IEEE P802.15
Wireless Personal Area Networks

Project	IEEE P802.15 Working Group for Wireless Personal Area Networks (WPANs)	
Title	**A Proposed Architecture for Short "Rolling Shutter" Messages**	
Date Submitted	14 March, 2014	
Source	[Harald Burchardt] [pureLiFi Ltd.] [ETTC, King's Buildings Mayfield Road EH9 3JL, Edinburgh]	Voice: [+44 131 4724 740] Fax: [ ] E-mail: [harald.burchardt@purelifi.com]
Re:	**IEEE802.15 OPTICAL CAMERA COMMUNICATIONS STUDY GROUP CALL FOR APPLICATIONS, November 2013**	
Abstract	This document describes a suggested format for short "rolling shutter" messages sent using optical camera communications.	
Purpose	The authors submits this in response to the CFA from Nov, 2013. The goal is to standardize the "rolling shutter sampling" short message structure.	
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 Proposed Architecture for Short "Rolling Shutter" Messages

Using visible light communications (VLC), there are products available today that can transmit short messages to a smartphone, using a technique known as *rolling shutter*.

To encourage interoperability between systems and products, there will need to be an architecture (formats and protocols) on those messages. This paper provides a proposal for such an architecture.

1 Current Format

In today's products, short messages of 16 characters (7-bit ASCII + 1 parity bit) are used to communicate text between transmitters and rolling-shutter enabled smartphones.

This has the following disadvantages:

1. The length of message severely restricts the information and formatting that can be displayed on the smartphone.
2. The implementation of one vendor's message format, may be incompatible with another vendors, reducing interoperability.

2 Proposed Format

This paper proposes an architecture for the message that will (a) provide extensibility and (b) enforce interoperability.

The proposed format of each message is that it is composed of a number of vectors, each of which describes some element of information. Each vector is formatted as follows:

Byte	**Meaning**
0	Vector ID
1	Offset to next vector (0=this is last vector)
2-15	Contents of vector

2.1 Multi-Vector Format

Byte	**Meaning**
0	Vector ID for vector 1
1	Offset to next vector, *e.g.*, N (where $N \leq 13$)
N	Vector ID for vector 2
N+1	Offset to next vector or 0 for last vector

2.2 Example: Free Text (Vector ID = 0)

Byte	Name	Sample
0	Vector ID	0
1	Vector offset	0
2-15	Text	“Up 2 13 chars”

2.3 Table Index (Vector ID = 1)

Byte	Name	Sample
0	Vector ID	1
1	Vector offset	0
2	Table ID	*N*
3	MSG ID	*M*
4	PARM ID	*K*
5	PARM ID = *K*	“*value*”

3 Proposed Application(s)

The proposed new format offers a multitude of applications across retail, indoor positioning and text messaging. In general, the structured form of communication allows app-based software to extend operation to many further markets. Due to the low rate(s) of camera communications, the majority of the system intelligence will lie on the application on the host device.

3.1 Indoor Positioning / Navigation

The most basic application for optical camera communications is indoor positioning, where each light transmits an identity beacon (IB) using a unique pulse signature. The positional app then can match the IB to a (approximate) position on the building/site map. The IB can be broken down into multiple layers, *e.g.*, campus/site building number, floor, and light ID within that floor. An example of such a message is given below.

A conceivable add-on to this application is that of indoor navigation (already demonstrated by Philips in the Netherlands (http://luxmagazine.co.uk/news/151/smart-lights-help-shoppers-find-groceries) and e-Mart in S. Korea ()), where the application can now use the physical location to and pre-programmed knowledge of the site map to guide the user to their requested destinations.

Byte	Name	Sample
0	Vector ID	2 (*indoor positioning*)
1	Vector offset	2
2-3	Position	*x* (*building*)
4	Vector Offset	2
5-6	Position	*y* (*floor*)
7	Vector Offset	0
8-15	Position	*z* (*light IB*)

3.2 Push Advertisement / Coupon

By using the precise localization available from, specifically, downlighters in a, for example, retail environment, customers can be sent targeted advertisement and/or coupons based on their position in a store. The lights would be pre-programmed (based on their location in the store) to transmit a continuous short message that identifies a particular advertisement/coupon from a database. The application, which is connected to the server/cloud via Wi-Fi, can then access this ad/coupon database entry and stream it onto the phone of the customer when passing under the light. As an example, different customers looking at jeans in H&M can get various advertisements or coupons for these jeans, whereas those customers standing only a few meters away looking at shirts would get ads/coupons targeted at that item.

Byte	Name	Sample
0	Vector ID	3 (*push service*)
1	Vector offset	3
2-4	Retailer	*x*
5	Vector Offset	3
6-8	Item	*y*
9	Vector Offset	0
10-15	Advertistement / Coupon	*z*

This application will allow retailers to itemise advertisement in (effectively) real-time and thus improve customer attention and retention to the particular item.

3.3 Augmented Signage

Using a similar vector structure as for push advertising, LED backlit signage can also be augmented using optical camera communications. A company advertising a particular item on the sign can now, again, transmit a continuous short message that identifies a particular

advertisement from a database. The application, which can now be connected to the Internet with either Wi-Fi or mobile connection, can then access this ad database entry and stream it onto the phone of the customer when viewing the sign.

Byte	**Name**	**Sample**
0	Vector ID	4 (*augmented sign*)
1	Vector offset	3
2-4	Company	*x*
5	Vector Offset	3
6-8	Item	*y*
9	Vector Offset	0
10-15	Advertistement / Coupon	*z*

This application will allow companies to augment advertisement on-demand and thus improve customer interest and satisfaction in the particular item.

3.4 Asset Tracking

In warehouse and manufacturing environments, it is often time-critical to locate and utilize specialized equipment. If there are only a few of such equipment available on a large manufacturing site, their locations may be unknown to employees needed to use them. Thus, by equipping them with a camera that receives an IB from the manufacturing/warehouse floor lights, these equipment can use RF infrastructures to communicate back to the central server/cloud their location on the site. Such a solution could also be helpful in hospital environments to track doctors, surgeons, or specialist equipment.

With such a system, delays can be avoided that may cause system / line breakdown and in the hospital case, improve emergency patient attendance.

Byte	**Name**	**Sample**
0	Vector ID	2 (*indoor positioning*)
1	Vector offset	2
2-3	Position	*x* (*building*)
4	Vector Offset	2
5-6	Position	*y* (*floor*)
7	Vector Offset	0
8-15	Position	*z* (*light IB*)