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A Shortest Path & Directed Acyclic Graph Based Technique for Multipath Routing

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Abstract: ***Nowadays the demand of network is increasing rapidly. The rationally growing applications of such network requirements also demands fast recovery from network or link failures. Multipath routing is one of the most promising routing schemes to accommodate the diverse requirements of the network. Load balancing and improved bandwidth are the two main advantages of the multi path routing. In this paper, we are proposing a comprehensive survey of the modern multipath routing techniques. The introduction of multipath routing with its merits and demerits is also given in the beginning section of the introduction.***

Keywords: Multipath Routing, Increased bandwidth, Directed Acyclic Graphs, Recovery from link failure

1. Introduction

Multipath routing, sometimes called traffic dispersion [8], has been one of the most important current directions in the area of routing. The current routing is based on the single path routing - between a source and a destination, the single minimum-cost path tends to be selected although different cost metrics may yield different paths. Though in a practically well-connected network there may exist several paths between a source-destination pair. The concept of multipath routing is to give the source node a choice at any given time of multiple paths to a particular destination by taking advantage of the connectivity redundancy of the underlying network. The multiple paths may be used alternately, the traffic uses or runs on one path at a time.

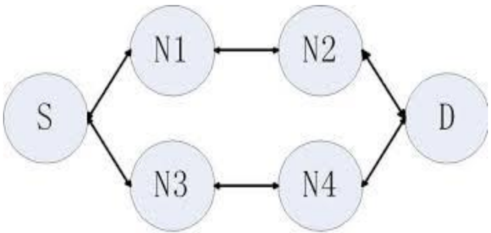

Figure 1: Multi path routing

Multipath routing has drawn extensive attention in MANETs and WSNs recently. The deployment of a large number of nodes in a network makes the multipath routing a nature and promising technique to cope with the frequent topological changes and consequently unreliable communication services.

The original idea behind using multipath routing approach in WSN was to provide path resilience (against node or link failures) and reliable data communication. In the fault tolerance dominion at whatever time a sensor node cannot forward its data packets towards the sink. It can also get the benefit from the availability of alternative paths to salvage its data packets from node or link failures [7].

Load balancing is also a very important advantage of the multi path routing. In this scheme, we can send the data using the parallel channels in such a way that the load is properly balanced at each path [8].

Delay time is reduced: The delay time is minimized in multipath routing because alternate routes are identified during route discovery [4].

By splitting data to the same destination into multiple streams while everyone is routed through a different path the effective bandwidth can be accumulated. This scheme is chiefly favourable when a node has multiple low bandwidth links but it requires a bandwidth that is greater than the one which an individual link can provide [4].

Link-independent (node-independent) DAGs satisfy the property that any path from a source to the root on one DAG is link-disjoint (node-disjoint) with any path from the source to the root on the other DAG. A polynomial time solvable algorithm is proposed in [1] computes link-independent and node-independent DAGs. Author [2,3] first proposes a modified version of the popular AODV protocol that allows us to discover multiple node-disjoint paths from a source to a destination. Th method [4] extracts the resource redundancy and diversity in the underlying network. It provides benefits such as fault tolerance, recovery from link failure, load balancing, security, bandwidth aggregation, and improvement delay metric. The spread scheme is proposed in work done in [6] . The SPREAD is based on two principles, one is secret sharing and the other one is multipath routing. Connection less multipath routing is proposed in [5].

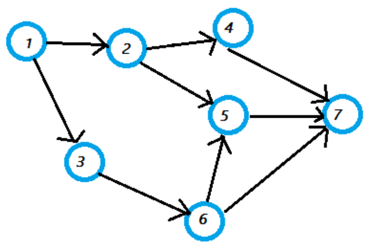

Figure 2: Directed Acyclic Graph

2. Related Work

In order to achieve resilient multipath routing,[1] introduces the concept of independent directed acyclic graphs (IDAGs) in this paper. Link-independent (node-independent) DAGs satisfy the property that any path from a source to the root on one DAG is link-disjoint (node-disjoint) with any path from the source to the root on the other DAG. Given a network, author used polynomial-time algorithms to compute link-independent and node-independent DAGs. The algorithm developed in this paper: 1) provides multipath routing; 2) utilizes all Mobile ad hoc networks [2] consist of nodes that are often vulnerable to failure. As such, it is important to provide redundancy in terms of providing multiple node-disjoint paths from a source to a destination. Author first proposes a modified version of the popular AODV protocol that allows us to discover multiple node-disjoint paths from a source to a destination.

[3]Research on multipath routing protocols to provide improved throughput and route resilience as compared with single-path routing has been explored in details in the context of wired networks. However, multipath routing mechanism has not been explored thoroughly in the domain of ad hoc networks.

[4]Multipath routing allows building and use of multiple paths for routing between a source-destination pair. It exploits the resource redundancy and diversity in the underlying network to provide benefits such as fault tolerance, load balancing, bandwidth aggregation, and improvement in QoS metrics such as delay. There are three elements to a multipath routing, namely, path discovery, traffic distribution, and path maintenance. Path discovery involves finding available paths using pre-defined criteria.

[5]Author presents a framework for the modeling of multipath routing in connectionless networks that dynamically adapt to network congestion. The basic routing protocol uses a short-term metric based on hop-byhop credits to reduce congestion over a given link, and a long-term metric based on end-to-end path delay to reduce delays from a source to a given destination.

In this paper [6], author investigates the security performance of the SPREAD scheme, which author proposed as a complementary mechanism to enhance data confidentiality in a mobile ad hoc network (MANET). SPREAD is based on two principles, secret sharing and multipath routing.

With the scheme, we can achieve robustness [2], load balancing [3], bandwidth aggregation [4], congestion reduction [5], and security [6] compared to the single shortest-path routing that is usually used in most networks Techniques developed for multipath routing are often based on employing multiple spanning trees or directed acyclic graphs (DAGs) [7]. When multiple routing tables are employed, a packet has to carry in its header the routing table to be used for forwarding. When the corresponding forwarding edge is not available, the packet needs to be dropped. This dropping is forced due to the potential looping of packets when transferred from one routing table to another. In the case of DAGs, computed by adding edges to the shortest-path tree, one cannot guarantee that a single-link failure will not disconnect one or more nodes from the destination. Techniques developed for fast recovery from single-link failures provide more than one forwarding edge to route a packet to a destination. The techniques may be classified depending on the nature in which the backup edges are employed. In [8], the authors develop a method to augment any given tree rooted at a destination with "backup forwarding ports." Whenever the default forwarding edge fails or a packet is received from the node attached to the default forwarding edge for the destination, the packets are rerouted on the backup ports. In [9], the authors present a framework for IP fast reroute detailing three candidate solutions for IP fast reroute that have all gained considerable attention. These are multiple routing configurations (MRCs) [10], failure insensitive routing (FIR) [11], [12], and tunneling using Not-via addresses (Not-via) [13]. The common feature of all these approaches is that they employ multiple routing tables. However, they differ in the mechanisms employed to identify which routing table to use for an incoming packet.

3. Proposed Methodology

The goal of the proposed technique is to construct independent directed acyclic graphs for ensuring reliable multipath routing. The proposed algorithm also selects the minimum cost path to route data from the source station to the destination station.

Step 1: Assume a network with N number of Nodes & E number of edges
Step 2: Generate the adjacency matrix of the network. Where w is the weight associated with twp edges.
Step 3: Enter the source node s and the destination node d,
Step 4: In this step, Independent Directed Acyclic Graph is generated using the Cho's algorithm.. The procedure for constructing the independent directed acyclic graph is as follows:

- 1st of all divide the network into 2 vertex connected 2V components.
- In every two vertex connected component, selected the distinctive articulation node through which every path from any node in that component should traverse to reach node d. This articulation node is the root node of the component. Then the component that contains node d we suppose that the root node of the component is node d itself.
- In each two vertex connected component, built 2 node independent DAG to the root node of that component.
- At the end all node independent DAG are merged to obtain the Link independent DAGs.

Step 5: Minimum cost path is selected, using the dijkstra's shortest path algorithm. The routing is performed. In case of link failure, the alternate path is chosen in DAG & routing is performed.

4. Conclusion

This paper presents an updated directed acyclic graph based method for multipath routing. As the cost of hardware devices decreased and there is steady increase in resource availability voice over IP and other multimedia data streaming is increased. In such applications high bandwidth is expected besides faster recovery from single point of failures. To achieve high bandwidth and recovery from the failure, a good solution multipath routing can be used. Proposed method is better as it offers increased number of paths and reduces the probability of link failure as well.

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