



Shifting Paradigms in IT: An Overview on VLC & BLE

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Abstract— Researchers across the globe have come up with a new technology that connects some devices/ transmitters like apple's iBeacon or in-store LED lights with consumers' smart phones and then using a downloadable app, people will be able to locate items on their shopping lists. Thus, allowing retailers to track the exact location of customers via their mobile devices. Present paper focuses on what this technology is, how it works and proposes a number of ways in which retailers might leverage the proximity of making these devices more consumer-friendly.

Keywords— BLE, iBeacon, Philips retail smart lighting system, Smartphones, VLC

I. INTRODUCTION

Nic Newman stated in his paper that BLE beacons are typically nothing more than super-small computers with Bluetooth radios that cost under US\$20 [10]. Andy Cavallini said iBeacons is the name Apple chose for a particular technology that allows Mobile Apps (running on millions of recent iPhones, iPads, etc.) to know how close they are to tiny, low-cost, wireless transmitters called hardware iBeacons (or just iBeacons)[1]. According to Wikipedia definition iBeacon is an indoor positioning system that Apple Inc. calls "a new class of low-powered, low-cost transmitters that can notify nearby iOS 7 devices of their presence. They can also be used by the Android operating system. The technology enables a device to send push notifications to iOS devices in close proximity [11]. Its advantage over GPS is that the iBeacons technology allows your Mobile device to understand its position, even in indoor locations where they are not able to pick up GPS signals from satellites above. And with VLC, data is transmitted by modulating the intensity of the light in such a way that it is not perceptible to the human eye. The data is received by a photo-sensitive detector which demodulates the light signal into electronic form [7]. A comparative study of both VLC and BLE in detail will be done.

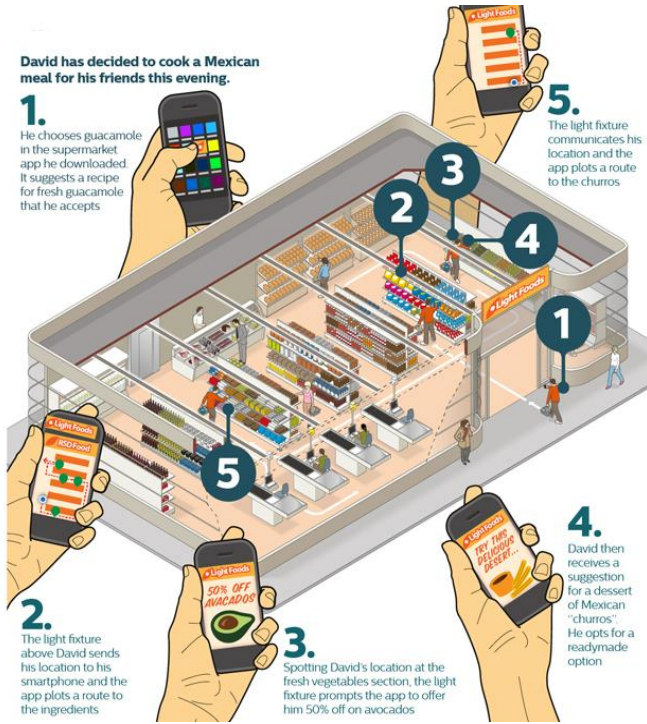
II. IBEACON IN DETAILS

iBeacons is a technology that allows Mobile Apps to identify the location of an iBeacon and are notified when the device moves in and out of range of iBeacons, and are able to monitor the distance as their proximity changes over time. iBeacon's technology isn't an Apple's monopoly; all recent Android devices are equipped with a system to support it too [1]. iBeacons broadcast signals using the Bluetooth Low Energy (BLE) standard, allowing precise, indoor geo-location, but also contextual interaction/engagement, as proximity to an iBeacon can trigger certain specific App functionalities [1]. Similarly Philips has also introduced a system that connects in-store LED lights with consumers' smart phones. "Using a downloadable app, people will be able to locate items on their shopping lists or get coupons as they pass products on the aisles. Retailers can send targeted information such as recipes and coupons to consumers based on their precise location within stores, while gaining benefits of energy-efficient LED lighting", says Philips. The system uses Visual Light Communications (VLC) to interact with consumers' smartphones. Unlike various other wireless protocols such as Wi-Fi, Bluetooth, and Zigbee, which use radio waves to transmit information, VLC depends upon the store lights to transmit data to the camera on a smart phone in fast pulses. Visible light communication (VLC) is a type of optical wireless communication medium which uses visible light between 400 and 800 THz (780–375 nm). Specially designed electronic devices generally containing a photodiode receive signals from light sources although in some cases a cell phone camera or a digital camera will be sufficient.

A Boston startup ByteLight has also developed a system similar to Philips' retail lighting network. Light pulses are used to communicate with consumers' smart phones in stores.

Other companies, such as Silver Spring Networks, in Redwood City, Calif., have developed street lights with sensors and radios that enable city managers to remotely monitor traffic density or air quality^[4].

A demonstration of this technology is given below:



Courtesy: Philips
 (<http://www.newscenter.philips.com/main/standard/news/press/2014/2014-0217-intelligent-in-store-led-lighting-communicates-with-your-smartphone.wpd#.UzFilmfnYjU>)

III. A COMPARATIVE ANALYSIS

A comparative study of Apple's iBeacon based on BLE and Philips retail smart light system which is based on VLC has been done in Table I.

TABLE I

Standpoints	Apple's iBeacon	Philips smart light system
Turning on the app	Mobile devices will automatically react to when they come within range of iBeacons: there is no need to take	Like iBeacon, here also mobile devices start interacting with the LED fixtures automatically as soon as they come in LEDs' vicinity. These apps too need to be installed beforehand.

	the mobile out of the pocket to manually start the pertinent iBeacon-enabled App. iBeacons are identified in the background by the operating system(iOS or Android),technic ally speaking, an App can register with iOS/Android to be started when specific types of iBeacons move in the range of the device.Of course you have to install the pertinent iBeacons-enabled App before you can actually enjoy the benefits	
Technology used	BLE(Bluetooth Low Energy).Radio waves are used here.	VLC(Visible Light Communication).Visible light spectrum is used.
Speed and range	50 m and 1 Mbit/s of air data rate. ⁶	10Kbit/s to 500 Mbit/s for LEDs and a distance of 1-2 km. ⁵
Energy consumption	Bluetooth Low Energy standard is very much battery friendly	No separate infrastructure/devices are required. In-store energy efficient LEDs which are used for store lighting perform the task.
Hardware	iBeacons are very easy to set-up and deploy; and also they are quite low in cost.	In-store light fixtures are used.
Internet connection	No connection to the Net is necessary.	No connection to Internet is required for its propagation. Since visible light spectrum is used for data transmission.



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IV. VLC HAS A NUMBER OF BENEFITS OVER BLE THAT INCLUDES

- *Higher Bandwidth*- The visible light spectrum is substantially more than RF spectrum, unlicensed and free to use.
- *Coherent*- Visible light can be well focused on a point/some area whereas RF tends to spread out and cause interference.
- *High speed* – As we have already seen in the characteristics table that the speed of the VLC can reach upto 500Mbps/s whereas that of RF is around 1Mbps/sec.
- *Planning phase* - Capacity planning is simple as it will be an illuminating infrastructure whereas RF is invisible and makes planning more complex.
- *Cheap* – requires fewer components than radio technology as in the case of smart lighting LEDs.

LED illumination is already efficient and the data transmission requires negligible additional power.

- *Underwater* – RF transmission and propagation in water is extremely difficult but VLC works better in this environment.
- *Safe* – As of now there are no known safety or health concerns for this technology.
- *Non-hazardous* – the transmission of light avoids the use of radio antenna systems that can cause sparks which are dangerous in certain environments.

V. PROSPECTIVE APPLICATIONS IN VARIOUS FIELDS

These technologies can be applied in many other areas too. Some of them are

- *Smart Lighting*. This is exclusively an area of VLC. Any private or public lighting including street lamps can be used to provide lighting and the same infrastructure can be used to make a hotspot for transmission of data.
- *Indoor Positioning*. Like in a parking lot these technologies would be quite useful.
- *Mobile Connectivity*. Laptops, smart phones, tablets and other mobile devices can interconnect directly using VLC/BLE.
- *Hazardous Environments*. VLC provides a safe alternative from electromagnetic interference in environments such as mines and petrochemical plants.

- *Hospital & Healthcare*. VLC emits no electromagnetic interference and so does not interfere with medical instruments.
- *Wi-Fi Spectrum Relief*. Excess capacity demands of Wi-Fi networks can be off-loaded to VLC/BLE networks where available.
- *Aviation*. LEDs are being used in aircraft passenger cabins. VLC can be used to reduce weight and cabling and adding flexibility to seating layouts. The in-flight entertainment systems can be supported by VLC.
- *Toys*. LED lights in toys can be used to enable extremely inexpensive communication between interactive toys and children.
- *Transportation*. If you are travelling by a train, it would be helpful as you download a train travel App that is aware of which train you are travelling on, and as you board it automatically starts telling your train's real-time progress.

VI. SOME OF THE CONCERNS

A. Security

Since data broadcasted by an iBeacon is public, anyone could pick up the signal and use it within an unauthorized Mobile App or even a hacker may clone an iBeacon for some fraudulent reason. Companies who fears for the security of their iBeacons can use effective encryption techniques to prevent unauthorized manipulations.

B. Privacy

Customers may not be pleased with the fact of being monitored by retailers at every step in the store and have the right to know how their location information (and any other data) is used. Moreover, what will happen if consumers will be constantly flooded on with irrelevant and unsolicited location-based offers as they walk through the city? iBeacons-enabled Mobile Apps would be a disaster then.

VII. SOME SUGGESTIONS

So Retailers, should be as transparent as possible and clearly explain how their iBeacons system works and how it interacts with shoppers' Mobile devices, tell them what data is specifically monitored and stored and for how long.



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VIII. CONCLUSION

So far we have considered Mobile devices as passively receiving signals from hardware iBeacons or light fixtures but Mobile devices can also actively transmit signals and thus opening up the Mobile world to new useful possibilities. By the way, many desktop/laptop computers are iBeacons-enabled too, and that opens up further possibilities. Both the technologies are new and they can actually revolutionize the data communication/network world and can be proved quite useful. But the security and privacy concern has to be kept in the mind before creating an app that would help the customer and not annoy him.

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