Preface

This book addresses two aspects of network operation quality; namely, resource management and fault management.

Network operation quality is among the functions to be fulfilled in order to offer quality of service, QoS, to the end user. It is characterized by four parameters:

– packet loss;

– delay;

– jitter, or the variation of delay over time;

– availability.

Resource management employs mechanisms that enable the first three parameters to be guaranteed or optimized. Fault management aims to ensure continuity of service.

Internet Protocol (IP), Multiprotocol Label Switching (MPLS) and Ethernet are the main technologies deployed by operators, in the case of wide area networks (WANs), and by businesses, in the case of local area networks (LANs). Initially, these technologies were not designed to deal with resource management, which partly explains their simplicity and commercial success. The features offered were sufficient at the time to offer services without QoS (best effort) constraints, such as web access and electronic messaging.

Resource management is indispensable when QoS constraints need to be taken into account. Voice and video are two applications illustrative of strong QoS requirements. Resource management can be provided using two different approaches:

– resources are managed node by node. No resource is allocated to a flow from end to end. In this case, there is a risk of congestion, as the resources of one node may become insufficient to meet demand. The network thus offers relative QoS;

– resources are allocated to a flow from end to end. The Connection Admission Control (CAC) function allows congestion to be avoided in the network, in that case offering guaranteed QoS.

Deployed networks essentially implement relative QoS, as they have the advantage of simplicity compared with guaranteed QoS. The oversizing of current networks, associated with traffic measurement functions that feed into capacity planning, has so far enabled congestion problems to be solved in a satisfactory manner.

Such a mode of operation can prove inadequate in cases of large increases in video traffic. The latter can be classified according to two communication patterns:

– broadcast video. A video source broadcasts one and the same program to several users. Resource consumption depends on the number of sources and is relatively independent from the number of users. A network offering relative QoS allows for the transport of this type of traffic, whose increase is not dramatic;

– unicast video. The video signal is exchanged in real time between a source and a user (on-demand video) or between two users. Resource consumption depends on the number of users. Given the required throughput per video program, oversizing the network may not be an adequate response. A network offering guaranteed QoS may prove to be the only option for this type of traffic.

Fault management relies on devices that enable a reconfiguration of the network following a fault in a node or link, and the reconfiguration of a node following a fault in the data processing board of the control plane.

The main parameter associated with the reconfiguration of the network is the convergence time. This is relatively long for IP and Ethernet networks. Depending on network size, it can reach several tens of seconds. These values may be sufficient for businesses that deploy LANs. In contrast, operators that deploy WANs require substantially quicker times and seek values less than one second or even one tenth of a second.

The reconfiguration of the node, upon its detection by adjacent nodes, will cause a first reconfiguration of the network when the processor board is faulty, and a second reconfiguration of the network once switching to the standby board has taken place. The purpose of Graceful Restart-type mechanisms is to avoid this double switching.

Consequently, this book is structured in 10 chapters; the main topics discussed therein are summarized in the following table.

Chapter	**Designation**	**Description**
1	Network Operation	IP, MPLS, Ethernet technologies
2	Characterizing Quality of Service	Operation quality parameters, requirements of applications, the service contract
3	Transport Protocols	The TCP, UDP, RTP, DCCP, and SCTP protocols
4	Implementing Operation Quality	Mechanisms associated with the user plane
5	IP Technology – Resource Management	Relative QoS: the *DiffServ* model; Guaranteed QoS: the *IntServ* model and the RSVP protocol
6	IP Technology – Fault Management	Network reconfiguration: LAN-side HSRP and VRRP protocols, WAN-side OSPF and BGP routing protocols. Node reconfiguration: the *Graceful Restart* mechanism
7	MPLS Technology – Resource Management	Relative QoS: *DiffServ* support; Guaranteed QoS: traffic engineering and the RSVP-TE and OSPF-TE protocols
8	MPLS Technology – Fault Management	Node reconfiguration: the *Graceful Restart* mechanism and the LDP and RSVP-TE protocols. Network reconfiguration: the FRR mechanism
9	Ethernet Technology – Resource Management	Relative QoS: frame tagging; the PON access network. Guaranteed QoS: the SBM protocol
10	Ethernet Technology – Fault Management	Network configuration: the STP, RSTP, and MSTP protocols; linear protection. Link reconfiguration: the LACP protocol