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

Submission Title: Cognitive Spectrum Management (CSM) Signaling Options
Date Submitted: March 6, 2011
Source: Mark Wilbur **Company** Collaborative Wireless Strategies LLC
Address: Concord Ohio USA
Voice: 01 (440) 221-2101 **E-Mail:** cws@ieee.org

Re:

Abstract: Comment Resolution

Purpose: Information to be used to describe functionality of new coexistence option

Cognitive Spectrum Management (CSM) Signaling Options

Collaborative

Wireless Strategies LLC

440-221-2101

cws_wireless@sbcglobal.net

Comment Resolution
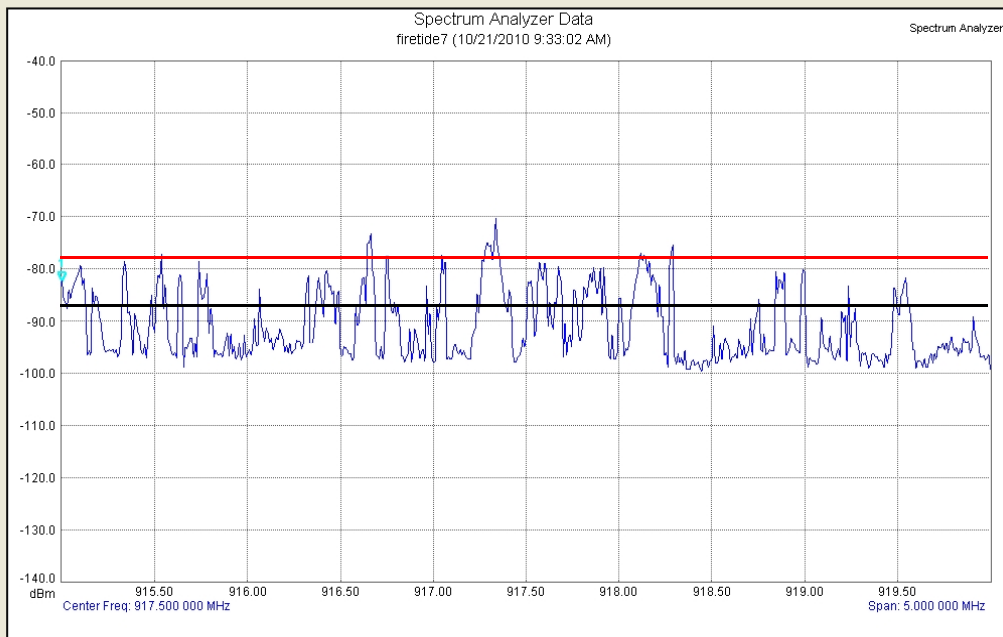
Comments # 53,54,55,67,70,72,73

Add the following text to the TG4G draft

in the appropriate locations

- Number of CSM channels = Floor (Valid channels / 16)
- Ch # = X(floor (((Max Valid Channel -1) – (Min Valid Channel +1) / N))
- IF MPM used EBI duration = N (EBR duration + Delay) ^{2}
- EBR consist of 512 bits
- EBR transmitted at 50 kbps
- Settling Delay is 1.28 uS
- Add text and illustrations from slides 6-9 of doc 802.15-15-11-166-01 to draft to define the non-beacon enabled co-existence mechanism

Does 802 really need CSM ?

802.15.4G Min ACR limit
Rx Sensitivity + 3db

Example of real-world 902-928 ISM spectrum (Rural)

Enhanced Beacons and Beacon Requests

- The latest version of the 802.15.4G amendment has introduced two new information sharing mechanisms , <u>Enhanced Beacons</u> and <u>Enhanced Beacon Requests</u>. They are fundamentally identical to the existing 802.15.4I defined beacons and beacon requests but have been enhanced to include all of the operational PHY details.

- It is the intension of this presentation to define how the non-beacon enabled PAN operation currently defined within 802.15.4-2006 may be implemented utilizing the newly defined EB and EBR mechanism to enhance coexistence between the 3 otherwise orthogonal PHY's included in the 4G draft amendment.

- Some network resources must be shared to monitor for beacon requests.

- A significant reduction in retransmissions is likely in densely utilized bands (additional work recommended to document collision reduction potential)

CSM Example For 902-928 ISM Band

902 MHz

26 MHz

928 MHz
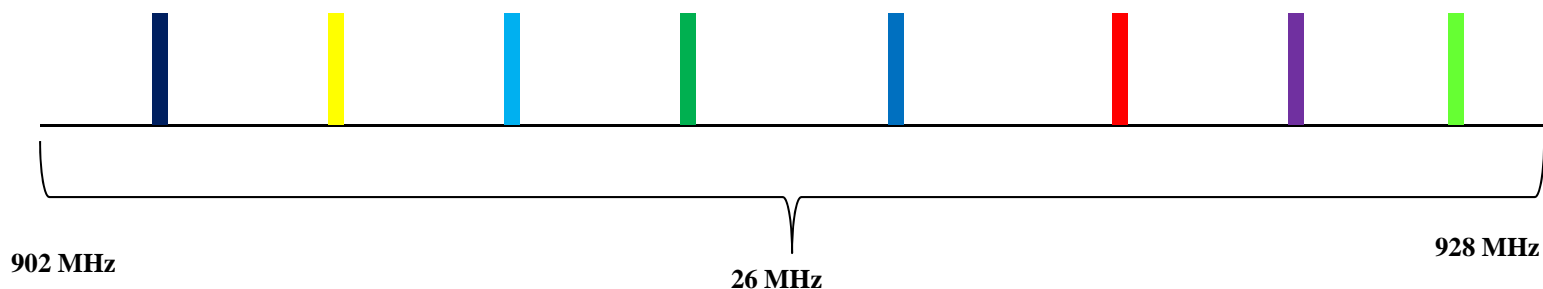
902-928 Band = 128 Valid Channels

"N" = Number of CSM signaling channels = Floor (Valid channels / 16 = 8 (for the 902-928 band)

1/16th of the available channels available in the band selected for coding efficiency
(additional research may be required to validate this is the ideal value)

X =1   For N   X=X+1

CSM CHANNEL NUMBER =   X(floor (((Max Valid Channel -1) – (Min Valid Channel +1) / N))

CSM 01 = 01(floor ((128 -1) – (1+1) / 8)) = 015
CSM02 = 02(floor ((128 -1) – (1+1) / 8)) = 030
CSM 03 = 03(floor ((128 -1) – (1+1) / 8)) = 045
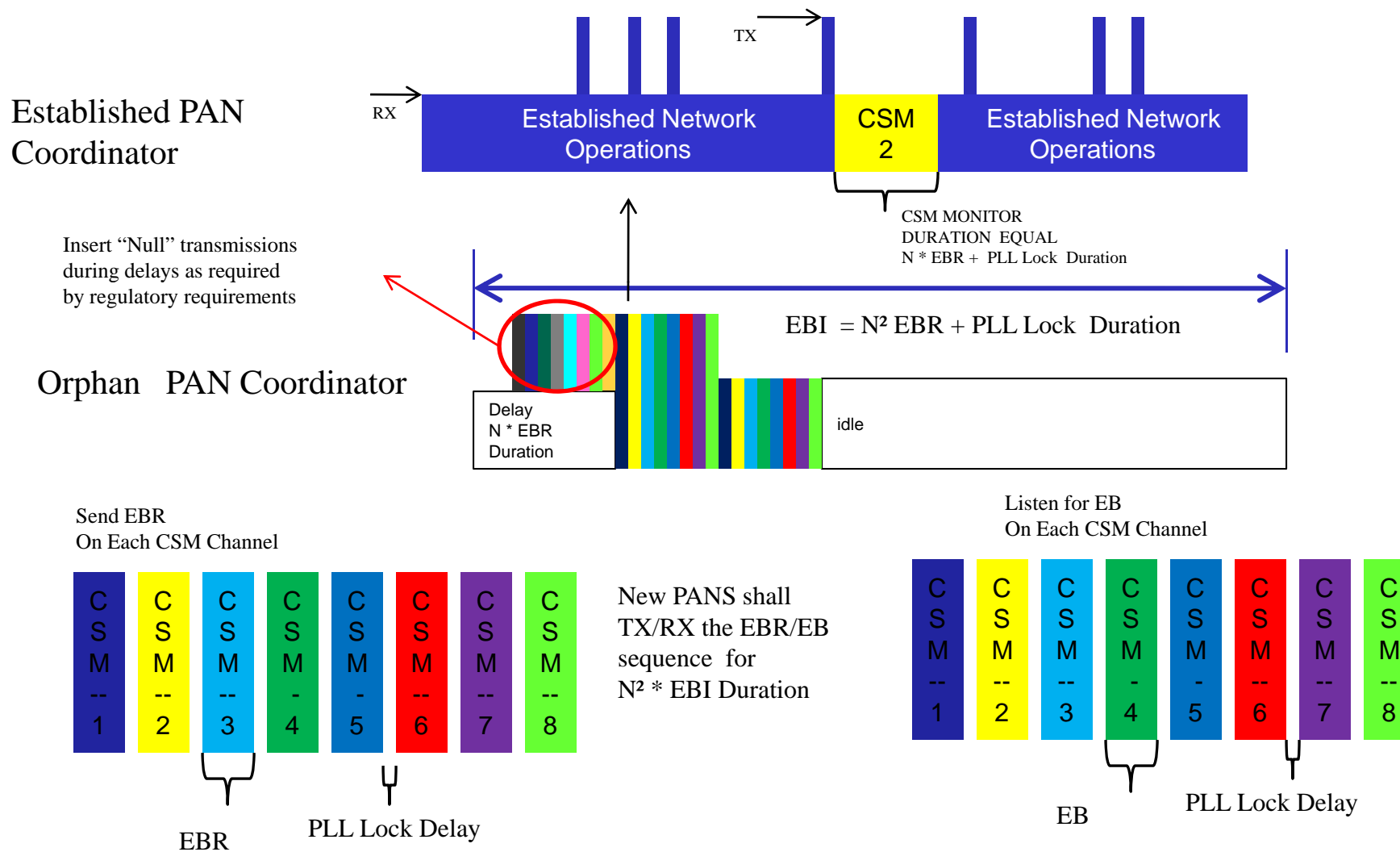**- - - - - - - - - - - - - - - - - - - -**
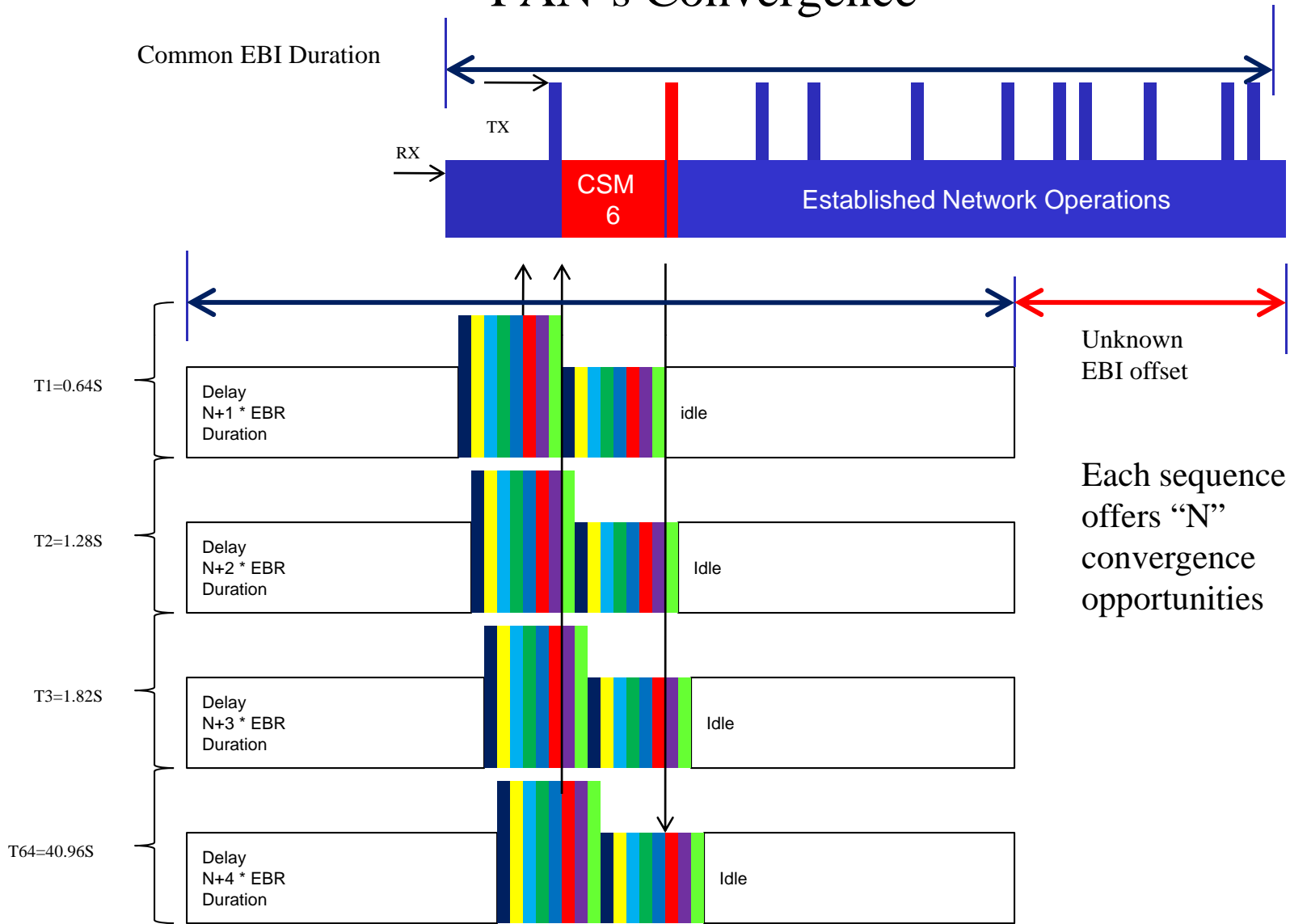**CSM 08 = 08(floor ((128 -1) – (1+1) / 8)) = 120**

"N" = Number of channels used for CSM signaling

CSM defined channels may be use for network traffic when necessary

EBR & EB Signaling Sequence

TX

Established PAN
Coordinator

RX

Established Network
Operations

CSM
2

Established Network
Operations

CSM MONITOR
DURATION EQUAL
N * EBR + PLL Lock Duration

Insert "Null" transmissions
during delays as required
by regulatory requirements

Orphan   PAN Coordinator

$EBI = N^2 EBR + PLL \text{ Lock Duration}$

Delay
N * EBR
Duration

idle

Send EBR
On Each CSM Channel

C S M -- 1	C S M -- 2	C S M -- 3	C S M - 4	C S M - 5	C S M -- 6	C S M -- 7	C S M -- 8

New PANS shall
TX/RX the EBR/EB
sequence for
N^2 * EBI Duration

EBR

PLL Lock Delay

Listen for EB
On Each CSM Channel

C S M -- 1	C S M -- 2	C S M -- 3	C S M - 4	C S M - 5	C S M -- 6	C S M -- 7	C S M -- 8

EB

PLL Lock Delay

PAN's Convergence

Common EBI Duration

TX

RX

CSM
6

Established Network Operations

Unknown
EBI offset

T1=0.64S

Delay
N+1 * EBR
Duration

idle

Each sequence
offers "N"
convergence
opportunities

T2=1.28S

Delay
N+2 * EBR
Duration

Idle

T3=1.82S

Delay
N+3 * EBR
Duration

Idle

T64=40.96S

Delay
N+4 * EBR
Duration

Idle

Dynamic Network Priority Definition

Network Traffic Priority

12.5% EBR Monitor (1 of 8 slots)

Max Converge Time = EBI Duration * N^2 Attempts = 0.64S * 64 = 40.96 S

EBI

TX

RX

CSM
2

Established Network Operations

Co-Existence Priority

50 % EBR Monitor (4 of 8 slots)

Max Converge Time = (EBI Duration * N^2 Attempts = 0.64S * 64) / 4 = 10.24 S

EBI

TX

RX

CSM
2

CSM
3

CSM
4

CSM
5

?Questions ?

Collaborative
Wireless Strategies LLC

440-221-2101

cws_wireless@sbcglobal.net