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Path Computation Algorithm Using Delay & Bandwidth Constraint

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ABSTRACT
MPLS is a fast forwarding mechanism which provides support for traffic engineering. In the MPLS network constraint based routing computes routes, it not only considers the topology of the network but also another parameters such as bandwidth, delay etc. It may find a longer but lightly loaded path which is better than heavily loaded shortest path. This paper deals with modification of Wang-Crow croft algorithm based on best fit approach in the computation of label switch path resulting increases the quality of service. Both algorithms have been implemented in NS-2 and compared on the basis of throughput.
Keywords:- MPLS, NS-2, LSP, Wang Crow croft

I. INTRODUCTION

MPLS [4] is a forwarding mechanism which forward the data packet based on labels rather than long network address, avoiding complex lookups in routing table. It makes use of labels to create virtual link for data transmission between data nodes.

The structure of MPLS consists of various routers that support MPLS and are known as Label Switching Routers LSRs. The LSRs which are in the periphery of the MPLS Network are called Edge LSRs or Label Edge Routers (LERs) and must be capable of accepting packets from all types of networks. The end-to-end virtual path that is set up with the use of labels is known as LSP (Label switched path). An LSP starts at the ingress node and terminates at the egress node passing through several intermediate routers. Ingress LSR receives a packet that is not labeled yet, it insert a label in front of the packet and send it on link. Egress LSR receives labeled packets, remove the label and send them on link [3].

The basic function of a PCE [8] is to find a network path that satisfies multiple constraints (as QoS Bandwidth Constraint) [4]. A PCE can be realized according to two models-

1. Centralized computation Model.

2. Distributed computation model.

Centralized Model-In this model all the paths are computed by a single, centralized PCE .This may be a dedicated server or a designated router. In this model off-line path computation algorithm is used. A centralized PCE can take into account global information on network resources and existing connection paths to implement optimal computation procedures. Off-line path computation algorithms have the knowledge of the entire set of demands and make more efficient use of network capacity.

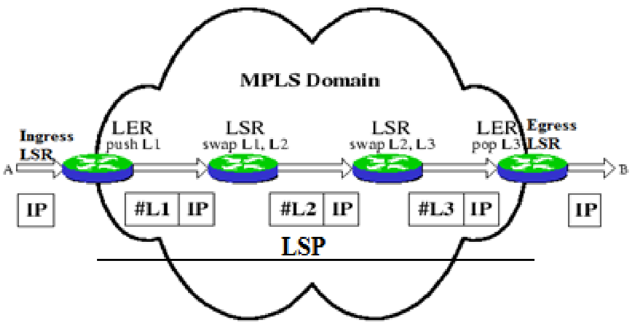

Figure 1: Structure of MPLS Network

Distributed Model-This model include multiple PCEs and where the computation of paths is shared among the PCEs. A given path may in turn be computed by a single PCE or by multiple PCEs, but often the computation of an individual path is entirely performed by a single PCE. Distributed PCEs usually adopt on line path computation algorithms.

II. QOS METRICES

Routing metrics are links features used to represent a network. Given the metric d(i, j), associated to the link(i, j), and the path p=(i, j, k, … , l, m), the metric d is:

- additive if d(p)=d(i, j)+d(j, k)+ ... +d(l, m)
- multiplicative if d(p)=d(i ,j)*d(j, k)* ... *d(l, m)
- concave if d(p)=min[d(i, j);d(j, k); ... ;d(l, m)]

Routing protocols usually characterize a network through a single metric (the cost of the link). In the case of QoS routing protocols and constrained-based path computation algorithms, the network is described by means of multiple metrics. The most common ones are the following:

1. **Cost:** it is an additive metric, because the cost of a path is the sum of the costs of the links.

2. **Bandwidth:** (or residual bandwidth) it is a concave metric. Indeed, we define the bandwidth of a path as the minimum of the residual bandwidth of all links on the path.

3. **Delay**: it is an additive metric, since the delay of a path is the sum of the delays of its links. It consists of three components: propagation delay, transmission delay and queuing delay.

III. WANG CROWCROFT ALGORITHM

It finds out a path which satisfies multiple QoS constraints in terms of bandwidth and delay [2].

Each Link (i, j) is characterized by two parameters: Residual Bandwidth ($b_{i\,j}$) and delay ($d_{i,\,j}$)

The algorithm consists of the following steps:

1. Set $d_{ij} = \infty$ if $b_{ij} < BMIN$.

2. Compute the path *P* with the minimum delay *D** (applying the Dijkstra algorithm).

3. Compare *D** with *D*MAX. If *D** < *D*MAX select the path, otherwise the request is rejected

IV. MODIFICATION IN WANG CROWCROFT ALGORITHM

In the modification of WC algorithm, we used best fit approach which is used in memory management of operating system. If there are several requests at a time, this algorithm process them in decrement order of their bandwidth constraint value.

The algorithm consists of the following steps:

1. Call WC Requests (X requests accepted).
2. Sort the requests in decreasing order of bandwidth constraint value.
3. Call WC Algorithm (Y requests accepted).
4. If (Y≥X)
   Consider Bandwidth based reordering of requests.
   Else
   Consider normal ordering of requests.

Suppose there are 4 traffic flow requests which are being made:

Each request has a constraint (minimum bandwidth and maximum time delay) associated with it. As 1st request needs minimum 2 Mbps bandwidth and time delay should not be more than 40 ms.

Traffic Flow	Source Node	Destination node	Bandwidth (Mbps)	Delay (ms)
1	8	12	2.0	40
2	9	13	2.5	30
3	13	10	1.0	45
4	11	10	2.0	28

Table 1: Traffic Flow Request

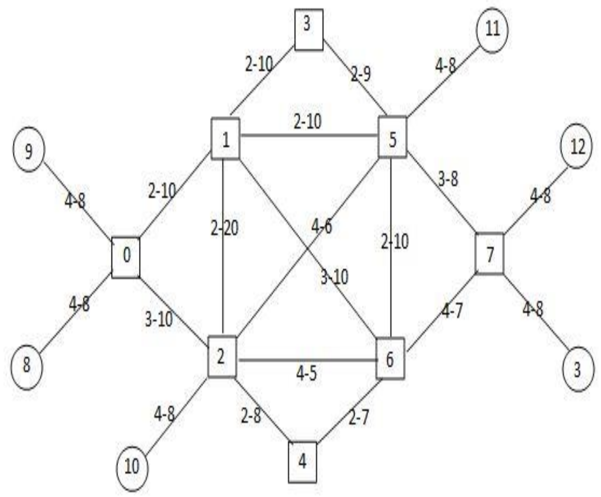

Figure 2: Network Topology

When first traffic flow request is processed it is allocated to path (0-2-6-7).Now 2nd traffic flow request will be processed which will be rejected as minimum bandwidth requirement is not fulfilled.
After LSP allocation to 1st request Link 0-2(1 Mbps) and Link 0-1(2 Mbps) do not have required minimum bandwidth (2.5 Mbps).

Traffic Flow	Path
1	0-2-6-7
2	No Path Allocation
3	7-6-2
4	5-2

Table 2: WC Algorithm Output

The requests are sorted in decreasing order of bandwidth constraint value, as given below.

The processing order 2,1,4,3 permits to satisfy all the requests.

Traffic Flow	Source Node	Destination node	Bandwidth (Mbps)	Delay (ms)
2	9	13	2.5	30
1	8	12	2.0	40
4	11	10	2.0	28
3	13	10	1.0	45

Table 3: Requests in Descending order of Bandwidth value

LSP allocation to the traffic flow requests are given as:

Traffic Flow	Path
2	0-2-6-7
1	0-1-5-7
4	5-2
3	7-6-2

Table 4: LSP Allocation according to WC Algorithm with Best Fit Approach

V. SIMULATION & RESULT ANALYSIS

In order to evaluate the performance of both algorithm simulation has been carried out on NS-2 and result is analyzed on the bases of throughput.

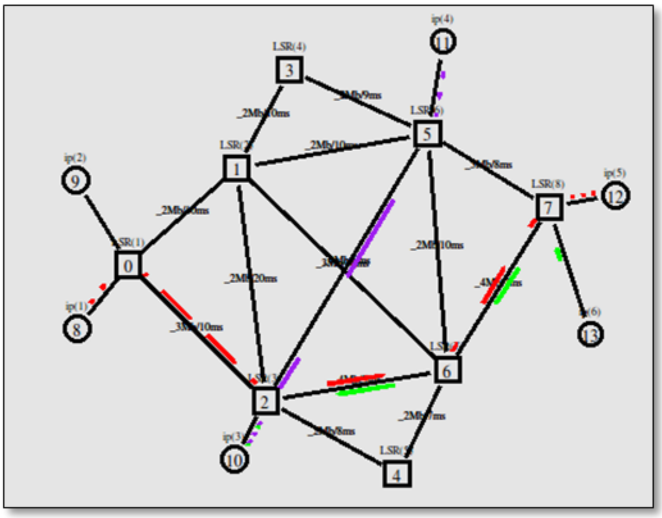

Figure 3: Simulation of WC Algorithm

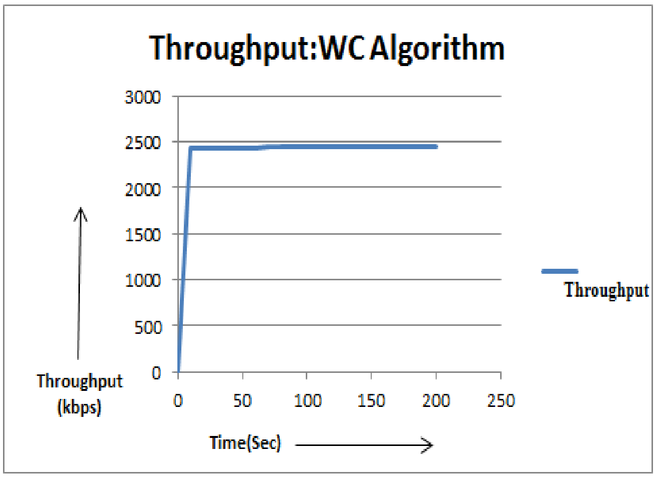

Figure 4: Throughput of WC Algorithm

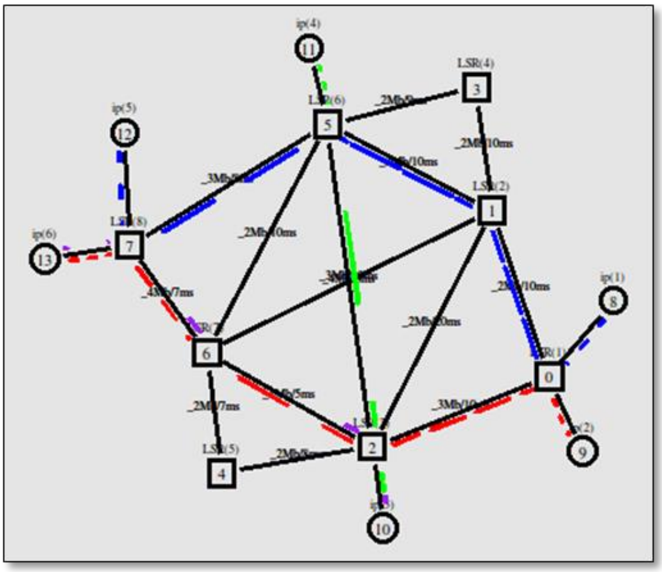

Figure 5: Simulation of WC Algorithm with Best Fit Approach

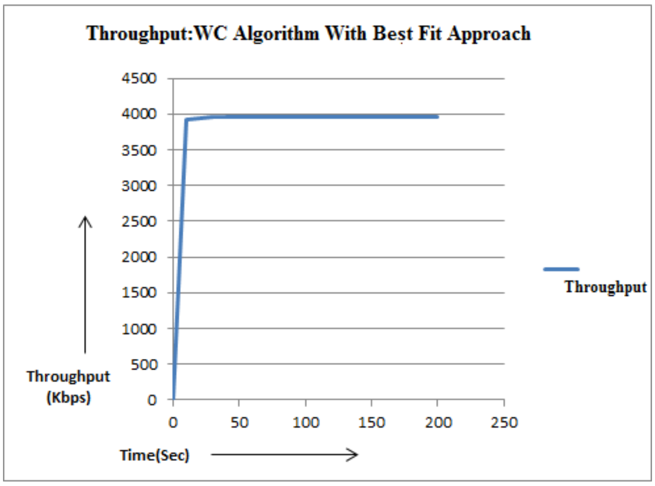

Figure 6: Throughput of WC Algorithm with Best Fit Approach

Figure 4 & 6 are representing that throughput of WC algorithm with best fit approach is higher than WC

Algorithm. At 40sec throughput of WC algorithm is 2436 KBps (Figure 4) and WC algorithm with best fit approach is 3957 KBps (Figure 6).

VI. CONCLUSION

As in MPLS Constraint path computation is a key function for providing traffic engineering. In literature several algorithms have been proposed for LSP allocation requests. This paper deals with Wang Crowcroft Algorithm and Wang Crowcroft Algorithm with Best Fit Approach. Results are calculated on the bases of throughput. After analyzing results it is represented that WC algorithm with Best Fit Approach performs better than WC. WC Algorithm with best fit search also provides better resource utilization (ratio of the allocated bandwidth and the total link bandwidth) as compared to WC Algorithm.

VII. FUTURE SCOPE

It is quite possible that some pending requests having low bandwidth is not allocated to LSP. Due to this reason certain requests are never served because of their shorter bandwidth and create starvation. This can be eliminated by using Aging Model.

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