DYNAMIC WAVELENGTH ALLOCATION IN WDM OPTICAL NETWORKS

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Abstract: This paper investigates the problem of dynamic wave length allocation and fairness control in WDM optical networks. A f network topology, wih a two-hop path network, is studied for three classes of traffic. Each class corresponds to a source and destination pair. For each class call inter arrival and holding times are studied. The objective is to determine a wavelength allocation policy to maximize the weighted sum of users of all the three classes. This method is able to provide differentiated services and fairness control in the network. The problem can be formulated using markov decision process to find the optimal allocation policy.. It has been analytically and numerically shown that the optimal allocation policy has the form of a nondecreasing switching curve for each class. Simulation results compare the performance of the optimal policy and the heuristic algorithm, with Dynamic partitioning with those of complete sharing and complete partitioning policies.

Index Terms – Dynamic wavelength allocation, Markov decision procee (MDP) monotonic optimal policy, wavelength – division multiplexing (WDM).

INTRODUCTION

The large and huge bandwidth need of the next generation networks can be catered by Wavelength division multiplexing. The communication is defined by light paths and they are assigned with a specific wavelength between their source and destination. This wavelength allocation is called Continuity of the wavelength. This continuity can be relaxed by using wavelength converters inbetween. Routing and Wavelength allocation is a major issue in the WDM optical networks. It further have two main issues called Wavelength assignment and Wavelength routing.

Many algorithm such as Random, Least-Used, Most-Used, and First-Fit wavelength assignments have been already pronounced to assign wavelengths in WDM optical networks with dynamic traffic. The algorithms aim at bringing fairness control by increasing the overall user weightage and by decreasing the call blocking. Many analysis have been done to find the quantum of call blocking and the catalyst for the same. On studying the results of these analysis it has been found that all the users are given the same class and hence the fairness is not attained, hence it is essential to implement a class based algorithm.

In this paper, we investigate the wavelength allocation problem and fairness control issues for different classes of users with dynamic traffic with the objective of maximizing the weighted sum of class-based utilization, we define a Markov decision process (MDP) model. Based on which the optimal wavelength allocation policy is determined [7]. In many admission control and resource allocation problems in telecommunications, it has been shown that under some conditions, the optimal policy of a MDP exists and it is stationary and monotone [8],[9]. In [10], the multimodularity, sub modularity, and convexity properties imply the monotonicity of optimal policy in the context of stochastic control. In this study, by using the multimodularity of the cost function and the induction method, we prove that the optimal policy is a nondecreasing switching curve. Moreover, the policy iteration algorithm [7] is deployed to determine numerically the optimal policy, we develop a simple heuristic algorithm to provide fairness in WDM ring networks.

The paper is designed as follows. In subdivision II, we describe the problem and explain the assumptions of the network. In subdivision III, the problem is formulated in an MDP framework. subdivision IV shows the dynamic functioning of the value function and provides the structure of optimal policy. subdivision V introduces our algorithm and subdivision VI compares the performance of our proposed algorithms with other standard policies. Conclusions are presented in subdivision VII.

PROBLEM DESCRIPTION

We first consider a two-hop path network topology for a single fiber circuit-switched wavelength routing network, as depicted in Fig 1(a). This fundamental topology can represent the link-load correlation model [5],[6]. The total number of available wavelength in the system is W Traffic is divided in to three classes. Each class corresponds to a different source-destination pair. Class 1 (respectively, Class 3) consists of the users that use hop H1 (respectively, H2); Class2 includes the customers that use both hops H1 and H2. If a WC is deployed at node 2, than a class 2 call is accepted whenever there is at least one available wavelength in both hops. Without a WC at this node, the same wavelength must be availab;le in both hops to accommodate a class 2 call. Any arriving call is blocked when all wavelength along its path are used. Blocked calls do not interfere with system. Arrivals of class l calls, l = 1,2,3, are distributed according to poisson process with rate ^l . The call holding time of a class l call is exponentially distributed with mean l-1.

Wavelength allocation policy is a particular problem related to resource allocation policies. In general, current wavelength allocation strategies are deploying heuristic alogorithms such as complete sharing (CS) and complete partitioning (CP) [12]. When implementing CS, no wavelength is reserved for any class. In addition, an arriving call will be accepted if at least one wavelength is available throughout all the hops along its path. Although the global network utilization is high in this case, this approach is greedy, and it is high suboptimal it different classes of users provide different rewards for the same grade of service. When deploying CP policy, each class is assigned a constant number of wavelengths that cannot be used by calls from the other classes. Hence, it supports service differentiation and controls class-based blocking probabilities. However, CP policy may not maximize the overall utilization of the available resources.

To improve the system performance in a dynamic environment, it would be essential to assign a certain number of wavelength to each class as a function of the current number of customers from different classes. This paper investigates a dynamic wavelength allocation policy, which is called dynamic partitioning (DP) hereafter. It consists of determining the appropriate number of wavelengths allocated to each class taking into account the current state of the system, with the objective of maximizing the weighted sum of the number of calls for each class, This approach can take advantage of both CP and CS policies.

PERFORMANCE COMPARISON

In this section, we compare the performance of our proposed DP and heuristic allocation policies, with those of CS and CP policies. In order to implement CP policy for the two-hop network shown in fig 1, one can divide the total number of wavelengths W into two parts. Let M be the number of wavelengths dedicated to class 2 and W – M be the number of wavelengths reserved for classes 1 and 3. Note that M is a constant value. Using Erlang"s B formula, we compute pu, the probability of having u user of class l in the system

Where Tl is the total number of wavelengths reserved for class l. One can notice that pt is the probability that all dedicated wavelengths to class l are busy (i.e., ptl2 is the blocking probability class l calls). Using Pw-M" Pw-M' we can derive the expected number of calls of each class in the system

$$N_l(M) = (l/l)\,(1-p_t)$$

We also define M* as

$$M^* := \arg\max N_1(M) + N_2(M) + N_3(M).$$

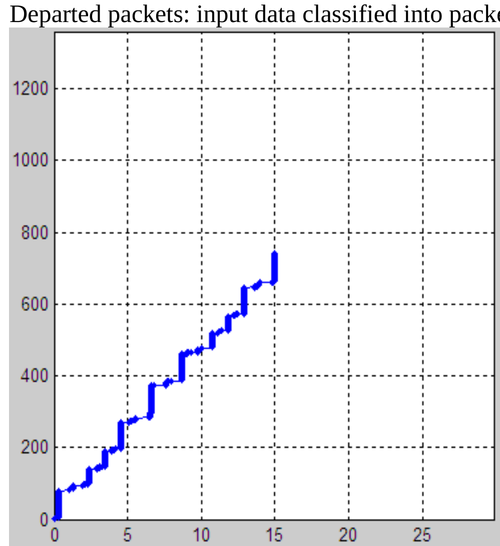
To compare the performance of DP,CP,and CS policies, we simulate the system by deploying the optimal policy implemented in Section IV to evaluate the performance metric of DP policy, For CP, the simulation results is carried out for two independent W/M(W – M*) queues associated with class 1 and class3 and one M/M/M*/M* queue related to class2. Finally, we simulate the system without any allocation policy to evaluate the performance of CS policy.

We first study a two-class system. Figs 7 and 8 depict the average-time reward function (n1 + n2) versus the total offered load p, where p=1/u1 +2/u2. In both examples, the parameters are set as follows: W=10, h1=h2, o=1, and 6<_p<_40. The difference between the two examples lies in the value of b. In fig 7 we set b=0.1 which is significantly smaller than o. It shows that for low load, all the policies have similar performance. As the load increases, DP policy shows much better performance, in particular when compared with CS policy. Fig 8 illustrates the performance of the system when b=0.5. Comparison of fig 7 and 8 shows that Dp policy outperforms Cp policy and in particular CS policy as the difference between o and b increases.

Another important performance metric is the weighted sum of blocking rates. Applying DP and CS policies, we simulate and determine this quantity for a system with W=10, h1=h2, o=1,b=0.1 and 6<_p<_80. To determine the relative performance improvement of DP policy, we calculate the relative performance ratio (DPp-CSp)/CSp, where DPp and CSp represent the blocking performance of DP and CS policies, respectively. This quantity is plotted versus the offered load in fig 9. One can see that DP policy have higher performance, upto 45% for intermediate offered load (e.g., p_15), which is a fact observed in networks and is in agreement with institution.

VII Results

Departed packets: input data classified into packets



Queue 1 : Dynamic wavelength allocation 50 Percent

No of bits transmitted 3882

No bits dropped due to traffic 0

No of bits received 3882

Queue 2 : Dynamic wavelength allocation 25 Percent

No of bits transmitted 1991

No bits dropped due to traffic 0

No of bits received 1991

Queue 3 : Dynamic wavelength allocation 25 Percent

No of bits transmitted 1991

No bits dropped due to traffic 0

No of bits received 1991

Block Parameters: D1_Class

simulation settings (mask)

Parameters

WRED Max Threshold for the in profile traffic	117
WRED Min Threshold for the in profile traffic	39
WRED Max Threshold for the out of profile traffic	38
WRED Min Threshold for the out of profile traffic	19
Drop probabilty for the in profile traffic	20
Drop probabilty for the out of profile traffic	20
Exponential Weight	9
BW Precent	50

Block Parameters: D2_Class

simulation settings (mask)

Parameters

WRED Max Threshold for the in profile traffic	122
WRED Min Threshold for the in profile traffic	61
WRED Max Threshold for the out of profile traffic	68
WRED Min Threshold for the out of profile traffic	34
Drop probabilty for the in profile traffic	20
Drop probabilty for the out of profile traffic	20
Exponential Weight	9
BW Precent	25

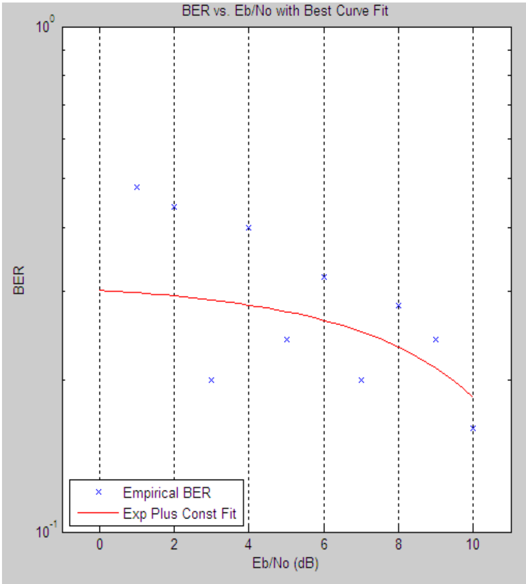
Block Parameters: D3_Class

simulation settings (mask)

Parameters

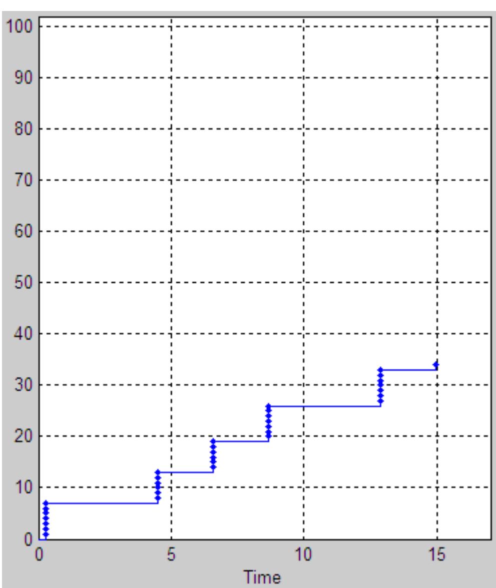
WRED Max Threshold for the in profile traffic	156
WRED Min Threshold for the in profile traffic	78
WRED Max Threshold for the out of profile traffic	102
WRED Min Threshold for the out of profile traffic	51
Drop probabilty for the in profile traffic	20
Drop probabilty for the out of profile traffic	20
Exponential Weight	9
BW Precent	25

Name	Value
BW_Share_D1	50
BW_Share_D2	25
BW_Share_D3	25
Bc	51200
Max_INP_D1	117
Max_INP_D2	122
Max_INP_D3	156
Max_OOP_D1	38
Max_OOP_D2	68
Max_OOP_D3	102
Min_INP_D1	39
Min_INP_D2	61
Min_INP_D3	78
Min_OOP_D1	19
Min_OOP_D2	34
Min_OOP_D3	51
Police_Bc_D1	25600
Police_Bc_D2	12800
Police_Bc_D3	12800
Policing_rate_D1	256000
Policing_rate_D2	128000
Policing_rate_D3	128000
Ran_INP_D1	20
Ran_INP_D2	20
Ran_INP_D3	20
Ran_OOP_D1	20
Ran_OOP_D2	20
Ran_OOP_D3	20
Tc	0.1000
expoconst_D1	9
expoconst_D2	9
expoconst_D3	9

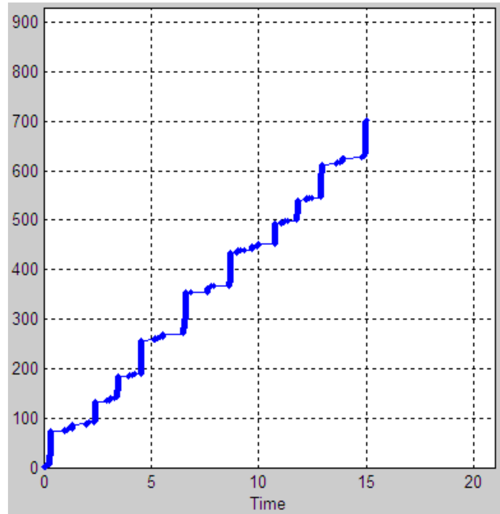


EbNo = 0 dB, 6 errors, BER = 0.12
EbNo = 1 dB, 12 errors, BER = 0.48
EbNo = 2 dB, 11 errors, BER = 0.44
EbNo = 3 dB, 5 errors, BER = 0.2
EbNo = 4 dB, 10 errors, BER = 0.4
EbNo = 5 dB, 6 errors, BER = 0.24
EbNo = 6 dB, 8 errors, BER = 0.32
EbNo = 7 dB, 5 errors, BER = 0.2
EbNo = 8 dB, 7 errors, BER = 0.28
EbNo = 9 dB, 6 errors, BER = 0.24
EbNo = 10 dB, 8 errors, BER = 0.16

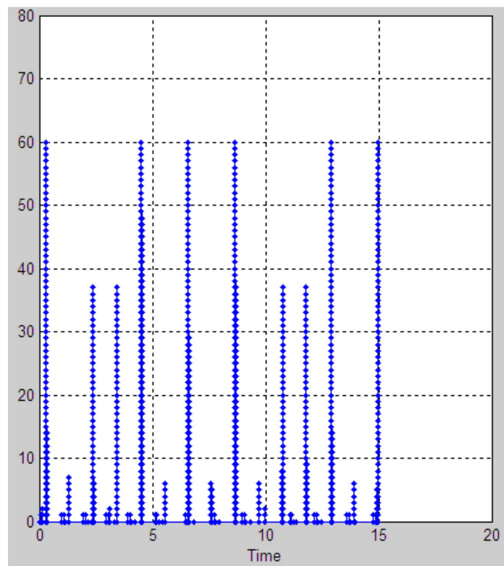
Dropped Packets: The packets being dropped during a traffic in queue



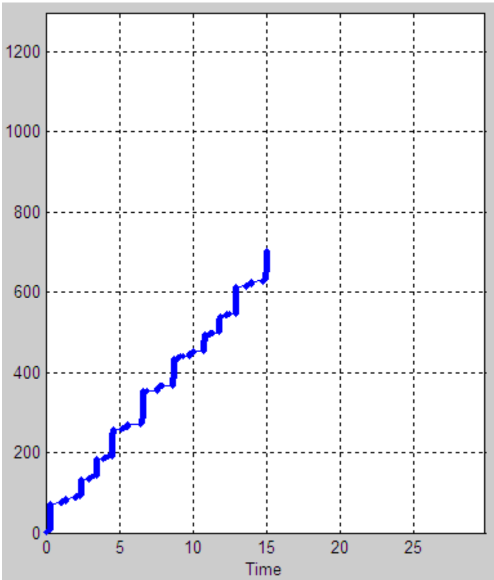
Output Final Packets:



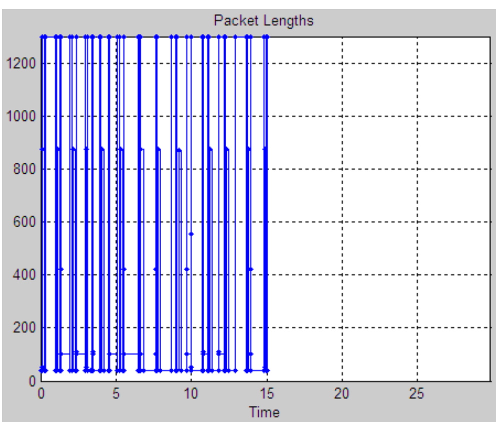
Queued Packets: Various Packets in a Queue



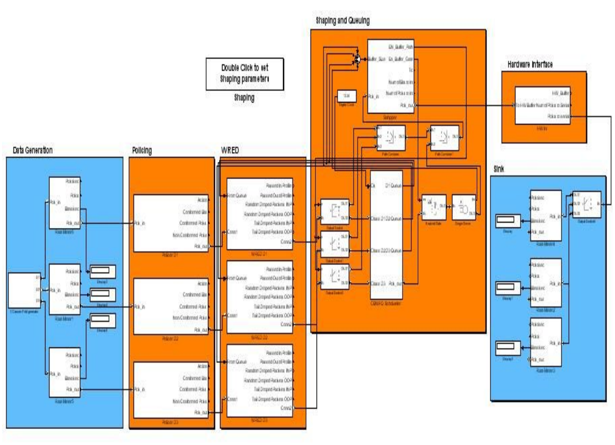
Sent Packets: Input data sent through the channel



Final Output: Output thus obtained after passing through the queue



Communication window



VIII Conclusion:

Thus an approach to the problem of Dynamic wavelength allocation in the WDM optical network was proposed in this paper and the results were analysed. I is proved that the results for the transmission through the two hop networks is successful with reduced BER and the packet drops and effective communication in the prescriped light path is explained for MDP.

IX. REFERENCES

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X. BIOGRAPHIES

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