REDUCTION OF BLOCKING PROBABILITY IN SHARED PROTECTED OPTICAL NETWORK

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ABSTRACT-

In this paper we have proposed a restricted shared protection scheme in wavelength convertible optical network. In our proposed approach we have included both alternate path routing and partial placement of wavelength converters for reduction of blocking probability. The simulation result shows the performance of our proposed approach is better than the existing protection schemes.

KEYWORDS

.-Light path, wavelength routing, wavelength conversion, path protection

I. INTRODUCTION:

All Optical Networks [1-5,8] have become an efficient mean to fulfil the tremendous demand of bandwidth due to skyrocketed increase of internet users. In this regard, dynamic Routing and wavelength assignment (RWA) plays an important role for highly variable traffic pattern of Optical network. Here, after getting a connection request of a source-destination (s-d) pair in the network, the establishment of light path is carried out by dynamic RWA approach. If the connection request is not served within a time interval (termed as holding time), it is rejected. It is termed as blocked connection. The objective of dynamic RWA is to select the best combination of a route and a wavelength of each connection, such that the numbers of blocked connections are minimized.

The efficient and reliable design of optical network requires resilient light path provisioning, against failures because of its survivability [8]. The survivability is made in optical network by providing back up path for each connection that is established. This is also called as protection in the network. There are two types of protection -dedicated and shared protection. In dedicated (1:1) protection [10], a dedicated back up path is established for each individual connection where as in shared protection (1: M), a wavelength may be shared among multiple back up paths. The latter case gives less blocking probability than the former case.

For the improvement of blocking probability performance, the network requires the placement of wavelength converters. Wavelength convertible optical networks have been studied using various techniques: converter placement [13], converter allocation [14], conversion based router architectures [15] and sparse wavelength conversion [16]. Here, to reduce the number of wavelength converters for blocking performance improvement, we use optical placement of wavelength converter in limited number of nodes of the network.

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In this paper, we have implemented a dynamic RWA algorithm based on alternate path routing and wavelength converter placement in irregular network topology. For the survivability of the network, shared protection mechanism is proposed. The performance of the proposed techniques is presented in simulation results. We have also compared the results of dedicated and shared protection.

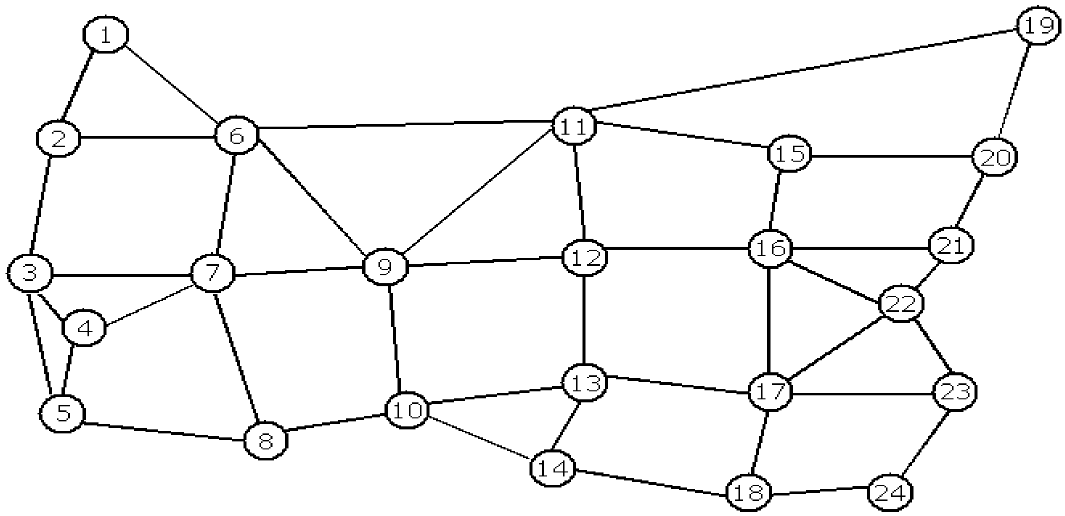

Fig-1 ARPANET backbone with 24 node network

II. Problem Formulation:

To formulate the problem, physical topology of the network has been modeled as a unidirectional graph G (V, E, W), where, V is the number of nodes, E is the set of links between different nodes in network, W =set of wavelength carried by each fiber link it is assumed that each can carry the same number of wavelength. As mentioned earlier, we consider each link consisting of two unidirectional fibers (two fiber can carry same wavelengths in reverse direction). Each link corresponds to geographical distance between nodes. We first introduce the following notation.

i , j denotes the end points (i.e. nodes) of physical link that might occur in the route of a connection.

e is used as an index for link number where e = 1 , 2 , 3 ……..E ;
w is used as an index for the wavelength number of link e, where w = 1 , 2 , 3……….W; W=total number of wavelength per link.
l is an index of a s-d pair /connection where l =1,2,3……..L; L is total number of possible s-d pairs W_e is the number of wavelengths used in link, e for protection. Se is the number of wavelength for traffic flow in link, e is used in primary path

$RP_{ij}^{l,w,b}$ =integer takes a value 1 if the link ij of the route 'b' is assigned a wavelength 'w' for shared protection of l th s-d pair/protection otherwise it is zero. S-source and d-destination. The RAW problem of Shared protected optical network is formulated as follows:

Objective: Minimize W ----- (1)
W=We+Se--------- (2)

The RWA problem of restricted shared protected optical network is formulated with objective
The constraints are as follows

$$\sum_{j:(ij\epsilon E)} RP_{ij}^{l,w,b} = \sum_{j:(ji\epsilon E)} RP_{ji}^{l,w,b} \quad i \neq s, d, \forall (w\epsilon W) \qquad \text{--------- (3)}$$

$$\sum_{w\epsilon W} \sum_{j:(ij\epsilon E)} RP_{ij}^{l,w,b} - \sum_{w\epsilon W} \sum_{j:(ji\epsilon E)} RP_{ji}^{l,w,b} = 1 \quad i = s \qquad \text{--------- (4)}$$

$$\sum_{w\epsilon W} \sum_{j:(ij\epsilon E)} RP_{ij}^{l,w,b} - \sum_{w\epsilon W} \sum_{j:(ji\epsilon E)} RP_{ji}^{l,w,b} = -1 \quad i = d \qquad \text{--------- (5)}$$

The equation (1) shows the objective function of shared protection.

III. PROPOSED ALGORITHM

For efficient utilization of network resources, the RWA algorithm needs to serve maximum connection requests. For this purpose, we have proposed the algorithm based alternate path routing with optical placement of converters. In this algorithm, each node in this network is required to keep record of link state information, which is updated periodically. On the basis of link state information, ordered list of m number of routes are selected for connection request of a s-d pair for entire session. The proposed algorithm is described below:

When a connection request is generated, then the following steps are used.

1. Compute m number routes (Ri) (on the basis of link state information) in descending order of time delay,(where, i = 1,2,3……..m correspond to 1st ,2nd ………mth shortest time delay path).
2. Choose first shortest time delay path (i=1) and select the assign the wavelength using parallel reservation scheme. If the wavelength is not available, then we use CONV_PLACE algorithm for establishment of connection of s-d pair. If it is assigned, set up protection path; else go to the next step.
3. Try to assign wavelength for next alternative path in descending order of time delay. If it is not assigned to wavelength, then we place converters in same positions as that in the step-2 for assigning a wavelength to the connection. If it is assigned, set up protection path using protection tree and the equations (3) – (5), else go to next.
4. If it is not assigned, repeat step -4 up to (m-2) times, else go to next step.
5. Connection is blocked and back up path for the connection is rejected.

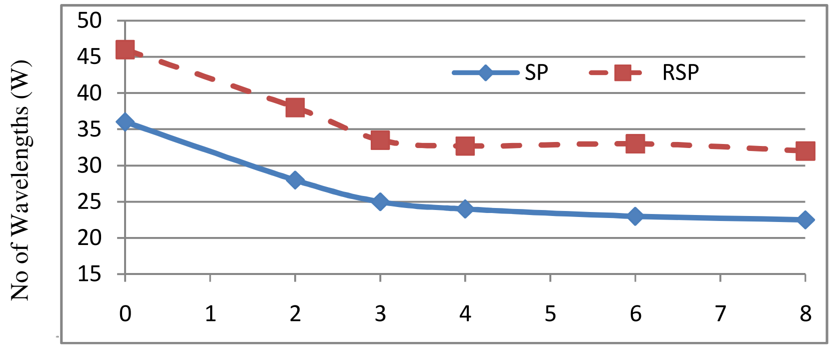

Fig-2 No of wavelength (W) Vs No of Convertors for SP and RSP

IV. CONV_PLACE ALGORITHM

We place the converter properly in such a way that the blocking probability should be reduced. The procedure of CONV_PLACE algorithm is given below:

Fix the number of converter (C)

Choose a particular converter placement$\left(\{x_i^k\} = \{x_1^k, x_2^k, \ldots . x_N^k\}\right)$ and find $\sum_{i=1}^{N} U_i^k . x_i^k$ where U_i^k is utilization factor of i th node and k th placement

Repeat the step-2 till maximize $\sum_{i=N}^{N} U_i^k . x_i^k$ End

V. SIMULATION RESULTS

In this section we have performed simulation of the proposed algorithm for ARPANET backbone as shown in Fig.1. Our proposed algorithm is based on dynamic RWA with placement of wavelength converters in some of the nodes of the network under shared and restricted shared protection. We have placed these wavelength converters optically in the network, so that the blocking probability is reduced. We have simulated the network using fixed routing with connection request coming for all possible s-d pairs. To reduce the blocking probability, we have simulated using alternate path routing and CONV_PLACE algorithm. Considering number of connections ~ 2*10^4 for all s-d pairs, Fig-3 compares SP network and DPP (dedicated path protection) network under non-blocking condition using alternate path routing. It is seen that the number of wavelength (W) require accommodating all the connections in SP network is less than that of DPP network. This is because the number of wavelengths reserved for protection in SP network is less than that of DPP network. Considering C=3, the simulated result of the blocking probability variation with W for DPP and SP network are shown in Fig-3.

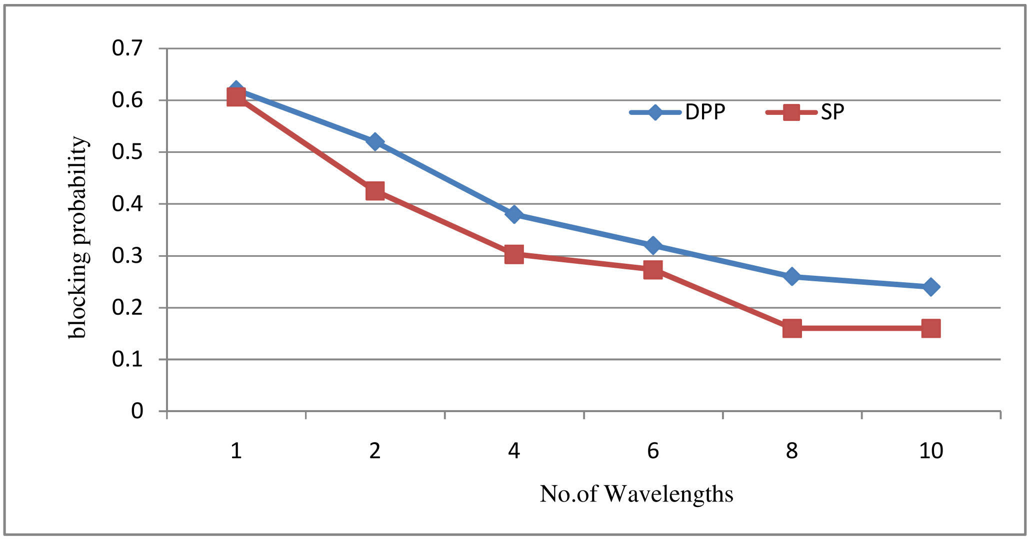

Fig-3.Blocking Probability Vs no.of Wavelengths

It is evident that the blocking probability with and without converter in SP and DPP network respectively; it is reduced with use of converter. This is because most of the links utilizes all the wavelengths up to these values of W. The reduction of blocking probability with use of converters in case of SP network is less than the DPP network.

VI.CONCLUSION

In this paper, we have studied the reduction of blocking probability using alternate path routing and wavelength converter in protected optical network. To increase reliability of protection, we have proposed shared protection against failures. It is observed that the number of wavelengths required to establish all the connections present in shared protection network. In SP networks blocking probability is reduced than the DPP network, placing three wavelength converters at the same position.

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