Poster ID: 21

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Poster Session at Graduate School Information Fair

Cross-layer Design, Analysis and Optimization for Optical Wireless Communication (OWC)

General Background

Definition

OWC is a form of optical communication in which unguided visible, infrared (IR), or ultraviolet (UV) light is used to carry a signal

Advantages

Quick deployment, Cost-effectiveness, High data rate

Classifications

Outdoor: Free-space optical communication (FSO)

Indoor: Visible Light Communication (VLC)

Topologies: p2p, relaying; hybrid FSO/RF, hybrid FSO/PON, hybrid VLC/Wifi

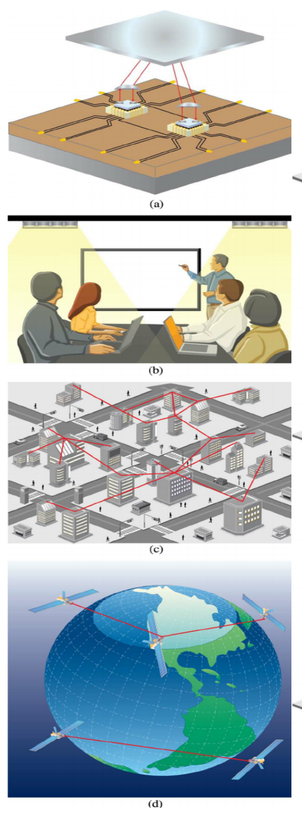


Fig. 1.

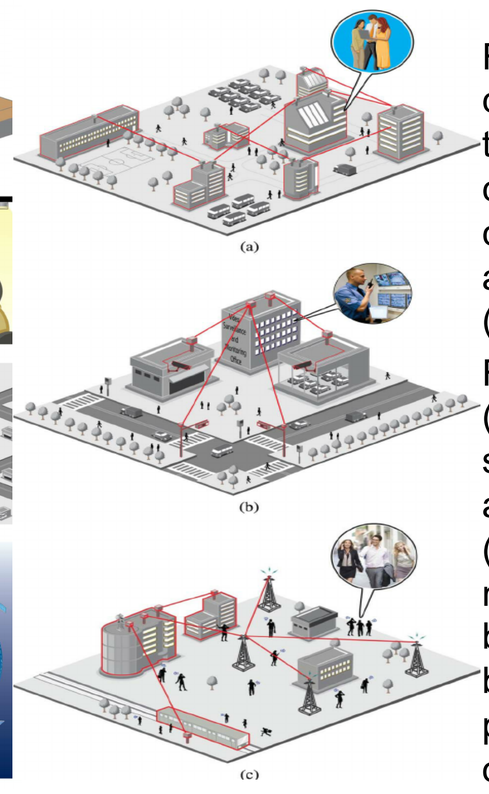


Fig. 2

Applications

Fig. 1. Some OWC applications categorized with respect to transmission range. (a) Inter-chip connection, (b) Visible light communication for indoor wireless access, (c) Inter-building connections, (d) Inter-satellite links [1]

Fig. 2. Some typical applications of FSO: (a) An envisioned campus connectivity scenario where inter-building connections are enabled by high data rate FSO links. (b) High quality video surveillance and monitoring of a city can be made possible by FSO links. (c) FSO links provide backhaul for cellular systems. These are particularly useful for cases where fiber optic installment is expensive or difficult to deploy [1]

Cross-layer Design, Analysis and Optimization for OWC

Research Challenges

The optical power launched from the transmitter is affected by various factors before arriving at the receiver. These include system loss, geometric loss, misalignment loss, atmospheric loss, atmospheric turbulence induced fading, and ambient noise. As a result, *the traditional method of designing networks using the layered approach might be unsuitable and inefficient for designing OWC networks*

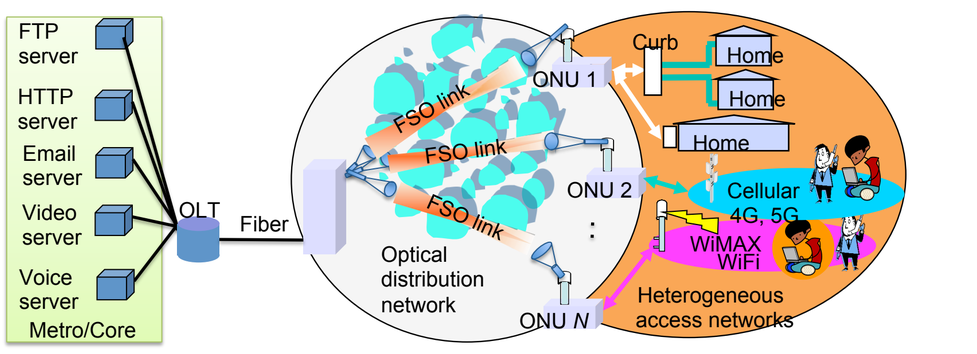
My Approaches

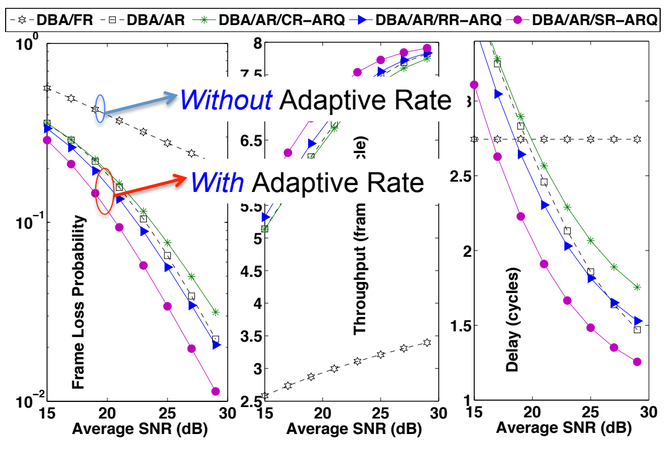
Cross-layer design is an emerging methodology, which can help to improve and optimize the performance of system by exploiting the interactions between the various protocols/layers. In my graduate research project, *I study Cross-layer Design, Analysis and Optimization approaches to improve the performance of OWC networks*

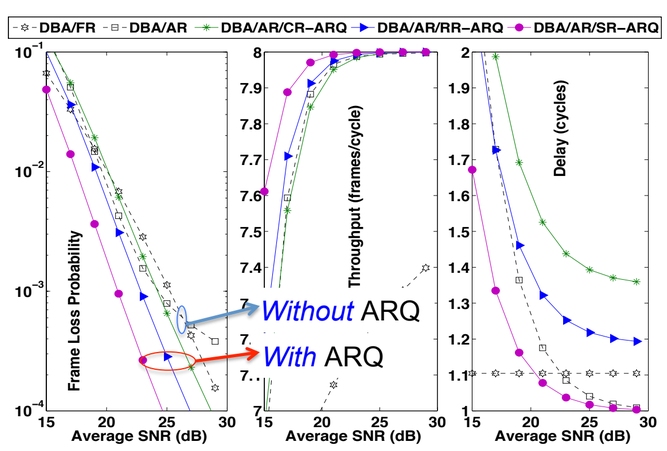
Layers & Protocols Considered in My Study

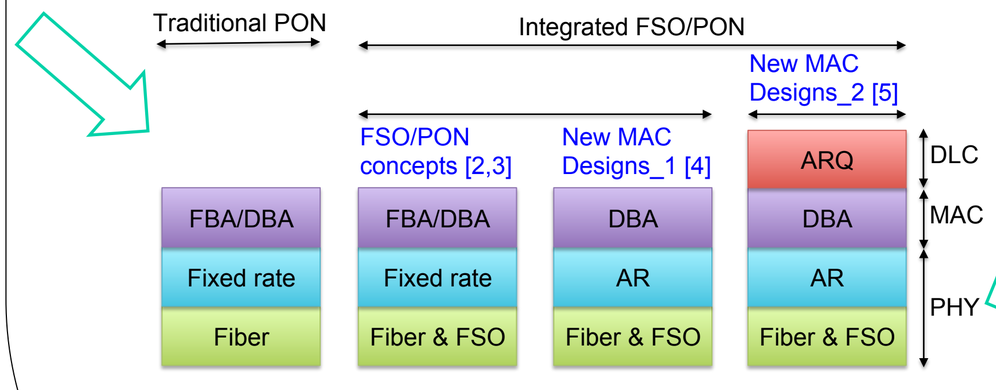
Application layer	VLC Indoor Positioning System
Transport layer	Performance Analysis of Transmission Control Protocol (TCP) over FSO, VLC
Network layer	Possibilities of Integrating OWC in Existing Networks & Technologies • Hybrid FSO/RF Networks • Integrated FSO/PON Networks • Hybrid VLC/Wifi Networks
Link layer	New designs for media access control (MAC) protocols in the integrated networks • Dynamic bandwidth allocation (DBA) for Integrated FSO/PON networks • Joint IEEE 802.15.7 and IEEE 802.11 CSMA/CA(s) for Hybrid VLC/ Wifi Networks Applications of Automatic-repeat-request (ARQ) protocols for reliable transmissions
Physical layer	Applications of Adaptive-rate (AR) schemes for effective transmissions

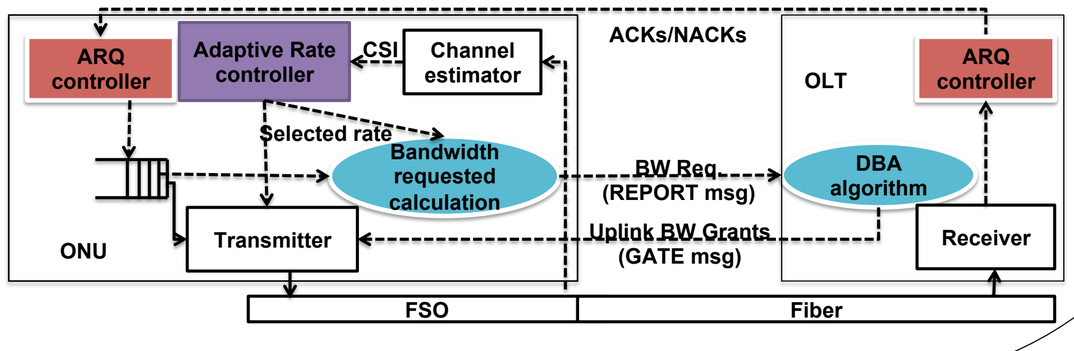
A Case of Study: Protocol Stack Design and Analysis for Integrated FSO/PON











[1] M. A. Khalighi and M. Uysal, "Survey on Free Space Optical Communication: A Communication Theory Perspective," *in IEEE Communications Surveys & Tutorials*, vol. 16, no. 4, pp. 2231-2258, Fourthquarter 2014.
[2] N. Khumancha *et al.* Energy aware free space optical access network. *2012 International Conference on Fiber Optics and Photonics*, pp. 1–3, Dec 2012.
[3] S. Di Bartol *et al.* Experimental demonstration of a gpon free space optical link for full duplex communications. *2014 Fotonica AEIT Italian Conference on Photonics Technologies*, pp. 1–3, May 2014.
[4] **Vuong V. Mai** *et al.* Adaptive rate-based MAC Protocols Design and Analysis for Integrated FSO/PON Networks. *Proc. IEEE International Conference on Communications (ICC'15)*, London, UK, June 2015.
[5] **Vuong V. Mai** and Anh T. Pham. Integrated FSO/PON for Broadband Access Networks: A Comprehensive Protocol Stack Design and Analysis. *Proc. IEEE Globecom 2015 (GLOBECOM'15)*, San Diego, CA, USA, Dec. 2015