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Cross-layer Design, Analysis, and Optimization for Optical Wireless Communications

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This poster showcases my current interests in Optical Wireless Communications (OWC) for both indoor and outdoor networks.

In outdoor networks, Free-space Optical (FSO) communications is a transmission technology in which the optical signal is transmitted through the atmosphere. FSO has been considered an alternative solution for a wide range of applications thanks to its advantages such as being license-free, having high data rate, quick and easy deployment, and cost-effectiveness. Depending on the deployment scenario and application, FSO communication systems are suitable for terrestrial and space based communication. In the case of terrestrial communication, FSO systems are usually deployed for last mile access, enterprise connectivity, fiber backup and long haul. For space-based communication, FSO systems are applied for inter-satellite communication, manned spacecraft, data broadcasting satellites and satellite and ground station communications.

In indoor networks, Visible Light Communication (VLC) based on light-emitting diodes (LEDs). VLC has the potential to be an integral part of 5G networks thanks to the availability of broad bandwidth, high security, non-existence of electromagnetic interference, etc.

There are several challenging issues in practical deployments of these technologies. Particularly, in FSO systems, especially over extended links, the atmospheric turbulence may lead to an increase in link error probability and consequently degrades the reliability of FSO systems. Regarding VLC systems, fluctuations of the brightness of light (i.e., the flickering) when transferring data may be harmful to human eyes. Caused by object movements, such as people or paper, temporary blocking may happen in VLC links. Additionally, the presence of inter-symbol interference (ISI), reflection (by walls) and non-uniform of light power distribution corresponds to an intentional increase of the link loss.

As FSO and VLC networks own unique characteristics, my study mainly focuses on Cross-layer Design, Analysis, and Optimization for OWC to find answers for two critical issues. Firstly, how the physical layer impacts on the operation of upper layers. This refers to cross-layer analysis of the upper layer over FSO and VLC networks. The second point is related to the possibility of designing/modifying upper layers to adapt to the harsh condition of physical layers.

References:

Vuong V. Mai and Anh T. Pham. Adaptive Multi-Rate Designs and Analysis for Hybrid FSO/RF Systems over Fading Channels. *IEICE Transactions on Communications*, Vol. E98-B, Iss. 8, pp. 1660-1671, Aug. 2015.

Vuong V. Mai, Truong C. Thang, and Anh T. Pham. Performance of TCP Over Free-Space Optical Atmospheric Turbulence Channels. *IEEE/OSA Journal of Optical Communication and Networking*, Vol. 5, Iss. 11, pp. 1168-1177, Nov. 2013.