BONE Major Achievments

WP25 : Optical Interconnects

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WP Objectives

The purpose of WP25 Topical Project “Optical Interconnects” has been to study the optical implementation of the interconnection subsystems inside a high-performance switching/routing system. Electrical wiring between the modules of high-capacity switches sets severe bounds to their performance. In this scenario photonics appears to be a promising and effective solution.The main target of the WP has been to develop the capability to design and optimize an optical backplane in high-performance switching nodes, finding the technology and architecture best-fitting system requirements.

WP25 was started on the second year of the BONE project and lasted until the end of BONE, with a total 2 year of activity.

Status at start of the BONE-project

The application of optical interconnections within electronic is still today a rather new and relatively unexplored research field. Bringing photonics “inside-the-box” can have a relevant impact on interconnection topologies and architectures (the so called “backplane”) of switching-nodes subsystems. In this framework a specific research activity dedicated to optical-interconnection architectures for switching nodes appeared well motivated and strategic at the start of the BONE-project 4 years ago, and to the best of our knowledge, it would be the same also at the present time.

Major progress during BONE-project

This project studies the optical implementation of the interconnection systems “inside the box” at different levels of interconnection, mainly focusing on the board-to-board (linecard-to-linecard) connections and the on-chip networking.

About eleven partners have actively collaborated to this workpackage. The detailed description of the results obtained in the eight Joint Activities (JAs) set up by the involved partners are reported in the two technical Deliverables D25.2 and D25.3, beside several publications.

The target of developing the capability to design and optimize an optical backplane has been achieved by the involved BONE partners, and it has implied two main steps.

The first step, carried out in the first three JAs of WP25 (Task 1, active in the first year of the WP) was aimed at exploring literature in order to list and classify technologies and architectures proposed so far for optical interconnections “inside the box”. This work also analyzed the framework of requirements to optical interconnection systems when used to implement the backbone of high-performance network-switching nodes and investigated the potential advantages (energy efficiency, high bandwidth, immunity to electro-magnetic interference, etc.) of optical interconnection over traditional electrical wiring.

This preliminary task, leading per-se to interesting results (that will be proposed for publication in ample survey papers, still under preparation) was completed by two further steps, oriented to challenge the designer to exploit also optical-signal switching capability seeking for new, more efficient and reliable backplane architectures.

The second step was carried out by a set of JAs, active during the whole duration of WP25, each one dedicated to a specific aspect of optical interconnection:

- In JA5 (“Performance and complexity analysis of optical switching fabrics”), investigation on different complementary aspects of performance and complexity has been carried out in parallel: (a) on optical packet switching architectures with shared wavelength converters; (b) on micro-ring-resonator structures (tree-topology demultiplexers, bus based structures); (c) on OBS-OCS networks.
- In JA6 (“Optical backplanes utilizing microring resonators”) research activity was mainly dedicated to modeling the resonators as switching devices and to proposing microring-based optical-backplane architectures.
- In JA7 (“Hardware efficient optoelectronic switch fabric”), significant results (including experimental prototyping) have been obtained on the implementation of the control algorithms for monolithic

optoelectronic interconnection networks and on lossless monolithic 16x16 QW semiconductor optical amplifier switching architectures.

- JA8 (“On-chip” networking) was dedicated to the investigation of optical interconnection implemented on silicon chips mainly for multi-core chip; originally conceived as independent JA (leading to a survey on On-chip optical architectures at the end of the first year), JA8 was later integrated in JA6 and JA7.

The final step of WP25 has been achieved by JA4 (“The "BONE switch": a reference architecture for the optical backplane”). The task of this JA was to make a synthesis of the knowledge acquired by the other JAs (and in particular JA1 to JA3) in order to define a possible reference model which would represent the “ideal” application scenario for an optical backplane. The JA, after further analyzing the requirements of optical switching fabrics inside electronic switches, proposed an asynchronous AWG-based architecture as a possible implementation of the “BONE switch”.

Added value of the BONE NoE

The main value added by BONE WP25 to European research in the area of Optical Interconnection was the creation of a pool of European Institutions sharing knowledge and expertise on this new field. This was according to the primary mission of BONE and to the objective of the WP (reported above). This achievement is partially testified by the dissemination activity carried out during the WP duration (11 joint and 26 single papers), which was rather limited by the relatively unfavourable and brief timing of the WP (only two years, starting from the second BONE year). Actually, many more (especially joint) papers (including three long surveys) are still in course of preparation and will be submitted after the end of BONE. However, publication activity is not the only outcome: perhaps more important have been the numerous mobility actions (7, with only 11 partners) that strengthened the links between the partners and will most probably lead to future extensions of collaboration. In particular, these mobility actions were fundamental to develop the collaborative experimental activity in JA7 and the entire design and analysis activity in JA4, plus other research and academic joint initiatives (such as PhD programmes).