**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: | [IEEE P802.15-15-0412r0] |
| 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](#_Toc424870324)

[1. Introduction 4](#_Toc424870325)

[2. References 4](#_Toc424870326)

[3. General Solution Criteria 4](#_Toc424870327)

[3.1. Technical Feasibility 4](#_Toc424870328)

[3.1.1. Manufacturability 5](#_Toc424870329)

[3.1.2. Time to Market 5](#_Toc424870330)

[3.2. Scalability 5](#_Toc424870331)

[3.2.1. Definition 5](#_Toc424870332)

[3.2.2. Values 5](#_Toc424870333)

[4. MAC Protocol Supplements 5](#_Toc424870334)

[4.1. Alternate PHY Required MAC Enhancements and Modifications 5](#_Toc424870335)

[4.1.1. Definition 5](#_Toc424870336)

[4.1.2. Values 5](#_Toc424870337)

[5. PHY Layer Criteria 6](#_Toc424870338)

[5.1. Operational Frequency and Bandwidth 6](#_Toc424870339)

[5.2. PHY-SAP Payload Bit Rate and Data Throughput 6](#_Toc424870340)

[5.2.1. Gross Bit Rate 6](#_Toc424870341)

[5.2.3. Data Throughput 6](#_Toc424870342)

[5.3. Regulatory Requirements, Co- and Cross-Channel Interference 6](#_Toc424870343)

[5.4. System Performance, Modulation and Error Correction 7](#_Toc424870344)

[5.5. Link Budget 7](#_Toc424870345)

[5.6. Power Consumption 8](#_Toc424870346)

[5.7. Antenna Parameters and Beam Steering 8](#_Toc424870347)

[Annex A: Selection Criteria Importance Levels 9](#_Toc424870348)

[A.1. General Solution Criteria 9](#_Toc424870349)

[A.2. PHY Protocol Criteria 10](#_Toc424870350)

[Annex C: List of contributors 12](#_Toc424870351)

# 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-tbd], 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.

This document and the TG3d Technical Requirements document [14-0309-tbd] 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 802.15.3-2003 Standard. This Evaluation Criteria Document references the IEEE 802.15.3-2003 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 802.15.3-2003 Standard

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

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

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

# 3. General Solution Criteria

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

## 3.1. 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.

### 3.1.1. Manufacturability

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

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

### 3.1.2. Time to Market

Time to Market addresses the question of when the proposed technology will be ready for market. The proposal shall include an estimate of a schedule for when the PHY would be available for market.

## 3.2. Scalability

### 3.2.1. 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.

### 3.2.2. 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.

# 4. MAC Protocol Supplements

## 4.1. Alternate PHY Required MAC Enhancements and Modifications

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

### 4.1.1. 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 IEEE 802.15.3-2003 MAC as amended by IEEE 802.15.3b MAC and IEEE 802.15.3c.

### 4.1.2. 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.

# 5. PHY Layer Criteria

## 5.1. Operational Frequency and Bandwidth

Proposal shall include the carrier frequency and the bandwidth of the transmitted signal.

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

### 5.2.1. Gross Bit Rate

The Gross Bit Rate is defined as the bit rate at which bits are transmitted over the radio link including all overhead data like stuffing bits, tail symbols, etc. For IEEE Std 802.15.3-2003, examples of optional gross bit rates at the PHY are 11, 33, 44, 55 Mb/s and the mandatory payload bit rate is 22 Mb/s.

The proposer should provide the supported Gross Bit Rates provided by their proposal. Please bear in mind that the mandatory data rates for the PHY-SAP as defined in clause 8 of [TRD] have to be met.

### 5.2.3. Data Throughput

The proposer should provide supported net bit rate of their proposal. That is the Gross Bit Rate at the PHY-SAP reduced by all overhead data.

##

## 5.3. Regulatory Requirements, Co- and Cross-Channel Interference

First priority is to protect the passive services identified the ITU Radio Regulations in footnote 5.565. Additionally, coexistence between and inside the use cases should be ensured. For example an intra-device link should not be disturbed by a backhaul if the device is several meters away from the direct path of the backhaul. Since the sensitivity of the receiver at the victim is not specified the maximum tolerable interference is unknown. Therefore all proposals shall provide the radiated power on a vertical (Phi=0°, Theta=0-359°) and a horizontal (Theta=90°, Phi= 0-359°) circle around the antenna of the transmitter with a resolution of one degree. The main direction of the antenna is direct in the direction of the x-axis (Theta=90°, Phi=0°, see below). Please note, that the antenna is not steered for this evaluation. The strongest sidelobes of an antenna have to be covered in the evaluation on the two circles or must be presented in addition.

For the Intra Device and Close Proximity use case the circles have a radius of 1 m. For the Fronthaul and Backhaul use case three radii should be evaluated: 3 m, 10 m and 100 m. In the data center use case two radii are of interest: 1 m and 10 m.

Figure: The coordinate system

## 5.4. System Performance, Modulation and Error Correction

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

Proposals have to describe all the necessary parameters, e.g. the modulation schemes, the forward error correction code, etc. For comparisons the results of the following simulations shall be included in the proposals for an Additive White Gaussian Noise (AWGN) Channel only and the Channel Models (with AWGN) from [CMD].



Figure 1: Architecture of link level simulations.

Although the proposers may need to make alterations to the system setup in Figure 1 to more adequately reflect their proposal, the figure identifies the minimum expected level of detail.

All assumed parameters have to be presented in the proposal, e. g. antenna gains, noise figures, etc.

Proposals shall at least include a figure which presents the required SNR for a Bit Error Rate (BER), with the proposed error correction, in the range of 10^-2 to 10^-6. The proposals should provide evidence that the provided error correction is suitable to match the requirements defined in the TRD.

## 5.5. Link Budget

Link budget is used to determine proposal capabilities under certain operating conditions for the standards specified data rates, ranges, and bit error rate. An example which identifies the necessary parameters and equations can be found in [TRD].

Proposers should complete that 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. A link budget has to be provided for each of the targeted use cases with reasonable distances.

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

## 5.6. Power Consumption

T

Proposers shall report whether their proposed solution can be fully integrated. The proposers should report on the overall power consumption of their proposed solutions. The requirements are met if the given values are suitable for the applied use case/use cases.

## 5.7. Antenna Parameters and Beam Steering

The required antenna size and form factor depends on the specific use case.

The antenna form factor should be described with reference to expected size for the use cases. The antenna pattern has to be described in at least a horizontal and a vertical diagram (c.f. Co-Channel and Cross-Channel Interference).

Proposers shall indicate how the necessary beam steering can be applied. Furthermore, proposers have to provide information on the required precision for the antenna alignment and the impact on the system performance in terms of SNR (or gross data rate) of small misalignments.

Any additional information the proposer desires to provide on the antenna such as frequency response or on the beam steering approach 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 C: List of contributors

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