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

Submission Title: [Channel models in VLCC]

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Abstract: [The overview of channel models which has been discussed in VLCC Japan.]

Purpose: [Contribution to IEEE 802.15 TG7]

VLC Channel Models in VLCC

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VLCC organization and Channel models

Honorary Chairman: Masao Nakagawa (Professor, Keio University)
Chairman: Shinichiro Haruyama (Professor, Keio University)
Vice Chairman: Ken Sakamura (Professor, Tokyo University)
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General Meeting

Chairman of the board of directors : Shinichiro Haruyama (also hold the post of Chairman)
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Executive: Jun Yoneda, Sharp Corporation
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Board of Director

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Shinichiro Haruyama

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Toshiharu Nakatsu

Social System Project

Fundamental Technologies Investigation WG

WG1, WG2

- Lighthouse Sub Project
- Traffic Signal Sub Project

- Visible Light Portable Terminal Working Group
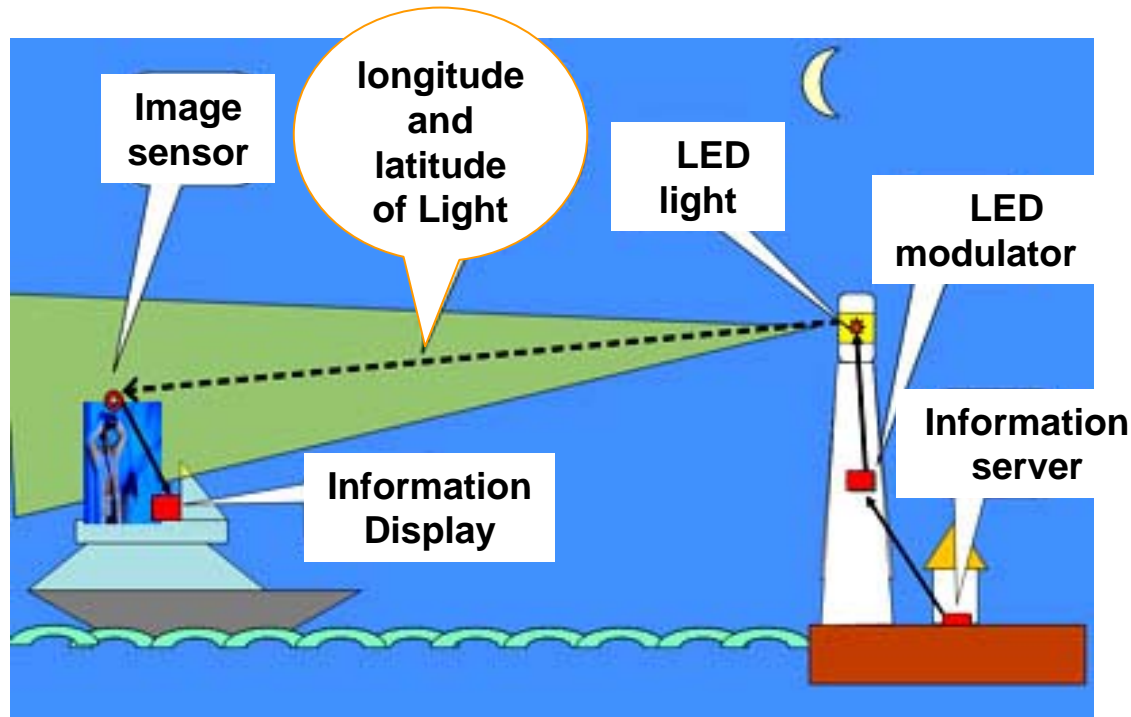- Visible Light LAN Working Group

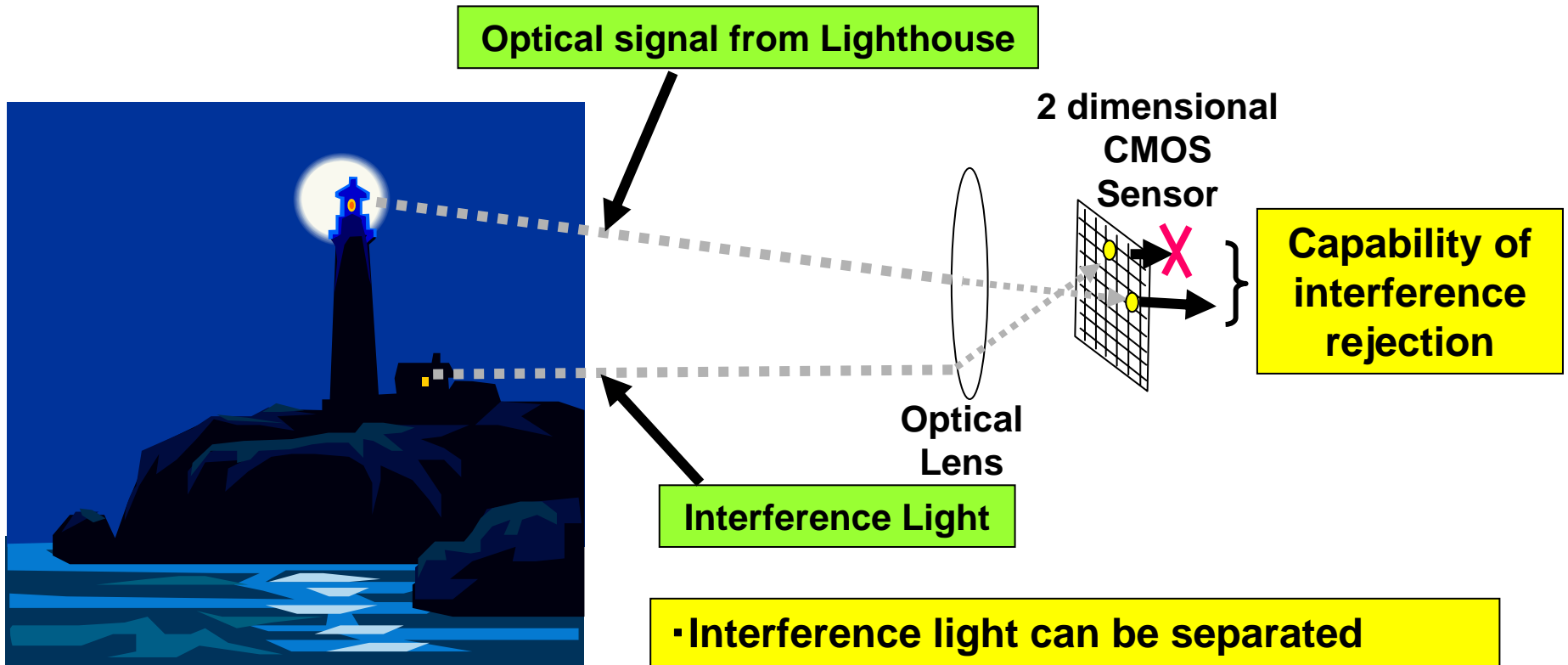**Channel models using Image Sensor**

Channel models using PD/APD

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Channel Models using Image Sensor:

(1) Lighthouse Sub Project –
The Lighthouse Sub Project is one of "the Social System Projects", and it studies the VLC long distance transmission, using image sensor.

Optical signal from Lighthouse

2 dimensional CMOS Sensor

Capability of interference rejection

Optical Lens

Interference Light

·Interference light can be separated

·Background noise is less in night time

·Long distance transmission is available

Long distance transmission experiment

Experimental
LED lighthouse

Light from LED
lighthouse

VLCC succeeded in the world record of long-distance telecom experiment by the visible light communication using image sensor communications technology

The transmission rate was at 1200bps for the communications distance of 1km and 2km, respectively.
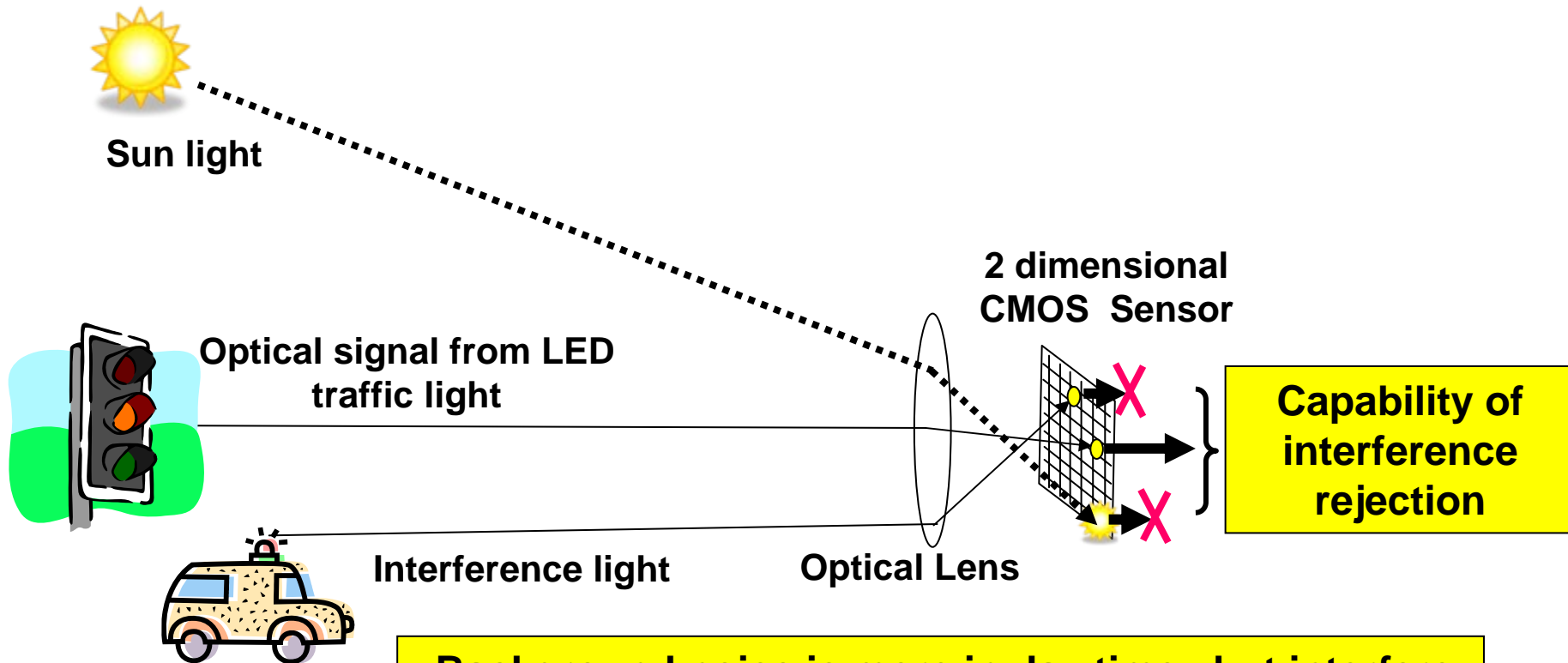
(2) Traffic Signal Sub Project -

Traffic Signal Sub Project is one of the Social System Projects, and it does verify a practical possibility of a visible light communication for the traffic signal, using image sensor.

Control information transmission using image sensor

The Traffic Signal Sub Project started studies about the use of the visible light communication to control information transmission between traffic signals using image sensor receivers

It is pushed forward to experiment the transmission of "signals" including "control contents" and "sensor information", etc.

Sun light

2 dimensional CMOS Sensor

Optical signal from LED traffic light

Capability of interference rejection

Interference light

Optical Lens

·Background noise is more in day time, but interfere nce light can be separated, using image sensors.

·LED traffic light signal power is large enough for the middle (~400m) transmission

On going long-term experimental setup

Target LED traffic signals

Image sensors
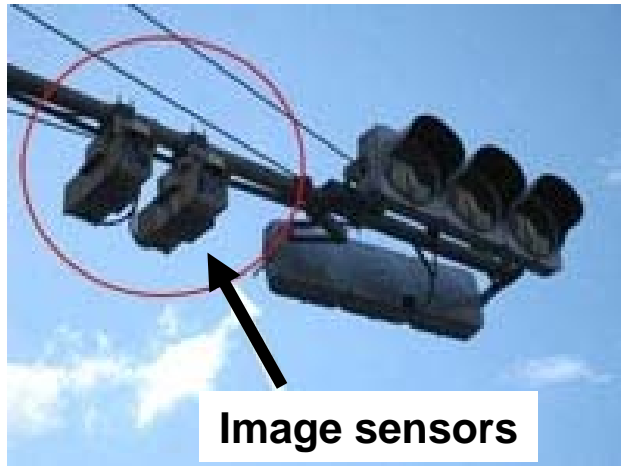
From September, 2008, the Traffic Signal Sub Project started "environm ental measurement experiment" using real signals with several measure ment machineries including "weather machine" to measure the climate conditions such as wind, humidity, rain, fog, etc and "accelerometer" to measure the vibration of the signal occurred by the vehicle traffic, etc and "camera" to measure the influence of the weather conditions , etc.

Channel Model using PD/APD

In October, 2008, it was announced that VLCC had begun in cooper ation with "Infrared Data Association (IrDA)" and "Infrared Communi cation Systems Association (ICSA)".
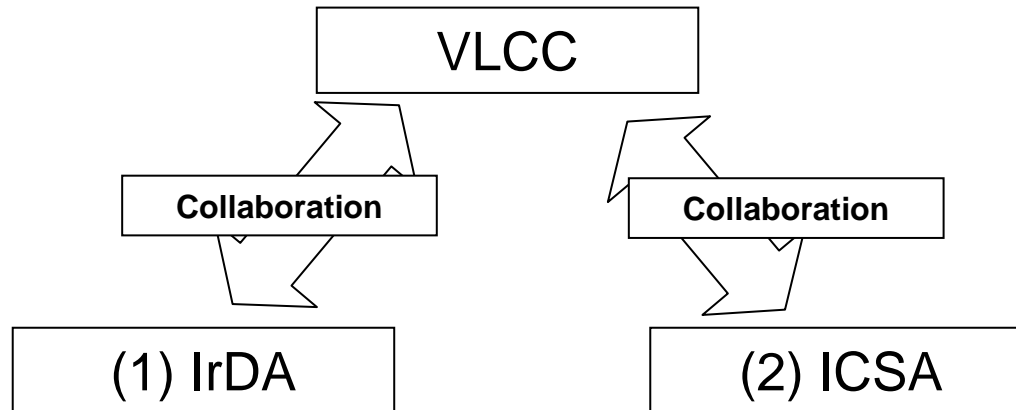
Joint development and cooperation With IrDA and ICSA

(1)Joint development and cooperation with IrDA （= IrDA extension）

- Public space Visible Light to mobile terminal
- Visible Light mobile terminal to mobile terminal

(2) Joint development and cooperation with ICSA （= ICSA extension）

- Visible Light Wireless LAN System for room

FOR IMMEDIATE RELEASE:

 The Infrared Data Association (IrDA) and Visible Light Communications Consortium (VLCC) Announces Complimentary Research and Development Effort

Walnut Creek, CA., September 3, 2008 – The Infrared Data Association (IrDA) which establishes in frared standards that provide convenient wireless connectivity and the Visible Light Communication s Consortium (VLCC) which is working on research, development, and the standardization of safe visible light communications (VLC) announce a cooperative agreement between the two organizati ons. This agreement recognizes the synergies between the organizations and the potential to coo perate in the promotion of optoelectronic technologies such as infrared and visible light communica tions.

This agreement allows both organizations to further research practical applications driving optoelec tronic implementations in such devices as consumer mobile devices (cell phones, cameras), lightin g apparatus, traffic signals, indicator lights, video displays, cars and toll booths. "We are very excit ed about the possibilities of this joint cooperation. With both technologies in the optoelectronic spe ctrum, we are looking forward to mutual development to complement each other and provide new a pplications to advance the industry" said Daphne Terrell, Executive Director, IrDA.

Chairman of VLCC, Professor Masao Nakagawa of Keio University, said, "By combining the widely used cellular phone IrDA technology and the new visible light communication technology, we expec t a new standard of very user-friendly communication system".
On Wednesday, October 21, 2008 IrDA will conduct an optoelectronic conference in Tokyo followe d on the 22nd by its October General meeting. On Friday October 24, 2008 VLCC will be conducti ng their Fall General meeting in Tokyo.

Advantage of joint development and cooperation

- As IrDA has been already installed in many cellular phones , and Visible Light Communication can be used simply by changing a physical layer of IrDA.
- VLCC is allowed to use the protocol stack and the patents of IrDA.
- VLCC can use their accumulated knowhow and test site of IrDA freely for its interoperability test between the different kind equipments (Ex., Nokia, docomo, etc) .
- It is quite easy for VLCC to interchange data between VLC and IrDA.

(1)-1 High transmission rate (576Kbps～4Mbps) specification (IrDA)

Advertising illumination
Information display
Digital Signage etc.

Image of Application
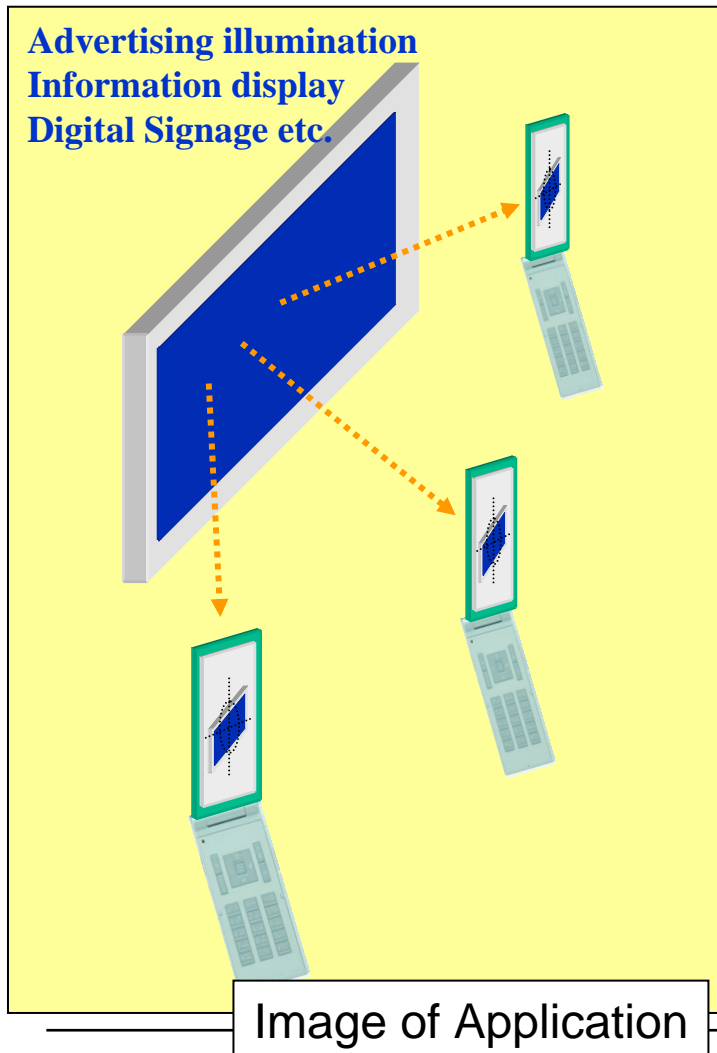
Features

- Enable to obtain Information from the targeted/focused place.
- Enable to deliver information from one place to many people. (1 to N)
- Enable to deliver a large volume of contents.

Specification

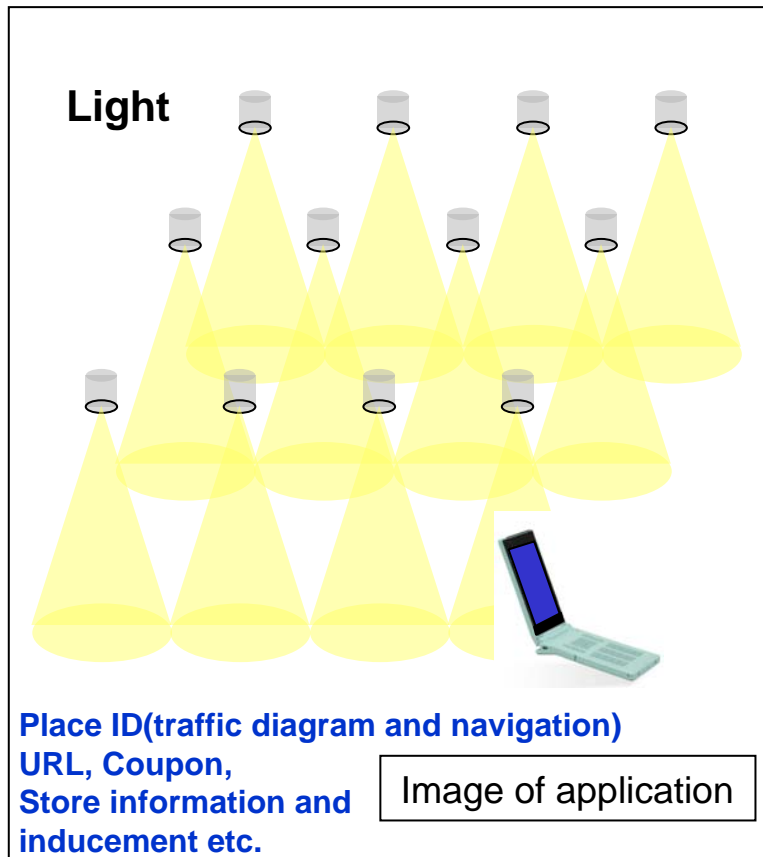| Transmission rate	576kbps,1.152Mbps(MIR) to 4Mbps(FIR)
Contents	Data including Movies/Audio , etc (The streaming is also acceptable) .
Transmission distance	More than 3meters (Capture data from the target.)
Delivery form	Broadcasting type(1 to N)

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(1)-2 Low transmission rate (300bps～9.6kbps) specification (IrDA)

Features

- Enable to capture information/data anytime by cellular phone.
- Enable to provide place Information such as ID, URL, etc from the lighting.
- Enable to provide wider services through cellular phone networks.

Specification

Transmission rate	300bps to 9.6 kbps (SIR)
Contents	Place ID, URL etc.
Transmission distance	Several meters (Enable to capture them by the reflection.)
Delivery form	Broadcasting type(1 to N)

Light

**Place ID(traffic diagram and navigation)
URL, Coupon,
Store information and
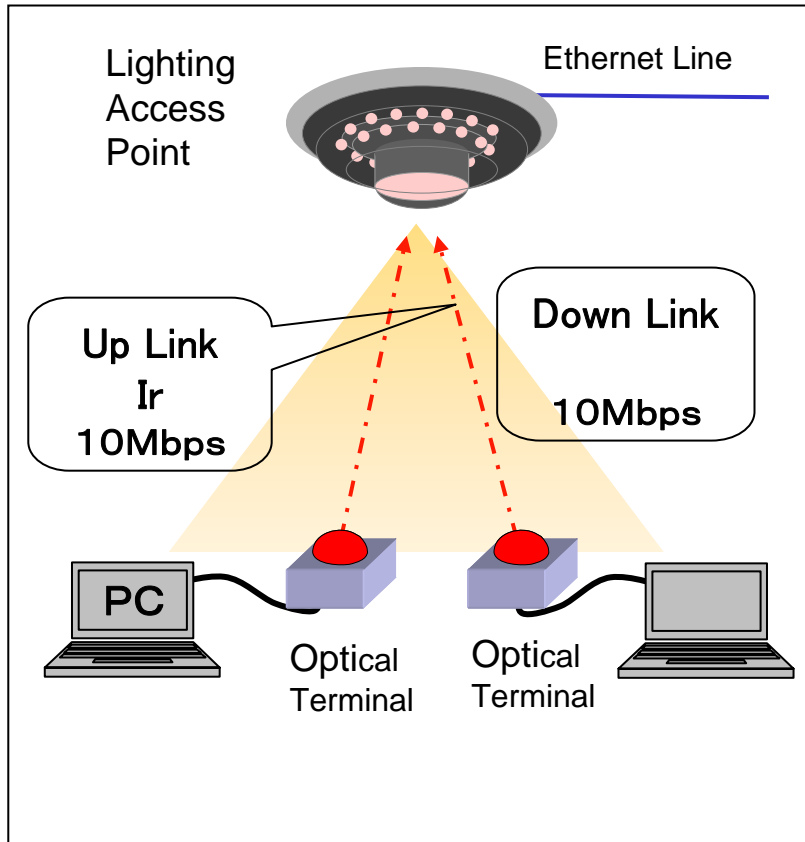inducement etc.**

Image of application

(2) Indoor Wireless LAN System (ICSA)

Features

- · 1 to N Wireless LAN through lighting access point
- · Connect to Ethernet Line/PLC
- · Based on ARIB STD-T50

Lighting Access Point

Ethernet Line

Up Link
Ir
10Mbps

Down Link

10Mbps

PC

Optical Terminal

Optical Terminal

Specification

Data transfer rate	10Mbps
Network	IEEE802.3 10BASE-T
Network Toplogy	1toN Half Duplex
Access Control	CSMA/CD

Road map of joint development and cooperation

2008 **2009** **2010**

October   January April   October   October

IrDA extension Visible Light Communication

Draft for standardization

Standardization Work completed

Conformance test of specification and Interoperability test

Marketing

ICSA extension Visible Light Communication

- 10 Mbps draft for -standardization

-Standardization Work completed

Examination for higher transmission

Conclusion

- To expand and promote Visible Light Communication, VLCC does a lot of technological examination tests and standardization activities.

- VLCC has been working on the standardization draft for IrDA extension specification (cellular Phone) and ICSA extension specification (wireless LAN)

- VLCC cooperates the standardization activities with TGvlc.