

# INTERNATIONAL STANDARD



Information technology – Wireless beacon-enabled energy efficient mesh network (WiBEEEM) for wireless home network services – Part 1: PHY layer

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# INFORMATION TECHNOLOGY – WIRELESS BEACON-ENABLED ENERGY EFFICIENT MESH NETWORK (WIBEEM) FOR WIRELESS HOME NETWORK SERVICES –

## Part 1: PHY layer

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International Standard ISO/IEC 29145-1 was prepared by subcommittee 25: Interconnection of information technology equipment, of ISO/IEC joint technical committee 1: Information technology.

The list of all currently available parts of the ISO/IEC 29145 series, under the general title *Information technology – Wireless beacon-enabled energy efficient mesh network (WiBEEM) for wireless home network services*, can be found on the IEC web site.

This International Standard has been approved by vote of the member bodies, and the voting results may be obtained from the address given on the second title page.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

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## INTRODUCTION

This International Standard specifies the WiBEEM (Wireless Beacon-enabled Energy Efficient Mesh network) protocol, which provides low-power-consuming mesh network functions by enabling the “beacon mode operation”. WiBEEM is based on the IEEE 802.15.4 standard with additional upper layer protocols and a specific usage of the MAC layer protocol. Through the novel use of beacons, WiBEEM technology achieves longer battery life, larger network support, quicker response, enhanced mobility and dynamic reconfiguration of the network topology compared with other protocols such as ZigBee.

In the beacon mode, beacon information propagates over the entire mesh network nodes during the BOP (Beacon-Only Period) of the superframe structure without any beacon conflicts by utilising a smart beacon scheduling technique in the BOP. It also provides location information about moving devices without spending extra time running a positioning and locating algorithm by using RSSI (Received Signal Strength Indication). These features allow the WiBEEM protocol to be widely used for wireless home network services in the ubiquitous network era.

One of the key features of the WiBEEM protocol is that it has a special time interval called BOP (Beacon-Only Period) in the superframe structure that allows more than two beacons to be transmitted. This unique time period is located at the beginning of the Superframe. Because the BOP does not use the CSMA/CA mechanism, the network will not work properly in the beacon mode unless an appropriate algorithm is applied. This algorithm needs to manage and control multiple beacons in a single superframe. The solution is the Beacon Scheduling method applied in the BOP to avoid collisions among beacons, providing synchronisation among all the nodes of the entire mesh network.

For the network layer, the NAA (Next Address Available) mechanism, which is a short address allocation algorithm, has been adopted to provide an efficient way of utilising the complete 16-bit address space. The NAA algorithm does not limit the maximum number of children nodes that a node of a mesh network can have. Since the number of children nodes is unlimited, the NAA mechanism allows the WiBEEM protocol to be used not only for home network services, but also for community services. WiBEEM can be used where high network expandability through efficient use of short address spaces, device mobility and end-to-end QoS are required.

This part of ISO/IEC 29145 specifies the Physical (PHY) layer for the WiBEEM protocol.

# INFORMATION TECHNOLOGY – WIRELESS BEACON-ENABLED ENERGY EFFICIENT MESH NETWORK (WiBEEM) FOR WIRELESS HOME NETWORK SERVICES –

## Part 1: PHY layer

### 1 Scope

This part of ISO/IEC 29145 specifies the physical (PHY) layer of WiBEEM (Wireless Beacon-enabled Energy Efficient Mesh network) protocol for wireless home network services that supports a low power-consuming wireless mesh network topology as well as device mobility and QoS.

### 2 Normative reference

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.

ISO/IEC 29145-2, *Information technology – Wireless beacon-enabled energy efficient mesh network (WiBEEM) for wireless home network services – Part 2: MAC layer*

### 3 Terms, definitions and abbreviations

#### 3.1 Terms and definitions

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

##### 3.1.1

##### **access control list**

table used by a device to determine which devices are authorised to perform a specific function

##### 3.1.2

##### **association**

service used to establish the membership of a device in a wireless mesh network

##### 3.1.3

##### **authentication**

service used to establish the identity of one device as a member of the set of devices authorised to communicate securely to other devices in the set

##### 3.1.4

##### **confidentiality**

assurance that communicated data remain private to the parties for whom the data are intended

##### 3.1.5

##### **co-ordinator**

wireless device configured to provide synchronisation services through the transmission of beacons

Note 1 to entry: If a co-ordinator is the principal controller of a wireless mesh network, it is called the WMC (WiBEEM Mesh Co-ordinator).

### 3.1.6

#### **data integrity**

assurance that the data have not been modified from their original form

### 3.1.7

#### **device**

entity containing an implementation of the WiBEEM applications, NWK, MAC and physical interface to the wireless medium

### 3.1.8

#### **frame**

data format of aggregated bits from a medium access control (MAC) layer entity transmitted in a specified sequence

### 3.1.9

#### **packet**

format of aggregated bits transmitted in a specified sequence across the physical medium

### 3.1.10

#### **personal operating space**

space of typically about 10 m around a person or object, no matter whether this person or object is stationary or in motion

### 3.1.11

#### **portable device**

device that may be moved from location to location, but uses network communications only while at a fixed location

### 3.1.12

#### **protocol data unit**

unit of data exchanged between two peer entities

### 3.1.13

#### **pseudo-random number generation**

process of generating a deterministic sequence of bits from a given seed that has the statistical properties of a random sequence of bits when the seed is not known

### 3.1.14

#### **service data unit**

information delivered as a unit through a service access point (SAP)

### 3.1.15

#### **WiBEEM end device**

WiBEEM device acting as the leaf device of a mesh network

### 3.1.16

#### **WiBEEM mesh co-ordinator**

WiBEEM device acting as the principal controller of a mesh network

Note 1 to entry: A WiBEEM mesh network has exactly one WiBEEM mesh co-ordinator.

### 3.1.17

#### **WiBEEM routable co-ordinator**

WiBEEM device acting as the router of a mesh network

**3.1.18****wireless medium**

medium used to implement the transfer of protocol data units (PDUs) between peer physical layer (PHY) entities of a low-rate wireless mesh network

**3.2 Abbreviations**

The following acronyms and abbreviations are used in this standard. They are commonly used in other industry publications.

AES	Advanced Encryption Standard
BO	Beacon Order
BOP	Beacon Only Period
BOPL	Beacon Only Period Length
BPSK	Binary Phase-Shift Keying
CAP	Contention Access Period
CBC-MAC	Cipher Block Chaining Message Authentication Code
CCA	Clear Channel Assessment
CSMA-CA	Carrier Sense Multiple Access With Collision Avoidance
DSP	Deep Sleep Period
ED	Energy Detection
EIRP	Effective Isotropic Radiated Power
EVM	Error-Vector Magnitude
ID	Identifier
IFS	Interframe Space or Spacing
LLC	Logical Link Control
LQ	Link Quality
LQI	Link Quality Indication
LPDU	LLC Protocol Data Unit
LR-WPAN	Low-Rate Wireless Personal Area Network
LSB	Least Significant Bit
MAC	Medium Access Control
MIB	MAC Information Base
MLME	MAC Layer Management Entity
MLME-SAP	MAC Layer Management Entity-Service Access Point
MPDU	MAC Protocol Data Unit
MSB	Most Significant Bit
MSC	Message Sequence Chart
MSDU	MAC Service Data Unit
NAA	Next Address Available
NB	Number Of Backoff (periods)
O-QPSK	Offset Quadrature Phase-Shift Keying
PD-SAP	PHY Data Service Access Point
PDU	Protocol Data Unit
PER	Packet Error Rate
PHR	PHY Header

PHY	Physical Layer
PIB	PAN Information Base
PICS	Protocol Implementation Conformance Statement
PLME	Physical Layer Management Entity
PLME-SAP	Physical Layer Management Entity-Service Access Point
PN	Pseudo-Random Noise
POS	Personal Operating Space
PPDU	PHY Protocol Data Unit
PQP	Prioritised QoS Period
PSD	Power Spectral Density
PSDU	PHY Service Data Unit
QoS	Quality of Service
RF	Radio Frequency
RSSI	Received Signal Strength Indication
RX	Receive or Receiver
SAP	Service Access Point
SDL	Specification and Description Language
SDU	Service Data Unit
SFD	Start-of-Frame Delimiter
SHR	Synchronisation Header
TRX	Transceiver
TX	Transmit or Transmitter
WED	WiBEEM End Device
WiBEEM	Wireless Beacon-enabled Energy Efficient Mesh network
WLAN	Wireless Local Area Network
WM	Wireless Medium
WMC	WiBEEM Mesh Co-ordinator
WRC	WiBEEM Routable Co-ordinator

### 3.3 Conventions

All the italicised words used in this standard shall implement all the primitives that are specified in Clause 6 and represent relevant constants defined and stored in the MIB (Management Information Base) of each layer.

## 4 Conformance

A wireless device that claims conformance to this standard shall meet all the requirements specified in 6.2, and shall implement all the primitives specified in 6.3, the PPDU formats in 6.4, the PHY Constants and the PIB attributes in 6.5, the PHY specifications in 6.6 and the general radio specifications in 6.7. Each WiBEEM device shall be able to act as a WMC, a WRC or a WED. When operating in the role of a WMC, it shall act as specified in 5.3.2, when operating in the role of a WRC, it shall act as specified in 5.3.3, and when operating in the role of a WED, it shall act as specified in 5.3.3.