**IEEE P802.15**

**Wireless Personal Area Networks**

|  |  |
| --- | --- |
| Project | IEEE P802.15 Working Group for Wireless Personal Area Networks (WPANs) |
| Title |  |
| Date Submitted | [13 May, 2015] |
| Source | [][][Schleinitzstr. 22,38106 Braunschweig, Germany] | Voice: [ +49 531 391 2439 ]Fax: [ +49 531 391 5192 ]E-mail: [ rey@ifn.ing.tu-bs.de ] |
| Re: | [If this is a proposed revision, cite the original document.] |
| Abstract | [This document is the TG3d evaluation criteria document.] |
| Purpose | [This is a working document which will provide guidance how proposals have to be assessed to be considered in the selection process for a Draft Standard for TG P802.15.3d.] |
| 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. |

# Revision History

Rev. 0: Initial Proposal based on IEEE P802.15-05-0493-27-003cTable of Contents

[Revision History 2](#_Toc419295292)

[1. Introduction 5](#_Toc419295293)

[2. References 5](#_Toc419295294)

[3. General Definitions 6](#_Toc419295295)

[3.1. RF power measurements/calculations 6](#_Toc419295296)

[3.2. Eb/N0 reference point 6](#_Toc419295297)

[4. General Solution Criteria 6](#_Toc419295298)

[4.1. Unit Manufacturing Cost/Complexity (UMC) 6](#_Toc419295299)

[4.1.1. Definition 6](#_Toc419295300)

[4.1.2. Values 6](#_Toc419295301)

[4.2. Signal Robustness 6](#_Toc419295302)

[4.2.1. General Definitions 6](#_Toc419295303)

[4.2.2. Interference and Susceptibility 6](#_Toc419295304)

[4.2.3. Coexistence 6](#_Toc419295305)

[4.3. Technical Feasibility 7](#_Toc419295306)

[4.3.1. Manufacturability 7](#_Toc419295307)

[4.3.2. Time to Market 7](#_Toc419295308)

[4.3.3. Regulatory Impact 7](#_Toc419295309)

[4.4. Scalability 8](#_Toc419295310)

[4.4.1. Definition 8](#_Toc419295311)

[4.4.2. Values 8](#_Toc419295312)

[5. MAC Protocol Supplements 8](#_Toc419295313)

[5.1. Alternate PHY Required MAC Enhancements and Modifications 8](#_Toc419295314)

[This section is copied from IEEE P802.15-05-0493-27-003c so far. 8](#_Toc419295315)

[5.1.1. Definition 8](#_Toc419295316)

[5.1.2. Values 8](#_Toc419295317)

[6. PHY Layer Criteria 9](#_Toc419295318)

[6.1. Size and Form Factor 9](#_Toc419295319)

[6.1.1. Definition 9](#_Toc419295320)

[6.1.2. Values 9](#_Toc419295321)

[6.2. PHY-SAP Payload Bit Rate and Data Throughput 9](#_Toc419295322)

[6.2.1. PHY-SAP Payload Bit Rate 9](#_Toc419295323)

[6.2.2. Packet Overhead 9](#_Toc419295324)

[6.2.3. Data Throughput 9](#_Toc419295325)

[6.3. Co-Channel and Cross-Channel Interference 10](#_Toc419295326)

[6.3.1. Definition 10](#_Toc419295327)

[6.3.2. Values 10](#_Toc419295328)

[6.5. System Performance 10](#_Toc419295329)

[6.5.1. Definition 10](#_Toc419295330)

[6.5.2. Values 10](#_Toc419295331)

[6.6. Link Budget 10](#_Toc419295332)

[6.6.1. Definition 10](#_Toc419295333)

[6.6.2. Values 10](#_Toc419295334)

[6.7. Sensitivity 12](#_Toc419295335)

[6.7.1. Definition 12](#_Toc419295336)

[6.7.2. Values 12](#_Toc419295337)

[6.8. Power Management Modes 12](#_Toc419295338)

[6.8.1. Definition 12](#_Toc419295339)

[6.8.2. Values 12](#_Toc419295340)

[6.9. Power Consumption 12](#_Toc419295341)

[6.9.1. Definition 12](#_Toc419295342)

[6.9.2. Value 12](#_Toc419295343)

[6.10. Antenna Practicality 12](#_Toc419295344)

[6.10.1. Definition 12](#_Toc419295345)

[6.10.2. Value 12](#_Toc419295346)

[Annex A: Selection Criteria Importance Levels 13](#_Toc419295347)

[A.1. General Solution Criteria 13](#_Toc419295348)

[A.2. PHY Protocol Criteria 14](#_Toc419295349)

[Annex B: Items to be reported together with proposals 15](#_Toc419295350)

[B.1. Simulation Scenarios 15](#_Toc419295351)

[B.1.1 PHY 15](#_Toc419295352)

[B.2. Items to be reported 15](#_Toc419295353)

[Annex C: List of contributors 16](#_Toc419295354)

# 1. Introduction

This is the criteria for the evaluation of the alternate PHY Draft Proposals. In order to accurately and consistently judge the submitted proposals, technical requirements are needed that reflect the application scenarios as described in the TG3d Application Requirements Document (ARD) [14-0304-16].

This working document will become the repository for the requirements to be used in the selection process for a PHY Draft Standard for P802.15.3d. The criteria presented in this document are based on TG3d Technical Requirements Document [14-0309-05], which takes precedence, and may also contain more general marketing requirements on which the proposers are asked to comment.

The document is divided into three sections: General Solution Criteria, MAC Protocol Supplements Criteria, PHY Layer Criteria.

Document [t.b.d?] provides the TG3c down selection process.

This document and the TG3d Technical Requirements document [14-0309-05] provide the technical content for the project to develop an alternate physical layer (alt-PHY). This alt-PHY shall be a supplement to the IEEE 802.15.3-2009 Standard. This Evaluation Criteria Document references the IEEE 802.15.3-2009 Standard.

Throughout this document the proposers are asked to provide parameters and performance measures related to their proposal. The proposers are only required to provide these values for the portions of the system that are covered in their proposal.

It is recognized that physical implementations and/or measurements are not required. Only simulations and calculations are required in order to provide all characteristics required in this document.

# 2. References

[15.3] IEEE 802.15.3-2009 Standard

[TRD] IEEE P802.15-14-0309-05, TG3d Technical Requirements Document

[ARD] IEEE P802.15-14-0304-16, TG3d Application Requirements Document

[CMD] IEEE P802.15-14-0310-06, TG3d Channel Model Document

# 3. General Definitions

## 3.1. RF power measurements/calculations

e.g. Power at the connector to the antenna

## 3.2. Eb/N0 reference point

e.g. at the receiver antenna connector

# 4. General Solution Criteria

This section defines the technical and marketing system level concerns of the proposals.

## 4.1. Unit Manufacturing Cost/Complexity (UMC)

### 4.1.1. Definition

### 4.1.2. Values

## 4.2. Signal Robustness

### 4.2.1. General Definitions

#### 4.2.1.1. Error Rate

#### 4.2.1.2. Receiver Sensitivity

### 4.2.2. Interference and Susceptibility

#### 4.2.2.1. Definition

#### 4.2.2.2. Interference Model

### 4.2.3. Coexistence

#### 4.2.3.1. Definition

#### 4.2.3.2. Coexistence Model

## 4.3. Technical Feasibility

This is intended to determine if the proposal is real or academic. Proposers will be asked to comment on criteria listed in the following sections.

### 4.3.1. Manufacturability

#### 4.3.1.1. Definition

Manufacturability is defined in terms of the use of available, cost effective manufacturing processes with evidence of effective mass production capability, with respect to the time line of the standard.

#### 4.3.1.2. Values

The proposers are asked to submit proof of the claims by way of expert opinion, models, experiments, pre-existence examples, or demonstrations.

### 4.3.2. Time to Market

#### 4.3.2.1. Definition

Time to Market addresses the question of when the proposed technology will be ready for market.

#### 4.3.2.1. Values

The proposal shall include an estimate of a schedule for when the PHY would be available for market.

### 4.3.3. Regulatory Impact

#### 4.3.3.1. Definition

The proposal should specify to which geopolitical regions it applies and identify any applicable requirements with which it conflicts. Merit will be awarded for proposals with regulatory compliance of wider geopolitical scope.

#### 4.3.3.2. Values

The proposer shall state which regions the proposal is in regulatory compliance. Merit is awarded for each region of compliance.

Regulatory domains to be considered:

1. Australian regulations
2. Canadian regulations
3. Japanese regulations
4. US FCC regulations
5. Other national regulations

For details on specific regulations in different regions refer to document [05-0596-rr].

Specific conflicts and potential derogations should be detailed.

## 4.4. Scalability

### 4.4.1. Definition

Scalability refers to the ability to adjust important parameters, such as those mentioned below, (if they are required by the applications) without rewriting the standard. The modified MAC should be able to support the scaling of the PHY.

### 4.4.2. Values

Scalability parameters include; power consumption, PHY-SAP Payload Bit Rate and Data Throughput, complexity, range, frequencies of operation, occupied bandwidth of operation, and other functions deemed appropriate. Providing parameters such as power consumption and complexity estimates are not mandatory.

# 5. MAC Protocol Supplements

## 5.1. Alternate PHY Required MAC Enhancements and Modifications

### This section is copied from IEEE P802.15-05-0493-27-003c so far.

### 5.1.1. Definition

Supplements and modifications to the MAC will be required to accommodate the alternate PHY. The modified MAC should stay backwards compatible to the current IEEE802.15.3-2003 MAC and IEEE802.15.3b MAC.

### 5.1.2. Values

Proposals should justify and explain the supplements that may be necessary in support of additional features for the alternate PHY.

Proposals should justify and explain the modifications that may be necessary to support or enhance operation of the alternate PHY.

# 6. PHY Layer Criteria

## 6.1. Size and Form Factor

### 6.1.1. Definition

The smaller the package, the easier it is to embed, especially, in a consumer electronics device. The size of the Antenna is considered separately from the one of the MAC and PHY.

### 6.1.2. Values

Proposers shall report whether their proposed solution can be fully integrated. The proposers should also report whether their proposed PHY and the 802.15.3 MAC complies with form factors such as Mini PCI, USB dongle, etc. The proposers shall also provide the size of the antenna used for performance evaluation.

## 6.2. PHY-SAP Payload Bit Rate and Data Throughput

### 6.2.1. PHY-SAP Payload Bit Rate

#### 6.2.1.1. Definition

The PHY-SAP Payload Bit Rate is defined as the bit rate at which the payload, FCS and any stuffing bits and tail symbols are transmitted. For IEEE Std 802.15.3-2003, examples of optional payload bit rates at the PHY-SAP are 11, 33, 44, 55 Mb/s and the mandatory payload bit rate is 22 Mb/s.

#### 6.2.1.2. Values

The proposer should provide the PHY-SAP Payload Bit Rates provided by their proposal, including those required to meet the mandatory data rates for the PHY-SAP as defined in clause x of [TRD].

### 6.2.2. Packet Overhead

#### 6.2.2.1. Definition

#### 6.2.2.2. Values

### 6.2.3. Data Throughput

#### 6.2.3.1. Definition

#### 6.2.3.2. Values

## 6.3. Co-Channel and Cross-Channel Interference

### 6.3.1. Definition

### 6.3.2. Values

## 6.5. System Performance

### 6.5.1. Definition

System performance refers to the ability of the system to successfully acquire and demodulate data packets at the required data rates and bit and packet error rates, both in the free space AWGN channel and in the channels specified by the channel model document [CMD].

Details form the CMD in addition to details about the link-level simulations.

### 6.5.2. Values

## 6.6. Link Budget

### 6.6.1. Definition

Link budget is used to determine proposal capabilities under certain operating conditions for the standards specified data rates, ranges, and bit error rate.

### 6.6.2. Values

The table below identifies the necessary parameters and equations that should be used to compute the final link margin. Proposers should complete this link budget table and identify and explain all assumptions. Although the proposers may need to make minor alterations to this table to more adequately reflect their proposal, the table identifies the minimum expected level of thoroughness, detail, and justification.

Parameters from the [CMD] may be explicitly be required here.

Table 1. Sample link budget calculations

|  |  |
| --- | --- |
| **Parameter** | **Value** |
| PHY-SAP Payload Bit Rate (*Rb*) | Gb/s |
| Average Tx power () | dBm |
| Tx antenna gain () | dBi |
| Center frequency (*fc*) |  |
| Path loss at 1 meter ()  m/s |  |
| Rx antenna gain () | dBi |
| Average noise power per bit () | dBm |
| Rx Noise Figure Referred to the Antenna Terminal ()1 | dB |
| Average noise power per bit () | dBm |
| Minimum Eb/N0 for AWGN channel (*S*) | dB |
| Shadowing link margin (*Mshadowing*) | dB |
| Implementation Loss2 (*I*) | dB |
| Tolerable path loss (*PL = PT+GT+GR-PN-S-Mshadowing-I-PL0*) | dB |
| Maximum operating range (*d = 10 PL/10n*) | m |

1 Per text book definition, the NF is the ratio of the SNR at the antenna output with respect to the SNR at the demodulator input. The NF should include not only the LNA but also cascaded stages as per Friis’ equation. Each proposer should justify the proposed noise figure number, or else use a default value of 8 dB.

2 Implementation loss is defined here for the AWGN channel only, and could include such impairments as filter distortion, phase noise, frequency errors, etc.

## 6.7. Sensitivity

### 6.7.1. Definition

### 6.7.2. Values

## 6.8. Power Management Modes

The ability to reduce power consumption for consumer electronic devices is important.

### 6.8.1. Definition

### 6.8.2. Values

## 6.9. Power Consumption

### 6.9.1. Definition

### 6.9.2. Value

## 6.10. Antenna Practicality

### 6.10.1. Definition

Required Antenna size and form factor depends on the specific application. The antenna form factor should be consistent with the envisioned applications.

### 6.10.2. Value

Antenna form factor should be described with reference to expected size. Any additional information the proposer desires to provide on the antenna such as size, frequency response, and radiation characteristics would be beneficial.

# Annex A: Selection Criteria Importance Levels

In order to indicate the importance level of each of the criteria, an ABC leveling scheme is used.

* A – Most Important Requirement
* B – Important Desired Requirement
* C – A “Nice to Have” Requirement

Unless otherwise stated above, it is desired (but not mandatory) that the proposers provide the following information.

## A.1. General Solution Criteria

|  |  |  |
| --- | --- | --- |
| ***CRITERIA*** | ***REF.*** | ***IMPORTANCE******LEVEL*** |
|  |  |  |
| ***Signal Robustness*** |
|  |  |  |
| *Technical Feasibility* |
| Manufacturability |  |  |
| Time To Market |  |  |
|  |  |  |

## A.2. PHY Protocol Criteria

|  |  |  |
| --- | --- | --- |
| ***CRITERIA*** | ***REF.*** | ***IMPORTANCE*** ***LEVEL*** |
| ***PHY-SAP Payload Bit Rate & Data Throughput*** |
| Payload Bit Rate |  |  |
| Packet Overhead |  |  |
| PHY-SAP Throughput |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |

# Annex B: Items to be reported together with proposals

The proposers should provide the following items together with their proposals. Reporting of all other simulation results, parameters, etc, are encouraged but not mandatory.

## B.1. Simulation Scenarios

## B.1.1 PHY

The proposers should use the results for the following simulation scenarios:

Details of the channel model should follow here. E.g.

1. PHY link using AWGN channel
2. PHY link using CM channel for front-/backhaul
3. …

## B.2. Items to be reported

The proposers should provide the following results:

Basically a definition of the figures to be presented follows here. E.g BER over SNR for a BER range of 1e0 to 1e-5.

# Annex C: List of contributors

1. Sebastian Rey (Technische Universität Braunschweig)
2. Thomas Kürner (Technische Universität Braunschweig)