BONE Major Achievments

WP11 : VCE on Network Technologies and Engineering.

WP Leader: Franco Callegati (UNIBO)

WP Objectives

Exploit the long and successful history of European research on metro and core optical networks, to create a VCE where the existing expertise supports a fully integrated view of the problems of optical networks design.

The technical goals are to propose integrated traffic engineering procedures, seamless QoS all over the network, multi-layer protection and fault management and thus meet the foreseeable future demand of users and operators.

Status at start of the BONE-project

The status of this area already presented a good level integration between some sub-groups of partners thanks to the participation in the e-Photon/ONe and e-Photon/One+ projects.

Nonetheless research on access and transport network technologies were carried on separately and very little integration existed with the drawback of replication of activities and lack of focus on end-to-end network issues.

Major progress during BONE-project

The main R&D effort was devoted to identify and run the Joint research activities (JAs). Results of the JAs are indeed a measure of the progress made during BONE.

JAs dealt with OBS and OPS, rather mature research topics, and provided extensive overview and wrap of existing results, with reference to routing strategies, admission control, and benchmarking and cost/performance trade-offs of the different switching technologies.

An outcome is that, when comparison is made on similar network conditions and by defining a proper revenue function, OBS does not seem to provide any real advantage over OCS, outlining an evolution scenario in favour of OCS and, in a longer time frame, of OPS.

JAs devoted to protection and restoration tackled problems arising in real implementation related to the impact of delayed control information on the network and to specific topologies such as Double Ring with Dual Attachment (DRDA).

In the area of network planning and traffic engineering new emerging techniques were proposed and investigated. For instance Flow-Aware Networking (FAN) was applied to solve the IP over WDM traffic engineering problem and a novel optical network planning approach was proposed that takes into account device faults and physical-layer attacks during the Routing and Wavelength Assignment phase. A fault/attack prevention tool that reduces attack consequences without the need for expensive specialized equipment was developed.

Topology optimization was investigated in WDM optical MANs with ring topology, single tunable transmitter and multiple fixed-wavelength receivers, showing improvements in channel sharing capability and cost reduction with respect to existing ring architectures.

Moreover a novel adaptive AC scheme for all-optical packet-based GMPLS networks was proposed, where an ingress node is in charge of establishing new LSPs between edge nodes while trying to maximize the throughput and meet specific QoS requirements.

Last but not least an extensive experimental demonstration of techniques for core and metro networks was jointly carried on in the VCE. The experimental activities focused on how Carrier Ethernet technologies will determine the migration of network routing functionalities from layer 3 to layer 2. Experimental activities were implemented, to test transport solutions based on Carrier Ethernet VPLS proving that it offers:

- QoS control in access networks with a limited bandwidth (e.g. in xDSL, in PON networks etc.);
- compatibility with novel optical technologies such as all optical wavelength conversion;
- integration with MPLS restoration and protection thanks to Fast Reroute and Standby Secondary allowing restoration times under 50 ms;
- suitability to long links given WDM GbE transmissions was demonstrated on legs up to 350 km by using all optical amplifiers.

Added value of the BONE NoE

The main added value of the BONE NoE can be found in the fostering of the Joint Research Activities (JAs), which are key to "integration" and the main driver to improve quality and quantity of research. By working together in the JAs the BONE researchers strengthened the mutual knowledge and also were motivated to share know how and delegate problem to others.

The JAs were driver of most of the quantitative results of the VCE which published 62 joint papers co-authored by researchers from 30 partner institutions, with an average of 5.4 authors per paper, and sponsored 26 mobility actions for a total of 979 days with an average of 37 days per action.

The VCE also promoted several dissemination and teaching activities, the most significant of which is the publication of the book "Enabling Optical Internet with Advanced Network Technologies", edited by J. Aracil and F. Callegati, that was the joint effort of 32 researchers belonging to 15 partner institutions.