

# Analysis of Qos Parameters Over WDM Networks Using MPLS System

<sup>1</sup>Mandeep Kaur Sandhu, <sup>2</sup>Shalini Tripathi

<sup>1,2</sup>Dept. of ECE, RBIEBT, Chandigarh, UT, India

## Abstract

Wavelength Division Multiplexing (WDM) has becoming main network in communication for high bandwidth and low delay. The main traffic problem is due to sharing of videos/ audios between data centers, IPTV and VoIP in which QOS are very important. Earlier many techniques has been proposed to solve this problem. So in this paper, we investigate the problem of traffic due to multicast requests with the objective of to minimize the blocking probability, delay and load. Instead of using traditional methods here new heuristic method has been utilized and two blocking models are taken into account like session blocking probability and destination blocking probability. In addition to this seqR-P and SeqR results has also been evaluated in comparison with SBP and DBP too. The results shows that SeqR-Pperforms better than seqR.

## Keywords

Wavelength Division Multiplexing (WDM), Traffic Engineering, Multicast Routing

## 1. Introduction

The popularity of IP over internet is very promising these days in data traffic engineering [1]. This growth is mainly due to the high consumption rate of power and storage capacity by the users. The reason of applications of the artificial intelligence and high bandwidth requirement [2]. There are various technologies that can solve the problem of high bandwidth requirement like Asymmetric Digital Subscriber Line (ADSL), High-bit-rate Digital Subscriber Line (HDSL), and fibre to the home (FTTH). But due to change in the traffic pattern leads to the need of traffic management. In the past data traffic was small w.r.t to voice traffic. But in today's era both are needed at same rate [3]. These are the two effects that leads to the core requirement of traffic management for data as well as voice. Such architectures leads to the need of Qos optimization [4-6].

To meet these requirements WDM has moved from traditional methods to new methods. WDM has increased the usage of fibre communication by dividing the bandwidth named wavelength to manage the traffic [7]. Today's internet is dominated by various IP protocol services. Therefore, IP over WDM has a good combination that can manage traffic well.

The field of fiber optics communications has exploded over the past two decades [8]. Fibre is an integral part of modern day communication infrastructure and can be found along roads, in buildings, hospitals and machinery. Fiber-optic communication is a method of transmitting information from one place to another by sending pulses of light through an optical fiber. The light forms an electromagnetic carrier wave that is modulated to carry information [9-11].

Main motivation of fiber optics is to meet demand of increase in the telecommunication data transmission [12]. It totally works on the total internal reflection (critical angle, using Snell's law). An optical fiber is flexible, transparent fiber made of high quality extruded glass (silica) or plastic, slightly thicker than a human hair. It includes a core surrounded by transparent cladding material [13].

From last year's we have witnessed point to point WDM transmission technology in internet. The requirement of high bandwidth in the network has highlighted the need of faster switching. In addition to this there is also another important need of enhancement in Internet Protocol to support traffic engineering. MPLS makes the internet architecture to behave in a connection-oriented fashion to support Qos and traffic engineering [14].

## A. MPLS in WDM network

Multi-Protocol Label Switching (MPLS) was developed as a packet-based technology and is rapidly becoming key for use in core networks, including converged data and voice networks. MPLS does not replace IP routing, but works alongside existing and future routing technologies to provide very high-speed data forwarding between Label-Switched Routers (LSRs) together with reservation of bandwidth for traffic flows with differing Quality of Service (QoS) requirements [15-17].

MPLS uses a technique known as label switching to forward data through the network. A small, fixed-format label is inserted in front of each data packet on entry into the MPLS network. At each hop across the network, the packet is routed based on the value of the incoming interface and label, and dispatched to an outgoing interface with a new label value [18].

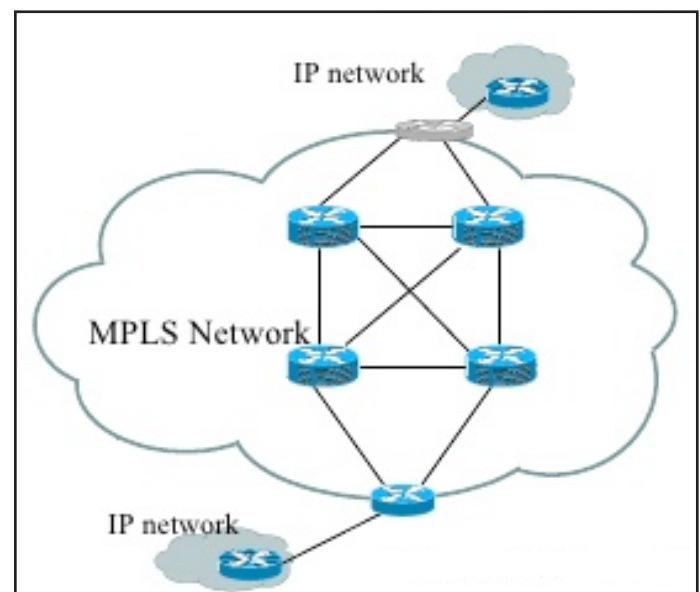


Fig. 1: MPLS Network

In traditional IP routing, packet transmission has been done then look back into lookup table for updating. But in MPLS network, data packets are assigned with labels so no need to look into look-up tables [19]. This is the main point that makes indifferent from traditional algorithms.

## B. Blocking Probability

Blocking in a system is when a circuit group is fully occupied and unable to accept furthermore calls. It also referred to as congestion. Due to blocking in telecommunications systems, calls are either queued (but not lost) or are lost. The formula for the blocking

probability ( $P_b$ ) is known as Erlang B formula. The mathematical representation of blocking probability ( $P_b$ ) is given below. Where  $A$  is the traffic intensity and  $C$  is the number of channels. The formula applies under the condition that an unsuccessful call, because the line is busy, is not queued or retried, but instead really disappears forever. It is assumed that call attempts arrive following a Poisson process, so call arrival instants are independent.

$$P_B(C, A) = \frac{\frac{A^C}{C!}}{\sum_{k=0}^C \frac{A^k}{k!}}$$

## II. Proposed Architecture

### A. Assumptions

Formally, the enhancement of Qos parameters problem can be defined as follows:

- **Input:** A WDM network having set of various wavelengths and set of multicast requests.
- **Output:** A set of light-structures satisfying the three constraints {multicast requests are rooted from source, MC-OXC has must one arc input, MC-OXC must be able to split the signal}
- **Objective:** Minimize delay, blocking probability and load balancing.

Table 1: Variables Used

Notations	Meanings
C	No. of channels
L	Loads
W	Wavelength
R	Multicast requests
S	Total MC-OXC
SBP	Session Blocking Probability
DBP	Destination Blocking Probability

### B. Methodology

- Step: 1 Initialize No. of channels  
 Step: 2 Initialize No. of links  
 Step: 3 Total no. of loads  
 Step: 4 Total no. of generations  
 Step: 5 Wavelength  
 Step: 6 Get MC-OXC

To support WDM multicasting efficiently, the networks should be equipped with multicast capable cross-connects (MC-OXCs) that are capable of splitting an incoming signal to multiple outgoing ports. However, they are costly in both fabrication and power consumption. That is why it is common in recent optical networks that all nodes are not capable of multicast. A small percentage of MC-OXCs mixed with multicast incapable cross-connects (MI-

OXCs) may suffice to support optical multicasting. The concept of “light tree” firstly proposed in optical routing and it is a point to multipoint optical channel and can be used to support multicasting at optical layer. To implement light tree, multicasting capable OXC (MC-OXC) is required to duplicate the optical signals. Traditionally, the light-tree was assumed to be a cost-effective route with the support of MC-OXCs at the branching nodes. Recently, a new multicast structure called light-hierarchy has been proposed in literature survey. A light hierarchy allows an MI-OXC to be crossed several times by using different input–output links, and hence relaxes the constraint of tree structure required by the routing.

Step: 7 No. of requests

For each request  $r_i$  to be considered (selected according to the indexed order  $r_1; r_2 \dots r_n$ ), on the layers (wavelength graphs)  $\lambda_1; \lambda_2; \dots \lambda_n$ , one by one (also according to the indexed order). Whenever a light-hierarchy is computed in a certain layer, it is directly assigned the corresponding wavelength. Then the affected layers are updated in such a way that the wavelength assignment are removed from the wavelength graphs. Repeat the operations until all the requests are attempted. The pseudo-code of the SeqR-P algorithm is shown in below algorithm. A request is considered to be accepted if all of its destinations are accepted. If not, the request is blocked, and the algorithm frees the wavelengths (restores the status for the used arcs) that have been assigned for the light-hierarchies computed for it. In contrast, if the request is not totally accepted, the accepted destinations are still served. This method is natural and relatively straightforward. It does not require global information of all the requests. Thus it can be applied for the dynamic traffic case.

Step: 8 Compute blocking

Step: 9 Plot blocking

Step: 10 Show: legend(‘Seq-Priority’, ‘SeqR’);  
 xlabel(‘Number of Wavelength(W)’);  
 ylabel(‘Session Blocking probability [%]’)

Step: 11 Show: legend(‘Seq-Priority’, ‘SeqR’);  
 xlabel(‘Channel Request’);  
 ylabel(‘Session Blocking probability [%]’);

Step: 12 Show: legend(‘Seq-Priority’, ‘SeqR’);  
 xlabel(‘Number of Request’);  
 y label (‘Session Blocking probability [%]’);

Step: 13 Plot Channel Usage

Step: 14 Plot destination block

Step: 15 Plot, load, delay and Destination blocking probability as in step 10 to 12.

### Sequential Request Priority Algorithm

*Input:* set of wavelengths ( $w_1, w_2 \dots w_n$ ) and requests ( $r_1, r_2 \dots r_n$ ).

*Output:* Set of light hierarchies

For all  $w_n$  and  $r_n$ .

Do

  Compute light hierarchy.

  Assign different wavelengths.

  Break

End

Calculate Blocking Probability

### C. Flowchart

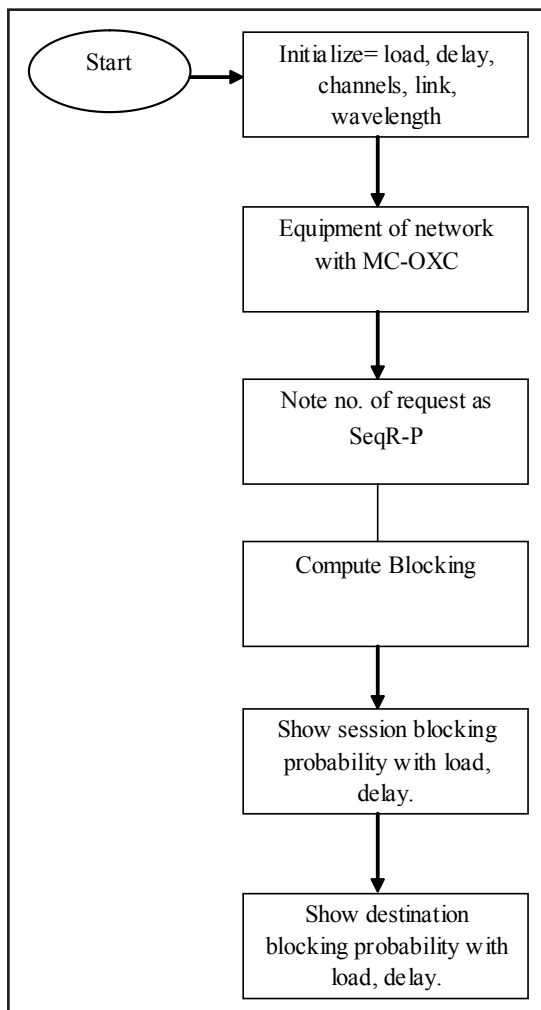


Fig. 2: Proposed Flowchart

### III. Results and Analysis

The whole simulation has been done In MATLAB environment to optimize delay, load and blocking probability.

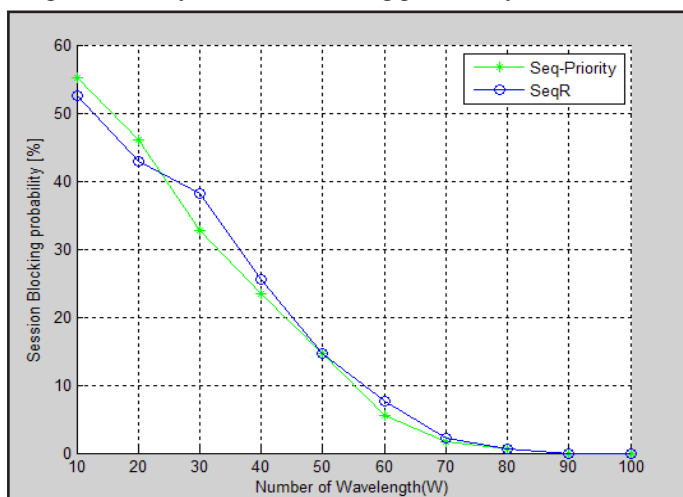


Fig. 3: SPB Versus Wavelength

To show the difference between the light-hierarchy solution and the light tree solution, we compare the performance of seqR with that of seqR-P. A novel multicast routing structure, i.e. light-hierarchy, is introduced instead of the traditional light-tree for Wavelength Division Multiplexing (WDM) networks. Here SeqR-P is light hierarchy algorithm. As we can see from the figures, seqR-P

outperforms seqR in session blocking probability used in all the studied contexts. This is because light-hierarchies allow us to exploit all the available wavelengths in the current network state by taking advantage of using all possible directions (arcs) on every link and cross connect.

Mainly strategies try to route as many requests as possible by making use of the available wavelengths on the layered graph, resulting in lower blocking probability. On the other hand some strategies just compute the physical topology neglecting the current state of the network, giving high blocking probability. The fixed alternate strategy has more choices compared with the fixed strategy; it still suffers from high blocking probability due to the inherent shortcoming of static routing. Above figure shows that SBP for SeqR-P is low in comparison to SeqR.

Indeed, since it is easier for small requests to be totally accepted, giving high priority to them probably results in lower SBP. However, when most of the small requests have been adopted, the availability of wavelengths becomes exhausted and the incoming (larger) requests will be blocked, causing high DBP.

Here the algorithm has used 8 channels in WDM. The channels are equi-spaced in frequency and not in wavelengths.

We can see from the figures, seqR-P outperforms seqR in destination blocking probability used in all the studied contexts.

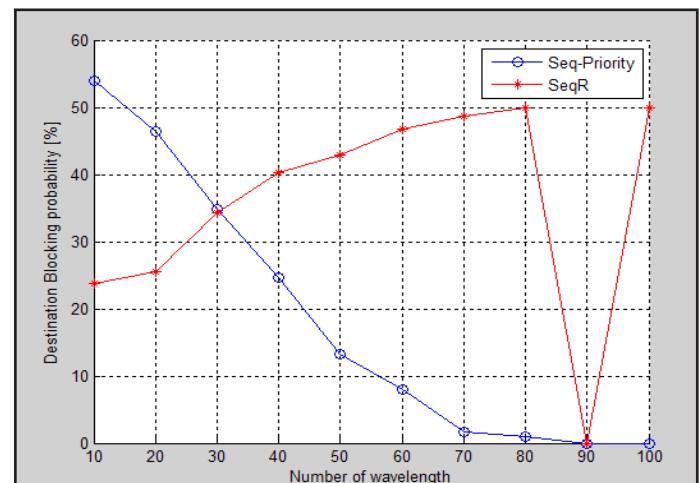


Fig. 4: DBP Versus Wavelength

This is because they allow us to exploit all the available wavelengths in the current network state by taking advantage of using all possible directions (arcs) on every link and cross connect.

DBP is destination blocking probability. Provisioning the larger requests first would allow more destinations to be served, or lower DBP. However, when most of the large requests have been adopted, the availability of wavelengths becomes exhausted and the incoming (larger) requests will be blocked, causing high DBP.

### IV. Conclusion and Future Scope

This paper investigated the problem of providing multiple static request in MPLS networks in WDM. The main aim is to minimize the blocking probability, delay and load considering two blocking models: Session blocking Probability and Destination Blocking Probability. We employed various adaptive algorithms to solve these problems. The contributions of this work include the following:

Providing IP Problem formulation over internet using exact solution for the Qos optimization problem in WDM network.

Providing sequential request adaptive heuristic algorithm for

dynamic traffic management.

Showing that SeqR-P is better than SeqR in terms of delay, loads and blocking probability.

Future scope lies in the investigation of more topics in WDM like traffic grooming, QoS-aware RWA, and power-aware RWA, are not investigated in this work. They will be the main concerns in our next study.

## References

- [1] C. Siva Ram Murthy, Mohan Gurusamy, "WDM Optical Networks, Concepts, Design and Algorithm", New Delhi, India. Printic-Hall, 2002.
- [2] Behrouz A. Forouzan, "Data Communication and Networking", New Delhi, India. Tata McGraw-Hill, 2004.
- [3] Osama Awwad, AlaAl-Fuqaha, Ammar Rayes, "Performance of WDM Mesh Networks with Limited Traffic Grooming Resources", IEEE WOCN 2007, Singapore, July 2-4, 2007.
- [4] Jun Zhou, Xin Yuan, "A study of dynamic Routing and Wavelength assignment with Imprecise network State information", IEEE, Parallel Processing workshop, 2002.
- [5] Ashok Kumar Pradhan, S. Barat, tanmay De, "A heuristic approach for multicast Traffic grooming in optical WDM Mesh network", I. J. computer Network and information security, 2014.
- [6] Amrinder S. Arora, Suresh Subraamaniam, "Converter placement in Wavelength Routing Mesh Topologies", IEEE publication 2000.
- [7] Gangxiang Shen, Rodney S. Tucker, "Sparse Traffic Grooming in Translucent Optical Networks", IEEE, Journal of Lightwave Technology, Vol. 27, No. 20, october 15, 2009.
- [8] H. Zang, J. P. Jue, B. Mukherjee, "A Review of Routing and Wavelength Assignment Approaches for Wavelength-Routed Optical WDM Networks", SPIE Optical Networks Magazine, Vol. 1, No. 1, pp. 47-60, January 2000.
- [9] Bishwanath Mukherjee, "Optical WDM Networks", Springer Publication 2006.
- [10] Keyao Zhu, Hongyue Zhu, Bishwanath Mukherjee, "Traffic Grooming in Optical WDM Mesh Networks", Springer Publication 2006.
- [11] A. Mokhtar, M. Azizoglu, "Adaptive Wavelength Routing in All-Optical Networks," IEEE/ACM Transactions on Networking, 6(2), pp. 197-206, 1998.
- [12] S. Ramamurthy, B. Mukherjee, "Fixed-Alternate Routing and Wavelength Conversion in Wavelength Routed Optical Networks," IEEE/ACM Transactions on Networking, 10(3), pp. 351-367, 1998.
- [13] R. Ramaswami, K. Sivarajan, "Routing and Wavelength Assignment in All-Optical Networks," IEEE/ACM Transactions on Networking, 3(5), pp. 489-500, 1995.
- [14] N. Zhang, H. Bao, "Re-routing Technology and Its Application in Optical Network," In Proceedings, 2010 International Conference on Innovative Computing and Communication and 2010 Asia-Pacific Conference on Information Technology and Ocean Engineering, pp. 24- 27, 2010.
- [15] M. Kodialam, T.V. Lakshman, "Integrated dynamic IP and wavelength routing in IP/MPLS over WDM networks", In: Proceedings of IEEE INFOCOM, 2001.
- [16] Zhen, Q., Gurusamy, M., "Multilayer protection with integrated routing in MPLS-over-WDM optical networks", Optical Networks. v15 i1. pp. 223-241.

- [17] Multiprotocol label Switching (MPLs), Web Proforum Tutorials, The International Engineering Consortium.
- [18] Shahram Mohrehkesh, Saleh Yousefi, Mahmoud Fathy, "A Path Computation algorithm in MPLS Traffic Engineering for reducing blocking probability", ITC19/ Performance Challenges for Efficient Next Generation Networks, 2005.
- [19] Haris Hodzic, Elmir Secerbegovic, "Support for Traffic engineering by online routing algorithm", 2009.



Shalini Tripathi done her B.tech in electrical and electronics form Gautam Buddha Technical Univesity, Utter Pradesh, India in 2011. Also pursuing M.tech degree in electronics and communication form Punjab Technical University, India.

At Present she was engaged in thesis which is related to wireless and communication. Worked as assistant engineer in transformer company Marsons India Pvt. Ltd. in 2012.