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Simulation of Heuristic Usage for Load Balancing In Routing Efficiency

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Abstract. The Open Shortest Path First (OSPF) is a link-state routing protocol that support equal cost load-balancing process in network. The OSPF traffic allows a router to use multiple paths to a destination when forwarding packets and splits the load equally at nodes where a multiple outgoing links on the shortest paths to the same destination. This paper presents a simulation of heuristic usage that reduces time executions in the optimization process. This simulation use to optimize the link weights in the heuristic usage method and result shows the increase of routing efficiency and network performance.

Keywords: simulation, traffic engineering, OSPF, optimization, routing, network

INTRODUCTION

Simulation often used in networking field to measure the efficiency of network process before implementing in a real network. In network the most commonly use routing protocol is Open Shortest Path First (OSPF). OSPF is well-known as a simple routing protocol in two senses. Firstly, its routing is completely determined by one weight for each link. Secondly, it provides simple load balancing by splitting traffic loads almost equally among equal cost paths. The routers in routing shortest path exchange link weights and construct a complete view of the topology inside the autonomous system (Retvari, G. Cinkler, T, 2004). In real networks, when a large amount of the traffic travel from one link to another, operators need to run the simulator model that was implemented in this research in order to get a new optimized link weights settings that deals with the current network configuration. When the optimization process is faster, the network problem solving will also be faster too. It is because rules of shortest path routing can affect the routing efficiency and network performance. In the shortest path routing each router computes shortest paths which is called path length in the summation of link weights and creates a routing table that controls the forwarding of each IP packet to the next hop in its route. The lower the link weight, the greater the chance that traffic will be routed on the link. The rule of equal cost multi path in shortest path routing splits the traffic equally between equal cost path and resources to manipulate routing through setting the administrative link weights in load balancing (D. Awduche *et.al*, 2002). In the case of multiple shortest paths, OSPF will use load balancing and split the traffic flow equally over several shortest paths (J. Moy, 1998). Dijkstra’s shortest path computation algorithm is widely employed in shortest path implementations.

This paper presents issues of routing protocols and simulation heuristic usage method for load balancing that solve the problems of minimizing the usage of demand matrix and reduce time executions needed in the optimization process.

ISSUE OF ROUTING IN NETWORK

Generally, size of the network growths OSPF implementations can become unbalanced due to processing overload caused by extremely flooding and/or by regularly Dijkstra executions during periods of network instability. OSPF implementations also apply various mechanisms to help scalability. Typically, the current shortest path routing suffers a problem of arising congested links (B. Fortz and M. Thorup, 2004), (B. Fortz, J. Rexford, M. Thorup, 2002). It is due to the extremely usage of the shortest paths, while the other paths are unutilized. Congested links could appear if they have lower link weights because all the traffic from any source to any destination will follow the shortest paths, while still other links or paths unutilized (B. Fortz and M. Thorup, 2002). Evenly balancing method is an optimization model proposed in B. Fortz and M. Thorup (2004). This simulation model optimizes the OSPF link weights in order to achieve an efficient use of network resources by increasing link utilization and decreasing congestion. Evenly balancing method has two parts to be presented, which are the evenly balancing heuristic and local congestion detection method. Evenly balancing heuristic is a local search that has been used inside a taboo search. The taboo search starts from the initial solution and iteratively creates neighbor solutions to select the best one according to the cost function value. It determines a set of link weight values to minimize the cost function.

This paper review the problem found in Fortz and Thorup's evenly balancing heuristic. This research intended to solve the problems of minimizing the usage of demand matrix and reduce time executions needed in the optimization process. Previous works in shortest path using the same traffic demand matrix in the experiment. The problem is to discover another matrix to optimize the link weights instead of using demand matrix. It is because the way to measure the demand matrix is a difficult task and need a constant monitoring of routers in a certain time. Previous balancing methods those optimize link weights suffer from a problem to reduce the time executions which is needed for the optimization process. This problem is deal with the research of designing the link weights optimization methods efficiently.

SIMULATION OF HEURISTIC USAGE

In the perspective of looking for an alternative matrix, consider a network of two-level hierarchical networks and waxman networks that is produced using GT-ITM generator as recommended in (Calvert K. *et al.*, 1997)(Zegura E.W. *et al.*,1996)(Waxman B. M.,1988) provides the routers with consistently distributed over a unit square. Heuristic usage method is proposed methods that count the usage of link in each shortest path link using counting selection technique that combines with the local congestion detection problem and selection balancing method. This method count and select a subset of the available forwarding paths based on the congestion report. Congestion detection is to predict congested link in forwarding paths. This improvement is realized by optimizing network link weights in order to support multiple paths in shortest path routing.

This simulation used three modeled networks in the simulation which are hierarchical-1, hierarchical-2 and waxman topologies. For each network, there are twelve scaled traffic demand matrices. In order to simulate the traffic demand increase between any pair of nodes a twelve scaled demand matrices are produced for each network topologies For each scaled demand matrix, the simulator performs ten executions, each execution iterates for five hundred times. Performance metrics that are used to compare the link weights setting method are cost averages, best cost, and convergence and time executions. Unit and inverse link weights are used once inside the routing part, while the other improved methods such as evenly balancing method and heuristic usage method are used inside the optimization part for producing optimized link weights. Then, the optimized link weights are used inside the routing part in order to compute the routing cost to perform a routing efficiency in network performance.

This simulation input will read the topology and the traffic demand matrix from the text file gives them all along with the initial weights to the routing part. The topology file for each tested network contains three fields separated by semicolon. The first field shows how each node is connected to the other nodes in the network. The second field gives the traffic demand matrix entries for each pair of nodes. Third field lists the capacities of each link in the tested network. The traffic demand matrices for each network are obtained from (Fortz and Thorup, 2004). This shortest path routing part uses the information from the input part in order to compute shortest paths between each node pairs and then distributes the amount of data traffic over the links belonging to the shortest paths between each source destination pairs. Depending on the traffic distribution, this part computes the routing cost based on a current set of link weights and traffic demand matrix.

This simulation link weights optimization used to optimize the network link weights. Optimizing the link weights will affect shortest path selection, traffic distribution, and the network routing cost. The link weights optimization part consists of two components which are optimization tool and heuristic method. There is a conditioned loop between routing part and link weights optimization part of the simulator. The loop stops when maximum number of iterations is reached. In this simulator, the maximum number of iterations is set to five hundred because experiments showed that after this number of iterations there is no significant improvement in the cost value whereas the running time after 500 iterations is very high. The initial link weights that equal to 1 will be compute in the routing part for the first iteration to give the result of initial shortest paths and initial routing cost value. Then the following iterations will use the optimization part and produce new link weights. The new link weights that have been optimized will change the shortest path, traffic load distribution and the routing cost.

The simulation output from the link weights optimization part produces the information of routing cost, best link weights, heuristics usage method of each link, time executions and link congestion.

RESULT AND DISCUSSION

This simulation results shows a different optimization methods for setting OSPF link weights. The simulator uses two types of default link weights and two types of optimized link weights which are assigned as unit, inverse, evenly balancing method and heuristic usage method. Default link weights are assigned directly to the links in the routing part of the simulator while optimized link weights are assigned to the links after the optimization process. Link weights are used to compute shortest paths, then the shortest paths will identify the amount of traffic that pass over each link according to the measured traffic demand matrix. The default link weights are assigned as Unit which setting each link with the link weights with value equal to one and Inverse which use the link weights value inversely proportional to this capacity. The optimization link weights use evenly balancing method that assigns for each link weights value achieved from the link weights optimization part of the simulator and heuristics usage that provides the link weights optimization with a counting selection technique that used as an alternative matrix and improved the routing performance proposed in evenly balancing method. This simulation compared the result between default and optimization methods to see the performance of network. The result shows the optimizing of link weights in heuristic usage method effect the time executions and link congestion that support the routing efficiency and network performance.

CONCLUSION

This research improves shortest path routing protocols on Open Shortest Path Routing. The problems of shortest path routing are addressed to minimize the time executions in the optimization process for operational network over multi-paths to specific destination increase of routing efficiency and network performance. Result show that heuristic usage method overcomes the previous work evenly balancing method in terms of routing cost, convergence and time executions. This proposed simulation heuristic method uses some parameter in the cost function to reduce the influence of the traffic demand matrix in the optimization process.

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