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Re: []

Abstract: [This document presents about Technical Requirements for VLC Applications]

Purpose: [To contribute the Technical Requirements Document of IEEE 802.15.7 VLC]

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Technical Requirements for VLC Applications

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Contents

• Technical Requirements
  – Topology
  – Uni/Bi-Directional
  – Data rate and Distance
  – Inherent Function of lighting source
  – Reliability

• Conclusions
Topology

- Network topology is the study of the arrangement or mapping of the elements (links, nodes, etc.) of a network, especially the physical (real) and logical (virtual) interconnections between nodes.
Physical Topology for VLC

- Six basic types of physical topology
  - Point-to-point, Bus, Star, Ring, Mesh and Tree

- Physical topology for VLC
  - Point-to-point and Star topology will be the physical topology which VLC can apply.
  - But we do not need to limit.
Logical topology for VLC

- Logical topology for VLC
  - Star, ring and mesh is possible and suitable.
  - But we also do not need to limit.

<table>
<thead>
<tr>
<th>Type</th>
<th>Diagram</th>
<th>Special feature</th>
<th>VLC applications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Star</td>
<td><img src="star.png" alt="Star Diagram" /></td>
<td>Master and slave</td>
<td>Infrastructure to any, mobile to fixed</td>
</tr>
<tr>
<td>Ring</td>
<td><img src="ring.png" alt="Ring Diagram" /></td>
<td>Token control</td>
<td>Fixed to fixed</td>
</tr>
<tr>
<td>Mesh</td>
<td><img src="mesh.png" alt="Mesh Diagram" /></td>
<td>Number of connection</td>
<td>Fixed to fixed, Vehicle to vehicle</td>
</tr>
</tbody>
</table>
Definition of Uni/Bi-directional

- Uni-directional: A VLC device that processes data flowing only in one physical direction (TX or RX)
- Bi-directional: A VLC device that processes data flowing in two physical directions (TX and RX)*

<table>
<thead>
<tr>
<th>Direction</th>
<th>Transmission mode</th>
<th>VLC Applications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uni-directional</td>
<td>Simplex</td>
<td>Information Broadcast, Image sensor with LED tag, Visible remote control</td>
</tr>
<tr>
<td>Bi-directional</td>
<td>Half-duplex</td>
<td>Most of applications</td>
</tr>
<tr>
<td></td>
<td>Full-duplex</td>
<td></td>
</tr>
</tbody>
</table>
The Necessity of Uni-directional

• At TRD
  – Do we need to consider uni-directional case (no acknowledgements)? Yes
  – Information broadcast is uni-directional case and one of important applications for VLC
    • Indoor navigation, visible remote control*
  – If bi-directional communication is possible, uni-directional case can be covered by MAC or PHY layer.

* 15-09-0173-00-0007-consideration-on-vlc-application
Uni-directional within bi-directional

Information broadcasting

LED
TX Only or TX & RX

Information packet with TX only option

ACK

TX & RX

LED
TX & RX

Information packet with TX/RX option

ACK

TX & RX

TX & RX
Data Rate vs. Distance

• At application definition and summary document (15-09-0125-03-0007)
  – Data rate: min 100kbps to max 1Gbps
  – Distance: min 50cm to max 100m

• Data rate is related to light source.*
  – Phosphor LED: <10Mbps
  – Phosphorless LED: <100Mbps
  – RCLED: <500Mbps
  – LD: 1Gbps

• Real data coverage at max data rate of each lighting source

* 15-08-0468-00-0vlc-vlc-wavelength-range
Classification of Data rate

• We need to define data rate requirement according to distance and light source
  – Because we can not increase transmission power (source intensity) for increasing distance at our pleasure.
  – Because we can not use LD or RCLED at illumination for high data rate.

• Summary of Application definition and summary document (15-09-0125-03-0007)

<table>
<thead>
<tr>
<th>Application</th>
<th>Distance</th>
<th>Data Rate</th>
<th>Expected Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>M-to-X</td>
<td>1~10m</td>
<td>100Mbps</td>
<td>RCLED</td>
</tr>
<tr>
<td>Illumination</td>
<td>3~10m</td>
<td>10Mbps</td>
<td>Phosphor or less</td>
</tr>
<tr>
<td>V-to-X</td>
<td>100m</td>
<td>100kbps</td>
<td>Phosphor or less</td>
</tr>
</tbody>
</table>
Suggestion of Data rate classification

• Define range*
  – Very short range : < 0.5m,   Short range : < 3m
  – Middle range : 3m ~ 10m,   Long range : >10m

• Determine data rate depending on distance and available light source at each device

<table>
<thead>
<tr>
<th>Application</th>
<th>Distance</th>
<th>Data Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>M-to-M, P-to-P</td>
<td>Very Short</td>
<td>?</td>
</tr>
<tr>
<td>M/P-to-F, illumination</td>
<td>Short</td>
<td>?</td>
</tr>
<tr>
<td>Illumination M-to-Infra</td>
<td>Middle</td>
<td>?</td>
</tr>
<tr>
<td>V-to-X</td>
<td>Long</td>
<td>?</td>
</tr>
</tbody>
</table>

* 15-09-0125-01-0007-vlc-applications-definitions and summary
Dae-Ho Kim, ETRI
Inherent Function of lighting source

• The inherent function and quality of the equipment should be maintained although VLC technology is applied.
  – Brightness of illumination
  – Dimming control of illumination
  – Color of illumination
  – Brightness control of Stop lamp of vehicle
  – Brightness of Head lamp of vehicle
Reliability of VLC

- **Reliability**: Link packet loss rate*
  - 802.15.4: less than 1%
  - 802.15.3: less than 8%
  - 802.15.5: consider related standard
  - Critical factor to some application
    - Emergency, Blind navigation, L-commerce**

* 15-04-0655-00-0005-tg5-technical-requirements
** 15-09-0117-01-0007-vlc-potential-use-cases-and-technical-requirement
Conclusions (1/2)

• Topology
  – Point-to-point and star for physical topology
  – Ring, star and mesh for logical topology
  – VLC can support all types of physical and logical topologies.

• Directionality
  – Bi-directional and Uni-directional (optional)

• Transmission mode
  – Half-duplex mode or Full-duplex mode
Conclusions (2/2)

- **Data rate**
  - VLC need to classify of data rate related to the transmission distance and lighting device

- **Inherency**
  - VLC should maintain the inherency of lighting source during communication.
  - Add to TRD

- **Reliability**
  - Add to TRD