ISSN:0975-9646

Best-Fit Wavelength Assignment Algorithm For Persistent Communication in Optical Networks

P.Sathishkumar[1], V.Mahalingam [2]

[1]*Computer science and engineering Department, Associate Professor,*
K.S.Rangasamy College of Technology

[2]*Computer science and engineering Department, M.E.(CSE) Final Year,*
K.S.Rangasamy College of Technology

***Abstract*— In this paper, we address traffic control enhancement in order to utilize bandwidth effectively in WDM based optical networks as well as the wavelength assignment problems and then develop an algorithm for both the problems. Traffics in WDM networks can be reduced based on the available free load, the number of wavelength used in the link as construction of pre-defined alternate paths, route and wavelength assignment can be done by considering each pair of source and destination the path with the minimum cost function is selected as the primary path for data transmission, allocating the adequate wavelength. This algorithm provides a reliable and dynamic path for the data transmission. This proposed system will use Dynamic RMSA with HSMR algorithm to be used and the performances will be evaluated by using ns-2 simulation models.**

***Keywords*— Wavelength Assignment, Blocking probability, Optical WDM networks, RMSA, HSMR**.

I Introduction

The basic property of single mode optical fiber is its enormous low-loss bandwidth of several tens of Terahertz. However, due to dispersive effects and limitations in optical device technology are single channel transmission is limited to only a small fraction of the fiber capacity. To take full advantage of the potential fiber, the use of wavelength division multiplexing (WDM) technology has become the option of choice in WDM. A number of distinct wavelength are used to implement separate channels of optical fiber can carry several channels in parallel with each on a particular wavelength. The number of wavelength that each fiber can carry simultaneously is limited by the physical characteristics of the fiber and the state of the optical technology used to combine these wavelengths onto the fiber and isolate them off the fiber.

In currently available commercial technology, a few tens of wavelengths can be supported within the low-loss [1] [2] [3].

The main characteristics of WDM are summarized as follows:

•Fully specified network where fiber amplifiers are used
•Several channels are transmitted sequently in each fiber
•The network forms a large backbone-network

Optical networks employing wavelength division multiplexing (WDM) offer the promise of meeting the high bandwidth requirements of emerging communication applications are dividing the huge transmission bandwidth of an optical fiber (~50 terabits per second) into multiple communication. Channels with bandwidths (~10 gigabits per second) compatible with the electronic processing speeds of the end users.

In this work we are going to do the routing by using dynamic algorithm. Number of wavelengths used in the RWA problem is an important issue [4] [5] [6]. We must use minimum number of wavelengths to establish a maximum number of connection requests. For wavelength assignment we are going to use the Alternate path routing technique [7] [8].

Wavelength Division Multiplexing (WDM)

Wavelength-division multiplexing (WDM) is a method of combining multiple signals on laser beams at various infrared (IR) wavelengths for transmission along fiber optic media. Each laser is modulated by an independent set of signals. Wavelength-sensitive filters, the IR analog of visible-light color filters, are used at the receiving end.

WDM is similar to frequency-division multiplexing (FDM). But instead of taking place at radio frequencies (RF), WDM is done in the IR portion of the electromagnetic spectrum. Each IR channel carries several RF signals combined by means of FDM or time-division multiplexing (TDM). Each multiplexed IR channel is separated, or demultiplexed, into the original signals at the destination. Using FDM or TDM in each IR channel in combination with WDM or several IR channels, data in different formats and at different speeds can be transmitted simultaneously on a single fiber.

In early WDM systems, there were two IR channels per fiber. At the destination, the IR channels were demultiplexed by a di-chroic (two-wavelength) filter with a cutoff wavelength approximately midway between the wavelengths of the two channels. It soon became clear that more than two multiplexed IR channels could be demultiplexed using cascaded di-chroic filters, giving rise to coarse wavelength-division multiplexing (CWDM) and dense wavelength-division multiplexing (DWDM). In CWDM, there are usually eight different IR channels, but there can be up to 18. In DWDM, there can be dozens.

Because each IR channel carries its own set of multiplexed RF signals, it is theoretically possible to transmit combined data on a single fiber at a total effective speed of several hundred gigabits per second (Gbps).

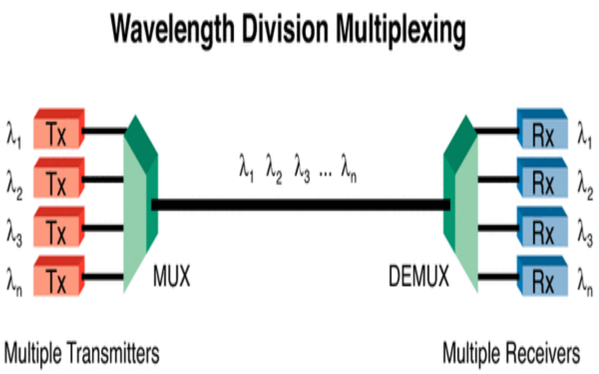

Fig.1. Wavelength division multiplexing

Fig. 1 will shows how the wavelength will be assigned to the each path of the channels and each wavelength is like a separate channel (fiber).

II EXISTING SYSTEM

The O-OFDM networks are only using the Single path routing so the overall bandwidth blocking probability will high [11] [12] [13]. If collision occurs in between routing path that data could be discard from the transmission process. Here more data loss, more blocking probability and low through put [14] [16].

A. Routing and Wavelength Assignment (RWA)

A connection needs to be established in the optical layer in order to carry the information between the clients of the network. The optical connection that is maintained between a source node, s and destination node, d is known as an optical path or light path. In order to allocate and route a wavelength for each of the route set, it is necessary to establish an optical path between the source and the destination. This problem is called as the problem of routing and assigning wavelength (RWA) [17].The problem of RWA is divided into two problems; routing and wavelength assignment. The wavelength assignment problem is again subdivided into two problems; search and selection criteria. The search problem is simple because, for the determined route, any wavelengths can be assigned. The simplest scheme is the first fit. But the selection procedure is comparatively harder when the requirement is to reduce the number of wavelengths used [19]. Likewise in the traffic model, the RWA problem is considered as two; Static Light path Establishment (SLE) and Dynamic Light path Establishment (DLE). In SLE, the set of connections is known in advance and DLE, is a case where there is random arrival of connection request, over an infinite time horizon, and are served on a one-by one basis [20].

B. Routing:

I. Fixed Routing:

In fixed routing, a single fixed route is predetermined for each source-destination pair. When a connection request arrives, the network will attempt to establish a light-path along the fixed route. If no common wavelength is available on every link in the route, then the connection will be blocked. A fixed routing approach is simple to implement; however, it is very limited in terms of routing options and may lead to a high level of blocking. In order to minimize the blocking in fixed routing networks, the predetermined routes need to be selected in a manner which balances the load evenly across the network links. Fixed routing schemes do not require the maintenance of global network state information [21].

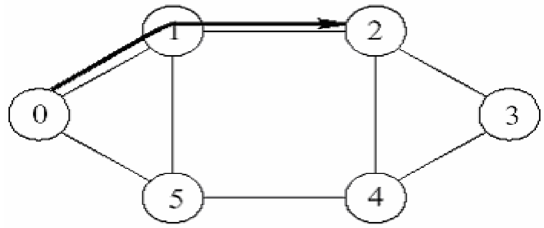

Fig.2. Fixed –shortest path routing

Fig. 2 shows an example of fixed-shortest path routing.

II. Fixed-Alternate Routing:

In fixed-alternate routing, each node in the network is required to maintain a routing table which contains an ordered list of number of fixed routes to each destination node. When a connection request arrives, the source node attempts to establish the connection on each of the routes from the routing table in sequence, until a route with a valid wavelength assignment is found. If no available route is found from the list of alternate routes, then connection request is blocked and lost. In most cases, the routing tables at each node are ordered by the number of fiber link segments (hops) to the destination. Therefore, the shortest path to the destination is the first route in the routing table. When there are ties in the distance between different routes, one route may be selected at random. Fixed-alternate routing provides simplicity of control for setting up and tearing down light paths and it may also be used to provide some degree of fault tolerance upon link failures [22]. Another advantage of fixed-alternate routing is that it can significantly reduce the connection blocking probability compared to fixed routing. This is shown in the fig. 3

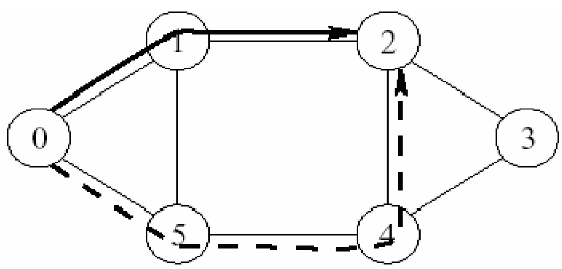

Fig.3. Fixed-alternate routing

III. Dynamic routing:

In adaptive routing, the route from a source node to a destination node is chosen dynamically, depending on the network state. The network state is determined by the set of all connections that are currently in progress. One form of adaptive routing is adaptive shortest-cost-path routing. For the network in Fig. 4, if the links (1,2) and (4,2) in the network are busy, then the adaptive-routing algorithm can still establish a connection between Nodes 0 and 2, while both the fixed-routing protocol and the fixed-alternate routing protocols with fixed and alternate paths would block the connection [23].

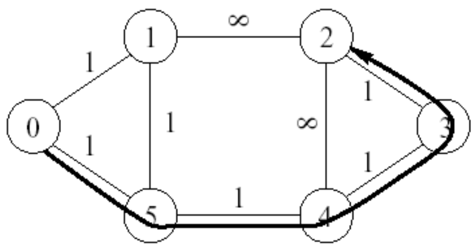

Fig. 4. Adaptive routing

C. Wavelength Assignment Algorithms

In routing there are two ways to use the wavelength. In First case, we can use the same wavelength throughout the path which spans from source to destination [24] [25] [26] [27]. In the second case, we are allowed to use different wavelengths in the path running from source to destination. Among possible others, few independent wavelength assignment algorithms are,

- Random (R) wavelength assignment
- First-Fit (FF) assignment
- Most-used (MU) assignment
- Least-Used (LU)

III PROPOSED SYSTEM

The previous Optical system considers the static path transmission. We have propose and develop the best fit wavelength assignment algorithm in this paper for persistent communication in optical networks. It increases the Throughput, reduces the blocking probability and time delay. The Adaptive routing path approach is used for transmitting data, if congestion occurs routing is done through alternate path. This alternate path routing assumes that every node stores the first N shortest and predetermined paths to each destination by utilizing global and local node link information. Congestion part is determined by the number of wavelengths available per path. It is totally dynamic those are realized in simulation results.

This proposed system, a route between a sender node and receiver node is selected from a set of Pre-defined alternate routes. If any collision occurs in the routed path the data will change and transmitted through alternate path from source to destination. Multi-Path routing provides increased throughput and utilizes the network resources more efficiently.

The proposed scheme provides an RWA approach for multi-fiber WDM networks with wavelength conversion. In the proposed scheme, a route between a sender node and a receiver node is selected from a set of pre-defined routes which are free from congestion occurrence which do not share a link, and a wavelength is selected within the selected route. The proposed route considers location of nodes with wavelength conversion capability in selected route. The proposed scheme divides each path into segments between nodes with wave length conversion capability and also selects a route among pre-defined paths and assigns wavelengths to segments along the selected route in such a way as to avoid the generation of congestion links and the depletion of a specific wave length. To do so, the proposed scheme selects a route based on wavelength availability in each segment. A collision occurs when data is transmitted in certain link. If wavelengths in the link are in concurrent use alternative path for transmission cannot be established in the link. Hence, it aim to reduce the congestion probability by reducing the generation of traffic deadlock links. In order to share loads and avoid the generation of congestion routs, the proposed algorithm alternatively selects a route which has segments with many available wavelengths.

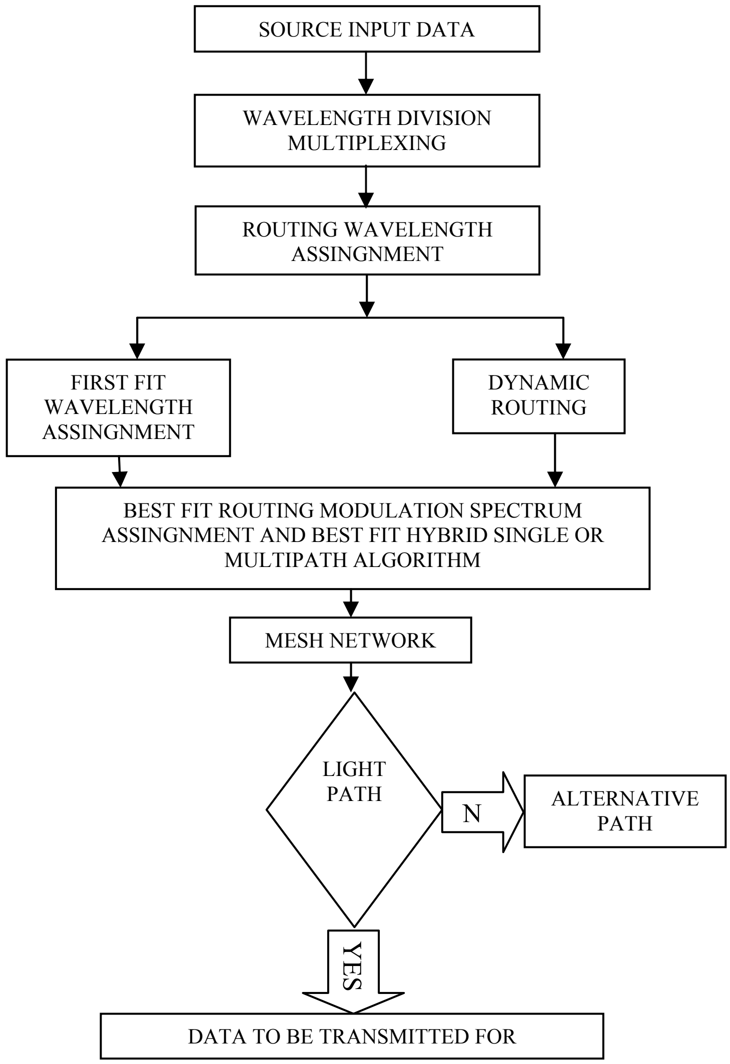

Fig.5. System flow diagram for Best Fit Optical Network

IV PROPOSED ALGORITHM

Best fit Routing Modulation Spectrum Assignment with Hybrid Single/Multi-Path Routing Algorithm:

In this below algorithm the physical topology is mentioned as 'G' (V,E,B,D) where V stands for all the nodes in the network, E stands for the fiber links of the network, B is the number of frequency slots that each fiber links accommodate at a time, D is denoting the length of the links[5]. First the network monitoring system will collect the available resources and all the node details, then update the link weights based on the current network status. Then the virtual topology G', will be calculated and then the parameters of the incoming request like source, destination and capacity will be processed to find out the K-shortest paths of the network then the paths will be sorted based on the weighted total node distance and the current status of G. Then all the paths will be sorted in ascending order, then the maximum possible modulation level will be calculated for the selected path and the incoming request will be provisioned with the required capacity. At the end of data transmission the allotted resources will be freed up for the upcoming requests. The below algorithm shows the detailed procedure in implementing the proposed algorithm and we calculate the routing path set for the path selection of each request using network status.

Algorithm Steps:

1: collect link status of G (V, E, B, D);
2: **while** the network is operational **do**
3: restore network resources used by expired requests;
4: update link weights $\{d_e^{'}\}$ based on the current network status, using (8)–(9);
5: construct virtual topology $G^{'}$ ($V^{'}$, $E^{'}$, $B^{'}$, $D^{'}$) with $\{d_e^{'}\}$;
6: get parameters of an incoming request LR(s, d, C);
7: calculate K -shortest routing paths from s to d in $G^{'}$ ($V^{'}$, $E^{'}$, $B^{'}$, $D^{'}$);
8: sort the paths based on the weighted total distances $\sum_e d_e^{'}$;
9: **for** all paths in the ascending order **do**
10: determine the highest modulation level M_i for the path with its real distance $\sum_e d_e^{'}$ using (1);
11: **for** all available slot blocks with sizes >= g **do**
12: allocate capacity C_i to slot blocks with (3);
13: **if** $\sum_i C_i = C$ **then**
14: break inner and outer for-loops;
15: **end if**
16: **end for**
17: **end for**
18: **if** $\sum_i C_i < C$ **then**
19: reverse all the spectrum allocations;
20: mark the request as blocked;
21: **end if**
22: **end while**

Example for Proposed System

Fig. 5 illustrates an intuitive example of the usage of BW (Bandwidth) allocation granularity g in service provisioning with HSMR. Fig. 5(a) shows a network topology with six nodes, and we label each link with (BW and length), i.e., it's available BW in terms of the number of slots and its link length. For simplicity, we assume that each link only has one slot block available.

With this G (V, E, B, D), we will not be able to serve a request from node 1 to 6 for a BW of four contiguous slots with a single routing path. Hence, we calculate multiple routing paths and label them with the sizes of available slot blocks, as shown in Fig. 5(b).It clear that Path E: 1-2-3-6 is not a qualified path for a BW allocation granularity g=2 because it only has a slot block of one slot available. We select Paths A and C for less lengths and provision the request for a BW of four slots from node 1 to 6 successfully [as shown in Fig. 5(c)].

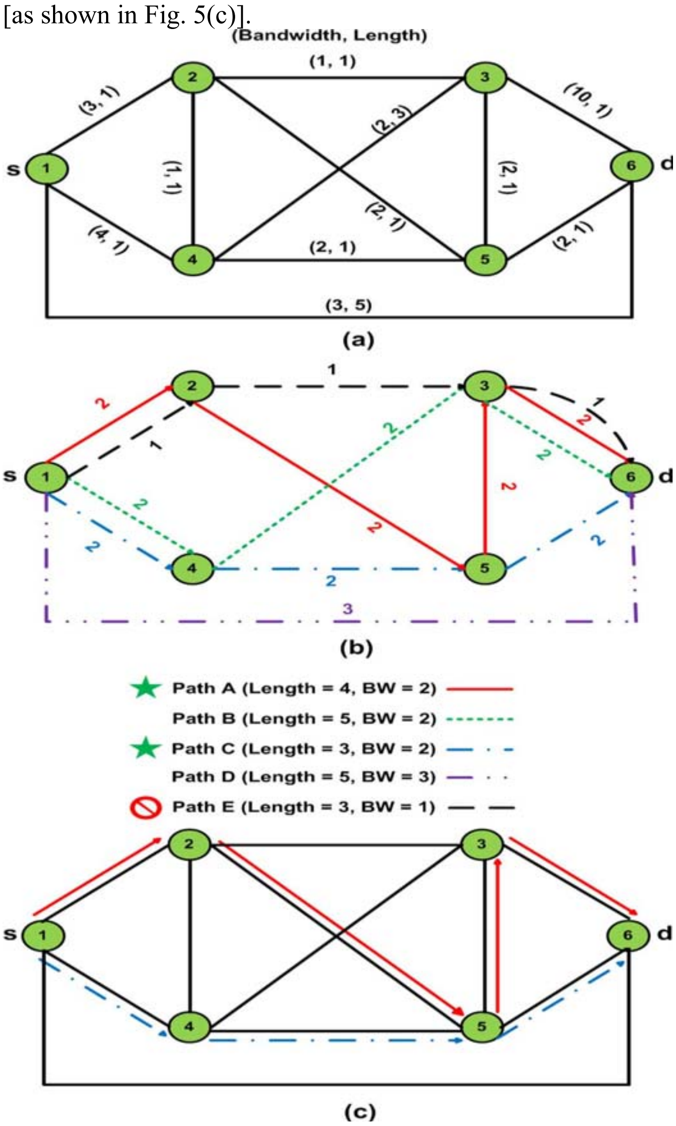

Fig.6. Example of service provisioning using multipath routing with a BW allocation granularity of g=2. (a) Network topology G (V, E, B, D). (b) Path computation results. (c) Elastic multipath provisioning scheme for a request with BW= 4 and g=2.

V Simulation & Results

In this paper we are using the Network Simulator (ns2) for the simulation of the performance [15] [18] [19]. This will reduce the overall blocking probability and increasing the throughput.

Steps in Simulation:

1. Sending Packet Data request between source and destination node in a TCP/IP network using mesh topology.
2. Data packets will be sent to the destination node by the source node.
3. The possibility of occurrence of congestion in the transmission route.
4. The Alternate Path (backup path) will be choosing and the traffic will be routed through backup path to avoid collision.

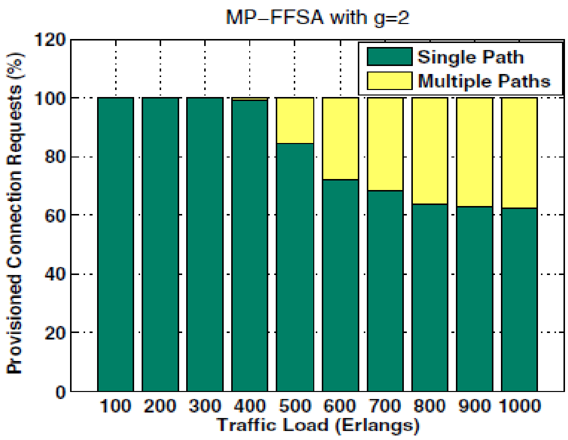

Fig.7. The Performance analysis of Single Path and Multi-Paths.

IV. Conclusion

In this paper a dynamic RWA scheme for WDM optical networks with routing and wavelength assignment algorithm is applied. The route and wavelengths are selected for each light-path based on wavelength availability Dynamic Routing and First-Fit Wavelength Assignment algorithm. Hence to obtain an efficient path for a given source and destination pair hence primarily the bandwidth and delay will be calculated for every link which can form a path between the given node pair.

In case if the link is completely loaded further path will not be generated, If it not completely loaded and has free channels for wavelength assignment then it is considered for the formation of the new path. Next the shortest and low traffic path is calculated based on assigning minimum granularity values. Finally RMSA with HSMR algorithm to be used for alternate path selection methods. Furthermore, it will demonstrated the robustness of the proposed paper against system parameter values such as the number of wavelengths supported by each fiber and the number of fibers in each link. finally this paper developed the dynamical RWA algorithm for optical networks for fast and long distance data transmission. Hence it is observed that the paper efficiently reduces blocking probability in WDM optical networks in simulation experiments.

References

[1]. Armstrong, J. (2009) ‘OFDM for Optical Communications’, Journal of Light wave Technology, Vol. 27, No. 3.

[2]. Chen, J. Chan, S. H. and Li, V. (2004) ‘Multipath routing for video delivery over bandwidth-limited networks,’ IEEE Journal on Selected Areas in Communications, Vol. 22, No. 10.

[3]. Christodoulopoulos, K. Tomkos, I. and Varvarigos, E.A. (2011) ’Elastic Bandwidth Allocation in Flexible OFDM-Based Optical Networks’, Journal of Light wave Technology, Vol. 29, No. 9.

[4]. Charbonneau, N. and Vokkarane, M. (2012) ‘Static Routing and Wavelength Assignment for Multicast Advance Reservation in All-Optical Wavelength-Routed WDM Networks’, IEEE/ACM Transactions on Networking, Vol. 20, No. 1.

[5]. Dhritiman, B. and Biswanath, M. (2000) ‘Wavelength-Routed Optical Networks: Linear Formulation, Resource Budgeting Tradeoffs, and a Reconfiguration Study’, IEEE/ACM Transactions on Networking, Vol. 8, No. 5.

[6]. Erik Van, B. Jan, C. and Davy De, W. (2006) ‘Overspill Routing In Optical Networks: A True Hybrid Optical Network Design’, IEEE Journal On Selected Areas In Communications, Vol. 24, No. 4.

[7]. Filippo, C. Gianluca, M. and Francesco, P. (2012) ‘Demonstration of Flexible Optical Network Based on Path Computation Element’, Journal Of Light wave Technology, Vol. 30, No. 5

[8]. Guoying, Z. Marc, D. Annalisa, M. and Biswanath, M. (2013) ‘A Survey on OFDM-Based Elastic Core Optical Networking’, IEEE Communications Surveys & Tutorials, Vol. 15, No. 1.

[9]. Huang, S. Martel, C. and Mukherjee, B. (2011) ’Survivable multipath provisioning with differential delay constraint in telecom mesh networks,’ IEEE/ACM Transactions on Networking, Vol. 19, No. 3, pp. 657–669.

[10]. Jason, P. J. (2010) ‘Lightpath Establishment in Wavelength-Routed WDM Optical Networks’, Center for Advanced Telecommunications Systems and Services.

[11]. Kouji, H. and Dewiani, (2012) ‘Dynamic Routing and Wavelength Assignment in Multifiber WDM Networks with Wavelength Conversion Capability’, Network and Communication Technologies Vol. 1, No. 2.

[12]. Kavitha, T. and Rajamani, V. (2012) ‘Efficient Multipath Routing and Wavelength Allocation Using Traffic Grooming In Optical Wavelength Division Multiplexing Mesh Networks’ , Journal of Computer Science, Vol. 8, No. 11, pp. 1839-1848.

[13]. Konstantinos, M. Archontoula, A. and Emmanouel, V. (2013) ‘Energy Efficient RWA Strategies for WDM Optical Networks’, Journal of Optical Communication Network Vol. 5, No. 4.

[14]. Long, G. Xiang, Z. and Zuqing, Z. (2012) ‘A Two-Population Based Evolutionary Approach for Optimizing Routing, Modulation and Spectrum Assignments (RMSA) in O-OFDM Networks’, IEEE Communications Letters, Vol. 16, No. 9.

[15]. Marc Greis (2002), http://www.isi.edu/nsnam/ns/tutorial/

[16]. Masahiko, J. Takuya, O. Yoshiaki, S. and Osamu, I. (2011) ‘Elastic and Adaptive Optical Networks: Possible Adoption Scenarios and Future Standardization Aspect’, IEEE Communications Magazine, pp. 0163-6804.

[17]. Ma, Z. Shao, H. and Shen, C. (2004) ‘A new multi-path selection scheme for video streaming on overlay networks,’ IEEE Communications Society, pp. 7803-8533-0.

[18].Mohittahiliani(2011),http://www.mohittahiliani.blogspot.in/2011/08/awk-scripts-for-normalized-routing.html

[19]. Norouzi, A. Halim, Z. Berk Burak, A. (2011) ‘An integrate`d survey in Optical Networks: Concepts, Components and Problems’, International Journal of Computer Science and Network Security, Vol.11, No.1.

[20]. Rajeev, S. (2012), http://home.iitk.ac.in/~rajeevs/research-ns2.html

[21]. Shieh, W. Yi, X. and Tang, Y. (2007) ‘Transmission experiment of multi-gigabit coherent optical OFDM systems over 1000km SSMF fibre’, Electronics Letters Vol. 43 No. 3.

[22]. Srivastava, A. (2006) ‘Flow aware differential delay routing for next-generation Ethernet over SONET/SDH’, in Proc. 2006 ICC, pp. 140–145.

[23]. Son-Hong, N. Xiaohong, J. and Susumu, H. (2004) ‘Dynamic Routing and Wavelength Assignment in WDM Networks with Ant-Based Agents’, Springer-Verlag Berlin Heidelberg, pp. 829–838.

[24]. Vitthal, J. and Aditya, G. (2010) ’Performance Evaluation of Wavelength Routed Optical Network with Wavelength Conversion’, Journal of Telecommunication’s, Volume 2, Issue 1.

[25]. Wei, L. Xiang, Z. Long, G. Mingyang, Z. and Zuqing, Z. (2013) 'Dynamic Multi-Path Service Provisioning under Differential Delay Constraint in Elastic Optical Networks', IEEE Communications Letters, Vol. 17, No. 1.
[26]. Xiaowen, C., Bo, L. Imrich, C. (2003) 'Wavelength Converter Placement under Different RWA Algorithms in Wavelength-Routed All-Optical Networks', IEEE Transactions on Communications, Vol. 51, No. 4.
[27]. Zhu, K. Zang, H. and Mukherjee, B. (2003) 'Exploiting the benefit of virtual concatenation technique to the optical transport networks,' In Proceeding 2003 OFC, pp. 363–364.