Optimal Traffic Engineering in Link State Routing Protocols

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ABSTRACT
From last many years traffic in internet is increasing very rapidly. But as internet in growing up it required quality and have to increase the efficiency of network. Also it should concentrate on load balancing & resource utilization. In today's internet world mostly Open Shortest Path First (OSPF) routing protocol is used which is based on link weighs, as optimizing link weight in OSPF to the group traffic is well-know NP-Hard problem. In the consideration of current situation of the network paper introduce a new method called Multi-Shortest Path First routing protocol to achieve optimal traffic engineering in network with the help of OSPF. It will reduce the time required to compute the weight on link and find the best links to forward the packet within short time. Our concept is to split the traffic over first few multiple shortest paths to reach to destination. As traffic increases our protocol automatically sends packet through next shortest path present in the network.. As compare with the OSPF packet forwarding mechanism is same just difference is in splitting mechanism.

General Terms
IP wired Network

Keywords
Open Shortest Path First (OSPF), Optimization, Traffic Engineering.

1. INTRODUCTION
Now a days to find the shortest path from source to destination node in any sized network Link state routing protocols are commonly used, protocols such as Open shortest path first (OSPF) and Intermediate system to Intermediate system (IS-IS). We know, from last few years the importance of IP network has surprisingly increased. Because increasing use of network number of unpredicted connections are increased, so network unable to manage traffic. Ones the network protocol fails to manage traffic; automatically question arrives for quality of service. To manage the traffic it have to watch on link capacity and current load on link. Protocols like OSPF and IS-IS that selects the path based in link weights, with these protocols computing the right link weight is NP-hard [1].

Before start with our proposed protocol we have to discuss functionality and problems of OSPF and IS-IS. OSPF has its own packet forwarding mechanism: Hop-by-Hop and destination based. It split the traffic over shortest path based from source to destination. If traffic is increases then it difficult to transfer the packets from source to destination through single route. Because of that QoS is decreased and TE issues are increased. Paper referred traffic engineering as improving network performance and making efficient use of resources requires adapting the routing of traffic. The important challenging part in network is to manage an IP network with the help of existing protocols. To manage network in sense of managing the load on a link and utilization of resources is an important issues. Also to optimize traffic engineering (TE) is main challenge. For managing a routing protocol if the complexity were not a concern then other approaches could use to achieve optimal traffic engineering. As in [2] one possibility in multicommodity – flow type of routing, where an optimal traffic distribution is realized by dividing an arbitrary fraction of traffic over many paths. This can be supported by a flexible way to spit traffic over shortest path [7].

The purpose behind this report is to discuss the practical and theoretical issues of MSPF routing protocol. This report was written during the MSPF protocol implementation.

Paper is develop a new routing protocol who accept this challenge and try to achieve optimal traffic engineering in link state routing protocols. To develop this protocol first it should know the three main components which are to be used to design a link state routing protocol. First is computation of weight, second is traffic splitting and third is packet forwarding. The set of link weights computes through a periodic and centralized optimization in weight computation method. In traffic splitting each router decides traffic splitting ratio among its outgoing links for every destination with the help of link weights. With the help of these three components of link state routing protocols paper were tried to develop a new link state routing protocol named Multi shortest path first (MSPF). The name itself gives the basic idea behind the project. In our MSPF routing protocol weight computation and packet forwarding mechanism are same but the difference is in traffic splitting. In this protocol split the traffic over multiple shortest paths to forward packet from one source to destination. Will see the brief introduction of this protocol in remaining paper.

The rest of the paper is organized as follows. Paper introduce literature survey related to our protocol in section II. In III section we introduce our new routing protocol. We conclude and point out our next scope of work in section IV.

2. LITERATURE SURVEY
Many researchers have done their research on traffic engineering with the help link state routing protocols like OSPF & IS-IS. They tried to achieve optimal traffic engineering. In this literature survey it is going to study each and every existing protocol with the help of a single example with consideration of hop by hop forwarding mechanism. As in our protocol or in all survey protocols OSPF is used so will start our survey with the same protocol.

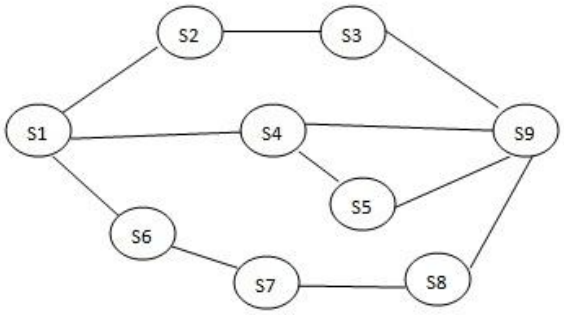

Fig. An IP Network

Open shortest path first (OSPF) is one of the most popular routing protocol in today's network. Concept behind OSPF is to forward packet with the help of shortest path only from any source to any destination. In OSPF, with the help of hello packet, nodes will come to know about neighbors. Then with the help of Dijkshtra's algorithm it will calculate shortest path from each and every node to another. But the major problems are the chosen path is not robust under change in traffic or network state. Also optimizing link weight in OSPF to the group traffic is NP-Hard problem [2]. For better understanding of OSPF will see its working with the help of fig. 1

Suppose G = <V,E>, where V is the vertices and E is the edge. If S1 wants to send packet to destination S9 it will first check the shortest path. S1 → S4 → S9 will be the shortest path by hop-by-hop method. It means S1 will send the packets to S9 through S4. If the traffic is more on the same path then also it will continue to send the traffic through same path. It means the final path in OSPF to send the packet is S1 → S4 → S9. With the help of OSPF, next protocol is tried to develop by Ari lappetelainen, which is Equal cost multi-path (ECMP) routing in IP network. ECMP split the traffic over equal cost multipath. This protocol tried to utilize resources [11]. But it is not able to split the traffic equally [1]. Also it will not useful if the equal cost paths are not present to a particular destination node. For better understanding will take an example with reference to Fig. 1.

In ECMP, S1 will send the packet to S9. First it will check whether it have equal cost path is present to S9. If paths are present then it will send through multiple paths which have equal cost to destination S9.But ECMP will not calculate current flow on link at runtime.

Next protocol is LB-SPR; Load balanced shortest path routing using OSPF with the help of two phase forwarding mechanism. It optimized for arbitrary traffic pattern. When a packet arrives to its source router it will forward the packet to next intermediate router with the help of current load on the link along with the preference of shortest path. Suppose the packet arrives from node S1 to intermediate node S4. S4 will check whether the load on link S4 → S9 is more. If not then packet directly send s to S9 otherwise it will change the next intermediate node, which link does not have traffic. Likewise this protocol forwards the packet in two phases. First phase is from source node S1 to intermediate node S4 and second is from intermediate node S4 to destination node S9. Process of changing next intermediate is happening on each intermediate node. The major consideration is to find out next intermediate node with the consideration of current load on link [4].

At last will see the next protocol which is DEFT: Distributed exponentially weighted flow splitting. This is link based protocol with the database synchronization is major issue. Consider the same example. S1 is source and S9 is destination. The S1 has total three links so it will split the traffic in three parts towards the destination. DEFT will not think much more about shortest path. In DEFT utilization is more but problem regarding required delay of packets to reach destination.

While studying all above protocols it has been observed that they have not concentrated on utilization of resources and traffic engineering [TE]. While proposing the new protocol design, it fully concentrated on above two major issues.

3. MSPF (Multi-Shortest Path First)

Consider a wired IP network as directed graph G = <V,E>, where E is the set of links and V is the set of vertices (or node). As shown in fig, 1. It can consider S1 as a source and S9 is destination where the link (a,b) has traffic capacity ${}_tCa,b$.

Table 1. Summary of key notation

PARAMETER	PARTICULAR
$w_{a,b}$	Assigned weigh to link (a,b)
${}_tf_{a,b}$	Traffic Flow on link (a,b)
${}_tf^t_{a,b}$	Traffic Flow on link (a,b) destined to node Sj
${}_tf^t_a$	Total incoming traffic flow (destined to Sj) at a
${}_tC_{a,b}$	Traffic capacity of link (a,b)
${}_t\tilde{C}_{a,b}$	Required traffic capacity of link (a,b)
${}_tD(s,t)$	Traffic demand from source Si to destination Sj
d (a,b)	Shortest path from a to b
$\tilde{\omega}$ (p)	Alternative path
Ri and Rj	Route i and route j

Suppose S1 wants to send packet to S9, with the help of shortest path algorithm.

$$d(a,b) = \begin{cases} \{\min \{ \tilde{\omega}(p): a \to b\} & \text{If there is a path from a to b.} \\ \text{Otherwise} & \text{Where, } \tilde{\omega}(p) \text{ is alternative path.} \end{cases}$$

First it will find out first two shortest path and sends the traffic through route r_i and route r_j. If the traffic is more on any of these links then source node S1 will go for third shortest path. With consideration of same example S1 is source and S9 is destination, first shortest path is S1→ S4 → S9 and another one is S1 → S2 → S3 → S9. Now consider if traffic

is more on route r_j, in our example S1 → S2 → S3 → S9 then traffic will shift to third shortest path which is S1 → S4 → S5 → S9. The capacity of any link is considered as ${}_tCa,b$ and the current load means current flow is considered as ${}_tfa,b$ on each link (a.b). If it need to maintain traffic engineering then out link cost function should be $0 < {}_tCa,b / {}_tfa,b > 1$. It means our objective for traffic engineering is to minimize the maximum the utilization of link (a.b).

The most important issue in our protocol is it need to calculate link weight at runtime and then split the traffic again check whether traffic is more on link if not continue with the transfer. As suggested in [2] for computation of link weight and link weight update, paper refer those two algorithms as follows.

For Link Weights Calculation paper have to set our flow up to necessary capacity of link means, algorithm for computing the necessary traffic capacity ${}_t\tilde{c}$

while ${}_tf \neq {}_t\tilde{c}$
do
w ← Link_Weight_Updates (f)
${}_tf$ ← Traffic_Splitting (w)
end while
Return w

Then, the procedure increases the weight of each link (a,b) if the traffic flow exceeds the necessary traffic capacity, or decreases it otherwise. The parameter ά is a positive step-size, which can be constant or dynamically adjusted. For updating of link weight of any link (a,b)

do
$w_{a,b} \leftarrow w_{a,b} - \acute{\alpha} ({}_t\tilde{c}_{a,b} - {}_tf_{a,b})$
end for
Return new link weights w

After updating traffic it have to split the traffic through first two shortest paths σ (a,b) as per our example. It already discuss how MSPF achieve optimal traffic engineering with the help of Link state routing protocols in this section. For this analysis will consider four parameters which are Delay, Throughput, Average arrival time and Bandwidth. As per as analysis part is concern it is trying to prove the network performance improvement and utilization of resources in IP network. We are developing this protocol in NS-2 (2.34).

4. CONCLUSION

In IP based network we are trying to achieve optimal traffic engineering with the help of Link state routing protocols. We already show the working in numerical as well as in theoretical manner how our protocol is going to work. As future scope is concern it can develop this protocol without OSPF. Because of signaling mechanism of OSPF, performance of network is going to decrease. Also in OSPF database synchronization is big issue.

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