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

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Abstract:

Purpose: Call for Application Response

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Kookmin University Response to 15.7r1 CFA:

Applications of OWC

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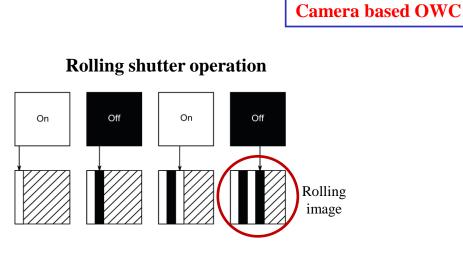


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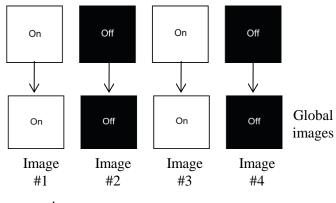


Data Decoding Procedure of OWC



Exposure time

- Rolling shutter sequentially exposes each row of the image sensor.
- Thus when the LED is on, the output of the exposed row will be a white band (bit 1).
- On the contrary, when the LED is off the output of the exposed row will be a black band (bit 0).



Global shutter operation

Exposure time

- Global shutter exposes whole part of the image sensor simultaneously.
- ✤ When LED is on, the whole frame will give a bright band (bit 1), and a dark band while it is off (bit 0).
- Therefore, in each frame only single bit information can be received

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Also PD can be used to decode data in OWC

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Comparison Between Different OWC Receiver

Tech item	Rolling shutter	Global shutter	PD
Operation	Sequentially exposes each raw of image sensor	All pixels are exposed at the same time	Always being exposed and no frame sampling
SNR	High	Low	High
Skew	Appears due to the horizontal motion of a camera	No	No
Wobble	Appears due to vertical motion of a camera	No	No
Data rate	Rolling shutter effect can be used to increase data rate	MIMO can be used to increase data rate	By increasing LED modulating frequency

The standard provides PHY for supporting Rolling shutter and global shutter

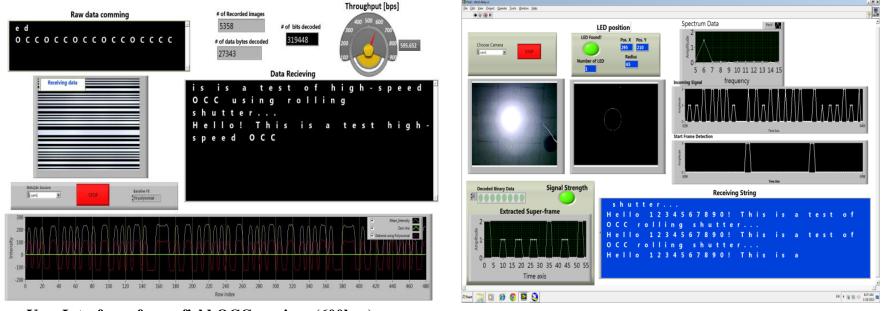
camera for OCC

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Asynchronous LED-to-Rolling shutter camera based OWC

LED acts as transmitter

- Short distance: Data rate achieved = 600bps
- 3m distance: Data rate achieved = 8bps



User Interface of near-field OCC receiver (600bps)

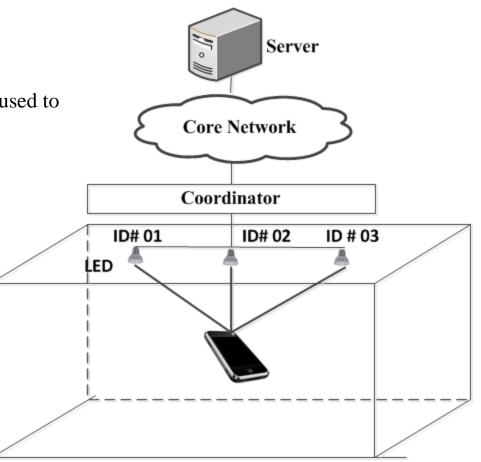
User Interface of far-distance OCC receiver (8bps)

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- Asynchronous Scheme is applied for unidirectional communication, mitigating variation in camera frame rate
- 600bps data rate achieved at short distance
- 3m distance can be achieved by transmitting low speed.

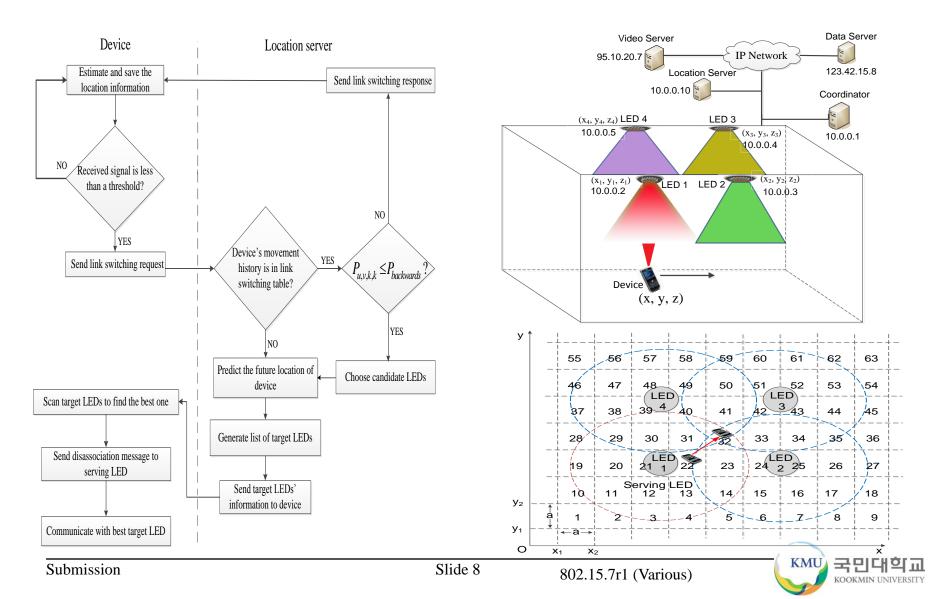
OWC based Positioning

- Transmission of ID (coordinate) through LEDs
- Camera can be used to decode ID information.
- Triangulation method along with LEDs ID are used to determine user's position.
- Some legacy positioning methods for OCC are
 - ✤ TOA
 - TDOA
 - ✤ AOA
 - RSS
 - Cell ID

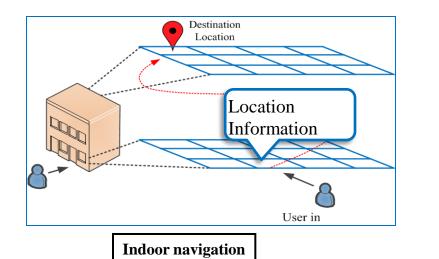


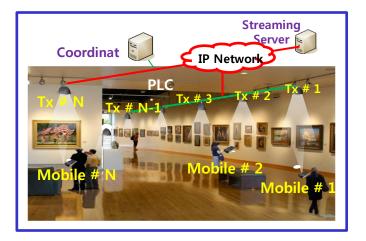


LBS application (Location Based Link Switching)



Positioning and Navigation using OWC





Guiding in museum scenario



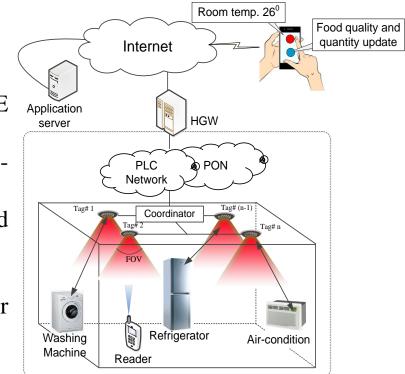
Products information marketing



Internet of LED (IoL)

Network Model considered—

- Transmission medium visible light
- Functional architecture compatibility IEEE 802.15.7r1 (Ongoing standardization)
- Supported network topology star, peer-topeer and broadcasting
- Coordinator –mainly network operation and resource allocation
- PLC or PON as backhaul
- Home gateway (HGW) connects indoor networked devices with internet



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User can control networked devices in home with an app

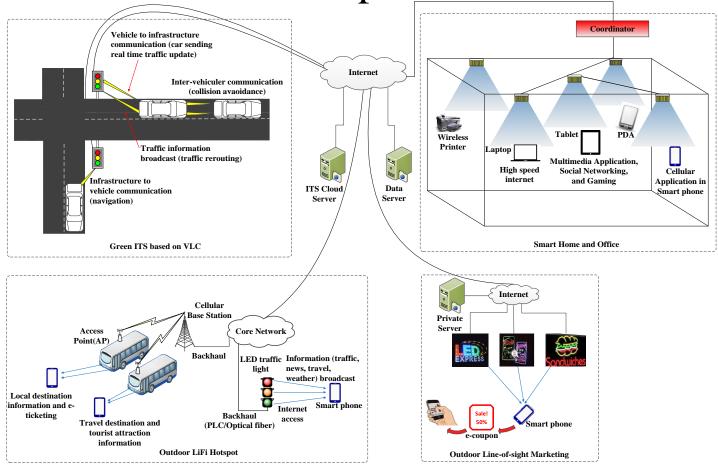
LED-ID: Reader-Tag Operation in IoL

Management TAG Coordinator READER Platform of IoL Two different modes: * **ID-Detection** mode Wakeup Mode Change Signal Request and data reception mode ID detection Beacon Generation mode Mode ID-Detection (IDD) operation is completed in * Selection CAP mode Beacon (ID, mode) ID and Mode Selection Data Request Wake up Tag wakes up when Authentication/ Certification and media consulation readers send request Send request and service information -Resource Block Allocation Tag will be synchronized Beacon Data Beacon Generation by superframe reception Communication mode Data send Request Reader request traffic Beacon (Superframe information) Resource Tag allocates slots based -- Data send ----allocation on reader's request Acknowledgement -Ending order Data transmission using Data Transmission allocated slot Release of communication link



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Connected Object Domain in IoL: An Application Perspective



• Saha, N.; Ifthekhar, M.S.; Mondal, R.K.; Hosain, M.A.; Yeong Min Jang, "The internet of LED: A LED-ID based interoperability and interconnectivity perspective," ICTC2014, vol., no., pp.535~540, 22-24 Oct. 2014



Conclusion

- **Need PHY for bidirectional and unidirectional communication**
- **Need PHY for rolling shutter and global shutter camera**
- Need application dependable PHY and MAC
- **Need to have a link switching functionality**
- **Need to put the IoT concept using LED, digital signage, display and**
- Need to have a LED-ID operation

