Contention-free scheduling for LiFi networks

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Optical Wireless Communication (OWC) is a promising solution to offer ultra-reliable communication in ultra-dense scenarios. As a result, it has attracted significant attention from academia and industry to complement traditional radio frequency (RF) communications. In a Light-Fidelity (LiFi) network, light-emitting diodes (LEDs) are employed as transmitters, while users can receive the emitted light signal with a receiver such as a photodiode or a camera. These LED transmitters have a local and narrow coverage area, and as a result, LiFi networks can potentially serve many users with a large number of non-interfering transmitters, all using the same spectrum while creating narrow signal regions around the intended receivers.

For handover and robustness against blockage of the line-of-sight (LoS), the coverage areas of the transmitters are designed to overlap, such that receivers see multiple transmitters within their field-of-view. This inevitably results in strong contention and inter-user interference. Nonetheless, guaranteed Quality of Service (QoS), without random back-offs after message collision, is one of the main drivers for the adaptation of LiFi in the market today. This is also reflected in the latest standardization for LiFi networks. A new medium access control (MAC) protocol is proposed in the IEEE P802.15.13 task group which controls medium access in a deterministic manner to guarantee the QoS [1].

To handle contention and inter-user interference, several scheduling approaches have been investigated in the LiFi community. These can be categorized in centralized versus distributed, contention-free versus contention-based. An ideal protocol for LiFi networks is centrally controlled favouring global optimization, while distributing as much as functionality as possible for scalability. To guarantee throughput, latency, and thus QoS, a contention-free scheme is preferred, because it avoids competition among transmitters and packet collisions which reduce the channel utilization.

In this work, we give an overview of existing contention-free scheduling approaches for LiFi networks. We show that the existing centralized approaches are not scalable, due to their high computational complexity and/or excessive knowledge about the network topology.

Next, we present the concept of a coarse/fine-grained interference control mechanism, which allows to determine with low complexity when two transmitters can be active simultaneously, and when they should be silenced. This information is the foundation of our scheduling protocol, which exploits it to achieve adequate resource management with a very low complexity. Special attention is given to the communication overhead among the transmitters and the flexibility to adapt the scheduling to the actual traffic need. Finally, we compare our work to the state of the art, showing the potential of our coarse/fine-grained interference control as a promising solution for LiFi resource management.

References

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