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

Submission Title: [**Material for SFF TBD Comment Resolutions**]
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Re: [In response to TG4g Call for Proposals]
Abstract: [SFF comment resolutions]

Summary

This document summarizes SFF proposals each of which is related to the seven technical comments

- SFF-TBD-CID#1: Data rate for China allocation
- SFF-TBD-CID#2: Channel page
- SFF-TBD-CID#3: Transmission power
- SFF-TBD-CID#4: SFD value
- SFF-TBD-CID#5: Reference modulation diagram
- SFF-TBD-CID#6: FEC
- SFF-TBD-CID#7: Radio specifications

SFF-TBD-CID#1: Data rate for China allocation

SFF proposes the following PHY parameter for China allocation

Frequency band	PHY parameter	Low rate		Medium rate	High rate
		Non FEC	FEC		
470~510MHz (China)	Data rate (kbps)	50	50	100	200/400
	Symbol rate (ksymbol/s)	50	100	100	200
	Channel spacing (kHz)	200	400	400	600
	Channel separation (kHz)	200	200	200	200
	Modulation	2GFSK	2GFSK	2GFSK	2GFSK/ 4GFSK
	Mod. index	1.0	1.0	1.0	1.0/0.33
	Channel overlap	N	Y	Y	Y

SFF-TBD-CID#2: Channel page (1/4)

- Keeping the same mechanism for channel page and providing extensibility to support large amount of channels for TG4g
- Additional details considering SFF proposal are shown in the following slides

SFF-TBD-CID#2: Channel page (2/4)

SFF proposes the following description of channel pages in the draft, where *"SFF400start"* and *"SFF950start"* shows first values of successive indices allocated for SFF proposal

In channel index SFF400start+0, there are 5 channels using GFSK at 50kbps in 400MHz band:

Fc = (a + 0.1) + 0.2k MHz, for k = 0, …, 4

In channel index SFF400start+1, there are 4 channels using GFSK at 50kbps with FEC in 400MHz band:

Fc = (a + 0.2) + 0.2k MHz, for k= 0, ..., 3

In channel index SFF400start+2, there are 4 channels using GFSK at 100kbps in 400MHz band:

Fc = (a + 0.2) + 0.2k MHz, for k=0, ..., 3

In channel index SFF400start+3, there are 3 channels using GFSK at 200kbps in 400MHz band:

Fc =(a+0.3) +0.2k MHz, for k= 0,..., 2

In channel index SFF400start+4, there are 3 channels using 4GFSK at 400kbps in 400MHz band:

Fc =(a+0.3) +0.2k MHz, for k= 0,..., 2

where a (MHz) is the lower band edge frequency, which is currently under consideration in Japan.

In channel index SFF950start+0, there are 33 channels using GFSK at 50kbps:

Fc=951.0+0.2k MHz, for k=0,..., 32

In channel index SFF950start+1, there are 32 channels using GFSK at 50kbps with FEC:

Fc=951.1+0.2k MHz, for k = 0,..., 31

In channel index SFF950start+2, there are 32 channels using GFSK at 100kbps:

Fc=951.1+0.2k MHz, for k = 0,..., 31

In channel index SFF950start+3, there are 31 channels using GFSK at 200kbps:

Fc=951.2+0.2k MHz, for k = 0,..., 30

In channel index SFF950start+4, there are 31 channels using 4GFSK at 400kbps:

Fc=951.2+0.2k MHz, for k = 0,..., 30

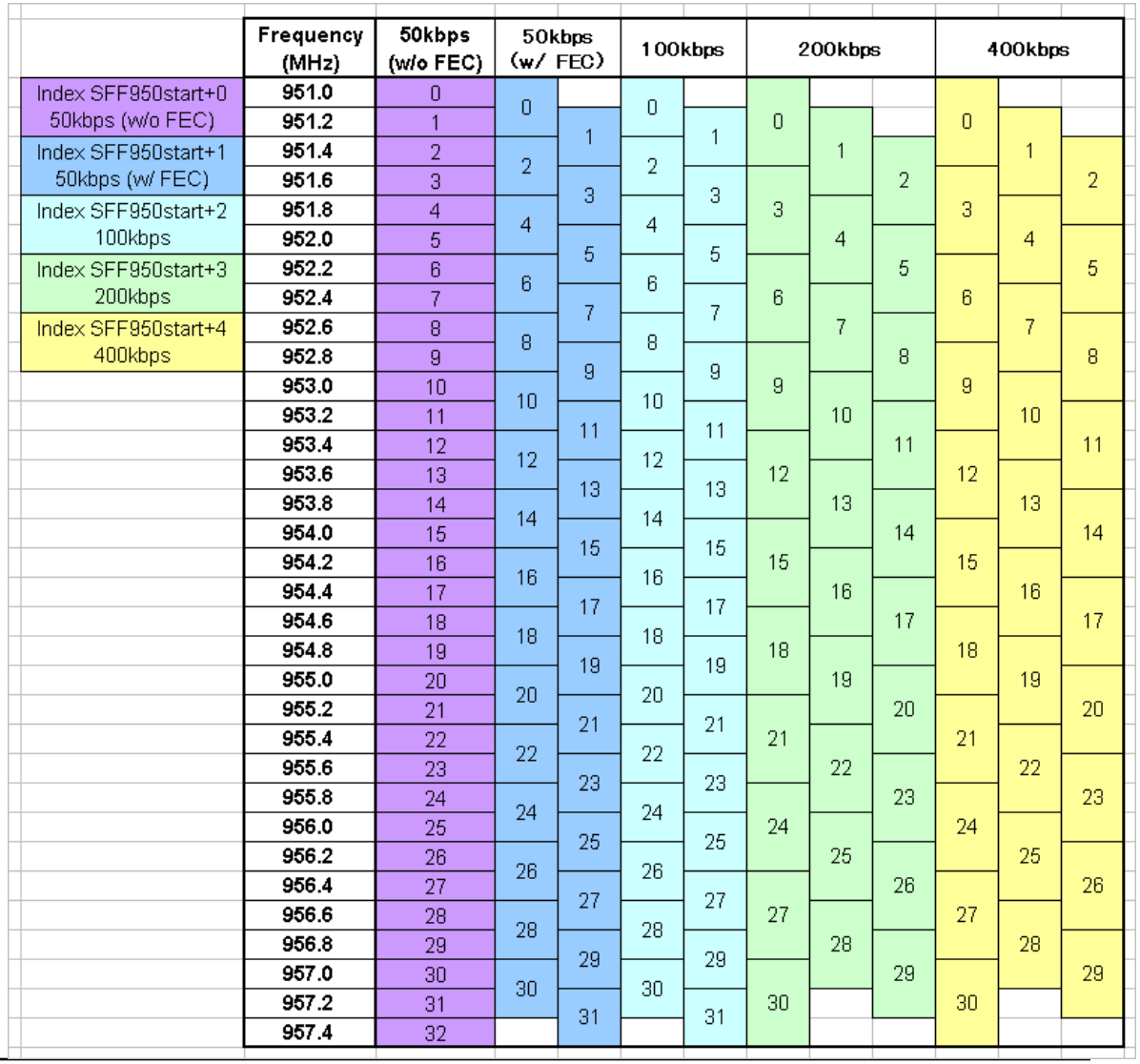
SFF-TBD-CID#2: Channel page (3/4)

The new definition of channel pages shall be depicted in the following table

Channel page (decimal)	Channel index (decimal)	Channel number(?) (decimal)	Channel number description
7	SFF400start+0	0 – 4	Channels 0 to 4 in 400 MHz band using GFSK at 50kbps (w/o FEC)
		5 – 503	Reserved
7	SFF400start+1	0 – 3	Channels 0 to 4 in 400 MHz band using GFSK at 50kbps (w/ FEC)
		4 – 503	Reserved
7	SFF400start+2	0 – 3	Channels 0 to 3 in 400 MHz band using GFSK at 100kbps
		4 – 503	Reserved
7	SFF400start+3	0 – 2	Channels 0 to 2 in 400 MHz band using GFSK at 200kbps
		3 – 503	Reserved
7	SFF400start+4	0 – 2	Channels 0 to 2 in 400 MHz band using 4GFSK at 400kbps
		3 – 503	Reserved
7	SFF950start+0	0 – 32	Channels 0 to 32 in 950 MHz band using GFSK at 50 kbps (w/o FEC)
		33 – 503	Reserved
7	SFF950start+1	0 – 31	Channels 0 to 31 in 950 MHz band using GFSK at 50 kbps (w/ FEC)
		32 – 503	Reserved
7	SFF950start+2	0 – 31	Channels 0 to 31 in 950 MHz band using GFSK at 100 kbps
		32 – 503	Reserved
7	SFF950start+3	0 – 30	Channels 0 to 30 in 950 MHz band using GFSK at 200 kbps
		31 – 503	Reserved
7	SFF950start+4	0 – 30	Channels 0 to 30 in 950 MHz band using 4GFSK at 400 kbps
		31 – 503	Reserved

SFF-TBD-CID#2: Channel page (4/4)

Graphic image of 950MHz allocation is shown



	Frequency (MHz)	50kbps (w/o FEC)	50kbps (w/ FEC)		100kbps		200kbps			400kbps		
Index SFF950start+0 50kbps (w/o FEC)	951.0	0	0		0		0			0		
	951.2	1		1		1		1			1	
Index SFF950start+1 50kbps (w/ FEC)	951.4	2	2		2				2			2
	951.6	3		3		3	3			3		
Index SFF950start+2 100kbps	951.8	4	4		4			4			4	
	952.0	5		5		5			5			5
Index SFF950start+3 200kbps	952.2	6	6		6		6			6		
	952.4	7		7		7		7			7	
Index SFF950start+4 400kbps	952.6	8	8		8				8			8
	952.8	9		9		9	9			9		
	953.0	10	10		10			10			10	
	953.2	11		11		11			11			11
	953.4	12	12		12		12			12		
	953.6	13		13		13		13			13	
	953.8	14	14		14				14			14
	954.0	15		15		15	15			15		
	954.2	16	16		16			16			16	
	954.4	17		17		17			17			17
	954.6	18	18		18		18			18		
	954.8	19		19		19		19			19	
	955.0	20	20		20				20			20
	955.2	21		21		21	21			21		
	955.4	22	22		22			22			22	
	955.6	23		23		23			23			23
	955.8	24	24		24		24			24		
	956.0	25		25		25		25			25	
	956.2	26	26		26				26			26
	956.4	27		27		27	27			27		
	956.6	28	28		28			28			28	
	956.8	29		29		29			29			29
	957.0	30	30		30		30			30		
	957.2	31		31		31						
	957.4	32										

SFF-TBD-CID#3: Transmission power

- Introduce a new PIB parameter phyTransmitPowerArray, which is an array storing the transmit power values, in dBm, for each transmit power level and allow the current transmit power to be set to one of those levels.

SFF-TBD-CID#4: SFD value (1/2)

- SFF has proposed to employ Golay complementary pairs as 16-bit "Golay field" in SFD in order to indicate whether the following PHR+PSDU is coded or not
- Golay field value #1; Coded PHR+PSDU:

-1	1	1	1	-1	-1	1	-1	1	-1	1	1	1	1	1	-1

- Golay field value #2; Uncoded PHR+PSDU:

-1	1	1	1	-1	-1	1	-1	-1	1	-1	-1	-1	-1	-1	1

- Features/Advantages of Golay complementary pairs employment
  - Consists of a pair of binary sequences "a" and "b," and has the length of 2N, where N is a positive integer
  - Sum of the autocorrelation of "a" and "b" results in a main-lobe peak including no side-lobe, such autocorrelations can be realized by simple matched filter
  - Able to carry 4-state information using "+ a," "- a," "+ b" and "- b"

SFF-TBD-CID#4: SFD value (2/2)

- Allocation in SFD: totally four different indications, but using three 8bit-Golay sequences (24 bits in total):

Golay field (24 bits)			
Golay seq. “b” (8 bits)	Golay seq. “a” (8 bits)	Golay seq. “b” (8 bits)	: Golay field value #1 (Coded PHR+PSDU)
Golay seq. “-b” (8 bits)	Golay seq. “a” (8 bits)	Golay seq. “-b” (8 bits)	: Golay field value #2 (Uncoded PHR+PSDU)
Golay seq. “a” (8 bits)	Golay seq. “b” (8 bits)	Golay seq. “a” (8 bits)	: Reserved
Golay seq. “-a” (8 bits)	Golay seq. “b” (8 bits)	Golay seq. “-a” (8 bits)	: Reserved

- a=[1 -1 -1 -1 1 1 -1 1]
- b=[-1 1 -1 -1 -1 -1 -1 1]

SFF-TBD-CID#5: Reference modulation diagram

- Include simple diagram showing the progression on the TX side from PSDU bits, to symbols via bit-to-symbol mapping as shown in section 6.12a.2.2, followed by GFSK/FSK modulation. Include new section on GFSK/FSK modulation as 6.12a.2.3 and refer to it from the diagram. This section should include the details of how symbols are frequency modulated (e.g. frequency deviations for the various modulation indexes and bit rates). The nominal frequency deviation, Δf, shall be the symbol frequency * modulation index / 2. For 2-level FSK/GFSK modulation, symbol 0 is modulated on -Δf and symbol 1 is modulated on +Δf. For 4-level modulation, Gray coding is used and symbol 1 is modulated on -Δf*3, symbol 0 is modulated on -Δf, symbol 2 is modulated on Δf and symbol 3 is modulated on Δf*3.

SFF-TBD-CID#6: FEC (1/3)

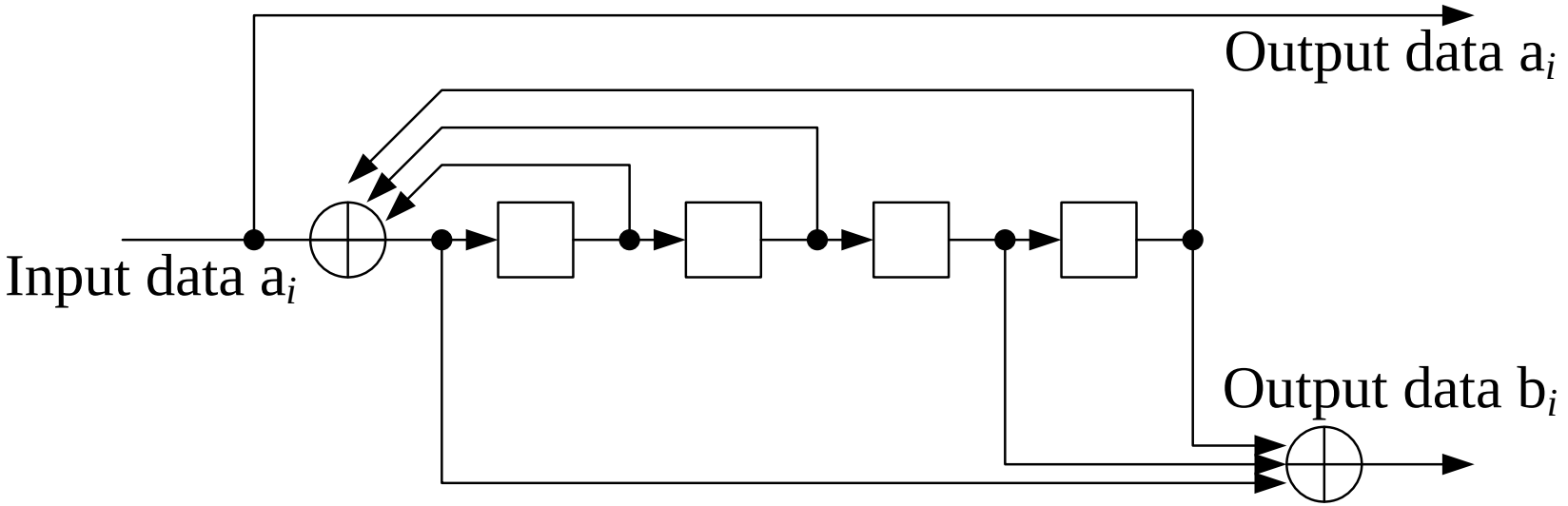
- SFF has proposal on FEC for 50 kbps mode: Systematic convolutional code (R=1/2, K=5)
- Another FEC scheme: Performance of RS (R=3/4) and BCH code are under validations
- Same as other systematic coders, a systematic convolutional encoder **outputs original input data** (see the following figure), which means the receiver can **demodulate the received encoded data without Viterbi decoding**
  - The receiver can choose decoding method (Viterbi decoding or withtout-decoding) according to link performance or power consumption he want to achieve
  - Manufacturer also can decide to implement the Viterbi decoder in the receiver according system they use
- Smaller K is possible to use for lower burden with moderate coding gain

SHR		PHR	PSDU
Preamble	SFD		

50kbps(a) (mandatory)	50ksymbols/s (no FEC, 2GFSK)	50ksymbols/s (no FEC, 2GFSK)	50ksymbols/s (no FEC, 2GFSK)
50kbps(b) (mandatory)	100ksymbols/s (no FEC, 2GFSK)	100ksymbols/s (no FEC, 2GFSK)	100ksymbols/s (**FEC (with Systematic Convolutional code R=1/2,K=5)**, 2GFSK)
100kbps (mandatory)	100ksymbols/s (no FEC, 2GFSK)		
200kbps (optional)	200ksymbols/s (no FEC, 2GFSK)		
400kbps (optional)	200ksymbols/s (no FEC, 2GFSK)		200ksymbols/s (no FEC, 4GFSK)

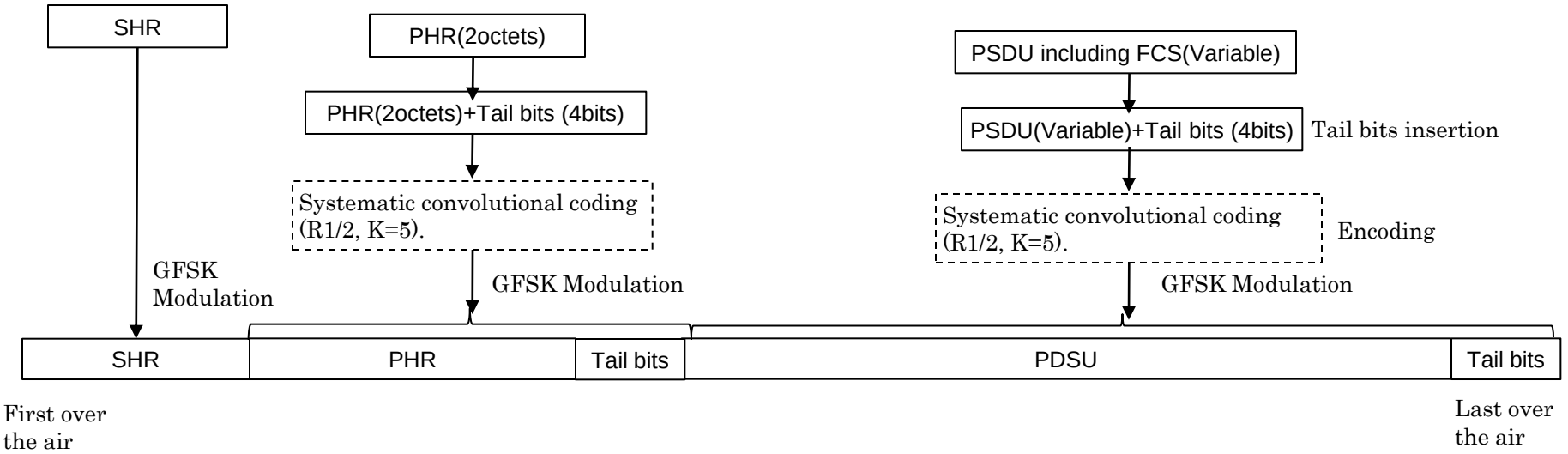
SFF-TBD-CID#6: FEC (2/3)

- SFF suggestion for systematic convolutional code encoder



SFF-TBD-CID#6: FEC (3/3)

- 4bit-tail-bits insertion is employed in the systematic CC coding case



SFF-TBD-CID#7: Radio specifications

The following specifications shall be included in Clause6 or suitable Annex:

- PSD mask: as specified below
- Sensitivity: -85dBm (in case of 20 octets, 1%)
- Symbol rate: accuracy of 20ppm +-
- Jamming resistance: 0/24dB (adjacent/alternate)