Northumbria Research Link

Citation: Beltran, Marta, Morant, Maria, Perez Soler, Joaquin and Llorente, Roberto (2008) UWB wireless coexistence by fibre-based photonic ADC interference monitoring. In: 6th ISIS Workshop on Wireless Communications and their interaction, 2-3 June 2008, Stockholm.

URL:

This version was downloaded from Northumbria Research Link: https://nrl.northumbria.ac.uk/id/eprint/1988/

Northumbria University has developed Northumbria Research Link (NRL) to enable users to access the University's research output. Copyright © and moral rights for items on NRL are retained by the individual author(s) and/or other copyright owners. Single copies of full items can be reproduced, displayed or performed, and given to third parties in any format or medium for personal research or study, educational, or not-for-profit purposes without prior permission or charge, provided the authors, title and full bibliographic details are given, as well as a hyperlink and/or URL to the original metadata page. The content must not be changed in any way. Full items must not be sold commercially in any format or medium without formal permission of the copyright holder. The full policy is available online: http://nrl.northumbria.ac.uk/policies.html

This document may differ from the final, published version of the research and has been made available online in accordance with publisher policies. To read and/or cite from the published version of the research, please visit the publisher's website (a subscription may be required.)

Northumbria University NEWCASTLE

University Library

UWB wireless coexistence by fibre-based photonic ADC interference monitoring

Marta Beltran, Maria Morant, Joaquin Perez, and Roberto Llorente

Nanophotonics Technology Center, Universidad Politecnica de Valencia,
C/ Camino de Vera, s/n; Valencia, 46022, Spain
Phone: +34 963879768, Fax: +34 963877827, Email: {marbelra, mmorant, joapeso, rllorent}@ntc.upv.es

Abstract –The interference monitoring of UWB wireless picocell clusters through an in-house fibre installation is proposed and evaluated in a proof-of-concept experiment. UWB clusters enable range extension of UWB technology providing Gbit/s communications in home or office buildings. Coexistence of a large number of UWB clusters with other wireless services is guaranteed by a photonic analog-to-digital converter employing the in-house optical fiber installation.

Introduction – UWB technology targets low-cost short-range high bitrate applications like high-definition (HD) audio/video cabling replacement or wireless universal serial bus (USB) data transmission. A large number of HD audio/video link solutions based on UWB technology have been very recently reported [1]. UWB data transmission has been reported in point-to-point wireless communication at 480 Mbit/s bitrate [2], and has been further extended to 1 Gbit/s single user bitrate in record indoor demonstrations [3]. Several interesting characteristics are driving UWB market introduction: (a) The extremely low power spectral density employed, minimising interference; (b) The high spectral efficiency due to its carrier-less signal transmission; (c) Capability for providing more than 1 Gbit/s bitrate per user [4] in its actual implementation. UWB technology targets short-range communications with limited reach. Several technology demonstrations have been reported so far targeting to maximise the UWB reach, achieving 100 Mbit/s bitrate at 10 m [5] and 50 Mbit/s bitrate at 60 m range [6]. An UWB cellular architecture has been proposed in the European project FP7-ICT-1-216785 "UCELLS" [7] to provide indoor Gbit/s communications in wider areas employing standard low-cost UWB transceivers. The presence of a large number of UWB transmitters, despite its low average transmitted power, requires interference monitoring to guarantee coexistence due to the extreme bandwidth allocated in current UWB regulation, from 3.1 to 10.6 GHz [8]. Interference monitoring by a Photonic analogue-to-digital converter (Ph-ADC) employing the in-house standard single-mode fibre (SSMF) infrastructure is proposed in this paper.

UWB cluster Ph-ADC concept – Fig. 1 depicts the UWB cluster concept altogether the Ph-ADC infrastructure. Fig. 1 shows a set of UWB transceivers arranged in different UWB picocells which can establish peer-to-peer communications inside the cell between UWB transceivers or can connect to an UWB access node, if required. A large number of UWB transmitters in simultaneous operation are expected in the cluster arrangement.

Proper UWB cluster operation requires spectral coexistence in the UWB bandwidth (3.1-10.6 GHz). Coexistence requirements make necessary UWB spectrum monitoring. We propose a Ph-ADC to monitor the spectrum over the whole UWB band in real

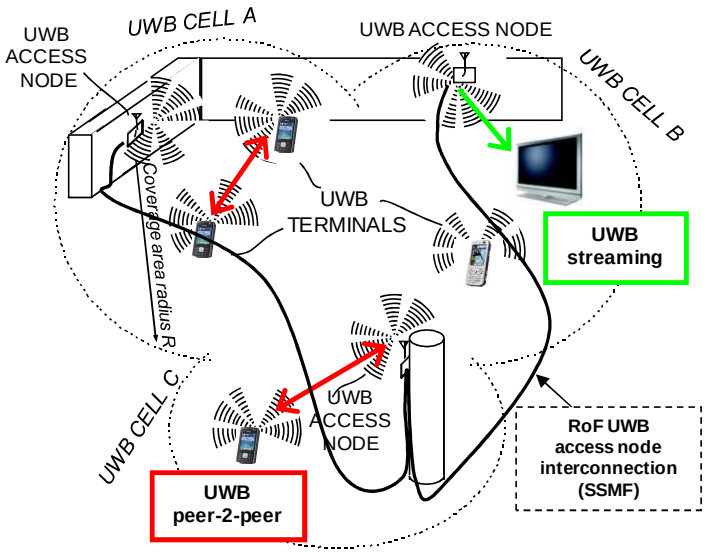

Fig. 1. UWB picocell cluster. The in-house RoF connects access nodes.

time. Ph-ADC spectrum monitoring advantages are: 1) Sampling the whole UWB band; 2) Dynamic range enough to accomodate UWB low-power signals in presence of high transmission levels from other wireless interferers; 3) Good spectral resolution, and 4) Feasible fast probing of the "air channel" due to its real-time implementation. The Ph-ADC is based on a radio-over-fibre SSMF infrastructure.

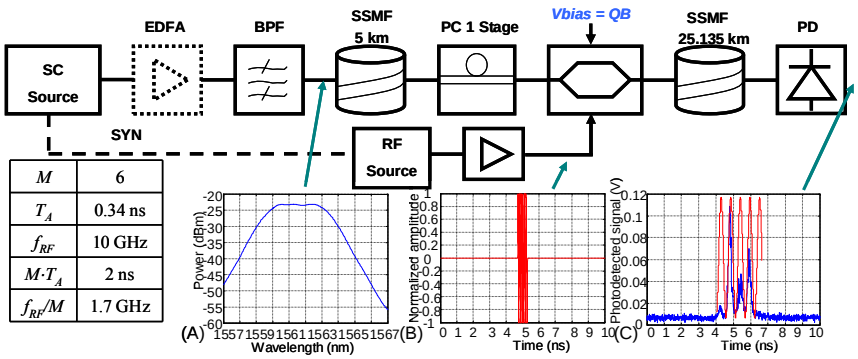

Fig. 2. Ph-ADC experimental set-up. The table contains system parameters used in the proof-of-concept experiment as well as measured pulsewidth and bandwidth of the stretched signal (C). SC: Supercontinuum, BPF: Bandpass filter, PC: Polarization controller, QB: Quadrature Bias, PD: Photodetector, SYN: Synchronization.

Ph-ADC UWB monitoring proof-of-concept experiment – Tte Ph-ADC comprises two spans of fibre from the RoF links shown in Fig. 1. Fig. 2 shows the time-stretching Ph-ADC proof-of-concept experimental set-up. This set-up targets to demonstrate time-stretching Ph-ADC operation on UWB signals. Fig. 2 Inset (B) shows the ideal input UWB monopulse under analysis. Ph-ADC operation is as follows: The SC source generates optical pulses, which are stretched to 340 ps and chirped by propagation through 5 km SSMF fibre. Inset (A) shows the measured super-continuum (SC) spectrum (4 nm -3 dB BW), and Inset (C) shows the measured time-stretched RF signal superimposed to ideal stretched RF signal. The electrical UWB signal received from the antenna would be modulated by an electro-optical modulator on the chirped SC pulses. In the proof-of-concept experiment, the UWB signal is a RF pulse comprising 6 cycles 100 ps period, shown in Inset (B). The UWB modulated signal is time-stretched in a second spool of fibre (25.135 km) before photodetection. The UWB RF signal is effectively slowed down prior to its conversion, as shown in Inset (C). This optical process relaxes the requirements of the ADC required in processing; A stretch factor of 6 is achieved in the proof-of-concept experiment implying the whole UWB can be digitized using a 1.8 GSample/s electronic ADC.

Conclusion – In this paper, a spectrum monitor based on a time-stretching Ph-ADC architecture has been proposed as a suitable approach for UWB monitoring in real-time employing an in-house radio-over-fibre infrastructure. This approach has been validated in a proof-of-concept experiment, in which the time-stretch of a 600 ps UWB pulse by a factor of 6 employing SSMF radio-over-fibre, and it further photodetection and capturing is demonstrated.

Acknowledgement – This work has been partly funded by the ISIS NoE, IST-FP6-026592, and by the FP7-ICT-1-216785 UCELLS project. Marta Beltran's work was supported by the Spanish MEC grant BES-2006-12066.

References

[1] R. Lawler, Enganged "WirelessHD version 1. 0 is complete", available in http://www. engadget.com/2008/01/03/wirelesshd-version-1-0-iscomplete/(January 2008).

[2] Staccato Communications, Intel and Philips; "Demonstration to show future of high-speed wireless USB"; MBOA UWB TECHZONE at CES; CES 2005 Las Vegas.

[3] "Pulse~LINK Demonstrates UWB Wireless, Cable and Power Line Communications", ITU-R Global Conference on UWB, Demonstrations of New High Bandwidth Technology Showcase Opportunities for Connected Home, Boston,MA. Jun.2004.

[4] Office Communications, OFCOM "Ultra wideband. An input document for discussion at the ECC TG3#11 preparation group and gives the views of the UK on a way forward for a harmonised generic UWB solution for CEPT/EU", Sept. 2005.

[5] H. Sheng, P. Orlik, A. M. Haimovich, L. J. Cimini, J. J. Zhang; "On the Spectral and Power Requirements for Ultra-Wideband Transmission", IEEE International Conference on Communications, 2003. vol. 1, pp. 738-742.

[6] Jia Li, T. Talty, "Channel Characterization for Ultra-Wideband Intra-Vehicle Sensor Networks", Military Communications Conference, MILCOM 2006. pp. 1-5.

[7] Ultra-wide band real-time interference monitoring and CELLular management Strategies, http://www.ist-ucells.org.

[8] FCC 02-48, "Revision of Part 15 of the Commission's Rules regarding ultra-wideband transmission systems", Apr. 2002.