

# REVIEW PAPER ON VARIOUS TOOLS AND METHODS FOR OPTIMIZING THE ROUTING ALGORITHMS IN OPTICAL NETWORKS

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**Abstract-** In order to provide continuous service in the presence of network failure, survivability of a network has been used. WDM network carries a single channel that may accept tens of gigabits of data per second, a single failure would cause a huge amount of service disruption to a large number of users. Design of survivable optical networks has therefore attracted the attention of the research community. The categorization of a network failure has link or node failures. Link failure usually occurs because of cable cuts, while a node failure occurs because of equipment failure at network nodes as well as the channel failures are also possible in WDM networks. A channel failure is usually caused by the failure of transmitting or receiving equipment operating on that channel (wavelength). The restoration schemes differ in their assumption about the functionality of cross-connects, traffic demand, performance metric, and network control. The mainly used protection schemes are shared path protection and dedicated path protection. In case of shared path protection, spare capacity is shared among different protection paths, while in dedicated path protection, the spare capacity is dedicated to individual protection paths. Shared path protection, although more difficult to implement, have been proven to be more capacity efficient than dedicated path protection. This paper is proposed to study various tools and methods for optimizing the routing algorithms in optical networks and to deal with the future aspects of the proposed work.

**Key Words:** WDM-Wavelength Division Multiplexing, DWDM – Dense Wavelength Division Multiplexing, RWA-Routing & Wavelength Assignment, LP-Linear Programming, ILP-Integer Linear Programming, MILP-Mixed Integer Linear Programming, ADM – Add Drop Multiplexer, OADM – Optical Add Drop Multiplexer, OXC – Optical Cross-Connect, SOA – Semiconductor Optical Amplifier, EDFA – Erbium-Doped Fiber Amplifier, LED-Light Emitting Diode, WAN- Wide Area Network, LAN – Local Area Network.

## 1. INTRODUCTION:

A routing algorithm establishes the paths that messages must follow to reach their destination. The performance of

an interconnection network is deeply influenced by certain properties of the routing algorithm used. Among these properties, two are of greater importance, deadlock and livelock freedom and adaptivity.

Adaptivity is the ability of a routing algorithm to route packets through alternative paths in the presence of contention or faulty components. This is opposed to deterministic routing in which a message, originating at a specific source node, is always routed through the same path to reach a specific destination.

Deadlock and livelock freedom is the ability to guarantee that messages will not block or wander across the network forever. The deadlock situation occurs when no message can advance towards its destination because of being blocked by other messages that can not advance towards their destination in a similar manner. The deadlock situation occurs when messages indefinitely wander across the network never reaching their destination. Livelock may only occur when the routing algorithm in a network is non-minimal. Minimal routing algorithms always route messages through the shortest path to their destination while non-minimal routing algorithms do not necessarily do so.

Deterministic routing has been used in many practical multi-computer systems using virtual channels to ensure deadlock avoidance. This is achieved by forcing messages to visit the virtual channels in a strict order. This form of routing has the advantage of being simple, but is unable to adapt to conditions such as congestion or failure. Dimension-order routing is a typical example of deterministic routing where messages visit network dimensions in a pre-defined order. However, if any channel along the path happens to be heavily loaded, the message will experience a large delay and if any channel along the path is faulty the message will not be delivered at all. This is while other minimal paths may exist through which the message can be routed without excessive delay.

Adaptive routing usually has the ability to provide better performance which is less sensitive to the communication pattern and paths can be chosen according to the degree of channel congestion at the node where the routing decision is being taken. Many adaptive routing

algorithms (minimal and non-minimal) have been reported in the literature for *torus* networks. These algorithms display interesting tradeoffs between their degree of adaptivity and the number of virtual channels needed for deadlock-free operation.

Survivability of a network refers to a network's capability to provide continuous service in the presence of failures. In a WDM network, as a single channel may be carrying tens of gigabits of data per second, a single failure would cause a huge amount of service disruption to a large number of users. Design of survivable optical networks has therefore attracted the attention of the research community. The basic types of failures in the network can be categorized as either link or node failures. Link failure usually occurs because of cable cuts, while a nodes failure occurs because of equipment failure at network nodes. Besides, channel failures are also possible in WDM networks. A channel failure is usually caused by the failure of transmitting and/or receiving equipment operating on that channel (wavelength). The restoration schemes differs in there assumption about the functionality of cross-connects, traffic demand, performance metric, and network control. Survivability paradigms are classified based on their re-routing methodology as path/link based, execution mechanisms as centralized/distributed, by their computation timing as precomputed/real time, and their capacity sharing as dedicated/shared. There are two commonly used protection schemes: shared path protection and dedicated path protection. In case of shared path protection, spare capacity is shared among different protection paths, while in dedicated path protection, the spare capacity is dedicated to individual protection paths. Shared path protection, although more difficult to implement, have been proven to be more capacity efficient than dedicated path protection.

## 2. LITERATURE SURVEY

**Ahmed Mokhtar et. al.** [1] proposed the adaptive routing algorithms to improve the blocking performance of the network. Author consider the routing and wavelength assignment in wavelength-routed all-optical networks with circuit switching and adopted a general approach in which all paths between a source-destination (s-d) pair has been considered and incorporate network state information into the routing decision. This approach performs routing and wavelength assignment jointly and adaptively and outperforms fixed routing techniques. They also presented adaptive routing and wavelength assignment algorithms and evaluated their blocking performance. They have also obtained an analytical technique to compute approximate blocking probabilities for networks employing fixed and alternate routing.

**Yoo Younghwan et. al.** [2], presented four adaptive routing algorithms which favour paths with near-

maximum number of available wavelengths between two nodes, resulting in improved load balancing. These presented adaptive routing algorithms were simulated and compared with least loaded and fixed routing algorithms for small networks. First-fit wavelength assignment policy was used for simulation of these proposed algorithms.

**G. Mohan et. al.** [3], considered wavelength rerouting in wavelength routed wavelength division multiplexed networks with circuit switching. The lightpaths between source-destination pairs were dynamically established and released in response to a random pattern of connection arrival requests and connection holding times. They also presented a time optimal rerouting algorithm for wavelength-routed WDM networks with parallel Move-to-Vacant Wavelength-Retuning (MTV-WR) rerouting scheme.

**R. Ramaswami et. al.** [4], considered the problem of routing connections in a reconfigurable optical network using wavelength division multiplexing. They derived an upper bound on carried traffic of connections for any routing and wavelength assignment algorithm in a network.

**R. Ramamurthy et. al.** [5], proposed an approximate analytical model that incorporates alternate routing and sparse wavelength conversion. They considered an optical network which employed wavelength routing cross-connects that enabled the establishment of wavelength-division-multiplexed connections between the node pairs. The simulations studied the relationships between alternate routing and wavelength conversion which were performed on three representative network topologies.

**Xiaowen Chu et. al.** [6], considered rerouting as an effective approach to decrease the blocking probability in legacy circuit-switched networks and proposed a routing algorithm. They also implemented intentional lightpath rerouting in all-optical WDM mesh networks. They proposed a Dynamic Least Congested Routing (DLCR) algorithm which dynamically switches the lightpath between the primary route and alternate route according to the network traffic distribution. Extensive simulation results showed that DLCR algorithm achieved better blocking performance than traditional routing algorithms including shortest path routing, fixed-alternate routing and least congested path routing.

## 3. PROPOSED WORK

We have proposed a routing algorithm in this thesis which is an improvement of the shortest path algorithm. In this algorithm first of all the source-destination (SD) pair is selected and after selection of the SD pair the route is being established by using the shortest path algorithm

(Dijkstra Algorithm). When the route is selected then that route is checked for the fault. This fault is assumed as a dynamic fault so the routing is dynamic routing. The route is checked for the fault; if the fault does not exist then the blocking probability is reduced and if the fault exist on the selected path then the path is left and the next path in the order of shortest path is selected. In this way the blocking probability is reduced to a certain extent.

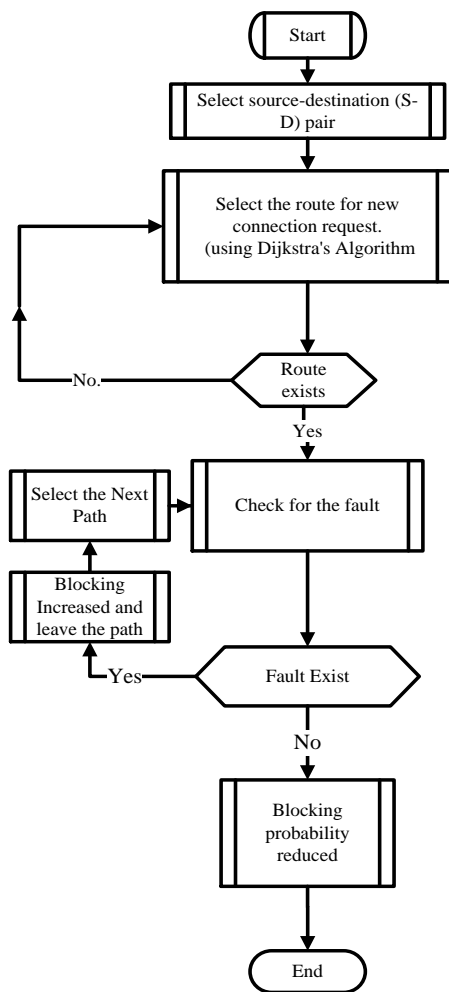


Figure 1 Proposed Routing Algorithm

In the first phase, a route for a new connection requests is selected on the basis of the shortest path. If such a route does not exist the phase 2 is performed. In second phase, a route for a new connection request is selected and the path is checked for the fault if the fault exists then the next path in order of the shortest path algorithm is selected, leading to the survivable algorithm. In phase 1, a conventional shortest path algorithm (such as Dijkstra's algorithm) is used to select the shortest path on each of the sub graphs (or wavelengths). Only free edges are considered while finding the shortest paths. Then the minimum weight path among them is chosen and it represents a path with the minimum number of physical hops. Phase 2 is performed only if phase 1 cannot give

successful results. This phase consists of two steps. In first step, all path are arranged in order of their length in coordination with the shortest path algorithm. In second step, the paths are checked for the fault on the links. If the link selected is faulty then the next path in order of the shortest path is selected and if this path is fault free then the same path is selected. In this way we try to propose a method which can be used as a survivable routing algorithm.

## 5. CONCLUSION

Survivability of a network refers to a network's capability to provide continuous service in the presence of failures. In this survey paper We have proposed a routing algorithm in this survey paper which is an improvement of the shortest path algorithm. In this algorithm first of all the source-destination (SD) pair is selected and after selection of the SD pair the route is being established by using the shortest path algorithm (Dijkstra Algorithm).

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