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PATH IDENTIFICATION IN 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 lighten 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 some multipath routing approaches considering path construction and selection criteria.

Keywords: Multipath routing, multiple paths, Single shortest path.

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 can not 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-

Fault Tolerance:

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

Increased Bandwidth:

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

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.

Quality of Service (QoS): Multipath approach can be used as an architecture for implementing quality of service by aggregation of flows.

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

PATH CONSTRUCTION

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 possess link disjointness or node disjointness. Paths between a given pair of source and destination nodes in a network are called link disjoint if they have no common (i.e. overlapping) links and A pair of paths is considered node-disjoint if, besides the source and destination nodes, they have no common nodes. Node disjoint paths provide more reliability than the link disjoint paths In general a link-disjoint path algorithm can be extended to a node-disjoint algorithm with the concept of node splitting, i.e. replacing one node with two nodes that are linked together via a link with zero-valued weights.

[5] Presents the solutions of unconstrained shortest path problem. For the unconstrained problem, algorithms are divided in two sets:first set is based on the optimality principle and second set of algorithms determine a set which contains the set of K shortest paths. To find the k-shortest path, shortest path algorithms Dijkstra & Bellman-ford-Moore algorithms can be used in the generalization form .For first set of algorithms it asserts that to follow the principle of optimality there is a shortest path formed by shortest sub- paths .For the second set of algorithms. It has been presented that the set of the k shortest paths forms a tree in the sense of theory of graph so proposed new algorithms which computes tree containing atleast all the K shortest paths.

[12] Has presented the algorithm that is not necessarily loop less. The main idea of this algorithm is to translate the problem for one with two terminals s,t to a problem with one terminal .One can find paths from s to t simply by finding paths from s to any other vertex and concatenating a shortest path from that vertex to t. It can be done by maintaining a priority queue of paths, initially using breadth first search that initially contains the single zero-edge path from s to itself; then repeatedly remove the shortest path from the priority queue, add it to the list of output paths, and add all one-edge extensions of that path to the priority queue. The idea presented in this algorithm is to construct a binary heap for each vertex, listing the edges that are not part of the shortest path tree and that can be reached from that vertex by shortest-path-tree edges.

A multipath routing scheme, termed equal cost multipath (ECMP) has been proposed in [1] for routing packets among multiple paths of equal cost. 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.

[2] uses ECMP, but instead of depending upon weight assignment , it samples traffic load information and floods it. This information is used to change local load splitting decisions.

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. . The key idea of MPA is to maintain an efficient data structure in a router that helps to compute alternate viable nest hops .When each router forwards its packets to any of the viable next hops, all the packets will be routed to their destinations on loop free paths. More specifically, a given router S will maintain for each destination node X the shortest distance d (S, X) from the router S to X. This information can be computed with existing SPT algorithm such as Dijkstra and Bellman ford. In addition the cost w(S, ρ) for each outgoing link S to next hop ρ is also maintained .By maintaining this data structure ,The MPA identifies viable next hops for destination X making use of the following principle if dp (S,X)-w(S, ρ)< d(S,X) ,then ρ is a viable next hop. An advantage of maintaining viable next hops in a router for each destination is to speed up recovery from link failure.

In [10] Yen‘s algorithm finds loopless paths that have shortest lengths from one node to another node in a network. The significance of this algorithm is that its computational upper bound increases only linearly with the value of k. The algorithm takes every node in the shortest path except the terminating node and calculates another shortest (spur) from each selected node to terminating node. For each such node, the path from the start node to the current node is the root path. Two conditions are placed on the spur path.First, It must not pass through any node on the root path (loopless) and secondly it must not branch from the current node on any edge used by a previously found shortest paths with the same root. When a new spur path is found it is added to the root path for that node .That path is next candidate shortest path. All such paths are stored .The same process is repeated calculating spur paths from each node in each new k shortest paths until the required no of K paths have been found.

[11] Describes an algorithm to find the k-shortest loopless paths. This algorithm is based on replacement paths. But the replacement paths subroutine is known to fail for some directed graphs. However the failure is easily detected. In a directed graph G with non-negative edge weights, and a pair of nodes s, t and P = (e1 , e2 , . . . , ep) denote the sequence of edges in a shortest path from s to t in G.,The replacement paths problem is to compute the shortest path from s to t, in each of the graphs G \ ei , that is, G with edge ei removed, for i = 1, 2, . . . , p. (Another variant of the replacement paths problem arises when nodes of the path P are removed one at a time).

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.

PATH SELECTION

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 distributing network traffic across parallel data paths ,some of the techniques for selecting the paths among all paths are round-robin, random ,hashing, flowcache.[3][7]

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.

Random:

Among all the available hops,next hop is chosen in random order.

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

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.

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.

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 with HRW is that the next-hop selection is more expensive than hash-threshold. [8]

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]

CONCLUSION

Multipath routing employs multiple parallel paths between a source and destination in networks. It provides increased bandwidth and reliability by using multiple path simultaneously. In multipath approach network resources are more efficiently used than the single shortest path approach. Multipath routing aggregates the resources of multiple paths, allowing data transfer rate at higher rate when compared to a single path. Thus it increases the reliability of delivery. The major consideration of this approach is to compute multiple paths and traffic distribution. In this paper we have discussed various approaches for path identification for mutipath routing. No particular basis has been taken for selecting the described techniques. The techniques described have been taken keeping in mind the extension of multipath to QoS.

REFERENCES

[1]. J. Moy, “OSPF version 2,” RFC2328, 1988.

[2]. C. Villamizar, ``OSPF Optimized Multipath (OSPF OMP)," Internet Draft, 1999. vailable: http://www.ietf.org/ proceedings/99mar/I-D/draft-ietf-ospf-omp-02.txt

[3]. Thaler, D. and C. Hopps, "Multipath Issues in Unicast and Multicast", RFC 2991, November 2000.

[4]. P. Narvaez, K. Y. Siu, ``Efficient Algorithms for Multi-Path Link State Routing," ISCOM'99, Kaohsiung, Taiwan, 1999.

[5]. E.Q.V. Martins, M.M.B. Pascoal and J.L.E. Santos, “The K Shortest Paths Problem,” Research Report, CISUC,June 1998.

[6]. R. Guerin and A. Orda, “QoS-based Routing in Networks with Inaccurate Information: Theory and Algorithms.” IEEE/ACM Pansaction on Networking, Vol. 7, No. 3,June 1999, pp. 350-364.

[7]. H.Jiayue ,J.Rexford “Towards Internet –wide Multipath Routing”

[8]. Thaler, D. and C.V. Ravishankar, "Using Name-Based Mappings to Increase Hit Rates", IEEE/ACM Transactions on Networking, February 1998.

[9]. Yanxia Jia, Ioanis Nikolaidis and P. Gburzynski, "Multiple Path QoS Routing",Proceedings of ICC'01 Finland, pages 2583-2587, June 2001

[10]. J.Y.Yen ,Finding the K-shortest loopless paths in a Network, Management Science, Vol. 17,No. 11,july,1971

[11]. J.Hershberger,M.Maxel,S.Suri,Finding the K shortest paths:A New algorithm and its implementation,ACM Transactions on Algorithms, Vol. 3, No. 4, Article 45, Publication date: November 2007.

[12]. D.Eppstein,Finding the k Shortest Paths, March 31, 1997

