Exploring Issues Related to Multipath Routing

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ABSTRACT
Multipath routing is a routing technique of leveraging multiple good paths instead of a single best path for routing. It can be effectively used for maximum utilization of network resources. In contrast to single path approach, multipath routing can better utilize network bandwidth and balance network traffic. It gives the node a choice of next hops for the same destination. There are two strategies for allocating traffic over available path. First is to distribute traffic among multiple paths instead of routing all the traffic along a single path. Second is to forward traffic using only the path with the best metric and keep other discovered paths as backups that can be used in case of congestion or blocking. Thus multipath routing is an alternative to single shortest path routing to distribute load and alleviate congestion in the network. There are various algorithms presented in literature for effectively calculating the multiple paths and ways to minimize delay and increased throughput. In this paper, we have discussed the issues regarding the path selection for multipath routing.

KEYWORDS
Multipath routing, Multiple paths, Single shortest path.

I. INTRODUCTION
Unlike traditional routing schemes that route all traffic along a single path, multipath routing strategy uses multiple paths. Single path routing may lead to unbalanced traffic distribution and congestion. It cannot achieve the proper utilization of resources. On the other hand, Multipath routing is more efficient than the single shortest path routing. Multipath routing can better utilize network resources and balance network traffic as the traffic bound to a destination is split across multiple paths to that destination.

Benefits of Multi path Routing: Multipath routing would offer many benefits as following.

A. Fault Tolerance

When multiple path are available, traffic can move to an alternate path on the occurrence of congestion. This will lead to less delay and packet loss.

B. Increased Bandwidth

If multiple path exists, an application can access more bandwidth by using multiple path simultaneously.

C. Improved Reliability

If multiple path exists, traffic can switch quickly to an alternate path when a link or router fails.

Load Balancing:- By using multiple path simultaneously, network resources can be more used by distribution of traffic among several paths. This is reverse to single shortest path routing scheme where one path is completely busy and others are under loaded. So with multipath routing load balancing can be achieved.

D. Quality of Service

Multipath approach can be used as an architecture for implementing quality of service by aggregation of flows.

In this paper, we have discussed the main concerns regarding multipath approach. Section II describes the path construction and path selection. Section III discusses Quality of Service. Section IV concludes the paper.

II PATH CONSTRUCTION AND SELECTION
The two main concerns to implement multipath routing scheme are the calculation of multiple paths and traffic distribution among multiple paths. To determine the multiple paths various k-shortest path algorithms have been used. The k-shortest means determining not only the shortest but also the second, the third ………………the kth shortest path (for given integer k>1). Regarding this, Two different types of problems are usually considered: the unconstrained and the constrained k-shortest path problem. While in the former no restriction is considered in the definition of path. In the constrained k-shortest path problem all the paths have to satisfy some condition e.g. to be loop less and to be disjoint. A path from s to t is a loop less path, if all its nodes are different. A path is disjoint if it does not share any node with other path. To find the k-shortest path, shortest path algorithms dijkstra &
Bellman-ford-Moore algorithms can be used in the generalization form. [5] In literature, Most of the researchers have presented solutions to find multiple paths based on heuristic scheme. Under the heuristic category, a multipath routing scheme, termed equal cost multipath (ECMP) has been proposed for balancing load along equal cost multiple shortest paths. But ECMP considerably reduces the load balancing capabilities of multipath routing by limiting itself to shortest paths. It further limits the ability to decrease congestion through load balancing. [1]

In [4], authors present Multiple Path Algorithm (MPA) that can be implemented as an extension to OSPF. MPA finds only a subset of paths that satisfy a condition for loop-freeness. However, it does not find all loop-free paths to a destination. A router only considers paths with next-hop such that the weight of shortest path from next-hop to destination is less than the weight of the shortest path from router to destination.

In [2] OSPF-OMP allows splitting traffic among paths unevenly but the traffic distribution mechanism result in an inefficient flow distribution. These heuristic methods can be optimized to further reduce the congestion. This shows that the multipath solutions obtained by optimal congestion reduction scheme are fundamentally more efficient than solutions obtained by heuristics. It has been shown that if the traffic distribution of ECMP or OSPF-OMP scheme had been optimal, the network congestion would have decreased.

After calculating multiple paths the next job is to select the paths for transferring data and splitting traffic over multiple paths between source – destination pair. For distribution network traffic across parallel data paths various techniques can be used such as round-robin, Random, Hashing, Flowcache.

A. Round robin
In round robin the least recently used hop is chosen as next hop. Round robin scheduling can achieve very accurate splitting percentages. This technique put a very little overhead on forwarding functions. The problem with this technique is that some packet which belong to the same flow could arrive out of order. It would lead to out of order packet arrivals and hence performance degradation. ECMP uses round robin for distribution of load equally over multiple equal cost paths.

B. Random
Next Hop is chosen randomly.

C. Hashing
A router may perform a hash on routing information of the packet to generate a hash value corresponding to the packet flow associated with the packet. The router may map the hash value of the packet to a forwarding element associated with a data path. Hashing insures in-order delivery of most packets since a flow is likely to be mapped to a specific path for its entire duration. But in this technique it is difficult to achieve the accurate splitting percentage. Hashing can be used in the following forms

(i) Modulo-N Hash
Modulo-N is a “simpler” form of hashing. To select a next-hop from the list of N next-hops the packet header fields which describe the flow are run through a hash function. A final modulo-N is applied to the output of the hash. This result then directly maps to one of the next-hops. This method is very fast.

(ii) Hash-Threshold
The router first selects a key by performing a hash over the packet header fields that identify a flow. The N next-hops have been assigned unique regions in the key space. The router uses the key to determine which region and thus which next-hop to use.

(iii) Highest Random Weight (HRW)
Highest random weight (HRW) similar in some ways to hash-threshold with non-fixed sized regions. For each next-hop, the router seeds a pseudo-random number generator with the packet header fields which describe the flow and the next-hop to obtain a weight. The next-hop which receives the highest weight is selected. The advantage with using HRW is that it has minimal interruption. The disadvantage of HRW is that the next-hop selection is more expensive than hash-threshold. [8]

(iv) Flow Cache
A flow cache is a forwarding table that keeps track which path each active flow traverse. A flow cache ensure packets belonging to the same flow always follow the same path. The major drawback of this technique is that a high speed link could carry tens of thousands concurrent flows leading the flow cache to consume a significant amount of additional memory in the router. [7]

III MULTIPATH APPROACH AND QUALITY OF SERVICE
Quality of service is an active area of research. The basic problem of QoS routing is to find a path satisfying multiple constraints. It is concerned with identifying the path that will consider multiple parameters like bandwidth, delay, cost, hopcount etc. instead of one. QoS (quality of service) can be successfully implemented with Multipath architecture as -
Multipath routing has the potential to aggregate bandwidth, allowing a network to support data transmission rates higher than what is possible with any one path. In connection oriented networks with QoS guarantees, they reduce blocking probabilities. Multipath routing algorithms are able to multiplex connectionless traffic, thereby reducing congestion.

In [6],[9] k-shortest path QoS routing scheme for connection oriented networks have been presented. The algorithm finds one to all loopless k-best paths. The path construction algorithm is generalization of dijkstra’s algorithm. This paper has presented two classes of routing algorithms: bandwidth based and hop based. The hop based algorithms can be recommended for networks in which link state information can not be updated too frequently. Those algorithms scale much better to the increasing network size than other QoS routing solutions.

IV. CONCLUSION

Multipath routing employs multiple parallel paths between a source and destination in order to relax the most heavily congested link in networks. It provides increased bandwidth and reliability by using multiple path simultaneously. Network resources are more efficiently used than the single shortest path algorithm.

Multipath routing is capable of aggregating the resources of multiple paths and reducing the blocking capabilities in QoS oriented networks, allowing data transfer rate at higher rate when compared a single path. It also increases the reliability of delivery.

Thus Multipath routing is an interesting tool to present a fast reaction time to protect networks failure and congestion. The major consideration of this approach is to compute multiple paths and traffic distribution. There is a good combination of QoS and Multi path approach. Although this approach decreases packet loss and end-to-end delay, it is only efficient and reliable if a relationship can be found between the number of paths and QoS constraints. Our future work will focus on this combination.

REFERENCES

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