ANALYTICAL MODELS IN WAVELENGTH ROUTED OPTICAL NETWORK: A REVIEW

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Abstract

The Wavelength- routed optical network has become a topic of keen interest for its attractive and unique features Since wavelength conversion increase the efficiency and performance of a network, it play an important role in wavelength -routed optical network. Wavelength conversion is one of the challenging features of wavelength- routed network that eliminate wavelength continuity constraints as well as improve blocking probability performance typically in backbone networks. This paper reviews the analytical models to quantify the benefits of wavelength converter. We focused on literature on wavelength-routed network, benefits of wavelength conversion, and challenges of wavelength conversion and some of the probabilistic model.

Keywords: *Wavelength Conversion, Wavelength Routed Optical Network (WRON), Blocking Probability, Lightpath.*

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1. INTRODUCTION

The optical network offers data transmission setup in view of fiber optics technology that has enormous potential in respect of transmission limit. Benefits of optical technologies include bandwidth, i.e., utilizing this technology it is possible to send data at a rate of 50 Terabits for every second (Tb/s), low signal attenuation 0.2 dB/km, and signal regenerator are used once ;as it causes low signal attenuation and distortion. The fast growth of worldwide information transfer relies on an optical network for their larger capacity and robust performance. Recent advances in optical technology promise that optical networks can provide adaptability, flexibility, improved speed, diminished cost and bolster the interest of huge information transmission applications. The main reason for multiplexing is to transmit data at a higher rate in a single fiber than at lower rate in multiple fibers which can be accomplished by expanding the bit rate. Remembering the finished objective to achieve this, different multiplexing systems have been investigated. Wavelength-division multiplexing (WDM) is one of the multiplexing techniques adopted in optical communication, and it is very similar to frequency- division multiplexing (FDM). The guideline behind WDM technology is to modulate different wavelengths of the optical signal and transmit them at the same time on a fiber. In a Wavelength -routed optical network (WRON), it is feasible to send data to particular destinations depending on their wavelengths. The use of wavelengths for sending the data to their destination along a path is wavelength routing and a network use this process referred as a wavelength-routed network. Basicaly a wavelength routed network architecture consists of optical cross connects (OXCs),A light path which basically consists of an optical communication channel between two nodes in a network..

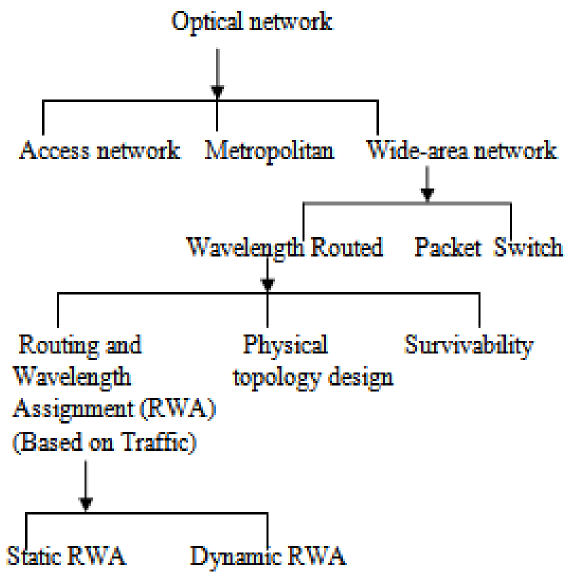

Fig.1: Classification of optical network

This paper is arranged as Section 2, describes need of Wavelength conversion. Section 3, review of various papers which describes performance analysis by calculating blocking probability and finally the conclusion is given in Section IV

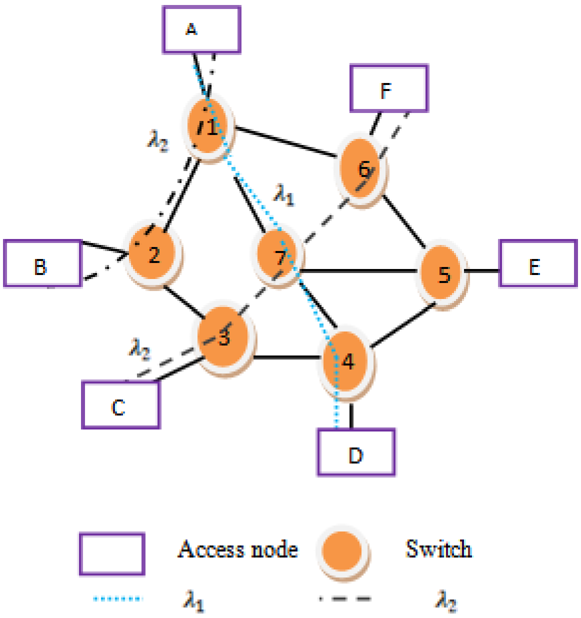

Fig.2: Wavelength-routed optical network

2. WAVELENGTH CONVERSION

In an N- node, if there enough wavelengths on a fiber links and each node is provided with N-1 transmitters and receivers and, then each node could be connected by an all optical light path, and there is no networking problem to solve. However, it should be noted that the network size (N) should be scalable, transmitters and receivers are costly so that every node could also be equipped with only few of them, and technological constraints dictate that the number of WDM channels which will be supported during a fiber be restricted to W.Thus,only a limited number of light paths may be set up on a network[5]. To setup a light path, it needs that identical wavelength should be allotted on all links along the path, which is known as wavelength continuity constraint. Wavelength continuity constraint will be eliminated if the information arriving at a node on a link can be converted to different wavelength at intermediate node and again forwarded it to alternative links. This process is known as wavelength conversion which improves the efficiency of a WRON. A device that is used for wavelength conversion is known as wavelength converter. In Fig.3, two lighpaths can be setup, between node A and node B and between node B and node C having wavelength λ_1 and λ_2 respectively. Without wavelength conversion, establishing a new light path from node A to node C cannot be possible because the wavelengths that are available on the two links are different. Therefore, wavelength continuous network suffers from higher blocking. Fig.4, shows at node B, a wavelength converter is placed so that a light path can be established from node A to node C as it convert the data from λ_2 to λ_1. In a wavelength convertible network, a light path use different wavelength on each link along its path.

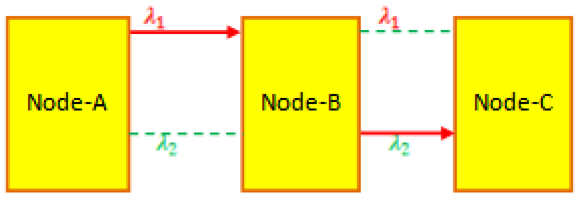

Fig.2. Nodes without wavelength converter

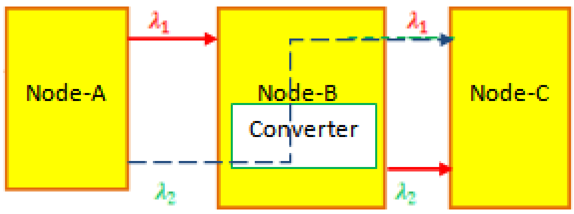

Fig 4: Node-B with wavelength converter

3. PERFORMANCE ANALYSIS

Both wavelength routing and wavelength conversion can improve the performance and efficiency of a WRON [5]. The device which used for wavelength conversion is known as wavelength converter. However, wavelength converters are very expensive, so it is important to know how to save the number of wavelength converter so that it is cost effective, reliable and more feasible The important issues in wavelength conversion are enabling technologies [4], algorithms and benefit analysis. Again this benefit analysis of wavelength conversion in a WRON can be examined with probabilistic model and gain characterization. This paper focuses on how the performance of a WRON depends upon network topologies, network models, traffic and different routing algorithm. This also emphasizes the term performance which can be analyzed in term of blocking probability. We present a review of several analytical models.

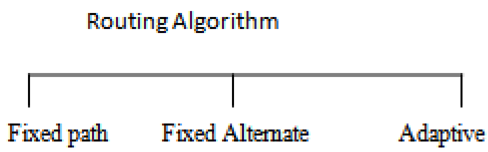

Fig 5: Classification of Routing Algorithm

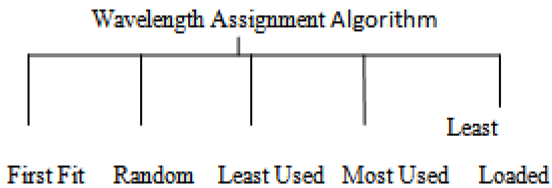

Fig 6: Wavelength Assignment Algorithm

4. ANALYTICAL MODELS REVIEW

This paper analyzes different analytic method proposed by researcher which is based on the calculation of blocking probability in a network .A brief review of the Analytical models given below.

1) Kovaˇcevi´c et al. [6]

Overview: Kovaˇcevi´c *et al. [6] developed a*n approximate analytical model, both with and without wavelength conversion for a fixed-path routed circuit switched network. The objective of this paper was to give some understanding into the impact of clear-channel wavelength conversion on an optical network. This paper presented the most challenging issue, wavelength conversion on three different network topologies such as nonblocking centralized switch, ring,and mesh-torus based on performance in term of blocking probability and network load. The analytical model in [6] considered i) Poisson arrival ii) Independent link loads iii) Static routing and iv) Random and Firs-fit wavelength assignment strategies. From the analytic and simulation result observed that there was a significant diminishing in the blocking probability when wavelength conversion is allowed for a mesh network.Without wavelength conversion, the load per station is inversely proportional **to** the network size. With wavelength conversion network load increases directly with the square root of network size and load per station inversely proportional to the square root of network size[6]. Simulation results in term of network offered load and network size of a mesh network with wavelength conversion essentially enhanced the adaptability.It cannot be applied to a ring network as very high load correlation along the links of a path in a ring network invalidates the independent link-load assumption.

2) Subramanian et al. [7]

Overview: Subramaniam *et al.* *[7]* described an approximated analytical model using sparse wavelength conversion. The major advantage of sparse wavelength conversion is some of the nodes in a network placed with wavelength converters. In this model the switching nodes used in a network were: i) nodes with no wavelength conversion ii) nodes with wavelength conversion. Analytic and simulation results observed the blocking probability increases with wavelength conversion density.The basic aim of this research was to develop the usefulness of wavelength converters which depends on the connectivity of the network. The blocking probability using Sparse wavelength conversion. Converters are not exceptionally helpful in networks with low availability, for example, the ring, in view of the high load correlation between connections. In addition, converters are likewise observed to be of little use in systems with high availability, for example, the hypercube, due to the small hop lengths. However, Converters offer a significant advantage in the mesh-torus network where the link load correlations are negligible and the hop-lengths are large.

3) Biraman [1]

Overview: Biraman ***[1]*** provided an approximate method for calculating the blocking probability in a wavelength routed network and compared with the circuit switched network. The blocking probability observed in wavelength routing model increase with number of hops and larger in compared to circuit switched network. Two different routing schemes are considered: *fixed routing*, where the path from a source to a destination is unique and is known beforehand, and *least loaded routing* (LLR), where the route from source to destination is taken along the path which has the largest number of idle wavelengths. The approximated model for blocking probability for both fixed routing and LLR compared.

Table-1: Analytical Models Performance

Parameter / Analytical Models	**Routing Algorithm**	**Wavelength Assignment Algorithm**	**Calculation**
Kovaˇcevi´c *et al.*,[6], Subramaniam *et al.*[7]	Fixed	Random	Blocking Probability
Biraman[1]	Fixed Least-Loaded	Random	Blocking Probability
Barry *et al.* [8]	Fixed	Random	Wavelength Utilization Gain

4) Barry et al.[8]

Overview: Barry et al.[8] discussed an approximated analytical method for evaluation of blocking probability in circuit switched all optical network .The blocking probability with and without wavelength conversion observed and analyzed the impact of network parameters on blocking probability. The important network parameter studied in this model was path length, switch size and interference length. This model considered two independence assumptions: Link independence assumption and wavelength independence assumption. The network with high interference length has lower blocking probability.

5. CONCLUSION

This paper has reviewed the analytical model of calculating blocking probability with and without wavelength conversion. Several extensions are possible to calculate blocking probability in Wavelength routed optical network. Probabilistic demand pattern may also be considered in future studies

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