

Chapter 10

Conclusions and future works

This work has been focused on the optical packet switching paradigm, a long-term and more flexible alternative to the circuit-switched optical network currently being deployed by operators to support the extraordinary data traffic growth in the public domain. This innovative paradigm aims at optimizing the utilization of the WDM channels by means of fast and highly dynamic resource allocation based on a statistical multiplexing scheme, overcoming the typical inefficiency of the circuit transfer modes.

One of the open problem in such an environment is providing QoS schemes able to cope with the QoS requirements of the client networks. In this context, the dissertation specifically addresses such a problem using OPS technique for both wide area and metropolitan environments.

For the metropolitan environment and according to what developed in the electrical metro network, we have identified that 3 different classes of service must be supported, namely guaranteed service, priority service and best effort (like in standardized electrical metropolitan networks such as FDDI). Two network architectures based on composite topologies have been considered, namely the multi-PON and multi-ring networks. Both networks have been proposed within the European Project IST DAVID. Our contributions on this topic have concentrated into three different tasks per each network architecture:

1. extensive performance evaluation to identify the weakness of the architecture and the MAC protocol;
2. propose optimized mechanism to improve the performance;
3. design a mechanism to provide the missing service; the priority service for the multi-PON network and the guaranteed service for the multi-ring network.

Simulation results have demonstrated the effectiveness of the proposed mechanisms for both networks.

For the multi-PON architecture, the performance results have been obtained using a real scale simulator including self-similar traffic model and different traffic patterns between interconnected PONs. Two main weaknesses have been identified and

overtaken by optimized mechanisms. The validity of the proposals have been demonstrated, in fact both throughput and maximum end-to-end delay measures achieve better results than the original proposal. A QoS strategy for two classes of traffic has been also suggested. A good class differentiation has been achieved in a very robust way, which must be credited to the QoS strategy. In every scenario studied in this work, the achieved throughput for HQ traffic perfectly matches its relative load percentage, at expense of the BE traffic. Nonetheless, the overall throughput is always close to 95%.

For the multi-ring architecture, two main drawbacks have been identified and improved by optimized mechanisms. The first one regarding the exploitation of the spatial reuse capability while the second one ability of overtaking congestion situations. The validity of the proposals have been demonstrated by numerical results. Finally we discussed the problem of allocating resources to provide guaranteed and best-effort services in different configurations of the DAVID metro network. If the Hub performs ring-to-ring permutations, the Hybrid solution is preferable when the GS traffic is less than 50% of total resources. Whilst TD and FD solutions can be adopted when the bandwidth on network links is not a bottleneck. If the Hub performs wavelength-to-wavelength permutations, better guarantees can be offered to both best-effort and guaranteed services at the expense of increasing notably the complexity of the scheduling algorithm.

For the wide area environment, we have considered a connection-oriented OPS network. In such a scenario, we have identified two different problems: the first one regarding the set up of the OVCs (OVC-to-wavelength setup assignment problem) and the second one the packet contention under QoS requirements.

For the former problem, original policies have been proposed. Results have been demonstrated that considerable switch performance improvements can be obtained by grouping the conflict-free flows (i.e., flows coming from the same input wavelength). For example, in the scenario studied in this paper, the GRP algorithm yields a PLR one order of magnitude lower than balancing the OVC load when the switch is lightly loaded. This concept has been efficiently inferred to provide quality differentiation between two type of OVCs.

For the latter problem, the novel SCASS (service category-to-algorithm switching selection) technique has been designed to provide QoS. In this paper we have defined a system with three different OPS service categories based on three different contention resolution algorithms. An ad-hoc buffer architecture has been designed to coordinate and optimize the behavior of the system. The obtained results highlight its goodness compared to other approaches (i.e., the EQWS and MINGAP algorithms using buffer threshold technique). For example in the studied scenario, the loss-sensitive service achieves 7.6810^{-6} packet loss rate with a forwarding opacity (estimation of the complexity) of 5.93% which are better results than those obtained with MINGAP: 9.7410^{-4} and 81.05%, respectively.

The results obtained in this dissertation provide good inputs for further investigations. On the metro side, composite topologies proves that they are very suitable for coping with very large amount and heterogenous traffic. Nonetheless, recovery mechanisms to provide survivability issues are more complex. In both architecture

studied in this thesis, the Hub results a critical point. Duplication of the Hub may result in a excessive and costly solution and therefore coordination strategies must be developed.

The same issue is also valid on the wide area side. Despite of its importance, very few (no) works have been focused on the survivability in OPS networks. In this context, the study of routing problems in a global optical network scenario is of prime importance.

From the experience obtained in this thesis we started to focus on the Optical Burst Switching paradigm which is currently one of the more interesting technology. Indeed it is characterized by a separation of data and control channels as well as a prior transmission of control information, before sending the data (formed in longer burst units), to support intermediate nodes reconfiguration which are well compatible with the current investigations on the control plane aspects.

