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

Submission Title: [Comments for TRD input – Part 2]
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Source: [Sridhar Rajagopal, Ying Li, Farooq Khan, Jae-seung Son, Taehan Bae, Eun Tae Won]
Company [Samsung Electronics]
Contact: [sridhar.r@samsung.com]

Re: [TG7 Call For Contributions]

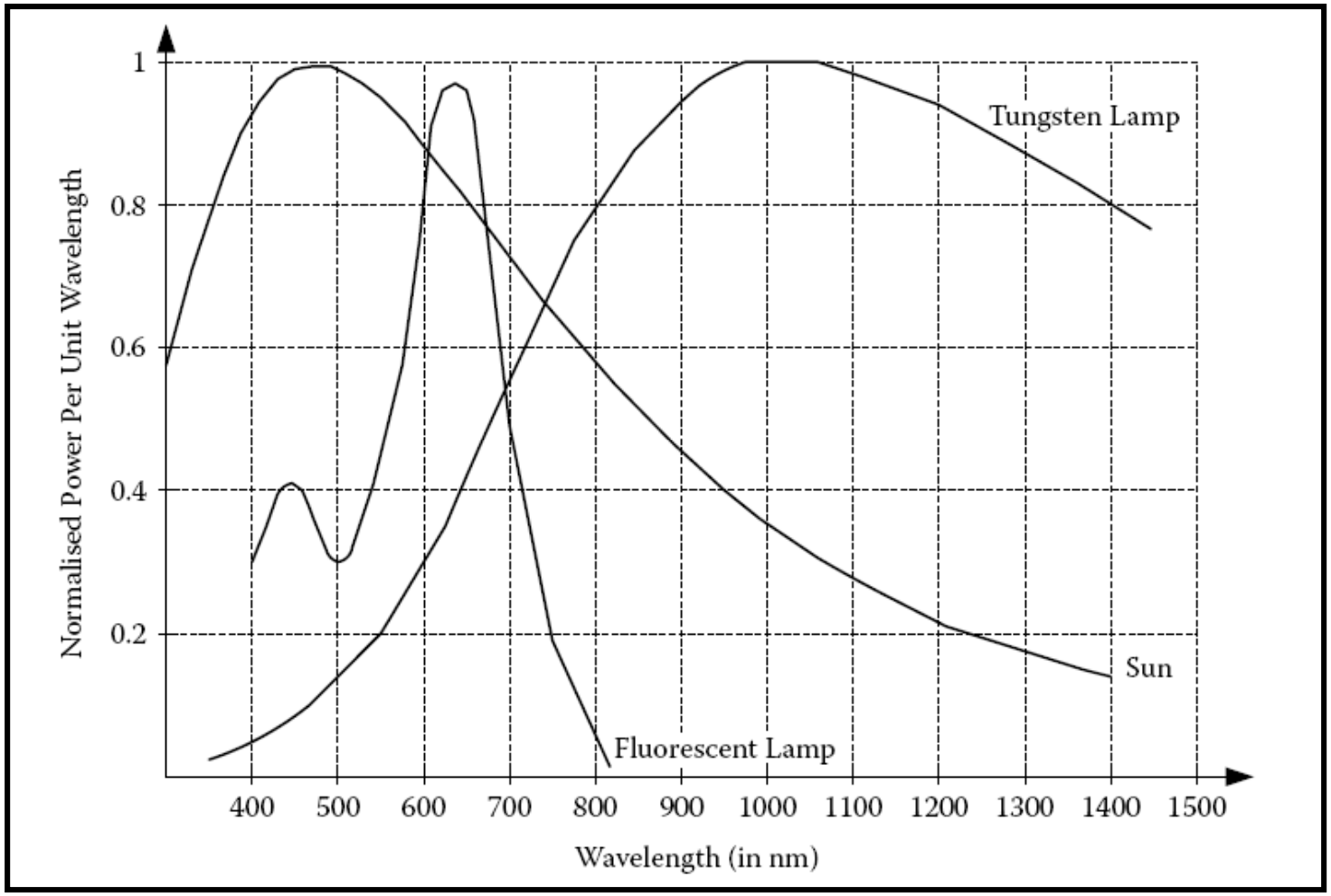
Abstract: []

Purpose: [To provide comments to TRD document and trigger discussion with other group members of TG7]

Topics – Part 2

- Ambient interference
- Security
- Power consumption
- QoS
- Form factor
- Complexity

Ambient Light Characteristics



Source: Optical Wireless Communications : IR for Wireless Connectivity, R. Ramirez-Iniguez, CRC Press

Frequency selectivity for ambient light

- Defining a frequency-selective or source-specific ambient light tolerance would make the TRD unnecessarily complicated
- Recommend specify parameter that is not frequency-selective for ambient light tolerance
- Recommend specify parameter that is not source-specific

Illuminance of typical light sources

Illuminance	Example
10^{-5} lux	Light from Sirius, the brightest star in the night sky
10^{-4} lux	Total starlight, overcast sky
0.01 lux	Quarter moon
0.2 lux	Design minimum for emergency lighting (AS2293).
0.27 lux	Full moon on a clear night
50 lux	Family living room
100 lux	Very dark overcast day
320 lux	Recommended office lighting (Australia)
400 lux	Sunrise or sunset on a clear day. Well-lit office area.
500 lux	Lighting level for an office according to the European law UNI EN 12464.
1,000 lux	Overcast day - typical TV studio lighting
10,000–25,000 lux	Full daylight (not direct sun)
32,000–130,000 lux	Direct sunlight

Source: http://en.wikipedia.org/wiki/Lux

Indoor vs. outdoor applications

- Sunlight more relevant to outdoor applications
- Artificial light more relevant to indoor applications
- This could be used for separating requirements for indoor vs. outdoor light tolerance

Other requirements

Ambient light tolerance should be specified for light falling within the FOV of the receiver

Ambient light tolerance should be specified for the highest data rate sensitivity at a given range

- Interference would be more of the typical case of operation

Acceptable PER degradation for interference should be specified for highest data rate

- Recommend PER degradation < 1 dB at 8% PER

Range between TX and RX for ambient light tolerance specified at 8% PER

Recommendation

Ambient Light	Minimum Tolerance level (lux)
Outdoor	10000
Indoor	500

Matches typical indoor and outdoor illuminance levels

Verified with testing indoor and outdoor using a standard luxmeter.

Security requirements from PAR

Unique characteristic of visible light communication

- Purpose of Proposed Standard: … The standard will provide … (iii) additional security by allowing the user to see the communication channel;
- Need for the project: … Thirdly, the unique feature of visibility can enhance the physical-layer security and offer intuitive usage. … Potential application include secure point-to-point communication, …, secure point-to-Multipoint communication …

Security options for VLC

Consider data integrity, data authenticity and encryption

VLC is inherently safe due to WYSIWYT property. However, additional data confidentiality and authenticity mechanisms may be required for applications such as kiosk downloads

AES-128 symmetric-key cryptography algorithm can be considered for TRD

An approach similar to multi-level security in IEEE 802.15.4 can also be considered for TRD if different levels of security are desired for different services

Power consumption

Power consumption may not be an issue for the infrastructure devices

However, mobile devices need to conserve battery power for longer stand-by times.

Recommend that TRD should support power saving mechanisms such as sleep modes, duty-cycle, power save modes

Quality of Service (QoS)

Reliability and Latency

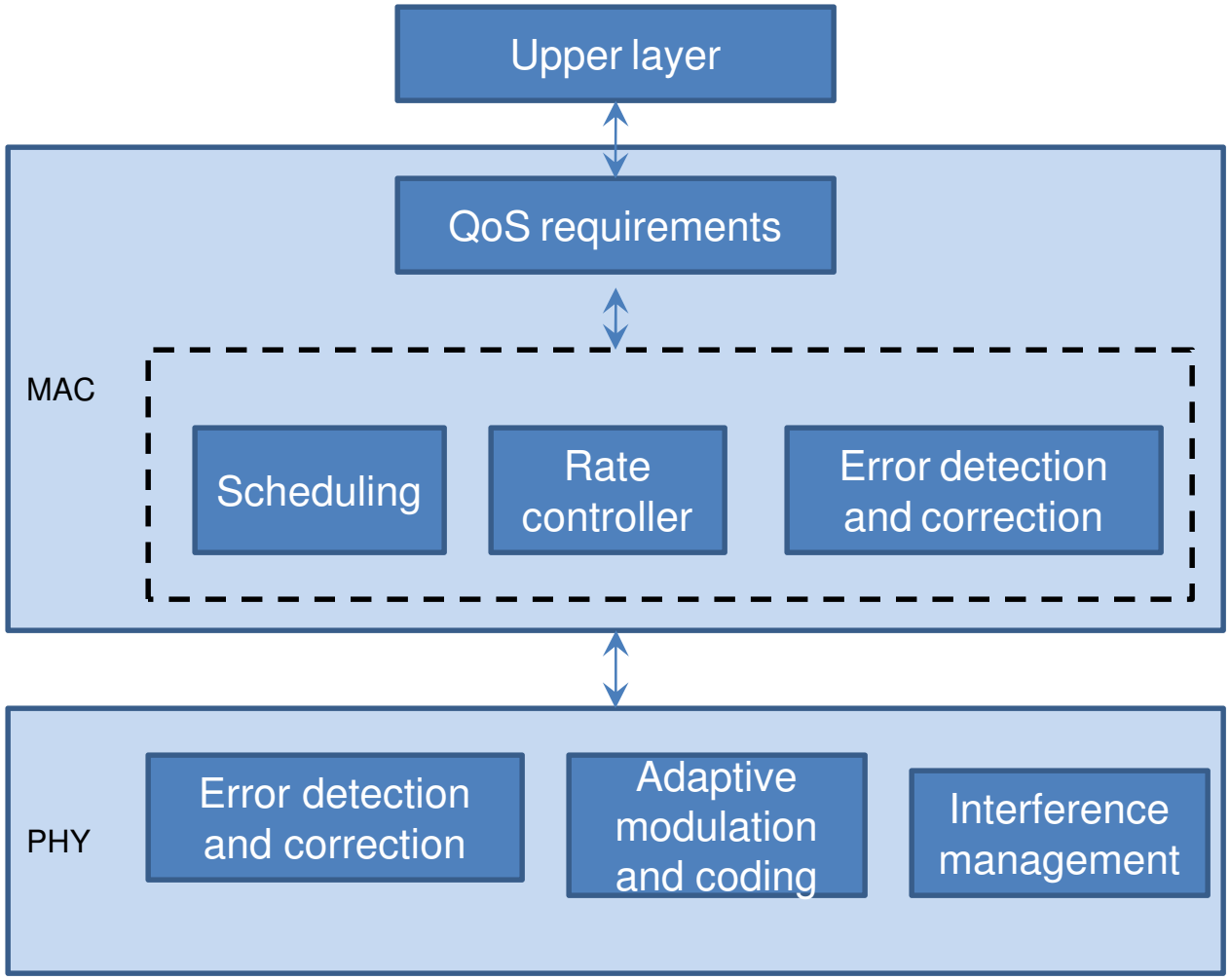
- Reliability: Appropriate error detection and correction methods, interference avoidance methods , or any other suitable techniques should be provided at PHY and MAC level
- Latency: Point-to-point delay and delay variation

Real-time, delay-sensitive information

- Real-time data should be delivered with limited delay (latency) and the parameter of such delay requirement would impact the scheduling etc.

TRD should support flexible QoS provisions such that they can be tailored to suit application needs.

QoS impact on MAC and PHY



Example of QoS Requirement

Different applications have different requirement on rate, loss, and delay (latency).

TRD should support various applications with different QoS requirements.

	Application example	Rate at the Application Layer	Loss	Delay
Audio	music	Low	<3% FER	<150ms
Data	File download	High	Zero	Insensitive
	Delay-sensitive broadcast	Low-high	Zero	< 250ms
Multimedia	Videophone	Medium to High	<1% FER	< 150ms
	Online video / broadcasting	Medium to High	Some loss tolerant	Initial delay of a few seconds Small jitter

Form factor

Should be easy to integrate with existing dimmer and driver circuits for infrastructure

Should be able to integrate well with mobile phones

Complexity

Low complexity to enable mass commercial adoption

- Cell phones, displays, traffic lights,

Should have ease of integration into existing/upcoming LED-based products

Gate count, die size, BOM should be minimized

References

Optical Wireless Communications : IR for Wireless Connectivity, R. Ramirez-Iniguez, CRC Press

http://en.wikipedia.org/wiki/Lux

802.15.7 TG-VLC PAR IEEE P802.15-08-0656-01-0007

802.15.6 TG-BAN TRD IEEE P802.15-08-0644-09-0006