IEEE P802.15

**Wireless Personal Area Networks**

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| Project | IEEE P802.15 Working Group for Wireless Personal Area Networks (WPANs) | |
| Title | **Principles and requirements for 802.15.8 PAC** | |
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| Re: | TGRD | |
| Abstract | This contribution provides some principles and requirements for PAC | |
| Purpose | To be discussed by 802.15.8-PAC in order to be adopted into the TGRD. | |
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# Introduction

In Atlanta TG-8 has decided to work on a Technical Guidance / Requirements Document for 802.15.8 PAC.

This contribution is offered as a basis for discussion of potential requirements of 802.15.8 PAC.

# Discussion

Some requirements follow directly from the PAR:

The PAR requires that 802.15.8 PAC specifies a “peer to peer and infrastructure-less communications with fully distributed coordination”. From this we obtain the first requirement:

1. 802.15.8 PAC shall support a decentralized, scalable, and self organized system.

Many of the use cases (e.g. store advertisement broadcast) require group based communication, from which we obtain the second requirement:

1. 802.15.8 PAC shall support group (one-to-many) communication.

Some applications require multiple connections. Multiple connections are also required as a basis for multi-hop forwarding, from which we obtain the next requirement:

1. 802.15.8 PAC shall support device participation in at least two independent peer to peer communications with different peers at the same time.

Other than for some specialized (possibly machine type) applications, 802.15.8 PAC devices will be required to support multiple applications simultaneously. “Simultaneously” could be defined as happening within latency budget.

1. 802.15.8 PAC shall support a device having simultaneous communication links for different applications. Two links are considered simultaneous if they both meet their latency requirements.

As 802.15.8 PAC must be able to operate in unlicensed spectrum,

1. 802.15.8 PAC system shall support the deployment of multiple groups of devices in the same spectrum.

For some uses (e.g. Smart Grid) we could potentially find up to thousands of devices within range of each other, therefore:

1. 802.15.8 PAC discovery and communications shall take place in massive deployment of devices.

Emergency communication is an example of an important application for which we often do not necessarily require high data rate. We do however require long range. It is difficult to specify range as it depends mostly on propagation and power, both outside of our control, but we can control coding and modulation parameters, therefore,

1. 802.15.8 PAC shall support a low data rate long distance mode.

In order to be acceptable to users, they will want to be able to control aspects of the discovery process. In some cases, such as e.g. for commercial advertisement, a device may only be designed to be discoverable. Other devices may therefore be designed to discover only, and some may do both. Therefore:

1. 802.15.8 PAC shall support a device ability to:
   1. Discover other devices in proximity and be discoverable by them
   2. Discover other devices in proximity but not be discoverable by them
   3. Be discoverable by other devices but not discover them
   4. Neither discover nor be discoverable

Most social applications are based on the notion of a “friend” which, for our purpose, denotes a person (or his/her device) with whom we are willing to share a direct link discovery and / or communications, therefore:

1. Possibly aided by higher layers, 802.15.8 PAC shall support selective discovery and discoverability by specific other devices or groups of devices
2. Possibly aided by higher layers, 802.15.8 PAC shall support selective communications with specific other devices or groups of devices

Users would not likely agree to have identifying information sent openly over the air. Identifying information could include phone number, Facebook name or a MAC address – anything which can be used for the wrong purposes by the wrong people. Users would also want to have a reasonable level of confidence that the person (or the device) they are discovering / being discovered by is indeed who he or she claim to be. This will also give users confidence that they themselves cannot be impersonated to others. Finally, the user data itself must be kept private, therefore:

1. Possibly aided by higher layers, 802.15.8 PAC shall support the authenticity and privacy of the identity of a device
2. Possibly aided by higher layers, 802.15.8 PAC shall support the privacy of communication.

Signaling exchange that is necessary to discover, establish identity and privacy can present a significant load on spectrum use and battery consumption when used in repeated communication cases. Therefore:

1. 802.15.8 PAC shall support a quick set up of channels between devices that have already discovered each other.

Not all communication has the same latency requirements. Consider MTC communications (some of them having latency requirements measured in hours) vs. emergency calls. Therefore,

1. 802.15.8 PAC shall support prioritized channel access.

### 802.15.8 PAC Requirements for high layer and infrastructure interaction

Many of the requirements above can be greatly facilitated if infrastructure exists and can be used, via higher layers, to provide location, identity and security information. For example two PCD should be able to communicate securely without having exchanged prior information between them which is impossible without infrastructure connection. Therefore,

1. 802.15.8 PAC shall be able to interact with higher layers and a suitable infrastructure, if it exists, to facilitate the set up and maintenance of communication.
2. 802.15.8 PAC shall carry higher layer information that facilitates the establishment and management of discovery and direct communication.
3. 802.15.8 PAC shall support the report to higher layer with updated discovery and association info.

Lastly, infrastructure support in optimizing the network requires that the device provides some information, therefore:

1. 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.

### 802.15.8 PAC Performance requirements

Battery consumption is important – but only if the service itself can be provided:

1. 802.15.8 PAC discovery shall minimize impact on battery consumption without affecting user experience or machine functionality

Following are some performance requirements.

* Low latency is required for some gaming applications
* High mobility is required for e.g. toll collection etc., but we shouldn’t optimize PAC for a corner case
* Data rates are from the PAR
* 20MHz bandwidth is for unlicensed spectrum and a reasonable spectral density and MAC efficiency.

1. 802.15.8 PAC shall support low latency (to 5-15ms per hop) communication
2. 802.15.8 PAC shall support mobility up to 100 km/h
3. 802.15.8 PAC shall be optimized for pedestrian speeds 0-10 km/h
4. 802.15.8 PAC shall support data rate up to 10 Mbps
5. 802.15.8 PAC shall support bandwidth of up to 20 MHz

# >>>>>>>>>>>> Proposed text >>>>>>>>>>>>>>>>

# Terminology

Peer Communicating Device (PCD) – a device which complies with 802.15.8 PAC requirements

Discoverable – the property of performing a function that, pending the right propagation conditions, allows a device to be discovered by other devices which attempt to do so.

Discoverability – the property of being discoverable i.e. by other devices

Simultaneity: two links are considered simultaneous if their respective latency requirements can be met at the same time

# Requirements

1. 802.15.8 PAC shall support a fully distributed, decentralized, data scalable, and self organized system.
2. 802.15.8 PAC shall support one to one as well as one-to-many communication.

Alternatively: 802.15.8 PAC shall support multiple one-to-many communication simultaneously (note that then we don’t need next requirement)

1. 802.15.8 PAC shall support device participation multiple in at least two independent one-to-many peer to peer communications with different peers at the same time.
2. 802.15.8 PAC shall support a device having simultaneous communication links for different applications.
3. 802.15.8 PAC system shall support the coexistence of PAC devices used for different applications as well as non-PAC devices in the same spectrum.
4. 802.15.8 PAC discovery and communications shall take place in mass deployment of devices.
5. 802.15.8 PAC shall support low data rate long distance.
6. 802.15.8 PAC shall support a device ability to:
   1. Discover other devices in proximity and be discoverable by them
   2. Discover other devices in proximity but not be discoverable by them
   3. Be discoverable by other devices but not discover them
   4. Neither discover nor be discoverable
7. Possibly aided by higher layers, 802.15.8 PAC shall support selective discovery and discoverability by specific other devices or groups of devices
8. Possibly aided by higher layers, 802.15.8 device shall support selective exchange of data with specific other devices or groups of device s
9. Possibly aided by higher layers, 802.15.8 PAC shall support the authenticity and privacy of the identity of a device
10. Possibly aided by higher layers, 802.15.8 PAC shall support the privacy and confidentiality of communication.
11. 802.15.8 PAC shall support a quick set up of links between devices that have already discovered each other.
12. 802.15.8 PAC shall support prioritized channel access.

### 802.15.8 PAC Requirements for high layer and infrastructure interaction

1. 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.
2. ~~802.15.8 PAC shall carry higher layer information that facilitates the establishment and management of discovery and direct communication.~~
3. 802.15.8 PAC shall support the report to higher layers with updated discovery and association info. (note: could be merged into 15 except that this isn't necessarily related to infrastructure)
4. 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.

### 802.15.8 PAC Performance requirements

1. 802.15.8 PAC discovery shall minimize impact on battery consumption without affecting user experience
2. 802.15.8 PAC shall support low data latency (to 5-15ms per hop) communication (Note: requirement needed)
3. 802.15.8 PAC shall support absolute mobility of up to 100 km/h
4. 802.15.8 PAC shall be optimized for pedestrian speeds 0-10 km/h
5. 802.15.8 PAC shall support data rate up to typically 10 Mbps
6. ~~802.15.8 PAC shall support bandwidth of up to 20 MHz~~
7. 802.15.8-PAC shall support data discovery latency to xxx ms