INTERNATIONAL JOURNAL FOR DEVELOPMENT IN COMPUTER SCIENCE & TECHNOLOGY ISSN-2320-7884 (ONLINE)
VOLUME-1, ISSUE-II IS NOW AVAILABLE AT: www.ijdcst.com ISSN-2321-0257 (PRINT)

Self-Determining Directed Acyclic Graphs for Flexible Multipath Routing

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ABSTRACT:

In order to accomplish flexible multipath routing we introduce the concept of Independent Directed Acyclic Graphs (IDAGs) in this paper. Directed acyclic graph (DAG) replicas are accepted tools for describing fundamental relationships and for directing attempts to learn them from data. They appear to provide a means of extracting fundamental conclusions from probabilistic restrictive independence properties inferred from purely observational data. Any pathway from a source to the origin on one DAG is link-disjoint with any pathway from the source to the origin on the other DAG is satisfied by the property of Link self-determining DAGs. A polynomial time algorithm is developed in a given network to compute link self-determining and node self-determining DAGs. Here, the algorithm provides multipath routing which operates all feasible edges and assures the recovery from single link breakdown and attains all these with at most one bit per packet as overhead when routing is based on objective address and incoming edge. By evaluating key performance indices to that of the self-governing trees and multiple pairs of independent trees techniques through extensive simulations shows the effectiveness of the proposed IDAGs.

Keywords: *Self-Determining, Multipath Routing, Independent Directed Acyclic Graphs, DAG, Link-Disjoint.*

1. INTRODUCTION:

Nowadays IP networks utilize a number of diverse strategies for enhanced end-to-end bandwidth and load balancing and quick recovery from link and node failures. Multipath routing is a capable routing method to hold these requirements by using several pairs of routes between a source and a destination [1] [2]. Multipath routing in today's IP networks is purely restricted to equal cost multiple paths. Methods developed for multiple path routing are regularly based on employing various spanning trees or directed acyclic graphs

(DAGs) [2] [3]. A packet has to carry in its header the routing table to be used for forwarding when multiple routing tables are employed. The packet needs to be dropped when the corresponding forwarding edge is not available. Dropping is enforced due to the possible looping of packets when transferred from one routing table to another [5]. To route a packet to a destination, many techniques were developed for fast recovery from single link failures which provide more than one forwarding edge. Depending on the nature in which the backup edges are employed can be classified by these techniques [6] [7]. The packets are re-routed on the backup ports whenever the default forwarding edges are not succeeded or a packet is established from the node attached to the default forwarding edge for the destination. A framework for IP fast reroute detailing three candidate solutions for IP fast reroute is presented here so that they have all gained considerable attention. The three candidate solutions are multiple routing configurations (MRC), failure insensitive routing (FIR) and tunneling using Not-via addresses (Not-via) [8] [9] and the general characteristic of all these approaches is that they utilize multiple routing tables. However, they diverge in the mechanisms engaged to recognize which routing table to use for an incoming packet [10]. It is definitely achievable to use quick recovery techniques for multipath routing. However, all the techniques involve a comprehensively vast number of routing tables and a big number of extra bits in the packet header. Resiliency offers a single link breakdown and gives multipath routing to some degree is “colored trees” [12]. Two trees are assembled per destination node such that the paths from any node to the root on the two trees are disjoint.

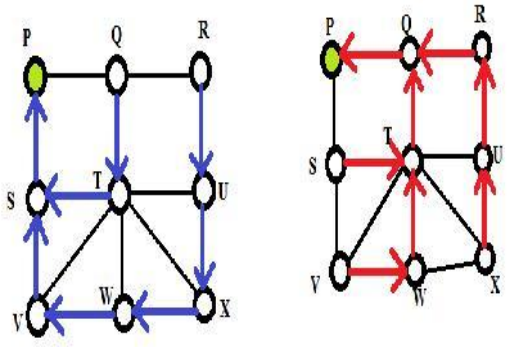

Fig 1. Illustrating Node Self Determining Trees

Fig 1 shows an example network where red and blue trees, rooted at node P, are constructed. This tree construction facilitates improvement from a single link breakdown by switching from one tree to another. For example, let us think about a packet that is promoted from node U to node P on the red tree. When there are no breakdowns, the

packet would take the path U–R–Q–P. If link R–Q fails, then node R would re-route the packet on the blue tree, thus the packet will follow the path: U–R–U–X–W–V–S–P. Assume that a second link failure occurs on link X–W. As only two self-determining trees were assembled and recovery from arbitrary two link breakdowns cannot be guaranteed, the packet will be plunged when the second link failure is met.

2. CONTRIBUTIONS FOR INDEPENDENT DIRECTED ACYCLIC GRAPHS:

A new approach for flexible multipath routing is developed in this paper. As an expansion of independent trees we introduce the concept of Independent Directed Acyclic Graphs (IDAGs). Any pathway from a source to the origin on one DAG is link-disjoint with any pathway from the source to the origin on the other DAG is satisfied by the property of Link self-determining DAGs [13] [14]. To compute link self-determining and node self-determining DAGs in a given network we develop algorithms. Every edge other than the ones originating from the root may be used in either of the two node-disjoint DAGs in a two-vertex-connected network is guaranteed by the algorithm. Similarly, we show that when link self-determining DAGs are constructed only a small number of edges will remain unexploited. The edges that will remain unexploited in both DAGs are defined by the topological constraint of the network. The maximum possible edges in the DAGs are employed by the algorithms which are developed [15]. The approach developed in this paper requires mainly two bits even when both DAGs are used concurrently.

3. RESULTS:

All the topologies measured are two-vertex-connected and the number of pathways from any node to the destination (together on both the trees) is at least the degree of the node. When the number of links in the network enhances then the number of paths increases considerably. All the pathways accessible on one color at a node are identical and the number of paths accessible on one color from a source to the origin is one. The number of separate paths depends on the network connectivity and topology.

4. CONCLUSION:

In this paper, a method for flexible multipath routing using two IDAGs are developed and the concept of independent directed acyclic graphs (IDAGs) is introduced here. To construct node self-determining and link self-determining DAGs using all possible

edges in the network is developed by a polynomial time algorithms. To prove the authority of the algorithm, the IDAGs approach was estimated on four real-life network topologies and evaluated with independent trees (ITrees) and multiple pairs of colored (independent) trees approaches. In terms of increasing number of paths offered through simulations, we have showed that the IDAGs approach achieves drastically better than the independent trees approach, dropping the possibility of a two-link failure by separating a node from the objective, and standard link load. Several pairs of colored trees approach is enhanced in terms of the product of the quantity of dangerous links and standard link load compared to the Independent Trees and IDAGs approaches.

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