



BONE Major Achievements

WP13 Virtual Centre of Excellence in Access

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WP Objectives

The Virtual Centre of Excellence on Access aims to provide a forum for exchange and consolidation of the latest research and development on access systems that use optics to provide true-broadband connections to fixed and mobile users. This encompasses a wide range of technologies including TDM-PONs, WDM-PONs, Radio-over-Fibre, Free-Space-Optics or xDSL-over-fibre. These technologies are all being developed and are competing in diverse scenarios. Of specific interest is the convergence of these technologies and the potential for hybrid solutions as well as the techno-economics that drive the innovative solutions being researched in these areas. Due to the range of expertise available within the VCE we believe that we are well placed to offer leadership in this important technological area.

Status at start of the BONE-project

The development of optical access was still in its infancy and despite years of research, deployments were still limited. At the start of the project (Dec 2007) there were 1 Million FTTH subscribers in Europe (80% in just 4 countries), today it is near 4.5 Million with over 26 million home passed. Over the course of the project the field of optical access has expanded significantly with both deployments and research activity growing. Within BONE the strength of the grouping and the expertise amassed has enabled participants to take advantage of the new industrial research and test-bed opportunities that have been presented.

Major progress during BONE-project

As a large number of candidate network architectures and design options for constructing access networks exist, evaluation methods are needed in order to determine the most appropriate ones for different area types and service demand profiles. An accurate construction of a techno-economic model allows to minimize errors in the network development phase and to calculate intermediate results, allowing an evolutionary development of the network solution.

Such a methodology for performing a complete techno-economic evaluation has been developed based on comparisons of costs vs. performance. Moreover, proper network design also reflects suitability of a certain network infrastructure to the considered scenario, and therefore it supports the optimal choice among the competing technologies. Several models have been developed to estimate the deployment cost of FTTH network, however, these models suffer from the inaccuracy problem, particularly when applied to the area with uneven population of users since they consider only the average values. To address this problem, a geographic approach to design the FTTH outside plant infrastructure has been proposed based on the real and detailed geospatial data in order to accurately estimate the deployment cost.

The first experimental demonstration of AWG cognition using SMF-tailed C-band VCSELs based on commercially available components was demonstrated. The proposed method can be readily extended to hybrid networks to assess radio channel performance, which can be advantageously for last-mile service provision.

Although Wavelength-Division Multiplexing (WDM)-PON is considered by most carriers and service providers as the natural evolution of existing current Fiber To The Home (FTTH) systems, we have demonstrated that OCDMA is a valid alternative for next generation access networks (NGAN) that can outperform WDM-based systems with respect to data confidentiality, bandwidth efficiency, while also simplifying the migration from existing PONs. Accurate comparisons between these two technologies, demonstrating their capabilities but also their limits and integration difficulties have been shown. In particular joint activities have shown the suitability of using real trigonometric transforms based processing for access networks and have investigated the use of OFDM schemes in PON networks, specifically, an optical OFDM system based on Hartley transform has been studied and designed to reduce the cost and the complexity of the OFDM transceivers.

An important aspect to Radio over Fibre research is the understanding of the performance of in-building multi-mode fibre (MMF) infrastructure, The temperature influence on the behaviour characteristics was investigated in a collaboration between 4 partners. In particular, the radio frequency (RF) transfer function of a MMF link based on the electric field propagation method has undertaken in order to evaluate the conditions upon which broadband transmission is possible in RF regions far from baseband. An IEEE 802.16-2005 compliant PON



architecture with wavelength band overlay is implemented experimentally to demonstrate distributed broadband wireless (DBW) access network following next generation PON requirements.

In an important aspect to RoF research, which is the understanding of the performance of within-building multi-mode fibre (MMF) infrastructure, UC3M has tested different MMFs to test the possibility of deployment of RoF based on legacy MMF links. In this regard, the temperature influence on the behaviour characteristics was investigated in a joint action with UC3M, FPM, UDE, and UPVLC. In particular, the radio frequency (RF) transfer function of a MMF link based on the electric field propagation method has been analyzed, in order to evaluate the conditions upon which broadband transmission is possible in RF regions far from baseband. Special attention to source parameter influence has also been analysed and experimentally tested. Novel monitoring techniques for access networks have also been analysed. BONE partners have demonstrated techniques to the management of Quality of Service (QoS) in radio-over-fibre networks including FTTx-WIMAX-LTE (Long Term Evolution) networks.

A collaboration between a University and an Industry partner has proposed techniques to combat Rayleigh Backscattering in Reflective Semi-conductor Optical Amplifier (RSOA) based ONUs through wavelength shifting by applying a special electrical signal to this device. A second technique was proposed to increase the transmission capacity of a RSOA based ONU.

Added value of the BONE NoE

Using a BONE mobility action we were able to bring a researcher to collaborate for 6 months providing the foundation for an EU project proposal. A French national project (ECOFRAME) was funded on optical packet rings thanks work resulting from BONE collaborations.

Through BONE UPC were able to have a close collaboration with T.U.Wien and perform a deep benchmark study on power efficiency of FTTH ngPON architectures, as compared with SARDANA (TUW is not a partner) resulting in 3 publications; including a best paper award.

In Spanish National Projects TEC2006-13273-C03 03 and TEC2009-14718-C03-03, funded by Spanish Ministry of Science, there was an active collaboration and support from Telecom Bretagne and in last one from Ericsson, funded by BONE

Relationships through BONE have helped to understand different ways to evaluate PhD education in different European countries aligned with objectives supported by Council for Doctoral Education of European Universities Association (CDE-EUA).

The experiences of FUB in the field of the access networks carried out in the framework of BONE projects have been fundamental for the FUB activities in the Italian Project VATE (Valutazione Tecnico Economica di reti NGN) supported by the Ministero dello Sviluppo Economica. BONE funding helped a PhD student to work as a research intern at Nokia Research, exploring the topic of using transport layer multi-path routing with multi-path TCP for energy efficient data scheduling on mobile devices.