Wired and wireless multi-service transmission over 1mm-core GI-POF for in-home networks


Simultaneous transmission of broadband wired and wireless signals over 50 m 1mm-core GI-POF is demonstrated for the first time. 2.2 Gbit/s DMT and 528 MHz 200Mbit/s UWB wireless signals are delivered with BER < 10^{-3} and EVM < 15.5%, respectively, in accordance with WiMedia standards.

Introduction: Delivery of multiple services through in-home networks does, of necessity, require increased bandwidth. The transmission capacity needed for delivering current and emerging home services can even exceed the access line capacity [1]. Currently, a plethora of delivery methods and cable media are employed for different kinds of services; e.g. coaxial cable for video broadcast, Cat-5 cable for computer data, twisted pair cable for wired telephony, and wireless LAN for Internet. Such multiple network infrastructures lead to a complicated consumer experience and high service and maintenance costs.

To provide a simplified and easily upgradable in-home network, a single common backbone infrastructure is required, as shown in Fig. 1. Whilst singlemode fibre has been considered as a future-proof transmission medium for optical networks, the associated hardware, installation and maintenance costs are prohibitive for mass deployment for brownfield access and in-building networks. Hence, for cost-sensitive in-home networks other solutions should be considered.

Experimental setup and results: The proposed system is based on a simple intensity-modulated direct-detection (IM-DD) optical link. The photo-receiver based on a Ø230 μm Si-APD, followed by Ø1 mm core 50 m PMMA GI-POF and a two-stage DPO, shows the performance of the two signals with UWB power of 1 dBm while DMT power varies from 0.2 to 5.0 dBm. With DMT power fixed to 1 dBm, respectively, to 3.2 and 7.2 dBm.

Fig. 1 In-home POF infrastructure for converged transport of wired and wireless services

Fig. 2 Experimental setup for simultaneous transmission of DMT and UWB signals over POF

Fig. 3 DMT and UWB performance against DMT and UWB input power

a Against DMT input power
b Against UWB input power

The electrically combined signal is used to directly modulate a VCSEL at 667 nm with an eye safe optical emitted power of 0 dBm. The VCSEL is followed by Ø1 mm core 50 m PMMA GI-POF and a photo-receiver based on a 0.230 μm Si-APD, followed by a two-stage electrical amplifier with a gain of 40 dB. The detected signal is fed to a digital phosphor oscilloscope (DPO) in order to capture a time-window of the received signal for off-line performance evaluation. The maximum data rate at a bit error rate (BER) below 10^{-3} for DMT and error vector magnitude (EVM) for UWB is measured.
achieve 2.2 Gbit/s DMT transmission with the UWB EVM below 13%. In Fig. 4, the received constellation for the subcarriers of the DMT signal with 3 bits allocated is shown. In addition, the QPSK constellation of the demodulated UWB signal is shown. Both constellation plots indicate the excellent quality of the received signals.

Fig. 4 Constellation diagrams of received signals after simultaneous transmission over 50 m POF

Conclusion: We have experimentally demonstrated for the first time a combined transmission of wired and wireless signals over Ø1 mm core 50 m PMMA GI-POF. Two broadband signals are simultaneously transmitted: a 2.2 Gbit/s DMT signal with BER < 10^{-3}, and a 528 MHz WiMedia-compliant UWB signal with EVM < 13%. This work validates the use of Ø1 mm POF links as a common infrastructure for in-home networks capable of transmitting wired and wireless in-home services. In addition, implementation costs are minimised by employing simple transceivers, IM-DD optical systems, and advanced modulation formats.

Acknowledgment: The authors are grateful for financial support of this work in the EU research programmes FP7 ICT-224521 POF-PLUS and ICT-212352 ALPHA.

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16 November 2010
doi: 10.1049/el.2010.7273
One or more of the Figures in this Letter are available in colour online.

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