000628	0.0009	0.000012772

The blocking probability is evaluated using the equations 4, for 14 NODE NSFNET. The results are obtained from the analytical calculation using the traffic matrix shown in table 1. The blocking probability of PSO and DE is obtained from simulation results of the reviewed papers and are tabulated for comparison with the blocking probability of our proposed algorithm in table 3.

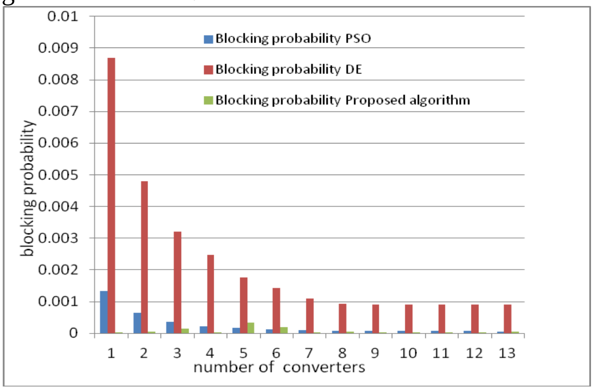

Fig 2: Blocking probability of PSO, DE and proposed Adaptive Algorithm

The comparison graph is plotted for PSO, DE and Adaptive Algorithm. It is noted that the proposed algorithm shows the least blocking probability among the other two conventional methods. The node with minimum blocking probability is considered to be optimal for the placement.
The efficiency of DE, PSO and Adaptive Algorithm is tabulated in the table 4 below.

Table 4: Efficiency of PSO, DE and Proposed Algorithm

Node	PSO	DE	Proposed Algorithm
1	62	64	52
2	86	86.81	77.7
3	90	88	89.72
4	96	95	95.05
5	98	95.65	97.3
6	97	96	98.17
7	96	98.13	98.4

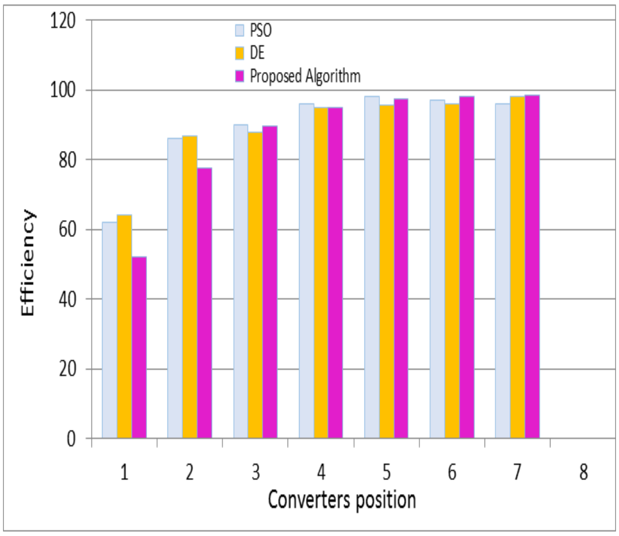

Fig. 3: Comparison the Efficiency of Different Algorithms

The graph is plotted for the comparison of efficiency of DE, PSO and Adaptive Algorithm. The graph is plotted for efficiency verses converters position. The efficiency of Adaptive algorithm is attained 98% much faster and remains to be constant, compared to PSO and DE algorithms.

VI. CONCLUSION

The mathematical calculation is performed, the minimum value of blocking probability at some node is achieved. The minimum value of blocking probability at the precise node is considered to be optimized to place the Wavelength Converter. It has enhanced the performance of the Network. The proposed algorithm is considered to be best to place the Wavelength Converter at a great extend was succeeded. The proposed algorithm has attempted to introduce a mathematical method of optimizing the blocking performance in peak traffic condition in optical networks and considers being best.

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