Towards efficient MPLS traffic engineering :

New Load Balancing Algorithm using Pheromone Deposit for Deviation Path Selection

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Abstract - *With the growth of mobile network application and traffic rising. The mobile network is exposed to an increasing frequency of congestion. Multiple Protocol Label Switching (MPLS) uses its explicit routing technology to implement traffic engineering. However, it has an important inconvenient that some segments of the network are quite congested while other segments are under-utilized. LBDP algorithm uses the concept of deviation path to solve this problem; it uses the shortest path algorithm to select the deviation path. The shortest algorithms choose a path from a limited number of selected paths, which may place significantly more traffic on some nodes than others also the probability of nonexistent qualified deviation path is high than anticipated. To solve this problem and select the adequate deviation path from a large number of selected paths, we propose to use the pheromone deposit approach in selection phase rather than the shortest path algorithm.*
Our new algorithm minimizes congestion and improves the network performance by providing lower delay smaller packet loss rate and higher throughput comparing it to LBDP algorithm.

Key Words: Mobile network, MPLS, MPLS Traffic Engineering (TE), pheromone deposit, deviation path.

1. INTRODUCTION

Along the increase of telecom customers demand, product and service offerings the telecom operator has to be able to create new services, and achieve high quality of service. With the growth of network application and traffic rising, the network is exhibited to an increasing frequency of congestion.

Nowadays, MPLS has become the dominant transport technology of choice in packet-based core networks. MPLS technology has enabled the development of a number of mechanisms by which the level of network availability, reliability and optimality can be increased. Minimizing congestion is a primary traffic and resource oriented performance objective.[1]

MPLS is also used for traffic engineering to control traffic flows through a network, thus optimizing resource utilization and network performance, and minimizing congestion.

Congestion manifests typically under two scenarios: (1) When network resources are_ insufficient or inadequate to accommodate offered load. (2) When traffic streams are inefficiently mapped onto available resources; causing subsets of network resources to become over-utilized while others remain underutilized [1].

The first type of congestion problem can be addressed by expanding the capacity of the network, which is extremely expensive. The second type of congestion problems, namely those resulting from unbalancing distribution of network traffic, can be addressed by adopting load balancing policies. Therefore how to balance the network traffic while keeping an efficient resource allocation and improve the network performance and internet quality of service is becoming the most crucial issue.

2. MPLS TRAFFIC ENGINEERING

Traffic engineering (TE) is the optimization of traffic flow in an MPLS network using topology information, constraints, specialized algorithms such as (routing algorithms, load balancing algorithms) and a signaling protocol.

A major objective of traffic engineering is to minimize or eliminate high-loss situations. In particular, the number of lost packets should be as close to zero as possible. Another goal of MPLS traffic engineering is to balance the network performance and the Quality of Service (QoS) against the cost of operating and maintaining the network.

There are many strategies that can be used for traffic engineering like IP-over-ATM [3], constraint based routing [4] and others. MPLS (Multiple Protocol Label Switching) Traffic Engineering overcomes the limitations of these approaches by perfectly combining the flexibility of layer 3 with the traffic management capability of layer 2 and is regarded as the key technique of next generation IP based network. Its emergence provides strong technical support for traffic engineering. Most of the previous works on two-layer models focus on the optimization of flow.

3. LOAD BALANCING ALGORITHM USING PHEROMONE DEPOSIT FOR DEVIATION PATH SELECTION (LBPDP)

The techniques cited above have taken a big step towards the optimization of flow. But with the growth of network application and traffic rising, the network is exhibited to an increasing frequency of congestion. Therefore more adaptive adjustment capabilities to the network are very essentials.

Load balancing is an operation that distributes traffic flow rationally in the current network topology over multiple paths. [2]

Some load balancing Algorithms proposed in the literature are Topology-Based Static Load Balancing Algorithm TSLB that is improved on the basis of traditional shortest path routing.

In this algorithm, the shortest path is examined, if it meets the bandwidth requirement, then it will be selected otherwise that path is deleted from the feasible set [4].

Resource-Based Static Load Balancing Algorithm RSLB pre-computes the set of paths the same way as TSLB, but it examines the paths to find the one with the lowest bandwidth that can afford the need for the new arrival traffic. But when there are only few low-rate flows are sent during a long time, links with large capacity in the Internet will be idle for quite some time. [2]

Load Balancing Algorithm using Deviation Path (LBDP) switches a selected flow to a deviation path when congestion is about to happen, it uses the shortest path algorithm to select the deviation path, but this algorithms may place significantly more traffic on some nodes than others, also it choose the qualified deviation path from a limited number of selected paths; In LBDP a qualified deviation path is found only while no loop existed and available bandwidth is wide enough; The probability of selecting unqualified paths here is quite high. In the case of no qualified deviation path found, the congestion will occur.

To solve this problem, and avoid getting in the case of selecting unqualified deviation path, we propose a Load balancing algorithm using deviation path based on ant colony pheromone table to choose the adequate deviation path from a large number, where the probability to select an unqualified path is lower.

3.1 General Terminology in LBPDP

G(N,L): is a graph of a network topology

N= {N1,N2,N3…Nn} where N is a set of nodes in an MPLS network (LSRs and LERs), and L is a set of links in the network. We use l(i,j) to refer to the link between node i and node j.
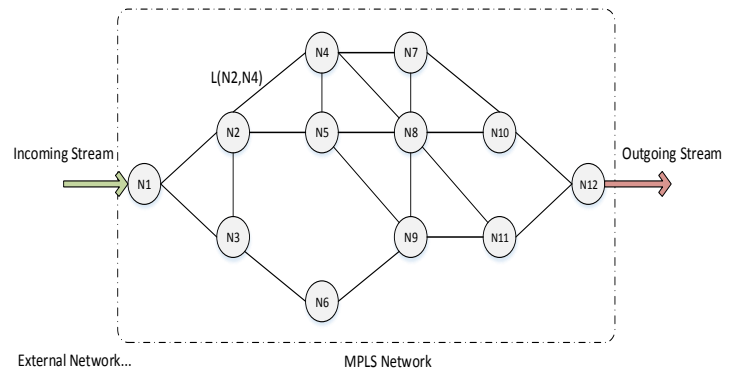

 Fig -1: Network topology

As shown in Fig. 1, the neighbor nodes for N2 that take to the same destination N12 are N4, N3 and N4.

We used in our Algorithm the identification of Isolines defined in LBDP to facilitate the selection of the adjacent nodes that take to the same destination

Isoline: a line on a network topology map connecting nodes with equal distance value to the destination of a certain flow.[2]

Deviation Path [5]: There is a path from node Ni to node Nj called d1 / d1= ni,n1,n2,…,nk,…, nj . And another path from node ni to node vj called p2 is existed too, d2= ni,n1,n2, …, nk,…, nj . If ni,n1,n2,…, nk=ni,n1,n2,…, nk and nk+1 ≠ nk+1 ,

then node nk+1 is called the deviation node of node nk+1 and d2 is the deviation path of d1 against node nk+1.

3.2 LBPDP Model

The general idea of the proposed Algorithm is as follow:

We start by creating the pheromone table in each node using the ant agents who will put a pheromone in each link between two nodes, they will scan large number of network nodes, and collect information about the network while moving and delivers it to the network nodes. Each node will have its own table that contains pheromone values for the adjacent links. (The algorithms of this category are not using the agents to optimize the paths as in S-ACO or S-ACO meta-heuristic [6]. It is just used to deliver more updated information about the network to the network nodes, which speeds up the optimization process in the next step of path selection.)

Secondly, when a congestion is about to happen, we create spanning tree that will be quite useful in the deviation node selection. Thirdly, we choose and select the flow to redirect

Next phase, we select the optimal path by using the pheromone table. And finally we redirect the selected flow in the selected path. And finally we switch the selected flow on the selected deviation path.

4. THE IMPLEMENTATION OF LBPDP

4.1 Create Pheromone table

Using the ant agents of the first category:

1- Move randomly in the network to scan nodes of the network

2- Collect information about the network

3- Deliver more updated information to all the network nodes, with a pheromone value they deposit in each path.

Every node in the network can function as a source node, destination node, and/or intermediate node. Every node has a pheromone table. (TABLE I)

Table -1: Pheromone Table

Node ID	Pheromone Value

P(i, j) is the pheromone deposited in the path between 'i' and 'j'. The pheromone update policy was already implemented in Ant Colony Optimization algorithm in [3] as follow:

$$T(i, j) \leftarrow (1-\alpha) \bullet T(i, j) + \sum (1-\alpha) \bullet T(i, j) \qquad (1)$$

The information we gathered from this section will be quite useful for the implementation of the algorithm, especially for the path searching and selecting part.

4.2 Spanning Tree creation (Graph structers)

We use the Breadth First Search BFS algorithm for keeping track of all visited nodes, as output we get the following tree (spanning tree) (Fig.2), and from the spanning tree we can extract the isolines, for example in Fig.2 , the nodes N2, N3 are in the same isoline, same thing for N4,N5,N6 etc.
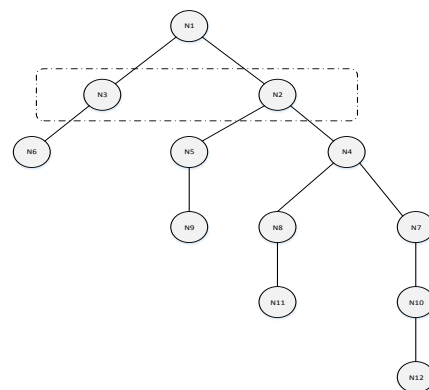

Fig -2: Spanning tree of G1

4.3 Flow selection

Each LSR in the MPLS network periodically checks its outcome links. They compute the bandwidth utilization rate of the links periodically, than if the value of a certain link l(i,j) exceed the predetermined threshold ɣ we set, it indicates that a congestion is about to happen. In this case we select a flow according to two criteria:

1- Lower Priority

2- Minimum Bandwidth in the selected set of lower priority flows

4.4 Path Searching and selection

The probability of selection a neighbor j at the node I for the destination D is:

$$prob(D,i, j) = Fun(PH,i, j) - - - - -if , j⧠ N \qquad (2)$$

Where PH is the pheromone value corresponding to the node j at pheromone table of the node i.

Assuming that P1 is the current path / where P1= N1,…,Ni,Nj,…, Nd, if we can find a deviation path of P1 called P2 that uses the neighbor Nj we get from (2), as the deviation node then we can use it as the path for flow switching since it's a path that steer clear of congested link (Ni,Nj).

4.5 Flow switching

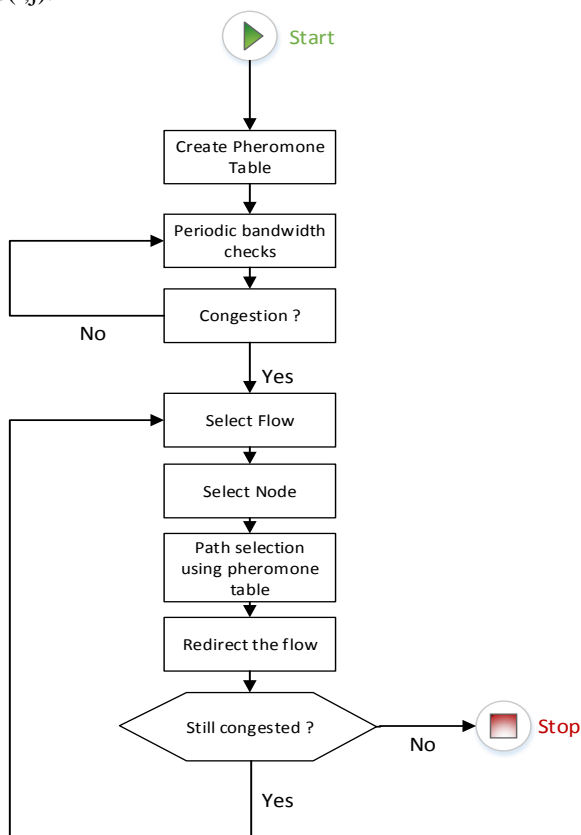As a final step we switch the selected flow f onto the selected path e(i,j).

Fig -3: LBPDP Algorithm

5. CONCLUSIONS

The major challenge that MPLS networks have to resolve are functional requirements with today's growing amount of traffic, subscribers and services. With the increase of delay and packet loss sensitive traffic, network performance control and traffic categorization needs have emerged.

In this paper, we first discuss the general issues of routing algorithms. We then present the MPLS Traffic Engineering

technique, and tow load balancing algorithms of MPLS TE; especially we exposed the limitations of LBDP algorithm.

After that, we present our proposed new load balancing algorithm called LBPDP. Finally, The Simulation results of our proposed Algorithm LBPDP will be shown in the next paper.

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BIOGRAPHIES

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