Research on Channel Assignment Algorithm of IP over WDM Network Using Time-Division Switching

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Abstract. In order to solve congestion of IP over WDM network using time-division switching, and to meet the demands of different services, we presented a channel assignment scheme named queuing algorithm. The main idea was adding queuing caches and controller in each HUB, which can assigned wavelength channels and time-slots dynamically according to different transmission priorities, the higher the transmission priority, the better was the opportunity to be assigned more wavelength channels. The theory of this algorithm was introduced, and the performances were analyzed by building random queuing model. The results appear that it is an efficient way to improve QOS and the usage of wavelength channels with low latency.

Keywords: WDM, time multiplexing, QOS, time-slot, dynamic wavelength assignment, queuing algorithm, network congestion.

1 Introduction

T. S. Peter Yum and Frank Tong proposed a new routing architecture of IP over WDM network using time-division switching, as shown in Figure 1 [1]. Suppose the number of HUB is L, each HUB is connected to K REX, the time-slot orders of HUB are shown in Figure 2. At REX level, IP packets are assigned to different transmission queues according to their respective labels, the transmission from each queue onto the optical backbone network are then organized into transmission cycles, with each subdivided into wavelength burst periods using WDM [1]. However, if the number of REX is lesser than the number of available wavelengths, blank time-slot must be filled. On the other hand, because of quantitative restriction on wavelengths, if the number of REX exceeds the number of available wavelengths, network congestion will happen, so the channel competing algorithm must be provided. Besides, to support the varying Quality-of Service (QOS) requirements, we must define different transmission priorities.

This paper is structured as follows: we present a channel competing algorithm to solve congestion in section 2, the performance of this algorithm is analyzed by random queuing model. In section 3, we give a scheme to assign wavelength channels drastically to some special services according to their transmission priorities. In section 4, some useful conclusions and further research issues complete the paper.
2 Queuing Algorithm

2.1 Introduction of Queuing Algorithm

Firstly, we define some variables:

L: the number of HUB, it is also the number of time-slots.
K: the number of available wavelengths. Wavelengths $\lambda_1, \lambda_2, \ldots, \lambda_K$ can be used circularly to every REX in permission time-slots, but in the same subdivided time-slot, wavelengths used by different REX must be differentiated.

$A_{ij}$: $K \times K$ wavelength assignment matrix. It denotes the assignment results of wavelength channels, $i$ is the number of the source HUB, $j$ is the number of destination HUB.

The main idea of our algorithm is shown in Figure 3. Setting a channel distributor in each HUB, it is consists of L queuing caches and a central controller, queuing cache $m$ is intended for storing requests to HUB $m$ from different source REX, controller is intended for assigning channels. Before transmitting data, every REX must send an access request to HUB’s distributor through public wavelength channel $\lambda_0$, distributor records its request into queuing caches. Controller reads access requests from queuing caches periodically, and then, calculates wavelength assignment matrix $A_{ij}$ according to the ruler of first come first served. At last, HUB $i$ must broadcast the contents of matrix $A_{ij}$ to every destination HUB. We can broadcast $A_{ij}$ through synchronization.

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**Fig. 1.** IP over WDM network using TDM switching

**Fig. 2.** Time-slot orders between HUB

| HUB1 | 1 to 1 | 1 to 2 | 1 to 3 | $\ldots$ | 1 to L |
| HUB2 | 2 to 2 | 2 to 3 | 2 to 4 | $\ldots$ | 2 to 1 |
| HUB3 | 3 to 3 | 3 to 4 | 3 to 5 | $\ldots$ | 3 to 2 |
| HUBn | L to L | L to 1 | L to 2 | $\ldots$ | L to L-1 |