**IEEE P802.15**

**Wireless Personal Area Networks**

|  |  |
| --- | --- |
| Project | IEEE P802.15 Working Group for Wireless Personal Area Networks (WPANs) |
| Title | TG3d Technical Requirements Document for close proximity point-to-point (P2P) millimeter wave system |
| Date Submitted | July 4, 2014 |
| Source | Kiyoshi Toshimitsu | E-mail: kiyoshi.toshimitsu@toshiba.co.jp  |
| Re: |  |
| Abstract | TG3d System Requirements to be developed |
| Purpose | Supporting document for the development of the amendment 3d of IEEE 802.15.3 |
| 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. |

|  |
| --- |
| **List of contributors** |
| Kiyoshi Toshimitsu | Toshiba Corporation |
| Ichiro Seto | Toshiba Corporation |
| Ken Hiraga | NTT Corporation |
| Keiji Akiyama | Sony Corporation |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |

Table of Contents

[1. Definitions: 4](#_Toc390334367)

[2. General Guidelines [1] 4](#_Toc390334368)

[3. Introduction 7](#_Toc390334369)

[4. Protocol Reference Model 7](#_Toc390334370)

[5. Use Case Summary 7](#_Toc390334371)

[6. TRD Summary 7](#_Toc390334372)

[7. Topology 7](#_Toc390334375)

[8. Data Rates 7](#_Toc390334376)

[9. Operational Frequency Bands 7](#_Toc390334377)

[10. Coexistence/Protection Existing Services and Other Use Cases 8](#_Toc390334378)

[11. Regulatory requirements 8](#_Toc390334379)

[12. Transmission range 8](#_Toc390334380)

[13. Antenna gain and required alignment accuracy 8](#_Toc390334381)

[14. Channel models 8](#_Toc390334382)

[15. Link budget and SNR analysis 8](#_Toc390334383)

[16. Size, Weight and Power 9](#_Toc390334384)

[17. Media access mechanism 9](#_Toc390334385)

[17.1 Multiband operation 9](#_Toc390334386)

[17.2 Half-duplex opration 9](#_Toc390334387)

[17.3 “Touch and Get” operation 10](#_Toc390334388)

[18. Security mechanism 10](#_Toc390334389)

[19. I/O Interfaces and Memory Buffer Considerations 10](#_Toc390334390)

[20. Fast connection setup scheme 10](#_Toc390334391)

[21. References 11](#_Toc390334392)

1. Definitions:

|  |  |
| --- | --- |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |

1. General Guidelines [1]

This technical requirements document (TRD) describes the technical aspects that TG3d standard must fulfill, such as performance-related issues, reliability issues and availability issues. These types of requirements are often called quality of service (QoS) requirements; other requirements are usually maintenance-level requirements or external constraints, sometimes called compliance. Technical requirements are summarized as any other specifications; they have a name and a unique identifier. Technical requirements are documented in the same manner as any specifications, including a description, an example, a source or references to related technical requirements and a revision history.

TG3d needs to effectively define and manage requirements to ensure they are meeting needs of the applications, while proving compliance.

Ideally, requirements are:

• Correct (technically and legally possible)

• Complete (express a whole idea or statement)

• Clear (unambiguous and not confusing)

• Consistent (not in conflict with other requirements)

• Verifiable (it can be determined that the system meets the requirement)

• Traceable (uniquely identified and trackable)

• Feasible (can be accomplished within cost and schedule)

• Modular (can be changed without excessive impact)

• Design-independent (does not pose a specific solution on design)

Each requirement must first form a complete sentence, containing a subject and a predicate. These sentences must consistently use the verb “shall”, “will” or “must” to show the requirement's mandatory nature, and “should” or “may” to show that the requirement is optional. The whole requirement specifies a desired end goal or result and contains a success criterion or other measurable indication of the quality.

The TRD needs to capture these levels of user requirements, maintaining intelligent traceability and change impact analysis between them.

Typical constraint requirements can specify:

• Performance

• Interfaces

• Security

• Safety

• Reliability

• Availability

• Maintainability

An efficient way of writing better requirements is to ensure they are clearly mapped to test cases. Making sure each requirement is clearly verifiable from the start, not only helps prepare later phases of the project, it also puts the developer in the correct state of mind. Requirements and their associated tests must also indicate what the system should not do, and what happens at the limits (degraded mode).

This rule also applies for compliance requirements: indicating how they shall be tested is a good way to write better requirements.

The TRD needs to implement a reliable and repeatable change control process that helps turn this challenge into an opportunity.

By providing examples and counter-examples of good requirements and documents, IEEE can enhance the quality, consistency, and completeness of the requirements. These can originally be templates, industry standards and rules inside a repository, such as the IEEE server.

Requirement typical sentence construction

Defects to avoid:

* Vagueness
* Weakness
* Over specification
* Subjectivity
* Multiplicity
* Unclear meaning
* Implicit meaning

Some words to be used with caution:

“adequate”, “applicable”, “appropriate”, “approximate”, “bad”, “best practice”, “between”, “clearly”, “compatible”, “completely”, “consider”, “could”, “down to”, “easy/easily”, “effective”, “efficient”, “equivalent”, “excellent”, “good”, “his/her”, “however”, “ideal”, “etc”, “in order to”, “include but shall not be limited to”, “least”, “like”, “low”, “maximise”, “may”, “most”, “minimum/mal”, “must”, “nearly”, “necessary”, “needed”, “normal”, “or”, “possible/bly“, “practicable”, “provide”, “quality”, “readily”, “relevant”, “safe/ly“, “same”, “should”, “significant”, “similar”, “so as”, “subject to”, “substantial”, “sufficient”, “suitable”, “support”, “target”, “typical”, “up to”, “user friendly”, “whether”, “will”, “with”, “worse”.

1. Introduction

This document provides the technical contents of the project to develop the amendment 3d to IEEE 802.15.3 to enable data rates of 100 Gbps for point-to-point (P2P) system whose topology is always limited to two active devices according to the PAR and CSD of this project [2,3]. This document will provide guidance on how to respond to a call for proposals.

1. Protocol Reference Model

The communication protocol reference model used for this document is shown in Figure 1.



Figure 1: Reference partitioning

1. Use Case Summary

The use cases and applications with performance and functional requirements are described in the Applications Requirements Document (ARD) [4].

1. TRD Summary

(Abstracts of chapter 7 and thereafter will be written here.)

1. Topology

Topology is required to be limited to Point-to-Point (P2P).

1. Data Rates

Data rates are described in the Applications Requirements Document (ARD) [4].

1. Operational Frequency Bands

The system uses the 60 GHz unlicensed band. The channel plan is the same as that of IEEE802.15.3c. Ch2 and Ch3 in this band are designated as unlicensed bands in many countries. Hence the system shall support the use of these two channels.

1. Coexistence/protection with existing services and other use cases

As for the close proximity P2P system, the individual proposers shall consider coexistence with the following wireless devices: IEEE802.15.3c, IEEE802.11ad, Wireless HD, millimeter wave analog broadcasting systems, and millimeter wave vehicular radars. By guaranteeing the maximum transmission range of this close proximity P2P system, it can coexist with those existing services.

1. Regulatory requirements

The output RF power and other regulations in each country allowing the use of the unlicensed 60 GHz band shall be followed.

1. Transmission range

The maximum transmission range should be set to a value is 50 mm [TBD].

1. Antenna gain and required alignment accuracy

These items are out of scope on this document since they are implementation dependent.

1. Channel models

Concerning the usage model of close proximity P2P wireless communications, the channel is assumed to be line-of-sight propagation in millimeter wave, 60 GHz band.

Generally, TSV model is introduced in millimeter wave PAN/LAN systems in IEEE802.15.3c and IEEE802.11ad. For proximity communications usage, reflections are observed inside terminals and at surface of terminals, etc. The channel model shall be modified to represent such propagation mechanisms.

The channel model shall apply at least one of the several kinds of propagation depending on the antenna configurations.

The channel models are described in the Channel Modeling Document [5].

1. Link budget and SNR analysis

The usage model is assumed to be P2P communication under line-of-sight propagation in millimeter wave of 60 GHz band. The propagation loss is based on free-space communication under far field, including no obstacles except for terminal cases. Coding gain and target packet error rate would be determined depending on PHY and protocol technologies. The reference table below contains useful information in regards to link budget calculations.

The proposer shall show evidence that the system meets the requirement in section 12 (Transmission Range). For example, the proposer may show the maximum transmission range by system margin being below 0 dB at that range.

Example Link Budget:



1. Size, Weight and Power

The close proximity P2P system in millimeter wave is expected to have extremely short active time and at least either one of the P2P devices in the system is expected to be mobile. From that sense, the mobile device in this system shall be designed to have low power consumption in stand-by state. The device on the other side, especially such as kiosk, should be designed to have low average power consumption.

Other features regarding this concern are out of scope on this document because it is implementation dependent.

1. Media access mechanism

## Multiband operation

The following features may be considered:

* MIMO
* Channel bonding

## Half-duplex operation

The following features may be considered:

* FDD
* TDD

## “Touch and Get” operation

The close proximity P2P system shall have the following features to achieve its basic requirements:

* Connection setup without any network identifiers
* Network topology always limited to two active devices
* Fast connection setup time prior to active state to meet application requirement
* A means of ensuring spatial division from other systems without beamforming
* CSMA/CA not required prior to data transmission
* No periodic management frame transmission after connection establishment.
* A method to estimate whether a peer device drew apart and a procedure to promptly dissolve connection and change to a standby state when such estimation is made.

The fourth, fifth and sixth features are derived from the requirement that the close proximity P2P system shall have an access mechanism which achieves high and secure throughput. The last feature is derived from the requirement to limit the communication range.

1. Security mechanism

Because of the limitation of the transmission range, security mechanisms can be omitted for a close proximity P2P system. If required, it can be done at the higher layers. Note that security setup may give impact on the application requirement by imposing longer connection setup time.

1. I/O Interfaces and Memory Buffer Considerations

Choice of features regarding these items are up to the implementer.

1. Fast connection setup scheme

Time for connection setup is the time required to change from the standby state to the connected state where each device is ready for data transfer.

To realize “touch and get” user experience, a fast connection setup scheme having a capability to establish connections within 20 ms [TBD] is required.

1. References

[1] TG6 Technical Requirements Document IEEE 802. 15-08-0644-08-0006

[2] 100G PAR, <https://mentor.ieee.org/802.15/dcn/13/15-13-0523-07-0thz-100g-working-draft-par.docx>

[3]100G CSD, <https://mentor.ieee.org/802.15/dcn/13/15-13-0522-06-0thz-100g-working-draft-5c.docx>

[4] Applications Requirements Document (ARD) for close proximity P2P millimeter wave system, <https://mentor.ieee.org/802.15/dcn/14/15-14-YYYY-00-003d-applications-requirement-document-ard-yyyy.docx>

[5] Channel Modeling Document, <https://mentor.ieee.org/802.15/dcn/14/15-14-0310-00-003d-channel-modeling-document.docx>

[6] Ref. to Radio Regulations