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**Re:**

**Abstract:** Comment Resolution

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

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# Cognitive Spectrum Management (CSM) Signaling Options



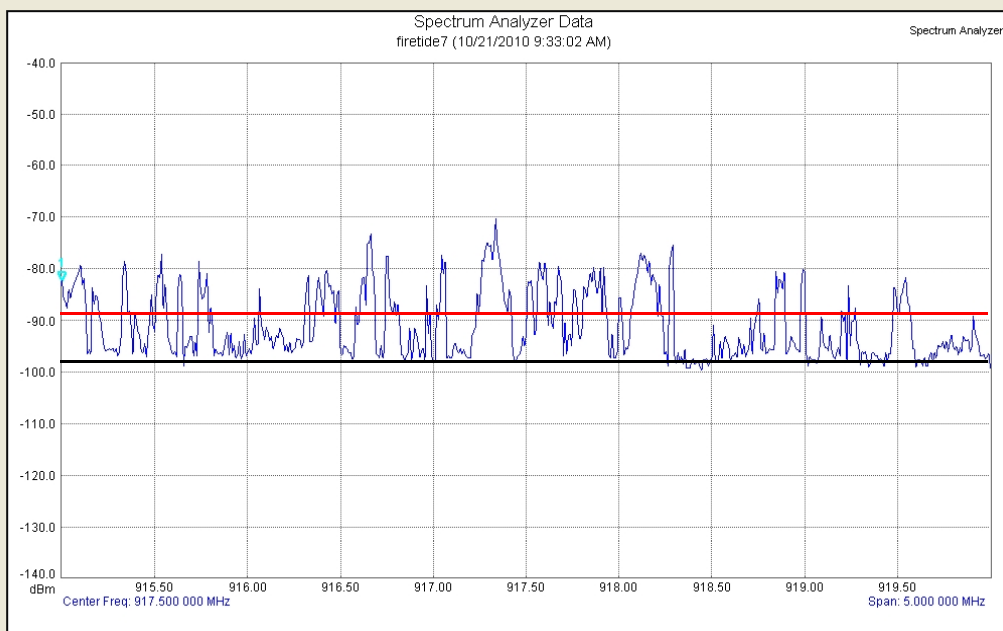
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# Does 802 really need CSM ?

— 802.15.4G Min ACR limit  
— Rx Sensitivity + 3db

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



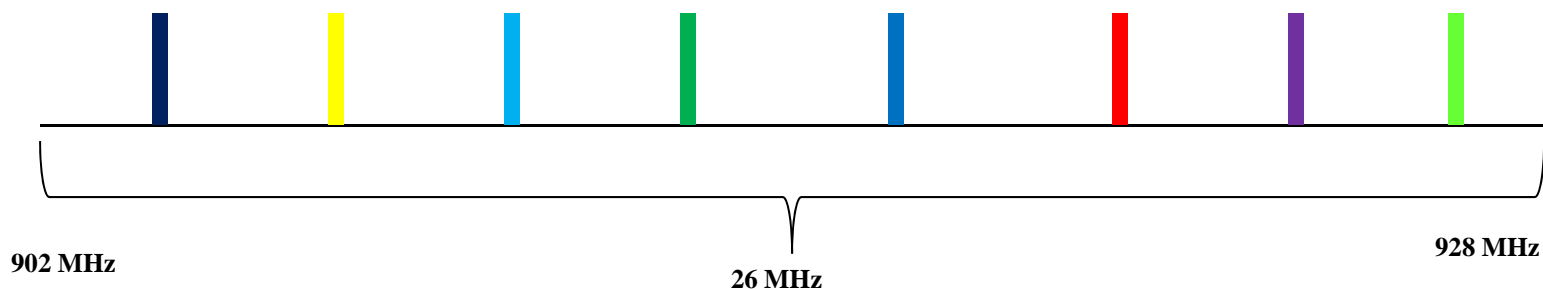
Measurement Parameters			
Trace Mode	Max Hold	Frequency Span	5.000 000 MHz
Preamp	ON	Reference Level	-40.000 dBm
Min Sweep Time	0.001 S	Scale	10.0 dB/div
Reference Level Offset	0.0 dB	Operator Name	
Input Attenuation	0.0 dB	Tower	
RBW	1.0 kHz	Serial Number	1018077
VBW	1.0 kHz	Base Ver.	V3.38
Detection	Peak	App Ver.	V4.35
Center Frequency	917.500 000 MHz	Model	MS2712E
Start Frequency	915.000 000 MHz	Options	25_31
Stop Frequency	920.000 000 MHz	Date	10/21/2010 9:33:02 AM
		Device Name	



# Enhanced Beacons and Beacon Requests

- The latest version of the 802.15.4G amendment has introduced two new information sharing mechanisms , Enhanced Beacons and Enhanced Beacon Requests. 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 introduce a new CSMA mechanism that may be used to improve coexistence between the 3 otherwise orthogonal PHY's included in the 4G draft amendment.
- The EB includes all of the PHY information details required for a orphan PAN to initiate a request-to-join to the existing network or to avoid the existing network by excluding the existing PAN's operational PHY.
- 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



**902-928 Band = 128 Valid Channels**

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

**1/16<sup>th</sup> 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**

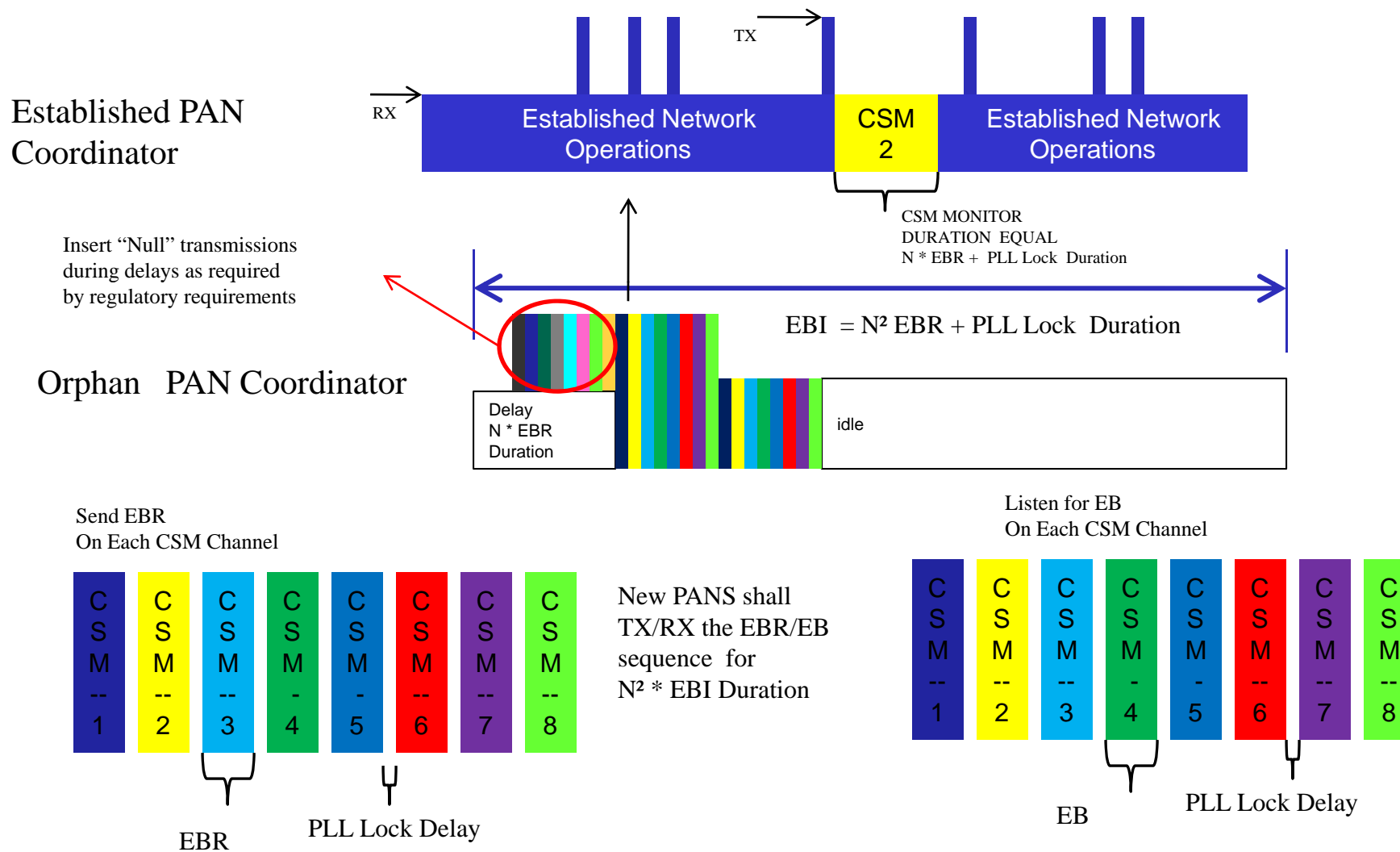
**- - - - -**

**CSM 08 = 08(floor ((128 -1) – (1+1) / 8)) = 120**

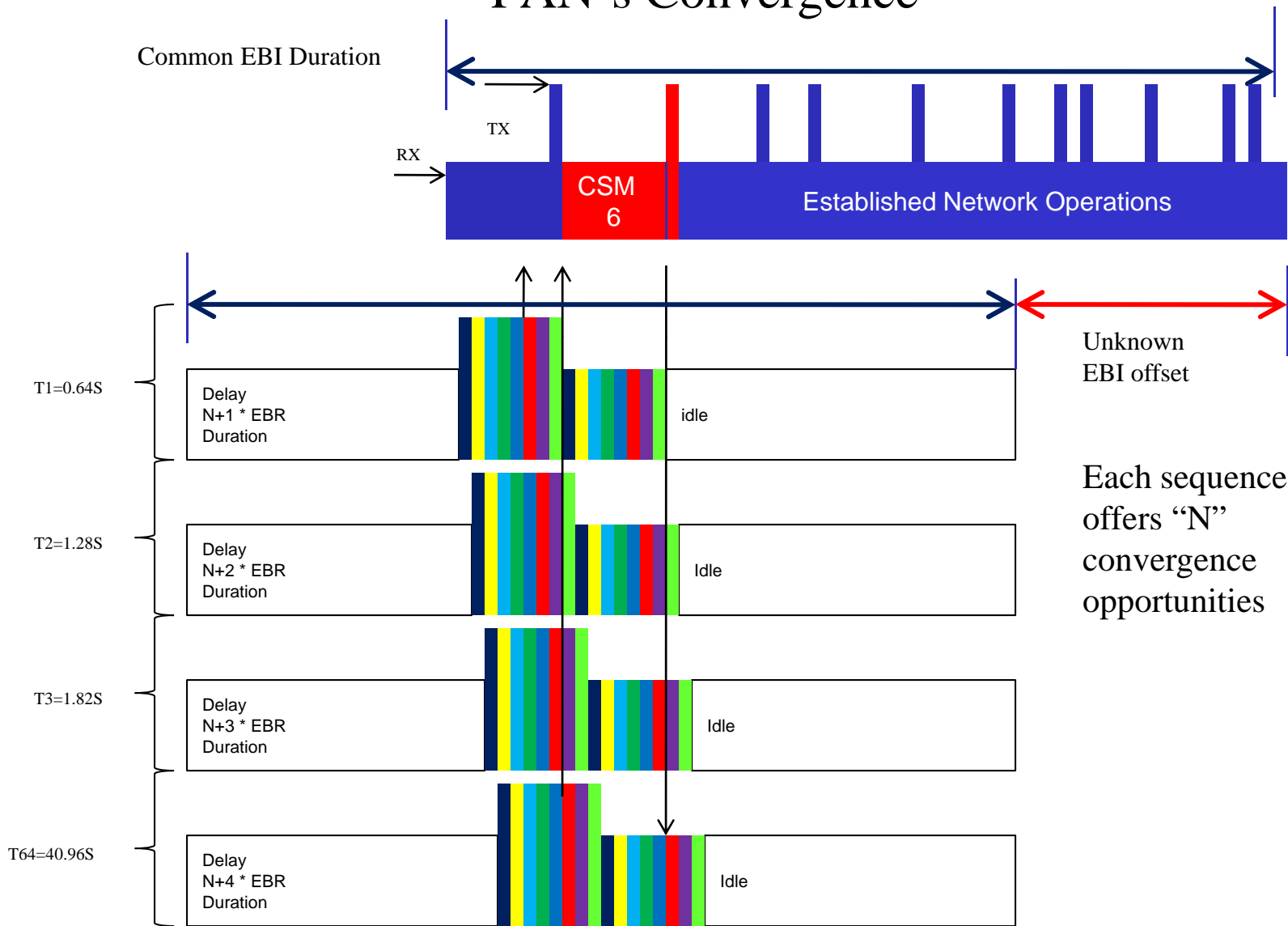
**“N” = Number of channels used for CSM signaling**

**CSM defined channels may be use for network traffic when necessary**

# EBR & EB Signaling Sequence



# PAN's Convergence



# Dynamic Network Priority Definition

## Network Traffic Priority

12.5% EBR Monitor (1 of 8 slots)

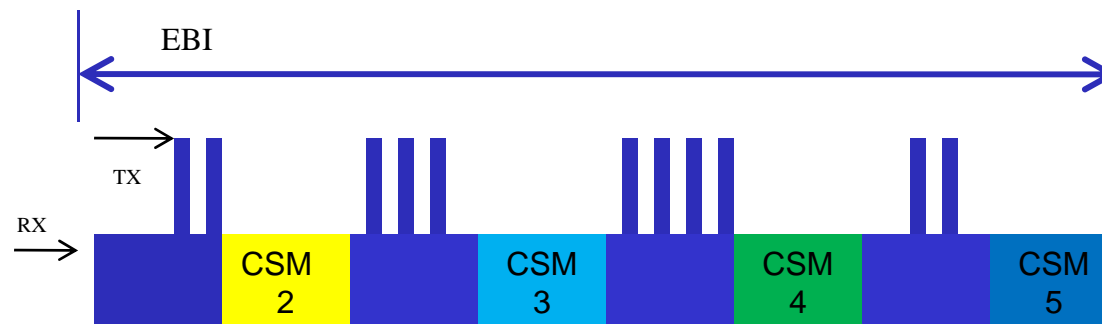
$$\text{Max Converge Time} = \text{EBI Duration} * N^2 \text{ Attempts} = 0.64S * 64 = 40.96 S$$



## Co-Existence Priority

50 % EBR Monitor (4 of 8 slots)

$$\text{Max Converge Time} = (\text{EBI Duration} * N^2 \text{ Attempts}) / 4 = 0.64S * 64 / 4 = 10.24 S$$





## Predefined Attributes Necessary for Optimal CSM Performance

- Number of CSM channels = Floor (Valid channels / 16)
- Ch #` =  $X(\text{floor}(((\text{Max Valid Channel} - 1) - (\text{Min Valid Channel} + 1) / N))$
- EBI duration =  $(\text{EBR duration} + \text{Delay})^2$
- EBR consist of 512 bits
- EBR transmitted at 50kbps
- Settling Delay is 1.28 uS

# ?Questions ?



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