

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

Submission Title: [MPM Comment Resolution]

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Abstract: [Overview of comments related to MPM in general and the additional issues with MPM for frequency bands where the CSM requires the use of frequency hopping spreading]

Purpose: [Discuss MPM issues for all frequency bands with a focus on regions where the common signaling mode (CSM) requires frequency hopping communications. Resolutions to comments related to these issues are proposed in this document]

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Comment Resolution

- Resolutions to the following TG4g D2 comments are proposed in this presentation:

106, 107

- Comment 973 is related to this topic and the resolution to this comment is still a work in progress

Multi PHY Management (MPM)

- The MPM scheme is to be used for communications between coordinators to facilitate co-existence
 - If MPM is mandatory, potential coordinators are required to attempt communications with other coordinators prior to starting a new network
- Multi-PHY management (MPM) uses the defined common signaling mode (CSM) for each frequency band
- In many regions, the CSM requires the use of frequency hopping

MPM Communications

- There are two options for coordinators to communicate for MPM purposes:
 - The “new” coordinator sends Enhanced Beacon Requests (EBRs) to solicit an EB from an existing coordinator. If an EB is not received within a defined time period, the new coordinator determines that another network is not present.
 - The coordinator(s) in the existing network periodically send an Enhanced Beacon (EB). The “new” coordinators wait for receipt of an EB or time out and determine that another network is not present.

MPM Communication Option #1 - EBR

- Use of EBR:
 - Problematic in that the existing coordinator is not likely to be using the CSM for normal network communications
 - The existing coordinator would have to periodically listen for the EBR, but there is no synchronization between the listening time of the existing coordinator and the time of transmission from the new potential coordinator
 - For frequency bands where the CSM requires the use of frequency hopping, one must also account for the fact that communications could occur on a large number of channels. The MPM scheme must account for the coordination (or lack thereof) between the receiver's channel and the channel selected for transmission of the EBR.

MPM Option #1 – EBR (continued)

- Using the 915 MHz band as an example:

Device Transmitting EBR

- Could transmit on 128 different channels

Device Targeted to Receive EBR:

- Could receive on 128 different channels

- Since the CSM is likely different from the normal communication mode, coordinating the listen time (listen in CSM) with the transmission time of the EBR is challenging at best
- The problem is much worse when frequency hopping is required (1/128 chance of both devices using the same channel)
- **Conclusion – EBR cannot be used for reliable MPM coordination**

MPM Communication Option #2 – Wait for EB

- The “new” coordinator must wait for a period of time for the EB before determining that another network is not present:
 - The coordinator(s) in the existing network would periodically transmit the EB.
 - The list of channels used for transmission of the EB must be defined. If a specific definition is not provided, one must assume that all available channels **must** be used, and the existing network must periodically transmit an EB on each channel.
 - The receiving coordinator would pick one channel at a time on which to listen for the EB. The minimum required listen time must be defined and would be based on the existing coordinator’s period between EB transmissions on each channel.

MPM Option #2 – Wait for EB (continued)

- Using the 915 MHz band as an example:

Device Transmitting EB

- Must transmit on 128 different channels
- A definition of the time between transmissions on given channel must be provided.

Device Waiting to Receive EB:

- Would select one of 128 channels on which to wait for the EB
- The definition of the time between transmissions on a given channel determines the minimum time the device must wait on a specific channel for the EB.

MPM Option #2 – Wait for EB (continued)

- 915 MHz band, example #1:

Device Transmitting EB:

- 128 channels
- Per FCC rules, the max possible transmit time on a given channel in a 20-second window is 400 msec
- Assume a CSM EB occurs once every 400 msec and the transmissions cycle through the channel list
- A CSM EB on a given channel occurs every $128 * 0.4 = 51.2$ seconds

Device Waiting to Receive EB:

- Would select one of 128 channels on which to wait for the EB
- Must wait at least 51.2 seconds on this channel for receipt of the EB
- Ideally would check more than one channel before determining that another network is not present

MPM Communication Option #2 – Wait for EB

- The wait time shown in the previous example (51.2 seconds) is only an example. A shorter or longer time could be used.
- As the time is shortened, the burden of MPM, i.e. the percentage of the network communication time dedicated to MPM, increases.
- The key point is not the actual time, but the need for a definition of the time.
 - Without a consistent definition, two devices cannot ensure they complete the MPM requirements
- The times may be specific to each frequency band (times would logically be determined based on the number of channels in the band).

Related Comments

- CID #106:

Communication parameters to be used to transmit the coex beacon (or enhanced beacon) must be properly defined to allow devices to communicate. When the PHY mode used for CSM requires frequency hopping, parameters must be defined for how long a device must wait to hear a beacon before it can assume that another network is not operating in the band

Commenter's Proposed Resolution:

For each frequency band, a list of channels to be used and the hopping dwell times must be established. This allows the device waiting to hear a beacon to determine the time required to wait on a specific channel before it can assume that a network is not operating in the same POS. Reducing the number of channels used for CSM (without reducing the number of channels used for other network activities) reduces the overhead "hit" to the real network.

- Comment spreadsheet currently shows this as “Resolve as in CID 144” but the resolution for CID 144 does not completely resolve this comment

Related Comments

- CID #107:

CSM requires a coex beacon to be sent at a very frequent interval and also requires a device receiving the CSM message to be listening when the message is transmitted. It is not clear how timing information is coordinated to ensure that the transmitting and receiving devices are synchronized such that they can communicate on a given channel at a given time.

Commenter's Proposed Resolution:

Define rules by which devices can synchronize communication parameters such that they can communicate using CSM. To minimize the impact on an operating network, this is likely to require a passive scan, where the existing network is required to send the beacon in CSM at regular intervals and the receiving device is required to wait for a defined period of time on a given channel before assuming that another network does not exist

- Comment spreadsheet currently shows this as “Resolve as in CID 144” but the resolution for CID 144 does not completely resolve this comment

Proposed Resolutions to MPM Comments

- CID #106, 107:
Proposed Resolution:
Accept in Principle

Using document 10/954r3 as the starting point, make the following modifications:

1. In the first sentence (line 1) on page 121, change the word “should” to “shall”
2. In Table 103, change the valid range of ScanDurationNBPAN to 0-262143
In Table 108, change the valid range of NBPANEnhancedBeaconOrder to 0-262144 and change the description to indicate a value of 262144 indicates that no EB will be transmitted.
In Table 127, change the valid range of macNBPANEnhancedBeaconOrder to 0-262144 and change the description to indicate a value of 262144 indicates that no EB will be transmitted.

Proposed Resolutions to MPM Comments

- CID #106, 107:
Proposed Resolution (continued):

Using document 10/954r3 as the starting point, make the following modifications:

3. Add the following text after the paragraph that ends on line 3 of page 121:
"In a frequency hopping PAN, an existing coordinator shall transmit an EB in CSM at least once on every available channel every EB transmission interval. The channels on which the EB must be transmitted are all those which are defined for the CSM. The existing coordinator shall also transmit an EB upon receiving an EBR. Any intending coordinator shall listen on at least two different channels, each for the duration of $EBI_{NB PAN}$, or until an EB is detected, whichever occurs first. An intending coordinator should satisfy the above timing description before it can assume that the failure to receive an EB indicates that another network is not present. To facilitate the MPM scheme, the maximum values for $EBI_{NB PAN}$ are specified in Annex xx for each frequency band."

Proposed Resolutions to MPM Comments

- CID #106, 107:

Proposed Resolution (continued):

Using document 10/954r3 as the starting point, make the following modifications:

4. Add Annex xx (normative) – MPM Timing Requirements (where xx is assigned by the editors. Annex xx contains the following:

The MPM scheme shall be supported by SUN devices acting as a coordinator. To facilitate the MPM scheme, the time interval between transmission of Enhanced Beacons (EBs) is specified, and these timing specifications shall be used by the existing coordinators and potential coordinators to ensure the two devices communicate prior to the potential coordinator determining it is safe to start a new network.

Frequency Band (MHz)	Num Channels Used for MPM	Maximum Value of $E_{BI_{NB PAN}}$ (symbols)	Maximum Value of $E_{BI_{NB PAN}}$ (seconds)
470-510	1	834	1
863-870	1	834	1
902-928* (option 1)	128	42667	51.2
902-928* (option 2)	64	21334	25.6
950-958	1	834	1
2400* (option 1)	392	130667	156.8
2400* (option 2)	196	65334	78.4

Only one definition per frequency band will be listed, and the entries are dependent on the resolution to CID 973.

* In these bands, the CSM requires the use of frequency hopping spreading

Related Comments

- Comments have been submitted proposing ways to minimize the burden of MPM while still supporting the MPM scheme
 - CID #973:
CSM using all channels is inefficient and will decrease EB and EBR probability of success and will increase discovery and join times.

Commenter's Proposed Resolution:

Use a subset of the available channels for better CSM efficiency

- A reduction in the number of channels used for MPM would not change the intent of MPM, but would either reduce the timeout period (time a device must wait to receive an EB) or reduce the “burden” of MPM on normal network communications
- The subset of channels would only apply to MPM communications and do not apply to all other network communications