**IEEE P802.15**

**Wireless Personal Area Networks**

|  |  |  |
| --- | --- | --- |
| Project | IEEE P802.15 Working Group for Wireless Specialty Networks (WSNs) | |
| Title | 15.4ab Technical Guidance Doc | |
| Date Submitted | 17-May-2021 | |
| Source | [Benjamin Rolfe] [Blind Creek Associates]  [Benjamin A. Rolfe]  [BCA] | E-mail: [ben.rolfe @ ieee.org ] |
| Re: | Meeting minutes | |
| Abstract | Draft of the technical characteristics and guidance for technical contributions | |
| Purpose | Support call for contributions and content development | |
| 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. | |

Technical Guidance Document

For 802.15.4ab

# Introduction

## Purpose

This document provides technical guidance for preparation of proposals. The objective of this guidance is to provide technical recommendations for preparing and evaluating proposals and should not be understood as mandatory requirements for the system design.

The intent is to use a flexible and efficient process that provides sufficient descriptions of the technical drivers to enable relevant responses, with efficiency of effort while meeting the critical need for a timely amendment.

## Using this TGD

The group does not expect a contribution to be all encompassing; ideally it will complement the current contributions as best known by the proposer. The group welcomes partial contributions that further the project objectives.

Contributors are encouraged to review the project objectives in the Objectives Checklist and objectives and identify which are addressed by the contribution and summarize in the table briefly how the addressed.

Review the technical characteristics and other guidance provided in this document as an aide in focusing the contribution. Proposals and contributions should identify which technical characteristics relevant to the contribution.

Note that all contributions must comply with the IEEE patent and copyright policies.

## Reference

This document has been prepared using the content of Document # [15-21-0268-02](https://mentor.ieee.org/802.15/dcn/21/15-21-0268-02-04ab-15-4ab-technical-guidance-framework.pptx).

# Objectives Checklist

Each proposal should identify which of the project objectives stated in the proposed project authorization request (PAR) are addressed by the proposal. The left column summarizes the objectives. For each objective which is addressed by the proposal, indicate in the right column how it is addressed in the proposal.

It is not expected that all proposals will address all objectives. Table 1 summarizes the project objectives as stated in the draft PAR. This provides a convenient form for summarizing the objectives covered.

Table - Project Objectives Summary

|  |  |
| --- | --- |
| PAR Objective | Proposed Solution (how addressed) |
| Safeguards so that the high throughput data use cases will not cause significant disruption to low duty-cycle ranging use cases. |  |
| Interference mitigation techniques to support higher density and higher traffic use cases |  |
| Other coexistence improvement |  |
| Backward compatibility with enhanced ranging capable devices (ERDEVs). |  |
| Improved link budget and/or reduced air-time |  |
| Additional channels and operating frequencies |  |
| Improvements to accuracy / precision / reliability and interoperability for high-integrity ranging; s |  |
| Reduce complexity and power consumption; |  |
| Hybrid operation with narrowband signaling to assist UWB; |  |
| Enhanced native discovery and connection setup mechanisms; |  |
| Sensing capabilities to support presence detection and environment mapping; |  |
| Low-power low-latency streaming |  |
| higher data-rate streaming allowing at least 50 Mbit/s of throughput. |  |
| Support for peer-to-peer, peer-to-multi-peer, and station-to-infrastructure protocols; |  |
| Infrastructure synchronization mechanisms. |  |

# General Guidance

The following provides general guidance and goals for technical contributions. Contributors should consider these characteristics in preparing contributions and provide background analysis that supports how the feature meets the required or recommended characteristic.

* Must be within the scope of the PAR
* Must coexist with existing HRP and LRP ERDEV implementations
* Must provide compatibility with HRP and/or LRP ERDEVs
* MAC additions related to:
  + PHY support
  + ranging and localization related information exchange
  + MAC functions to support ranging and localization control
  + Sensing
  + Data streaming
  + Simplifications, corrections based on experience
  + Mechanisms to enhance discovery and connection setup efficiently
* May include additional coding, preamble and modulation schemes to support improved link budget and/or reduced air-time
* May include additional channels and operating frequencies
* May include interference mitigation techniques to support higher density and higher traffic use cases
* May include improvements to accuracy / precision / reliability and interoperability for high-integrity ranging
* May include means to reduce complexity and power consumption
* May include definitions for tightly coupled hybrid operation with narrowband signaling to assist UWB;
* May include sensing capabilities to support presence detection and environment mapping
* May include mechanisms supporting low-power low-latency streaming as well as high data-rate streaming

Other considerations which will assist the group to understand and evaluation technical contributions:

* Consider cost and complexity of implementation
  + Building upon the existing standard (know what is there)
  + Building upon the existing ecosystem
  + Consider the future
* Consider application needs and differences in use case requirements
  + Requirements may be different for different use cases e.g. capabilities exchange, knowledge of context.
  + Some uses may not be exposed to legacy devices
  + Some proposals may not apply to some use cases
* Proposals should address how backward compatible is achieved
  + Analysis or comparison of impacts on compatibility
  + Trade-offs between coexistence/compatibility/functionality and cost/complexity
  + How things are expected to change with time

# Collected Requirements

Based upon use case requirements as presented to the group, there are several key areas that have been included in many (in some cases all) use cases presented. These include:

* Compatibility and coexistence (see Notes on coexistence and compatibility)
* Greater flexibility for performance trade-offs (range/data rate/device density/etc)
* More channels
* Improved accuracy and resolution
* Further enhancements for low-energy consumption
* Broader application space
  + Presence detection, motion tracking, environment detection, etc
  + Flexible network scenarios and topologies
* Retain or improve upon robustness and integrity
  + Ensure new features are robust
  + Ensure new features are not harmful

Requirements that have been identified for specific use cases, often more than one use case area, include:

* Low energy consumption
  + Energy usage can be asymmetric
* Support for multiple topologies including Peer to peer, peer-to-multi-peer, and station-to-infrastructure
* Support for very low cost, low complexity implementations
  + In some applications a mix of device capabilities is expected
* Scalability to a very large number of tags
  + In some applications the number of tags can exceed 5,000
  + Many anchors that may not be in radio SOI of each other
  + Minimizing spectrum usage per device
* Efficient resource uses
  + Minimize transmissions
  + Leveraging multiple communication mechanisms (out of band / different band for command and control)
* Flexibility to support transmission scenarios and performance trade-offs
  + Ability to support broadcast ranging (GPS like), Blinks, Two-way ranging
  + Enable longer distance between devices or smaller interference footprint
* Flexibility and adaptability to environment and varying application needs
  + Scenario detection
  + Detecting other users
  + Rate and power adaptation
  + Multi-mode operation
* Mobility support
  + Objects may move in large groups
  + Efficient handover, discovery, synchronization
* Ability to support low-latency communication
  + Latency of a few milliseconds
  + Without monopolizing the channel
    - Ensure coexistence with ranging operations
    - Provide sharing with many devices
    - Include interference reduction and mitigation techniques
    - Moderate duty cycle and activity factor
  + Typically low latency applications require short link distances

# Notes on coexistence and compatibility

There are many ways to define compatibility and coexistence. For this project, ensuring that new features can be implemented without causing disruption of legacy device operation is a top priority. Consider the following when preparing or evaluating proposed features or mechanisms.

At a minimum operation of new version devices in the sphere of influence of legacy devices does not disrupt operation of legacy device (doesn’t break it). This can be achieved when the behavior of a legacy device upon reception of the “new” signal/packet/frame is well define and not harmful. When the legacy device is able to ignore the new packet.

***For 15.4ab, this means will not cause significant disruption to low duty-cycle ranging use cases.***

Degrees of ‘compatible’ may be provided, for example:

* New signal not even detected by legacy devices,
* New signal demodulated and ignored
* New signal can be demodulated and understood, without the benefit of “new” features
* The Ability to interoperate and/or cooperate with legacy ERDEVs.

For this project, compatibility with legacy ERDEVs (as defined in IEEE Std 802.15.4z) is essential. The ability to interoperate with legacy ERDEVs is highly beneficial and desired. Coexistence without disrupting non-ERDEV legacy devices is important. Interoperability with non-ERDEV legacy devices is not essential.

Other coexistence considerations:

* Consider behavior and performance in an environment with a high density of UWB devices in same space and channel (both legacy and new)
* Consider impacts on and from non-UWB devices in the same space and channel (or same device)

It is reasonable to focus on what is used or likely to be used in real world use cases. A plethora of use cases have been presented to the group, which can provide further ideas on what may be most relevant.

***Proposals should consider and describe the level of compatibility and how coexistence is achieved.***