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

Submission Title: [VLC for Mobile to Mobile]
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Abstract: [Some visible light communication (VLC) application is described in this document. Especially mobile to mobile application is mentioned. Some consideration points and issues of that application are also presented.]

Purpose: [Contribution to IEEE 802.15 SG-VLC]

VLC for Mobile to Mobile

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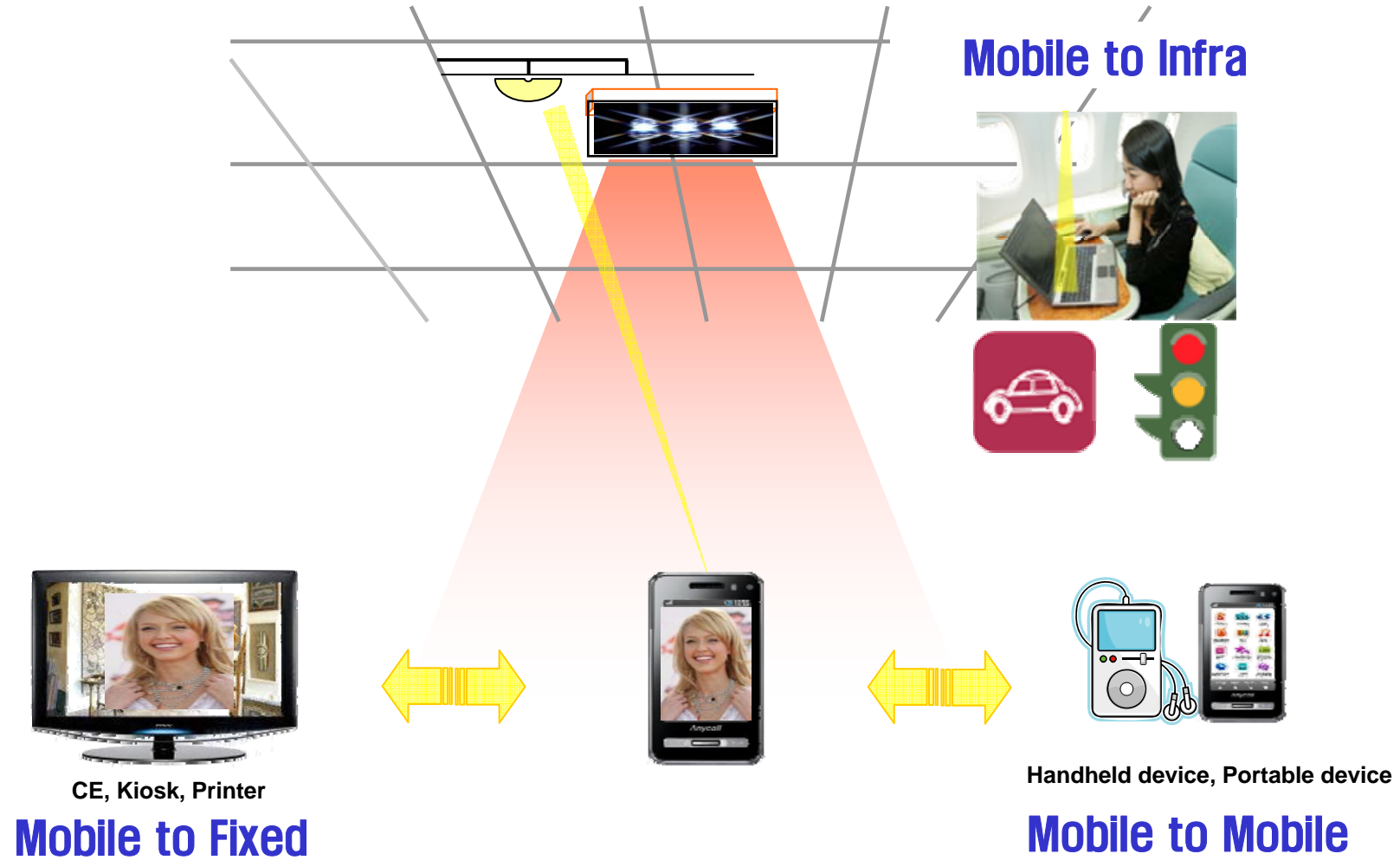## Samsung Electronics

Contents

- **VLC applications**

- **LED Infrastructure**

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- **Considerations of VLC**

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- **M2M VLC applications**

- **Summary**

VLC Applications

Mobile to Infra

CE, Kiosk, Printer

Mobile to Fixed

Handheld device, Portable device

Mobile to Mobile

General Advantageous features of VLC

■ **Visible Light Communication**

■ **Visibility**

■ **Security**

■ **Unregulated**

■ **Using inside the RF restricted area**

   (aircraft, hospital, etc…)

■ **Through glass, not through wall**

■ **Light Emitting Diode (LED)**

■ **Small**

■ **Relatively Long life**

■ **More efficient energy-saving**

■ **Low power consumption**

■ **Difficulty in damaging with the external shock**

■ **Minimal heat generation**

LED Infrastructure

■ VLC & LED Infrastructure

■ **An indispensable element of the VLC.**

■ **LED works as a light source**

■ **VLC applications related to LED infrastructure**

■ Drawback

■ **Light compatible**

- ▪ **Work both illumination and light source for the communication.**

- ▪ **Main job is the illumination.**

■ **LED infrastructure**

■ VLC W/O LED infrastructure

Considerations of VLC

❖ **Visibility**

■ **General consideration**

◆ **Can be verified by the naked eyes**

■ Unique protocol

■ In case of turning the light On / Off

■ **Specific consideration for M2M VLC**

◆ **LED choice**

■ Independent from LED infrastructure (White LED, RCED, LD, etc)

■ Consumer Needs

◆ **Light source choice**

■ W/O LED & PD

Considerations of VLC

❖ **Distance (Coverage)**

▦ **General consideration**

◆ **The distance and the communication ability,**

The coverage and the communication ability

■ Long distance, wide coverage, high power

▦ **Specific consideration for M2M VLC**

◆ **Divergence angle control, FOV control and etc.**

◆ **Can be optimized for only M2M device within the short range**

■ Independent of the illumination

■ Mobile to Mobile - short range

Considerations of VLC

❖ **Noise**

▪▪ **General consideration**

◆ **Ambient light (Sun, Incandescent, Fluorescent,…)**

◆ **FOV, Divergence, Indoor, Outdoor, …**

▪▪ **Specific consideration for M2M VLC**

◆ **Divergence angle , FOV control and etc.**

▪ Outdoor: Sun light

▪ Indoor: Fluorescent, Incandescent light

◆ **Using the Image sensor**

▪ Not affected by the optical noise

▪ Relatively long distance

Considerations of VLC

❖ **LOS (Direct path) / NLOS (Multi path)**

- **General consideration**

  - ◆ **Depend on Comm. Environment (M2M, M2F, M2I)**

  - ◆ **Direct path light is dominant.**

  - ◆ **Ignore the NLOS (Multi-path light) ?**

    - ■ Mobile to Fixed, Mobile to Infra

- **Specific consideration for M2M VLC**

  - ◆ **Direct path light is dominant.**

  - ◆ **LOS guarantee by intent.**

  - ◆ **Should consider the multi-path in VLC M2M device?**

Considerations of VLC

❖ **Mobility**

▪▪ **General consideration**

◆ **Depend on Comm. Environment (M2M, M2F, M2I)**

◆ **Partial mobility & Full mobility**

▪▪ **Specific consideration for M2M VLC**

◆ **Key element**

◆ **One way / Two way (both way)**

Considerations of VLC

❖ **the others**

▪▪ **General consideration**

◆ **Eye safety**

◆ **Quality of Service (QoS)**

◆ **Modulation**

◆ **Network Topology**

◆ **Power saving/power control**

▪▪ **Specific consideration for M2M VLC**

◆ **TX & RX**

▪ **Installation place of TX & RX**

Mobile to Mobile VLC

- **There are two major advantageous features of VLC.**

  - LED infrastructure proliferation

  - Visibility

- **Visibility**

  - Intuitive communication
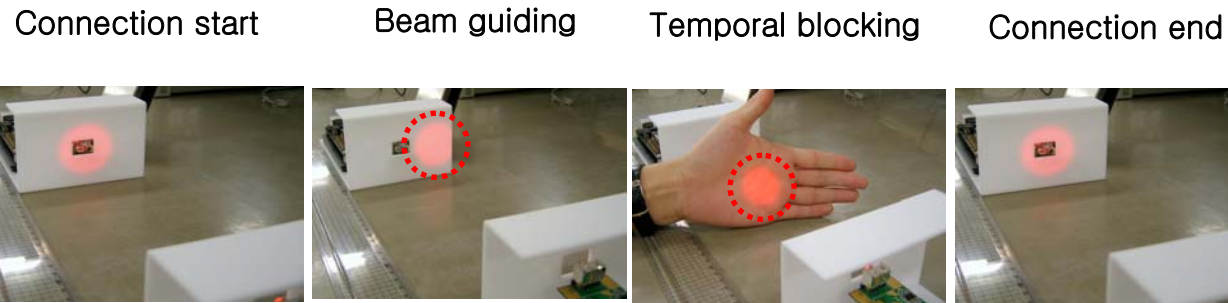
  - Fun & Aesthetics

  - Relatively Short range

  - High Security (Physical layer security)

M2M VLC Applications

- **M2M VLC with Mobility**

  - **Visible Remote control**

  - **Large display, Electric photo frame**

  - **Cradle**

  - **Kiosk, Optical hot-spot**

  - **Secure Point-to-point data communication**

  - **Vehicle to vehicle**

MAC issue in M2M

Connection start   Beam guiding   Temporal blocking   Connection end

- **Visibility-based feature**

  - **Visible guiding for user alignment**

  - **Visible link failure indication for intuitive usage**

  - **IrDA and Ethernet cannot support these features.**

SUMMARY

- VLC applications and advantage

- LED Infrastructure

- Considerations of VLC

- M2M: Consideration, Issues and application