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Bidirectional WDM-over-POF Multi-Gbps LiFi POF-Luminaire with Spatial Diversity

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The exponential increase in demand on wireless connections, caused by the large number of intelligent integrated devices, is leading to a congestion in the electromagnetic spectrum. One of the main options that can be used to ease the pressure on the radio spectrum is the optical wireless communication (OWC), which makes use of the unlicensed optical spectrum and offers high bandwidth. Among the OWC solutions the visible light communication (VLC), a.k.a LiFi, is one of the most promising. The main advantage of the VLC systems is to provide both data illumination and data communication through the already existing light sources [1]. Usually the LiFi systems make use of the already existing light emitting diodes (LEDs) as their light source due to their low cost. However, the illumination LEDs have narrow bandwidth and suffer from high linearity, which severely limit their application. Another LEDs technique, such as small area LEDs (μ-LEDs), have been used to provide larger bandwidth. Although providing larger bandwidth these LEDs suffer from efficiency droop and need additional techniques to mitigate this effect and, consequently, increasing their price and undermine the reasons to use them [2]. Since an indoor communication infrastructure must be simple and low cost, we proposed to use optical fibres, acting as luminaires, that are remotely connected to a broadband laser diode (LD) and photodiode (PD) and are centrally located in the building [3].

Several optical networks can be considered to carry the data from the central site to individual rooms. Although silica single- and multi-mode fibres have excellent transmission, they are brittle and labour intensive to install, so are costly and not easy to deploy in an indoor network. To overcome these problems, we propose to use the standard 1-mm core size polymethyl methacrylate (PMMA) step index (SI) plastic optical fibre (POF). This standard POF is low cost, due-it-yourself (DIY) technology and works in the visible range, that can enable visual link testing and ease the installation [4]. A major drawback of the POFs is the strong modal dispersion that can however be compensated with the use of efficient modulation formats, enabling multi-Gbps transmission [5]. In addition to modulation formats, increasing throughput can be realized by wavelength division multiplexing (WDM) that can also enable distributed multiple input multiple output (D-MIMO) in the wireless link. The use of D-MIMO supports user's mobility and can guarantee a consistent link performance. With the use of D-MIMO and spatial diversity, the major drawback of the OWC systems, the lack of connection due to the non line-of-sight, can for a large part be overcome.

In Fig. 1 the concept of the proposed indoor network is presented. The connection between the central unit and each room is realized by POF. The user devices receive the wireless signal from the POF-end faces. The wireless channel is composed by two POF-end faces: 658nm (red) and 520nm (green), with a lens placed in a defocused position to extend the coverage area, and consequently increase the number of users.

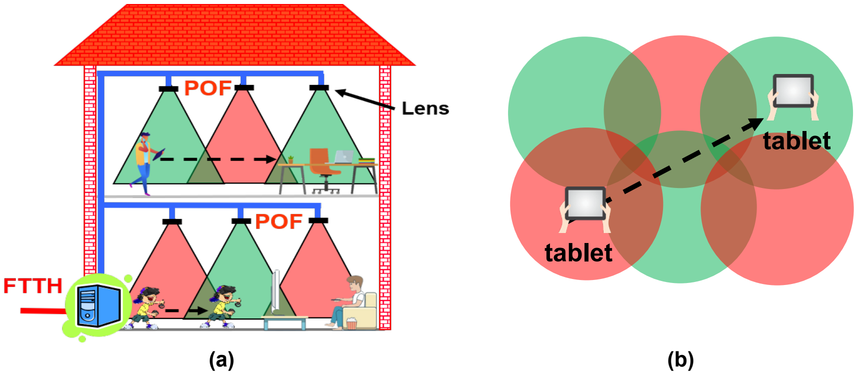

Fig. 1: An in-home network employing luminaire-free LiFi transmission systems using POF and lens (a) and wireless cells (b) with an example of user's movement crossing several wireless cells.

We believe that the proposed bidirectional spatial diversity indoor system allows user movement, guarantees a consistent link performance, and provides Gbps throughput. In addition, this is a potentially low-cost and an attractive technique to achieve high capacity for indoor systems.

References

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