Simulation Study of Multi-Path Routing Algorithm in Different Situations

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Summary

Throughput, Traffic Engineering and Load balancing concepts are very important in multi-path adaptive routing algorithm which stresses the need of multi-path adaptive routing algorithm as compared to single path routing algorithm. This paper evaluates the performance of multi-path adaptive routing algorithm in different situations like bottleneck link , traffic splitting among two output links of equal and unequal bandwidth paths at a router. It also presents a case study with the help of simulation that how the performance at the destination node by taking different buffer capacities at the splitting links at multi-path nodes is improved. The simulation results in network simulator(NS-2) conclude how congestion can be reduced by the appropriate size of the buffer at the links.

Keywords:
Routing, multi-path routing, metric, Performance Analysis, Packet Loss Analysis.

Introduction

There are certain algorithms[1] which plays very important role in today's internet like link-state and distance vector routing algorithms. The example of link-state routing algorithm is OSPF and that of distance vector is RIP. Simulation comparison of link state and distance vector routing algorithm conclude that link-state routing is better than distance vector routing in core networks of large size where large volume of data transaction takes place. In this paper the performance of multi-path routing algorithm is analyzed in the core networks in different situations. The paper is divided into different sections. Section 1.0 gives the background of routing algorithms. Section 2.0 gives the concept of multi-path routing algorithm. Section 3.0 gives the topologies used in the paper. Section 4.0 gives the simulation results. Section 5.0 gives performance graphs. Section 6.0 concludes the paper. Section 7.0 gives the references used in the paper.

1.0 Background Of Routing Algorithm

The path chosen may only represent which outgoing line to use, if there are two or more paths between source and destination nodes in the core network. The routing algorithm calculates the path between source and destination nodes or routers depending on the metric. The metric may be no. of hops or may be bandwidth +delay or links etc. Many different metrics[5] can be used to judge the shortest path, like no. of links, distance in terms of hops, delay, bit-rates(bandwidth) and cost.

2.0 Concept Of Multi-Path Routing Algorithm

In core networks where there is a huge amount of data transactions and there are more than one equal cost route possible from a source node to destination node, the multi-path routing algorithm[6][7][9] may be used, which improves the available resources utilization and helps in reducing congestion, balancing the load between equal cost multi-paths. The utilization of links[2] can be improved by having large full queues which in turn implies increasing delays, so sort of trade off is required for limiting the size of queue. The simulation results helps in deciding the appropriate size of queue at the link for better performance. The multi-path routing algorithm should follow the principle of avoiding congestion at a particular node including cross-traffic as given here.

(1) Departure traffic at a node $\leq$ Arrival traffic at that node.
(2) In case of multi-path routing algorithm it is necessary for load balancing that none of the outgoing link of a router is utilized more than 100%.
(3) The RED queue may be maintained at the bottleneck links for better performance.

3.0 Topology

The topologies used in the paper for experimental purpose have six nodes and seven links shown in fig. 1.

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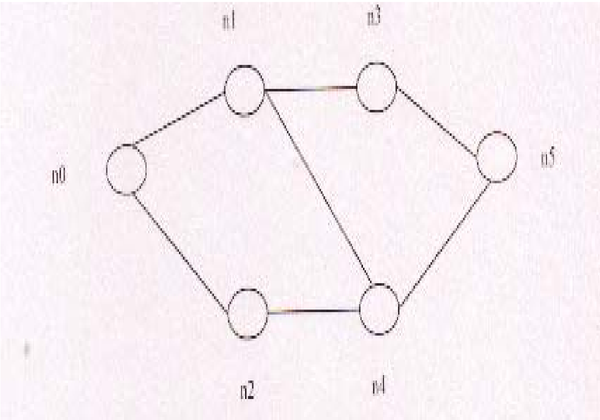

Fig.1 : Experimental Topology

4.0 Simulation Result

The simulation study was performed on Network Simulator (NS2) [8]. The Simulation result are evaluated in different cases using topology of fig.1 .

4.1 Bottleneck Link Case

Offered load at n0 node = 9.5 Mbps. Buffer size at all links is 4900 packets except link n1-n4 where it is 2000 packets. Here the simulation is performed for 5.0 sec. The bandwidth of link n0-n1 is 2.6 Mbps, The bandwidth of link n1-n4=1.1 Mbps. The bandwidth of link n0-n2 is 3.0 Mbps, The bandwidth of links n2-n4, n3-n5, n4-n5 is 2.0 Mbps respectively. By maintaining the RED and FIFO queues at the bottleneck links the simulation results are obtained as shown in fig. 2.

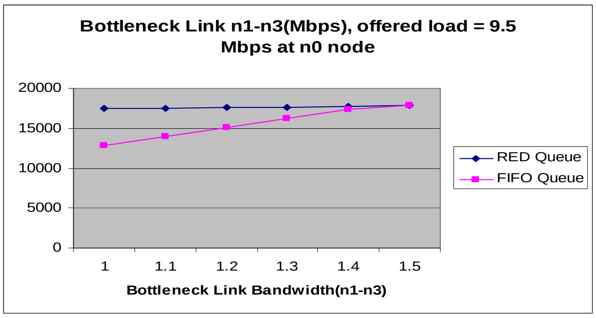

Fig. 2: Packet Loss Comparison when RED queue and FIFO queue are maintained at the bottleneck link n1-n3 for a multi-path link state routing algorithm when offered load is 9.5 Mbps.

4.2 Effect Of Buffer Size On The Performance At The Destination Node

Case A:- When at multi-path node there are two outgoing links and buffer size at one link is changed while the buffer size at the other link is kept constant. The bandwidth of link n0-n1, n0-n2 is 3.0 Mbps respectively. The bandwidth of n1-n3, n1-n4 is 1.5 Mbps respectively. When simulation is performed for 5 sec. The bandwidth of other links are 2.0 Mbps.

Case B:- When at the multi-path node there are two outgoing links and buffer size at both the links are changed at the same size simultaneously.

4.3 Traffic Splitting

If the traffic at a multi-path node is splitted among equal bandwidth paths subject to the condition that the Buffer size at link n0-n1 is 4950, at link n0-n2 is 5050, at link n1-n4 is 2000 and buffer size at links n1-n3,n2-n4,n3-n5,n4-n5 is 4900 packets respectively. The offered rate is 9.5Mbps.The bandwidth of link n1-n3, n1-n4 is 1.5Mbps and bandwidth of link n2-n4,n3-n5,n4-n5 is 2.0Mbps respectively. Here if the buffer size at link n1-n4 is increased from 2000 packets to 2100 packets, the loss remains the same i.e. 0.475 percent. It means that it is the suitable buffer size chosen with the help of simulation for this particular case. From simulation there is loss of 15.59% at the destination when the offered load is 9.5Mbps at a multi-path node having two outputs links of capacity 2.5Mbps each. From Simulation results there is a loss of 18.29% at the destination node when the offered load is 9.5Mbps at a multi-path node having two outgoing links of capacity 2.0 and 3.0 Mbps respectively. Therefore if the traffic load at a multi-path node is heavy and distributed among equal bandwidth paths gives better performance than unequal bandwidth paths when the incoming traffic is more than the capacity of the output links as shown in fig. 4 and fig.5.

5.0 Performance Graphs

The performance of multi-path link state routing algorithm is better than multi-path distance vector as shown in fig. 3 .The performance graph for bottleneck link, when two different types of queues i.e RED(Random Early Discard) and FIFO(First in First out) are maintained at the bottleneck link is shown in fig. 2. The simulation results helps in deciding the type of buffers at the bottleneck links. The case study of buffer type for a particular case is explained. The Performance graph helps in deciding the appropriate size of buffers at the bottleneck links for a particular case so that the congestion in the network may be reduced and performance may be improved.

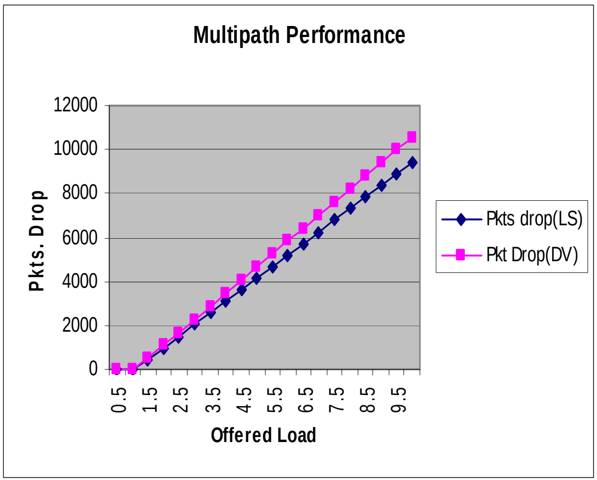

Fig.3: Packet Loss Comparison of multi-path distance vector and link state routing algorithm.

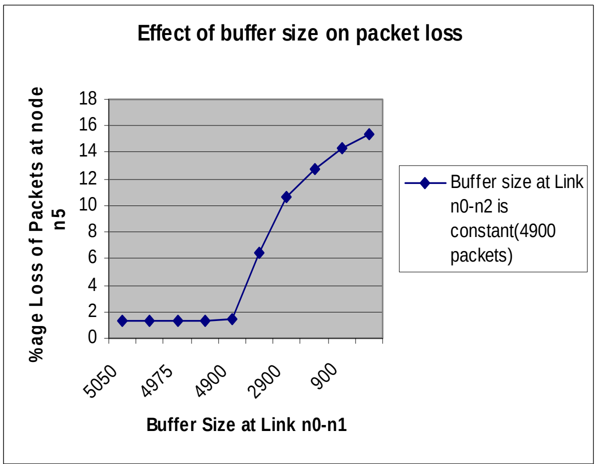

Fig.4: Packet Loss Comparison of multi-path distance vector and link state routing algorithm during link failure.

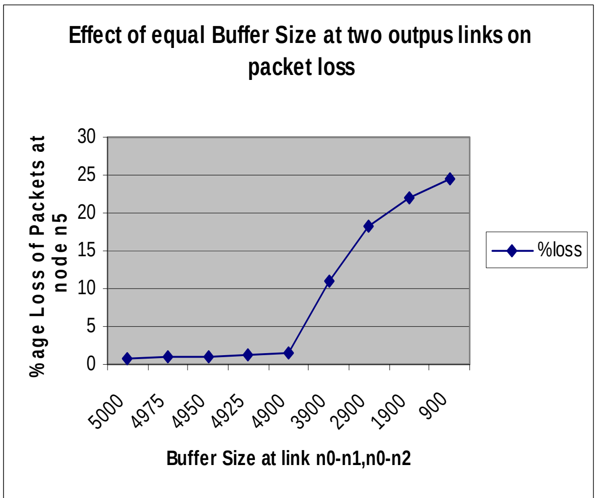

Fig.5: Effect of buffer size selection at link n0-n1 on the packet Loss at the destination router.

6.0 Conclusion

It is concluded that the multi-path link state routing algorithm performs better than the multi-path distance vector routing algorithm. The case study of buffer size selection at the bottleneck links for a topology used in the paper is shown. The simulation results shows that the buffer size of 4950 packets at link n0-n1 and 5050 packets at link n0-n2 gives better performance. The simulation results also gives better results for the case when two different size queues are maintained at a multi-path node instead of two same size queues at the bottleneck links. If the offered load is applied among two equal paths in terms of bandwidth and unequal cost paths then the equal cost paths gives better performance i.e. less packet loss. Therefore the load balancing becomes necessary in the network to avoid congestion.

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