**IEEE P802.15**

**Wireless Personal Area Networks**

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| Project | IEEE P802.15 Working Group for Wireless Personal Area Networks (WPANs) | |
| Title | UWB Coexistence working session notes | |
| Date Submitted | 15-Sept-2018 | |
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| Re: | TG4z September Meeting | |
| Abstract | Notes from working session on coexistence. | |
| Purpose | Document results | |
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**Working Notes:**

**UWB Coexistence Discussion**

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# Introduction and Background

At the September 2018 Task Group 4z meeting, a “split out” session was conducted to discuss UWB coexistence. This document captures the results of the discussion. There were many contributors to the contents of this document. The discussion was coordinated by Tony Fagan (Decawave) who took notes and provided the results for capture in this document.

The goal is to discuss and develop a “good coexistence story” for all 802 wireless that considers the existing UWB standard and related regulatory considerations along with ongoing work in 802.15 and 802.11 and proposed changes to licensed exempt rules.

The three “work items” identified by the group:

1. Justification for UWB current and near term forecasts – size of UWB opportunity;
2. What are the technical impacts if 802.11 allowed to operate at high power
3. Elevator pitch

The group broke into teams to brainstorm and work on each re-converge. This document captures the results from Group 1 and Group 2. The results of group 3 are contained in document 15-18-0464-01 [<https://mentor.ieee.org/802.15/dcn/18/15-18-0464-01-004z-uwb-protection-elevator-pitch.docx>].

# Outcomes

## Group 1 outcome:

* Largest markets in order
  + Mobile
    - 30% of phones are UWB 1.7B units by 2025
    - Wearables 30% of 1b = 300M by 2025
  + Commercial
    - Payment systems, smart sensors, remotes, smart home, etc
    - Wave of mobile half the mobile unites = 850M
  + Automotive
    - 1-2M chips/year today
    - 100 M units/year by 2025
    - Driven by major car makers coming on board now
  + Industrial
    - Robots, manufacturing, etc.
    - 70M units by 2025
  + Total about 3 billion units per year

## Group 2 outcome:

From notes taken at an ad hoc meeting of a subset of the IEEE802.15.4z task group on 12 September 2018 and presentation and discussion in TG4z:

* UWB has an uphill battle in fending off 11ax
* Perception is of a one-sided problem (only UWB impacted)
* Because of its much higher transmit power, 11ax has the potential to seriously impact UWB transactions at some considerable distance unless coexistence processes are agreed.
* We (all of 802) need a useful, authoritative coexistence study. This should be done jointly between TG4z and 11ax.
* Need to define:
  + Failure thresholds: at what point or points does interference result in operational degradation and then failure
    - Degradation thresholds and performance metrics, impacts of packet loss on latency, etc.
    - Total failure point – where does it go from “impaired” to “broken”.
    - Need to define for specific use-cases the impaired, broken.
      * Performance metrics include things like latency, range accuracy
      * For example: via simulation or test, measure PER / interference; define PER thresholds that map to the use-case performance impacts
* Provide specific coexistence scenarios for study
* Work with 11ax to do the work
* Joint efforts
  + Analysis 15+11
  + Mitigation 19
  + Regulatory recommendations w/18
* Some other scenarios
  + Non-continuous interference
    - vary interference duty cycle
    - Timing e.g. simulating typical inter-frame spacing and other ‘gaps’ provided by the MAC protocol.
  + What if IR radio is operating at proposed (high) power levels same as 802.11ax (new rules):
    - High power IR (0dBm up to 30 dBm / MHz).
    - 802.11 CSMA performance w/ higher power IR
    - UWB device using 802.11 signaling e.g. bandwidth reservations
    - Long range ranging scenarios
    - Realistic scenarios based on both perspectives;
      * Impact of 11 on UWB is half the story
      * Impact of IR on 11 if using the same rules needs to be added
    - Avoiding killing low power IR when high power used
    - Near-far affects
    - Fading profiles
    - Study using simulations and possible measurements in conducted environment
    - Define Channel characteristics (use 15.4a channel models?)
  + 320 MHz channel width scenarios
    - OFDM at 320 MHz
    - UWB => very wideband
  + 802.11 channel width threshold and Fc offsets
* We need to understand what features are being proposed for 11ax and try to influence relevant features. Features of 802.11ax:
  + Is it mainly indoor?
  + Mainly fix stations?
  + Likely restrictions?
* We could propose that 11ax backs off its tx power when UWB activity is detected but this is unlikely to be accepted.
* A vehicle is needed for joint work between 4z and 11ax. IEEE 802 should make its own decisions and present them to FCC, rather than have them dictated by FCC. Good coexistence story can be very powerful. A “single voice” of 802 can be relevant; divided voice not so much.
* Current 11ax TG is unlikely to take much notice of UWB, unless somehow UWB can be seen as a threat.
  + This threat to 11ax could arise if a high power IR UWB was approved. Then 11ax would sit up and take notice. Point out any rules change allowing higher power could applied to IR too
  + Note: Any high power UWB scheme would need to be protective of, and compatible with existing low power UWB systems, thereby also protecting them from 11ax.
  + The “unlicensed jungle” works both ways – unlikely FCC will allow one technology preference over the other but can and should consider existing licensed exempt operations in rulemaking process
* Mitigation considerations
  + OFDM is good at dealing with impulsive noise, but if the bursts from the UWB radio were strong enough to cause front end saturation in the OFDM rx then we could force a coexistence strategy.
  + A high power UWB system could borrow the medium reservation technique used by OFDM systems. This could function by a UWB node announcing though a 11ax sync sequence data frame header that it is going to transmit an OFDM data frame of a certain length. The destination address would be itself and in fact no OFDM signal would be transmitted, thus clearing the medium for a number of UWB transactions.
  + It might be thought that because of its high spreading factor that high power IR UWB is spectrally inefficient. But in fact the very low duty cycle makes it extremely efficient.
  + There can be no channelization for the 320MHz wide OFDM band, which means a door can’t be opened here for UWB.
  + The resources to be shared are time and frequency. If frequency can’t (or won’t) be shared, then maybe there can be sharing of the time resource. The 11ax protocol could be obliged to leave time gaps for UWB to operate in.
  + Other Mitigation techniques
    - Time based sharing
    - Power restrictions – expect 802.11 will reject substantially lower power than currently allowed in the 5 GHz bands.
    - Other that are suitably “mobile friendly”
* Need to show that what we have is useful, significant and bi-directional in impact.
  + Coexistence analysis is good for 802.11 vendors as well as UWB vendors
  + Good coexistence benefits everyone
* We want useful new rules that do not harm the efficacy of UWB in current and expanding markets
* Work to be done
  + Volunteers are needed from 4z to work with 11ax
  + Specific additions to Billy’s work so far
    - Better emulation of 11ax operation
    - Add scenarios with “gaps” in the OFDM signal
    - Need a good characterization of 11ax
  + At the sponsor ballot for 11ax, 4z needs to be in there making comments
  + More lab work needs to be done. The work already done by Billy Verso of Decawave is appreciated and is very useful but more realistic scenarios need to be investigated.
  + Also need simulation support

## Group 3 outcome:

See document 15-18-0464-01.

<https://mentor.ieee.org/802.15/dcn/18/15-18-0464-01-004z-uwb-protection-elevator-pitch.docx>