

# INTERNATIONAL STANDARD

Information technology – Wireless beacon-enabled energy efficient mesh network (WiBEEEM) for wireless home network services – Part 3: NWK layer

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

## Part 3: NWK layer

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International Standard ISO/IEC 29145-3 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.

## 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 network layer (NWK) of the WiBEEM protocol for wireless home network services that support a low-power-consuming wireless mesh network as well as device mobility and QoS.

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

## Part 3: NWK layer

### 1 Scope

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

### 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.

ISO/IEC 29145-1:2014, *Information technology – Wireless beacon-enabled energy efficient mesh network (WiBEEM) for wireless home network services – Part 1: PHY 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

##### **association**

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

##### 3.1.2

##### **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).

##### 3.1.3

##### **device**

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

##### 3.1.4

##### **frame**

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



**3.1.5****packet**

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

**3.1.6****personal operating space**

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

**3.1.7****protocol data unit**

unit of data exchanged between two peer entities

**3.1.8****WiBEEM end device**

WiBEEM device acting as the leaf device of a mesh network

**3.1.9****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.

**3.1.10****WiBEEM routable co-ordinator**

WiBEEM device acting as the router of a mesh network

**3.1.11****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 and commonly used in other industry publications.

AES	Advanced Encryption Standard
ARQ	Automatic Request-Response
BO	Beacon Order
BOP	Beacon Only Period
BTTSL	Beacon Transmit Time Slot Length
CAP	Contention Access Period
ID	Identifier
MIB	Management Information Base
NAA	Next Address Available
PDU	Protocol Data Unit
PQP	Prioritised QoS Period
QoS	Quality of Service
RAP	Reservation-Based Access Period
WED	WiBEEM End Device
WiBEEM	Wireless Beacon-enabled Energy Efficient Mesh network
WMC	WiBEEM Mesh Co-ordinator

WRC      WiBEEM Routable Co-ordinator

### 3.3 Conventions

All the italicised words used in this standard represent relevant constants defined and stored in the MIB (management information base) of each layer.

## 4 Conformance

A WiBEEM device that claims conformance to this part of ISO/IEC 29145 shall implement all the primitives that are specified in 6.2. Each WiBEEM device shall be able to act as a WMC, a WRC and a WED. When operating in the role of a WMC it shall act as specified in 5.3.2 of ISO/IEC 29145-1:2014, when operating in the role of a WRC, it shall act as specified in 5.3.3 of ISO/IEC 29145-1:2014, and when operating in the role of a WED, it shall act as specified in 5.3.3 of ISO/IEC 29145-1.

## 5 Overview of the WiBEEM technology

Clause 5 of ISO/IEC 29145-1:2014 presents an overview of the WiBEEM technology and the functionalities of the WiBEEM devices.

## 6 NWK layer specifications

### 6.1 General

This clause specifies the NWK layer of this standard. The NWK layer handles network management, message broker and routing. This clause specifies the services that shall be provided by the WiBEEM NWK layer.

Constants and attributes that are specified and maintained by the MAC layer are written in the text of this clause in italics. Constants have a general prefix of “a”. Attributes have a general prefix of “mac”.

### 6.2 NWK layer service specifications

#### 6.2.1 Overview

The NWK layer services provide an interface between the NWK layer and the APP layer. The NWK layer provides two services, accessed through two SAPs:

- MAC data service, accessed through the NWK layer data SAP (NLDE-SAP); and
- NWK management service, accessed through the NLME-SAP.

Figure 1 depicts the elements and interfaces of NWK layer.

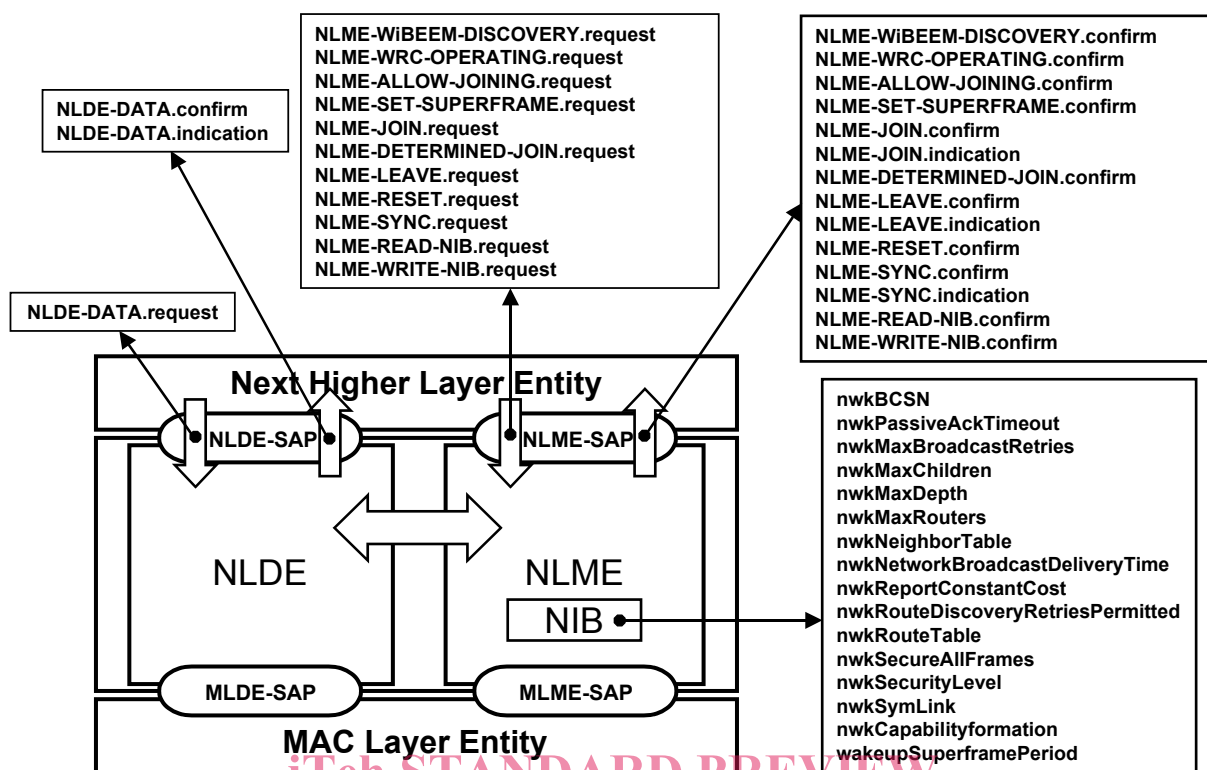


Figure 1 – NWK layer structure

6.2.2 NWK data service

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6.2.2.1 Overview

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The NWK layer data entity SAP (NLDE-SAP) supports the transport of application protocol data units (APDUs) between peer application entities.

6.2.2.2 NLDE-DATA.request

6.2.2.2.1 Function

This primitive requests the transfer of a data PDU (NSDU) from the local Application layer entity to a single or multiple peer application layer entities.

6.2.2.2.2 Semantics of the service primitive

The semantics of this primitive is as follows:

- DE-DATA.request (
  - DstAddr,
  - NsduLength,
  - Nsdu,
  - NsduHandle,
  - BroadcastRadius,
  - DiscoverRoute,
  - SecurityEnable
 )

Table 1 specifies the parameters for the NLDE-DATA.request primitive.

**Table 1 – NLDE-DATA.request parameters**

Name	Type	Valid range	Description
DstAddr	Device address	Specified by the DstAddr	The network address of the entity or entities to which the NSDU is being transferred.
NsduLength	integer	≤nwkcMaxPayloadSize	The number of octets comprising the NSDU to be transferred.
Nsdu	Set Of Octets	-	The set of octets comprising the NSDU to be transferred.
NsduHandle	integer	0x00 to 0xff	The handle associated with the NSDU to be transmitted by the NWK layer entity.
BroadcastRadius	integer	0x00 to 0xff	The distance, in hops, that a broadcast frame will be allowed to travel through the network.
DiscoverRoute	Boolean	TRUE or FALSE	The DiscoverRoute parameter may be used to enable route discovery operations for the transit of this frame. TRUE = enable route discovery FALSE = disable route discovery
Security enable	Boolean	TRUE or FALSE	The SecurityEnable parameter may be used to enable NWK layer security processing for the current frame.

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**6.2.2.2.3 When generated**

This primitive is generated by a local APS sublayer entity whenever a data PDU (NSDU) is to be transferred to a peer APS sublayer entity.

**6.2.2.2.4 Effect on receipt**

On receipt of this primitive on a device that is not currently associated, the NWK layer will issue an NLDE-DATA.confirm primitive with a status of INVALID\_REQUEST.

On receipt of this primitive, the NLDE first constructs an NPDU in order to transmit the supplied NSDU.

If, during processing, the NLDE issues the NLDE-DATA.confirm primitive prior to transmission of the NSDU, all further processing is aborted.

**6.2.2.3 NLDE-DATA.confirm**

**6.2.2.3.1 Function**

This primitive reports the results of a request to transfer a data PDU (NSDU) from a local APS sublayer entity to a single peer APS sublayer entity.

**6.2.2.3.2 Semantics of the service primitive**

The semantics of this primitive is as follows:

```
NLDE-DATA.confirm (
    NsduHandle,
    Status
)
```

Table 2 specifies the parameters for the NLDE-DATA.confirm primitive.