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Information technology — Specification of low power wireless mesh network over channel-hopped TDMA links

Technologies de l'information — Spécification des réseaux maillés sans fil à faible puissance par liens AMRT à saut de canaux

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Foreword

ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) form the specialized system for worldwide standardization. National bodies that are members of ISO or IEC participate in the development of International Standards through technical committees established by the respective organization to deal with particular fields of technical activity. ISO and IEC technical committees collaborate in fields of mutual interest. Other international organizations, governmental and non-governmental, in liaison with ISO and IEC, also take part in the work. In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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The committee responsible for this document is ISO/IEC JTC 1, *Information technology*, SC 6, *Telecommunications and information exchange between systems*.

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Introduction

This working draft defines the protocol for the low-power wireless mesh network over channel-hopped TDMA links (LPWMN). The objective of LPWMN is to define a wireless mesh network specification, which is relatively lightweight compared to the legacy WPAN network specifications and can maximize usefulness of the channel-hopped TDMA link which is followed by the deterministic and synchronous multichannel extension (DSME) MAC specified in IEEE 802.15.4e-2012 amendment.

In recent years, there is market demand for applying the low-energy short range communication of the WSN to the networks for mission-critical services or real-time services including remote monitoring and alarming of health devices or medicine equipment, sensing and actuation control of process automation, and voice service over the low-energy short range networks. To provide more reliable link and deterministic delay for the mission-critical services, enhancements of the IEEE 802.15.4-2006 MAC specification was started in March 2008 and the draft of the amendment is approved in February 2012. In the IEEE 802.15.4e-2012 amendment, three types of TDMA and two types of channel diversity function are added as optional MAC features.

These new MAC features introduce two attributes to be managed in the network layer, which includes time slots and radio channels. To employ the new enhanced MAC for the reliable and real-time services in the low-cost, low-power, short-range communication network, the network protocol needs to be designed for managing the network resources including time slots and radio channels. The LPWMN is a network specification over the DSME of IEEE 802.15.4e-2012 amendment. The LPWMN is applicable to industrial applications that require a loss sensitive large wireless network guaranteeing deterministic end-to-end delay with low-power resource-constrained communication nodes.

The International Organization for Standardization (ISO) and International Electrotechnical Commission (IEC) draw attention to the fact that it is claimed that compliance with this document may involve the use of a patent concerning the functional procedure and message structure of LPWMN given in Clauses 5, 6, 7, and 8, and a patent concerning the authentication and key establishment protocols given in Annex B.

ISO and IEC take no position concerning the evidence, validity, and scope of this patent right.

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Information technology — Specification of low power wireless mesh network over channel-hopped TDMA links

1 Scope

This International Standard defines the network specification for devices, which are operated on IEEE Std. 802.15.4-2011 PHY, capable to support the channel-hopped TDMA links of the DSME MAC of IEEE Std. 802.15.4e-2012, to provide low-cost communication network that allows reliable, deterministic-latency, and scalable wireless mesh connectivity.

This International Standard provides the following:

— DSME MAC link control;

— unbalanced cluster-tree based network formation;

— directional multiple grades mesh connection;

— link-path routing and data forwarding;

— link and link-path maintenance.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEEE Std 802.15.4-2011, *IEEE Standard for Local and metropolitan area networks—Part 15.4: Low-Rate Wireless Personal Area Networks (LR-WPANs)*

IEEE Std 802.15.4e-2012, *IEEE Standard for Local and metropolitan area networks—Part 15.4: Low-Rate Wireless Personal Area Networks (LR-WPANs), Amendment 1: MAC sublayer*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
coordinator
device in a low-rate wireless personal area network (LR WPAN) that provides synchronization services to other devices in the LR WPAN

3.2
device
any entity containing an implementation of the IEEE 802.15.4e-2012 DSME medium access control and physical interface to the wireless medium

Note 1 to entry: A device may be a reduced-function device or a full-function device.

3.3
frame
format of aggregated bits from a medium access control sublayer entity that are transmitted together in time

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3.4
full-function device
FFD
device capable of operating as a coordinator

3.5
personal area network (PAN) coordinator
coordinator that is the principal controller of a PAN

Note 1 to entry: An IEEE 802.15.4 network has exactly one PAN coordinator.

3.6
reduced-function device
RFD
device that is not capable of operating as a coordinator

4 Abbreviations

The following acronyms are used in this document.

AKEP	Authentication and Key Establishment Protocols
CSMA-CA	Carrier Sense Multiple Access – Collision Avoidance
DLCE	DSME MAC Link Control sublayer Entity
DLIB	DSME MAC Link network Information Base
DLNE	DSME MAC Link Network sublayer Entity
DLPDU	DSME MAC Link network sublayer Protocol Data Unit
DLSDU	DSME MAC Link network sublayer Service Data Unit
DSME	Deterministic and Synchronous Multi-channel Extension
FFD	Full Function Device
GTS	Guaranteed Time Slot
ID	Identification
IDAP	ID-based Authentication Protocol
IEEE	Institute of Electrical and Electronics Engineers
LPWMN	Low-Power Wireless Mesh Network
LSAP	Light-weight Shared-key Authentication Protocol
MAC	Media Access Control
MCPS	MAC Common Part Sublayer
MIB	MAC Information Base
MLME	MAC Layer Management Entity
MSDU	MAC Service Data Unit
PAN	Personal Area Network

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