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

Submission Title: Siemens's view on the standardisation of wireless visible-light communications
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Re: N/A

Abstract: We discuss potential use cases for wireless visible-light communications (VLC), our expertise in this field, and or view on VLC standardisation and what topics an IEEE VLC would need to cover.

Purpose: Helping the 802.15 VLC SIG to shape the scope of a VLC standard

Siemens's view on the standardisation of wireless visible-light communications

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Outline

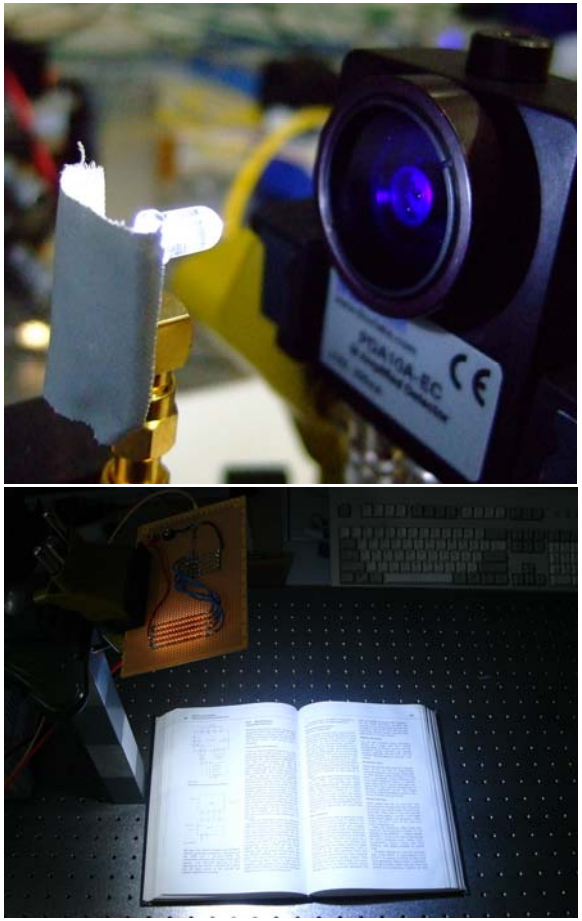
- Use cases for VLC
- Technical expertise at Siemens Corporate Technology
- Necessity of international VLC standardisation
- Topics a VLC standard needs to cover

VLC use cases

- Indoor positioning and localisation-based services with (ceiling) lighting
- Communications in RF-sensitive environments (e.g., NMRs)
- Information broadcast with (ceiling) lighting in (semi-)public areas (airports, trains, railway stations, conventions …)
- Wide-area “high-speed” back up for Gbit/s in-building wireless network
- Management of sensor networks, e.g., selective configuration of network nodes
- “Data drop”: High-speed download to mobile devices (PDA, mobile phone, …), but also onto trolleys etc.
- Car2x / Train2x communication
- Wireless extension of DALI standard

Technical Expertise at Siemens Corporate Technology

- Proof of principle of more than 100 Mbit/s data transfer with white-light LEDs (ECOC 2007, post-deadline paper)
- Demonstrators (e.g., MuLi – Music over Light)
- Participation in OMEGA (EU FP 7-1, lead: Orange Labs, France Telecom); aim: 100 Mbit/s broadcast with ceiling lighting in a show room in Rennes, France



Necessity of international VLC standardisation

- Markets all over the world
- Siemens pursues business all over the globe
- VLC can potentially harm people (flicker, eye safety); with international standard less likely that harmful VLC technology is deployed in any country
- Need VLC technology that embraces all viable use cases

Topics a VLC standard needs to cover … (1)

… in addition to what Eun Tae Won already stated in last year [IEEE 802.15-07/0911r0, Slide 18]:

- Scenarios to be supported
  - fixed-fixed
  - fixed-mobile
  - mobile-mobile

Topics a VLC standard needs to cover (2)

- PHY
  - Regulations and technical solutions (PHY and/or MAC) for flicker-free VLC light
    - Even one harmful/lethal incident (e.g., epileptic seizure) might put VLC out of business
    - This item is NOT optional!
  - Modulation formats; support for various data rates (from < 1 kbit/s to ~ 1 Gbit/s)

Topics a VLC standard needs to cover (3)

- PHY
  - Link budget (for data rate classes)
  - PHY for mobility (beam tracking, …)
  - Needs to cover LED RGB and phosphor technology
    - How to achieve > 100 Mbit/s with phosphorescent LEDs
    - Exploiting RGB technology for multichannel and/or increased data rates

Topics a VLC standard needs to cover (4)

- MAC
  - support of
    - uni-directional VLC link
    - duplex VLC link
    - multiple access
      - FDMA
      - CDMA
      - ???
  - handover between light spots (lighting scenario)
  - rate adaption for mobility

Topics a VLC standard needs to cover (4)

- Integration
  - Connection to fixed and wireless networks (802.1, PLC?, …)

Topics a VLC standard needs to cover (5)

- Coexistence
  - Radiation from other light sources (interference, saturation of Rx, …) and VLC interference with other optical communications technology
    - sunlight
    - fluorescent lighting
    - IrDA
    - remote controls

Topics a VLC standard needs to cover (6)

- Coexistence
  - Coexistence with (LED) lighting standards, i.e. standards for room lighting and the like; also we need to be compliant with automotive standards!
    - Arrange VLC standard along lighting industry's future roadmap

Topics a VLC standard needs to cover (7)

- Coexistence
  - Coexistence with PWM (use for dimming LEDs in lighting applications)
    - PHY- and MAC-layer approaches to low- and high-data-rate transmission with PWM-dimmed lamps

Summary and Conclusions

- VLC important emerging communications technology
- Needs international standardisation
- Broad, complete, but focussed standard
  - Addressing health issues
  - Addressing communication with illumination LEDs
  - Supporting of mobility

Thank you
for your attention!

Appendix

DALI: Digital Addressable Lighting Interface

- Open standard for communication with and control of lighting devices (electrical ballasts, dimmers, …)
- So far only addresses wired networks
- Duplex, 12 kbit/s baud rate, up to 64 clients