**IEEE P802.15**

**Wireless Personal Area Networks**

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| Re: | Technical Guidance for 802.15.8 Proposals | |
| Abstract | This is the draft baseline of 802.15.8 Technical Guidance Document | |
| Purpose | To provide the technical guidance including functional and technical requirements to the P802.15 Working Group. | |
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# Overview

The 802.15.8 specification shall be developed according to the P802.15.8 Peer Aware Communication (PAC) project authorization request (PAR), as approved on 30th March 2012 [1], and Five Criteria document [2].

# Definitions

## General definitions

## Specific definitions to this standard

Device ID: e.g. MAC address

. This is a unique identifier for a compliant PD.

Device group ID:

. This is a unique identifier for a group of compliant PDs.

Application type ID:

. This identifies a class of specific applications enabled in a PD.

. e.g. SNS, gaming, etc.

Application-specific ID:

. This identifies a specific application enabled in a PD.

. e.g. Facebook, Twitter, Space Invaders, etc.

Application-specific user ID:

. This is the user account ID linked to a specific application.

. e.g. account@facebook

Application-specific group ID:

. This identifies a group of selected Application-specific users.

Peer: this is equal to Application-specific user ID.

# Abbreviations and acronyms

PD (PAC Device)

# General descriptions

This clause provides the basic framework of PDs. The framework serves as a guideline in developing the functions of PDs and their interactions specified later in detail.

## Concepts and architecture

IEEE 802.15.8 shall support a fully distributed, decentralized, and self organized system composed of PDs.

Some of these devices may be able to connect on an opportunistic basis to infrastructure, which is out of scope for IEEE 802.15.8.

IEEE 802.15.8 shall support one-to-one and one-to-many communications.

IEEE 802.15.8 shall support scalable data rate to accommodate many applications such as listed in the Application Matrix (doc. #350r4 or the latest revision).

Possibly aided by higher layers, a PD shall support data transfers between itself and identified PDs or groups.

IEEE 802.15.8 shall support both one-way and two-way communications.

## States of the PD

## Topology

Several topologies are considered to support various service interactions within PDs.

One-to-one and one-to-many topologies shall be supported.

IEEE 802.15.8 shall support a PD participation in at least two independent one-to-many communications with different peers at the same time.

IEEE 802.15.8 shall support a PD having simultaneous communication sessions for same or different applications.

Mesh topology may be supported.



## Reference model

All PDs are internally partitioned into a physical (PHY) layer and a medium access control (MAC) sublayer of the data link layer, in accordance with the ISO/OSI-IEEE Std 802-2001 reference model. Direct communications between PDs are to transpire at the PHY layer and MAC sublayer as specified in this standard; Message security services are to occur at the MAC sublayer, and security operations are to take place inside and/or outside the MAC sublayer.

Within a PD, the MAC provides its service to the higher layer through the MAC service access point (SAP) located immediately above the MAC sublayer, while the PHY provides its service to the MAC through the PHY SAP located between them. On transmission, the higher layer passes MAC service data units (MSDUs) to the MAC sublayer via the MAC SAP, and the MAC sublayer passes MAC frames (also known as MAC protocol data units or MPDUs) to the PHY layer via the PHY SAP. On reception, the PHY layer passes MAC frames to the MAC sublayer via the PHY SAP, and the MAC sublayer passes MSDUs to the higher layer via the MAC SAP.



There may be a logical PD management entity (PDME) that exchanges network management information with the PHY and MAC as well as with other layers.

# General requirements

## Operating frequencies

All PDs shall operate in selected globally available unlicensed/licensed bands, below 11 GHz.

There are 4 candidate bands;

* Unlicensed Sub 1 GHz band
* Unlicensed 2.4 GHz, 5 GHz ISM band
* Unlicensed 6 ~ 10 GHz UWB band
* Licensed bands

## Duplex

IEEE 802.15.8 may support the following types of duplex.

Time Division Duplex (TDD)

Frequency Division Duplex (FDD)

Functional requirements

The functional requirements described in this document shall be met by IEEE 802.15.8 compliant PDs.

## 

Multiple access schemes shall be supported.

## Synchronization

## Discovery

An IEEE 802.15.8 device shall support peer discovery, service discovery, and group discovery.

Peer discovery includes device discovery.

The following properties are desirable for discovery process.

* Expedited discovery
* Energy-efficient discovery (e.g. low duty cycle)
* Support high PD density and high discovery traffic
* Efficient spectrum utilization

For the purpose of discovery of PAC peers, the discovery signal conveys information that may reflect one or more of the following IDs such as Device ID, Device Group ID, Application type ID, Application-specific ID, Application-specific user ID, Application-specific group ID.

Note that it is up to the implementer how to use and implement these IDs or to use part of them.

IEEE 802.15.8 may support that a peer ID is discovered to only other peers who is in the same application-specific ID/group ID or the designated application-specific ID/group ID.

IEEE 802.15.8 may support privacy that a PD is not tracked.

IEEE 802.15.8 may provide support proximity-based presence functionality that a PD shall recognizes another peer entering in the proximity as well as the peer going out of the proximity.

IEEE 802.15.8 may support that a user recognizes the activation status of peers.

802.15.8 PAC shall support a PD ability to:

* Discover other PDs in proximity and be discoverable by them
* Discover other PDs in proximity but not be discoverable by them
* Be discoverable by other PDs but not discover them
* Neither discover nor be discoverable

## Peering

IEEE 802.15.8 shall support peering. Peering is equivalent to link establishment; link establishment is the process at the end of which two or multiple PDs are ready to exchange data.

## Scheduling

IEEE 802.15.8 shall provide a fully distributed scheduling mechanism.

## QoS

IEEE 802.15.8 shall support prioritized services, various QoS classes, enabling an optimal matching of service, application and protocol requirements to resources and radio characteristics.

## Interference management

IEEE 802.15.8 shall provide the functionality to mitigate interference from other PDs.

Comments: what is interference? Need definition. e.g. interferences from PDs.

## Multicast

IEEE 802.15.8 shall support a multicast transmission including both one-hop and multi-hop cases.

Issues: a multicast transmission including multi-hop

Or a multicast transmission including both one-hop and multi-hop cases.

## Broadcast

IEEE 802.15.8 shall support a broadcast transmission including both one-hop and multi-hop cases.

Comments: reliability issues to malicious users

## Multi-hop support

IEEE 802.15.8 shall provide at least 2-hop relaying function.

Only relay-enabled PD shall relay discovery messages and/or traffic data from PDs in the proximity.

## Relative positioning

IEEE 802.15.8 shall support relative positioning for proximate PDs.

IEEE 802.15.8 shall support range or range difference measurements between proximate PDs.

## Power management

IEEE 802.15.8 shall support a power management functionality to reduce power consumption in PDs for all services as listed in the Application Matrix (DCN15-12-0350).

## Security

IEEE 802.15.8 shall include a security function which provides the necessary means to achieve:

* + - authenticity and privacy of the identity of a PD possibly aided by higher layers
* privacy and confidentiality of communication possibly aided by higher layers.

The impact of security procedures on the performance of other system procedures, such as discovery and peering procedures should be minimized.

## Scalability

IEEE 802.15.8 shall support scalability according to the number of PDs and data rates.

### Network scalability

* IEEE 802.15.8 shall support discovery and communications for at least a hundred of PDs.

Comments: mass deployment ->missing number (e.g. hundreds or thousands)

### Data rate scalability

* PAC shall support scalable data rate to accommodate many applications such as listed in the Application Matrix (DCN15-12-0350).

## Coexistence

IEEE 802.15.8 shall coexist with other specifications or systems (radio interface technology)at the same frequency band.

IEEE 802.15.8 shall support the coexistence of PDs used for different applications as well as non-PDs in the same spectrum.

## Requirements for high layer and infrastructure interaction

IEEE 802.15.8 may be able to interact with higher layers to access suitable infrastructure, if it exists, e.g. to facilitate the set up and maintenance of communication.

IEEE 802.15.8 shall support the report to higher layers with updated discovery and association information.

IEEE 802.15.8 shall perform measurements at the request of and report results to higher layers. These measurements may include received signal strength and interference levels.

How to handle discovery and peering in the absence of higher layers, infrastructure access or sufficient pre-configuration information is out of scope for 802.15.8.

# Performance requirements

The performance requirements described in this document shall be met by IEEE 802.15.8 compliant PDs.

## Transmission range

IEEE 802.15.8 shall provide sufficient one-hop transmission range to meet nominal service requirements.

|  |  |
| --- | --- |
| shorter than 200 m | Best performance |
| 200 to 500 m | Graceful degradation |
| longer than 500 m | Best effort |

## Areal spectral efficiency

The areal spectral efficiency means that the summation of link spectral efficiency (e.g. point-to-point link) in the certain dimension. IEEE 802.15.8 shall maximize the areal spectral efficiency (*[bps/Hz/km2])* without sacrificing other requirements.

*Example: The areal spectral efficiency in 1 km2 dimension is at least x [bps/Hz] when the number of links is y. [bps/Hz/km2]*

*(PD distribution model or link spectral efficiency equal to throughput/bandwidth should be defined at simulation scenarios or parameters.)*

## Data rate

IEEE 802.15.8 shall support data rate up to typically 10 Mbps.

## Error rate

### Packet error rate (PHY)

IEEE 802.15.8 shall provide a bit error rate smaller than or equal to 1% without retransmission.

*[Eldad] Not sure what it means? Any packet error rate can be achieved if the SNR is high enough… suggest remove this requirement.*

*Comments: needs test scenario?*

The packet error rate (PER) shall be less than or equal to 10% for a 256 octet packet size with a link success probability of 95% over all channel conditions as specified in the channel model document per frequency band.

A link success probability of 95% is defined as the PER averaged over the channels that result in the 95% best performance at a given Eb/N0 for a channel model, i.e., the PER performance due to the worst 5% channels at a given Eb/N0 should not be included in the average PER calculation.

## Latency

### Discovery latency

### Data latency

IEEE 802.15.8 differentiatedssupported es

IEEE TBD

* Comments: Add definition of discovery latency and data latency

## Fairness

IEEE 802.15.8 may meet fairness constraints.

Example: Max-min fairness, proportional fairness, 5%-tile user throughput, 5%-tile user latency

## Mobility

IEEE 802.15.8 shall support PDs with various mobility scenarios.

|  |  |
| --- | --- |
| Walking speed (up to 3km/h) | Best performance |
| Running speed (up to 10 km/h) | Graceful degradation |
| Vehicular (up to 60 km/h) | Best effort |

## System overhead

Overhead, including overhead for control signalling as well as overhead related to data communications shall be reduced as far as feasible without compromising overall performance and ensuring proper support of systems features.

## Complexity

Complexity should be minimal to enable mass commercial adoption for a variety of cost sensitive products.

# Regulations

H.B. will provide texts.

Refer to DCN477-0 Regulations-for-TGD.

# Evaluation methodology

## Antenna Configuration

PDs shall be equipped with antenna array configurations from one to four antennas.

## Channel models (Refer to DCN #15-12-0459r3 or the latest)

## Simulation scenarios and parameters

The channel model document specifies the following channel model conditions (path loss , small scale fading and scenarios):

- Indoor office, outdoor to indoor and pedestrian, vehicular for the 900 MHz band

- Outdoor to indoor and pedestrian, vehicular, typical urban for 2.4 GHz band

- Model A, B, C, D, E for 5 GHz band.

802.15.4a UWB channel models for UWB band.

## Link-level simulation (PHY)

## System-level simulation (MAC)

### scenarios & parameters for just PDs

This sub-clause is described for discovery phase

### scenarios & parameters for PD links

This sub-clause is described for communication phase (including unicast, multicast, broadcast).

# References