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Minimizing Link Utilization in Selfish Overlay Routing

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Abstract-
The rapid growth and increasing requirements for service quality, reliability had made everyone to choose the traffic engineering essential for the large public networks. The multi Protocol label switching is a protocol used when there is interaction between the traffic engineering and the overlay networks. This MultiProtocol Labeled Switching (MPLS) with the help of the nash equilibrium algorithm has given optimized performance better by reducing the latency and increasing the link utilization. But increase in link utilization will gradually increase the congestion in the network as the link is being used by all the nodes. So, to overcome this specific problem we have performed a formulation called dual programming formulation which has set of constraints that have to be satisfied, along with Open Shortest Path First(OSPF) protocol so as to reduce the maximum link utilization. We have simulated the results in five queuing models which includes BPR,PD1,PM1,MM1,MD1 using source, compliant, optimal overlay routing. The results are simulated using Ns2 with linux as platform.Link utilization is reduced based on the parameters such as traffic demands and the distance between the nodes with their respective demands.
Keywords-OSPF,MPLS,Traffic Engineering.

I. INTRODUCTION

In general overlay network are the networks built on top of another network. The selfish overlay network is a network present over the physical network in which the nodes behave in a selfish manner, without considering about the global criteria. They also don't take into account about their neighbor's protocols or any other things. Hence the forwarding of packets from the source node to the destination node will take place in a peaceful manner without the need to follow any protocol. The nodes in these networks can be thought of as being connected through virtual or logical links. The overlay networks have only selected number of nodes from the base physical network. Those selected nodes only will take part in transferring of

packets from source node to the destination node.The selfish overlay network is indulged with the Multiprotocol label switching. It is processed in such a way that the Nash Equilibrium is achieved by considering the latency and link utilization. Then we get an optimized output as reduced latency and maximum link utilization. The maximum link utilization at times might lead to congestion. Dual programming formulation is applied to the network so that the link utilization gets reduced with the help of the Open Shortest Path First protocol. The Queuing models say BPR, PM1, PD1, MM1, MD1 are used to get a queuing situation where there will user defined results with optimized output and the queuing models are compared with three routing types which includes overlay source routing, compliant and optimal routing. Overlay source routing is similar to the source routing in the physical networks where the source only makes traffic decisions. On the other hand the central authority takes the decision is said to be optimal overlay routing. Finally the compliant routing is where they follow the traffic route specified by the network level routing protocol.

II. RELARED WORK

An overlay network consist of the overlay nodes with set of demands from the nodes. Demands are nothing but the amount of traffic between the source and the destination. The link latency function uses five basic representatives namely M/M/1, M/D/1, P/D/1, P/M/1 and BPR. With the help of these representatives a comparison is made. When all the latency functions are compared with the different routing schemes, the selfish routing performance is found to be better than others. It is found that selfish routing yields low latency. When the overlay network considers only specific nodes then there can be only the covering edge nodes, where they don't lose any flexibility and the random partial coverage, they get the shortcuts. Selfish routing will reach an optimal latency and also tend to increase the link utilization. [1]

The traffic engineer is like the central authority. The routes for the users are assigned by this traffic engineer. The users themselves cannot directly get the route. A routing policy considered which is a user-server pair that assigns a policy between them. The traffic engineer has to find a routing policy that minimizes this over all possible distributions over routes.[2]

One important issue on this traffic assignment is that they have check load distribution. Network state information is one by which the state information is traversed in the network. Maximum link bandwidth, maximum allocation multiplier, default traffic engineering metric, Configuration management functions, performance and accounting management function and fault management function are included in the network management. The traffic statistics has to be characterized. [3]

One approach towards optimizing the network performance is to manage the bandwidth by routing the traffic over the selected links in the network. Fish problem allows the link capacity not to exceed and a predefined objective has to be optimized. So minimizing the maximum link utilization will make the link to direct the ports to take a different unused path away from the congested path. The problem to be solved is that the link utilization should not be increased as where there is checking done for the capacity of the links. A linear programming formulation has to be done to optimize the network links. This will give about the value to minimize the link utilization and also the traffic flow has to be specified for both in and out.[4]

Open Shortest Path First is one of the most widely used intra-domain routing protocols. This is because OSPF always forwards packet through shortest path. Even when the shortest path is congested and there is an alternate less congested path it does not have the capability to reroute packets through the alternate path. The demand has to be split over the network. The main idea here is to split traffic demand only at the source node. Looping is a major issue in any routing protocol. In S-OSPF, for a given demand, source node sends traffic to all its neighbors which are not OSPF ancestor in the sink tree rooted at that destination. Thus, the forwarding at source node ensures that it is loop free. From the next hop onwards, the packet of the given demand follows the OSPF path. LPF would allow nodes to split traffic of a given demand, which affects the performance of higher layer protocols.[5]

III.METHODOLOGY

Link utilization is defined as the process of getting the amount of link utilized, in which the utilization of the links that are available in the whole network area considered. When the link utilization is proper then there will be good network with good quality of service. Congestion occurs basically due to the poor resource utilization, the usage of the same network without using the other available network. In traffic engineering referred by link utilization, quality of service (QoS) refers to resource reservation control mechanisms rather than the achieved service quality. Quality of service is the ability to provide different priority to different applications, users, or data flows, or to guarantee a certain level of performance to a data flow.

Programming problem is one in which the available resources are arranged in such a way that they bring out optimal allocation resources. The linear programming problem means group of programming problem that are related in a linear fashion. To get an optimized result we have considered about the constraints and the functions in a linear manner. When a linear inequality is given then the result has to be either minimization or maximization of the linear function.

Transportation problem is one such example for the linear programming formulation. The dual programming formulation is used to minimize the maximum link utilization. Dual programming formulation is the dual form of the linear programming problem, which means that one linear programming problem associated with another. The dual programming formulation is given by,

$$\Sigma_{k\in K} d_k U_t k^k \quad (1)$$

$$U^k_j - U_i^k <= W_{ij}, k \in K, (i,j) \in E \quad (2)$$

$$\Sigma_{(i,j)\in E} C_{ij}^{Wij} = 1, \quad (3)$$

$$W_{ij}>=0,\ U_s k^k=0 \qquad (4)$$

here k represents the demands present in the network traffic, U the shortest distance from the source to the specified i^{th} node and W the weights of the data flowing link.

The first constraint does the summation of all the traffic demands, along with the shortest distances to the destination. Then the shortest distance between two nodes with their respective demand is got and checked out whether it is less than the weights, these done in the second constraint. The capacity is also calculated for the available weights. Final constraint checks for the weight to be greater than or equal to zero and also the shortest distance selection.

IV RESULTS AND DISCUSSION

When we consider the load scale factor on the x-axis and the maximum utilization on the y-axis which is measured in micro-seconds, we find that the link utilization for the compliant routing is the lowest. We consider 10 nodes while the transmission of packets gets slower after some time and at node 5 there is a packet drop. After few milliseconds the route is cleared by searching the correct route or by repairing the node using the traffic models. The above said was considered for all the queuing models and for example we have given only two queuing models. The five queuing models are compared considering link utilization as a function. The three routing types are also compared and they are simulated.

The topographic model was used to compare three types of routing namely source routing, optimal routing and compliant routing. Source routing results in selfish routing, since the source of the traffic makes an independent decision about how the traffic should be routed. The selfish routing scheme studied in most previous theoretical work is source routing. Optimal routing refers to a scenario where a single authority makes the routing decision for all the demands to maximize link utilization. The Nash equilibrium was achieved for all the queuing models where we got maximum link utilization. The maximum link utilization in any link will lead to congestion at the hotspots where the packets get accumulated. To overcome this problem we applied the dual programming formulation, to minimize the maximum link utilization. It is found that the link utilization was gradually decreased when compared with the Nash equilibrium. For all the graphs presented below, the normal lines indicate source routing, doted lines indicate optimal routing and the lines with cross marks represent the compliant routing.

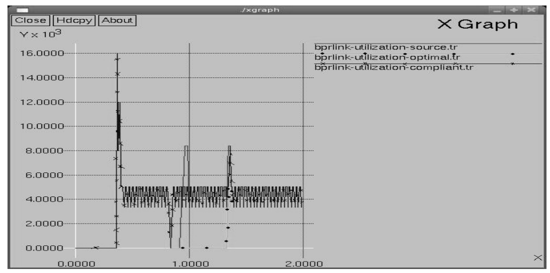

Fig 1:BPR-Before Nash Equilibrium

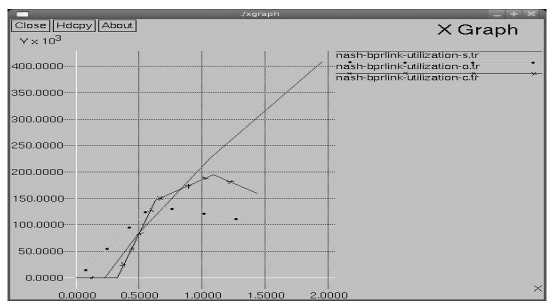

Fig 2:BPR-After Nash Equilibrium

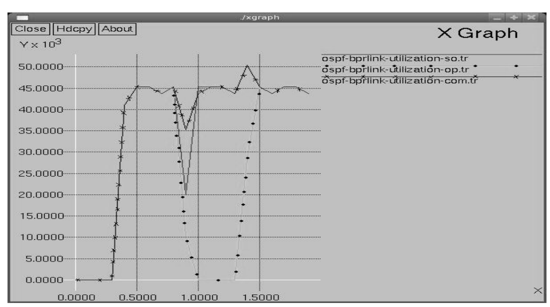

Fig3:BPR- Belittled link utilization(dual formulation)

Here optimal routing gives the least link utilization, then the source routing and the highest is the compliant routing.

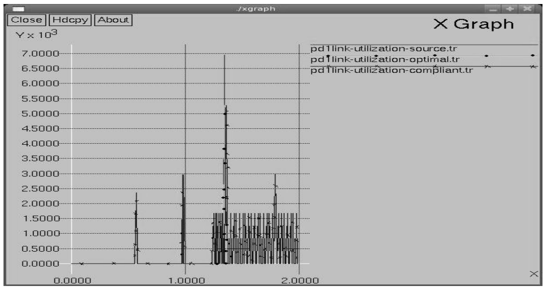

Fig4:PD1 link utilization before Nash

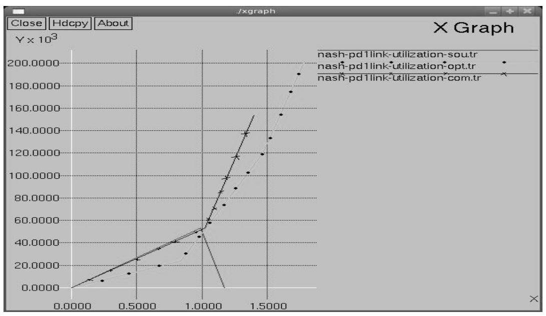

Fig5: PD1 Nash-equilibrium achieved

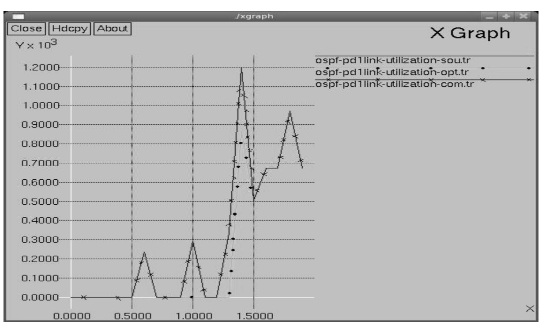

Fig6 PD1 Belittled link utilization(dual formulation)

Here the optimal routing shows the lowest link utilization, the source routing is overlying in other routing model and the compliant routing shows the highest link utilization.

Comparison of Queuing models:

Here we have compared the five types of queuing models based on link utilization.

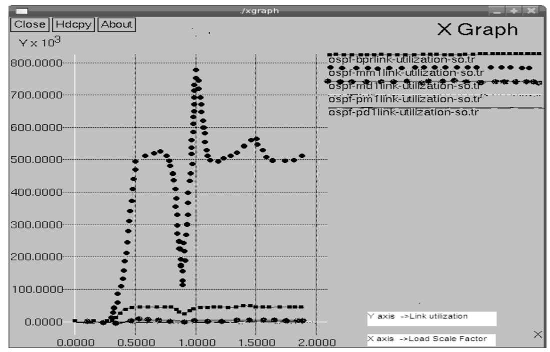

Fig 7: Comparison of Queuing models

From the figure it is found that the MM1 queuing model is found to have the highest link utilization, at the least the MD1, PD1, PM1 and the BPR in the mediocre

Comparison of routing type:

Here source routing, optimal routing and the compliant routing are compared for OSPF protocol.

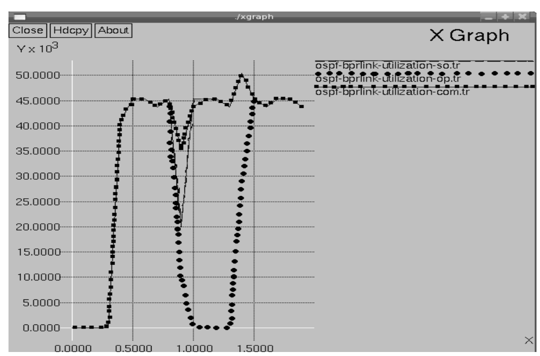

Fig 8: Comparison of routing types

V.CONCLUSION AND FUTURE WORK

The equilibrium state is achieved so as to get an optimized output. Also the maximum link utilization is minimized using dual formulation to make the link perform better away from congestion. Comparison of routing models and routing types are also simulated.When going through the types of routing the source routing and the optimal routing is found to be better than the compliant routing. The future work can be congestion avoidance mechanism to be set up so as avoid any congestion that might occur. Also a congestion feedback system can be set up. This is the one that can inform the nodes in the network that in a particular link congestion is going to occur due to the overflow of packets. Also it can tell the nodes to take any other route to continue their forwarding of packets.

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