13th International Conference on Applied Informatics
Eszterházy Károly Catholic University
Eger, Hungary, February 19–21, 2026

An Empirical Study of HomePlug AV2 Powerline Performance in Real-World Residential Electrical Networks

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Abstract

Powerline communication (PLC) represents a class of wired communication technologies that leverage existing low- and medium-voltage electrical wiring to transmit high-frequency modulated data signals, enabling network connectivity without the need for dedicated cabling. While PLC has gained significant traction as a practical alternative to Wi-Fi extenders and Ethernet cabling for in-home broadband distribution, empirical evidence on its real-world performance – particularly under diverse electrical topologies and noise conditions—remains limited [1–12]. This paper presents a controlled measurement study of a commercial HomePlug AV2 1000 Mbps kit (TP-Link TL-WPA8631P + TL-PA8010P), operated exclusively in wired Ethernet mode with Wi-Fi disabled. We evaluate throughput, latency, jitter, and packet loss across multiple residential scenarios, including same-phase versus cross-phase deployments, the presence of electromagnetic interference (EMI) sources, and the use of power strips. Our findings indicate that although theoretical data rates reach the upper limits advertised by the technology, the actual throughput observed in practice fluctuates widely, with significantly lower performance in cross-phase setups affected by electrical noise and noticeably higher performance on clean, same-phase circuits. Latency remains minimal under optimal conditions but deteriorates considerably when exposed to interference. These results highlight both the progress and the constraints inherent to PLC systems, providing useful insights for smart-home integrators and emphasizing how strongly PLC performance depends on the characteristics of a home's electrical network.

Keywords: PLC, HomePlug AV2, in-home network, performance, smart home.

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