Dynamic RWA in WDM optical network

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Abstract. As optical wdm networks are becoming the backbone building blocks of twenty first century's networks due to their capacity of carrying huge bandwidth. So evaluating the performance of optical wdm networks and optimizing it, is need of the day. For this the problem of routing and wavelength assignment is of significance importance. Researchers have done extensive simulations for both static and dynamic routing and wavelength problem. In this paper we have presented various algorithms for solving the dynamic RWA problem in literature.Also we have prepared a optical wdm network using which RWA problem is analysed.

1 Introduction

Nowadays optical wdm networks are emerging technologies networks that can provide routing, grooming, and restoration at wavelength level [2]. WDM technology of crucial importance for satisfying the ever increasing capacity requirements in telecommunication networks. Wavelength routed WDM networks can exploit the large bandwidth of optical fibers by dividing it among different wavelengths. These networks are equipped with configurable WDM nodes which enable us to set up and tear down all-optical channels, called light paths, between pairs of nodes. Given a network and a set of light path requests, the Routing and Wavelength Assignment (RWA) problem attempts to route each light path request, and to assign wavelengths to these routes subject to the following constraints [1,13] .

The RWA problem can be categorized into two types, static RWA (SRWA) and dynamic RWA (DRWA). In a wavelength-routed optical network (WRON), the traffic demands can be either static or dynamic In static RWA, all the connection requests are known in advance and the objective of RWA is to assign routes and wavelengths to all the light paths globally while keeping the amount of network resource required minimal [5].In a dynamic traffic pattern, a light path is set up for each connection request as it arrives and it is released after some finite amount of time. One of the challenges involved in designing wavelength routed networks with dynamic traffic demands is to develop efficient algorithms and protocols for light paths establishing [7, 8, 10 and 11].

In all-optical WDM networks, each of the connections going through a link is assigned a wavelength. If a connection is assigned the same wavelength on all links along its routing path, the signal is able to travel from the source node to the destination node using the same wavelength. In case that the connection has to be assigned two or more wavelengths on different links, one or more nodes along its routing path must have the capability of converting the signal from one wavelength to another wavelength. If all nodes along the routing path of a connection are incapable of converting a wavelength to another wavelength, the connection must be assigned the same wavelength on all links along its path. Otherwise, the connection is blocked. This is known as the wavelength continuity constraint. A wavelength which is available on all links along a routing path is referred to as a common available wavelength along the routing path[6]. In addition, light paths that share a common physical link cannot be assigned the same wavelength. This is called the wavelength clash constraint [13, 1].

There are number of algorithms available in literature for dynamic routing and wavelength assignment problem and rsearchers too have used optimization techniques and have formulated various new algorithms to optimize the performance of optical wdm network in terms of dynamic wavelength and assignment problem. In this paper we have presented the review of various techniques available for solving dynamic routing and wavelength problem.

2 ALGORITHM USED FOR DRWA

2.1 Fixed Path Routing

It uses only one route from source end to destination .In this approach the network resources are not properly utilized.[1]

2.2 Alternate Path Routing

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It uses alternate paths from source to a destination .If the first is unavailable then second path is used.[15]

In dynamic routing in DRW1 algorithm no weight assignment is done all links have same weight. First all possible paths between the source and destination is calculated then request is routed over the shortest path if wavelength is available else alternate shortest path is used. In DRW2 less weight is assigned to nodes which are used less. As the request arrived it is routed to the nodes having less weight if wavelength is available if not then request is routed through next higher weight nodes and the process is repeated. In DRW3 algorithm less weight is assigned to the nodes which are less used and are nearest and then routing of request is done through routes having minimum weight if wavelength is available else next higher weight is tried and the process is repeated [9] Another algorithm is proposed in literature which first selects K edge disjoint least weighted paths according to the current network state and then one such path is considered to route the request taking into account not only the load ,length of the path but also number of transceivers in the nodes along the path.after this an auxiliary graph is generated and request is routed on least weight route on the graph and wavelength is assigned for the same.[14]

2.3 Fixed alternate shortest Path routing with least Priority wavelength assignment Strategies

In this algorithm the wavelength information table is made according to the use of the each wavelength in the network then the lightpath is set on shortest or alternate shortest path with the least used wavelength if available else the route call is blocked.[16]

2.4 Exhaust Algorithm

It searches all the possible routes between source and destination and then finally selects the best route .So utilizing this route provides the flexibility of selecting any route according to the wavelength available.Source Initiated Reservation Algorithm In this algorithm the network resources are utilized by reducing control overhead .In this the route table is generated first and then resource and wavelength availability is updated .Next the route table is arranged according to minimum hops and maximum wavelengths available and route is searched according to that. If wavelength allotted the request is processed else the request is blocked and then whole process is repeated.[15]

2.5 Traffic Intensity Based Fixed –Alternate Routing

In this algorithm the traffic is splitted for each source destination pair onto the disjoint routing paths by solving the nonlinear multicommodity flow optimization problem. Further the routing path between end users is sorted in decending order according to the amount of traffics of source destination pair assigned to the routing paths. For the request arrived this algorithm tries the multiple routing paths between the particular source destination pair one by one in the sorted order to establish a connection until the request is processed successfully otherwise the request is blocked .Results proved that this algorithm have lower blocking probability as compared if sorting is done according to the hop count instead of traffic intensities.[3]

2.6 Priority and Maximum Revenue based Routing

In this algorithm two types of requests are kept in two light path request matrixes namely high priority matrix (HPM) and low priority matrix (LPM).High priority matix requests are entertained first before LPM requests. According to this algorithm the light paths in HPM must be fulfilled and revenue for the same is fixed while the light paths in the LPM can be set up selectively to optimize revenue when there is not enough uresource to accommodate all.[12]
Multiobjective integer linear program is proposed in literature for maximizing throughput and solving traffic engineering in wdm optical networks.This program collectively maximizes the network output,minimizes the resource consumption and achieves load balancing by minimizing the maximum link utilization.This algorithm solves the multiobjective problem as an e-constraint problem upper bounding the per route resource consumption and maximizing the throughput by routing through multiple widest paths.Simulations results obtained reveals that solving multiobjective problem by ILP (Integer linear Programming) yield promising results.[4]

3 Simulation Results

For analyzing the problem of routing and wavelength assignment we have prepared a wdm network in which each link is bidirectional and taken eight wavelengths per link. For routing shortest path algorithm is used and first fit for wavelength assignment. The traffic considered is dynamic in nature which follows the poisson process. We have analysed and calculated the thoughput for two types of applications i.e FTP and email .The simulation is carried on opnet modeler.

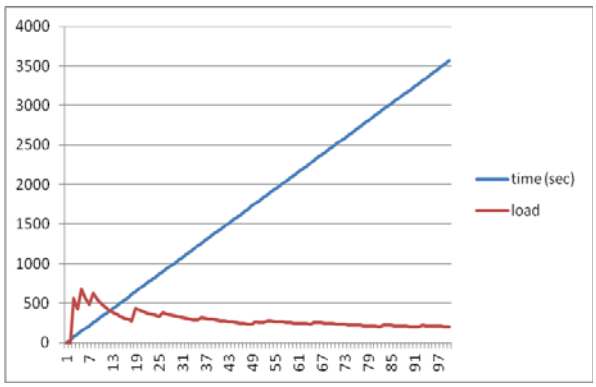

Figure 1. Load versus time for email application.

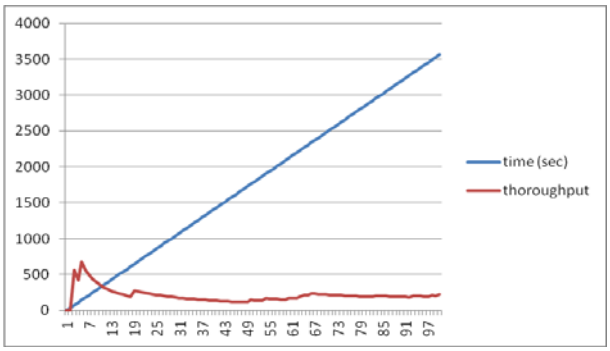

Figure 2. Throughput versus time..

Table 1. Data sheet for load and throughput.

	Data Collected	
time (sec)	load	throughput
0	0	0
36	0	0
72	565.33333	565.3333333
108	424	424
144	678.4	678.4
180	565.33333	565.3333333
216	484.57143	484.5714286
252	622.75	437.25
288	553.55556	388.6666667
324	498.2	349.8
360	452.90909	318
396	415.16667	291.5
432	383.23077	269.0769231
468	355.85714	249.8571429
504	332.13333	233.2
540	311.375	218.625
576	293.05882	205.7647059
612	276.77778	194.3333333
648	435.15789	278.9473684
684	413.4	265
720	393.71429	252.3809524
756	375.81818	240.9090909
792	359.47826	230.4347826
828	344.5	220.8333333
864	330.72	212
900	379.15385	207.9230769
936	365.11111	200.2222222
972	352.07143	193.0714286
1008	339.93103	186.4137931
1044	328.6	180.2
1080	318	174.3870968
1116	308.0625	168.9375
1152	298.72727	163.8181818
1188	289.94118	159
1224	281.65714	154.4571429
1260	318	153.1111111
1296	309.40541	148.972973
1332	301.26316	145.0526316
1368	293.53846	141.3333333
	Data Collected	
time (sec)	load	throughput
1404	286.2	137.8
1440	279.21951	134.4390244
1476	272.57143	131.2380952
1512	266.23256	128.1860465
1548	260.18182	125.2727273
1584	254.4	122.4888889
1620	248.86957	119.826087
1656	243.57447	117.2765957
1692	238.5	114.8333333
1728	233.63265	112.4897959
1764	262.88	144.16
1800	257.72549	141.3333333
1836	252.76923	138.6153846
1872	278	138
1908	274.81481	164.8888889
1944	269.81818	161.8909091
1980	265	159
2016	260.35088	156.2105263
2052	255.86207	153.5172414
2088	251.52542	150.9152542
2124	249.1	174.9
2160	245.01639	172.0327869
2196	241.06452	169.2580645
2232	238.92063	191.8095238
2268	236.84375	213.65625
2304	257.66154	212
2340	255.36364	232.8787879
2376	251.55224	229.4029851
2412	247.85294	226.0294118
2448	244.26087	222.7536232
2484	240.77143	219.5714286
2520	237.38028	216.4788732
2556	234.08333	213.4722222
2592	230.87671	210.5479452
2628	227.75676	207.7027027
2664	224.72	204.9333333
2700	221.76316	202.2368421

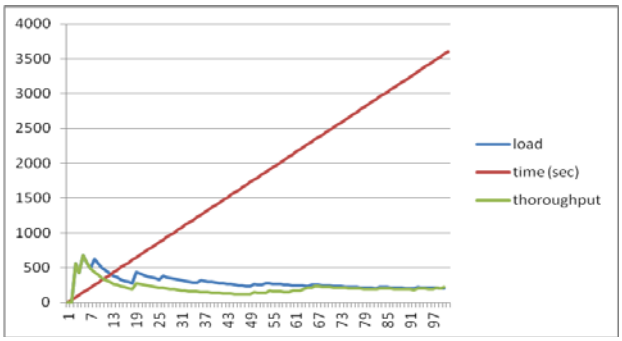

Figure 3. Throghput versus time and load for email.

4 Conclusion

The traffic is dynamic in nature so the load is varying w.r.t time. Throughput is the performance metric taken in this paper which is observed lesser compared to the load offered to the network which indicates the blockage of requests offered to the network. The throughput and blocking of the network can be optimized with some nature inspired technique in future.

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