

**NETWORK RECOVERY, PROTECTION AND RESTORATION OF OPTICAL, SONET-SDH, IP, AND MPLS**

**JEAN-PHILIPPE VASSEUR, MARIO PICKAVET, PIET DEMEESTER, MORGAN KAUFMANN PUBLISHERS (ELSEVIER), 2004, ISBN 0-12-715051-X, HARDCOVER, 521 PAGES**

**REVIEWER: PIOTR CHOLDA**

If one desires to learn as extensive and still evolving a field as network recovery, he or she will be interested in a book prepared by authors related to two somewhat separate worlds: industry and academia. Such a shared authorship allows the most novel and detailed issues to be presented in a very clear and understandable manner. One of the authors of the book brings experience from one of the most distinguished facility vendors, and two are affiliated with one of the European universities with the greatest expertise in the domain. This combination of knowledge gives an excellent overview of hot topics related to communications network resilience.

Chapter 1 looks at the general issues related to recovery methods. Basic concepts, network layers, and planes are briefly discussed, and availability in the communications context is introduced. Then causes and typical modes of failures affecting communication networks are characterized. Operator-client problems related to recovery are described. Afterward, a general recovery/reversion cycle and criteria for assessment of recovery mechanisms are given. Then the general differentiation, based mainly on capacity sharing, the recovery path setup method, recovery scope, control fashion, and layers, is outlined.

All chapters that follow are more detailed. Chapter 2 allows learning about the problems related to recovery in synchronous digital hierarchy (SDH) networks. After the introduction of the notion of a transmission network and its modeling, the structure of a SDH/synchronous optical network (SONET) network is given. The layering, frame structures, and network elements are discussed. Operational aspects of SDH recovery are studied very thoroughly. Later, an in-depth section devoted to ring and inter-ring protection is presented. Afterward, linear protection and restoration is reviewed. The chapter ends with a case study that presents a cost comparison of different ring schemes.

The third chapter focuses on per-

spectives of recovery in future optical networks. After introducing wavelength-division multiplexing (WDM), comprehensive information on optical transport networks (OTNs) is given. Subsequently, the reader is provided with a part concerning fault detection and propagation. The mechanisms and related optical data/transport/signal overheads are considered. In further sections resilience procedures for optical networks are characterized. Some of them are similar to the methods applied in SDH/SONET networks, so the discussion is mainly focused on the differences and specific aspects of OTNs.

The distinction between optical channel and optical multiplex section-based recovery is emphasized. The consequent part covers more efficient mechanisms that can be used in mesh networks. There are also case studies that show the difference between recovery in networks with and without wavelength conversion, as well as between various scopes and types of recovery. There is a section concerning the availability analysis for protected connections and restored traffic. A case study based on such an analysis shows mainly the relation between path and ring protection. At the end, two new and efficient recovery techniques are mentioned: p-cycles and meta-mesh recovery.

Internet Protocol (IP) is a technique developed to ensure substantial resilience to failures. Chapter 4 describes how it is performed. After explaining basic issues concerning routing protocols, the authors present the IP routing recovery cycle. They focus on specific questions like failure detection and characterization, dampening algorithms, and other link state advertisement mechanisms, and route computation. Then more detailed issues are presented: a temporary loop creation, equal cost multiple paths routing, solutions for QoS assurance, and the grateful restart mechanism. The problems are additionally explained in a case study. Then some supplementary questions related to IP are described: an algorithm's complexity, and the incremental shortest path first (iSPF) algorithm.

The subsequent chapter concentrates on the recovery mechanisms included in the multiprotocol label switching (MPLS) traffic engineering (TE) framework. After a short introduction of the general aspects of TE and some basic issues related to MPLS recovery, the longest chapter of the whole book follows. The authors con-

centrate on three recovery schemes: global restoration, path protection, and local protection (fast rerouting). The largest part of the chapter is devoted to issues related to the last scheme. The recovery cycle and general notions are dealt with. Global and local protection is compared from the viewpoint of recovery time, scalability, and bandwidth sharing. Afterward, the problem of link and node failure differentiation is studied. The chapter is provided with three case studies that enable understanding detailed issues related to the design of MPLS TE recovery. The last part of the chapter considers some particular questions related to fast reroute: Resource Reservation Protocol (RSVP) extensions and backup path computation conditions.

There is a common agreement that future networks will be formed as multilayer networks. The last chapter discusses recovery in such networks. First, automatically switched optical/transport network (ASON/ASTN) and generalized MPLS (GMPLS) fundamentals are characterized, and the concepts of the common control plane as well as three models of its interoperation between different layers are introduced. Then three general models of the recovery in multilayer networks are investigated: single-layer recovery and static multilayer schemes, and dynamic multilayer methods. In every case pros and cons as well as general issues are studied. The problem of supporting resources reserved for three models of multilayer recovery is also covered. Three case studies are presented here as well. Unlike in previous chapters, they deal with different technologies (e.g., optical restoration and MPLS TE fast reroute) without giving examples of networks with special requirements.

The advantage of this book is related to the fact that each chapter can be read separately, since the authors briefly repeat the most important ideas as necessary. The other benefit is that the current state of the development level of some techniques is signaled. To sum up, the book gives the reader a deep insight into "how it works." However, it does not imply that the issues described are uncomplicated. Some of them are simple indeed, and it makes the book very useful for people who are new in the field, but some of the covered topics are very advanced. Thanks to this fact, the book can be recommended to everybody interested in network recovery, from layperson to experienced designer who would like to learn about the latest solutions.