Part II

Introduction (Part II)

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When COST action 291 started in 2004, communication networks started to employ wavelength division multiplexing (WDM) to interconnect discrete network locations and provided thus high transmission capacities. Nevertheless, it was foreseeable that the application of conventional networking technologies for high capacity networks will not be the most cost efficient solution. This was mainly driven by the dramatic growth of required transmission and switching capacity as well as the agility of the network to react rapidly on changes in the traffic patterns.

In the background of this, the two working groups WG 2 and WG 3 focused on *novel network architectures* and a *unified control plane, network resilience and service security*, respectively. WG 2 focused on the evolution of network scenarios including the study of novel network architectures. It also studied different node architectures and technologies in terms of network performance and functionality. WG 3 addressed network survivability and security issues in such networks, covering topics such as protection and restoration, its impact on routing and wavelength assignment algorithms, fault isolation, disaster recovery, etc.

Both working groups focused their studies on three network architectures, i.e., wavelength routed networks, optical burst switching and optical packet switching.

In the first architecture, end-to-end lightpaths are provisioned depending on the chosen protection scheme and QoS requirements such that overall performance metrics are fulfilled. Also multi-layer scenarios have been considered where customer connections are provisioned on an electrical layer. The second and third architecture rely on the packet switching principle and thus can efficiently support applications with highly bursty traffic. End-to-end QoS schemes, contention resolution and scheduling schemes determine the overall network performance and network scalability in terms of throughput and cost efficiency.

This part summarizes the work of the two working groups. It introduces the issues that have been studied, presents the most important results in detail and gives hints for further reading. The remainder is structured as follows:

Chapter 6 is devoted to transparent wavelength routed networks based on DWDM. In such networks, the signal propagates through the network without O/E conversion and is distorted. To overcome this signal degradation different approaches have been investigated in the past, e.g. based on regenerators. In this chapter, a novel approach is investigated. The authors extend the routing and wavelength assignment process (RWA) such that it takes the distortions into consideration. They present a dynamic network planning tool residing in the core network nodes that incorporates real-time assessments of optical layer performance into impairment aware RWA algorithms. Furthermore, they show the integration into a unified control plane.

In Chapter 7, most important aspects of optical burst switching (OBS) and optical packet switching (OPS) are presented which have been investigated and discussed in COST Action 291. These all-optical network architectures rely on the packet switching principle and only convert the signal at the network edge from/to the electrical domain. While OPS is more advanced to be realized due to its technological requirements, OBS seems to be a compromise.

Beyond a general introduction into the different flavors of OBS and OPS, the chapter presents work on burstification algorithms, QoS provisioning and routing. Furthermore, cross-layer issues are tackled, i.e. the impact of routing and scheduling in the optical layer on the overall system performance including higher layer protocols.

Multi-layer Traffic Engineering is addressed in Chapter 8. Multi-layer networks are a very attractive solution to cope with the increasing dynamics and capacities in today's core networks. In such electro/optical multi-layer networks, client layer connections are groomed to wavelength channels and transported using end-to-end lightpaths. Also, intermediate grooming can yield to a more efficient utilization of network resources. In contrast to many other IP-over-WDM network architectures, a clear and efficient evolutionary path exists to upgrade today's networks.

This chapter presents different aspects of Multi-layer Traffic Engineering that have been investigated in COST action 291. These range from integrated routing schemes to mechanisms that improve the overall performance and increase the fairness among different users. Also, the impact of fundamental traffic and network characteristics on the performance are reviewed.

Chapter 9 is dedicated to network resilience in future optical networks. This topic is of deep concern to network operators due to on the one hand the significant loss of revenue in case of network failures, on the other hand the significant capital expenditures required for legacy resilience concepts. The chapter introduces a common terminology and resilience techniques. Based on this, the authors discuss network reliability from different perspectives ranging from models for calculation of availability and recovery times to concepts for differentiated resilience. Furthermore, security against malicious signals induced by attackers or component faults is discussed. Finally, the authors extend the scope to multi-layer networks and present approaches for recovery in IP-over-OTN networks.

An application of optical networks is investigated in Chapter 10. Storage area networks (SANs) are a promising technology to efficiently manage the ever-increasing amount of business data. The authors study unidirectional WDM ring networks operated in a slotted mode with one or more cross section links and investigate them with respect to traffic models, scheduling aspects or the MAC protocol.