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Throughput and Congestion Analysis with Improved Routing Algorithm

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ABSTRACT : In this paper the problem of congestion due to overload of links are solved with the new routing algorithm in multipath. Unlike traditional routing schemes that route all traffic along a single path, multipath routing strategies split the traffic among several paths in order to ease congestion. It has been widely recognized that multipath routing can be fundamentally more efficient than the traditional approach of routing along single path. It has been shown that using multipath to route messages between any source-destination pair of nodes (instead of using single path) balances the load more evenly throughout the network. Our aim is the compute a set of loop free paths in order to allow routers to share the load on several next hops depending on the current load measurement. Based on AOMDV protocol the proposed approach achieves this by finding reliable and secure paths for data packets before transmitting them. Since paths are verified for security and reliability at the beginning of data transmission, here probability of packet loss/delay misbehavior is minimum. With the help of this algorithm we can provide better environment from its old networking counterparts. This algorithm works when overload comes on links, and the overload is balanced by the alternate paths or by multi-paths. As a result the throughput is improved and the packet loss is reduced compared to single path system.

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I. INTRODUCTION

Current routing schemes typically focus on discovering a single “optimal” path for routing, according to some desired metric. Accordingly, traffic is always routed over a single path, which often results in substantial waste of network resources. *Multipath Routing* is an alternative approach that distributes the traffic among several “good” Paths instead of routing all traffic along a single “best” path.

Multipath routing can be fundamentally more efficient than the currently used single-path routing protocols. It can significantly reduce congestion in “hot spots”, by deviating traffic to unused network resources, thus improving network utilization and providing load balancing [14]. Moreover, congested links usually result in poor performance and high variance. For such circumstances, multipath routing can offer steady and smooth data streams.

In recent years, computer communication networks have developed rapidly. The reason why it develops so rapidly is due to one of the critical technologies—routing technology. For routing packets in the Internet, either a single-path can be used for all the packets from a source to a destination or multiple paths can be utilized. Many different kinds of single path routing, such as Dijkstra algorithm [4], SWP algorithm [5], and WSP algorithm [7] and so on, have been proposed. But according to these methodologies, transit node can only conduct data forward and transmission through single path, which will make message incline to take up nodes and links which have stronger processing capacity. Thereby, it easily leads to link congestion, data packet loss, network throughput reduction, link load unbalanced, which always makes some nodes and links in the state of congestion or overload , but the other in the low state in most times. The secondary paths can be used to transmit data packets, in case the primary path fails due to node mobility or battery failure, which avoids extra node mobility or battery failure, which avoids extra overhead generated by a fresh route discovery.

These multiple paths are more advantageous in larger networks, where he number of route breaks are high.

Providing multiple routing paths between any source-destination pair of nodes has been proved to be very useful in the context of wired networks. The general understanding is that dividing the flow among a number of paths (instead of using a single path) results in a better balancing of load throughout the network [1] and [8].

In the context of mobile ad hoc networks, several multipath routing protocols have been proposed [2], [10]. The performance of these protocols has been mainly studied through simulations. Recently, some paper have studied different aspects of multi-path routing by providing analytical models [3],[9].The only know result which studies the distribution of load in an ad hoc network is due to Pham and Perreau [6]. They have introduced an analytic model for evaluating the load balance in an ad hoc network under single shortest path routing. For multipath routing, they assume the load is uniformly distributed throughout the network, regardless of the number of paths used, and how these paths are chosen.

For analysis purpose, we define network topology and the flow path as: Disjoint routing mechanism in the bottleneck link, and it can supply better performance during the network transmissions from end to end. But all feasible paths between source nodes and destination nodes have been installed, that means all feasible paths will be known in advance, which restrict its application.

Through studying and analyzing existing routing algorithms [17-20], this article proposes a new multi-path routing algorithm. The algorithm aims at heavy loading links in the network can relieve hot link loads by transferring path for data packet, thereby reducing the congestion and packet loss in the network.

II. DESIGN OF ALGORITHM

This algorithm mainly aims at dealing with the degradation of performance in whole networks resulting from rare area congestion in wire transmission network. Firstly, the focus of our work is to keep the routing information in the source node, so as to conduct data transmission in method of alternative path or multi-path inter currently in source node when congestion happens. Secondly, check congestion regularly, meanwhile record the bandwidth of each link, and then judge whether the link in the state of overload by comparing excess bandwidth.

The following article will describe the algorithm by given network topology.

Volume of link bandwidth, b(s, r) represent the excess bandwidth of link, from formula (1), *Bi* is the used bandwidth of the link of No.*i*

$$b\ (s,\ d) = C(s,\ d) - \sum_{i=0}^{k} (B_i)$$

Set bandwidth threshold of link as B_l $B_{\ h}$ ($B_h = \alpha * \mathrm{C}$, $l\ B_l = \beta * C$, $0 < \beta < \alpha < 1$)

$$b(s,\ d) < B_l \qquad ...(2)$$

$$b(s,\ d) > (B_h + B_l)/2 \qquad ...(3)$$

*Definition 1***:** Let the set **SP** represent the set of all path from the source node to the destination in the graph ($p^s_d \subset \mathbf{SP}$), p^s_d stands for the path from node s to node *d*. And then define two sets **M** and **N**, which is used for containing some of the p^s_d.

III. PROPOSED ALGORITHM

This paper proposes a multipath routing scheme, in order to minimize the route break recovery overhead. This scheme provides multiple routes on the intermediate nodes on the primary path to destination along with source node. The primary path is the first path received by the source node after initiating the route discovery, which is usually the shortest path. Having multiple routes at the intermediate nodes of the primary path, avoid overhead of additional route discovery attempts, and reduce the route error transmitted during route break recovery. This Algorithm performs following steps:-

1. Call shortest path algorithm, evaluate the shortest path between source node and destination node, if set path is null set, quit, and otherwise continue.
2. Search and compare each path in SP, and do statistics of each link frequency
3. Check the excess bandwidth of each link in SP regularly.
4. Check the power of each node regularly.
5. We can judge from formulae (2) that this link is heavy load link, and put it into set M; and judge from formulae.
6. That it's an idle link put the links which satisfies the condition into set N.
7. If the node is fail then we need another shortest path so we use mobility concepts.
8. Pickup link from the set M, if *k* = 0 stop and otherwise to continue procedure 6.
9. Find out the upstream node w of the heavy link, find out w node in idle set, and select the node link of next hop.
10. After selecting the new path, figure out the bandwidth, and then sort it out and put into corresponding set (set M or set N).
11. If *k* = 0 stop calling the algorithm; otherwise, to continue to check the heavy load links, and split stream, then jump into the step 4

IV. SIMULATION SCENARIOS

In order to analyze the performance of algorithm presented in this text, the paper adopts a topology structure as Fig 1, in which the link relation of each node is displayed, and also the bandwidth and time delay .The unit is Mps and ms respectively. Let's take node 1 as source node, node 7 as destination node. In the analysis, we adopt traditional shortest path algorithm to compare with it.

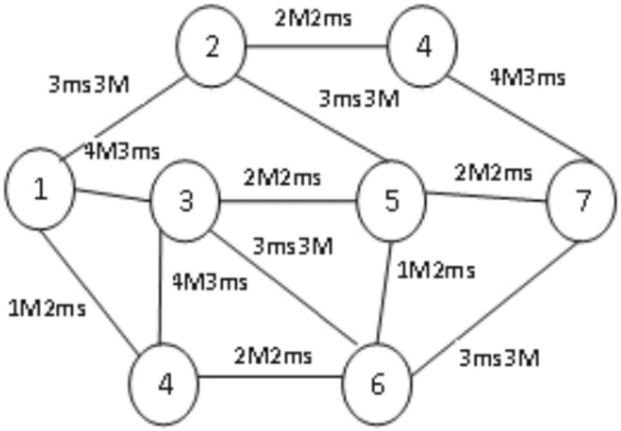
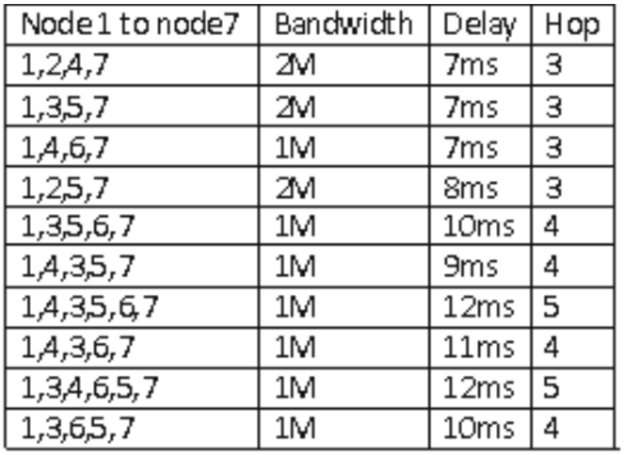


Fig. 1. Analog network.

Firstly, call any shortest algorithm, the path of data stream is (1, 3, 5, 7), bandwidth 2Mbps, time delay 7ms, hops 3.It would record other paths (as Table (i)) from source node to destination node. From Fig.1, it can be seen that the links marked red is the priority paths of many data packets, where the congestion happens frequently. Secondly, set time T as period; check out surplus bandwidth in each link regularly. Once congestion happens or it will happen, system will call the algorithm automatically, revise the routing information, and distribute new paths over again in alternative multipath set. As Table (i), the given path in graph is in order of priority from good to bad, these alternative paths split stream for the heavy load link, reduce the possibility of congestion, and reach link load balance.

Table 1: Possible paths from node 1 to node 7.



Node1 to node7	Bandwidth	Delay	Hop
1,2,4,7	2M	7ms	3
1,3,5,7	2M	7ms	3
1,4,6,7	1M	7ms	3
1,2,5,7	2M	8ms	3
1,3,5,6,7	1M	10ms	4
1,4,3,5,7	1M	9ms	4
1,4,3,5,6,7	1M	12ms	5
1,4,3,6,7	1M	11ms	4
1,3,4,6,5,7	1M	12ms	5
1,3,6,5,7	1M	10ms	4

V. CONCLUSION

The proposed algorithm in this article is based on multi path, which is a load balancing type of algorithm. To some degree, it can effectively avoid the problem of load unbalance effectively. By modifying the single path algorithm and compromising related path selection mechanism, it calculate each parameter (as available bandwidth, hops, reliability, mobility, power, packet loss rate, throughput and so on), and realize more flexible routing selection strategy, thereby propose a new resolution for heavy link load in present network. From the simulation result, it can be seen that the algorithm, which is proposed in this article has good robustness and load balancing ability.

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