Project: IEEE P802.15 Working Group for Wireless Personal Area Networks (WPANs)

Submission Title: Proposed Resolution of Some TG6 UWB PHY Comments
Date Submitted: 9 September, 2010

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Re: Response to IEEE 802.15.6 Letter Ballot comments

Abstract: This document proposes a resolution for Letter Ballot 55 comments, specifically for the UWB PHY subclause.

Purpose: For discussion by IEEE 802.15 TG6

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Proposed Resolution of Some TG6 UWB PHY Comments

S10-218 (S10-256, S10-336), **S10-531**, **S10-105**, **S10-18** (S10-63, S10-94), **S10-178** (S10-296, S10-380), **S10-504**, **S10-185** (S10-303, S10-387), **S10-181** (S10-299, S10-383), **S10-184** (S10-302, S10-386)

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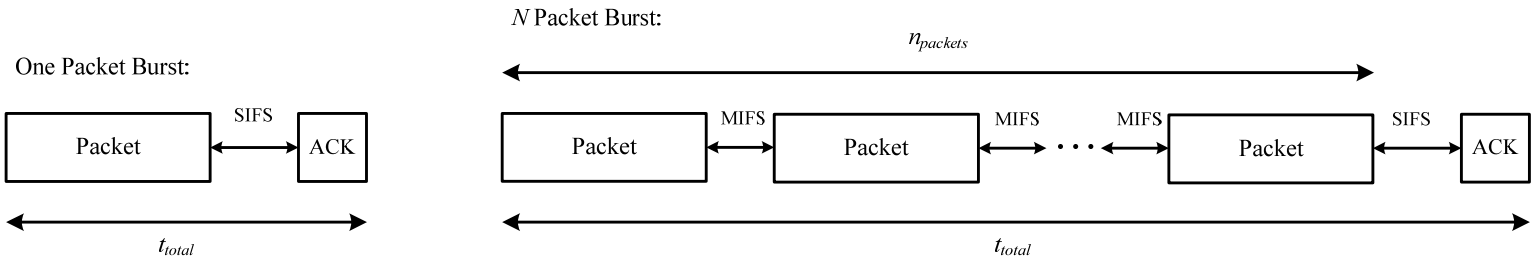
Bust Mode: S10-218, S10-256, S10-336

- **Comment**: The narrowband PHY supports burst mode transmission which reduces inter-frame spacing from SIFS to MIFS. It is advisable that the UWB PHY has the same support.
- **Proposed Change**: Use a bit in the PHR to as a "Burst Mode" field, in analogy with 9.3.1.3.
- **Proposed Resolution**: Accept comment S10-218. See Slide 8 for a proposed PHY Header that includes one bit for “Burst Mode”
  - Normal mode vs Burst mode



  - Burst mode allows higher throughput for e.g., streaming applications

Waveform Type: D0 Comment S10-531

- **Comment**: 2 bits should be added to the PHR for transmitted waveform information. This should be done for the following reasons: 1. Hopping sequence generator clock is different when dynamic scrambling is used. Thus, receiver needs this information. 2. Some receiver architectures benefit considerably if transmitter waveform type is known, e.g. correlation receiver, chirp receiver. 3. Sample-wise Differential Detection technique can be successfully applied only if there is no dynamic scrambling. Thus, receiver needs to know if dynamic scrambling is applied or not.

- **Proposed Change**: For example: 00 - Chirp pulse; 01 - Chaotic pulse; 10 - Short-pulse burst, static scrambling; 11 - Short-pulse burst, dynamic scrambling.

- **Proposed Resolution**: Accept comment S10-531 in principle. Add 2 bits for “Waveform Type” in the PHY Header. See Slides 8 and 9 for a proposed PHY Header that includes 2 bits for “Waveform Type”.

More Reserved Bits in PHR: S10-105

- **Comment**: Table 52
- **Proposed Change**: Need to have more reserved bits for header as it may not be efficient to transmit just 256 octets at 10 Mbps
- **Proposed Resolution**: Accept comment S10-105. Add 2 reserved bits right after “MAC Frame Body Length” in the PHY Header. See Slide 8 for proposed PHY Header that include 2 reserved bits right after “MAC Frame Body Length”.

PLCP Header: S10-18, S10-63, S10-94

- **Comment**: The PHY header (PHR) is 31 bits in length based on the BCH (31,19) code, and is not compatible with the non-coherent UWB PHY mode (Sec 10.11.3). More specifically, the length of the PHR (31 bits) is not aligned to a symbol boundary of group PPM (GPPM). The symbol mapping of the GPPM is defined as 6 bits which are mapped onto 12 bits (or 1 symbol). Thus, a symbol consists of 12 bits and the number of information must be a multiple of 6 bits. Since the PLCP header is of length 31 bits, the last GPPM symbol would consist of 1 bit and 5 zero or pad bits. The 5 zero or pad bits contains no information and is just overhead.

- **Proposed Change**: Modify the PHR structure to one of the followings:
  - 1) PHR information is reduced to 14 bits and apply BCH (30,18) to have PHR of length 30 bits. 14-bit PHR information forms as follows -- data rate (bit 0-2), MAC frame body length (bit 3-10), HARQ (bit 11-12), scrambler seed (bit 13), *OR*
  - 2) PHR information is 20 bits and apply BCH (36,24) to have PHR of length 36 bits. 20-bit PHR information forms as follows -- data rate (bit 0-2), reserved (bit 3), MAC frame body length (bit 4-11), reserved (bit 12-13), HARQ (bit 14-15), reserved (bit 16), scrambler seed (bit 17), reserved (bit 18-19).

Current PLCP Header

- Problems with the current PLCP Header
  - The PHY header (PHR) is 31 bits in length based on the BCH (31,19) code, and is not compatible with the non-coherent UWB PHY mode (Sec 10.11.3).
  - More specifically, the length of the PHR (31 bits) is not aligned to a symbol boundary of group PPM (GPPM).

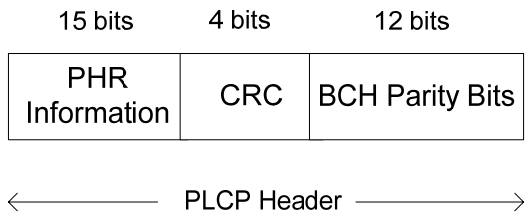


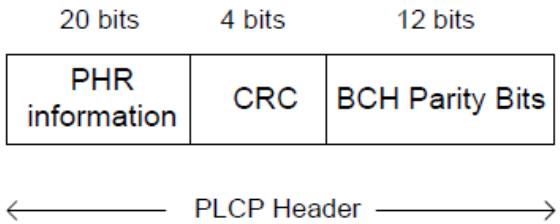
Table 52 — PHR information structure

Bit	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
	R0	R1	R2	L0	L1	L2	L3	L4	L5	L6	L7	r	H0	H1	S
	Data Rate			Frame length								a	HARQ		b

a = Reserved. b = Scrambler word.

Proposed Resolution: PLCP Header (1/2)

- Accepted comment S10-18 in principle. Use a shortened BCH (36,24) code, where the shortened BCH (36,24) code is a shorten code derived from BCH (63,51)
- Proposed PLCP Header structure



- Proposed PHR Information Structure

Bit 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
R0	R1	R2	R	L0	L1	L2	L3	L4	L5	L6	L7	R	R	B	W0	W1	H0	H1	S
Data rate			a	MAC Frame body length								a	a	b	Waveform		HARQ		c

a. Reserved.
b. Burst mode.
c. Scrambler word.

Proposed Resolution: PLCP Header (2/2)

- Burst Mode field

Burst Mode bit, "B"	Next Packet Status
0	Next packet *is not* part of burst
1	Next packet *is* part of burst

- Waveform Type field

"W0"	"W1"	Waveform Type
0	0	Short pulse
0	1	Short pulse
1	0	Chirp pulse
1	1	Chaotic pulse

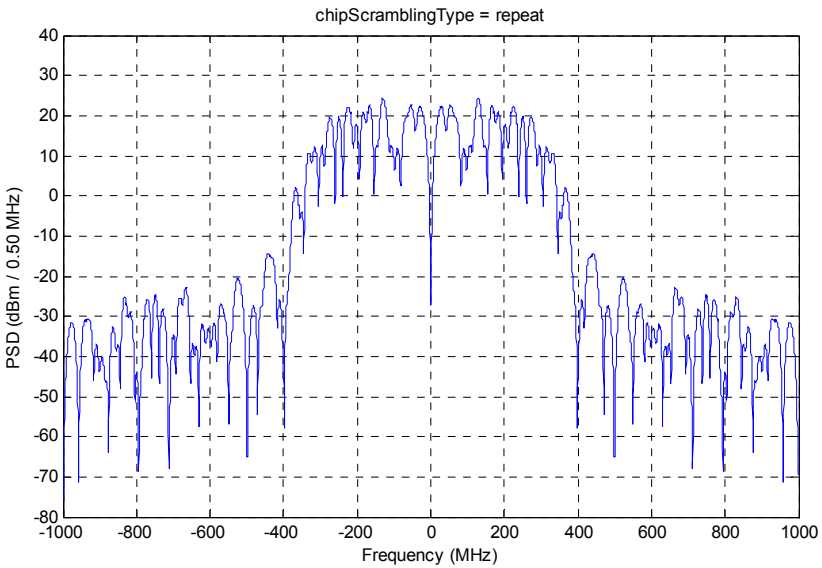
Chip Scrambling: S10-178, S10-296, S10-380

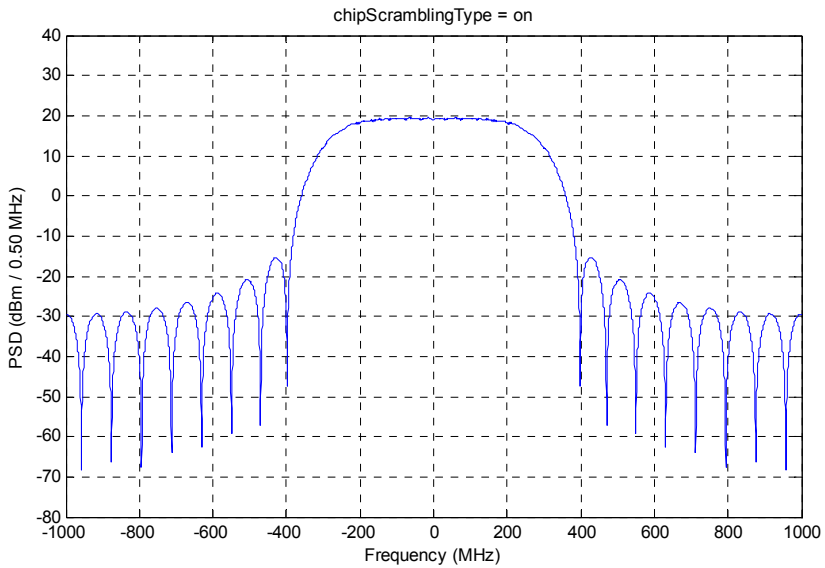
- **Comment**: Static chip-level scrambling specified in the section is using a fixed scrambling sequence repeatedly in each symbol, which creates severe spectral lines in the transmit spectrum. Need to check link budget analysis by taking necessary backoff that is required by static scrambling into account. High/medium date rates very likely have issues with the transmit power backoff (to meet the spectral mask) that would be required by static scrambling.

- **Proposed Change**: Apply dynamic scrambling specified in Section 10.11.1.1 as mandatory in all the cases. Alternative solution could be using dynamic scrambling in the noncoherent mode, and static scrambling in the differentially coherent mode (since higher link margin is expected).

- **Proposed Resolution**: Accept comment S10-178. Apply dynamic chip-level scrambling specified in Section 10.11.1.1 as mandatory in all the PHY modes that use short-pulse waveforms.

Spectrum* with Chip-Level Scrambling





- Scrambling code is repeated in each symbol
  ➔ Ripple over the passband is about 20 dB

- Scrambling code generated by an LFSR
  ➔ Chip-level scrambling enables the most desirably flat spectrum.

* Spectrum for the mandatory data rate of the non-coherent modulation mode: N_{burst} = 32, N_{cpb} = 32

Scrambler Seeds: D0 Comment S10-504

- **Comment**: It seems an unnecessary complication to have two different scrambler seeds.
- **Proposed Change**: Remove second scrambler seed, adjust PHY header accordingly (12.6.1.4)
- **Proposed Resolution**: Reject comment S10-504.
  - Two scrambler seeds are selected alternatively for each retransmission of a packet to increase the randomness of scrambled information bits.
  - There is no increase in logic to support two scrambler seeds, only need to initialize registers with different values.
  - Already well aligned to narrowband PHY by keeping the same bit-scrambling strategy.

Simple PHY Mode: S10-185, S10-303, S10-387

- **Comment**: Non-coherent modulation requires two decoders at the receivers, one for the 64-ary waveform-coding (aka GPPM), and the other for the BCH (63,51) code. One FEC is sufficient enough to meet all the technical requirements. Why we need two FECs?? Considering low-complexity and low-power are the most important in most BAN applications, the requirement for two FECs is definitely not good.

- **Proposed Change**: Add a new PHY UWB mode that is based on BCH and binary PPM, which requires only one FEC decoder at the receiver and allows low-power and low-complexity transceivers. This mode will allow reusing already-existing designs for many chip venders. One way to add the simple binary PPM mode is that we just keep the current symbol mapping structure of non-coherent modulation (Sec 10.11.3) but add a new codebook for binary PPM.

- **Proposed Resolution**: Accept comment S10-185 in principle. Add the simple binary PPM mode by just keeping the current symbol mapping structure of non-coherent modulation (Sec 10.11.3) but adding a new codebook for binary PPM.

D0 Comments S10-181, S10-299, S10-383

- **Comment**: [p 177, Sec 10.11.2, lines 12-15] These lines are not necessary to put. N_guard is "not computed on the fly", but is fixed for each data rate as shown in data rate tables (Table 54, 55).

- **Proposed Change**: Just remove the lines 12 - 15 to avoid any confusion.

- **Proposed Resolution**: Accept comment S10-181. Remove line 12-15 in Sec 10.11.2 as suggested in the proposed change.

D0 Comments S10-184, S10-302, S10-386

- **Comment**: [p 177, Sec 10.11.2, lines 1-18] Need to add range of "k" and initial parameter for time-hopping sequence.
- **Proposed Change**: Add "k >= 0" and initial value for time-hopping sequence "h^{(k-1)} = 0".
- **Proposed Resolution**: Accept comment S10-184. Edit the text based on the proposed change.