

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

Submission Title: [Proposal of MAC concept for VL-Image Sensor Communication (ISC)]

Date Submitted: [21.Sep.2009]

Source: [Nobuo Iizuka] Company [CASIO COMPUTER CO., LTD. / VLCC]

Address [3-2-1, Sakaecho 3-chome, Hamra-shi, Tokyo, Japan]

Voice:[+81-42-579-7159], FAX: [+81-42-579-7744], E-Mail:[iizukan@casio.co.jp]

Re: []

Abstract: [Proposal of MAC concept for VL-Image Sensor Communication.]

Purpose: [Proposal for IEEE 802.15.TG7]

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.

Proposal of MAC concept for VL-ISC (Visible Light Image Sensor Communication)

Nobuo IIZUKA

CASIO COMPUTER CO., LTD. /
VLCC

Contents

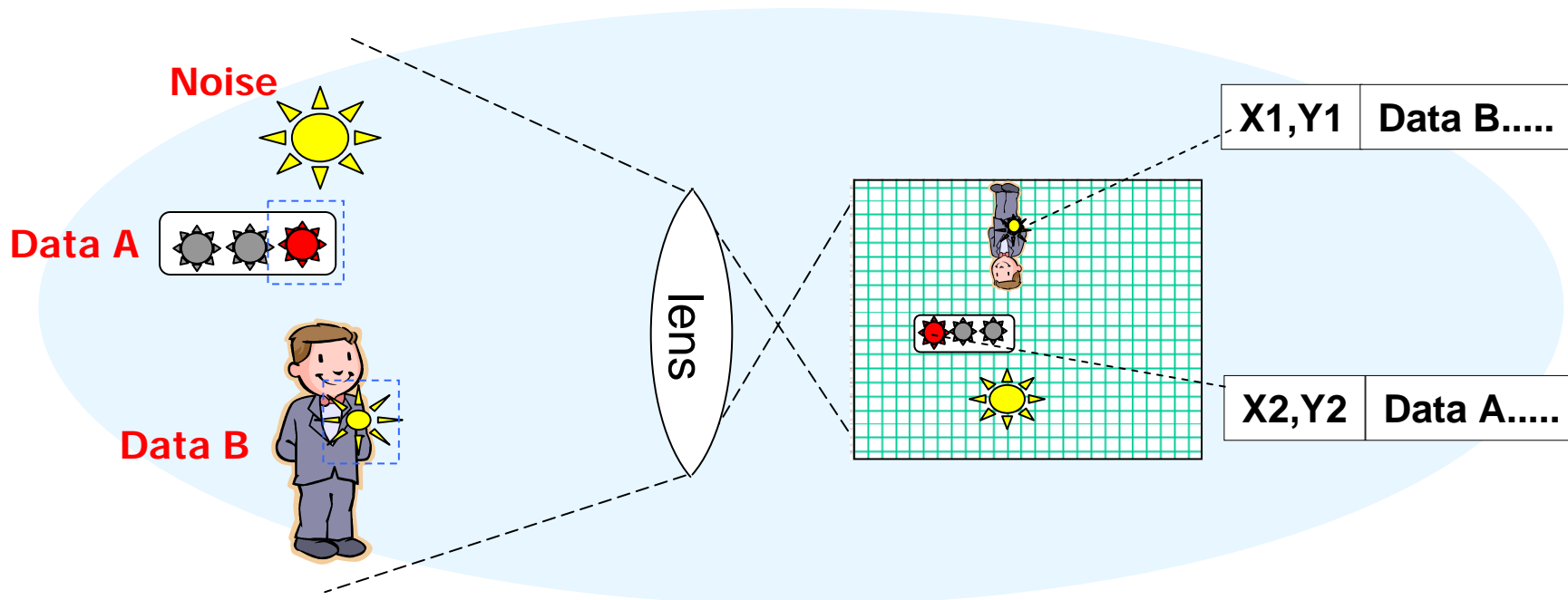
- Characteristics of ISC
- New MAC concept of ISC
- The example of CASIO's ISC
- Conclusion

Next....

- Characteristics of ISC
- New MAC concept of ISC
- The example implementation of CASIO
- Conclusion

Image Sensor Communication (ISC)

- Spatial separation capability
 - Brightness–Distance invariant law
 - Providing “Data” simultaneous with “Spatial position”
- (Should assume: MAC mode is broadcast / Multi-pt to pt communication)

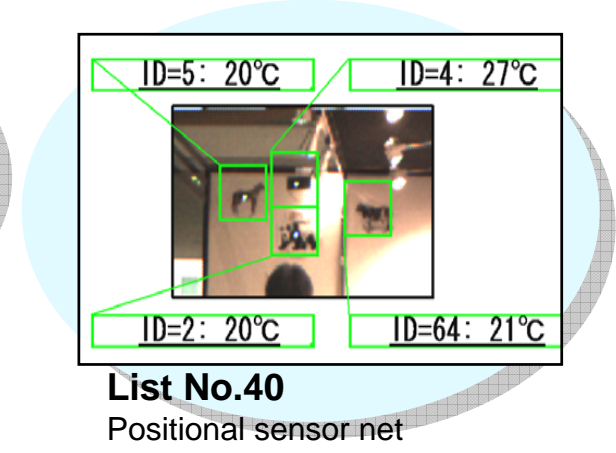
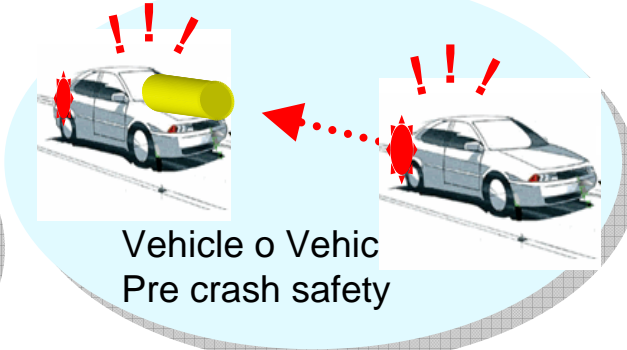
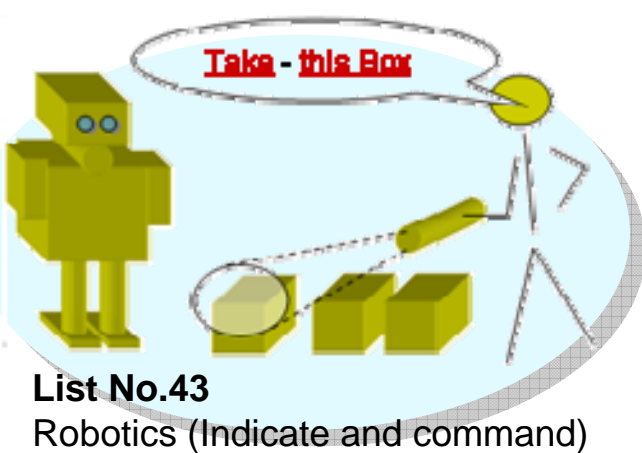
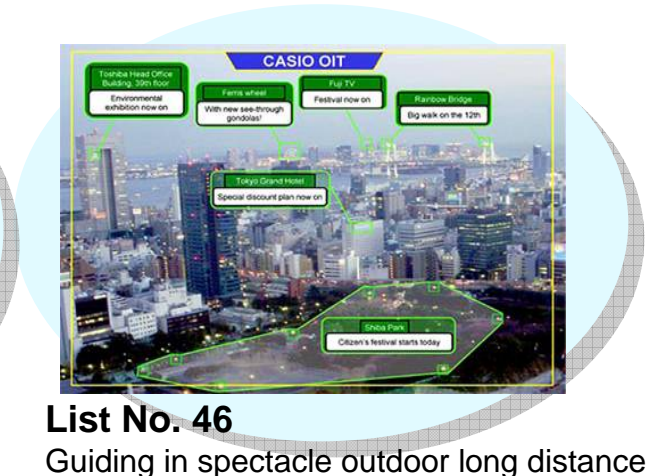
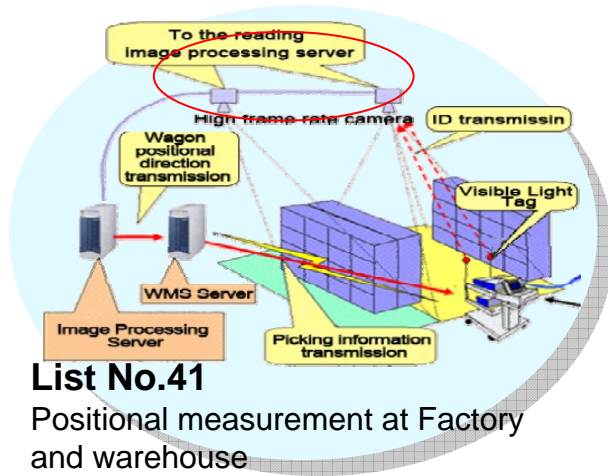


About VLC using Arrayed PD / Image sensor doc.: IEEE 802.15-<09-0502-00-10 July 2009 0007 >

Many applications of ISC

Application summary list:

doc.: 15-09-0125-08-0007-vlc-application-definitions-and-summary.xls



Motivation of ISC based on Visible Light characteristics

ISC utilizes

Visible Light advantages that should be considered

1. The short wavelength provides high spatial resolution
 - It is not only for “High data rate” or “many channels”
2. Image formation lens is usable
 - It provides “Imaging” capability.

ISC solves

Visible Light environment issue that should support

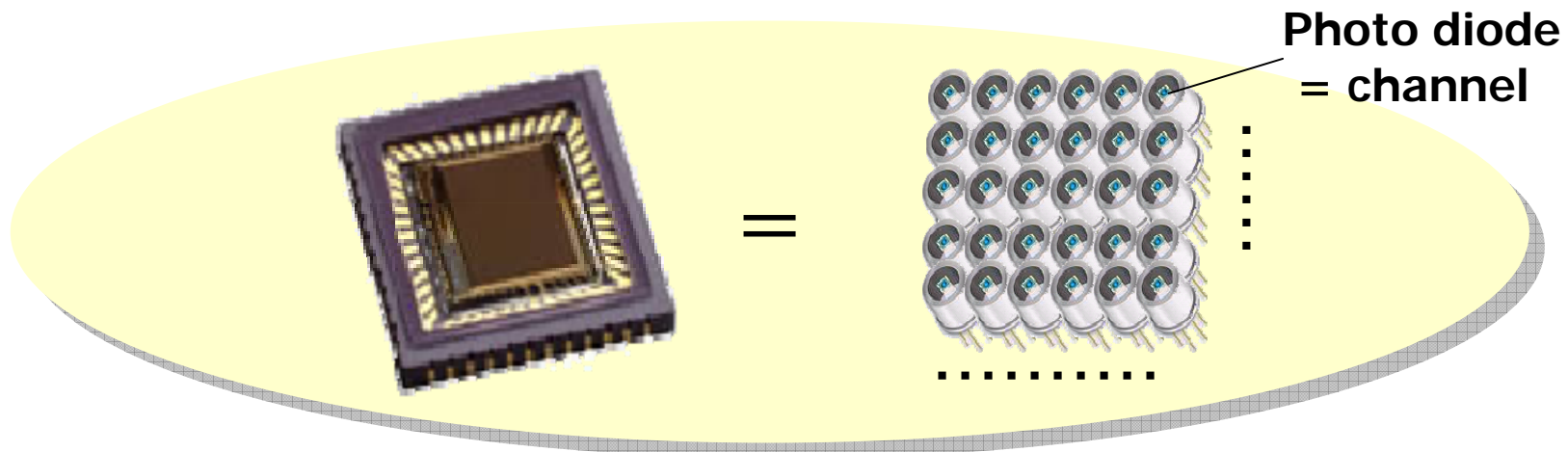
- A lot of strong ambient light noise/ interference
 - Sun light is severe DC noise in outdoor.
 - Indoor fluorescent lamp has 30–500kHz noise.

Next....

- Characteristics of ISC
- New MAC concept of ISC
- The example implementation of CASIO
- Conclusion

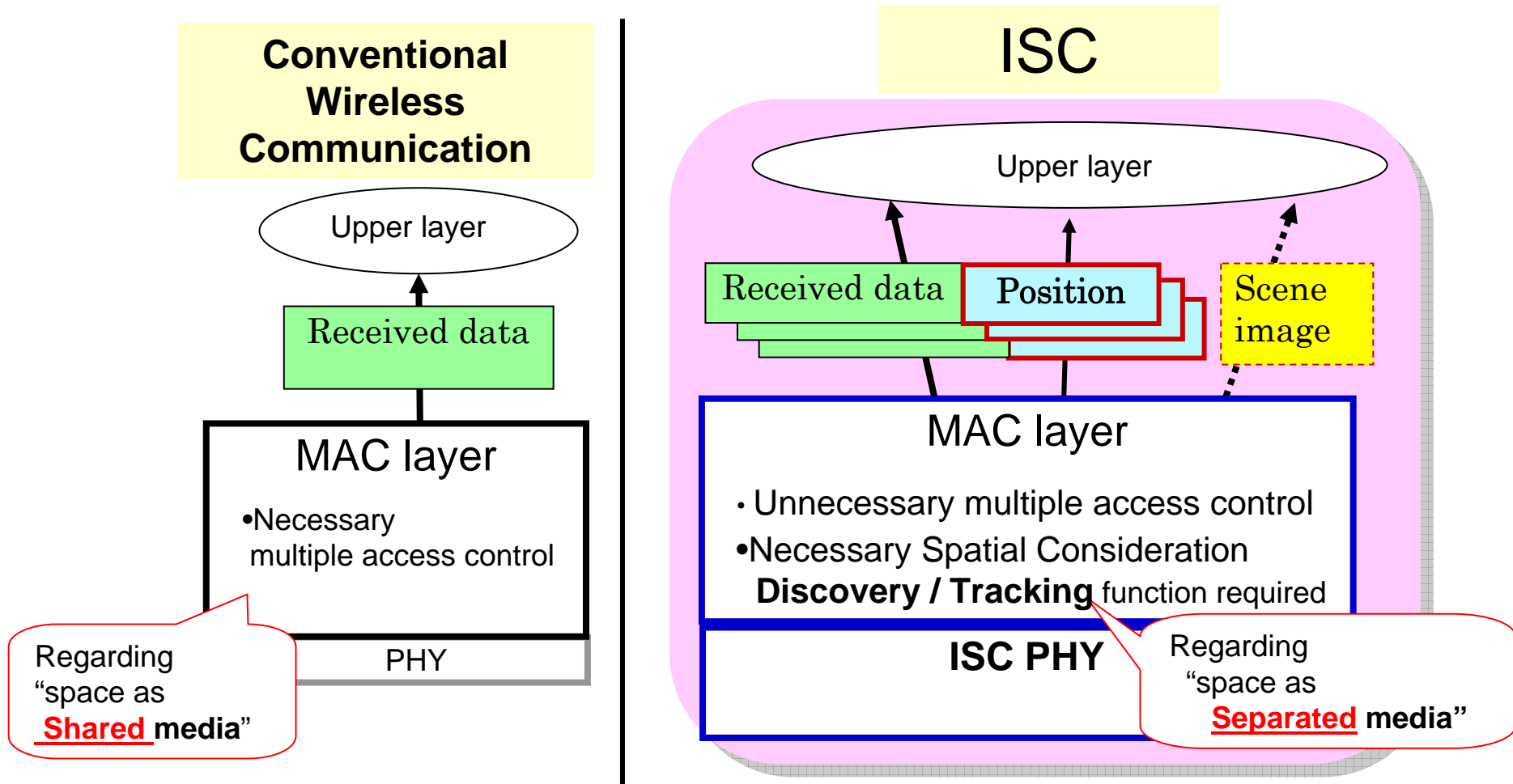
In a reductive point of view

The structure is arrayed photo diode...



- Is it the merely arrayed channels?
We think “No It brings a qualitative change”
- Does it need the consideration for standard?
We think “Yes we should consider it”

A new MAC concept of ISC



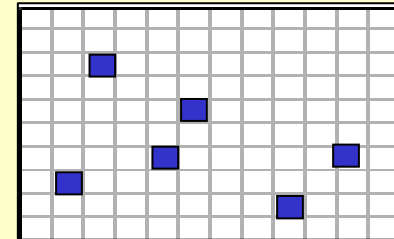
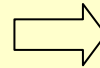
For the new effect / new issue, we should consider it

Discovery and Tracking required function of ISC

- **Discovery**

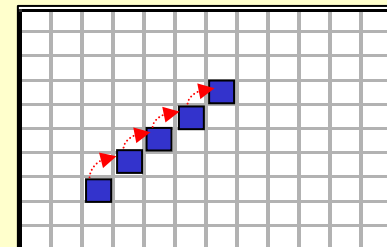
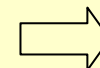
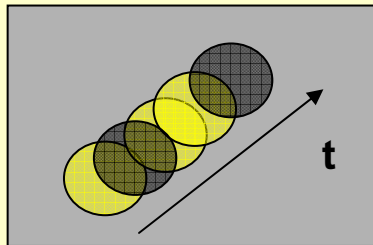
- It is Channel (s) selection from many channels in the array.

**Many Signals
and
Many Interference**



- **Tracking** optional function based on discovery

- It is like a hand-over method of mobile phone system.

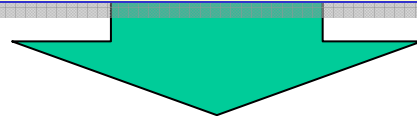


Next....

- Characteristics of ISC
- New MAC concept of ISC
- The example implementation of CASIO
- Conclusion

A realization of ISC-MAC of CASIO

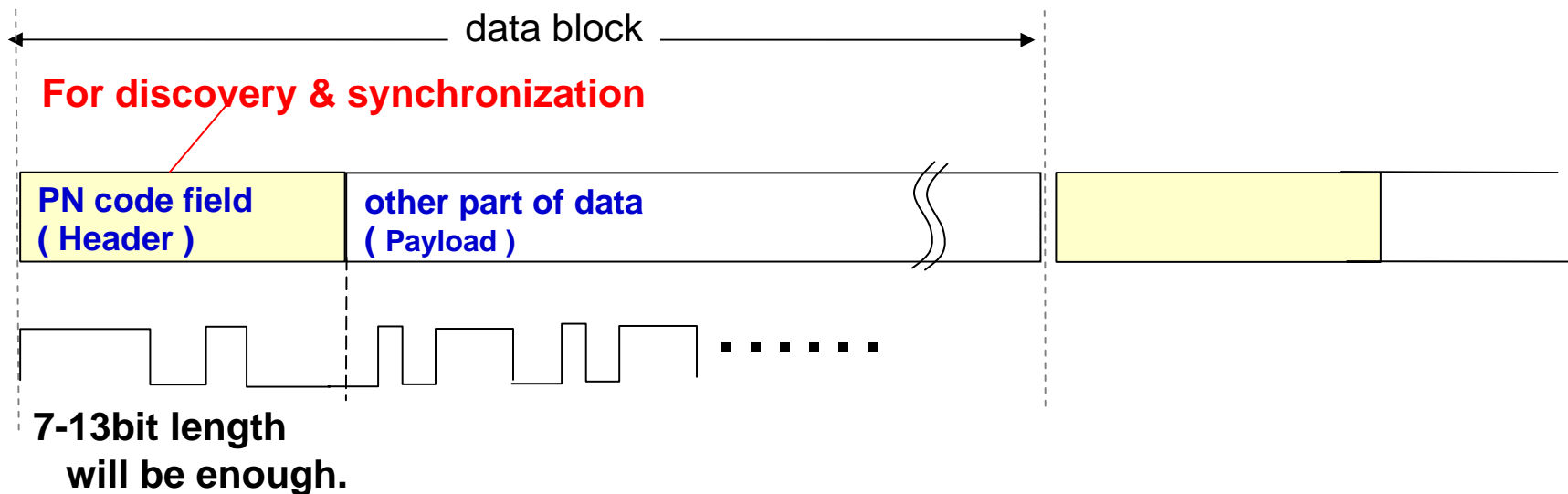
- Policy :
 - Simple architecture, available device
 - Performance of “discovery” have to be……
 - Stabilized in any environment.
 - Wide range of scalability in data rate
 - ultra low data rate (100bps) to low data rate (5K bps)



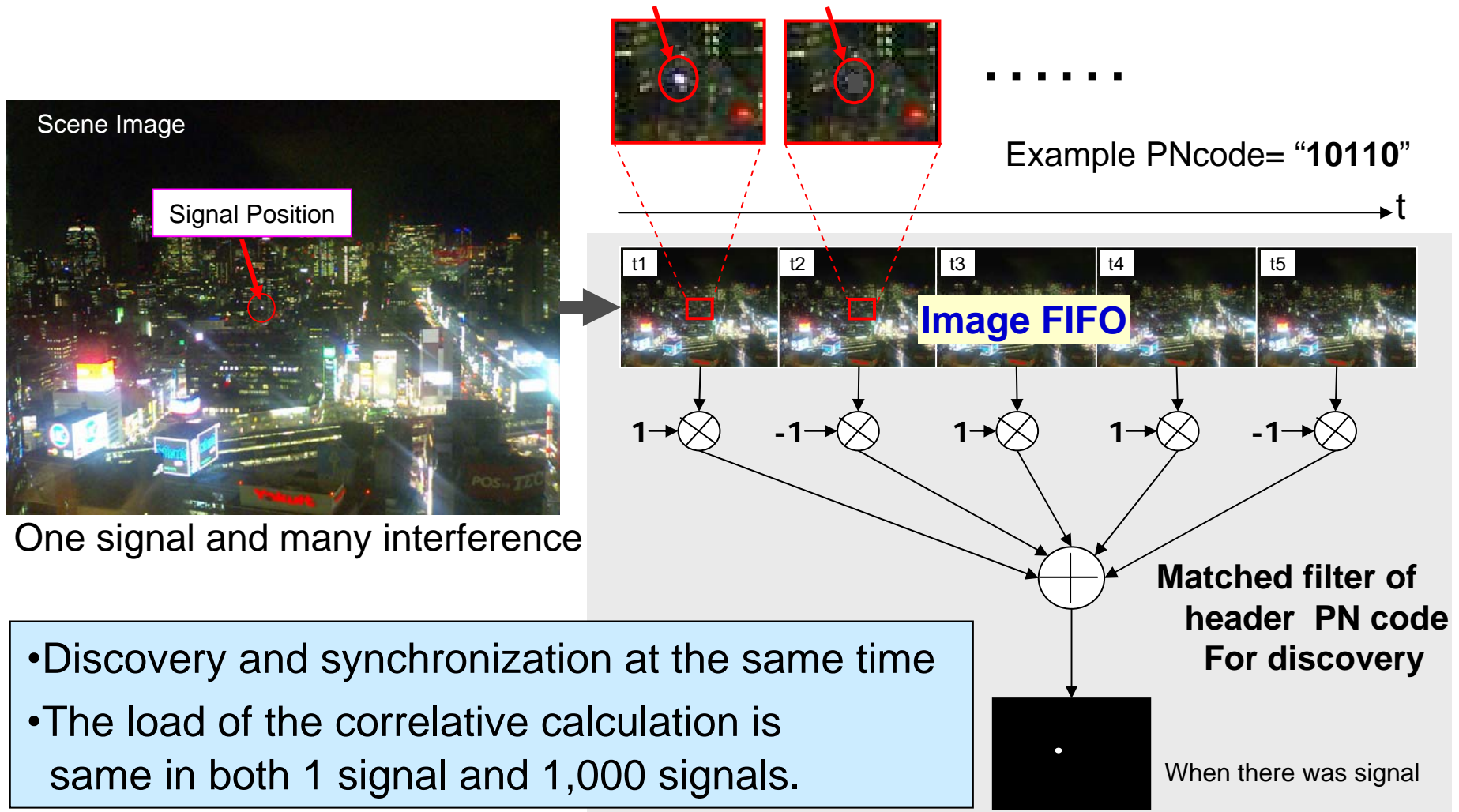
- Suitable method for “discovery” :
 - Consider about sending data for ISC.
 - Receiving devise use a **expansion of sending out data.**

Data format with ISC expansion

- Add specific PN (Pseudo Noise) code field in a data block.
- The PN-code is a **key of discovery**.
 - “Every natural brightness fluctuation” and the PN-code do not have a correlation each other.
 - “Other part of the block” and the PN-code also do not have a correlation each other.



ISC expansion : receive side process



- Discovery and synchronization at the same time
- The load of the correlative calculation is same in both 1 signal and 1,000 signals.

A demo movie

Discovery and Tracking using proposed data format



CASIO 2009.Sep. 2minutes.

The list of ISC examples

Image sensor	Application conscious	↔	Performance conscious
use existing sensor	CASIO (VLCC)	TOSHIBA (VLCC) NEC (VLCC)	
Make special hardware	SONY (VLCC)		KEIO Univ. (VLCC) Shizuoka Univ. NAIST ...etc

These examples have “discovery” function.

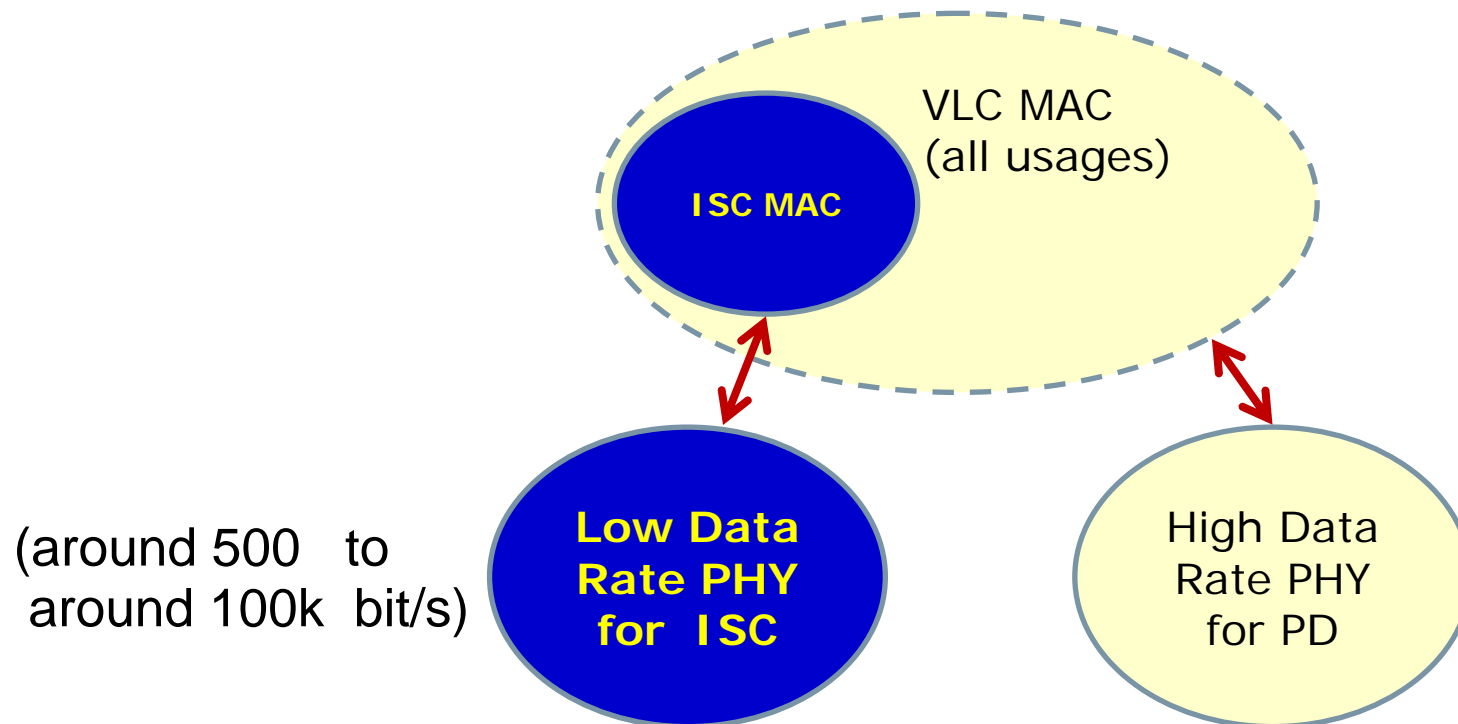
Next....

- Characteristics of ISC
- New MAC concept of ISC
- The example of implementation of CASIO

- Conclusion

VLC MAC/PHY logical diagram

- ISC includes a new concept of MAC, but it may be possible by expansion of conventional MAC.
- From the viewpoint of “time-to-market”, the standardization of ISC should begin examination by the PHY of the low data rate.



Conclusion

- To realize ISC, “Spatial consideration ” is mandatory.
- Especially “discover” is essential.

- An effective method for “discovery” was explained

- As ISC point of view, PHY modulation frequency should be considered in low data rate at first.

- ISC is one of the fundamental technology, and not just implementation matter. Spatial consideration for ISC should be discussed in TG7.