www.ijecs.in
International Journal Of Engineering And Computer Science ISSN:2319-7242
Volume 3 Issue 6 June, 2014 Page No. 6817-6819

A Review of Reliable Multipath Routing Techniques

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Abstract—In modern world, the demand of network is increasing rapidly. This ever increasing usage of such network requirements also demands fast recovery from network failures. The multipath routing is one of the most promising routing schemes to accommodate the diverse requirements of the network. It has basic features like load balancing and improved bandwidth. In this paper, we have presented a review of some modern and popular methods for the reliable multi path routing. A brief introduction to the concept of multipath routing is also elaborated. The merits and demerits of each multi path routing methods are discussed.

Keywords—Multipath routing, directed acyclic graphs, fast recovery.

I. INTRODUCTION

Multipath routing is a technique that exploits the underlying physical network resources by utilizing multiple source-destination paths. Traffic engineering has been used to imply a range of objectives. These objectives are multi path routing, load- balancing, conditional routing, protection switching, fast re-routing, etc.

The use of multipath routing is to minimize the overall delay in the network. The Internet today provides only a single path between any pair of hosts that fundamentally limits the throughput achievable between them. Multipath routing can be effectively used for maximum utilization of network resources. It is the main advantage of the multi path routing & multi path routing provides a choice of next hops to a node for the same destination.

Multipath routing is capable of aggregating the resources of multiple paths. It is also capable of reducing the blocking in QoS oriented networks. Multi path routing increases the data transfer rate. It is higher in comparison to the single path routing. It also increases the reliability of delivery.

ADAVANTAGES OF MULTIPATH ROUTING

- Better efficiency
  - Splitting load over multiple paths
- Better performance
  - Selecting the low-delay (or high-throughput) path
- Better reliability
  - Faster failover from one path to another
- Better security
  - Prevent on-path adversary from seeing all packets
- More control
  - Providing greater flexibility to upstream ASes

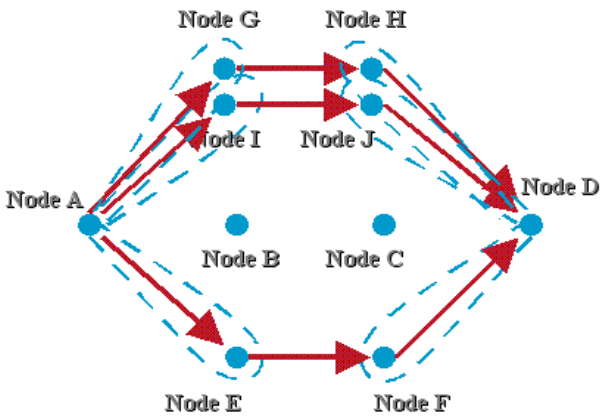

Figure: Multipath Routing

Multi-path routing uses k disjoint shortest paths:

First choose shortest path, then second shortest path, and so on k times.

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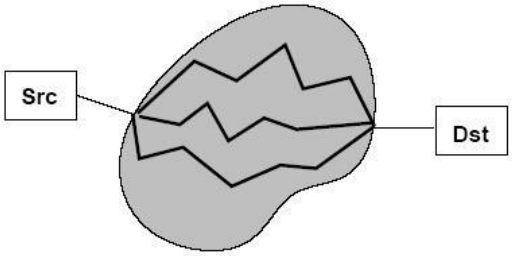

As the cost of hardware devices decreased and there is steady increase in resource availability voice over IP and other multimedia data streaming is increased. In such applications high bandwidth is expected besides faster recovery from single point of failures. In order to achieve this modern networks are employing various strategies such as load balancing, recovery from node failures, and end-to-end bandwidth. Towards a good solution multipath routing can be used. This scheme along with techniques can achieve security, congestion reduction, aggregation of bandwidth, load balancing and robustness.

II. LITERATURE SURVEY

In order to achieve resilient multipath routing,

[1] S. Cho, T. Elhourani, and S. Ramasubramanian 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;

[2] The mobile ad hoc networks proposed in consists 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, the multipath routing mechanism has not yet 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, resource utilization, bandwidth aggregation, load balancing, 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. 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.

[6], 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 Most of the present multipath routing methods use multiple routing tables. Also it is clear that when multiple routing tables are employed then in that case a packet has to carry routing table which is to be used for forwarding. Therefore when the corresponding forwarding edge is not available, then in that case the packet needs to be dropped. So dropping is forced due to the potential looping of packets when transferred from one routing table to another.

[7] J. Tsai and T. Moors introduce There are three elements to a multipath routing, namely, path discovery, traffic distribution, and path maintenance. Author presents a selection of these protocols and gives a discussion on how multipath techniques can be extended to wireless mesh networks.

III. MULTIPATH ROUTING IN WIRELESS NETWORKS

To improve performance or fault tolerance: 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.

Shortcomings of this method are:

- Some applications may be slower in offering traffic to the transport layer, thus starving paths assigned to them, causing under-utilization.
- Moving to the alternative path will incur a potentially disruptive period during which the connection is re-established.

A more powerful form of CMR (true CMR) goes beyond merely presenting paths to applications to which they can

bind. True CMR aggregates all available paths into a single, virtual path. All applications offer their packets to this virtual path, which is de-muxed at the Network Layer, the packets then being distributed to the actual paths via some method such as round-robin or weighted fair queuing. Should a link or relay node fail, thus invalidating one or more paths, succeeding packets are not directed to that (those) paths. The stream continues uninterrupted, transparently to the application. This method provides significant performance benefits over the former:

- By continually offering packets to all paths, the paths are more fully utilized.

- No matter how many nodes (and thus paths) fail, so long as at least one path constituting the virtual path is still available, all sessions remain connected. This means that no streams need to be restarted from the beginning and no re-connection penalty is incurred.

It is noted that true CMR can, by its nature, cause Out-Of-Order-Delivery (OOOD) of packets, which is severely debilitating for standard TCP. Standard TCP, however, has been exhaustively proven to be inappropriate for use in challenged wireless environments and must, in any case, be augmented by a facility, such as a TCP gateway, that is designed to meet the challenge. One such gateway tool is SCPS-TP, which, through its Selective Negative Acknowledgement (SNACK) capability, deals successfully with the OOOD problem.

Another important benefit of true CMR, desperately needed in wireless network communications, is its support for enhanced security. Simply put, for an exchange to be compromised, multiple of the routes it traverses must be compromised. The reader is referred to the references in the "To improve network security" section for discussion on this topic.

IV. CONCLUSION

Multi path routing is very important in the modern era. It provides alternative hops for a node. It has many advantages like: maximum resource utilization. Multipath routing is challenging in Scalability, control over data plane, tussle over control over the flow of traffic. In this paper, we surveyed reliable multi path routing methods. Their merits and demerits are also discussed.

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