

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

Submission Title: [A PHY and MAC Proposal of Visible Light Communications with LED Lighting]

Date Submitted: [September, 2009]

Source: [Tae-Gyu Kang, Sang-Kyu Lim, Dae Ho Kim, Ill Soon Jang, Dong Won Han] Company [ETRI]

Address [138 Gajeongno, Yuseong-gu, Daejeon, 305-700]

Voice:[+82-42-860-5232], FAX: [+82-42-860-5218], E-Mail: [tgkang@etri.re.kr]

Re: [Response to call for proposals]

Abstract: [This document describes a proposal of PHY and MAC for Visible Light Communication with LED Lighting]

Purpose: [Proposal to IEEE 802.15.7 VLC TG]]

Notice: This document has been prepared to assist the IEEE P802.15. It is offered as a basis for discussion and is not binding on the contributing individual(s) or organization(s). The material in this document is subject to change in form and content after further study. The contributor(s) reserve(s) the right to add, amend or withdraw material contained herein.

Release: The contributor acknowledges and accepts that this contribution becomes the property of IEEE and may be made publicly available by P802.15.

A PHY and MAC Proposal of Visible Light Communications with LED Lighting

Tae-Gyu Kang
tgkang@etri.re.kr
ETRI

Proposal Contents

- Architecture - Tae-Gyu Kang[678]
- PHY
 - Line Coding - Dae Ho Kim[675]
 - Band Plan & Modulation Scheme - Sang-Kyu Lim[674]
 - Multiplexing - Dae Ho Kim[677]
 - Color Channel Tolerance - Sang-Kyu Lim[676]
- MAC
 - Color Packet Scheme - Ill Soon Jang[679]
- Application/Regulation - Tae-Gyu Kang

Architecture Proposal

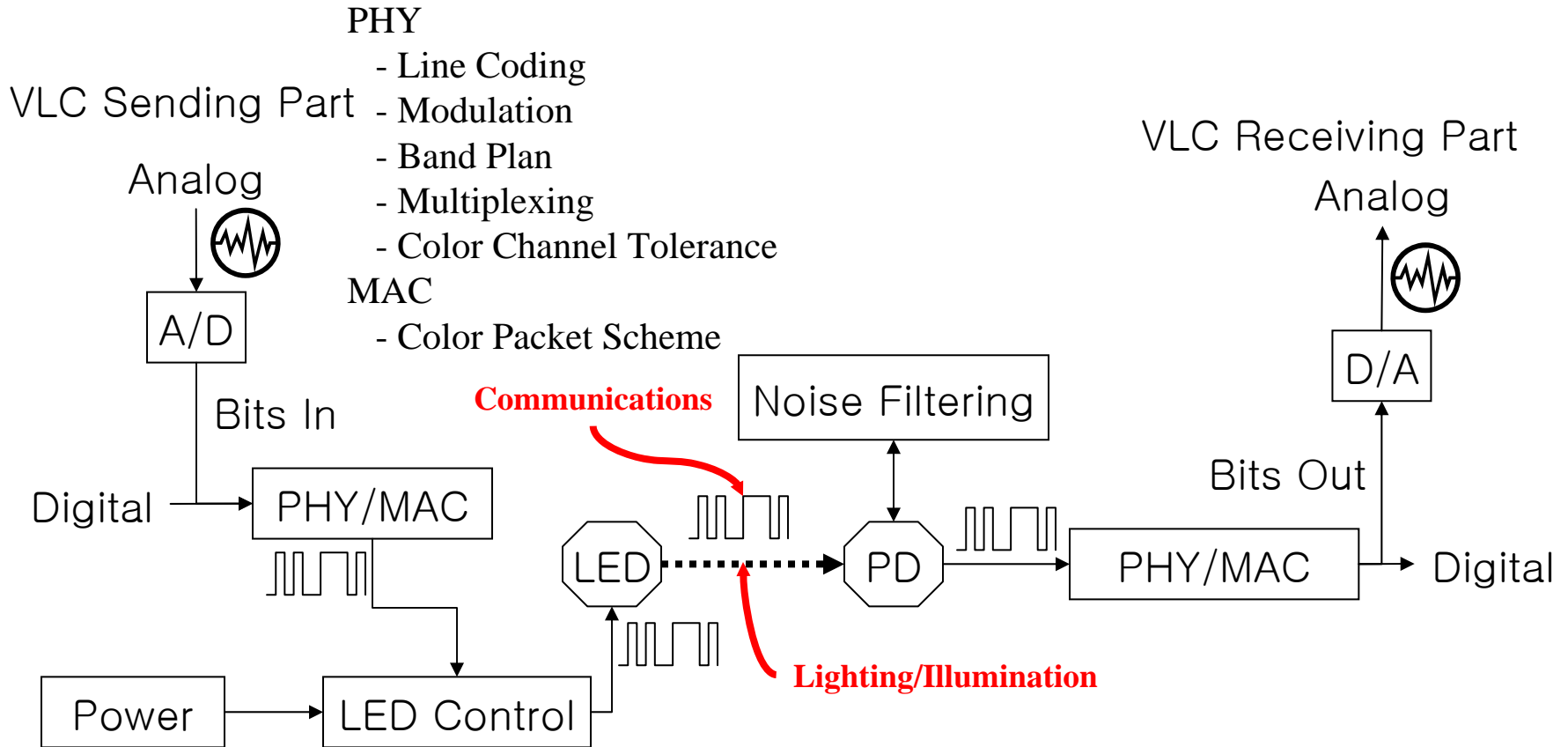
Fusion Functions from 2 Area

- Fusion from 2
 - LED Lighting
 - Communications
- LED Lighting Communications
 - New Communication with LED applications
 - Lighting, Signboard, Streetlight, Vehicle, Traffic Signal
 - New Functions
 - Color lighting wireless communications

A Proposal Approach for VLC PHY/MAC

- Key different characteristics
 - VLC Side effect to LED illumination
 - Color Light communication
- VLC PHY/MAC
 - LED Compatibility
 - PWM
 - Dimming
 - Flickering

VLC PHY Architecture with Lighting



VLC Configuration

- VLC Architecture
 - Sending Part
 - LED standard interface
 - Illumination/transmission performance
 - Receiving Part
 - PD standard interface
 - Avoidance from any other light interference
- Common Part
 - VLC PHY
 - Modulation, line coding
 - VLC MAC
 - Applications

PHY Proposal with Lighting

Proposal for Network topologies

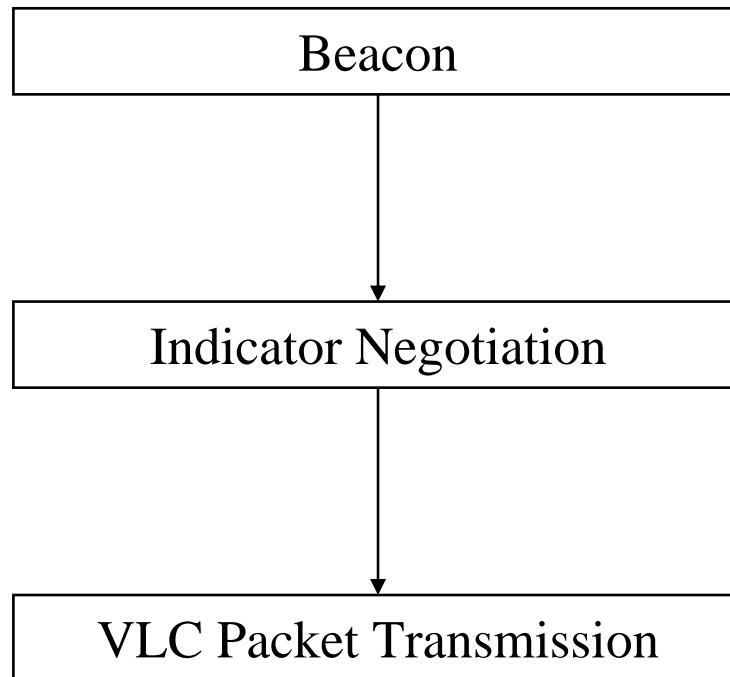
- Star network formation
 - Broadcasting data transfers
 - LED Lighting
- Peer-to-peer network formation
 - Peer-to-peer data transfers
 - Machine to machine

Proposal Contents

- Architecture - Tae-Gyu Kang[678]
- PHY
 - Line Coding - Dae Ho Kim[675]
 - Band Plan & Modulation Scheme - Sang-Kyu Lim[674]
 - Multiplexing - Dae Ho Kim[677]
 - Color Channel Tolerance - Sang-Kyu Lim[676]
- MAC
 - Color Packet Scheme - Ill Soon Jang[679]
- Application/Regulation - Tae-Gyu Kang

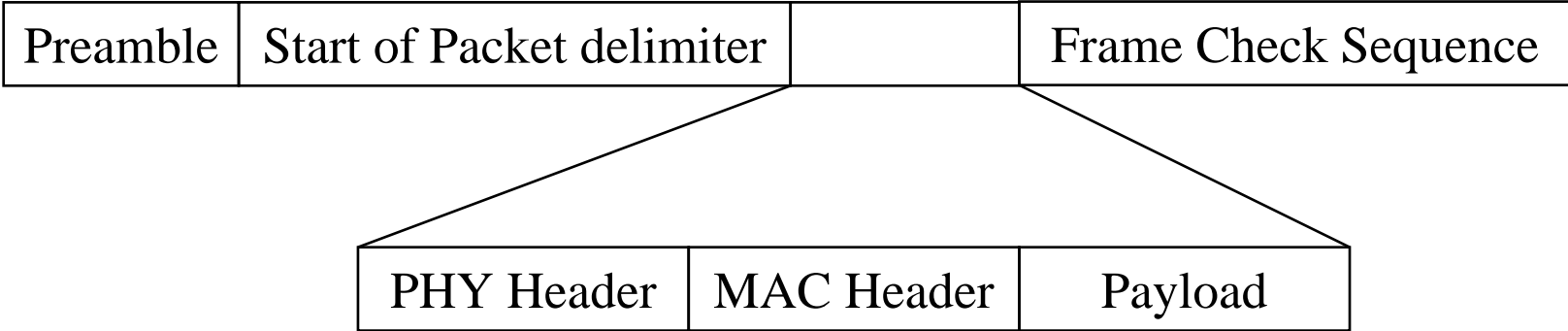
VLC MAC

VLC Setup Procedure



- Application indicator field
- Line coding indicator field
- Modulation indicator field

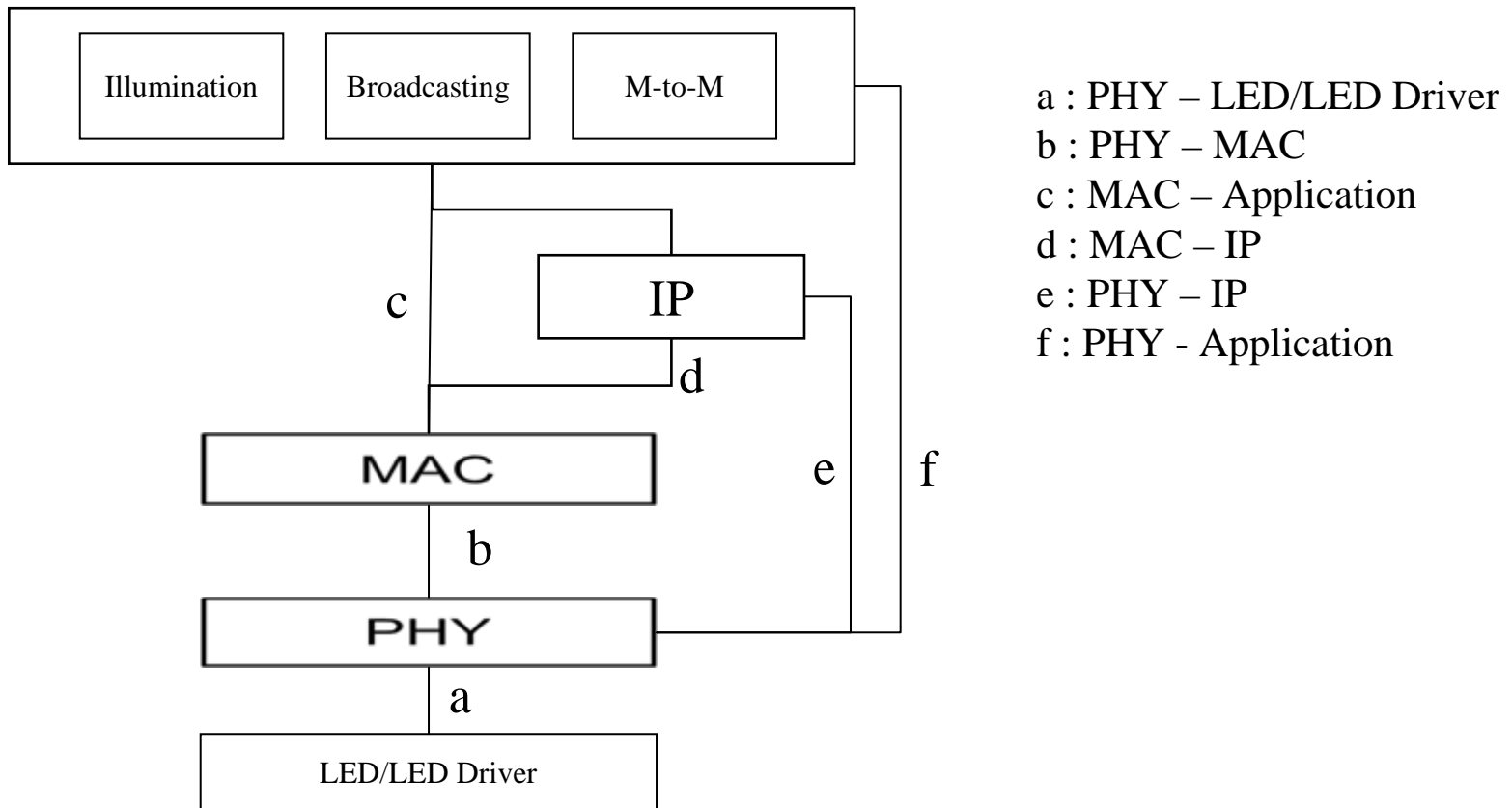
VLC frame format



Indicator fields for application

- Application indicator field
 - Lighting, Signboard, Machine-to-machine
- Line coding indicator field
 - Modified 4B5B, 4B6B, 8B10B
- Modulation indicator field
 - OOK, VPM, R-RZ

VLC Interfaces on Protocol Stack



Proposal Contents

- Architecture - Tae-Gyu Kang[678]
- PHY
 - Line Coding - Dae Ho Kim[675]
 - Band Plan & Modulation Scheme - Sang-Kyu Lim[674]
 - Multiplexing - Dae Ho Kim[677]
 - Color Channel Tolerance - Sang-Kyu Lim[676]
- MAC
 - Color Packet Scheme - Ill Soon Jang[679]
- Application/Regulation - Tae-Gyu Kang

VLC Proposal Applications

ETRI VLC Proposal Applications

- LED illumination
 - Office/Home illumination, Streetlight, Vehicle Lamp
- Broadcasting
 - Signboard, Office/Home illumination, Streetlight
- Machine-to-machine
 - Cellular Phone to Cellular Phone
 - Vehicle to Vehicle, Vehicle to Traffic signal, Vehicle to Streetlight

Proposal PHY/MAC depending on Application

- LED illumination with VLC
 - Dimming Control Scheme
 - Flicker Removal Scheme : 4B6B
 - Full Brightness Scheme
- Broadcasting
 - TDM: Signboard
- Machine-to-machine
 - Color Packet according to PER

Proposal for Eye Safety

- 1/minimum flickering frequency
 - 200Hz = 5ms
- Brightness of each Maximum Flickering Time Period (MFTP) must be all equal