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

Submission Title: [VLC Experimental Test & Results]
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Re: []

Abstract: [Experimental test of the visible light communication application for feasibility is described in this document. Some part of the results are also presented.]

Purpose: [Contribution to IEEE 802.15.7 TG-VLC]

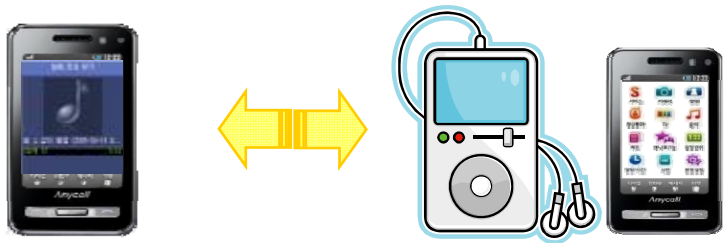
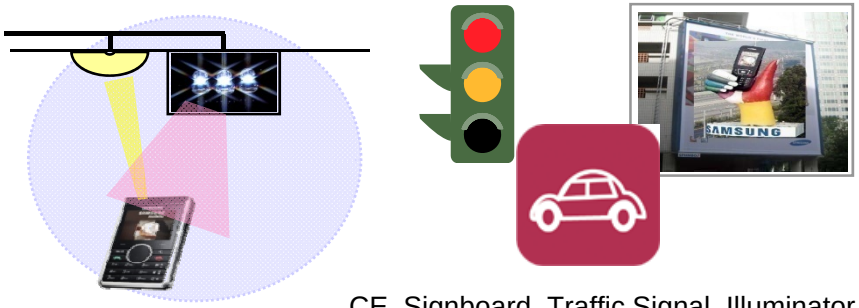
VLC Experimental Test and Results

2009. 01

Samsung Electronics

Contents

VLC Applications

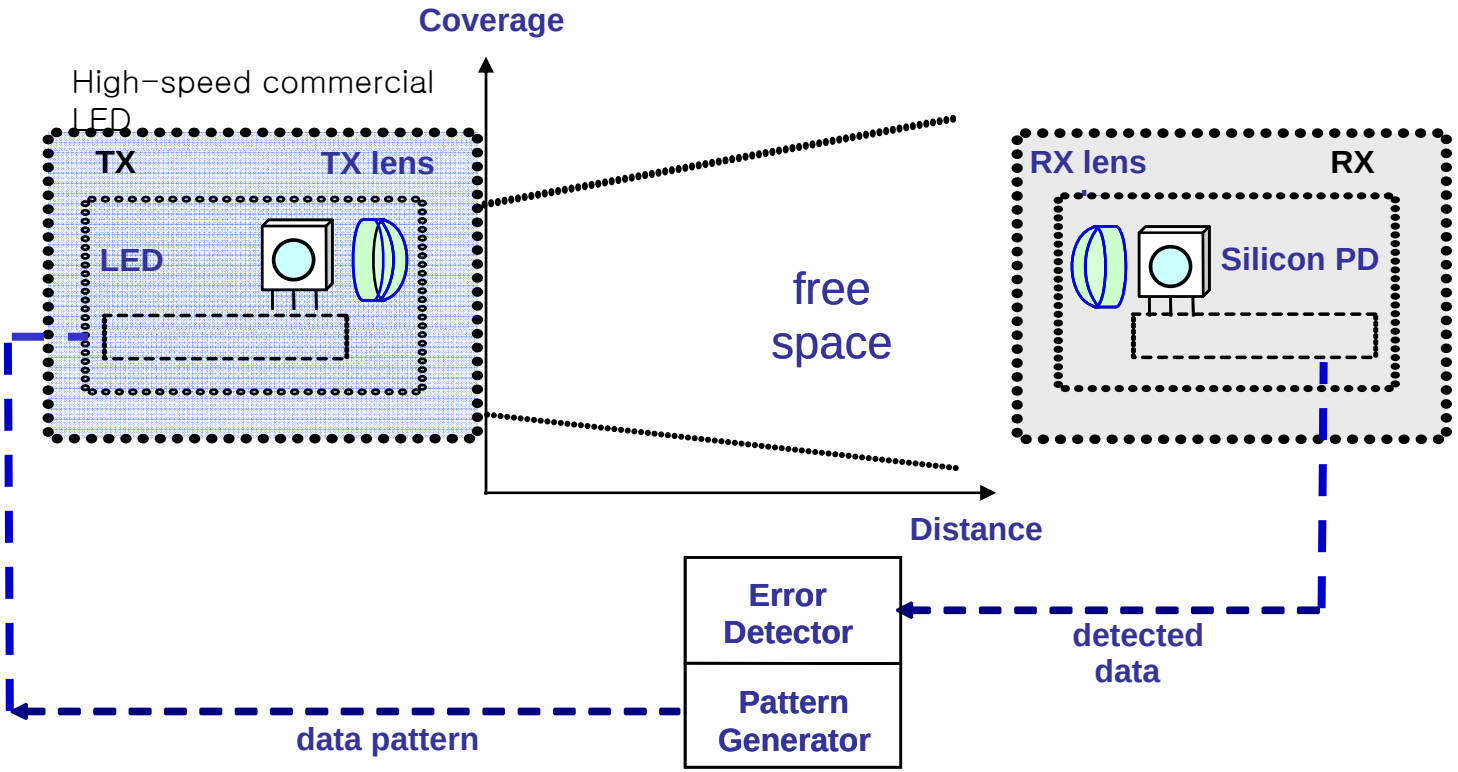
	Application	Function / Consideration
Mobile to Mobile	 Handheld device, Portable device	▪ Data transfer ▪ Contents sharing
Mobile to Infrastructure	 CE, Signboard, Traffic Signal, Illuminator	▪ Indoor Navigation ▪ Information-broadcasting system

Mobile to Mobile of VLC

- **Mobile devices**
  - For the portable mobile device.
    - Cell phone, PDA, UMPC, MP3 player, etc
  - Implementation
    - Built-In, Dongle style (USB, Serial, etc)

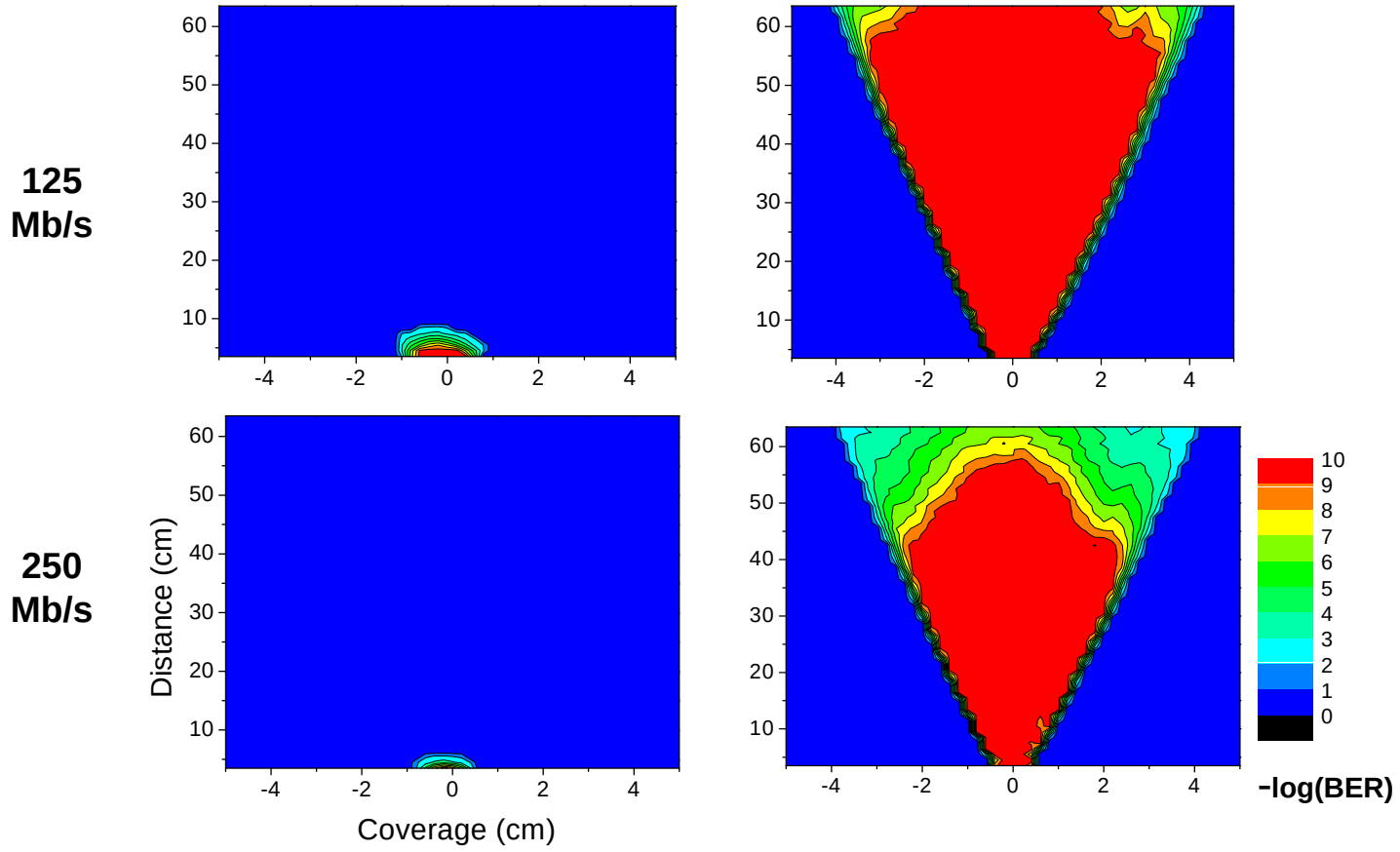
- **Feasibility of Mobile data transfer**
  - Coverage (Divergence Angle)
  - Distance
  - Visibility
  - Mobility
  - Ambient light effect
  - Multi-color

Basic Experimental Setup



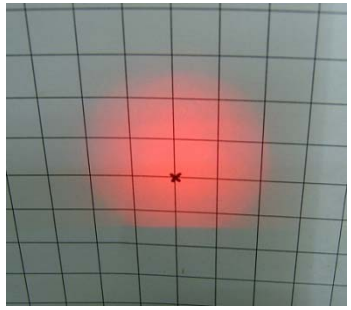
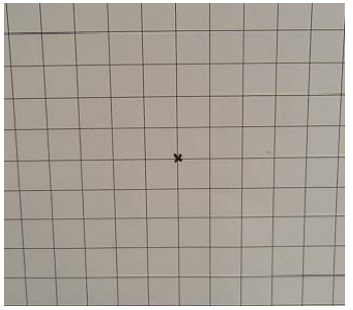
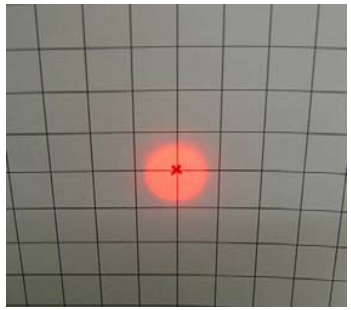
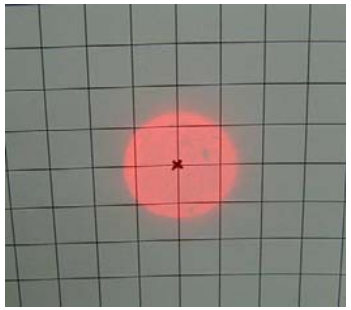
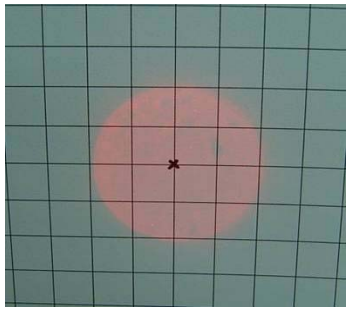
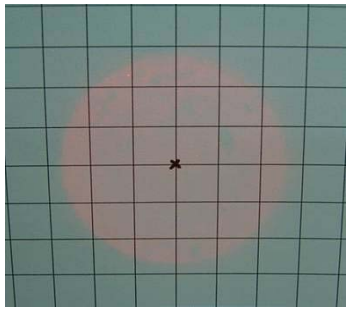
Test Results [Measured BER]

- VLC – coverage vs. distance



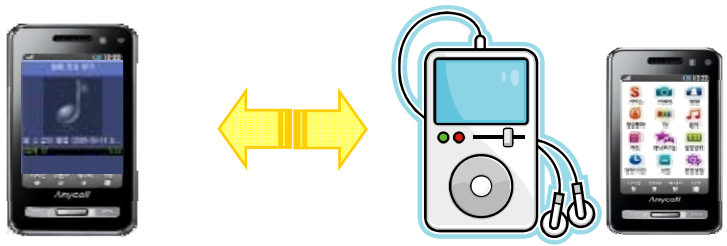
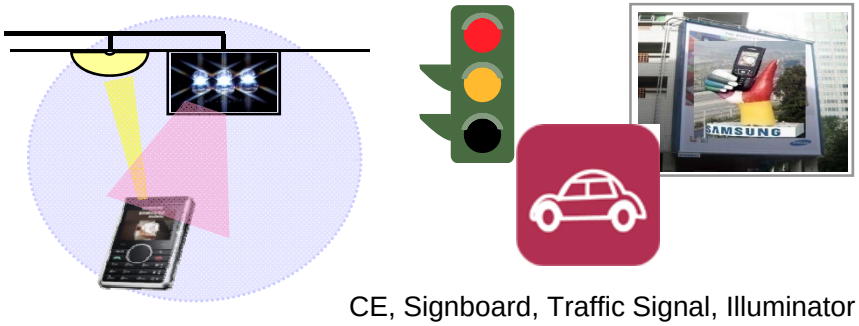
Test Results [Visibility]

- VLC – visibility vs. distance

Distance	10 cm	20 cm	30 cm	40 cm
W/O Tx lens				
With Tx lens				

1 cm / div

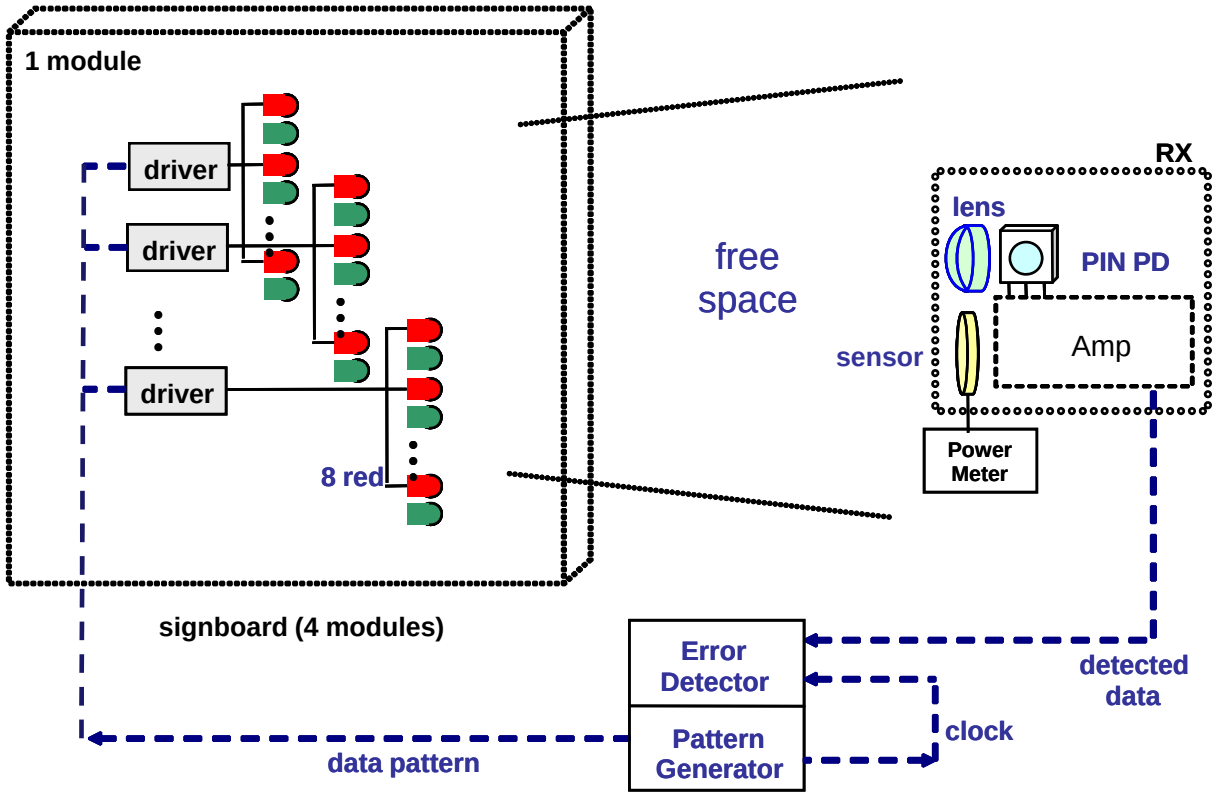
VLC Applications

	Application	Function / Consideration
Mobile to Mobile	 Handheld device, Portable device	▪ Data transfer ▪ Contents sharing
Mobile to Infrastructure	 CE, Signboard, Traffic Signal, Illuminator	▪ Indoor Navigation ▪ Information-broadcasting system

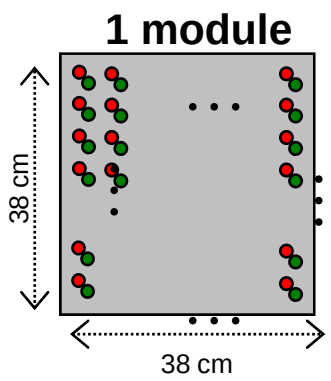
Mobile to Infrastructure Application of VLC

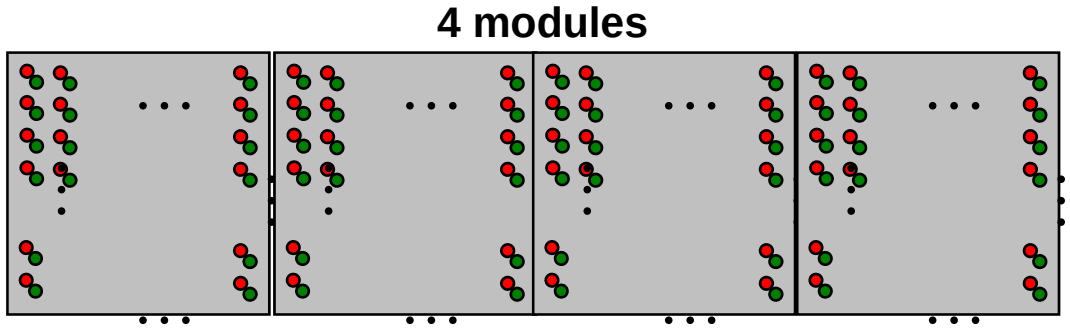
- **For the Infrastructure devices**
  - LBS, Indoor Navigation, Sign-board, E-vending machine, Message board, ITS, etc
- **Function**
  - Normal function as indication, illumination, and so on.
  - Additional communication function
  - Can be used as communication devices for transmitting & broadcasting information.
- **Feasibility of Information Broadcasting System**
  - Distance
  - Coverage
  - Ambient light effect
  - Multi-color

Experimental Setup



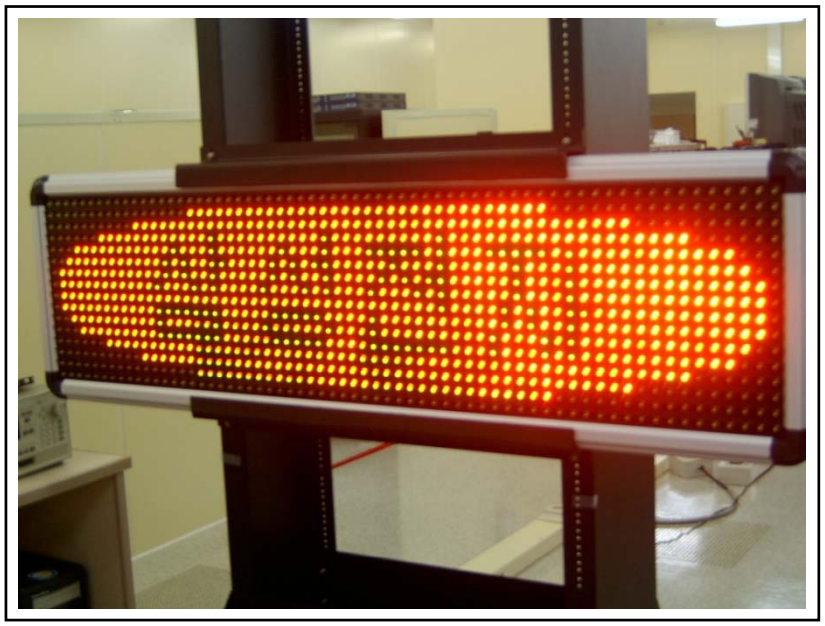
Feasibility Test (Signboard)



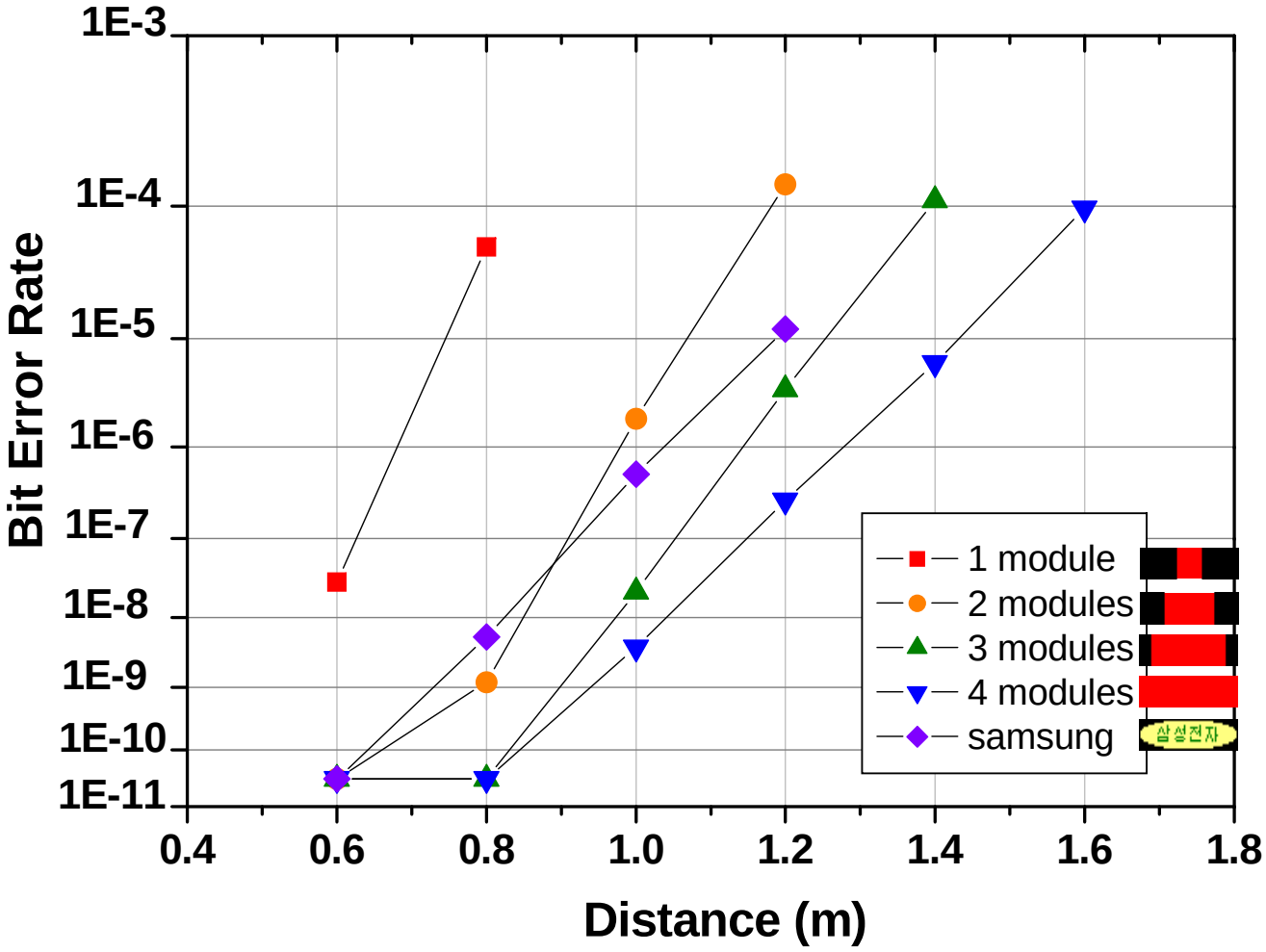


- **Red LED: 256 (16 x 16)**
- **Green LED: 256 (16 x 16)**

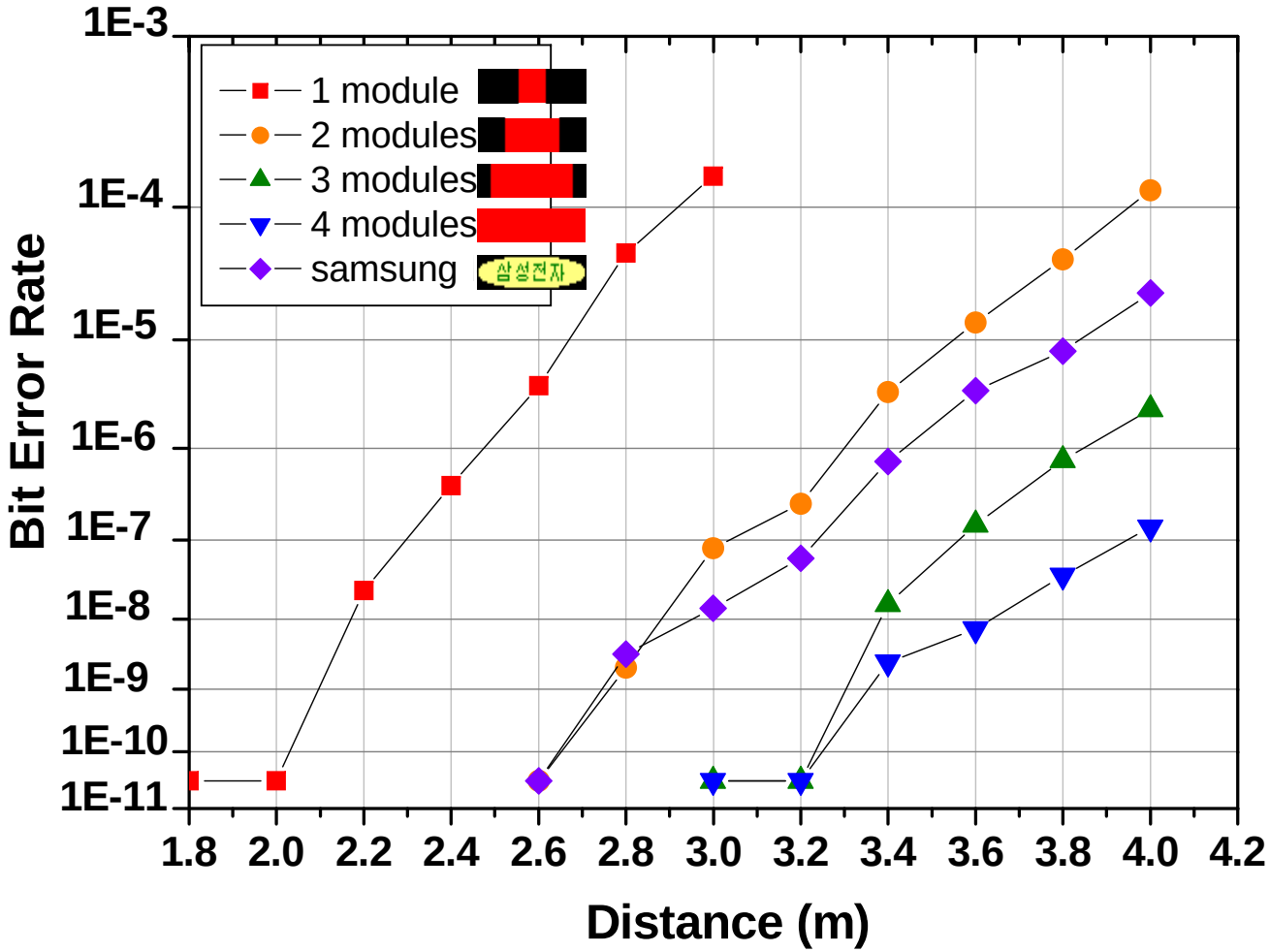
***** Only red LEDs were modulated



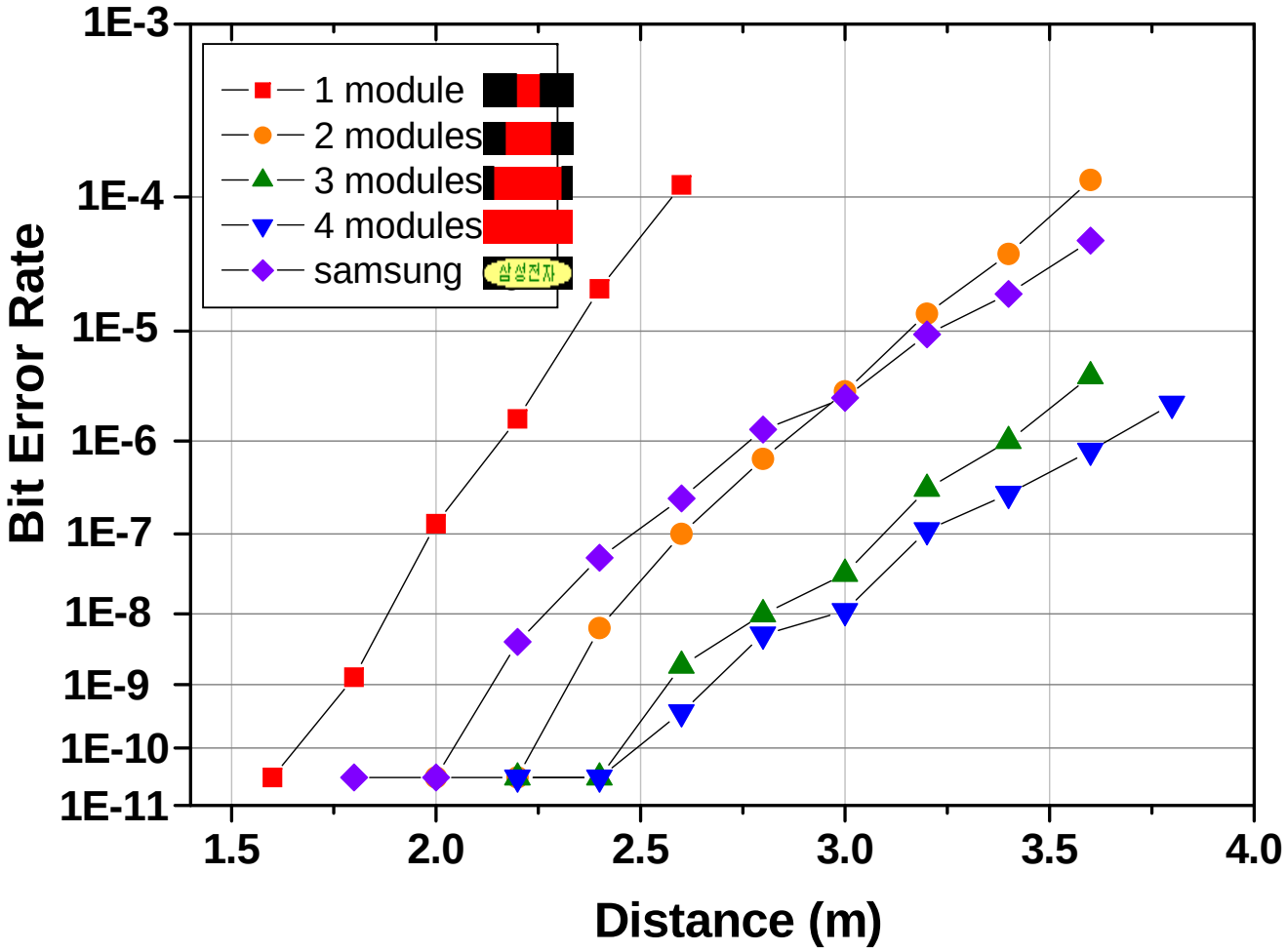
Test Result [Measured BER at 4Mbps w/o lens]



Test Result [Measured BER at 4Mbps with lens]



Test Result [Measured BER at 10Mbps with lens]



Summary

- **Feasibility of Mobile to mobile application was tested.**
  - TX (LED), RX (PD), w/, w/o Lens
  - Coverage and Distance
  - Visibility and Distance
- **Feasibility test of information broadcasting system was tasted.**
  - Sign-board
  - 4-Mbps and 10-Mbps
  - Using 4 LED array modules (BER 10^{-6}),
    - 4-Mbps visible light signals could be transmitted over 4.2 m with Rx lens.
    - 10-Mbps visible light signals could be transmitted to 3.6 m with Rx lens
  - possibility of LED's multi-color features

Summary

- **Distance / Coverage / Visibility**
  - Need to be decided based on applications
  - Visibility
    - Difficult to keep the visibility with long distance
    - Power consumption for the visibility
    - Not the visibility but the attractive idea
- **Future work**
  - Find unique advantageous features
  - Assurance of the visibility
  - Using the multi-color
  - Ambient light effect