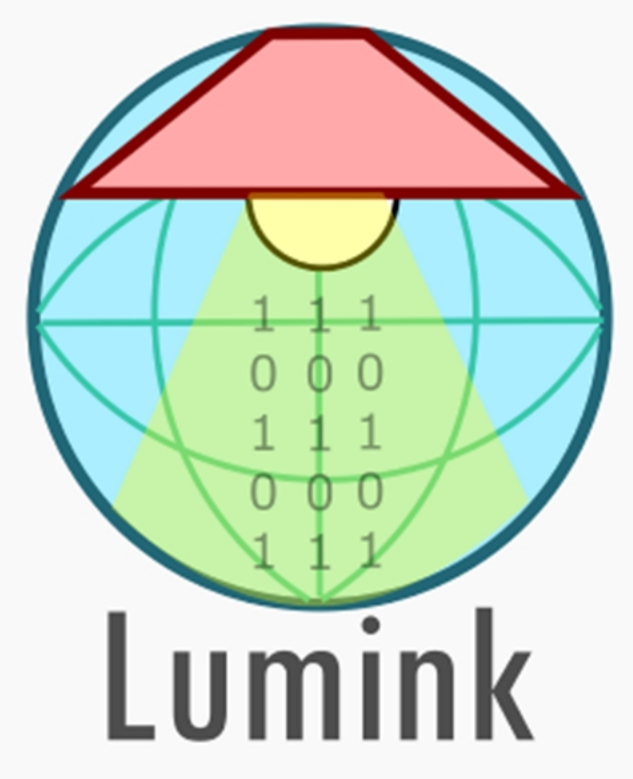# MACHINE TO MACHINE COMMUNICATION (M2M) BASED ON VISIBLE LIGHT COMMUNICATION (VLC)

## *APPLICATION CASE FOR LIGHT-FIDELITY (LI-FI) SYSTEMS*

Researcher: Prof. Trio Adiono, Dr. Amy Hamidah Salman, Syifaul Fuada, Fuad Ismail, Erwin Setiawan
Electrical Engineering Department, School of Electrical Engineering and Informatics, Institut Teknologi Bandung
University Center of Excellence on Microelectronics, Institut Teknologi Bandung
Indonesia
tadiono@stei.itb.ac.id

Partner: Prof. Yeon-Ho Chung
Department of Information and Communications Engineering, Pukyong National University, South Korea

Lumink

Product Description

Lumink is a single client wireless access point that utilizes visible light, instead of radio waves for data transmission.
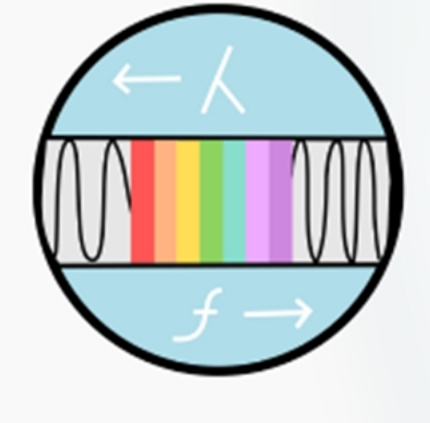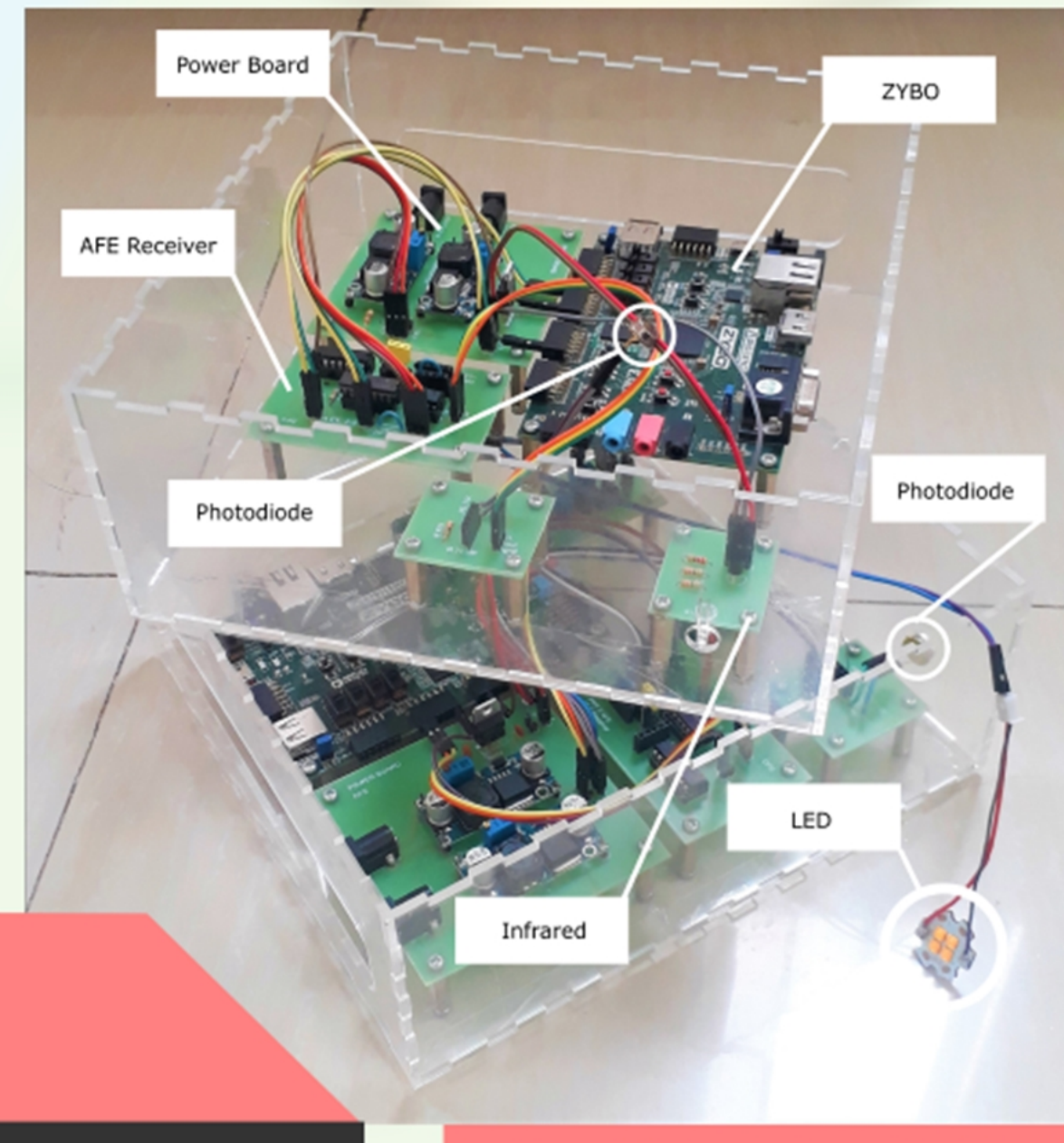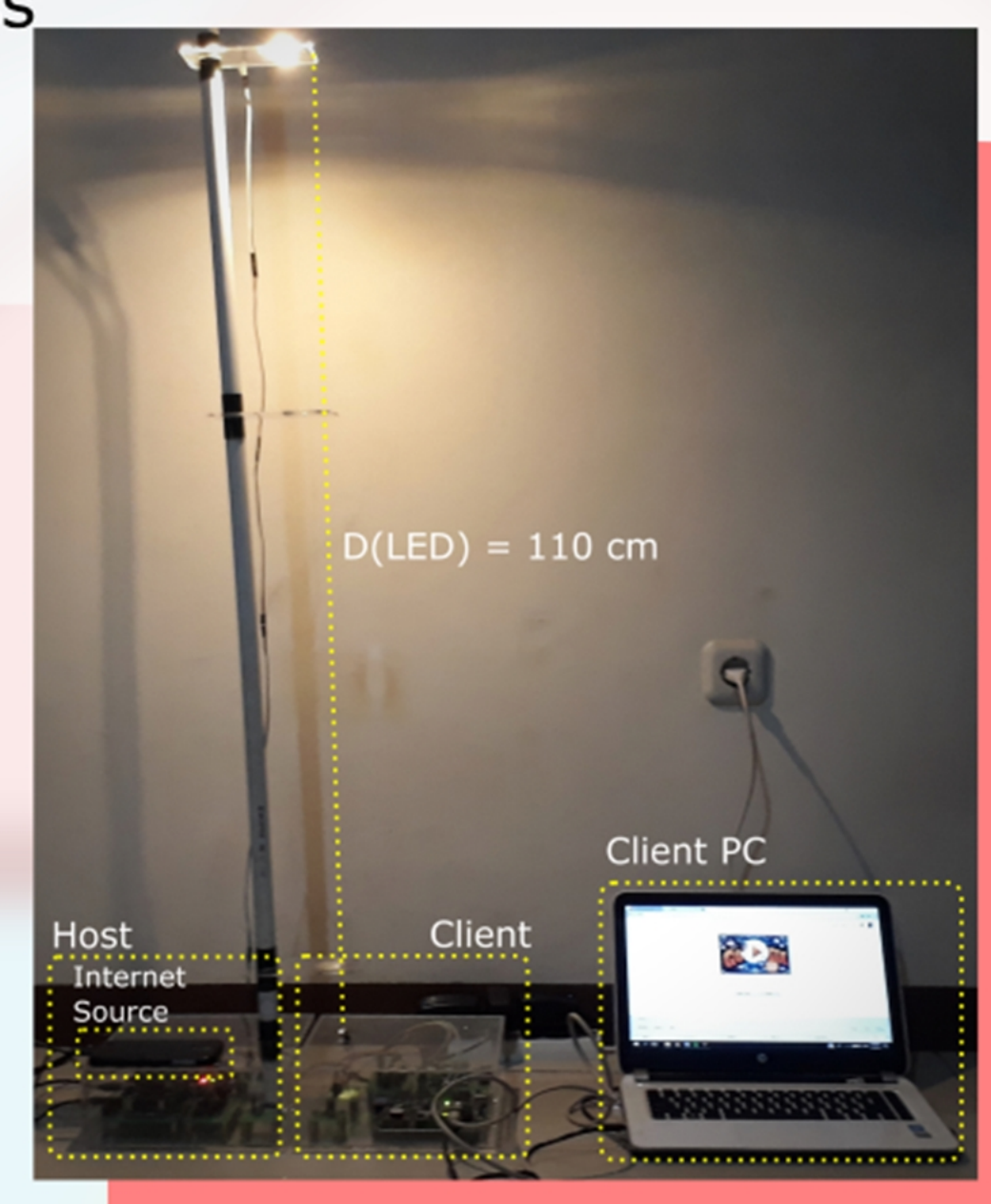
Background
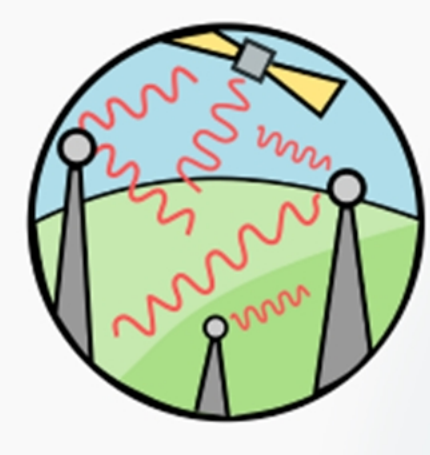
Radio wave spectrum used for data transmission is already too crowded

Wireless access point that uses radio waves poses security threats

Visible light spectrum which have an enormous bandwidth has not been used for data transmission

D(LED) = 110 cm

Host Internet Source

Client

Client PC

Product Features

- Speed up to **500 kb/s**
- Reception range up to **110 cm**
- **Minimal flickering** effect on lighting
- Suports almost every common internet services, notably seamless experience on 144p **YouTube video streaming**
- **Minimal setup requirement** for every device. (only requires static IP assignment on your PC)

Power Board

ZYBO

AFE Receiver

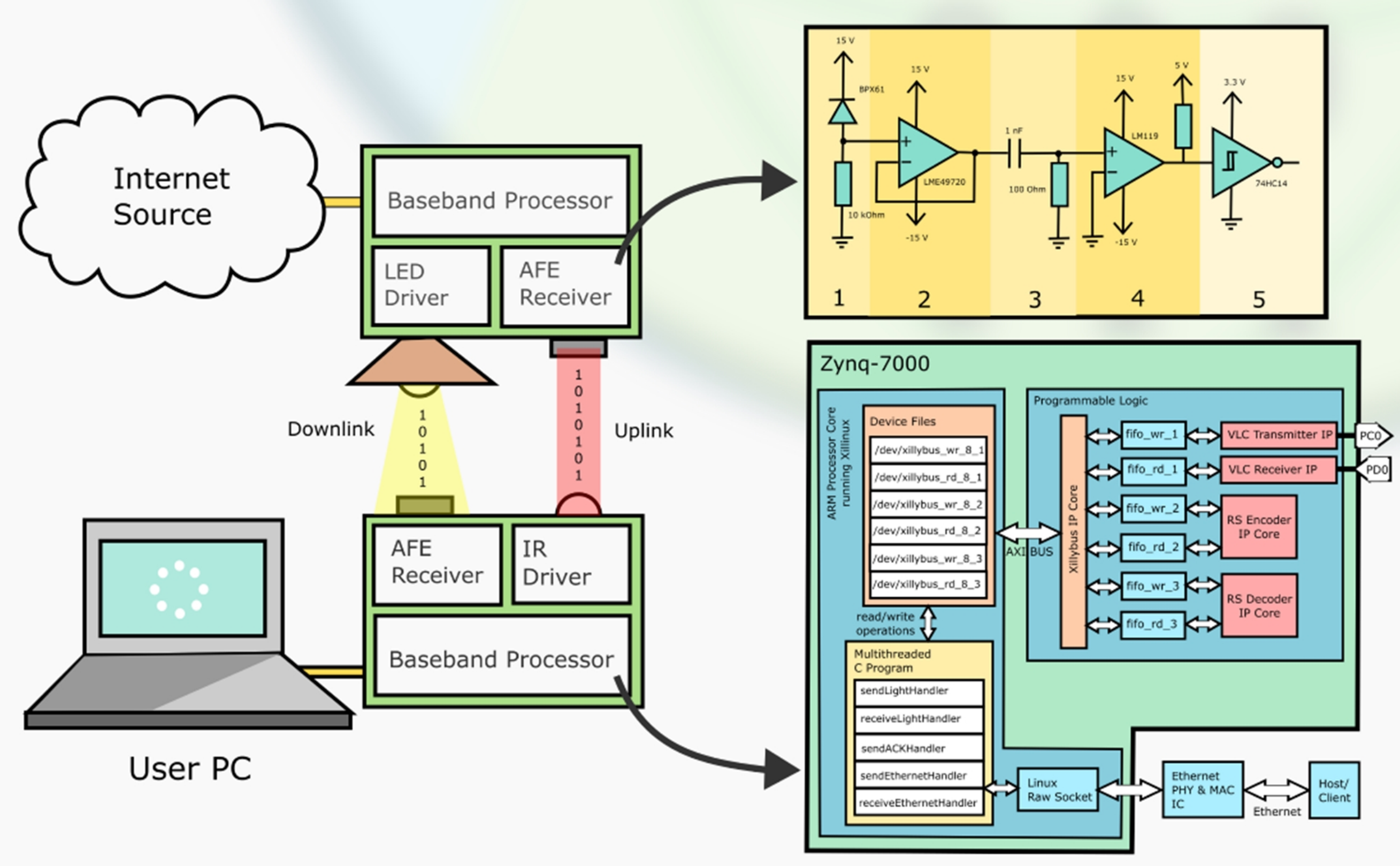Photodiode

Photodiode

LED

Infrared

Technical Specification

Digital

> Built on ZYBO Zynq-7000 APSoC (650 MHz Dual Core Cortex-A9 ARM + Artix-7 Equivalent FPGA)
> IPs Clocked at 100 MHz, Output at 2 MHz
> ARM running Xillinux
> Multithreaded Network & Data Link Program written in C
> Supports ARQ & NAT
> Supports ICMP, UDP, and TCP IPv4 Protocol
> VPPM Modulation
> Reed Solomon FEC (64,32)
> CRC-16 for Header Check Sequence
> Run Length Limited 4B6B
> Based on IEEE 802.15.7

Analog

> 2 MHz TX / RX
> OSRAM 6 Watt Yellowish White LED
> 3 mm IR LED
> OSRAM BPX61 Silicon PIN Photodiode (20 ns Switiching Time)
> Supply : +/- 15 V, 5 V, and 3.3 V
> LME49720 OpAmp (55 MHz GBW)
> LM119 Comparator (80 ns Response Time)
> 74HC14 Schmitt Trigger

System Overview

Internet Source

Baseband Processor

LED Driver

AFE Receiver

Downlink

Uplink

AFE Receiver

IR Driver

Baseband Processor

User PC

15 V | 15 V | 15 V | 5 V | 3.3 V
BPX61 | LME49720 | 100 Ohm | LM119 | 74HC14
10 kOhm | 1 nF | -15 V | -15 V
1 | 2 | 3 | 4 | 5

Zynq-7000

ARM Processor Core running Xillinux

Device Files
/dev/xillybus_wr_8_1
/dev/xillybus_rd_8_1
/dev/xillybus_wr_8_2
/dev/xillybus_rd_8_2
/dev/xillybus_wr_8_3
/dev/xillybus_rd_8_3

read/write operations

Multithreaded C Program
sendLightHandler
receiveLightHandler
sendACKHandler
sendEthernetHandler
receiveEthernetHandler

Programmable Logic
fifo_wr_1 | VLC Transmitter IP | PC0
fifo_rd_1 | VLC Receiver IP | PD0
fifo_wr_2 | RS Encoder IP Core
fifo_rd_2
fifo_wr_3 | RS Decoder IP Core
fifo_rd_3

AXI BUS

Xillybus IP Core

Linux Raw Socket

Ethernet PHY & MAC IC

Host/Client

Ethernet