

IEEE P802.15
Wireless Personal Area Networks

Project	IEEE P802.15 Working Group for Wireless Personal Area Networks (WPANs)		
Title	<IEEE802.15.4e Coexistence Assurance Document>		
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Source	[Pat Kinney] [<Kinney Consulting LLC> [Chicago, IL]	Voice: [+1.847.960.3715] Fax: [+1.630.524.9054] E-mail: [pat.kinney@ieee.org]	
Re:	[802.15 Interim Meeting in Waikoloa, HI]		
Abstract	[IEEE 802.15 TG4e Coexistence Assurance Document]		
Purpose	[Fulfillment of Coexistence Assurance Document Commitment to 802.19]		
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Background

Excerpts from 802.15.4e PAR

Title: IEEE Standard for Information Technology - Telecommunications and Information Exchange Between Systems – Local and Metropolitan Area Networks - Specific Requirements - Part 15.4: Wireless Medium Access Control (MAC) and Physical Layer (PHY) Specifications for Low Rate Wireless Personal Area Networks (WPANs) - Amendment: Amendment to the MAC sub-layer

5.2 Scope: The intention of this amendment is to enhance and add functionality to the 802.15.4-2006 MAC to a) better support the industrial markets and b) permit compatibility with modifications being proposed within the Chinese WPAN.

Specifically, the MAC enhancements are limited to:

- i. TDMA: to provide a) determinism, b) enhanced utilization of bandwidth
- ii. Channel Hopping: to provide additional robustness in high interfering environments and enhance coexistence with other wireless networks
- iii. GTS: to increase its flexibility such as a) supporting peer to peer, b) the length of the slot, and c) number of slots
- iv. CSMA: to improve throughput and reduce energy consumption
- v. Security: to add support for additional options such as asymmetrical keys
- vi. Low latency: to reduce end to end delivery time such as needed for control applications

5.4 Purpose: This functionality facilitates Industrial applications (such as addressed by HART 7 and the ISA100 proposed standards), and those enhancements defined by the proposed Chinese WPAN standard that aren't included in TG4c. This amendment addresses coexistence with wireless protocols such as 802.11, 802.15.1, 802.15.3, and 802.15.4.

5.5 Need for the Project: Industrial applications have requirements that are not addressed by the existing standard such as low latency, robustness in the harsh industrial RF environment, and determinism. The Chinese Wireless Personal Area Network standard has identified enhancements to improve network reliability and increase network throughput to support higher duty-cycle data communication applications.

Excerpt from 802.15.4e “5 Criteria” document (15-07-861-00)

“A coexistence assurance document will be submitted to the 802.19 TAG.”

TG4e Overview

Task Group 4e is drafting a proposed amendment to the 802.15.4-2006 standard to enhance MAC behavior to benefit Industrial wireless applications, Chinese WPAN applications, and also to assist the PHY amendment efforts of TG4f (RFID) and TG4g (SUN).

The TG4e efforts have been categorized into the following groups: Distributed Synchronous Multichannel Extension (DSME), Time Slotted Channel Hopping (TSCH), Low Latency (LL), Enhanced Security/Overhead Reduction (ESOR), Low Energy (LE), TG4f (4f), TG4g (4g), Enhanced Beacon Request (EBR), Fast Association (FastA), and additional device metrics (Metrics).

Impact on Coexistence by MAC group

A. Distributed Synchronous Multichannel Extension (DSME)

- This effort enhances the MAC's beacon mode to better serve applications such as the Chinese WPAN and other networks needing a periodic network beacon. These enhancements include:
 - Adding adaptive channel agility and channel hopping to enhance reliability in interference limited environments
 - Traffic per channel is reduced
 - Adaptive channel agility allow for occupied channels to be "black-listed"
 - Channel hopping can complicate fixed channel networks seeking out "clear" channels
 - Adding coordination between devices to reduce self interference
 - Above enhancements could achieve higher traffic without performance degradation of non-802.15.4 services

B. Time Scheduled Channel Hopping (TSCH):

- This effort enhances the MAC's non-beacon mode to better serve Industrial wireless process-control applications such as Wireless HART and ISA100.11a networks that provide time scheduled slots for each device along with frequency hopping and channel management. These enhancements include:
 - changes CSMA back-off to a slotted mechanism resulting in longer back-offs
 - Adds adaptive channel hopping to enhance reliability in interference

limited environments

- Traffic per channel is reduced
- Adaptive channel agility allow for occupied channels to be “black-listed”
- Channel hopping can complicate fixed channel networks seeking out “clear” channels
- Enables device coordination to reduce self interference
- Above enhancements could achieve higher traffic without performance degradation of non-802.15.4 services

C. Low Latency

- This effort enhances the MAC’s beacon mode to better serve wireless factory automation applications requiring high determinism and low latency for transmission e.g. sensor data in ≤ 10 ms for 15 devices. These enhancements include:
 - New frame format with reduced overhead to reduce transmit durations

D. Low Energy

- This effort enhances the MAC by adding a Coordinated Sampled Listening (CSL) and Receiver Initiated Transmission (RIT) to MAC with the following advantages:
 - Low-power operation for entire network lifecycle for both FFD and RFD that does not require central control
 - Always-on illusion, IP-friendly
 - Responsive to asynchronous, unscheduled events
- CSL and RIT allow low duty cycle devices to access the network with reduced energy usage
- RIT uses std 802.15.4 CSMA for low duty cycle transmissions
- CSL provides a quick succession of transmit frames (check with Wei Hong as to std 802.15.4 behavior)

E. Overhead Reduction

- Although 802.15.4 was intended to provide a low overhead MAC, the effort in this group is to reduce overhead to allow applications that are dependent upon very low overhead.

- Effect of this effort is reduced transmit durations

F. Enhanced Security

- New, optional secured acknowledgement is longer than non-secured acknowledgement but allows networks to reduce false acknowledgements

G. Fast Association

- The original 802.15.4 association operation included a minimal fixed time for association; this effort removes that fixed time along with the energy expended during that fixed time.
 - Reduced transmit time during an association

H. Added Metrics

- The original 802.15.4 standard included very minimal metrics for reporting channel access performance, this effort adds additional metrics to allow a network management function to better facilitate network performance
 - Enables higher layers to fragment MSDUs according to channel conditions and reduce retries

Conclusion

The 802.15.4e task group believes that the proposed changes will reduce the assailant footprint and improve a device's tolerance to interference