Project	**IEEE 802.16 Broadband Wireless Access Working Group <http://ieee802.org/16>**
Title	**Simulation on energy pulse in SUI|**
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Re:	80216h-05_023：Call for Contributions: IEEE 802.16 License-Exempt Task Group
Abstract	Show some simulation result for the energy pulse symbol duration
Purpose	Discussion the duration spec of the CTS symbol
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Simulation on energy pulse in SUI

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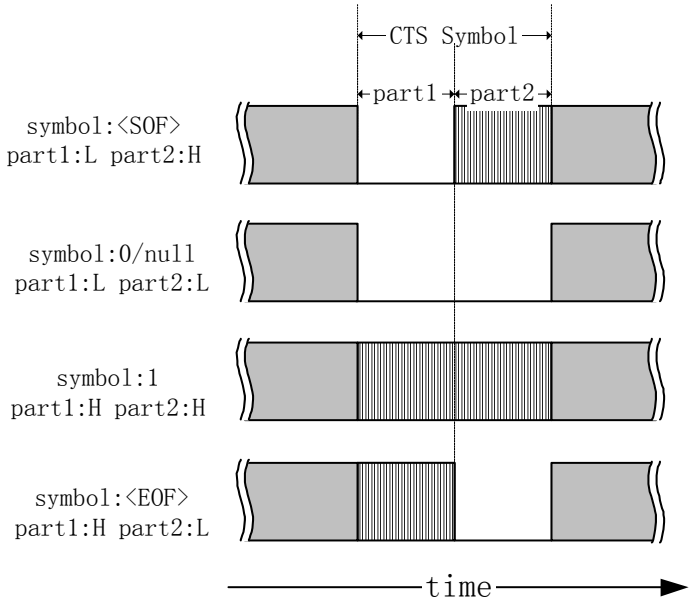
Background[1][2][3][4]

Symbols definition

We define the energy keying symbols as follows. The symbol is divided into to parts with equal length, each part could be transmitted either in high power(H) or low/no power(L). We mapped the four combination into different significations:

format		signification
Part1	Part2	
L	H	<SOF> Start of Frame
H	L	<EOF> End of Frame
L	L	0
H	H	1

The symbols are transmitted using the original PHY of the transmitter, and length of the symbol is 1/n of the CTS length. N is a natural number and to be decided and standardized in region/country.

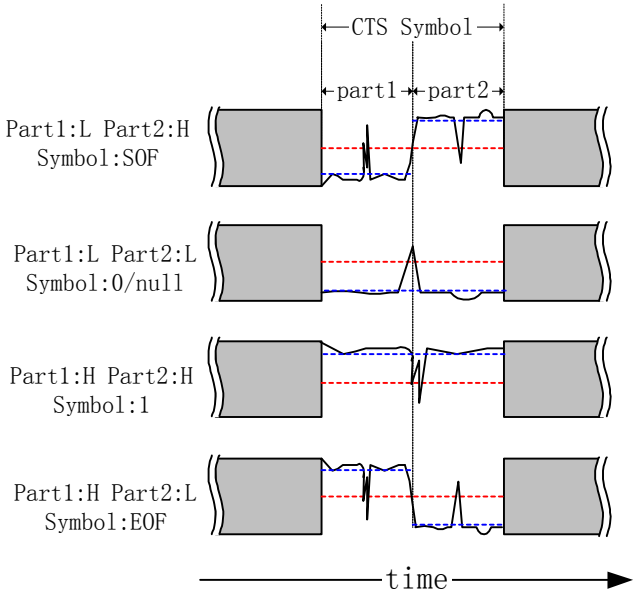


The receiver detect the RSSI in whole band during each CTS symbol time make the verdict in each part, by comparing the average RSSI value with the criteria gate value. By combining the result of two parts, the receiver will make the decision of the signification for each CTS symbol. see the figure below.

The receiver SSs will record the average RSSI in null CTS slots, and when they detect a continue symbol that meet the <SOF> aspect, the receiver will memorize the average RSSI values of each of the two

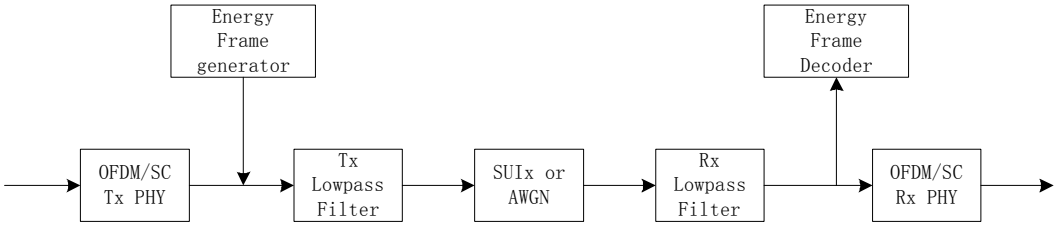
parts, and make the mean value as a criteria gate value to do further verdict on the following symbols in this IPBC frame.

By receiving different symbols, the receiver SS will change the internal state machine of the IPBC frame receive procedure. After end of receiving a IPBC frame. The receiving SS will report the result to the serving BS.



Simulation Environment[5][6]

Simulation block diagram

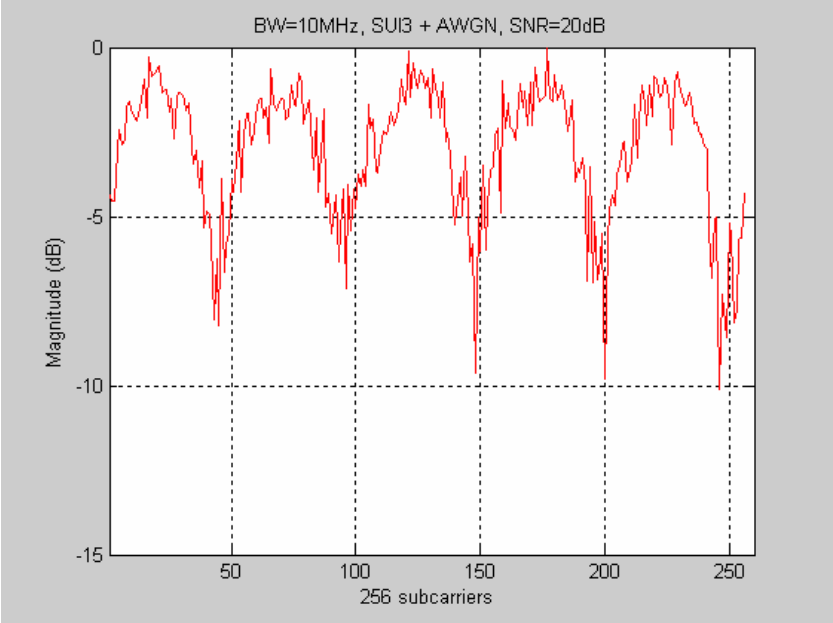


SUI 3 Channel model parameter

Table 1. SUI-3 channel parameter

SUI-3 Channel Terrain B				
	Tap1	Tap2	Tap3	Units
Delay	0	0.4	0.9	μs
Power(omni ant.)	0	-5	-10	DB
Doppler	0.4	0.3	0.5	Hz
Antenna Correlation	$\rho_{ENV} = 0.4$			
SUI-1 Channel Terrain C				
	Tap1	Tap2	Tap3	Units
Delay	0	0.4	0.9	μs
Power (omni ant.)	0	-15	-20	DB
Doppler	0.4	0.3	0.5	Hz
Antenna Correlation	$\rho_{ENV} = 0.7$			

The frequency selective fading on the 256 sub-carriers 10M OFDM for SUI3



Test Suits and Results

**note:*

1. The result diagram is to show the lest number of points that the receiver could continuously decode correctly and reassemble one energy pulse frame

2. The SNR in the simulation is fixed to use the equivalent QAM16 bit SNR ratio, so to be linear to the whole power SNR ratio regardless of the modulation mode;

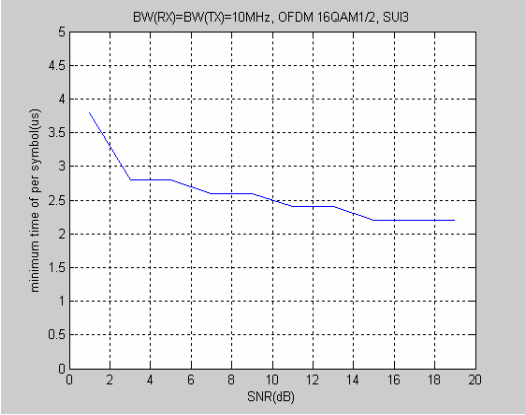
3. The test cases is still to be extended;

A) BW(RX)=BW(TX)，BW=10MHz, SUI3，Sampling time 1/BW:

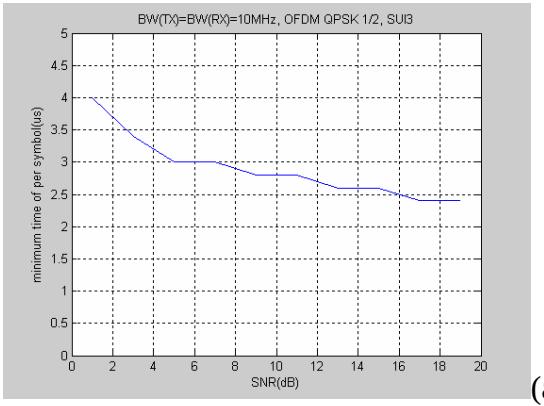
(a1) OFDM16QAM1/2 ;

(a2) OFDM QPSK1/2;

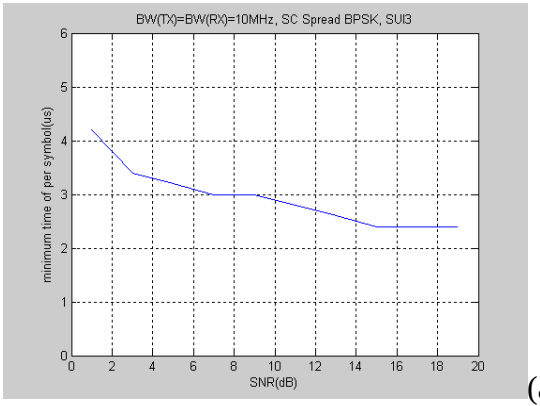
(a3) SC BPSK;



(a1)



(a2)

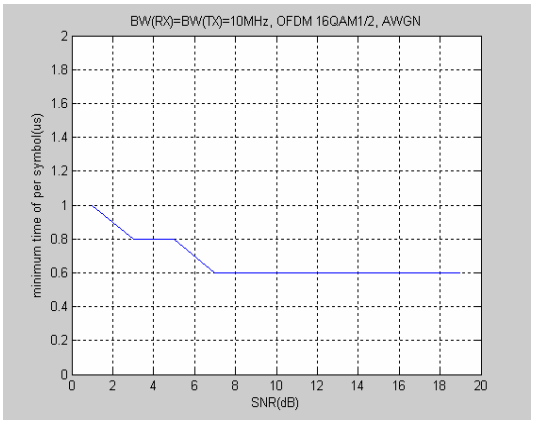


(a3)

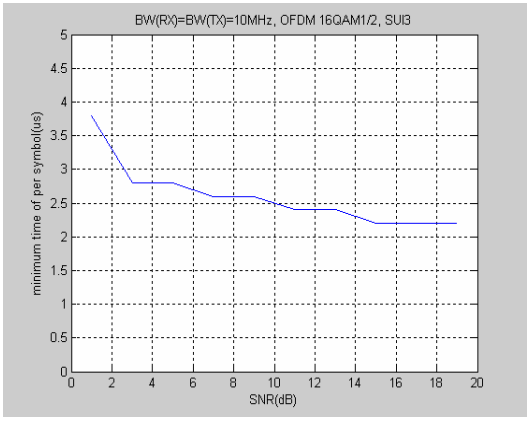
B) BW(RX)=BW(TX)=10MHz, OFDM 16QAM1/2, Sampling time 1/10MHz= 0.1us：

(b1) AWGN

(b2) SUI3/7km



(b1)



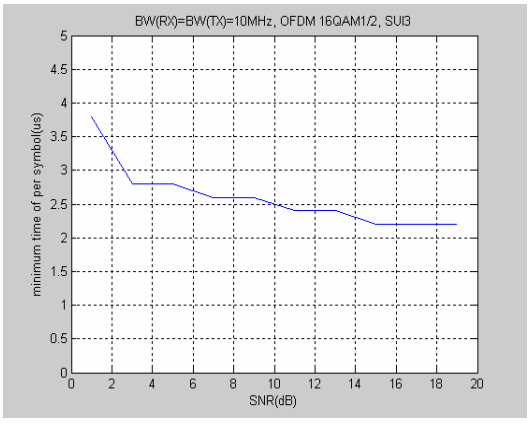
(b2)

C) OFDM 16QAM1/2, SUI3, Sampling time 1/BW：

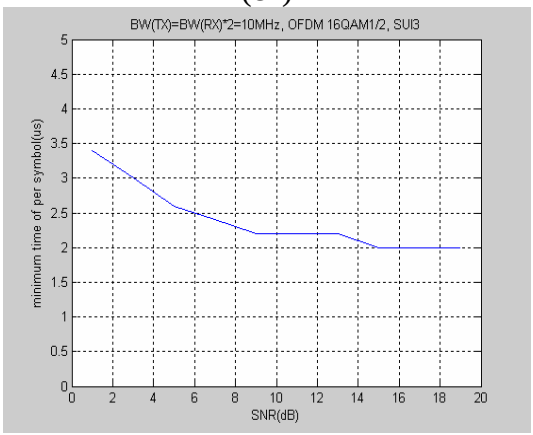
(c1) BW(RX)=BW(TX)=10MHz;

(c2) BW(RX)*2=BW(TX)=10MHz;

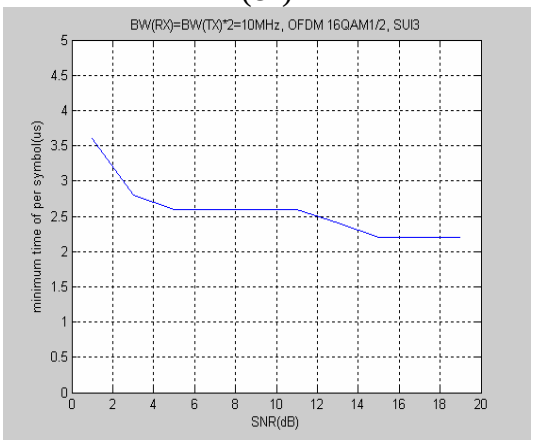
(c3) BW(RX)=BW(TX)*2=10MHz;



(c1)



(c2)



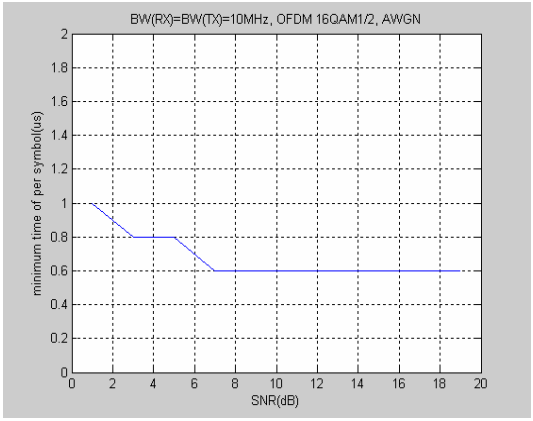
(c3)

D) OFDM 16QAM1/2, AWGN, Sampling time 1/BW:

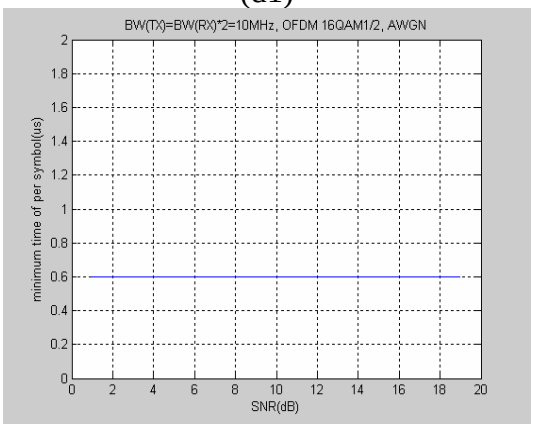
(d1) BW(RX)=BW(TX)=10MHz;

(d2) BW(RX)*2=BW(TX)=10MHz;

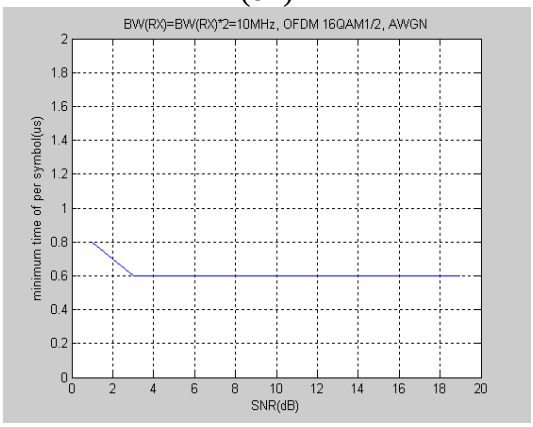
(d3) BW(RX)=BW(TX)*2=10MHz;



(d1)



(d2)



(d3)

Conclusion

1) Considering the **frequency selective fading** for channel model SUI3, it will have little to do with the energy pulse in time domain symbol, but have much to think about in the frequency domain symbol solution.

2) The necessary symbol length have little to do with the **modulation mode** and **RX/TX bandwidth mismatch**, but it related more to the multipath delay and power.

3) To increase the symbol length will increase the SNR tolerance, but when the SNR is bigger then 3dB, the energy pulse symbol necessary length is rather stable and will stop decreasing at a certain SNR value, this SNR point is less then 15dB. The necessary symbol value could define with different scenarios, in current channel model in SUI3, we find it's enough to define the energy pulse duration to be **less than 10us** including 100% allowance.

* Further study is needed on energy pulse transceiver.

Reference:

[1] *IEEE 802.16-05/022: working document Amendment for Improved Coexistence Mechanisms for License-Exempt Operation 2005-09-28*

[2] *IEEE 802.16h-05/023: Call for Contributions IEEE 802.16 License-Exempt Task Group2005-10-17*

[3] *IEEE C802.16h-05/029**:** Common PHY issue & Messages for Neighbor Discovery Using CTS 2005-09-06*

[4] *IEEE802.16h-05/020**:** License-Exempt Task Group Meeting Minutes – Session #39 2005-09-15*

[5] *IEEE IEEE 802.16.3c-01/29r4: Channel Models for Fixed Wireless Applications 2001-07-17*

[6] *IEEE 802.16a-02/18: Analysis of STFBC-OFDM for BWA in SUI channel 2002-01-22*