



## Wavelength Assignment Algorithms

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**Abstract**— *The main aim of this research paper is to analyse the performance of various wavelength assignment algorithms such as First Fit, Random Fit, Most Used, Least Used and their effect on the blocking probability. How routing and wavelength assignment scheme with traffic grooming can be used to reduce call blocking. Effect of varying number of wavelength converters, placement of traffic grooming devices and different traffic types on blocking probability.*

**Keywords**— *WDM Networks; Blocking Probability; First Fit; Random Fit; Most Used; Least Used; Traffic Grooming.*

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### I. INTRODUCTION

In recent years, demand for high bandwidth has been growing at a very rapid pace led by Internet and multimedia applications. Networks which employ optical fiber for transmission are very attractive because fiber provides an enormous bandwidth, low loss and very low bit error rate.

**1.1 Lightpaths:** In all-optical networks, the data remain in the optical domain throughout their path except at the ends. Such paths are termed lightpaths.

**1.2 Wavelength Conversion:** In networks using full wavelength conversion, a call is accepted if on all the links on its route there is at least one free wavelength. With no wavelength conversion, a call is accepted on a route if there exists at least one wavelength which is simultaneously free on all the links of that route.

This constraint is known as the wavelength continuity constraint. This means a call can be blocked even if there are free wavelengths (but not the same one) on all the links. Therefore, having full wavelength conversion is advantageous in that it decreases the blocking probability. However, implementing all-optical full wavelength conversion is quite difficult due to technological limitations. So, it is interesting to investigate whether we can do as well as full wavelength conversion in terms of blocking performance by using limited-range wavelength conversion, if not by using no wavelength conversion.

Limited wavelength conversion can imply a limit on the number of nodes with full wavelength conversion capability (sparse wavelength conversion), or a limit on the range of wavelengths to which a given wavelength can be converted (limited-range conversion) [8].

**1.3 WDM Technology:**

The currently favored technology to tap the huge bandwidth of optical fiber is wavelength division multiplexing (WDM). In WDM networks, the optical spectrum is divided into many different channels, and each channel corresponds to a different wavelength which can operate at the peak electronic speed. In wavelength routed WDM networks, the wavelength can be reused, provided no two lightpaths sharing a link are assigned the same wavelength.

To fulfill the demand of bandwidth required for the services such as transmission of audio, video and data using video on demand etc, the WDM optical network plays an important role in optical networks. Thus with the help of WDM technology, it is possible to transmit traffic on different wavelength within the same optical fibre simultaneously. But in early days the optical fibre communication was only confined to do transmission of single fibre channel, but now a days optical network satisfies the requirement of high transmission.

Since the data rate increases at rapid rate so in order to meet the efficient utilization of the fibre capacity WDM (wavelength division multiplexing) network came into scenario to meet the demand of high bit rate. WDM enables the efficient utilization of optical fibre by dividing its tremendous bandwidth into a set of disjoint wavelength bands, which are referred as wavelengths. Each of these wavelengths supports one communication channel which corresponds to an end user operating at an arbitrary speed and helping in overcoming the optoelectronic mismatch between multiple terabit per second bandwidth of optical fibre and gigabit per second electronic processing speeds at end user. WDM based optical network enables the fibre to provide the large throughput as each of these multiple channels have assigned different wavelengths and transmitted over the same fibre simultaneously. Wavelength Division Multiplexing also solves the problem of dispersion which came into the effect during transmission in the fibre by keeping the transmission rates of each channel at reasonably low levels and achieving a high data rate by combining many channels.

**1.4 WDM Network Categories:**

Based on different wavelength patterns the WDM networks are categorized as conventional or coarse WDM and dense WDM. Conventional WDM system provides upto 16 channels whereas dense WDM provides denser channel spacing on same transmission window.

The performance of WDM based optical network primarily depends on routing and wavelength assignment techniques used. These techniques are evaluated in terms of call/connection blocking probability in network. The connection blocking is the probability that an incoming call or connection request is blocked or denied, due to insufficient resources between source and destination. For every dynamic connection request, a light path is needed to be established, otherwise connection is blocked. A network's performance is inversely proportional to the amount of connection blocking in the network. The factors which causes the connection blocking in network are: insufficient network resources like wavelength or bandwidth, lack of wavelength converters in network, routing and wavelength assignment decision made on outdated network state information. Insufficient network resources means lack of available wavelength and converters. The wavelength continuity constraint increases the blocking probability. According to this constraint the same wavelength should be maintained on all links from source to destination. This constraint affects the performance of the network by the blocking connection requests because of unavailability of common wavelength on intermediate links.

*1.5 Traffic Grooming:* The RWA problem on sub wavelength demands with the objectives of minimizing the network cost and optimizing network throughput is called traffic grooming. The traffic grooming came in 1990's to address the gap in between channel capacity and individual traffic demands in optical networks. The problem of multiplexing and routing low speed traffic requests over light path as well as determining their wavelength assignment is known as traffic grooming technique. Bandwidth requirement of end users is too less as compare to big companies the end users are in Mbps, that is too less as compare to capacity of an entire wavelength. So to accommodate low speed streams and to reduce wastage of bandwidth, traffic grooming technique is used. According to their functionalities traffic grooming is of two types:

- ❖ Single hop grooming
- ❖ Multi hop grooming

Wavelength continuity constraint can be relaxed by using wavelength converters. A wavelength converter is a single input/output device that converts the wavelength of an optical signal arriving at its input port to different wavelength as the signal departs from its output port, but otherwise leaves the optical signal unchanged. Wavelength conversion increases the routing choices for a given light path resulting in better performance in terms of less blocking probability. It also reduces the bandwidth loss that results in better bandwidth utilization. However such converters are expensive. The routing and wavelength assignment (RWA) can be split up into two parts: first choosing the route then assigning the wavelength/channel to that route. In routing process the routes are chosen based on shortest path selected. [1]

*1.6 Various Wavelength Assignment Algorithms are as follows:*

*1.6.1 First Fit (FF) Wavelength Algorithm:*

In this method first the free wavelengths of traffic matrix are sorted in non decreasing order. FF strategy always chooses the lowest indexed wavelength from the list of free wavelengths and assigns it to the connection request. When the request is completed the wavelength is added back to the free wavelength set.

*1.6.2 Random Fit (RF) Wavelength Algorithm:*

In this method, a set of free wavelengths on particular path is determined. RF algorithm determines which wavelengths are available and then choose the wavelength randomly amongst the available set of free wavelengths.

*1.6.3 Most Used (MU) And Least Used (LU) Wavelength Algorithm:*

In most used algorithm, whenever the connection request is made it get to be allocated by the wavelength which is using on the greatest number of fibres in the network. Least used (LU) wavelength assignment is similar to the most used algorithm except in LU algorithm the least used wavelength in the wavelength is assigned [1].

## **II. Literature Survey**

Vikas Kaushik et. al. [1] This paper analyzes the performance of various wavelength assignment algorithm and their effect on the blocking probability of the connection request in the optical network with traffic grooming. The experimentation results indicate that the most used algorithms achieves reduced network blocking rate with and without Traffic Grooming.

Yvan Pointurier et. al. [2] In this paper, an analytical method to evaluate blocking probability in all-optical networks, accounting for several physical layer impairments: intersymbol interference (ISI), amplifier noise (both are static effects that only depend on the network topology only) and node crosstalk (a dynamic effect that depends on the network status) is presented.

Bijoy Chand Chatterjee et. al. [3] In this paper, a priority based routing and wavelength assignment scheme with incorporation of a traffic grooming mechanism (PRWATG) to reduce call blocking is proposed.

Jun He et. al. [4] In this paper, analytical expressions for the total blocking probability are derived for first-fit wavelength assignment for networks suffering from transmission impairments.

Yvan Pointurier et. Al. [6] In this paper, an analytical method to evaluate blocking probability in all-optical networks, accounting for physical layer impairments is presented.

Dr. Aditya Goel et. al. [7] In this work the effects of varying number of wavelength converters, different traffic types on fiber link utilization and network blocking probability are evaluated and results are shown that the blocking probability is minimum with wavelength conversion factor of 0.5. Thus a network with 32 and 64 wavelengths and 50% wavelength convertible nodes is proposed.

Tushar Tripathi et. al. [8] In this paper, a method to calculate the average blocking probability in all-optical networks using limited-range wavelength conversion is proposed.

### III. Conclusion

Various wavelength assignment approaches are discussed and their performance has been analysed. Blocking Probability of network increases when the requested wavelength is not available for any connection request. After the survey it is shown that the most used wavelength assignment algorithm achieves reduced network block rate and delay with increased channel utilization and throughput.

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