

# Comparative Study of Wavelength Assignment Algorithms for WDM Optical Network

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## Abstract

*Wavelength assignment in optical networks is a critical designing issue as it affects the overall performance of the network. In this paper, wavelength assignment algorithms have been reviewed namely random, first fit and dynamic (proposed) wavelength assignment algorithm. For given system parameters, the performance of all three algorithms is evaluated in terms of blocking probability. Results are showing that performance of dynamic algorithm is better than other two algorithms discussed.*

## 1. Introduction

Communication networks are reaching more and more people every day and providing new means of information exchange. Consequently, data and traffic demand is growing rapidly (exponentially). All these bandwidth hungry applications have increased user data traffic and therefore demand for bandwidth [1]. This exponential growth has triggered the development of new technologies, and the advancement of existing one promising technology that meets the high bandwidth demand of data networks is optical networking technologies. This can be accomplished by a multiplexing technique like time division multiplexing (TDM), code division multiplexing (CDM), and wavelength (or frequency) division multiplexing (WDM) [2].

WDM network can provide end-to-end optical communication channels through optical fibres and intermediate nodes with optical cross-connects, even the source and destination nodes are not connected by a fibre directly. There are issues related with optical communication system like congestion. The problem of congestion can be handled using wavelength assignment technique.

In this paper various wavelength assignment techniques have been reviewed and their performance comparison is done in terms of blocking probability. Section 2 briefly describes the routing and wavelength assignment issues and constraints. In section 3 pseudo code for Random, First-Fit and dynamic (Proposed) algorithms are given. In section 4 performance comparison for these algorithms is given for variable system parameters. In the end of this paper, conclusion is given based on simulated results.

## 2. Routing and Wavelength Assignment

RWA is the unique feature of WDM networks in which light path is implemented by selecting the path of a physical link between source and destination edge nodes and reserving a particular wavelength on each of these links for the light path. Routing deals with an optical connection and wavelength assignment policy allocate available wavelengths for the path selected for routing. Collectively it is known as routing and wavelength assignment (RWA) [3].

There are two constraints that have to be kept in mind by the approaches when trying to solve RWA.

- 1) **Distinct wavelength assignment constraint:** All light paths sharing a common fiber must be assigned distinct wavelengths to avoid interference. This applies not only within the all-optical network but in access links as well [4].
- 2) **Wavelength continuity constraint:** The wavelength assigned to each light path remains the same on all the links it traverses from source end-node to destination end-node [4].

Wavelength continuity constraints can be eliminated by using wavelength converter. The wavelength routed networks with this capacity is known as wavelength convertible networks.

## 3. Wavelength Assignment Algorithms

Wavelength assignment is a unique feature in which wavelength are searched before allocating to the path selected. Many algorithms have been proposed by researchers in past few years. In this section the most popular wavelength assignment algorithms have been reviewed [5]. These are:

1. Random wavelength assignment algorithm
2. First-fit wavelength assignment algorithm
3. Proposed wavelength assignment algorithm

### 3.1 Random wavelength assignment algorithm

- Step1: Initialisation of network parameters.  
 Step2: Select any source destination pair.  
 Step3: Select any root out of all possible roots for selected source destination pair.  
 Step4: Assign any wavelength out of available wavelengths.  
 Step5: Is blocking probability of path is greater than threshold value?  
 Step6: If yes, repeat step4 and select new wavelength value if no, establish network connection.  
 Step7: Repeat step2.

### 3.2 First – Fit Wavelength Assignment Algorithm

- Step1: Initialisation of network parameters.  
 Step2: Select any source destination pair.  
 Step3: Select any root out of all possible roots for selected source destination pair.  
 Step4: Arrange available wavelengths in ascending order.  
 Step5: Assign first/next wavelength to the selected path.  
 Step6: Calculate blocking probability for selected route.  
 Step7: Is blocking probability of path is greater than threshold value?  
 Step8: If yes, repeat step4 and select new wavelength value if no, establish network connection.  
 Step 9: Repeat step 2 for particular route.

### 3.3 Proposed wavelength assignment algorithm

- Step1: Initialisation of network parameters.  
 Step2: Pick a request with wavelength.  
 Step3: Find the first two paths.  
 Step4: If yes (path is returned), then make primary and secondary paths. If No, request has been discarded.  
 Step5: Send request for s-d pair.  
 Step6: Check the destination frequency (frequency matching).  
 Step7: If yes, update path selection matching, If no, then frequency conversion is done.  
 Step8: Update path structure in links.  
 Step9: Update load of the path assignment.  
 Step10: Update bandwidth structure of path.  
 Step11: Repeat step 2.

## 4. Performance Evaluation of algorithms

The system parameters considered in simulation set up are mentioned in Table 1 below.

**Table 1: System Parameters**

Parameter	Value
Simulator	NS2
Simulation Time	90 mSec
No of nodes	2-10
Traffic Model	CBR
Packet size	2 Bytes
No. of Packets	10
Wavelength Index	1550.X nm *X is variable

Table 2 to Table 6 are showing the performance comparison of mentioned algorithms for variable load and nodes. The load values taken in simulation are two, four, six, eight and ten only [6].

**Table2: Blocking Probability with Two Erlangs**

Number of Nodes	Blocking Probability with Two Erlangs load		
	Blocking Probability (%) x 10 <sup>-6</sup>		
	Random	First Fit	Dynamic
2	100	100	100
4	110	120	100
6	160	190	100
8	190	210	130
10	230	220	150

**Table3: Blocking Probability with Four Erlangs**

Number of Nodes	Blocking Probability with Four Erlangs load		
	Blocking Probability (%) x 10 <sup>-3</sup>		
	Random	First Fit	Dynamic
2	1.1	2	1.1
4	4.0	4	4.0
6	5.5	6	5.5
8	7.3	8	7.3
10	8.3	10	8.3

**Table 4: Blocking Probability with Six Erlangs**

Blocking Probability with Six Erlangs load			
Number of Nodes	Blocking Probability (%) x 10 <sup>-3</sup>		
	Random	First Fit	Dynamic
2	1.3	2	1.3
4	3.2	4	3.2
6	5.3	6	5.3
8	8.6	8	8.6
10	9.8	10	9.8

**Table5: Blocking Probability with Eight Erlangs**

Blocking Probability with Eight Erlangs load			
Number of Nodes	Blocking Probability (%) x 10 <sup>-3</sup>		
	Random	First Fit	Dynamic
2	4.1	2	4.1
4	5.9	4	5.9
6	7.9	6	7.9
8	9.2	8	9.2
10	9.9	10	9.9

**Table6: Blocking Probability with Ten Erlangs**

Blocking Probability with Ten Erlangs load			
Number of Nodes	Blocking Probability (%) x 10 <sup>-3</sup>		
	Random	First Fit	Dynamic
2	5.4	2	5.4
4	6.7	4	6.7
6	8.7	6	8.7
8	9.4	8	9.4
10	9.9	10	9.9

It is clear from the observations made in tables that dynamic wavelength assignment algorithm outperforms over first fit and random algorithm. Blocking probability of dynamic algorithm is significantly less than rest two algorithms studied in this paper.

## 5. Conclusion

In this paper, three wavelength assignment algorithms have been discussed. These are Random, First-Fit and Dynamic (proposed) wavelength assignment algorithm. For given system parameters (i. e. Table 1), the performance of all three algorithms is evaluated in terms of blocking probability. Results are showing that performance of dynamic algorithm is better than other two algorithms.

## References

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