**IEEE P802.15**

**Wireless Personal Area Networks**

|  |  |  |
| --- | --- | --- |
| Project | IEEE P802.15 Working Group for Wireless Personal Area Networks (WPANs) | |
| Title |  | |
| Date Submitted | [16 February, 2015] | |
| Source | [] [] [2-2-2, Hikaridai, Seika, Kyoto Japan] | Voice: [ ] Fax: [ ] E-mail: [ kitazawa@atr.jp ] |
| Re: | [ ] | |
| Abstract | [Working draft for TG4s technical guidance document] | |
| Purpose | [Summaries of technical topics discussed at TG4s] | |
| 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. | |

Document Overview

This technical document provides summary of contributions to SG SRU and TG4s regarding Spectrum Resource Measurement and Management.

|  |  |
| --- | --- |
| **List of contributors** | |
| Masayuki Ariyoshi |  |
| Shusaku Shimada |  |
| Mineo Takai |  |
| Takeshi Yamamoto |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |

Table of Contents

[**1** **Overview** 4](#_Toc411873984)

[**2** **Definitions** 4](#_Toc411873985)

[**3** **Abbreviation and acronyms** 4](#_Toc411873986)

[**4** **General descriptions** 4](#_Toc411873987)

[**4.1** **Summary of PAR** 4](#_Toc411873988)

[**4.2** **General requirement of SRMM** 5](#_Toc411873989)

[**4.3** **Spectrum Resource Measurement Report Structure** 5](#_Toc411873990)

[**4.4** **Use Case** 6](#_Toc411873991)

[**4.4.1** **Use Case1:Multiple PNC** 6](#_Toc411873992)

[**4.4.2** **Use Case 2: Anomaly Detection** 6](#_Toc411873993)

[**5** **Functional requirements** 7](#_Toc411873994)

[**5.1** **Spectrum Resource Measurement** 8](#_Toc411873995)

[**6** **Measurement metrics** 9](#_Toc411873996)

[**6.1** **PHY** 9](#_Toc411873997)

[**6.2** **MAC** 9](#_Toc411873998)

[**6.3** 9](#_Toc411873999)

[**7** **References** 10](#_Toc411874000)

[**Appendix A.** **Applications** 11](#_Toc411874005)

[**A.1**  **Hospital/Medical/Healthcare** 11](#_Toc411874006)

[**A.2** **Industrial Automation** 11](#_Toc411874007)

[**A.3** **Infrastructure Monitoring** 12](#_Toc411874008)

[**Appendix B.** **Related Standards** 13](#_Toc411874009)

1. **Overview**

This technical guidance document provides summary of MAC related functions to enable spectrum resource measurement and management for 802.15.4. The TG4s aims at building a standard to specify the MAC framework for exchanging information for the better use of spectrum resource usage.

1. **Definitions**

This section provides definitions of terms that discussed in TG4s.

1. **Abbreviation and acronyms**

The following abbreviations are used in this document.

LR-WAPN Low-Rate WPAN

SRM Spectrum Resource Measurement

SRMM Spectrum Resource Measurement and Management

SRU Spectrum Resource Utilization

TGD Technical Guidance Document

WPAN Wireless Personal Area Network

1. **General descriptions**

This section provides the basic framework for Spectrum Resource Measurement and Management (SRMM).

* 1. **Summary of PAR**

**Title:**

Standard for Low-Rate Wireless Networks: Amendment Enabling Spectrum Resource Measurement Capability

**Scope of the project:**

This amendment to IEEE Std 802.15.4 defines MAC related functions to enable spectrum resource management.

It specifies

* spectrum resource measurements and network performance metrics, such as packet error ratio, delay, etc,
* information elements and data structures to capture these measurements,
* procedures for collecting and exchanging spectrum resource measurement information with higher layers or other devices.

**Need for the Project:**

As various wireless systems are deployed in the shared and license exempt frequency bands including 2.4GHz and 915MHz bands, heavy interference has limited performance of the wireless systems. In order for these wireless systems to operate more effectively, a standardized set of spectrum resource measurements is needed that will facilitate management functions in these networks.

**Stakeholders for the Standard:**

The stakeholders include manufacturers and users of telecom, medical, environmental, energy, and consumer electronics equipment and manufacturers and users of equipment involving the use of wireless sensor and control networks.

The PAR can be found on the IEEE Standard Association Website.

<https://development.standards.ieee.org/P875300033/par>

* 1. **General requirement of SRMM**

This section describes Spectrum Resource Measurement and Management (SRMM)

* 1. **Spectrum Resource Measurement Report Structure**

SRM report header should include at least the following:

* Reporting device ID, PAN ID
* Measurement time
* Number of measurements included in the report

SRM report payload can include multiple pairs of measurement metric type and value as long as those measurements were performed by the same device at the same time.

All the measurement metric types and the details (precision, unit etc.) of their associated value(s) are to be defined in TG4s.

Figure SRM report payload

* 1. **Use Case**

The group discusses following categories of the SRM use case.

1. The Network manager (Next Higher Layer) request to the PAN coordinators about spectrum resource information.
2. PAN coordinator report to the Network manager (Next Higher Layer) about anomaly detection
   * 1. **Use Case1:Multiple PAN**

This use case depicts coexistence with multiple PAN’s.

The PAN coordinator notifies to the Network manager about spectrum resource usage information.

Figure 2 Multiple PAN

* + 1. **Use Case 2: Anomaly Detection**



Figure 3 Anomaly detection

1. **Functional requirements**

This chapter describes functional requirement of SRMM.

Table Measurement and Management items for SRMM

|  |  |  |  |
| --- | --- | --- | --- |
|  | Items | Detailed Items | Primitives |
| **Measurement Report** | Channel Load | ED (Passive) |  |
| CCA (Passive) |  |
| Active Scan |  |
| CCA value histogram |  |
| CA count |  |
| Noise? |  |
|  |  |
| Link Statistics | LQI value |  |
| LQI Histogram (History) |  |
|  |  |
| Interference measurement | What is different from ED ? |  |
| Fluctuation of floor ? |  |
| Deviation to fluctuation of floor ? |  |
| Same as media sensing Histogram ? |  |
|  |  |
| Node Statistics | Frame Error Count |  |
| Time out Occurrence Count |  |
| Retry Count |  |
|  |  |
| Channel Occupancy Statistics | Frame Air Time |  |
|  |  |
| Wakeup statistics | Average interval |  |
| Min./Max. interval |  |
| Aperiodic wakeup count |  |
| Average awake duration |  |
| Min./Max. awake duration |  |
|  |  |
| Timesynch. Error | Corrected error value |  |
| Drift rate |  |
| **Management Report** | Beacon Report |  |  |
|  |  |
| Slotframe Report |  |  |
|  |  |
| Anomaly Detection |  |  |
|  |  |
| Data/Ack Report |  |  |
| Hopping Channel Report |  |  |
| Noise & Interference Histogram |  |  |
| Node Statistics Report |  |  |
| Media Sensing Histogram |  |  |
| Channel Occupancy Statistics |  |  |
| PANID list |  |  |
| Misuse detection Report | Channel usage violation |  |
|  |  |  |

* 1. **Spectrum Resource Measurement**

The Spectrum Resource Measurement provides the following

* Measurement results of channel load and/or link quality
* Anomaly detection



Figure 4 LR-WPAN device architecture

Figure 4 shows typical LR-WAPN device architecture. The next higher layers

1. **Measurement metrics**
   1. **PHY**
   2. **MAC**

1. **References**
2. Kitazawa, Establishing a Study Group for a Spectrum Resource Utilization (SRU) through Radio Resource Measurement and Management for WPANs, IEEE 802.15-13-404r1
3. Kitazawa, Overview of SG SRU, IEEE 802.15-13-543r0
4. Additional use case of temporal and flexible industrial network deployment
5. Additional use case of temporal and flexible industrial network deployment, IEEE 802.15-13-654r1
6. Yamamoto et al., Simulation Methodology for SRU, IEEE 802.15-13-660r0
7. Proposal of radio resource management architecture(15-13-0285r1)
8. A Use Case of Self-Organizing Wireless Network for Medical System(15-13-306-0)
9. IG SRU Working Draft RRMM-usecases and 5C(15-13-0294r1)
10. IG SRU Usecase requirements table(15-13-0293r1)
11. An Initial Proposal of Reference Architecture for TG4s (15-15-027)
12. Overview of TG4s Spectrum Resource Usage (15-15-028)
13. Vigilance of Spectrum Resource Usage in private facilities for network stability and security (15-15-040)
14. Metrics used in some Wireless Sensor Network standards (15-15-72)
15. Proposed Spectrum Resource Measurement Report Structure (15-15-086)
16. Spectrum Resource Measurement and Management requirement table (15-15-089)
17. **Applications**

**A.1 Hospital/Medical/Healthcare**

Various wireless systems (WLAN, Bluetooth etc.) are deployed in medical environments.

Requirement

* + - Self-organizing wireless system
    - Spectrum sensing of whole band for searching vacant radio resources
    - Radio resource assignment and network topology management

****

Figure 5 Image of medical information system in hospital

**A.2 Industrial Automation**

Requirement

* + - Quick additional deployment
    - Quick withdrawal, relocation
    - Inexpensive and reusable



Figure 6 Industrial wireless network

**A.3 Infrastructure Monitoring**

Requirement



Figure 7

1. **Related Standards**