# ECE undergraduates' paper accepted at IEEE conference

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A paper co-authored by two undergraduates and a doctoral student in electrical and computer engineering (ECE) at Rice University has been accepted for presentation at the IEEE International Conference on Sensing, Communication and Networking (SECON) 2017.

“LiRa: a WLAN architecture for Visible Light Communication with a Wi-Fi Uplink” was written by Sharan Naribole, a fifth-year doctoral student, and Shuqing “Erica” Chen and Yuqiang “Ethan” Heng, both seniors. All belong to the Rice Networks Group of Edward W. Knightly, professor, chair of ECE and co-author of the paper, who refers to the project as “Edison meets Marconi.”

Visible light communication (VLC) is an emerging technology that uses LED-based lighting for illumination and communication. Ceiling-mounted luminaries modulate lighting in a manner undetectable by the human eye but that can be detected by mobile devices equipped with photo-diode surfaces. VLC-enabled luminaries can support low-rate “Internet of Things” applications and Gigabit-rate wireless networking for live HD video streaming. The wide coverage and relatively high transmit power realized by the downlink to accommodate illumination is problematic to realize in the uplink.

LiRa, a Light-Radio wireless local area network proposed by the Rice group, combines light and radio links on a frame-by-frame basis at the media access control layer. In contrast to commercial systems, LiRa does not require uplink infrared transmission by mobile clients, and instead uses a radio uplink integrated with already-existing Wi-Fi.

In a traditional Wi-Fi network, error control is maintained by allowing a user receiving a data packet from the Wi-

Fi Access Point (AP) to immediately send an acknowledgement (ACK) for which the Wi-Fi channel is reserved. However, in the joint VLC and Wi-Fi network, when the user receives data over VLC, there may be ongoing Wi-Fi transmissions preventing the user from immediately transmitting its ACK. Instead, the user has to contend on the Wi-Fi channel to get access for ACK transmission. This causes delays and increased packet loss over Wi-Fi.

To overcome the problem, Knightly's group designed AP-Spoofed Multi-client ARQ (ASMA) protocol. In ASMA, instead of every VLC user contending on Wi-Fi to transmit their ACKs, the LiRa AP triggers the VLC users for the feedback in configurable time intervals. This trigger message is designed to include a spoofing mechanism that defers Wi-Fi users from accessing the channel while providing collision-free access to the VLC users to transmit their ACKs.

"With our work, VLC can achieve its full potential through efficient error control feedback transmitted over Wi-Fi. Despite heavy internet traffic, our design enables smartphones to provide near-instant short Wi-Fi responses to maintain connection. Hospitals have heavy internet traffic and equipment that can prevent doctors from receiving real-time critical messages about patients' conditions. Doctors can rely on this technology to save time and save lives," Naribole said.

The conference will be held June 12-14 in San Diego. SECON reviewed 170 submitted papers and accepted 45 for publication and presentation at the conference.

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