**IEEE P802.15**

**Wireless Personal Area Networks**

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| Project | IEEE P802.15 Working Group for Wireless Personal Area Networks (WPANs) | |
| Title | **TG8 TGD – Rearranged** | |
| Date Submitted | 27 Aug. 2012 | |
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| Re: | Scheduled CC to discuss PAC TGD | |
| Abstract | Rearranged TGD based on San Diego agreements, some cleanups | |
| Purpose | To facilitate discussion and agreement of the TGD | |
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# Discussion

Reading the TGD from San Diego it seems that it has most if not all of what we need but in many cases there are duplications or the meaning is unclear.

Understanding of a requirement depends to a large extent on its classification as a functional, performance or operational requirement. The current TGD draft [1] appears to have some misclassified requirements.

To facilitate the discussion, I have created a table of contents for the TGD that is rearranged from [1] and populated it with [1] requirements. I did not (knowingly) eliminate or changed any requirements except as noted. In some cases while rearranging I have moved requirements based on the way they have been agreed, even if they should have probably been phrased differently. In other cases I have added clarifying text which can be derived from other requirements in [1].

*Italicized blue text is my editorial comments*

New or moved text is blue & underlined

Simple editorials are track marked.

# 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

* 1. General Definitions

*Some definitions from [1] 4.2 moved here*

PAC Peer Aware Communication

PD PAC Device

~~Discovering PD (DPD) means a PD which is doing discovery function and is not connected yet.~~

~~Connected PD (CPD) means a PD which is connected to another PD.~~

*[Eldad] Suggest replacing above with the following definitions:*

PPD – Peered PD, a device which has been peered with another device.

PSPD – Peer seeking PAC device, a device which is actively attempting to discover / be discovered by other devices in order to peer. *(Note that this definition allows a PD to seek other devices while already being peered)*

SG - Service Group - a collection of PDs that are members of the same service set.

*[Eldad] we need to define what is a service set*

* 1. Specific Definitions to this Standard
  2. Abbreviations and Acronyms

# General Description

This clause provides the basic framework of PDs and links. The framework serves as a prerequisite to supporting the functions of PDs and their interactions specified later in detail. It covers amongst others the following aspects — the architecture, components, services, the network topology used for medium access, the transmission range, the reference model used for functional partitioning, and the time base used for access scheduling, and the security paradigm.

## Concepts, architecture & topology

*This section describes general concepts, e.g. sects. 4.1, 4.5 in [1] with some of the original material moved elsewhere.*

This subclause presents the concepts of IEEE 802.15.8.

802.15.8 PAC shall support a fully distributed, decentralized, data scalable, and self organized system composed of single type of PAC device to be named PAC Device, or PD.

Some of these devices may be able to connect on an opportunistic basis to infrastructure through means that are out of scope for 802.15.8.

Possibly aided by higher layers, PD shall support selective exchange of data with specific other PDs or groups of PDs.

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

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

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

802.15.8 PAC shall support a PD having simultaneous communication links for different applications.

Mesh topology may be supported.

An illustrative 802.15.8-PAC topology is depicted in Fig. 1:



Fig. 1: 802.15.8-PAC topology. Solid lines are 802.15.8-PAC links. Red solid lines are one to many links. The dashed link to server is out of scope.

## Services

*Material from [1] 4.3*

802.15.8 PAC shall support a PD ability to:

* Discover other PDs or groups of other PD’s in proximity and be discoverable by them
* Discover other PDs or groups of other PD’s in proximity but not be discoverable by them
* Be discoverable by other PDs or groups of other PD’s but not discover them
* Neither discover nor be discoverable
* Communications with discovered PDs.

## Reference Protocol model

*Material from [1] 4.4*

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. Both MAC SAP and PHY SAP are not exposed and their specifications are beyond the scope of this standard.



Fig. Xxx: Protocol Architecture. Grayed out boxes signify layers and nodes not specified by 15.8. Dotted lines signify an intermittent connection

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.

# Functional requirements

*Section incorporates requirements originally under “general description” but note that some have been moved under performance or operational requirements*

## Multiple access

~~The multiple access schemes shall be designed as follows:. Contention-free access scheme, contention-based, or other access scheme may be considered for control and data transmission.~~

*[Eldad] Since any multiple access is either contention-based or contention-free I suggest replace with a simpler statement:*

Multiple access schemes shall be supported.

802.15.8 PAC shall support prioritized channel access.

## Operating bandwidths

## Discovery (Peer or PD discovery)

There are following requirements for discovery.

* Autonomous (should be edited) and continuous discovery(TBD) *[Eldad] clarify?*
* Energy-efficient discovery
* Support high PD density
* Efficient spectrum utilization
* Discovery without peering(association) (from PAR)

Possibly aided by higher layers, 802.15.8 PAC shall support selective discovery and discoverability by specific other PDs or groups of PDs

## Peering (link establishment or association)

IEEE 802.15.8 shall support a peering function to establish a link or multiple links between PDs or among PDs, respectively.

802.15.8 PAC shall support a quick peering between PDs that have already discovered each other.

## Scheduling

The system shall provide the 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 (including higher layer signalling) to resources and radio characteristics.

## Interference management

IEEE 802.15.8 shall provide functionality to mitigate interference.

## Multicast and broadcast

IEEE 802.15.8 shall support a multicast transmission.

IEEE 802.15.8 shall support a broadcast transmission.

*[Eldad] isn't it covered under one to many?*

## Multi-Hop Support

IEEE 802.15.8 shall provide at least 2-hop relaying function

## Relative positioning

~~IEEE 802.15.8 shall support relative positioning for proximate PD.~~

*[Eldad] given a single antenna positioning isn't possible, only distance. Suggesting rephrase as:*

802.15.8-PAC shall support range or range difference measurements between proximate PDs.

## Power management – functionality

*This section includes the functional requirement from [1] 5.14*

IEEE 802.15.8 shall support a power management functionality to reduce power consumption in PDs for all services and applications.

802.15.8 PAC discovery shall minimize impact on battery consumption without affecting user experience

## Security

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

* protection of the integrity of the system (e.g., stability and availability) *[Eldad] how is this related to security? (denial of service attacks?)*
* protection and confidentiality of user-generated traffic and user-related data (e.g. location privacy, user identity)

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

Possibly aided by higher layers, 802.15.8 PAC shall support the authenticity and privacy of the identity of a PD.

Possibly aided by higher layers, 802.15.8 PAC shall support the privacy and confidentiality of communication.

## Scalability

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

802.15.8 PAC discovery and communications shall take place in mass deployment of PDs.

## Coexistence

*[Eldad] Note current language is for functional support*

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

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

# Performance Requirements

## Peak spectral efficiency

The system shall support a peak spectral efficiency of up to [TBD] bps/Hz with single antenna in all PDs.

*[Eldad] is this single link? Areal? (areal already covered)*

## Transmission range

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

~~Transmission range may be extended by multi-hop~~. *[Eldad] multi-hop already required elsewhere so this sentence doesn’t add anything. Suggest remove.*

802.15.8 PAC shall support long range at least at a low data rate.

|  |  |
| --- | --- |
| 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 in the certain dimension. The system shall maximize the areal spectral efficiency 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.*

*(PD distribution model should be considered.)*

## Data rate

802.15.8 PAC shall support data rate up to typically 10 Mbps

## Bit error rate (PHY)

## Packet error rate

The system shall provide a packet error rate smaller than or equal to [TBD] 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.*

## Frame error rate

## Data latency

The system shall support differentiated data latency requirements of the supported QoS classes.

802.15.8 PAC shall support low data latency (to 5-15ms per hop) communication (Note: requirement needed)

## Discovery latency

802.15.8 PAC shall support data discovery latency to xxx ms *[Eldad] need to define “data discovery latency”*

## Fairness

*Note as it is phrased it is a performance requirement not a functional one*

The system shall meet fairness constraints.

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

*[Eldad] is there a requirement here? Any system will meet SOME fairness constraint; on the other hand specifying the right constraint dictates a solution*

## 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 |

~~802.15.8 PAC shall be optimized for pedestrian speeds 0-10 km/h~~ *[Eldad] appears to be redundant, suggest delete*

802.15.8 PAC shall support (relative / absolute) mobility of up to 100 km/h.

## Power management – performance

*This section includes the performance element from [1] 5.13*

802.15.8 PAC discovery should minimize impact on battery consumption without affecting user experience

## Complexity

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

## System overhead

Overhead, including overhead for control signaling 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.

# Operational requirements

## Operating Frequencies

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

There are 4 target bands considered for 802.15.8-PAC;

* Unlicensed Sub 1 GHz band
* Unlicensed 2.4 GHz, 5 GHz ISM band
* Unlicensed 6 ~ 10 GHz UWB band
* Licensed bands [Eldad] do we really want this?

## 

## Duplex schemes

## Requirements for high layer and infrastructure interaction

802.15.8 PAC shall 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.

802.15.8 PAC shall support the report to higher layers with updated discovery and association info.

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

# Regulatory Constraints

# Evaluation methodology

## Channel models

## Simulation parameters

# References

[1] 12-15-0385-01 draft TGD from San Diego