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# Different Heuristics for Static RWA Algorithms in Fiber Optical WDM Networks

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**ABSTRACT**

*The present day scenario explosive demand for network bandwidth has become a major challenge, due to increasing global popularity of the Internet and multimedia applications it affords. Optical data communication has been acknowledged as the best solution for meeting the present bandwidth requirements This is due to the fact that each optical fiber has the ability to support bandwidth demand of up to 50 THz. the bandwidth is divided into a number of channels on different wavelengths. This method of sending many light beams of different wavelengths simultaneously on the same fiber is referred to as "Wavelength division multiplexing" (WDM). Routing and wavelength assignment is the fundamental control problem in WDM wavelength routed networks. The RWA problem can be divided into route selection and wavelength selection. in this paper we are proved Shortest-path fixed-order method performs better than the shortest- path-random method.*

***KEYWORDS:*** *Optical Communication, WDM, RWA*



## I. Introduction

The explosive growth of the Internet and bandwidth-intensive applications such as video-on-demand and multimedia conferencing require high-bandwidth transport networks whose capacity (bandwidth) is much beyond what current high-speed networks such asynchronous transfer mode (ATM) networks can provide. Thus, a continuous demand for networks of high capacities at low costs is seen now. This can be achieved with the help of optical networks, as the optical fiber provides an excellent medium for transfer of huge amounts of data Optical networks, employing wavelength division multiplexing (WDM), is seen as the technology of the future.

## II. Optical Fiber Principles

Optical fiber consists of a very fine cylinder of glass (core) through which light propagates. The core is surrounded by a concentric layer of glass (cladding) which is protected by a thin plastic jacket in Fig(1)

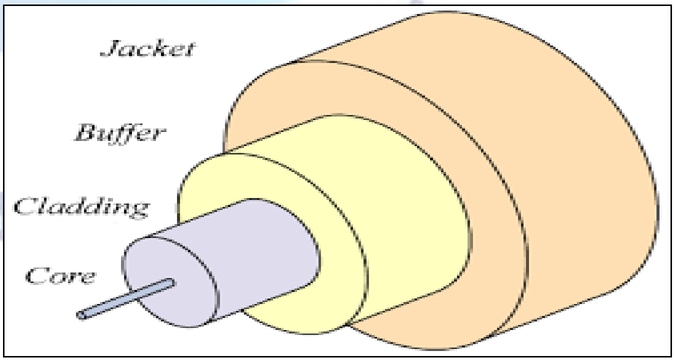



***Fig 1: Fiber optical principle diagram***

## III. Wavelength Division Multiplexing (WDM)

Theoretically, fiber has extremely high bandwidth (about 25 THz (terahertz), i.e., 25 million MHz (megahertz) or 25 x $10^{12}$ Hz (Hertz)!) in the 1.55 low-attenuation band, and this is 1,000 times the total bandwidth of radio on the planet Earth. However, only speeds (data rates) of a few gigabits per second are achieved because the rate at which an end user (for example, a workstation) can access the network is limited by electronic speed, which is a few gigabits per second. Hence it is extremely difficult to exploit all of the huge bandwidth of a single fiber using a single high-capacity wavelength channel due to optical-electronic bandwidth mismatch or "electronic bottleneck". The recent breakthroughs (Tb/s) are the result of two major developments: *wavelength division multiplexing* (WDM) Fig (2)

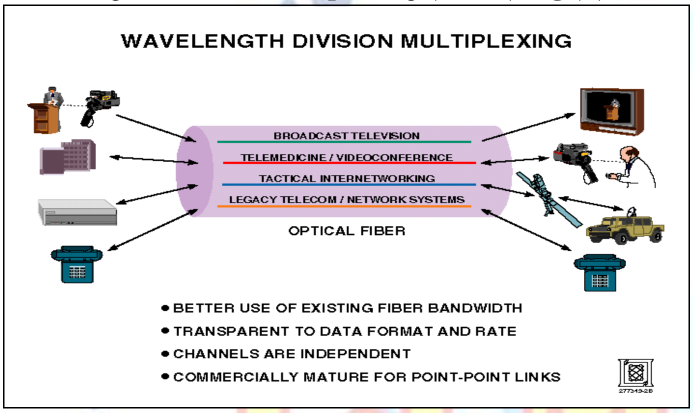


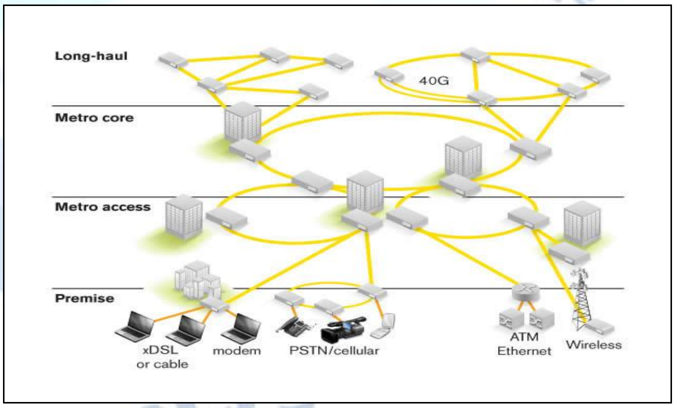

***Fig (2): Wavelength Division Multiplexing***

## IV. Wavelength Routed Networks

Wavelength routed WDM networks have the potential to avoid the three problems – lack of wavelength reuse, power splitting loss, and scalability to wide area networks (WANs) – of broadcast-and-select networks. A wavelength routed network consists of WXCs (routing nodes) interconnected by point-to-point fiber links in an arbitrary topology. Each end node (end user) is connected to a WXC via a fiber link. The combination of end node and its corresponding WXC is referred to as a (network) node. Each node is equipped with a set of transmitters and receivers, for sending data into the network and receiving data from the network, respectively, both of which may be wavelength-tunable.

In a wavelength routed network, a message is sent from one node to another node using a wavelength continuous route called a *lightpath(3)*, without requiring any optical-electronic-optical conversion and buffering at the intermediate nodes. This process is known as *wavelength routing*. Note that the intermediate nodes route the lightpath in the optical domain using their WXCs. The end nodes of the lightpath access the lightpath using transmitters/receivers that are tuned to the wavelength on which the lightpath operates.

Existing Internet backbone networks consist of high-capacity IP (Internet Protocol – developed for providing connectionless transfer of packets across an internetwork) routers interconnected by point-to-point fiber links. Traffic is transported between routes through high-speed gigabit links. These links are realized by SONET or ATM-over-SONET technology. The backbone routers use IP-over-SONET or IP-over-ATM-over-SONET technology to route IP traffic in the backbone network. Most of the SONET-based backbone transport networks provide data interface at the rate of OC-3 and OC-12. The traffic demand is growing at a faster rate and a point has been reached where data interfaces at the rate of OC-48 and more are required. Upgrading the existing SONET transport infrastructure to handle these high-capacity interface rates is not desirable, as it is impractical to go for upgrading every time the interface rate increases. Also, such upgrading is not economical. A viable and cost-effective solution is to use WDM technology in backbone transport networks Fig(3). In such (for example, IP-over-WDM) networks, network nodes are interconnected by WDM fiber links (where each link is capable of carrying multiple signals simultaneously, each on a different wavelength), and the nodes employ WXCs and electronic processing elements.




***Fig(3): WDM Back-bone Network***

## V. Static Versus Dynamic Traffic Demand

The connection requests (traffic demand) can be either static or dynamic. In case of a static traffic demand, connection requests are known *a priori*. The traffic demand may be specified in terms of source-destination pairs. These pairs are chosen based on an estimation of long-term traffic requirements between the node pairs. The objective is to assign routes and wavelengths to all the demands so as to minimize the number of wavelengths used. The dual problem is to assign routes and wavelengths so as to maximize the number of demands satisfied, for a fixed number of wavelengths. The above problems are categorized under the *static lightpath establishment* (SLE) problem. The SLE problem has been shown to be NP-complete (that is, it is computationally intractable or, in other words, the only known algorithms that find an optimal solution require exponential time in the worst case) (1). Therefore, polynomial-time algorithms which produce solutions close to the optimal one are preferred

In case of a dynamic traffic demand, connection requests arrive to and depart from a network one by one in a random manner. The lightpaths once established remain for a finite time. The dynamic traffic demand models several situations in transport networks. It may become necessary to tear down some existing lightpaths and establish new lightpaths in response to changing traffic patterns or network component failures. Unlike the static RWA problem,

## VI. Routing And Wavelength Assignment

In wavelength routed WDM networks, a connection is realized by a lightpath. In order to establish a connection between a source-destination pair, a wavelength continuous route needs to be found between the node pair. An algorithm used for selecting routes and wavelengths to establish lightpaths is known as *routing* and *wavelength assignment* (RWA) algorithm. Many problems in wavelength routed WDM networks have RWA as a subproblem. Therefore, it is mandatory to use a good routing and wavelength assignment algorithm to establish lightpaths in an efficient manner. Wavelength assignment is a unique feature in wavelength routed networks that distinguishes them from conventional networks.

### *6.1 Route Selection Methods*

The important routing methods considered in the literature are 1.*fixed routing*, 2.*alternate routing*, and 3.*exhaust routing(2).* In the fixed routing method, only one route is provided for a node pair. Usually this route is chosen to be the shortest route. When a connection request arrives for a node pair, the route fixed for that node pair is searched for the availability of a free wavelength. In the alternate routing method, two or more routes are provided for a node pair. These routes are searched one by one in a predetermined order. Usually these routes are ordered in non-decreasing order of their hop length. In the exhaust method, all possible routes are searched for a node pair. The network state is represented as a graph and a shortest-path-finding algorithm is used on the graph. While the exhaust method yields the best performance when compared to the other two methods, it is computationally more complex. Similarly, the fixed routing method is simpler than the alternate routing method, but it yields poorer performance than the other.

### 6.2 *Wavelength Selection Methods*

Based on the order in which the wavelengths are searched, the wavelength assignment methods are classified into

1.*most-used,*
2.*least-used,*
3.*fixed-order*, and
4.*random-order(4).*

In the most-used method, wavelengths are searched in non-increasing order of their utilization in the network. This method tries to pack the light-paths so that more wavelength continuous routes are available for the requests that arrive later. In the least-used method, wavelengths are searched in non-decreasing order of their utilization in the network. This method spreads the light-paths over different wavelengths. The idea here is that a new request can find a shorter route and a free wavelength on it. The argument is that the most-used method may tend to choose a longer route, as it always prefers the most-used wavelength. In the fixed-order method, the wavelengths are searched in a fixed order. The wavelengths may be indexed and the wavelengths with the lowest index is examined first. In the random method, the wavelength is chosen randomly from among the free wavelengths. The most-used and least-used methods are preferred for networks with centralized control. The other two methods are preferred for networked with distributed control. The numerical results reported in the literature show that the most-used method performs better than the least-used method and the fixed-order method performs better than the random method RWA algorithms may select routes and wavelengths one after the other

## VII. PERFORMANCE METRICS

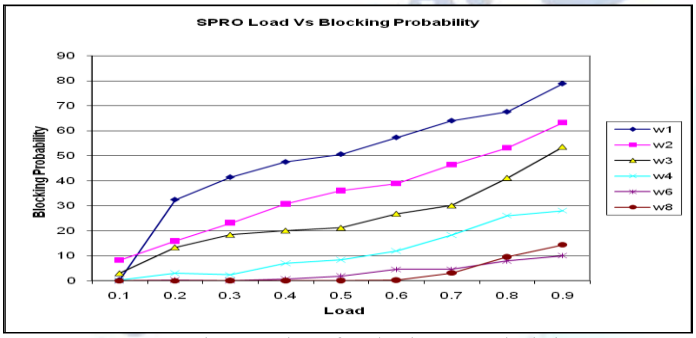
| Simulation Parameters | Values |
|---|---|
| Packet Generation Probability | 0.1 to 0.9 |
| Number of Iterations | 5000 nos |
| Packet generated Source and Destination pairs percentage | 40% |

| | |
|---|---|
| Network Model | 14 Node NSF |
| Number of wavelengths | 8 |

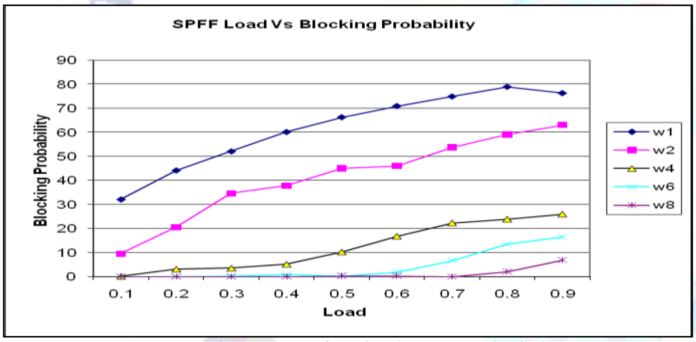
## VIII. Performance Analysis

**1.Packet Blocking Probability**: Packet Blocking Probability is ratio of total numbers of packets blocked and total number of packets generated.

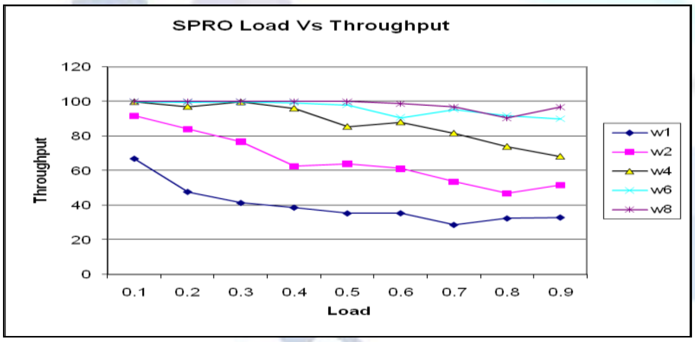
2. **Throughput:** ratio of packets reached and generated



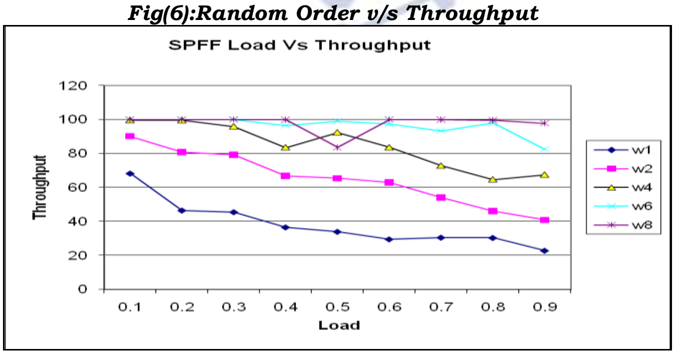

*Fig(4):Random Order v/s Blocking probability*




*Fig(5):Fixed- Order v/s Blocking probability*




*Fig(6):Random Order v/s Throughput*




*Fig(7):Fixed Order v/s Throughput*

## IX. Conclusion

We have briefly discussed the history and background of the fiber optic networks and differenttechniques for utilization of vast bandwidth of fiber optic media.for different aspects purpose we implement WDM optical network is presented. The characteristics of wavelength routing networks are taken into consideration for transmission packets in fiber optic networks.for applying the concept of routing and wavelength assignment for better utilization of bandwidth.in this paper shortestpath fixed-order gives better result compare to shortestpath random order with metrics of Blocking Probability and Throughput.In future I am applying all RWA Algorithms for both traffics.

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