Feedback Routing Algorithm in optical WDM Networks

J.JenoJasmine
Department of Computer Science and Engineering
Sethu Institute of technology
Tamilnadu, India
jenojasmine@gmail.com

J.Sutha
Department of Computer Science and Engineering
Sethu Institute of technology
Tamilnadu, India
Sutha_skad@yahoo.co.in

Abstract— This study is mainly concentrate on the routing problem in optical WDM network. In WDM network, the wavelength continuity constrain must be taken care in data communication. Lightpath is the communication channel between each pair of nodes. The lightpath is set up on basis of connection request, in such a way that no two ligthpaths shares the same link. The routing is based on the available wavelength and it assignment. This study focuses on the routing problem in wavelength routed WDM networks which works under wavelength continuity constrain. Various routing methods discussed are fixed routing, fixed alternate routing, adaptive routing, adaptive alternate routing and fault tolerance along with the blocking probability. The connection requests have been rejected, if there is lack of availability of resources for the requested link is known as blocking probability.

Keywords- WDM networks, lightpaths, wavelength continuity constrain, routing methods, blocking probability.

I. INTRODUCTION

In optical WDM network, wavelength routed networks are the promising candidates for meeting the growing high capacity and varied needs of data communication. Lightpaths are the logical channels which offer an end-to-end connectivity in optical networks [1][2].

Optical network uses a channel between the nodes are called lightpaths. It can traverse several physical links but information travelling on physical lightpath is carried optically from end-to-end. This lightpath is implemented by choosing a link in physical network and assigning a particular wavelength on each of these links. This is known as the wavelength continuity constraint, which indicates that a lightpath consists of a single wavelength over a sequence of physical links. This constraint can be relaxed by assuming the availability of wavelength converters at intermediate nodes. But this involves expensive equipment and further complications related to the tuning delay of converters along with the issue of converter placement [3].

For a given physical links of optical networks, the problem of setting of lightpath by routing and assigning a wavelength to each link between the nodes is known as Routing and Wavelength-Assignment (RWA) problem[4].

II. TYPES OF CONNECTIONS

There may be three types of connections: static, incremental, dynamic[3] [4].

A. Static traffic

The connection for a given network is known in advance. Then setting up a lightpaths is the problem, in global fashion in such a way the number off wavelength or the number of fibers must be less in order to minimize the network resource. In other way one may try to set up as many of these connections as possible for a given fixed number of wavelengths. This RWA problem for static traffic is known as Static Lightpath Establishment (SLE) problem[4].

B. Incremental-traffic

For a given network, the connection requests are arise sequentially. The ligthpath is established for each connection. Indefinitely the lightpath remains in the network. [3][4]

C. Dynamic traffic

For a given network, a lightpath is setup for each connection request as it arrives. Then the light path is released after some finit amout of time[3][4].

The vital role of increamental and dynamic traffic is to set up lightpaths and assign wavelengths to minimize the amount of connection blocking, or to maximizes the number of connections that are established in the network at any time. The problem is known as Dymanic Lightpath Establishment problem (DLE)[3][4].

The SLE and DLE problem is complicate to solve. So heuristic methods are generally employed. Heuristic exist for both routing subproblem and wavelength assignment subproblem[4][5].

In this study, we survey the various approaches of routing subproblem. There are three basic approaches found in routing. They are fixed routing, fixed-alternate routing, and adaptive routings.

III. ROUTING SUBPROBLEM

Further subdivided the routing subproblem into two components (1) search and (2) selection functions. For a given network, the number of state space is increased exponentially with number of nodes and path. So finding all possible source and destination path is impractical[7].

Therefore the search function is performed by well known techniques such as Shortest-Path algorithm, Dijkstra's, Bellman-Ford algorithm, [8]. The selection function is carried by sequential or combinatorial optimization algorithm[g].

Sequential selections have selection order and selection rule. Selection orders have random schemes, fixed schemes, longest-first schemes and shortest-first schemes. Selection rule have random schemes, first-fit schemes, probability schemes and minimum-weighted link-first schemes.In combinatorial selection, mixed integer program is used for an optimal solution and random routing algorithm for heuristic solution [7].

A. Fixed Routing

The Fixed routing algorithm accepts connection request between source and destination node, one and only if free wavelength is available on predetermined path between source and destination nodes. If free wavelength is not available in the path between source and destination node, then the connection request will be rejected[9].If the given traffics to different source and destination nodes are independent of one another, along with the traffic model which is asymptotic (limiting behavior) traffic property[9], then the fixed algorithm in asymptotically(limiting behavior) optimal.

B. Fixed Alternate Routing

Fixed alternate route is a advanced version of fixed routing. More than one set of routes for source and destination pairs are previously stored in the networks. When the connection request received, the primary route will be allocated if the free wavelength is available. If the primary route is not available then the pre-computed routes for source and destination will be allocated in sequential manner. Primary route is the first path between the source and destination pair.

If no free wavelength is available on the primary route, then the alternate route is create in such a way that the disjoint path from the previous route and repeat the procedure. For example, if the number of disjoint routes from source and destination is n, then repeat the process by n number of times. The blocking probability of fixed alternate route is comparatively less with fixed routing[8] [10].

C. Adaptive Routing

For a given network, the paths are assigned in a dynamic way. All nodes in the network maintains the complete network state information in routing table using link state algorithm[11].Adaptive routing is classified based on the local information, global information, neighborhood information[12].

Adaptive algorithm based in the local information are working with limited information is deflection routing, otherwise alternate link routing [hh10]. Instead of choosing alternate routes on end-to-end basis, the routes are chosen from alternate links on hop-by-hop basis.

Adaptive routing based on the neighborhood information verifies all links in the network to check least congested path. Complete state information is maintain in each node otherwise the information should be collected in real time as the lightpath is established.

D. Adaptive Alternate Routing

Adaptive alternate routing is based on dynamic alternate routing [13]which is working on random principle. Adaptive alternate routing is well employed for circuit switched network. Adaptive alternate routing is to distribute the load among two pre-computed links. These links are adapted with the effect of traffic load on each path. The important role of adaptive alternate routing is to minimize the network congestion [14]. For a given network, if the source and destination pair is connected directly, then the direct link path is attempt first. If direct link path is not available, then shortest path is preferred. Crankback mechanism is used for finding the alternate path, by checking the given network periodically for identifying the available bandwidth in the network link [13].

E. Fault Tolerance Routing

For a given physical network, the failure may occur when some nodes or links failed. Blocking probability becomes increase if the fault happened in the network. The routing mechanism should have alternate route when current route fails. Continuous probe signal may send from source to destination till the current communication session gets over [Ad-HOC].

Along with the above failure, delay also taken into account [15]. By adapting multiple point to point and multiple multicast routing for sufficient network connectivity, the delay can be reduced. The blocking rate probability is decreased very much to provide QoS routing in WDM networks.

IV. RELATED STUDY

The implementation of fixed routing algorithm is simple but the probability of blocking rate is high [17]. Fixed routing is not capable to handle the fault situation if one or more path fails in the given network [19]. The predetermined routes should be selected in such a way to balance the load evenly in network path for minimize the blocking probability. Usually fixed routing schemes do not maintain the link state information [18].

In the fixed-alternate routing, if no wavelength on the primary route is available, we compute a second route (disjoint from the previous one) and repeat the process. If there are N disjoint routes from a source to a destination, we could repeat this process for N iterations. But we can repeat the process at least twice only. The Best-fit attempts to compute the shortest route for each available wavelength. [8]

Adaptive routing based on Global information deployed on centralized way. Network manager, a single entity maintains the complete state information of the network. Network manager take incharge of finding the routes and setting up of lightpath. Since centralized high degree of co-ordination is not necessary but failure of single node cause major effect [12].

In Adaptive alternative routing, two disjoint links are identified between each node pair for sending data and control message. The identified paths are labeled to reducing the signaling and processing overhead. Traffic flow which is arriving at incoming nodes have large buffer to reduce the blocking rate and buffered, the packets while congestion occurs. Time window mechanism is used in periodically, to alter the time window with reference to previous window. Abrupt changes do not happen in state of the link state [14].

WDM optical network contains ligthpaths or optical circuit switched path (physically full connected) network. Dynamic reconfiguration or rerouting is possible with increase in traffic demands. Each source and destination pair nodes have primary path which is the current employed link. The protection mechanism has provided in such a way that always source and destination pair node have another alternate path which is known as back path. Therefore each path in the network have primary link and back up link [16].

V. FEEDBACK ROUTING ALGORITHM

Let the connection request Crq, wavelength ϵ, source S and detination D.

Step 1:

Connection request arrives Crq, find the path in the network using Scheduler;

1.1 If Fixed Routing (FR) have established between S and D, then assign ϵ;

1.2 Else if Fixed Alternate Routing (FAR) have established between S and D, then assign ϵ;

1.3 Else if Adaptive Routing (AR) have established between S and D, then assign ϵ;

1.4 Else if Adaptive Alternate Routing (AAR) have established between S and D, then assign ϵ;

1.5 Else Fault Tolerance Routing (FTR) have established between S and D, then assign ϵ;

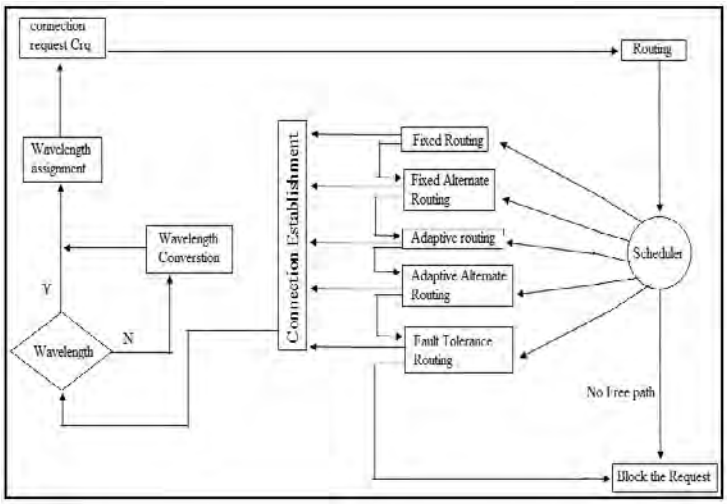

Figure 1. Feedback routing algorithm.

Step 2:

2.1 If ϵ is available, then assign to light path;

2.2 Else use wavelength conversion for available ϵ;

Step 3:

else go to Exception.

Step 4:

Exception:

if all the paths has been tried

then

connection request is blocked;

else

select an alternate path for go to step 1;

VI. RESULT

The simulation result of NSFNET with a parameters like load, connection drop rate, delay, channel utilization and blocking probability for the load of about 2MB, 4MB, 6MB, 8MB, 10MB and 12MB

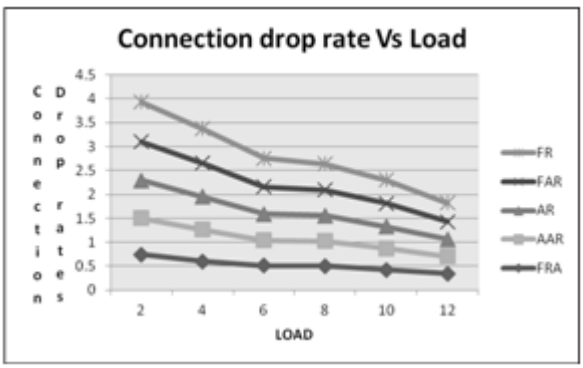

Figure 2.

Figure 2.shows that the proposed FRA is less connection drop rate than the FR, FAR, AR, AAR.

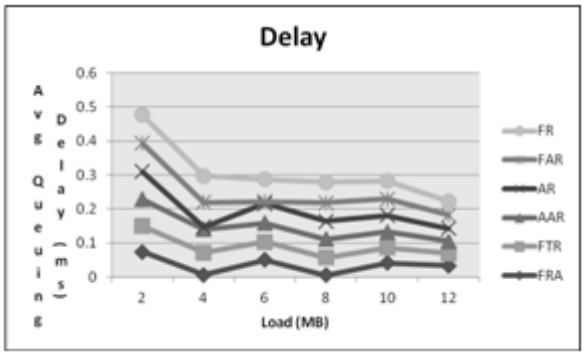

Figure 3.

Figure 3. shows that the proposed FRA is less delay in data delivery than the FR, FAR, AR, AAR.

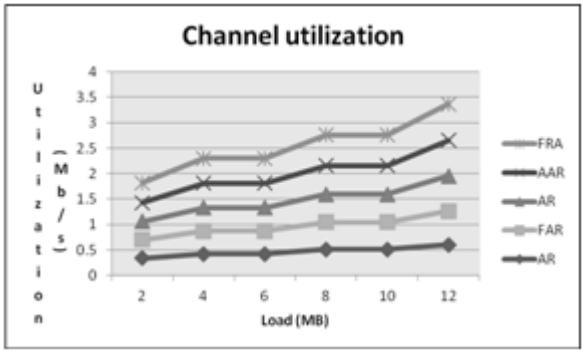

Figure 4.

Figure 4. shows that the proposed FRA have greater channel utilization than the FR, FAR, AR, AAR.

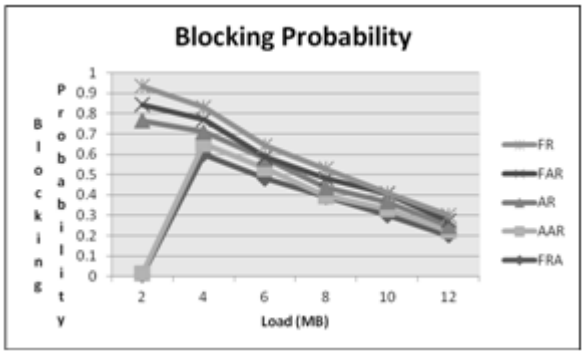

Figure 5.

Figure 5. shows that the proposed FRA is less blocking probability than the FR, FAR, AR, AAR.

VII. CONCLUSION

In this paper the performance of proposed FRA is much better than existing routing algorithm in connection drop rates, delay, channel utilization and blocking probability. The cost may increase due the usage of wavelength conversion.

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