

INDEPENDENT DIRECTED ACYCLIC GRAPH USING COLORED TREE APPROACH – A Review

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ABSTARCT:

The independent directed acyclic graphs (IDAGs) introduces Link-independent and Node-independent DAGs. The polynomial- time algorithms used to compute link-independent and node-independent DAGs. The algorithm provides : 1) provides multipath routing; 2) utilizes all possible edges; 3) guarantees recovery from single link failure; 4) recovery from dual link failure and 5) reduce the number of overhead bit required in the packet header. The effectiveness of the proposed IDAGs approach by comparing key performance indices to that of the independent trees and multiple pairs of independent trees techniques will shown in advanced JAVA platform.

Keywords: IDAG, Multipath routine

INTRODUCTION

The Increasing use of streaming multimedia and voice-over-IP, precipitated by decreasing cost of handheld multimedia devices and net books, necessitates increased bandwidth provisioning and fast recovery from network failures. Thus, present-day IP networks employ several different strategies for improved end-to-end bandwidth and load balancing (using multipath routing) and fast recovery from link and node failures (using fast rerouting strategies). Multipath routing is a promising routing scheme to accommodate these requirements by using multiple pairs of routes between a source and a destination. With the scheme, I will 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. Multipath routing in today's IP networks is merely limited to equal-cost multi paths [24], [25]. 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 [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. The readers are referred to [14] for a detailed description of the above techniques. It is certainly possible to use fast recovery techniques for multipath routing. However, all the above techniques require a significantly large number of routing tables, hence a large number of additional bits in the packet header. One approach that offers resiliency to single-link failure and provides multipath routing to some degree is “colored trees” [15], [16].

In this approach, two trees are constructed per destination node such that the paths from any node to the root on the two trees are disjoint. The trees may be constructed to obtain link-disjoint or node-disjoint paths if the network is two-edge or two-vertex connected, respectively. This approach is similar to those employing multiple routing tables, except that only two tables are required. Every packet may carry an extra bit in its header to indicate the tree to be used for routing. This overhead bit may be avoided by employing a routing based on the destination address and the incoming edge over which the packet was received, as every incoming edge will be present on exactly one of the trees. The colored tree approach allows every node to split its traffic between the two trees, thus offering disjoint multipath routing. In addition, when a forwarding link on a tree fails, the packet may be switched to the other tree. A packet may be transferred from one tree to another at most once as the colored tree approach is guaranteed to recover from only a single-link failure. The colored trees are also referred to as “independent trees” in the literature [17]. I will refer to the colored trees approach as the independent trees (I Trees) approach in the rest of this paper.

1. LITERATURE REVIEW

2.1 *Resilient multipath routing with independent directed acyclic graphs*

AUTHORS: S. Cho, T. Elhourani, and S. Ramasubramanian

In order to achieve resilient multipath routing, 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 possible edges; 3) guarantees recovery from single link failure; and 4) achieves all these with at most one bit per packet as overhead when routing is based on destination address and incoming edge. Author will show the effectiveness of the proposed IDAGs approach by comparing key performance indices to that of the independent trees and multiple pairs of independent trees techniques through extensive simulations.

2.2 *A framework for reliable routing in mobile ad hoc networks*

AUTHORS: Z. Ye, S. V. Krishnamurthy, and S. K. Tripathi

Mobile ad hoc networks 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 propose a modified version of the popular AODV protocol that allows us to discover multiple node-disjoint paths from a source to a destination. Author find that very few of such paths can be found. Furthermore, as distances betauthoren sources and destinations increase, bottlenecks inevitably occur and thus, the possibility of finding multiple paths is considerably reduced. Author conclude that it is necessary to place what author call reliable nodes (in terms of both being robust to failure and being secure) in the network for efficient operations. Author proposes a deployment strategy that determines the positions and the trajectories of these reliable nodes

such that author can achieve a framework for reliably routing information. Author defines a notion of a reliable path which is made up of multiple segments, each of which either entirely consists of reliable nodes, or contains a preset number of multiple paths between the end points of the segment. Author show that the probability of establishing a reliable path between a random source and destination pair increases considerably even with a low percentage of reliable nodes when Author control their positions and trajectories in accordance with our algorithm.

2.3 *Performance analysis of reactive shortest path and multi-path routing mechanism with load balance*

AUTHORS: P. P. Pham and S. Perreau

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. In this paper, author analyze and compare reactive single-path and multipath routing with load balance mechanisms in ad hoc networks, in terms of overhead, traffic distribution and connection throughput. The results reveals that in comparison with general single-path routing protocol, multipath routing mechanism creates more overheads but provides better performance in congestion and capacity provided that the route length is within a certain upper bound which is derivable. The analytical results are further confirmed by simulation.

2.4 *A review of multipath routing protocols: From wireless ad hoc to mesh networks*

AUTHORS: J. Tsai and T. Moors

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. A popular metric is path disjointness, a measure of resource diversity between paths. Traffic distribution strategy defines how concurrently available paths are used, and how data to the same destination is split and distributed over multiple paths. Path maintenance specifies when and how new paths are acquired if the states of currently available paths change. There are numerous multipath routing protocols proposed for wireless ad hoc networks, exploring characteristics in mobility, interference, topology, etc. Author presents a selection of these protocols and gives a discussion on how multipath techniques can be extended to wireless mesh networks. Lastly Author briefly describe the path selection framework in the current proposal for IEEE 802.11s mesh standard. Although the proposal does not define use of multipath routing, its extensible framework for path selection provides provision for such protocols to be implemented.

2.5 *Congestion-oriented shortest multipath routing*

AUTHORS: S. Murthy and J. Garcia-Luna-Aceves

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-by-hop 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. A worst-case bound on the end-to-end path delay is derived under three architectural assumptions: each router adopts fair queuing (or packetized generalized processor sharing) service discipline on a per destination basis, a permit-bucket filter is used at each router to regulate traffic flow on a per destination basis, and all paths are loop free. The shortest multipath routing protocol

regulates the parameters of the destination-oriented permit buckets and guarantees that all portions of a multipath are loop free.

2.6 A Simulation Study of Security Performance Using Multipath Routing in Ad Hoc Networks

AUTHORS: Wenjing Lou Weri Liu Yuguang Fang

In this paper, 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. By a secret sharing scheme, a secret message can be divided into multiple shares; then by multipath routing, the shares can be delivered to the destination via multiple paths. Improved security is expected because an adversary (adversaries) will have more difficulty in collecting enough shares to compromise the secret message. As the broadcast wireless channel of a MANET has a significant impact on the performance of multipath routing, author examine the performance of SPREAD based on the shared single wireless channel model by simulation. Our results show that SPREAD scheme is effective in reducing the message compromising and eavesdropping probability. The impacts of node mobility and different share allocations on the performance of SPREAD are also investigated. Major headings should be typeset in boldface with the words capitalized.

2. DESIGN PROCESS

3.1 SYSTEM ARCHITECTURE DIAGRAM

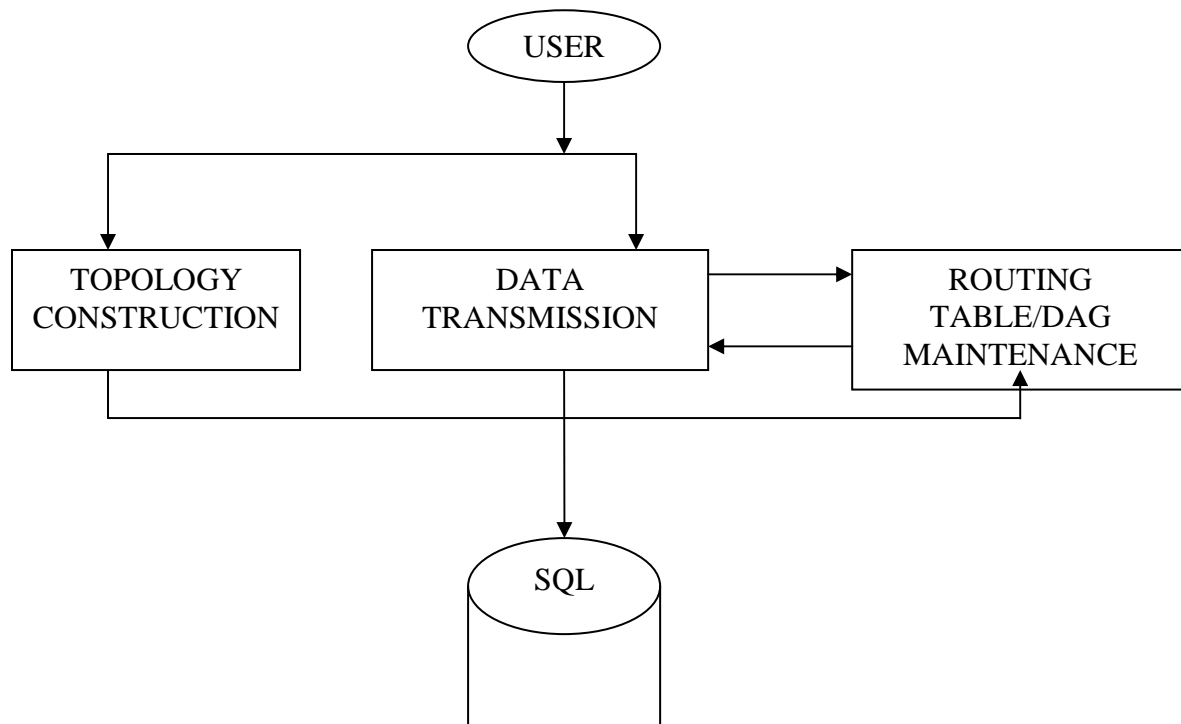


Fig 1: System Architecture Diagram

6.2 MODULES DESCRIPTION:

6.2.1 *Topology Construction:*

This module is used to construct the topology. The user gives the number of node used to construct the topology. The node is added in given name, IP address and port number of that node. Unique nodes are created so that it can be logged in separately. After adding the node, the source node name, neighbor node name and right of that path will be given for path connection. The node details are stored in database table called Node details. Routing details are stored in the routing table.

6.2.2 *Multipath Routing*

The network is assumed to employ link-state protocol; hence every node has the view of the entire network topology. Every node computes DAGs, for each destination and maintains one or more forwarding entries per destination per DAG. DAG to be employed for routing is carried in an overhead bit (DAG bit) in every packet header. Any DAG first (ADF), a packet may be transmitted by the source DAG. In addition to the DAG bit, every packet also carries an additional bit that indicates whether the packet has been transferred from one DAG to another (Transfer bit). A packet is routed on the DAG indicated in its packet header. If no forwarding edges are available in that DAG and if the packet has not encountered a DAG transfer already, it is transferred to the other DAG.

6.2.3 *Node Independent DAG*

Two-vertex-connectivity is the necessary and sufficient requirement for constructing two node-independent DAGs utilizing all the edges except those emanating from the given destination node. This necessary part of the requirement follows directly from the condition required for constructing two node-independent trees – a special case of DAG. Initialize the partial order for the nodes on the two DAGs. Compute the first cycle to be augmented. Compute successive paths to be augmented. The path starts and ends at distinct nodes that are already added to the DAGs; hence the paths from every node to the root of the DAG are node-disjoint. Note that the difference between the path augmentation employed for DAG construction here and that employed for tree construction.

6.2.4 *Link Independent DAG*

Two-edge connectivity is a necessary and sufficient condition for constructing two link-independent DAGs. Similar to the requirement of node-independent DAGs, the necessary part of the requirement follows from the independent tree construction. The procedure to construct two link independent DAGs. Divide the network into two vertex- connected (2V) components. A node may appear in more than 2V-component and the removal of such a node (articulation node) would disconnect the graph. In addition, any two 2V-components may share at most one node in common. Given a destination node d , identify the root node for every component the unique node through which every path connecting a node in that component and d must traverse. In components that contain node d , the root node is assumed to be d .

CONCLUSION

The Concept of independent directed acyclic graphs (IDAGs) and developed a methodology for multipath routing using two IDAGs is developed. Polynomial time algorithms to construct node-independent and link-independent DAGs using all possible edges in the network developed. The IDAGs approach was evaluated on four real-life network topologies and compared with I Trees and multiple pairs of colored (independent) trees approaches to prove the validity of the algorithm. Through simulations, author shows that

the IDAGs approach performs significantly better than the independent trees approach in terms of increasing number of paths offered, reducing the probability of a two-link failure disconnecting a node from the destination, and average link load. Even, a simulation result shows that the trees based on the shortest paths on the IDAGs have better performance than that of the I Trees approach since the average shortest path length on the IDAGs is shorter than the average path length on the I Trees. Multiple pairs of colored trees approach is better in terms of the product of the number of critical links and average link load compared to the I Trees and IDAGs approaches. However, the method is impractical since it needs many overhead bits in the packet header. In many experiments, the optimal approach took between 3-4 hours even when some of the variables are excluded or simplified, whereas authors approach generates results in 47 seconds on average. Note that, author report the optimal scheme results based on either completion or the best results generated within 24 hours. Author observes from these results that approach comes close to optimal for many of our embedded applications. In fact, the average energy saving values with author's scheme and the optimal scheme are 40.7 and 45.6 percent, respectively. But, authors also see some relatively larger difference in some benchmarks due to the heuristic nature of given Scheme.

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