ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 5, May 2015

A Review of Various Algorithms Used to Optimize RWA Problem in WDM Network

Reeta Rani[1], Harjeevan Singh[2]

PG Student, Dept. of ECE, Chandigarh University, Gharuan, Mohali, Punjab, India[1]

Assistant Professor, Dept of ECE, Chandigarh University, Gharuan, Mohali, Punjab, India[2]

ABSTRACT: Wavelength Division Multiplexing (WDM) is expected to be a popular technique for constructing large optical networks interconnecting a large number of nodes. With suitable optical cross connects (OXC) at the nodes, such a network will allow very flexible switching of the various wavelengths and light-paths between the active source-destination pairs. This flexibility in routing will make these networks easy to configure and operate and will also improve the reliability of the network by providing easy-to-set-up alternate paths in case of node and link failures. This paper discuss various nature inspired algorithms to optimize the RWA problem WDM network where traffic conditions are static or may change dynamically as a wavelength assignment problem. Aim of the algorithms explained in this paper is to reduce blocking probability, increase throughput and make the network more efficient for communication.

KEYWORDS: WDM; RWA; GA; ACO; BCO.

I. INTRODUCTION

As the number of internet users is increasing at very high speed requirement of bandwidth is also raise. Due to increasing trend of online services and application like HDTV programming, video sharing, voice calls, P to P file transfer, Emails[1],[2] ,these services require large bandwidth to process. So WDM is a a technology of coming generation network due to its transmitting capacity of data at very bit rates(tb/sec). Theoretically, WDM is similar to FDM used in conventional electronic system. In basic working of WDM network different signals of different wavelength are multiplexed and send on single fiber, for crosstalk free communication two signals should not carry similar wavelength. For communication between source destination pair(s-d) light paths are required when network is wavelength routed. Wavelength converters change the wavelength from one to another along the route. While light path will hold the alike wavelength along all links it travel if wavelength converters are not available and is named as wavelength continuity constraint(WCC).

RWA(routing and wavelength assignment) is important fundamental optimization problem in WDM network. RWA is classified in two sections, in first it provide path and in second it provide wavelength for that connection to every connection request turn up in the network. Further connection request is of two types: static and dynamic. In case of static traffic all information about request for connection is priorily known and routes are decided according to the number of light path requests will be served in the network. But, in dynamic traffic conditions any knowledge about light path requests is not priorily known, requests are arrive randomly, and on demand route will be provided to particular request. Amount of wavelength needed to route packet in static traffic is less than in dynamic traffic because all connection requests/light paths are known in advance and routes for only those requests will be formed. Solving RWA problem in dynamic traffic is more challenging.

To solve this RWA problem in WDM network Routing and Wavelength assignment are consider as a two individual tasks to solve. Further categorized routing techniques are named as fixed routing, fixed alternative routing and adaptive routing[2]. In fixed routing scheme, if network sending data to fixed destination from fixed source, it always use similar fixed path to travel from source to destination, which lead to increase blocking probability because if resource for that fixed path is exhausted the data packet will be blocked. While in fixed alternative routing scheme more than one or number of paths are available if any one path is blocked another alternative path to serve the data communication process, so this scheme offers supplementary QOS and decrease the connection blocking probability.

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 5, May 2015

Finally, in adaptive routing scheme blocking probability is less than other two routing schemes but in turn it cost more control overhead and large setup delay, because route calculation is dynamic according to networks conditions.

For dynamic traffic, wavelength assignment techniques are , like first fit in which first appropriate wavelength from available wavelength pool is assigned to the calculated route. While in least used wavelength assignment technique, minimum used wavelength is allocate to the route. While other techniques are most used, least-loaded, MAX-SUM[1].Where for static traffic model greedy heuristic is used to solve wavelength assignment in WDM network. There are different routing algorithms are proposed to find optimal path in WDM network and to utilize available resources more efficiently. These algorithm are like ACO, GA, ABC.

II.LITERATUE SURVEY

Large work has been done on routing and wavelength assignment(RWA) in recent researches. Different techniques to crack RWA problem are given under dynamic and static traffic models. Routing and wavelength assignment problem was solved by proposing new strategies i.e. "Fixed shortest or alternate shortest path routing with wavelength reservation (FSASWR)" and "Fixed alternate shortest path routing with least priority wavelength assignment (FASPL)"in multiclass WDM optical networks[9]. This network provides a subscriber with multiple classes of services according to the requirement; as a result this increase operational profitability and proposed strategies improve blocking probability. The ILP formulation is formed in [10] to model RWA problem and use a multi objective GA(Genetic algorithm) to establish a connection for requests with minimum congestion between the individuals. The hop count are decreased by GA based heuristic approach , duration of route, the quantity of used fiber links to process all requests for light path. This shows that multi-objective GA is more effective than single objective when optimize different network parameters. Research done in [11] proves ACO-based algorithm perform better than Genetic algorithm to solve any cost RWA problem in dynamic traffic of wavelength-routed optical networks because ACO –based any cost RWA decrease blocking probability than fixed shortest path first(SPF) and other algorithms of dynamic and load balancing.

In [12] they performed different heuristics of wavelength assignment under various routing techniques on light path request set and analyzed results depicts that the fixed alternate routing algorithm use fewer wavelengths than fixed routing and 'most-used' wavelength assignment heuristic gives better results than 'first-fit' wavelength assignment heuristic. It also shows that number of wavelengths used in static traffic model is greater than required in dynamic traffic model and wavelength requirement in network is directly proportional to number of nodes in network.[13] propose an protocol (Priority Scheme Earliest Available Time Scheduling - PS-EATS) which is extension of EATS protocol. PS-EATS modifies the rank order in which connection requests are performed allows long length messages requests to be processed prior to shorter one. Using PS-EATS improves throughput and decrease mean packet delay in network.[14] indicate different priority algorithm in optical mesh networks. Proposed algorithm benefits in resource utilization. To increase availability satisfaction rate and decrease blocking probability, algorithm benefits from service level agreement (SLA).Using this algorithm permit the service provider to provide good quality service request connections on lower cost.

Algorithm shows in [15] consider cost of link is based on load on link..In [15] dynamic traffic is categorized as low and high priority traffic where high priority traffic assigned with lower loaded links and low priority traffic is assign with heavily loaded links. More prior requests have supporting backup paths with primary paths to use in case of failure which in turn improve throughput and lower latency and blocking probability.

III.ALGORITHMS TO OPTIMIZE THE RWA PROBLEM

A. *ACO(ant colony optimization):*

Algorithm optimize the routing and wavelength by update network state continuously. As social creature like ant born without any notable individual intelligence, still they manage their coordination to perform any difficult job by indicating their signals using chemical named pheromone. Which modify the ones behavior, Same concept is used in telecommunication to find shortest path among source and destination or among the nodes. While, travelling in a network each ant leave a chemical mark known as pheromone. Which is followed by the other ants. So the decision to find shortest path is made after interaction of distinct individuals(ant). This is a method which is used to deal with many problems and escort to a metaheuristic called ACO(ant colony optimization)[5].

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 5, May 2015

In packet and circuit switched telecommunication network, algorithm using ACO is used to tackle the routing problem many researches performed in optical network used ACO algorithm to deal with RWA problem. Specifically in case of dynamic shaped traffic. Because in dynamic shape of traffic light path requests are enter randomly in WDM network and light path connections are established on user demand with centralized control.

ACO organize the routing sequence of nodes in table, which solve the RWA up to some extent, but algorithm used ACO is capable of not only to shape routing table but also gather some information about the range of wavelength existing for link in network to achieve this all nodes cooperate with one another to solve RWA problem in batter way, which results in lesser blocking probability[11]. Management data packet(artificial ants) are released in network, which follow the natural behavior of ant and choose their route depending on the quantity and state of artificial pheromone chemical. Ants release some pheromone at each node travelled by them, which leads to increase pheromone in the link through which it enter. Increased pheromone is the function of two variables, one is number of hops(distance) and second is common wavelength available in links sloping by ants. Ants update the network state after every release of pheromone. Which helps to decrease the blocked ends in WDM network. The updated state of network alert the followers ants to avoid the routes having dead ends. Which results in increased throughput and decreased blocking probability.

B. *GENETIC ALGORITHM TO SOLVE RWA PROBLEM(GA):*

GA is nature inspired algorithm. In this various individual solutions are evolved in the direction of better solution by taking the good properties from different individual solutions, and solution is usually calculated from different randomly generated individuals and this is an iterative process. After every iteration one fit value or fit solution is saved. At the end of various iterations number of fit solutions are saved ,which are used to find aggregated fitness function is evaluated. New fitness function is evolution of all those fit solutions. In WDM network, GA is used to optimize the RWA problem by finding some objective function.

GA consist of following features:

Step 1: Crossover:

In n-point crossover process, when route is formed for particular source and destination, but identity of the route is maintained in gross form. Then fitness function is formed, lies in between the best individual solution and worst individual solution. Fitness function is mapped on roulette wheel, and then the individuals have greater value than fit value and have best-fit value are chosen and individuals have worst fit value will be rejected.

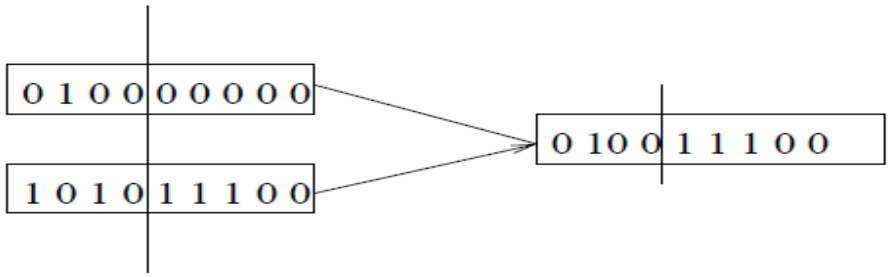

Fig:1 2-point crossover

Step 2: Mutation:

In mutation process individuals having worst fitness functions are chosen. Mutation process tries to form fitter individual from worst individuals.

Wavelength assignment- In this section GA tries to select the individual with such route which is capable of performing particular task using lesser number of wavelength in network. Wavelength assignment is done by several schemes like first fit, least fit, most fit. least loaded etc. Which technique will be selected to assign wavelength to particular connection depends upon various factors like state of network and algorithm used and so on[10].

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 5, May 2015

For every S-D pair, yen's algorithm finds K small length paths to communicate between two points, those small paths are named as a genes of chromosome. Some entry points exists in every gene of chromosome to enter in table, which hold real path. This indicate that one chromosome hold collection of possible paths. For 'n' S-D couples, chromosome is $[log_2 K]$ * n bits long[6]. To get cost linked with each chromosome objective formula is: G is chromosome G=P_{ab} ……..P_{ij} ,where P_{ij} any path from collection of K small length paths to join i and j which are sorce and destination respectively. Now collection of edges in P_{ij} path is expressed as E(P_{ij})

$$Set\ K^* = \cup_{\forall P_{ij} \in G}\ E(P_{ij})$$

C_k the cost,which is assigned to all edges, where K=K^* and C_K= number of paths in G having K as an edge
So, cost function for a chromosome is:

$$\sum_{\forall K \in K^*} V^{C_K}$$

Where V is number of nodes.

Cost function alter in exponential manner according to variation in cost of every edge(this alteration is proportional to the rate of occurrence of edge in source destination couple).

C. *BCO(Bee colony optimization) and ABC(Artificial bee colony optimization):*

This is another nature inspired optimization algorithm. In WDM network this is effective algorithm to deal with RWA problem. Bees are consider as a agent to solve the RWA and Max-RWA problem. In max-RWA problem aim is to increase the number of paths created for communication between two points using BCO[3]. Nodes request for a link which are signify in artificial network.

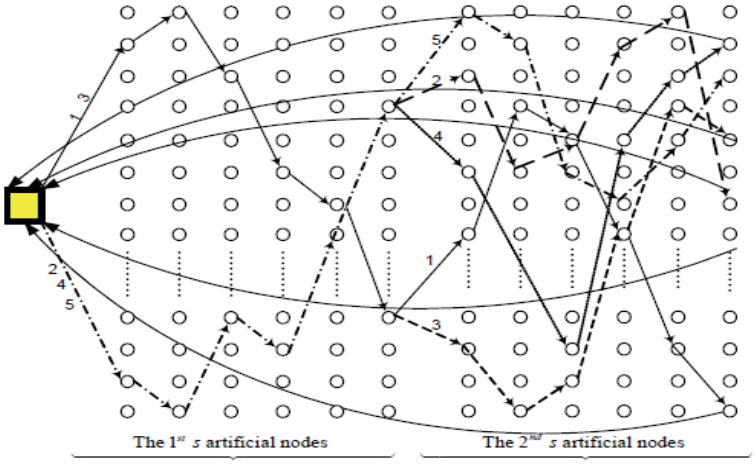

Fig:2 Bees flying through the artificial network

As revealed in fig.2, then all requested light paths are divided in clusters with different levels. As first level is stand for light paths will be created in first flying attempt of bees, while light paths will be created in second flight are fall in second level. Before starting process all the artificial bees gathered in there hive, hive is represented in square shape in fig.2. as the process starts bees fly in natural manner and move from one artificial node to next artificial node. While, their flight bees make two type of moves. One is Forward move and second is Backward move. In Forward move bees fly through the unvisited nodes with the aim of forming new paths. Formation of new routes/paths solve the RWA

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 5, May 2015

problem up to some extent. In backward move they return to hive, where they all share their information about visited nodes and form a solution by comparing the solution formed by each bee from their information gathered while flight. After decision making every bee have their individual choice whether discard the formed solution(bees B2,B3 and B4), and they will follow the other committed bees path. Before obeying the partial solution the select their nest mates. Every bee acquire some loyalty toward the, depending upon the quality of formed solution in hive[4].

Fig.2 shows that bee B1 and bee B2 joined bee B3,while bee B4 joined bee B5. Where in next forward move, B3 fly with B1 on the path found by bee B1. Where bee B2 and bee B4 fly and follow the path of B5. After reaching at the end of last generated path bees again make their own decision to follow the committed bees for visiting next node or not. Now, as fig.2 shows in second forward move bees enlarge the last formed solution in hive and form new light paths. After computing second forward move, bees again execute backward move and make an new better decision in hive by sharing individuals information and make next(third) forward move, so same process is performed again and again to form new solution.

In nutshell, in BCO algorithm, after every iteration bees make a one best partial solution ,so after number of best solutions are saved. Which helps to solve the Max-RWA and RWA problem. If chosen route is short in length, means wavelength's availability is increased for route. Which tends to higher bees utility. Bees utility is calculated as:

$$V_r^{s,d} = \left\{ a \frac{1}{h_r - h_{rmin} + 1} + (1 + a) \frac{W_r}{W_{max}} \right\}$$

V=K shortest path available between source and destination(s,d)
h_r=route length in the form of number of links or hops.
h_{rmin} = length of the smallest route V.

IV.CONCLUSION AND FUTURESCOPE

In this paper, various algorithm inspired from natural process have been presented for solving RWA problem in WDM optical. It has been reveal that different algorithms are useful in finding alternative and optimal paths and offer a efficient use of available wavelength by using various wavelength assignment techniques in WDM network. ACO algorithm can rapidly adjust to real-time variation in the system, which proves it a good algorithm to decrease dead ends in network while transmission of data. Use of these algorithms results in better use of network resources with increased throughput and decrease in blocking probability. These algorithms also support provision that they guarantee up to the fair share of the network capacity of each node. Future work involves use of these algorithms to get more efficient results by changing their objective functions and use these algorithms in different kind and different sizes of networks to optimize the RWA problem .

REFERENCES

1. Zang, H., Jue, J.P., Mukherjee, B, "A Review of Routing and Wavelength AssignmentApproaches for Wavelength Routed Optical WDM Networks" ,Optical Networks Magazine, 2000
2. Mukherjee, B "Optical WDM Networks" ,Springer,January 2006
3. G.Rajesh, S.Chitti BabuM. , "An Efficient and Reliable Algorithm for the RWA Problem in OpticalWDM Networks", International Journal of Engineering Research & Technology (IJERT)., Vol. 1 Issue 7, September 2012.
4. Z. Marković ,S. Aćimović, "Solving the RWA Problem in WDM Optical Networks Using the BCO Meta-Heuristic" ,Telfor Journal,, Vol. 2, No. 1, 2010.
5. Son Hong Ngo, Xiaohong Jiang, Susumu Horiguchi "An Ant-based Approach for Dynamic RWA in OpticalWDM Networks", Malaysian Journal of Computer Science, Vol. 14, pp. 46-57, June 2001.
6. Nilanjan Banerjee, Vaibhav Mehta and Sugam Pandey, "A Genetic Algorithm Approach for Solving theRouting and Wavelength Assignment Problem inWDM Networks" , IJCSI International Journal of Computer Science Issues, Vol. 8, , No 3, November 2011.
7. Sophia G. Petridou, Panagiotis G. Sarigiannidis, "On the Use of Clustering Algorithms for Message Scheduling in WDM Star Networks", IEEE, Journal of light wave technology, vol. 26, no. 17, September 1, 2008.
8. Kuntal Roy , Mrinal K. Naskar , "Genetic evolutionary algorithm for static traffic grooming to SONET over WDM optical networks", Computer Communications, Vol. 30, pp.3392–3402, 2007.
9. Uma RathoreSanjivTokekar "Routing and wavelength assignment algorithms for multiclass WDM optical networks" Elsevier, March 2014

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 5, May 2015

10. Ravi SankarBarpanda, Ashok Kumar Turuk "Genetic Algorithm techniques to solve Routing and Wavelength Assignment problem in Wavelength Division Multiplexing all-optical networks", IEEE, 2011.
11. KavithaBhaskaran, Joan Triay, Vinod M. Vokkarane" Dynamic Anycast Routing and Wavelength Assignment in WDM Networks Using Ant Colony Optimization (ACO)", IEEE, 2011.
12. Ravi TejaKogantia, DeepinderSidhua , "Analysis of Routing and Wavelength Assignment in Large WDM Networks", 9th International Conference on Future Networks and Communications (FNC-2014) Procedia Computer Science, Vol.34, pp.71 – 78, 2014.
13. Chrisoula Papazoglou, "A New Priority Scheme for WDM Star Networks", IEEE,2007
14. AlirezaNafarieh, "Statically Pre-Provisioned Priority-Aware Algorithm for Shared-Mesh Optical Networks"ICTON ,2010.
15. A.Rajkumar, Dr.N.S.Murthy Sharma "A Distributed Priority Based Routing Algorithm for Dynamic Traffic in Survivable WDM Networks"IJCSNS International Journal of Computer Science and Network Security, VOL.8 No.11, November 2008
16. BhaskarDasgupta and Michael A. Palis , "Provably Good Algorithms for Transmission Scheduling in WDM Optical Networks"Journal of Parallel and Distributed Computing Vol.57, pp. 345-357, 1999.
17. Soumitra Pal , AbhiramRanade , "Scheduling light-trails on WDM rings", J. Parallel Distrib. Comput.Vol.72, pp. 1226–1236, 2012.