# Metrology in Mpls Networks

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***Abstract*—** The many prowess of the "Multiple Protocol Label Switching" have introduced the concept of constraints to be solved in the routing of packets. Traffic engineering innovations require a better quality of the flows that circulate on the network. A packet succession processing mechanism is needed to achieve this. The classification of flows and traffic was presented as the effective solution. It consists in sorting the flows according to the quality of service that they require. In networks where several millions of flows are routed through routers, metrology is a science that makes it possible to separate traffic based on differentiated services. The objective of this article is to show the contributions of metrology to the performance of MPLS (Multiple Protocol Label Switching) networks.

***Keywords*—** Packet routing, flow classification, traffic, quality of service.

## I. Introduction

The emergence of IP networks has given rise to a new technique (MPLS) that can be seen as an interface bringing IP to connected mode and using Level 2 services (PPP, ATM, Ethernet, Frame Relay, SDH), [5]. MPLS is a technique whose role is to bring together the concepts of Level 3 IP routing and Level 2 switching mechanisms as implemented in ATM (Asynchronous Transfer Mode).

At a given time when routers saw their performance improve, the interest of MPLS is no longer the speed but the offer of the services it allows such as the quality of service, the virtual private networks, and the traffic engineering [4]..

MPLS is a network architecture that allows the routing of flows from the source to the destination based on the switching of labels. In the MPLS domain, there are two main routers that are the Label Edge Router (LER) and the Label Switch Router (LSR). LERs are edge routers that allow the addition and removal of labels while LSRs are Node routers located in the core of the MPLS network. When IP packets arrive at the MPLS network entry, they are treated differently. The LER input router adds a tag to a packet and allows it to pass through a LSR. On leaving the network this tag is removed by a LER that lets the IP packet continue its path. The path taken by the flows in the MPLS domain is called Label Switch Path (LSP) defined between two LSRs. During this routing mechanism, the nature of the flows exchanged may vary. Metrology consists of supervising the network and the flows that runs on it, which allows to have a better quality of service. Through this article, we present the scalability of MPLS and its associated specificities. Next, we propose approaches that measure flows in an MPLS domain.

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## II. Advanced Mpls

MPLS emanates from a group of engineers from Ipsilon Networks [3].. The initial design idea is to make it work on ATM. But over time it has become the standard of label switching technology. It builds on existing proposals: Ipsilon IP Switching, Cisco Switching Tag [Katz 97], IBM's Aggregate Route-based IP Switching [Viswanathan 97] and CSR (Cell Switched Router), from Toshiba [Katsube, 97].

Since its standardization by the IETF, MPLS has evolved with motivations such as VPN creation, flexibility, multicast routing, IP / ATM integration.

### A. Traffic engineering tools

The set of mechanisms that make best use of the resources of the MPLS network is called traffic engineering. The flows routed in the MPLS domain are oriented on the Label Switch Path (LSP) in the presence. An LSP is a path established between two LSRs of the core network. Streams that borrow LSPs cannot be replayed by them. An LSP is therefore unidirectional. Packages are directed so that no links are overused or underutilized. The routing protocols in the presence in the MPLS domain are used to generate the constraint algorithms. These algorithms make it possible to choose a route according to available resources such as the bandwidth and the quality of service involved.

### B. Constrained routing

In the traditional network, several packets take the same route to be routed from the source to the destination. Fig. 1 shows that links 2-3 and 3-4 are overused while links 2-7, 7-8, and 8-9 are underused.

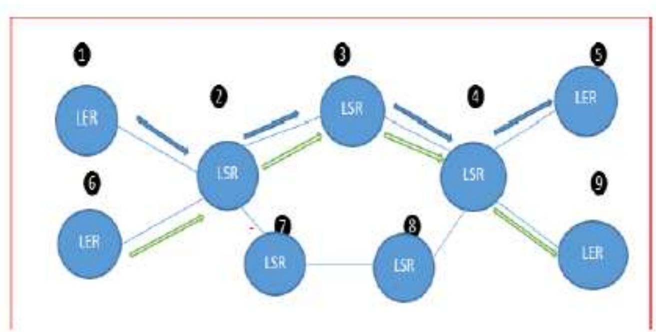


Fig. 1 Establishment of an LSP with OSPF

The basic idea of constrained routing is to force a route taken by an LSP to pass packets following certain criteria. Packet routing is no longer focused on a single link but on explicitly chosen links. When a packet enters the network, it is obliged to use the LSP passing through the 7-8 route other than 2-3 Fig. 2

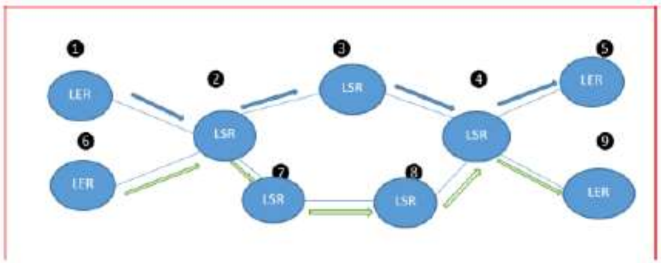

Fig. 2 Establishing an LSP with Explicit Routing

## III. Metrology

Metrology in traditional IP networks allows the classification of flows and traffic to be sorted according to the quality of service they require .MPLS supports this approach through the rational use of labels. A flow is a succession of packets and the traffic is the amount of flow that can cross a road in a given time. In an MPLS network in general, routers can process each packet differently or in a packet association. Metrology consists in applying a label to each packet or to a packet association called FEC (Forwarding Equivalence Class). It therefore uses tags to better distribute the packets for better processing. Metrology in MPLS networks offers many advantages: -The packets know the Label Switch Path (LSP) to borrow via the classification of incoming IP traffic - Facilitate the distribution of labels on the MPLS domain -Saving labels when the network is large. In the forthcoming lines, we present the different end-to-end flow classification mechanisms of the MPLS network. Further, we highlight the impact of metrology on LSPs and its importance in aggregating traffic.

### *A. Metrology in the presence of LSPs*

LSPs are specific paths implemented between two LSRs in the MPLS domain. Generally packets are routed explicitly through LSPs on the network. The presence of LSPs allows the distribution of loads and no link is overused or underused. The metrology on each LSP consists of finding a characterization of the traffic that passes over this link. The implementation of LSPs depends on several constraints. The constraints we describe in this section for metrology takes into account the total throughput on each link, latency, and jitter and loss rate.

The metrology method we use is the active one. Active metrology is used to monitor end-to-end traffic over the MPLS domain using highly active measurement tools. Among them the most famous are ping and traceroute.

The ping tool used confirms the validity of an LSP path between two LSRs and measures certain parameters such as the RTT or the loss rate. The traceroute tool used presents the LSR traversed by the packets transmitted from the input LER to the output LER and gives an indication of the transit times at each of its nodes. Typically the switching of labels in the core of the MPLS network causes the packets to be delivered at the output in their initial state, however the measurement of the loss rate of the streams is ignored. The total throughput on each link of the MPLS domain, allows to get an idea of the transmitted traffic. If xi packets cross a link and βj the label numbers that have been added to it by an LSR, the total bitrate of the link will depend on the total sum of labels per unit of time.

### *B. Metrology in flow classification*

The Diffserv model is the one we use in this section. It has been implemented by [9]. and supported in RFC 2475. The Diffserv model uses a measurement module and a classification module. In this model, the classifier is responsible for organizing the selected group traffic flows to which different levels of services apply.

The Diffserv classifier separates flows by FEC (group of packets that use the same label). Each group of packets is identified by a label value added to the IP packet. This classification is done on the LERs at the entrance of the MPLS network. Differentiated services in the MPLS domain contain two types of functional elements. Inbound LERs are responsible for packet classification and traffic conditioning. At the edge of the network, incoming packets have a certain DS value in their TOS (Type of Service) field. The label that a packet receives identifies the traffic FEC to which it belongs. After its labeling, the packet continues its journey in the network. LSRs are responsible for shipping only. When a labeled packet of its DS field arrives on an LSR, it is sent to the second node associated with the FEC of the packet.

### *C. Metrology in the aggregation*

Metrology in aggregation consists of classifying addresses with a prefix in common and the same next router. In the MPLS domain, an FEC is associated with each address prefix that appears in the routing table and a unique label is applied to a prefix union. The metrology approach in the aggregation makes it possible to reduce the number of labels necessary to process all the packets and thus a better performance of the LSRs.

## IV. Conclusion

In this article we have presented the considerable advances of MPLS which are forced routing and traffic engineering tools. Constraint-based routing is used to explicitly route packets. It allows a judicious distribution of the traffic loads by the establishment of LSPs. In the MPLS domain, traffic engineering relies on specific tools such as LSPs and label distribution protocols. The influence of metrology on LSPs made it possible to measure the fundamental parameters to the quality of service on the network. We presented the science of metrology that allows the supervision of the network and the flows that runs on it. Then we studied metrology under the strict framework of MPLS. It consists in sorting the flows arriving on the network and in deriving the best quality that they require. Finally, it allowed the aggregation of flows whose addresses share the same prefix. This article has presented the architecture of the quality of service that better meets metrology in the classification of flows. This has shown that metrology is a key point in the deployment of quality of service. It must be deployed before the QoS to evaluate the current performances of the network and the flows consumed by the different flows.

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