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

Submission Title: Merged proposal of 802.15.4 SUN OFDM HR(High Rate) for 802.15.4ad
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Re: [TG4ad Next Generation SUN PHYs]

Abstract: This contribution show merged proposal and its transmission performance for 802.15.4 SUN OFDM HR(High Rate) for 802.15.4ad.

Purpose: High rate 802.15.4 SUN proposal

Merged proposal of 802.15.4 SUN OFDM HR(High Rate) for 802.15.4ad

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Fundamental design policy

- 802.15.4 SUN OFDM is being promoted for use in smart meters and other applications
- The structure of 802.15.4 SUN OFDM should not be changed
- If the transmission rate is to be increased without changing the structure of 802.15.4 SUN OFDM, the most direct approach is to reduce the symbol duration
- If the symbol duration is reduced, the guard interval will also be reduced. But the current 802.15.4 SUN OFDM guard interval is 24 μs, and even if the symbol transmission time is reduced to 1/3, the guard interval will still be 8 μs, which is sufficient for use within urban structures. Also, even when transmitting over long distances, it is possible to reduce long-delay multipath by using directional antennas, so there is a high possibility that it will be of sufficient use
- Considering coexistence with 11ah, it is desirable that the channel spacing be the same.

802.15.4-2024 SUN-OFDM

		Option1	Option2	Option3	Option4
Channel spacing		1200 kHz	800 kHz	400 kHz	200 kHz
OFDM symbol duration		120 μs			
Subcarrier spacing		31.25/3 kHz			
DFT size		128	64	32	16
Number of subcarriers		104	52	26	14
Num. of data-subcarriers		96	48	24	12
Primary modulation scheme		BPSK(MCS 0-1), QPSK(MCS 2-4), 16QAM(MCS5-6)			
Coding Scheme and rate		Convolutional code (Constraint length: 7) Coding rate1/2 (MCS 0-3, 5), 3/4 (MCS 4,6)			
Spreading factor		4 (MCS 0), 2 (MCS1-2), 1(MCS 3-6)			
Data rate for PSDU (kb/s)	MCS 0	100	50	25	12.5
	MCS 1	200	100	50	25
	MCS 2	400	200	100	50
	MCS 3	800	400	200	100
	MCS 4	1200	600	300	150
	MCS 5	1600	800	400	200
	MCS 6	2400	1200	600	300

Proposed 802.15.4-2024 SUN-OFDM High Rate (HR) PHY

		Option1	Option2	Option3
Channel spacing		4000 kHz	2000 kHz	1000 kHz
OFDM symbol duration		40 μs		
Subcarrier spacing		31.25 kHz		
DFT size		128	64	32
Number of subcarriers		104	52	26
Num. of data-subcarriers		96	48	24
Primary modulation scheme		BPSK(MCS 0-1), QPSK(MCS 2-4), 16QAM(MCS5-6)		
Coding Scheme and rate		Convolutional code (Constraint length: 7) Coding rate1/2 (MCS 0-3, 5), 3/4 (MCS 4,6)		
Spreading factor		4 (MCS 0), 2 (MCS1-2), 1(MCS 3-6)		
Data rate for PSDU (kb/s)	MCS 0	300	150	75
	MCS 1	600	300	150
	MCS 2	1200	600	300
	MCS 3	2400	1200	600
	MCS 4	3600	1800	900
	MCS 5	4800	2400	1200
	MCS 6	7200	3600	1800

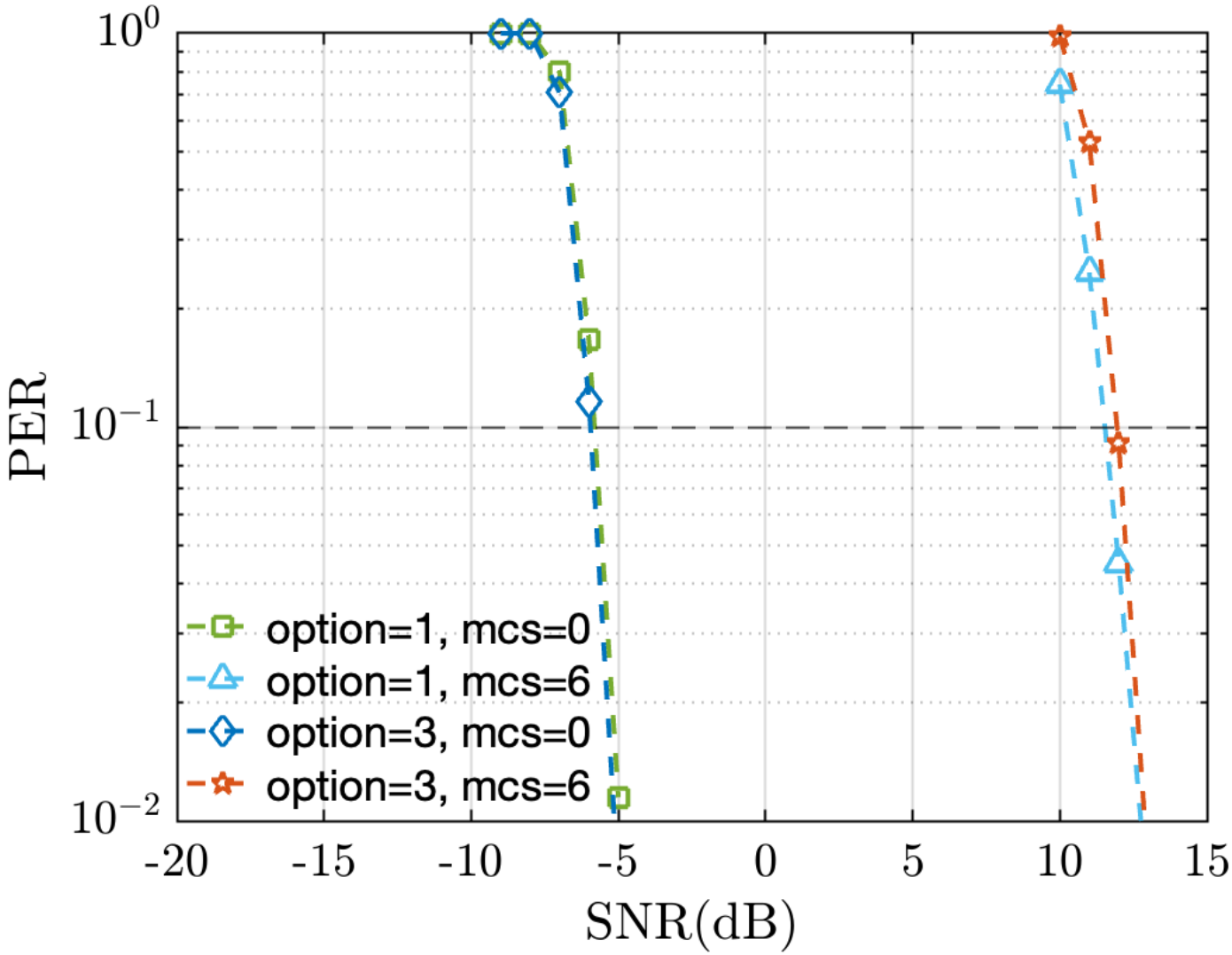
802.15.4-2024 SUN-OFDM HR

- Basically, it is based on 802.15.4-2024 SUN OFDM, and the only change is to reduce the length of the OFDM symbol to 1/3
- The basic transmitter configuration is the same as 802.15.4-2024 SUN OFDM
- Time-axis window-based filter standardized in 802.15.4m is required to fit the occupied bandwidth within the channel spacing range to fit into the spectrum
- Regarding FEC, we firstly consider using the convolution code standardized in 802.15.4-2024 SUN OFDM

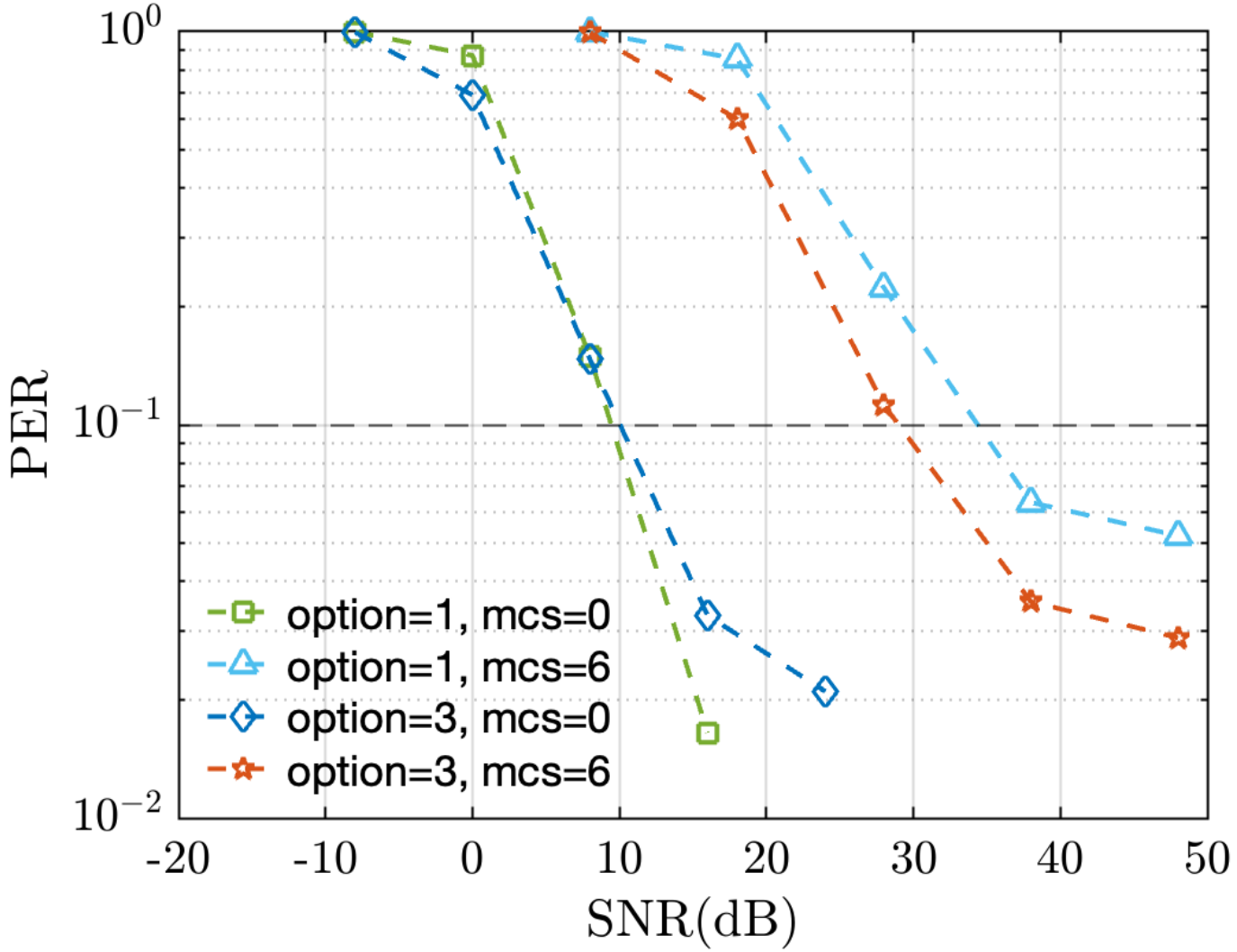
Simulation parameters

- Option 1 and 3
- MCS 0,6
- Packet size: 250 byte
- Interleave size: Same as IEEE 802.15.4 SUN OFDM
- Evaluation index: Packet Error Rate (PER)
- Padding bit: 2 bit
- Tail bit: 6 bit
- Gurad interval: ¼
- Perfect synchronization

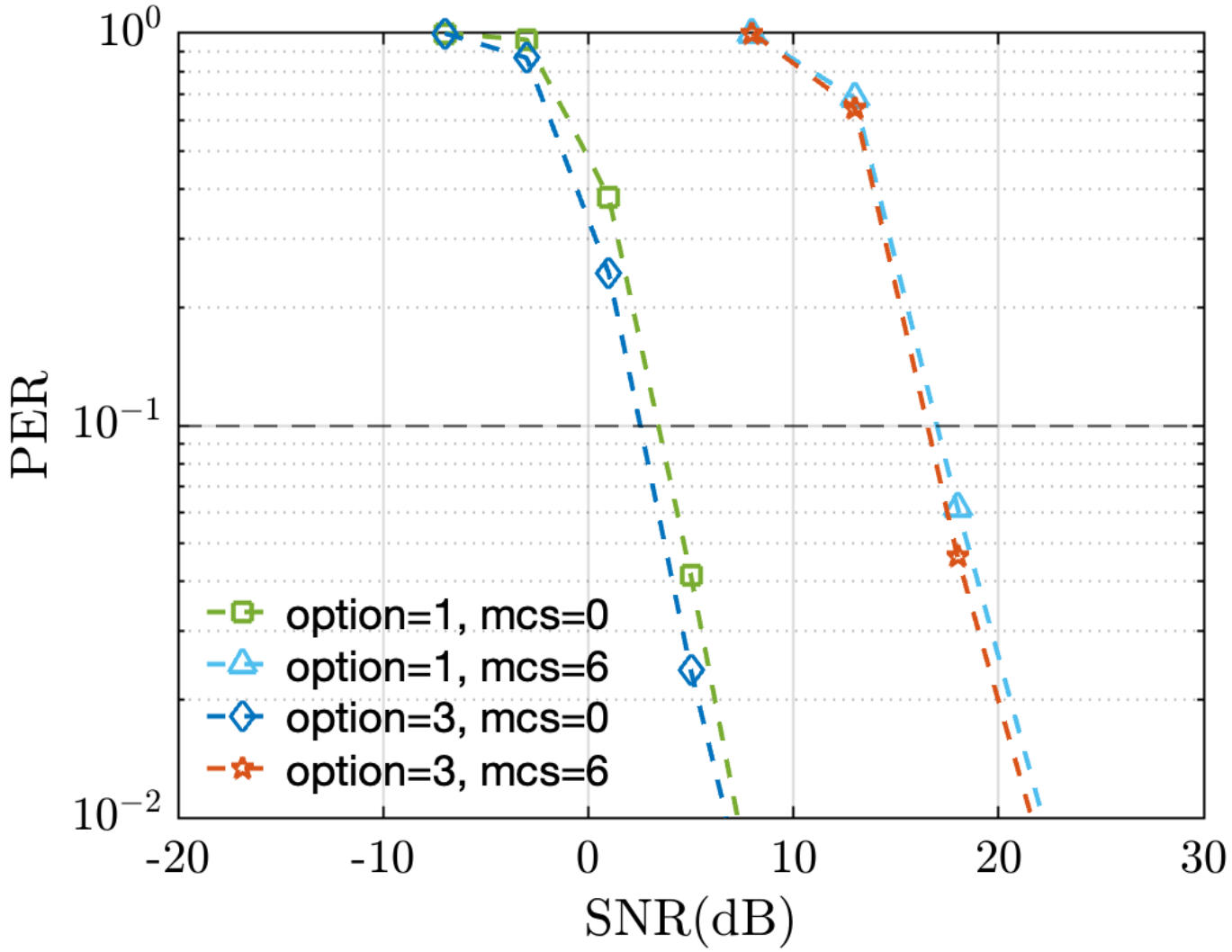
PER under AWGN



PER under TDL-B (fd=2.5Hz)



PER under TDL-D (fd=2.5Hz)



Requred SNR and power

Channel model	Option	mcs	Doppler frequency(Hz)	Required PER	Required power(dBm)
AWGN	1	0	N/A	10^{-1}	-114.7
		6			-97.3
	3	0			-120.8
		6			-102.9

Requred SNR and power

Channel model	Option	mcs	Doppler frequency(Hz)	Required PER	Required power(dBm)
TDL-B	1	0	2.5	10^{-1}	-99.4
		6			-74.5
	3	0			-104.8
		6			-85.9
TDL-D	1	0	2.5	10^{-1}	-105.4
		6			-91.9
	3	0			-112.3
		6			-98.3