



# Learnings from LiFi and OCC experiments

Subhas Mondal

Chief Architect- 5G, Wipro Ltd

05 Feb, 2019

India EU Stakeholders' Workshop on 5G Technology Landscape

# Agenda

**1** Video demo of LiFi & OCC solution

**2** Current state of the Standards

**3** Open challenges

**Need for Standards Development**

# LiFi demo setup

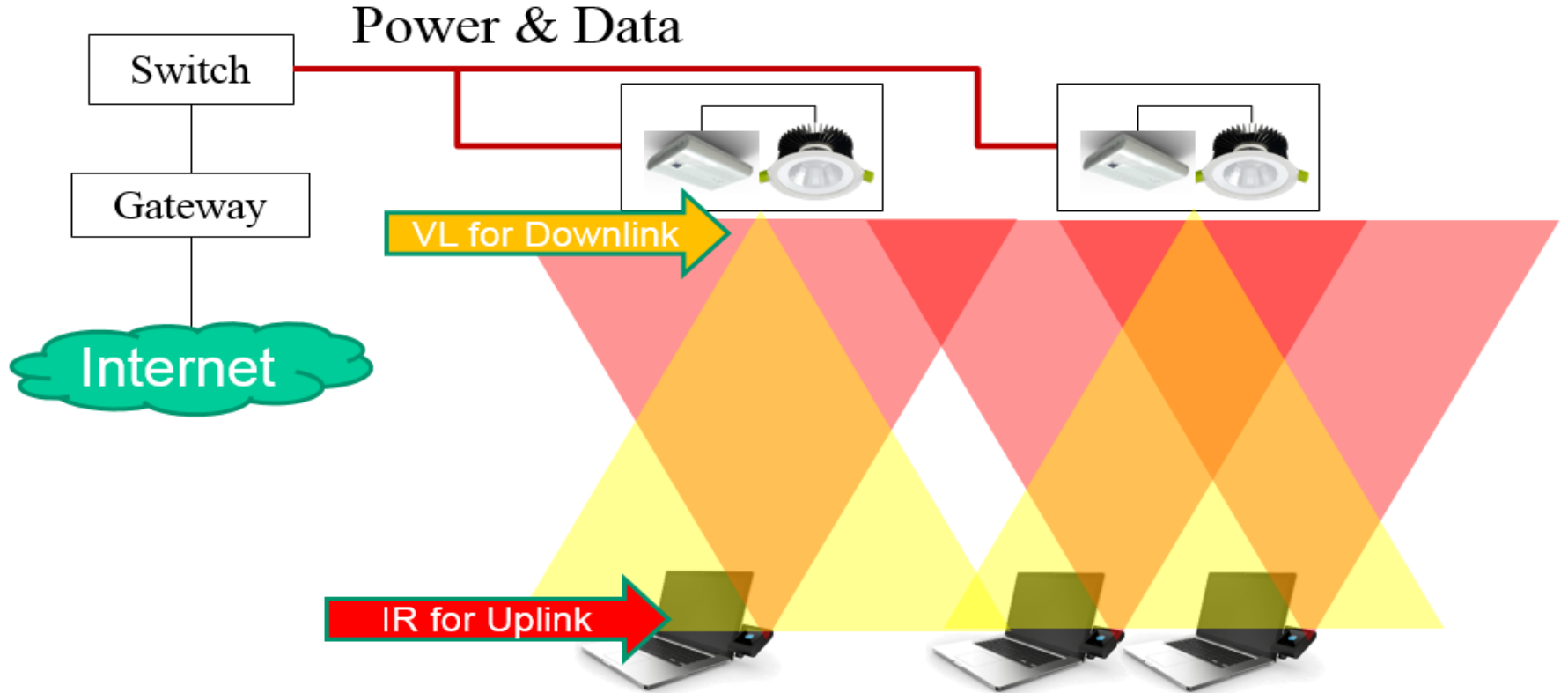
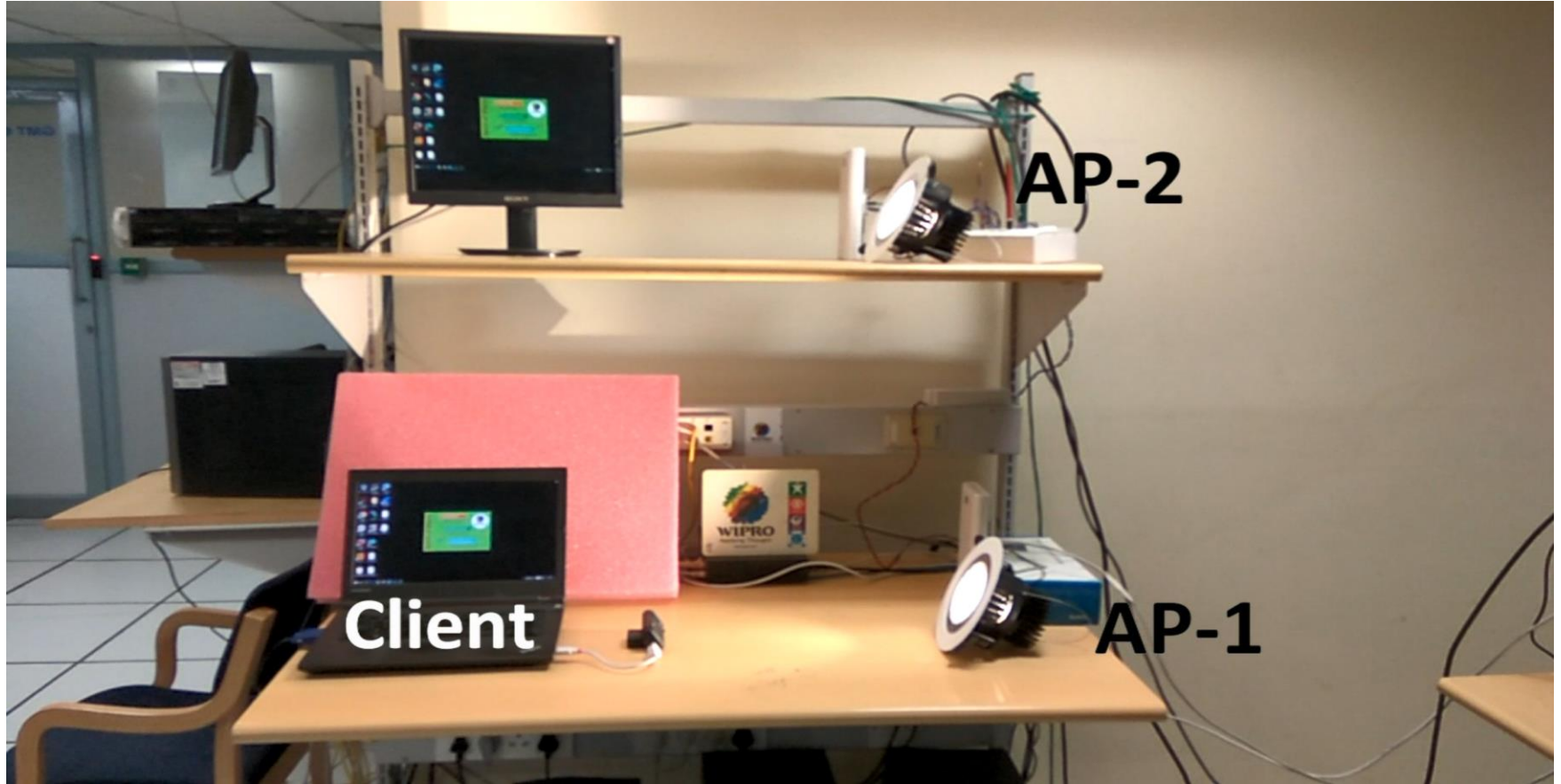


Image source- pureLiFi

# LiFi demo (embedded video link)



# Optical Camera Communication (OCC) Setup

1

## Display as transmitter

LED light/Pattern can be used to encode information to transmit

2

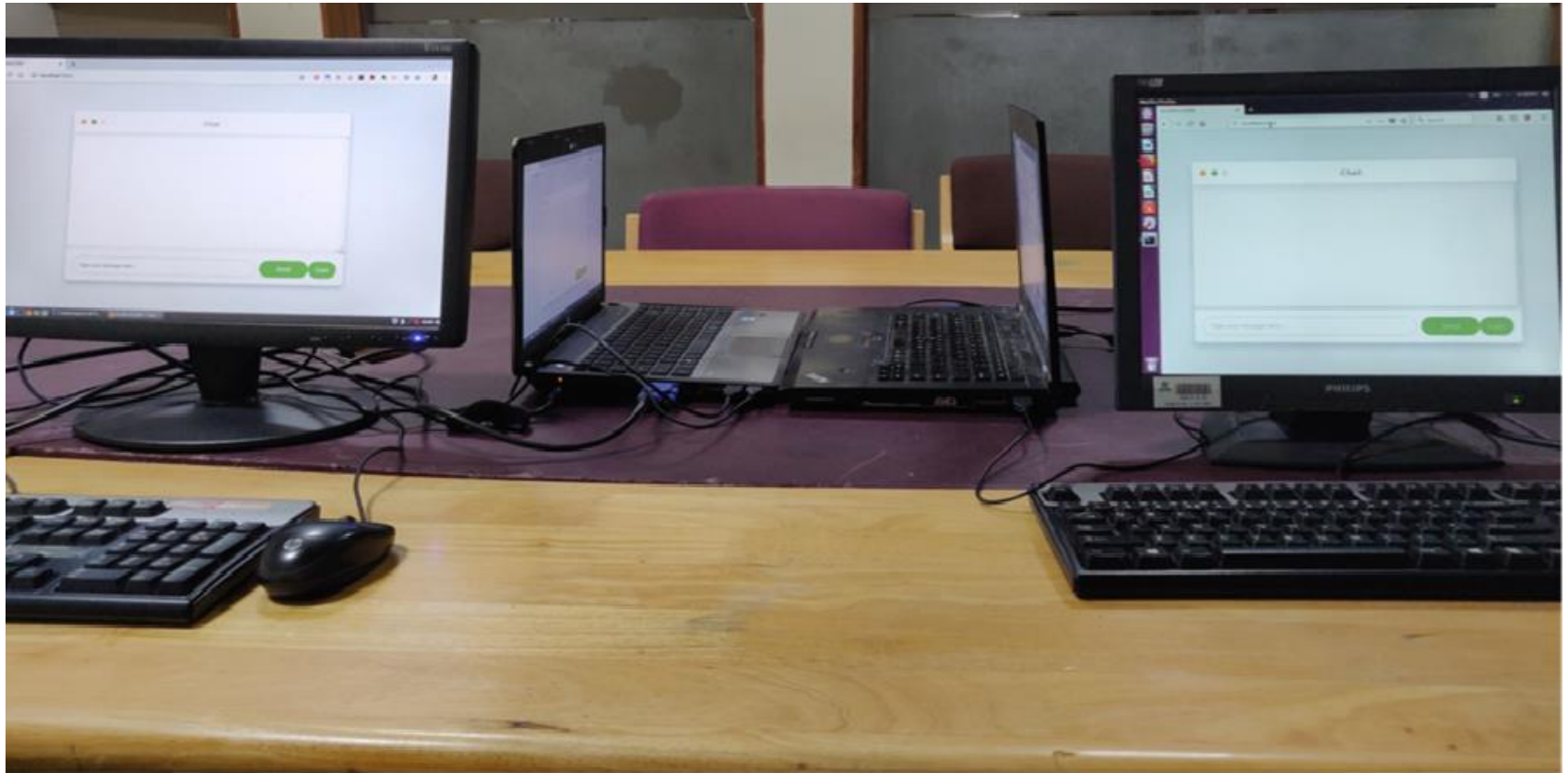
## Camera as Receiver

A phone camera/ laptop webcam can be used to decode the information at the receiver.



- Defined in the **IEEE standard 802.15-7r1**
- Colour/Pattern to encode transmit information –spatially arranged LED matrix.
- We published an IEEE paper on “**Bidirectional communication system with screen based transmission and camera based reception of QR encoded information**”, achieving a data rate up to 60kbps.

# OCC demo (embedded video link)



# Current state of the standards

## IEEE 802.15-7 – Short-Range Optical Wireless Communications using visible light

- Defines standards for Phy and MAC layer of free space short range optical wireless communication
- Modulation Techniques supported
  - OOK [ON OFF Keying]
  - PPM [Pulse Position Modulation]
  - CSK [Colour Shift Keying]
- Transmitter transmits information using a single LED
- Receiver side includes a photo detector to receive and decode the information.
- 802.15.7-2018 revision published



Image source- [shutterstock.com](https://www.shutterstock.com)

# Current state of the standards

## IEEE P802.11 Study Group for Light Communications

- **Title:** Standard for Short-Range Optical Wireless Communications (OWC)

**PAR:** Sep 2016 to Dec 2016

**Scope:**

- Defines the PHY and MAC layer for short range OWC
- Supports data rates sufficient for audio and video multimedia services
- Considers mobility of the optical link, compatibility with various light infrastructures, impairments due to noise and interference from sources like ambient light and a MAC layer that accommodates the unique needs of visible links as well as the other targeted light wavelengths.
- It also accommodates optical communications for cameras where transmitting devices incorporate light emitting sources and receivers are digital cameras with a lens and image sensor.
- The standard adheres to applicable eye safety regulations.

## Potential Use cases

- Secure point-to-point communication
- Indoor Location Based Service
- Optical Camera Communication
- Secure point-to-multipoint communication (office, hospital, airplane)
- Intelligent Transport System (ITS)
- Information Broadcast



# Key Challenges in OWC Systems

## Challenges

- Management of Downlink Interference due to the overlapping Access Points.
- Management of Uplink Interference.
- Hybrid Networking between Li-Fi and Wi-Fi and Vertical Handover for seamless mobility.
- Adaptive communication

## Technology Limitations

- Short Range Communication.
- Interference from ambient light sources, obstructions from opaque materials.
- High cost
- Loss due to weather conditions – hard to adapt in outdoor situations

# Need for Standards Development

- **Standards development is needed**

- **towards the interference minimization.**

In the standard IEEE 802.15-7, under the VLC cell design and mobility support, the standard talks about the logical movement of a device from one cell to another, due to either interference or deliberate switching. It doesn't mention how to stay in the interference region and still be able to receive the transmit data. The standard states the interference caused by the ambient light but not due to the overlapping access points.

- **For mobility support mechanism**

- **OCC  $\Leftrightarrow$  OCC, OCC  $\Leftrightarrow$  WiFi, OCC  $\Leftrightarrow$  3GPP**

- **Support for Multiple access technologies**

- **For device measurement reporting**

- **For supporting adaptive transmission/reception mechanism, to increase efficiency**

- **Introducing the concept of multiple channels in white light spectrum**



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# Thank You

Subhas Mondal

Chief Architect - 5G, CTO Team

