Increased use of multimedia content, hi-def digital TV and broadband is driving demand for more advanced fibre optics, e.g. multi-mode fibres for home and office use. **Isabelle Bucaille** reveals UROOF project's work in developing technology to enable 'range extension applications' for fibre optics

Ultra wideband will deliver broad benefits

The field of short-range communications has advanced dramatically over recent years, and the pace of development shows no sign of slowing. Novel technologies emerge on a seemingly continual basis and bring real benefits to users. It is in this context that the EC-funded UROOF (Ultra-Wideband Radio Over Optical Fibre) Project, an initiative encompassing nine partners from both industry and academia, must be viewed. UROOF is investigating photonic components and building blocks so as to enable the delivery of the UWB radio signal in the 3.1 – 10GHz range over low-cost optical fibre, something that we believe is very much in the long-term interests of both European research and European business.

Communications is an area crucial to modern commerce, and thus no company can afford to be left behind in the race to adopt the most advanced technologies and latest solutions. As such the UROOF project has developed a set of objectives very much in line with the pressing nature of the issue. The goal is to study, develop, test and implement very low cost solutions for direct optical-to-UWB (OUWB) and UWB-to-optical (UWBO) routing based on microwave photonic concepts. However, unlike state of the art radio-over-fibre (RoF) technologies that are used in the backbone of wireless access systems, UROOF will instead address the challenges of the low-cost wireless personal area networks (WPAN). This approach demonstrates that, while keen to develop innovative new technologies that respond to well-defined needs, UROOF is nevertheless well aware of the business bottom line.

Looking below the surface

There are a range of possible approaches to transmitting RoF over short-length optical fibres. However, the most cost-effective approach is using multimode fibre along with a vertical cavity surface emitting laser (VCSEL) connected to a photo detector – and it is this approach which the project has focused on. This is an extremely technically demanding task, and thus UROOF has been investigating how best to implement the approach outlined above. The methods that have been looked at so far include developing proof of concepts for O/UWB based on heterojunction phototransistors (HPT); optically controlled microwave converters (OCMC) and the use of a commercial PIN diode. The device that enables the bi-directional operation based on the integration of UWBO and OUWB is referred to as an 'Integrated UROOF Transceiver' (IUT), while the integration of other elements with the IUT is achieved through the UROOF access node (AN).

The first approach that we looked at in terms of achieving our overall goals was IUT based on VCSEL, an architecture that is well suited to UROOF range extension applications.

Meanwhile, we also paid close attention to an approach based on enhancing electro-absorption transceivers for UROOF applications, as linking multiple pico-cell access points together by a shared single-mode-fibre (SMF) is possible if either passive optical network (PON) or wavelength division multiplexing passive optical network (WDM/PON) architecture is used. However, if single-mode components are to be considered for a UROOF application then it is necessary to devise methods that significantly reduce the cost of assembly. The use of the enhanced EAT (E-EAT) structure can help in this regard, in large part because it is essentially a bi-directional device and, when operating in reflective mode, it requires only a single fibre termination.

This work has been enormously important in preparing the ground for the pursuance of the project's objectives and in ensuring its overall rigour. Once the initial foundations had been put in place the project was able to focus on detailed theoretical and practical analysis – in particular, the work on UROOF photonic components and devices to be used components must meet if they are to operate properly in every conceivable scenario. Not only that, but the project has also been able to define the engineering rules (fibre link distances, power levels, signal-to-noise ratios, etc.) for the complete UROOF system so as to guarantee its proper operability after deployment.

Meanwhile, several multiple-access (MA) architectures have also been proposed as part of the project's work. These architectures are all capable of bidirectional communication and are well suited to the identified scenarios. The power budget and carrier-to-noise degradation have been derived for several architectures, including Star, Ring, Star/Bus and Bus MA. The best balanced architecture (ie: the best trade-off between performance and deployment cost) has been identified as being the Bus architecture when it is implemented with two fibres – one for each propagation direction.

Unlike state of the art radio-over-fibre (RoF) technologies that are used in the backbone of wireless access systems, UROOF will instead address the challenges of the low-cost wireless personal area networks (WPAN)

over UROOF channels. To illustrate, the prototype of E-EAT has been built; models and experiments with OCMC have been undertaken, and research and development for SiGe HPT aimed at establishing it as a basic building block for the O/UWB converter has been carried out. An environment has been created to validate UROOF concepts and the first version of the UROOF validating platform has been built ready for further work to be carried out.

UROOF results

In addition to the extensive work outlined above, the project has also studied a number of other areas and generated some interesting results. UROOF's work on the target scenarios and suitable architectures has involved looking at the issues from both a business and technical perspective, thereby allowing us to gain a clearer picture of the commercial potential of UROOF devices. The results that have been obtained so far cover a number of areas, including the definition of the network topologies and functional requirements of UROOF technology in every identified scenario and also work on formulating the detailed specifications that UROOF

Such an approach demonstrates UROOF's commitment to exploring every possible avenue in the ongoing search for improved technologies, further reinforced by the projects functional requirement document (FRD), which covers the specifications and requirements for UROOF devices and UROOF-based systems. These calculations are largely based on their expected application scenarios in terms of linearity and the dispersion of UWB-over-fibre transmission. Meanwhile, a methodology for selecting the most suitable UWB technology – with a special emphasis on those aspects related to O/UWB and UWB/O conversion – has also been developed. Selection criteria include performance, frequency, bandwidth, transmission aspects, cost, robustness, scalability, dynamic range and network topology. Several UWB technologies have been investigated (including MB-OFDM, DS-UWB and IR-UWB) and it has been found that MB-OFDM has the qualities that will make it particularly attractive to the commercial sector. These are qualities which the UROOF played a key role in developing, and which we are determined to continue building upon. ★

At a glance

Full Project Title

Photonic components for Ultra-Wideband radio over optical fibre
Proposal acronym (UROOF)

Project Partners

Holon Institute of Technology (Israel), Wisair (Israel), Thales Communications (France), TES Electronic solutions GmbH (Germany), University of Essex (UK), Universidad Politecnica de Valencia (Spain), INESC Porto (Portugal), Centre for Integrated Photonics (UK), INPG (France).

Contact

Dr. Moshe Ran(Project Manager)
UROOF Project Manager &
A.Y.Y.T Director
H.I.T - Holon Institute of Technology
52 Golomb st. P.O.B 305 Holon,
58102, Israel
e-mail: mran@hit.ac.il
Tel: +972 3 5026687
Fax: +972 3 5026685

Isabelle Bucaille

WPL of Dissemination and Exploitation

Isabelle Bucaille received the engineering degree from ISEP (Institut Supérieur d'Electronique de Paris) in France in 1994. Then she joined the CNI Division of TH-CSF for digital processing studies and MAC simulations for wired and wireless LAN systems. She participated in 1997 to the ETSI group in charge of HiperLAN2 normalisation. In 1998 she was in charge of system definition concerning Stratospheric Platforms (HAPS). Since September 2001 she is in the Secured Wireless Products Activity of THALES Communications, in charge of sensor networks using new air interface technologies and in particular UWB technology. She participates to European projects dealing with UWB (PULSERS II, EUWB, UROOF) and participates to ETSI TG31C standardisatoin group for UWB in sensor networks applications.