Project: IEEE P802.15 Working Group for Wireless Personal Area Networks (WPANs)

Submission Title: PHY and MAC-layer approaches for uncoupling VLC from dimming
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Abstract: In the IEEE 802.15.7 baseline draft (see P15-09-0786-01-0007), dimming is made an integral part of the VLC Tx. This decision is based on the perception that the combination of interference-free VLC and dimming can otherwise not be ensured. In this contributions we provide our thoughts on how to decouple VLC from dimming and at the same time ensure high data rates with this approach.

Purpose: Helping TG 802.15.7 to shape the use-case scope of a VLC standard

MAC- and PHY-layer approaches for uncoupling VLC from dimming

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Motivation for this contribution

- Know-how for PWM-dimming resides within lighting industry, while VLC know-how resides within communications industry.
- Current baseline draft -out of perceived necessity- also covers dimming function → both VLC and dimming provided by VLC vendor
- However: lamp will often become part of adaptive-lighting systems controlled by light vendors →How to handle interfaces?
- Our approach: VLC independent of dimming, viz. no interface issues
- Here: Provide thoughts hatched within OMEGA (→ P802.15-09-0123-04-0007)

Outline

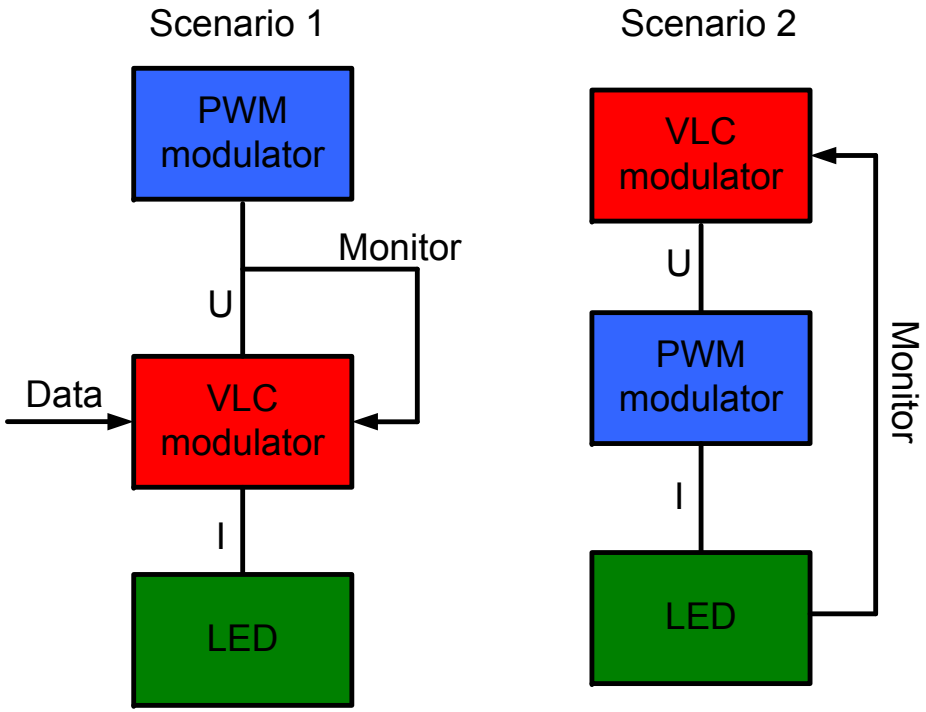
- Architecture of decoupled VLC and dimming
- MAC-layer approach
- PHY-layer approach
- Acknowledgment

Architecture of decoupled VLC and dimming

Two main architectures:

1. PWM dimmer upstream of VLC modulator
2. PWM dimmer downstream of VLC modulator

- Scenario 1 most practical



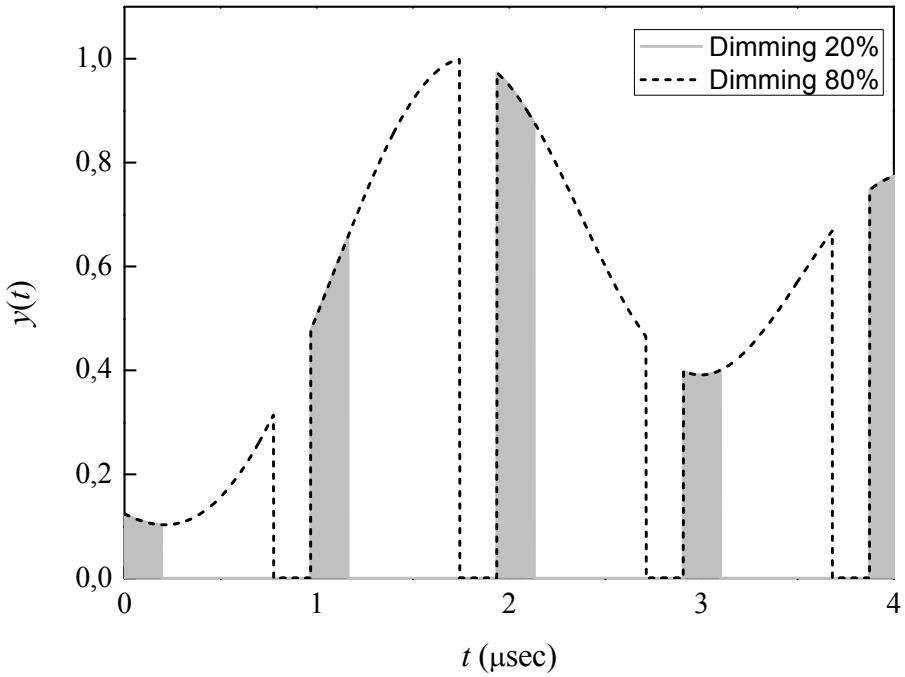
MAC-layer approach

Scenario 1: only send when PWM pulse on, control this at MAC layer

- Sensing voltage rise → signal to MAC
- MAC data → PHY: send
- PWM pulse shut off → signal to MAC → seize sending
- Various strategies available for dealing with shut-down period (resend packages, predict shut-down event, …)
- QoS: supported
- Superframes: tough, probably not supported (same issue though with baseline-draft schemes)

PHY-layer approach

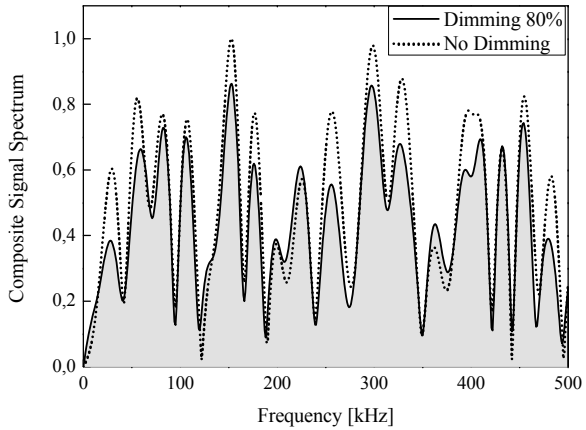
- Scenario 1
- Modulate “continuous” DMT signal onto PWM pulses
- PWM pulses sample DMT signal
- Is interference-free transmission feasible for dimming > 0%
- Answer: resounding YES

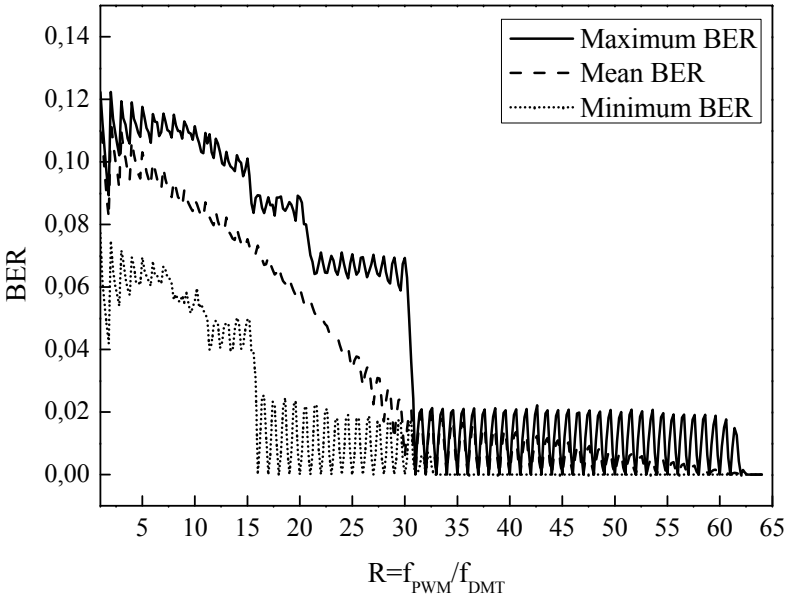


PHY-layer approach

Interference-free transmission when

- PWM cycle frequency > 2 x highest DMT frequency
- Estimation bias accounted for, stemming from finite length of PWM symbols
- Sync between DMT and PWM beneficial but not necessary
- Flicker: negligible for reasonable PWM frequencies (spectral power < 8 ppm of total power for 500 kHz PWM frequency)
- Data-rate boost through spectrally efficient modulation of each subcarrier





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