

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

**Submission Title:** [TRD comments from Samsung Part 1]

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**Re:** []

**Abstract:** [Comments for technical requirement document. Some consideration point of TRD are also presented.]

**Purpose:** [Contribution to IEEE 802.15.7 TG-VLC]

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# **TRD Comments from Samsung Electronics – Part 1 –**

**2009. 05**

**Samsung Electronics**

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# TRD contents

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- ❖ COMPLEXITY
- ❖ MOBILITY

# Topology

## ❖ Topology

Type	Possible Application	Requirement
1:1	Mobile to Mobile	Bi-directional
1:N	Information Broadcasting, LED sign-board, Info gate	Broadcasting
1:N	Visible LAN	Bi-directional <b>Need to limit N* number</b>

\* The maximum number(N) of active connections is 7 in Bluetooth.

# Device characteristic of Tx source and receiver

## ❖ Characteristic of Tx

### ■ Divergence Angle

#### ◆ Max 30° (Full angle): each LED

- For VLC mobile device
- Reason: For high data rate/lower angle due to visibility

### ■ Tx power

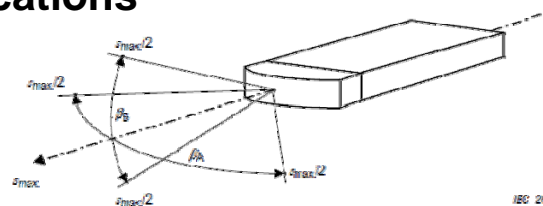
#### ◆ Maximum Intensity:

- Eye safety regulation
  - For example: IEC 60825
  - For example: letter to IEC TC 76.

### ■ Reference

#### ◆ IEC 61920 - Infrared free air applications

- Radiant intensity
- Angle of radiation
- Duration of radiation



$\lambda_{1l} = 930 \text{ nm}$   
 $\lambda_{1u} = 980 \text{ nm}$   
 $f_{1l} = 38 \text{ kHz}$   
 $f_{1u} = 60 \text{ kHz}$   
 $I_p = 45 \text{ mW/sr}$   
 $I_o = 20 \text{ mW/sr}$   
 $\alpha_A = 60^\circ$   
 $\alpha_B = 30^\circ$

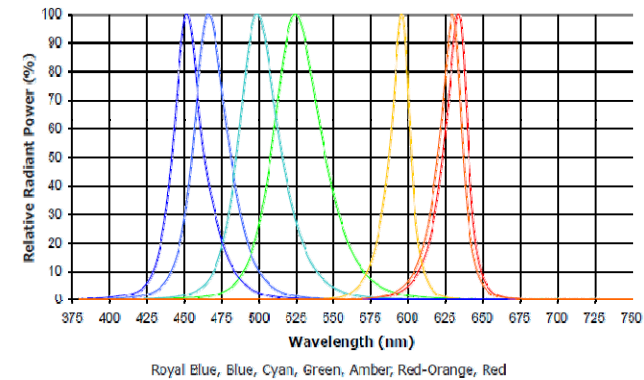
# Frequency Reuse

## ❖ We need to consider real LED specification

- Need to support at least RGB & White

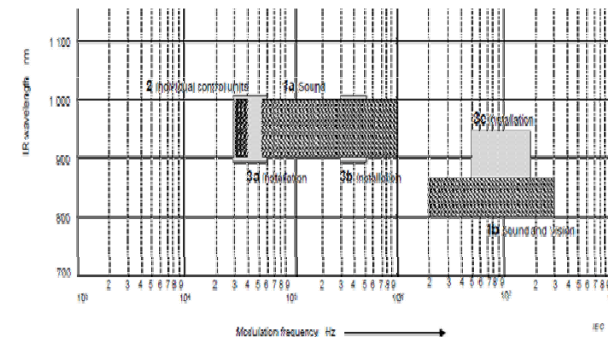
- Consideration

- ◆ LED manufacture's variation
- ◆ LED communication ability (ability for fast switching)



## ❖ Reference

- IEC 61920 - Infrared free air applications
  - ◆ Ranges of wavelength



# Data rate

## ❖ Demonstration in IEEE 802 Tutorial

**Mobile to Mobile**  
(100Mbps, Samsung)



**Tx, Rx**  
(~30Mbps, Univ. of Oxford)



**LED array**  
(~1Gbps, Keio Univ.)



**Music broadcasting**  
(6Mbps, Univ. of Oxford)



**Infra to Mobile**  
(10Mbps, Tamura Inc.)



**Sign board**  
(10Mbps, Samsung)



**Infra to Mobile (LAN)**  
(4Mbps, Samsung)





# Data rate

## ❖ ISO 21214

- Intelligent transport systems - Continuous air interface, long and medium range(CALM) – Infra-red systems
- Air interface using infra-red systems at 820nm to 1010nm
- Data rate: 1Mbps~128Mbps
- Supports vehicle speeds up to a minimum of 200km/h
- Supports communication distance up to 100m

Table 9 — Communications profiles

Parameter	Profile						
	0 (base profile)	1 (default profile)	2	3	4	5	6
Data rate	1 Mb/s	2 Mb/s	8 Mb/s	16 Mb/s	32 Mb/s	64 Mb/s	128 Mb/s
Modulation	8/16 OOK-RZ	6/16 OOK-RZ	CIR-8 HHH(1,13)	CIR-16 HHH(1,13)	CIR-32 HHH(1,13)	CIR-64 HHH(1,13)	CIR-128 HHH(1,13)
Bit time $T_{bit}$	1 000 ns ± 1 %	600 ns ± 1 %	n.a.				
Chip time, $T_{chip}$	1 000 ns ± 1 %	600 ns ± 1 %	83,4 ns ± 0,6 ns	41,7 ns ± 3,3 ns	20,8 ns ± 1,6 ns	10,4 ns	6,2 ns
Optical pulse on time, $T_{Pon}$	190 ns ± 20 ns	190 ns ± 20 ns	89,4 ns ± 0,9 ns	41,7 ns ± 3,3 ns	20,8 ns ± 1,6 ns	10,4 ns	6,2 ns
Optical pulse rise time <sup>a</sup> , $T_{Prise}$	≤ 75	≤ 75	≤ 38 ns	≤ 19 ns	≤ 9 ns	to be added	to be added
Optical pulse fall time <sup>a</sup> , $T_{Pfall}$	≤ 75	≤ 75	≤ 38 ns	≤ 19 ns	≤ 9 ns	to be added	to be added
Format	Syno.						
MAC flow control	By MAC commands (“Block start”, “Block end”, “Packet start”, “Packet end”, “Start of control block”).						
Forward error correction	Hamming $Z = 12, D = 3$ <sup>b</sup>		none <sup>b</sup>				
Multiple error detection	Hamming $Z = 12, D = 3$ <sup>b</sup>		CRC32				
NOTE Some of the parameters of profile 0 and profile 6 will be defined in future versions of this International Standard.							
<sup>a</sup> Equipment employing several communications profiles shall conform with the most stringent values, irrelevant which profile is active at a given time.							
<sup>b</sup> For details see Annex B.							

# Data rate

❖ **Data Rate Range**

- 10kbps ~ 1G from 37 contributions
- Count the number of contributions based on data rate

❖ **Divide into low and high data rate category**

- Low data rate: 10kbps~1Mbps
- High data rate: 1Mbps~100Mbps
- A device that can support high data doesn't need to co-exist with a device that can support low data rate.
- Recommend to focus the high data rate application.

	~ 10kbps	~ 100kbps	~1Mbps	~10Mbps	~20Mbps	~100Mbps	~1Gbps	TBS
All	3	2	1	9	2	13	1	4
Samsung	3	0	0	6	2	13	1	

**Low Data Rate**

**High Data Rate**

# Transmission Range

## ❖ Transmission Range

- Long Range Device: >3m
- Short Range Device: ≤3m based on Appl. Sum. Doc.
- Application summary document: Total 37 (2009.04)

~ 1m	~ 3m	3m~10m	10~100m	TBD
5	9	15	3 (Vehicle related:2)	5

- However it very depends on application and data rate
- Transmission range for VLC
  - ◆ It doesn't need to limit the range  
OR
  - ◆ max 10m & some cases may need to treat differently

# Summary

## ❖ TRD Comments

### ■ TOPOLOGY

- ◆ 1:1 Bi-directional
- ◆ 1:N Broadcasting/Bi-directional

### ■ DEVICE CHARACTERISTICS OF LIGHT SOURCES AND RECEIVERS

- ◆ TX : Divergence angle: FOV: 30°
- ◆ Max power: Eye safety regulation (ex: IEC 60825)

### ■ FREQUENCY USAGE

- ◆ Need to consider LED spec
- ◆ the number of channels

### ■ DATA RATES

- ◆ Low data rate and High data rate

### ■ TRANSMISSION RANGE

- ◆ Long Range Device:>3m
- ◆ Short Range Device:<=3m

**Thank you**

**Q&A**

# Reference

- ❖ **ISO 21214:2006**
  - **Intelligent transport systems - Continuous air interface, long and medium range(CALM) – Infra-red systems**
- ❖ **H. L. Minh, O'Brien, D., Faulkner, G., L. Zeng, "High-Speed Visible Light Communications Using Multiple-Resonant Equalization, " Photonics Technology Letters, IEEE, Volume 20, Issue 14, July15, 2008 Page(s):1243 – 1245**
- ❖ **<http://en.wikipedia.org/wiki/Lux>**
- ❖ **IEC 61920 - Infrared free air applications**
- ❖ **[http://sales.hamamatsu.com/assets/applications/SSD/photodiode\\_technical\\_information.pdf](http://sales.hamamatsu.com/assets/applications/SSD/photodiode_technical_information.pdf)**
- ❖ **<https://mentor.ieee.org/802.15/dcn/09/15-09-0115-01-0007-tg7-technical-requirements-document.doc>**
- ❖ **<http://www.cree.com/products/pdf/XLamp7090XR.pdf>**
- ❖ **<https://mentor.ieee.org/802.15/dcn/08/15-08-0673-03-0vlc-letter-to-iec-tc-76-concerning-led-wireless.doc>**