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Recovery from Link and Node Failures in Multipath Routing Using IDAG

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Abstract: As the Internet takes an increasingly central role in our communications infrastructure, the slow convergence of routing protocols after a network failure becomes a growing problem. To assure fast recovery from link and node failures in IP networks, we present a concept Directed Acyclic Graph. We develop algorithms to compute link-independent and node-independent DAGs. The algorithm guarantees that 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. The algorithms achieves multipath routing, utilize all possible edges, guarantee to recover the single node failures and reduce the number of overhead bits required in the packet header. Moreover, the use of multiple non disjoint paths is advantageous in load balancing and preventing snooping on data, in addition to improving resiliency to multiple link failures.

Keywords: multipath routing, network failures, IP Routing, DAG

I. Introduction

Multipath routing

It is the routing technique of using multiple alternative paths through a network, which can yield a variety of benefits such as fault tolerance, increased bandwidth, or improved security

CMR (Concurrent Multipath Routing) is often taken to mean simultaneous management and utilization of multiple available paths for the transmission of streams of data emanating from an application or multiple applications. In this form, each stream is assigned a separate path, uniquely to the extent supported by the number of paths available. If there are more streams than available paths, some streams will share paths. This provides better utilization of available bandwidth by creating multiple active transmission queues. It also provides a measure of fault tolerance in that, should a path fail, only the traffic assigned to that path is affected, the other paths continuing to serve their stream flows; there is also, ideally, an alternative path immediately available upon which to continue or restart the interrupted stream.

This method provides better transmission performance and fault tolerance by providing:

- Simultaneous, parallel transport over multiple carriers.
- Load balancing over available assets.
- Avoidance of path discovery when re-assigning an interrupted stream.

IP Routing

It is an umbrella term for the set of protocols that determine the path that data follows in order to travel across multiple networks from its source to its destination. Data is routed from its source to its destination through a series of routers, and across multiple networks. The IP Routing protocols enable routers to build up a forwarding table that correlates final destinations with next hop addresses.

When an IP packet is to be forwarded, a router uses its forwarding table to determine the next hop for the packet's destination (based on the destination IP address in the IP packet header), and forwards the packet appropriately. The next router then repeats this process using its own forwarding table, and so on until the packet reaches its destination. At each stage, the IP address in the packet header is sufficient information to determine the next hop; no additional protocol headers are required.

Network Failures

As the Internet takes an increasingly central role in our communications infrastructure, the slow convergence of routing protocols after a network failure becomes a growing problem. The Important issue is fast recovery from link and node failures in IP networks.

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.

Directed Acyclic Graphs

A directed acyclic graph (DAG), is a directed graph with no directed cycles. That is, it is formed by a collection of vertices and directed edges, each edge connecting one vertex to another, such that there is no way to start at some vertex *v* and follow a sequence of edges that eventually loops back to *v* again.

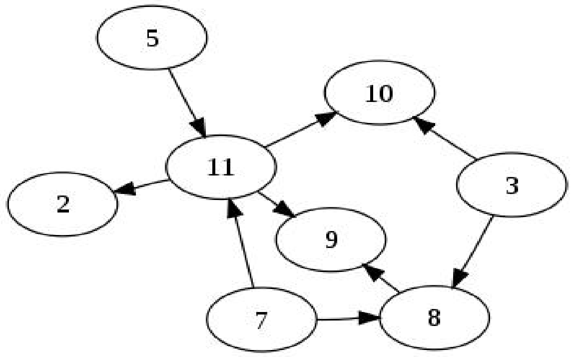

Figure 1: Acyclic Directed Graph

Network Protection

It consists of the provisions and policies adopted by a network administrator to prevent and monitor unauthorized access, misuse, modification, or denial of a computer network and network-accessible resources. Network security involves the authorization of access to data in a network, which is controlled by the network administrator. Users choose or are assigned an ID and password or other authenticating information that allows them access to information and programs within their authority. Network security covers a variety of computer networks, both public and private, that are used in everyday jobs conducting transactions and communications among businesses, government agencies and individuals. Networks can be private, such as within a company, and others which might be open to public access. Network security is involved in organizations, enterprises, and other types of institutions. It does as its title explains: It secures the network, as well as protecting and overseeing operations being done. The most common and simple way of protecting a network resource is by assigning it a unique name and a corresponding password.

II. Literature Survey

Literature review is an assignment of previous task done by some authors and collection of information or data from research papers published in journals to progress our task. It is a way through which we can find new ideas, concept. There is lot of literatures published before on the same task; only two papers are taken into consideration from which idea of the project is taken.

In recent years the Internet has been transformed from a special purpose network to an ubiquitous platform for a wide range of everyday communication services. The demands on Internet reliability and availability have increased accordingly. A disruption of a link in central parts of a network has the potential to affect hundreds of thousands of phone conversations or TCP connections, with obvious adverse effects.

The ability to recover from failures has always been a central design goal in the Internet [1]. IP networks are intrinsically robust, since IGP routing protocols like OSPF are designed to update the forwarding information based on the changed topology after a failure. This re-convergence assumes full distribution of the new link state to all routers in the network domain. When the new state information is distributed, each router individually calculates new valid routing tables.

This network-wide IP re-convergence is a time consuming process, and a link or node failure is typically followed by a period of routing instability. During this period, packets may be dropped due to invalid routes. This phenomenon has been studied in both IGP [2] and BGP context [3], and has an adverse effect on real-time applications [4]. Events leading to a re-convergence have been shown to occur frequently [5].

IV. Existing System

- All the previous techniques require a significantly large number of routing tables, hence a large number of additional bits in the packet header.
- 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 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 referred to as Independent tree.

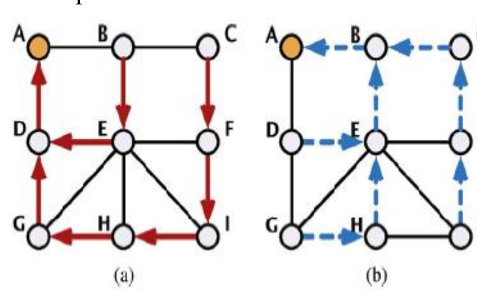

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Figure 2: Independent Tree a) red tree b) blue tree

- This tree construction enables recovery from a single-link failure by switching from one tree to another. For example, consider a packet that is forwarded from node F to node A on the blue tree. When there are no failures, the packet would take the path F–C–B–A. If link C–B fails, then node C would reroute the packet on the red tree, thus the packet will follow the path F–C–F–I–H–G–D–A. Assume that a second link failure occurs on link I–H. As only two independent trees were constructed and recovery from arbitrary two link failures cannot be guaranteed, the packet will be dropped when the second link failure is encountered.

III. Proposed System

The proposed system Direct Acyclic Graph, utilizes all edges in the network to increase the number of paths significantly. However, the algorithm does not provide a mechanism for backup forwarding when encountering a single link or node failure. Another approach is to employ multiple pairs of colored (independent) trees, however such a technique will require the packet to carry information on which pair is being used for routing.

Goals

- Achieve multipath routing.
- Utilize all possible edges;
- Guarantee recovery from single-link failures.
- Reduce the number of overhead bits required in the packet header.
- node-independent

The concept of *independent directed acyclic graphs* (IDAGs), an extension of independent trees. 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.

We develop algorithms to compute link-independent and node-independent DAGs.

The procedure to construct two link-independent DAGs.

- First divide the network into two-vertex-connected (2V) components.
- In each 2V components, identify the unique articulation node through which every path from any node in that component must traverse to reach d. we refer to this articulation node as the root node of the component. In the component. In the component that contains node d, we assume that the root node of the component is node d itself.
- In each 2V component, construct two node independent DAGs to the root node of that component.
- Merge the entire node independent DAGs to obtain the link independent DAGs.

Procedure to construct two node-independent DAGs

- Initialize the red and blue DAG, R and B , to contain only the root node d.
- In the original network G=(N,L) replace every link l connecting nodes x and y with a node vl and two links: (vl,x) and (vl,y). Let the resultant expanded network be denoted by G'(N',L').
- In the expanded graph G', construct two colored base DAGs.
- Contract each pair of links vl-x,vi-y in the expanded graph back to the original graph with red and blue color assigned in each direction appropriately.

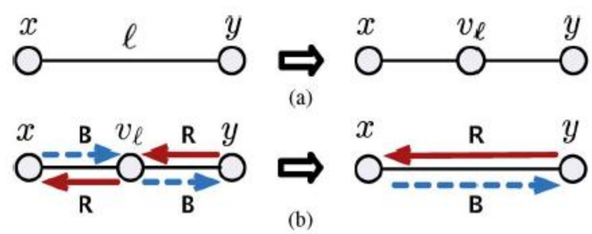

Figure: The construction of node-independent DAGs using a virtual node. (a) Expansion with virtual node. (b) Contraction to remove virtual node.

Procedure for Multiple Colored Tree Pairs Construction- utilizing the maximum number of links

- Initialize the link usage frequencies to zero
- Consider network links in the descending order of their usage frequency.
  a) If the graph remains two vertex connected without it then remove it form the graph.
- Construct two independent trees on the two vertex connected graph of step2.

- For each link used in the independent trees increment its link usage frequency.
- If the number of colored tree pairs is less than M go to step 2.

Experimental Result

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. In addition, the trees based on the shortest paths on the IDAGs have better performance than that of the ITrees approach since the average shortest path length on the IDAGs is shorter than the average path length on the ITrees.

Avg. path length ratio	ITREES	IDAGs
0	1.5	1.3
1	1.3	1.2
2	1.6	1.5
3	2.2	1.8

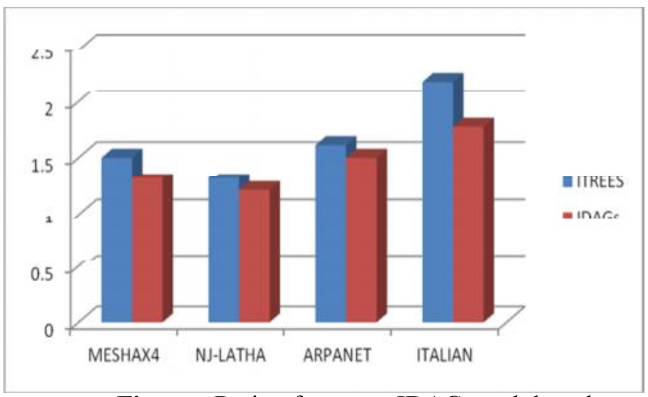

Figure : Ratio of average IDAGs path length to average ITrees path length.

Conclusion

The proposed IDAG approach reducing the network failures, utilize possible edges in a graph to recover the network failures and multipath routing i.e. any path failure from source to destination, it will send data from another path in IDAGs. The IDAGs approach performs significantly better than the independent tree approach in terms of increasing number of paths offered , reducing the probability of a two link failure disconnecting a node from the destination.

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