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Simulation and Analysis of Mass and Interactive flows in a Label Switching Backbone

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Abstract
This article presents the simulation of flows through a MPLS backbone using traffic engineering, and the obtained results are compared with an IP Backbone. We conclude that the use of MPLS is a robust alternative that ensures a high quality of service thanks to the RSVP protocol.

Keywords: IP, ER-LSP, LER, LSR, RSVP.

I. INTRODUCTION

Multiprotocol Label Switching (MPLS) [1] [2] appears in the late 90s, as a technology capable of optimizing the performance of IP-based networks. However, their study is now focusing on the development of applications related to guaranteeing traffic engineering guarantee, virtual private networks and quality of service (QoS).

This article seeks to demonstrate that applying traffic engineering can improve network utilization through traffic distribution according to the availability of resources, current traffic and expected traffic. As a result, the reduction of congestion will be ensured for any existing link in the cloud.

This control provided by the TE allows the ISP to reserve (forced) routes for certain classes of service or clients.

II. TRAFFIC ENGINEERING

As Traffic engineering can be defined as the process of distributing over the entire network topology the surrounding traffic to avoid congestion and saturated links. Improved network utilization does not necessarily imply the best route is obtained, but the best route for a particular type of traffic [9].

According to RFC 2702 "MPLS Traffic Engineering", that is Traffic Engineering on MPLS, should focus on optimizing network performance and involves tasks such as traffic measurement, performance evaluation, Backbone flow control.

Among the main objectives are:

Reroute traffic from the route set by the IGP (Interior Gateway Protocol) to a less congested route should the network be saturated.

Maximize the use of existing network resources (links, nodes, ends).

Ensure the reliability of the transmission in case of unexpected failures.

Establish criteria to ensure the preference of certain routes that may or may not be mandatory.

Securing resources imposed by the user before sending the information.

Among the actions that are necessary to control to implement the TE are:

Modification of traffic management parameters.

Changing the routing associated parameters (ie, transmission optimization routing the flows through links that among other things ensure minimal link delays, ensuring quality of service).

Variation of the attributes associated with existing network resources (allocation according to traffic priority).

III. EXPLICIT ROUTING

MPLS allows applying traffic engineering through explicit routing. An explicit route consists of a sequence of nodes (LSR's) between a LER router to a network input and an output LER defined and established from a border node.

If the input LER wants to establish a route that does not follow the default path, the IP routing protocol must use a label distribution protocol that supports the definition of explicit routes as RSVP (Resource Reservation Protocol) [3]. This leads to the concept of CBR (constraint-based routing), where the LSP route may be restricted by the capacity of the resources and the capacity of the nodes to meet the QoS requirements.

For the calculation of routes one of the following methods can be used:

Calculate in the input LER the end-to-end route based on information about the current state of the network [8].

Calculate the jump-to-jump route through the LSR's taking into account the information provided by the routing tables on the existing availability [4].

MPLS transmission occurs through routes (LSPs), which are established end-to-end based on traffic requirements. There are two ways to establish these routes:

Before data transmission (Control Driven).

Once a data stream is detected (Data Driven).

In addition to finding the most appropriate route it is necessary to reserve resources to meet the required service.

This is accomplished by use of explicit routing by using the signaling protocol TE-RSVP (resource reservation protocol with traffic engineering) using IP datagrams for communication between LSR's [5].

IV. EVEN SIMULATION AND ANALYSIS

Multiprotocol Label Switching together with the resource reservation signaling protocol allows applying traffic engineering.

This article will demonstrate the validity of MPLS and RSVP-TE for applying traffic engineering.

In order to carry out the different simulations a NS_2 [3] discrete event simulator has been used. Figure 1 shows a possible scenario composed of four traffic generators (0, 14. 15, 16), eleven LSR's (1, 2, 3, 4, 5, 6, 7, 8, 11, 12, 13) and 4 receivers (10, 9, 17, 18), showing the establishment of restricted routes.

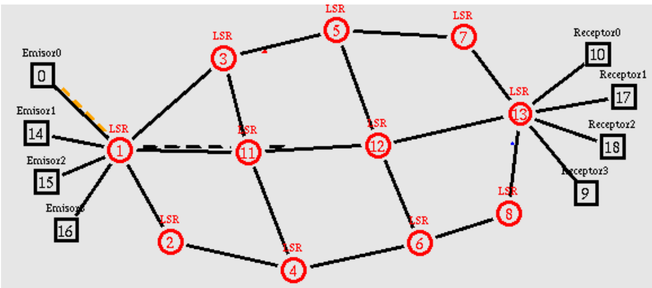

Figure 1. Topology to simulate.

Initially each source generates data at a rate of 700 Kbps. Traffic type, the relationship between each transmitter and receiver is shown in Table 1.

Table 1. Relationship between transmitters and receivers.

Traffic Type	Distinction Color	Transmitter	Receiver
Video	Orange	Node 0	Node 10
Data	Purple	Node 14	Node 17
Audio	Blue	Node 15	Node 18
Exponential	Black	Node 16	Node 9

The establishment of a ER_LSP using RSVP-TE, is also shown in figure 1.

The input LER (LSR 1) determines the need for a new route to the output LER (LSR 13), the traffic parameters for the session enable the LSR 1 to determine the best route, so the LSR1 generates and sends a PATH ***(blue)*** message with the restricted route (1, 11, 12, 13) and the traffic parameters that the session requires to the LSR 13 on a session with the UDP protocol [9]. LSR 11 receives the PATH message, it determines that is not the output LSR for the LSP and sends the order to the next LSR, until reaching the output LSR. The LSR 13 determines it is the output router for the new LSP, runs a final negotiation on the resources and makes the respective reservation for the LSP, assigns a new label to the new LSP and returns a RESV ***(red)*** message that will distribute the label that has been chosen, containing details of the of the final traffic parameters reserved for the LSP [6]. The LSR 12 receives the RESV message and joins it to the original order (PATH message), reserves the resources indicating the RESV, allocates a label for the LSP, updates the routing table, and sends the label to the router 11 in another RESV message. This routine is repeated until it reaches the input LSR.

When the LSR 1 receives the label, it sends a ResvConf confirmation message to indicate the route is established and transmission will begin.

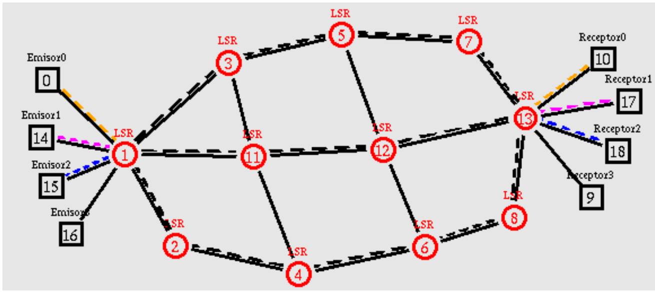

Figure 2. Surrounding network traffic.

From the figure above it can be concluded that only three of the four flows are being transmitted, because the fourth was unable to guarantee the requested petition.

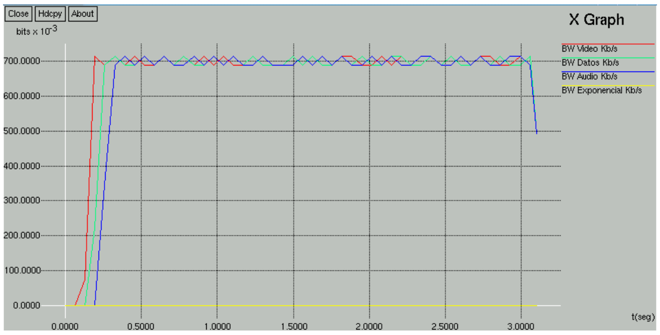

Figure 3. Distribution of bandwidth on links with traffic.

The display made in the NAM (figure 3) [7], leaves a clearer picture of what is happening in the network, but to have a closer analysis of what happens at each moment, the XGRAPH (Figure 4) is used, whereby the bandwidths used by video, data and audio traffic are observed, and which are relatively constant.

V. CONCLUSIONS

In the absence of traffic engineering, the IP flow follows the shortest route, ignoring alternative routes with better performance across the network. This leads to congestion on heavily loaded links, while other links remain underutilized.

A traffic-engineering network based on MPLS will feature equally loaded links, resulting in improved network robustness against traffic peaks and a higher overall performance.

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