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

Submission Title: [MAC design considerations for VLC]

Date Submitted: [9 March, 2009]

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Abstract: [MAC design considerations for VLC are discussed.]

Purpose: [Contribution to IEEE 802.15.7 VLC TG]

MAC Design Considerations for VLC

Samsung Electronics

Application Requirements

- Wide range of applications
  - Indoor/Outdoor
  - Infrastructure/Mobile/Vehicular
  - 10 Kbps – 1 Gbps
  - Multiple topologies (Peer to peer/star)
  - Mobility
 - Uni/bi-directional/broadcast data transfer

Other Factors Affecting MAC Design

- Spectrum/number of channels
- Choice of light sources/optical receivers
- Interference tolerance
- Delay spread (ISI)
- Time taken/required for synchronization

➢ We need to get better understanding of these issues for MAC design

A Single MAC

- Splitting MACs or PHYs for various applications will affect industry mass adoption

- May have optional modes for certain devices/applications

- Very low data rates may not be interesting
    - Other optical standards are developing Gbps rates

- Need to focus on a few important applications

➢ Recommend that we narrow the range of data rates, requirements and applications

VLC Protocol stack
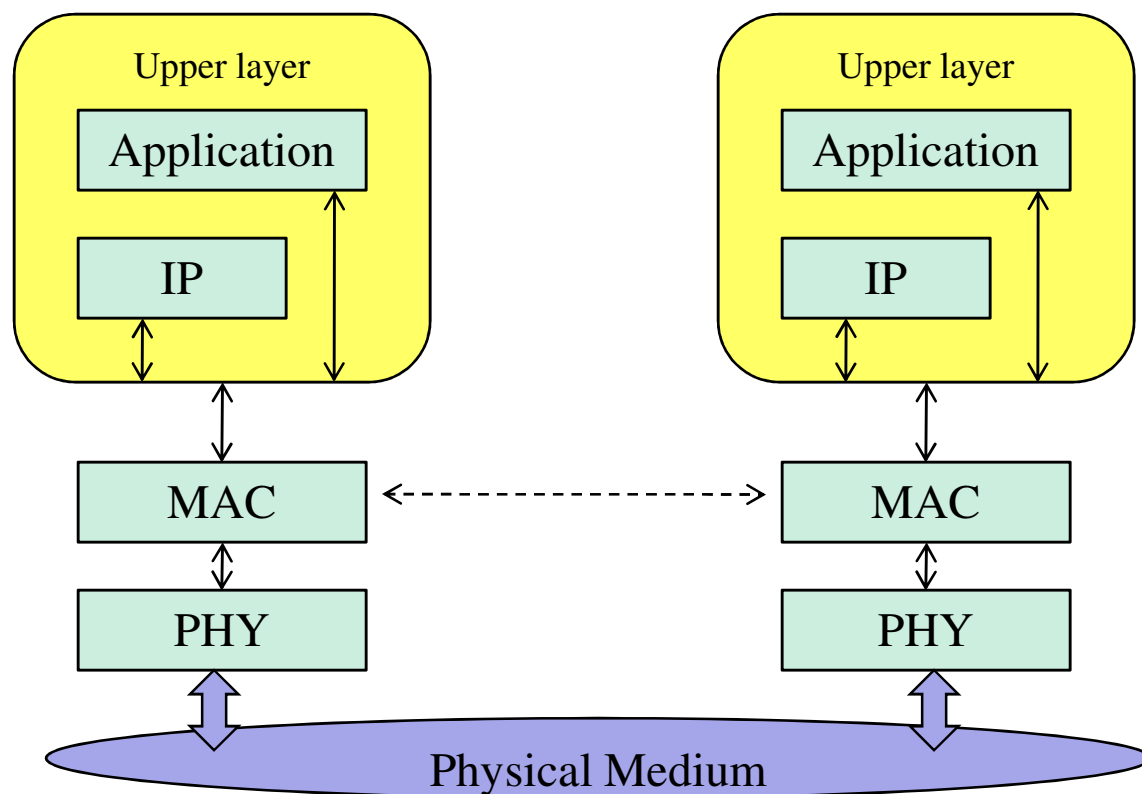
Network Topologies Supported

- Peer-to-Peer topology
  - Communication (data and control signaling) between two devices
  - One-to-one configuration

- Star topology
  - Devices communicate with an access point
  - One-to-many and many-to-one configuration, Bi-/uni-directional
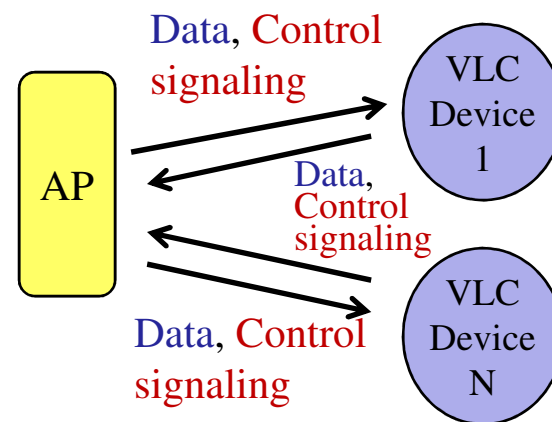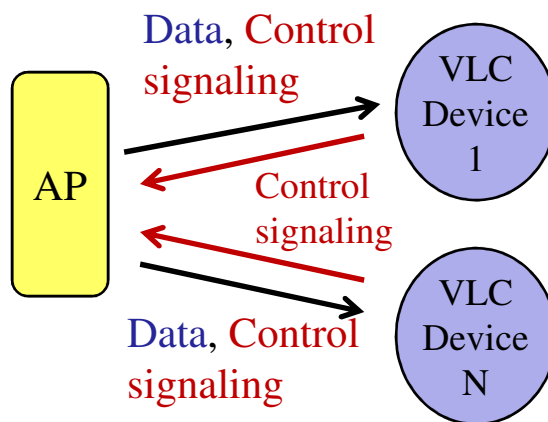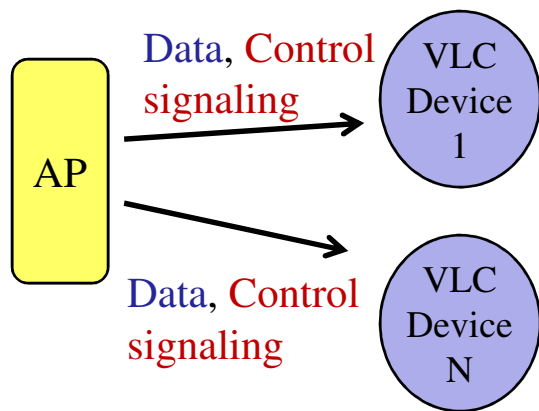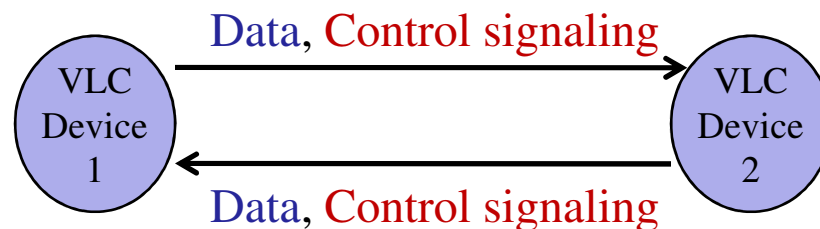
Spectrum and Channel Assignments

- Assign spectrum color codes for communicating the channels supported between devices
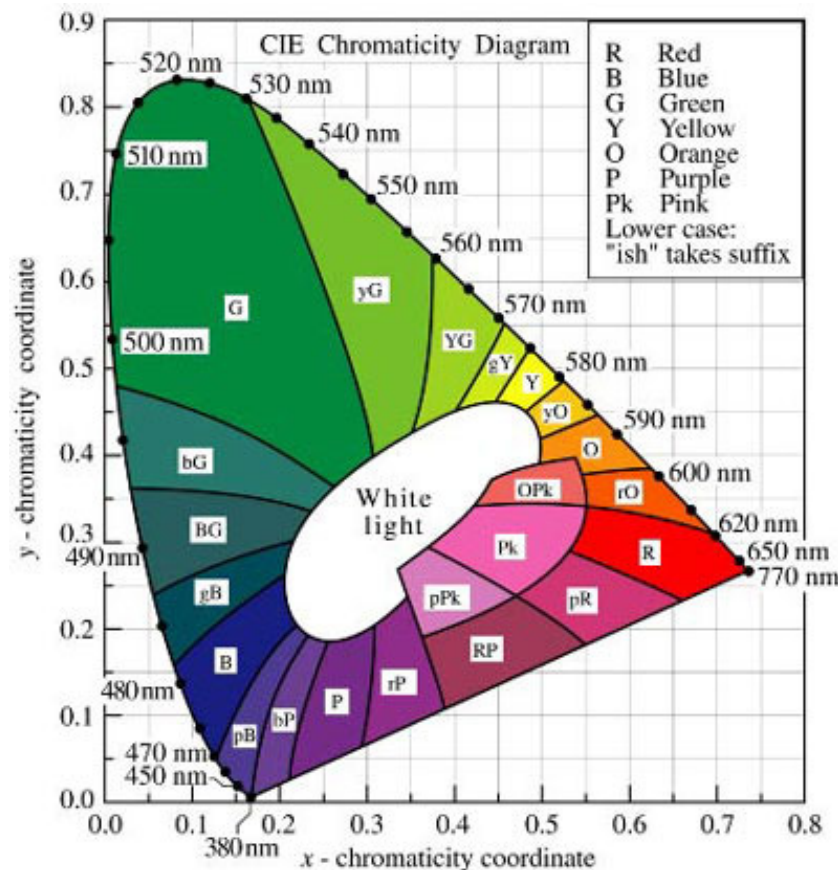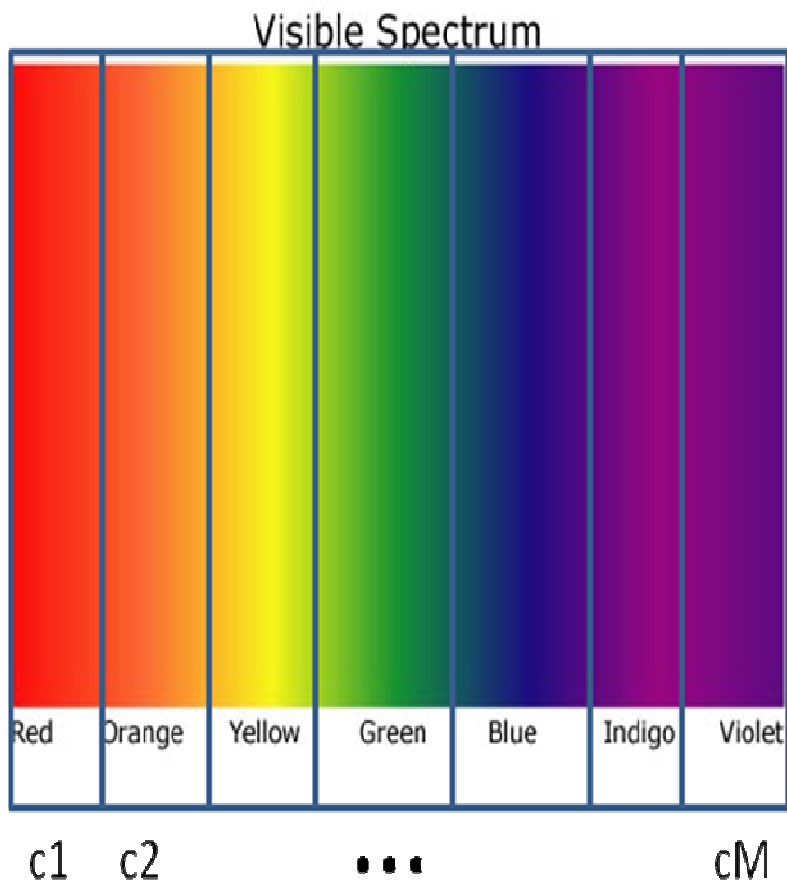
Source: http://www.ecse.rpi.edu/~schubert/Light-Emitting-Diodes-dot-org/chap17/F17-03%20Chromaticity%20diagram%20(Gage).jpg

Wavelength (Channel) Selection

- Channel access and wavelength (channel) selection
- Sensing protocols, CSMA-CA, contention periods and reservations mechanisms etc.
- Different light colors may experience different levels of interference.
- MAC should select color(s) for transmission that experience the least interference

Leakage

- ## Self-interference during full-duplex
  - The light source may impact its own receiver during full duplex operation

- ## MAC should take into account adjacent channel interference with various types of light sources from various manufacturers and applications


Source: http://www.theledlight.com/technical3.html
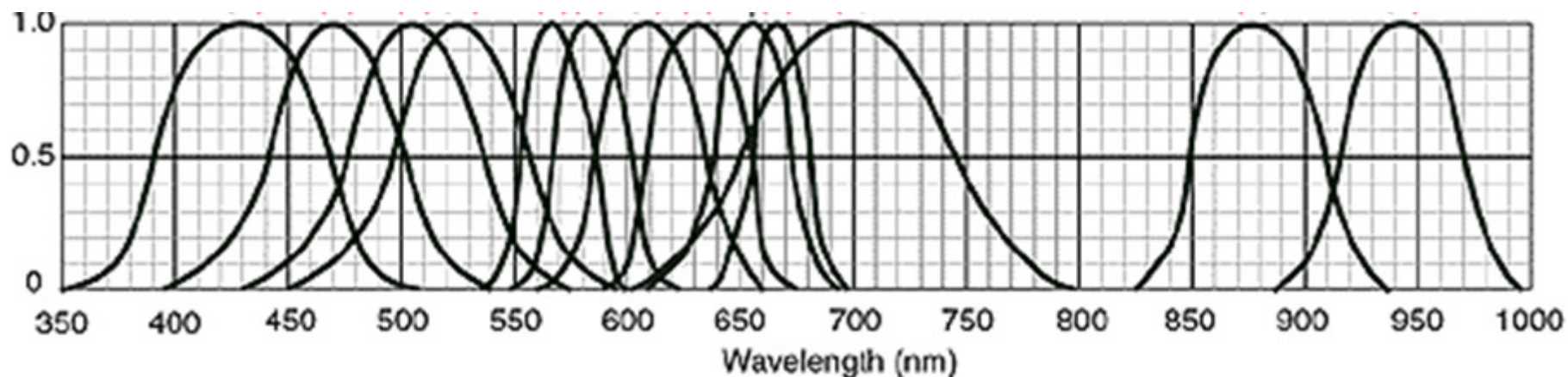
Guard Color Channels

- In order to support FDD duplex operation, we can define "guard color" channels for each channel used for transmissions.

- For every channel color, we define a list of guard colors that cannot be used (for TX/RX) when the chosen color is used for TX

- These guard colors can be used during channel selection process to select channel(s) that minimize interference.

- The criteria used for defining a guard color channel could be based on out-of-band leakage, exceeding a certain value (for example, 10 -20 dB) over the in-channel value that causes a considerable loss in receiver sensitivity in those channels.

Channel Quality Reporting
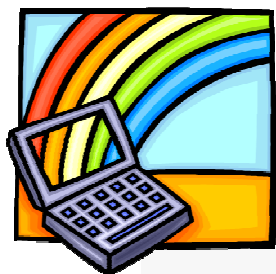
- Link channel quality monitoring and reporting
- Wavelength (color) specific channel quality monitoring
- Different light colors may experience different levels of interference.
- MAC should provide mechanisms to monitor and report channel quality in a color-specific manner.

Transmit Light Control (TLC)
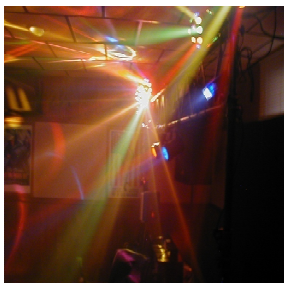
- Similar to transmit power control in RF systems for interference reduction.
- Multiple ways to reduce power possible
  - PWM, turning off some of the lights, dimmer circuits
- MAC should support TLC to reduce interference and maximize device battery life.

References

- *http://www.theledlight.com/technical3.html*

- IEEE 802.15.7 TG contribution:

  – *15-09-0125-01: VLC application definitions and summary*

- CIE chromaticity diagram:

  – *http://www.ecse.rpi.edu/~schubert/Light-Emitting-Diodes-dot-org/chap17/F17-03%20Chromaticity%20diagram%20(Gage).jpg*