Polymer Optical Fiber Based Fiber-Radio System for Wireless LAN Applications

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Abstract – Today, in-building networks are wireless or purely wired connections with both corresponding advantages and disadvantages. Given the fact that future in-building wired network backbones could contain thick and easy to install polymer optical fibers (POF), hybrid fiber-radio systems are of great interest. Hence, the development, design and measurement results on data rates, latency times, and signal quality of a new Wireless Local Area Network (WLAN, IEEE standard 802.11a/b/g) access point with a 100BaseFX interface for POF (WLAN-POF AP) using commercial off-the-shelf (COTS) components is presented.

Introduction – In current consumer targeted short range and in-building networks the combination of wired and wireless solutions unifying a high quality-of-service and a certain range of mobility is widely investigated [1]. In many cases the focus lies on direct radio-over-fiber solutions supplying distributed antenna systems directly with the radio frequency (RF) signal [2]. For the development of very low cost solutions Step-Index (SI-)POF can be and are already being used for in-building networking with advantages of eye-safety, immunity against EMI, and with the feasibility of do-it-yourself installation [3]. Due to its high modal dispersion a transmission of RF signals is limited by using SI-POF to only a few meters what inhibits the use of these fibers for direct RoF systems. Hence, a solution for a convergence of both network infrastructures by creation of a POF based Fiber-Radio System for WLAN is presented.

Design – A D-Link DWL-G700 AP containing a usual unshielded twisted pair (UTP) (e.g. Cat5) electrical interface for Ethernet connection and WLAN antenna was rebuilt. The UTP interface and the corresponding inductor were exchanged by a POF-Transceiver. The embedded D-Link/Realtek phyceiver chip has been converted from 100BaseTX to 100BaseFX operation by resetting the electrical connections and fitting the voltage levels (PECL) to the POF transceivers requirements by a suitably built driving circuit (Fig.1).

Figure 1: WLAN-POF Access Point

In the optical domain the baseband digital Fast Ethernet signals are transmitted over up to 70 m of standard SI-POF at a wavelength of 650 nm using LEDs. This data is converted by the integrated System-on-Chip IC RLT 8186 into OFDM and mixed with an RF carrier to the corresponding 2.4 GHz and 5.5 GHz, respectively.

Experimental Results – Data rate measurements using NetIO 1.23 software with both standard D-Link WLAN-UTP AP (Fig.2(a)) and rebuilt D-Link WLAN-POF AP (Fig.2(b)) were carried out. The setup contains two laptops; one connected to a UTP-(UTP)-POF-Switch and a second one connected to the AP via WLAN radio connection with a distance between AP and laptop of 2 m. In order to compare both measurements the UTP cable and standard WLAN-UTP AP were substituted by a duplex SI-POF connection of 25 m together with the rebuilt AP. With the NetIO benchmark program running on both laptops - one in slave mode (laptop 1) and one in master mode (laptop 2) - data rates of 10.02 Mbit/s (sending direction: laptop 2 ->1) and 7.88 Mbit/s (laptop 1->2) were obtained for the POF based version (b). In comparison the data rates for the standard UTP connection using the WLAN-UTP AP (a) were recorded to be 11.49 Mbit/s and 8.04 Mbit/s, respectively. As a result it can be summarized that the POF based AP has a slightly lower performance. The low data rates of around 10 Mbit/s compared to 54 Mbit/s as given in the IEEE 802.11g standard could not be reached most likely due to interferences of multiple WLAN base stations.

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The average latency time (100 requests by laptop 2) using the same setups as shown in Fig. 2(b) is at 189 ms. Compared to the standard AP version (a) the average latency time only raised around 9 ms; Maximum values were seen to be around (a)914 ms ((b)1143 ms); the minimum in both cases at 2 ms.

The signal quality was tested using the setup depicted in Fig. 3.

**Conclusion and future work** – A prototype WLAN-POF access point for fiber-wireless systems was realized. It was shown that the performance of the system is comparable to standard WLAN systems using the D-Link DWL-G700 AP. Further improvements could include the miniaturization of the driving circuit and the design of only one printed circuit board for all ICs and the optical interface.

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**References**

