SVENSK STANDARD
SS-EN 14908-1:2014

Fastställd/Approved: 2014-05-07
Publicerad/Published: 2014-05-09
Utgåva/Edition: 2
Språk/Language: engelska/English
ICS: 35.240.99; 91.140.01; 97.120

Öppen datakommunikation för byggnadsautomation, styrning och teknisk byggnadsdrift – Protokoll styr- och reglernätverk – Del 1: Protokoll stack

Open Data Communication in Building Automation, Controls and Building Management – Control Network Protocol – Part 1: Protocol Stack

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Denna standard ersätter SS-EN 14908-1:2005, utgåva 1.

The European Standard EN 14908-1:2014 has the status of a Swedish Standard. This document contains the official version of EN 14908-1:2014.

This standard supersedes the Swedish Standard SS-EN 14908-1:2005, edition 1.

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EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 14908-1

April 2014

ICS 35.240.99; 91.140.01; 97.120

Supersedes EN 14908-1:2005

English Version

Open Data Communication in Building Automation, Controls and Building Management - Control Network Protocol - Part 1: Protocol Stack

Réseau ouvert de communication de données pour l'automatisation, la régulation et la gestion technique du bâtiment - Protocole de contrôle du réseau - Partie 1: Niveaux du protocole

Offene Datenkommunikation für die Gebäudeautomation und Gebäudemanagement - Gebäude-Netzwerk-Protokoll - Teil 1: Datenprotokollschichtenmodell

This European Standard was approved by CEN on 12 April 2013.

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This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
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EUROPÄISCHES KOMITEE FÜR NORMUNG

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Ref. No. EN 14908-1:2014 E

Contents

Foreword

This document (EN 14908-1:2014) has been prepared by Technical Committee CEN/TC 247 “Building Automation, Controls and Building Management”, the secretariat of which is held by SNV.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by October 2014 and conflicting national standards shall be withdrawn at the latest by October 2014.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

This document supersedes EN 14908-1:2005.

This European Standard is part of a series of standards for open data transmission in building automation, control and in building management systems. The content of this European Standard covers the data communications used for management, automation/control and field functions.

The following is a list of technical changes since the previous edition:

— EN 14908-5 has been added to the normative references;

— the normative Annex A has been re-worked for a better understanding. The reference implementation of the standard shows in detail which part is normative and hardware independent, which one is normative but hardware dependent and which one is not normative because it is hardware dependent. This information supports the development of a protocol stack and the understanding of the specified communication services.

EN 14908-1 is part of a series of European Standards under the general title *Control Network Protocol (CNP)*, which comprises the following parts:

Part 1: *Protocol stack;*

Part 2: *Twisted pair communication;*

Part 3: *Power line channel specification;*

Part 4: *IP communication;*

Part 5: *Implementation;*

Part 6: *Application elements.*

According to the CEN-CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

Introduction

This European Standard has been prepared to provide mechanisms through which various vendors of building automation, control, and building management systems may exchange information in a standardised way. It defines communication capabilities.

This European Standard will be used by all involved in design, manufacture, engineering, installation and commissioning activities.

1 Scope

This European Standard applies to a communication protocol for networked control systems in commercial Building Automation, Controls and Building Management. The protocol provides peer-to-peer communication for networked control and is suitable for implementing both peer-to-peer and master-slave control strategies. This specification describes services in layers 2 to 7. In the layer 2 (data link layer) specification, it also describes the MAC sub-layer interface to the physical layer. The physical layer provides a choice of transmission media. The interface described in this specification supports multiple transmission media at the physical layer. In the layer 7 specification, it includes a description of the types of messages used by applications to exchange application and network management data.

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.

EN 14908-5, *Open Data Communication in Building Automation, Controls and Building Management Implementation Guideline - Control Network Protocol - Part 5: Implementation*

3 Terms and definitions

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

For the purposes of this European Standard, the following subclause introduces the basic terminology employed throughout this European Standard. Most of it is commonly used and the terms have the same meaning in both the general and the standard context. However, for some terms, there are subtle differences. For example, in general, bridges do selective forwarding based on the layer 2 destination address. There are no layer 2 addresses in this standard protocol, so bridges forward all packets, as long as the domain address in the packet matches a domain of which the bridge is a member. Routers, in general, perform network address modification so that two protocols with the same transport layer but different network layers can be connected to form a single logical network. Routers of this standard may perform network address modification, but typically, they only examine the network address fields and selectively forward packets based on the network layer address fields.

3.1
channel
physical unit of bandwidth linking one or more communication nodes.

Note 1 to entry: Refer to Annex E for further explanation of the relationship between a channel and a subnet.

3.2
physical repeater
device that reconditions the incoming physical layer signal on one channel and retransmits it onto another channel

3.3
store-and-forward repeater
device that stores and then reproduces data packets onto a second channel

3.4
bridge
device that connects two channels (x and y); forwards all packets from x to y and vice versa, as long as the packets originate on one of the domain(s) that the bridge belongs to

3.5
configuration
non-volatile information used by the device to customise its operation. There is configuration data for the correct operation of the protocol in each device, and optionally, for application operation. The network configuration data stored in each device has a checksum associated with the data. Examples of network configuration data are node addresses, communication media parameters such as priority settings, etc. Application configuration information is application specific

3.6
domain
virtual network that is the network unit of management and administration. Group and subnet (see below) addresses are assigned by the administrator responsible for the domain, and they have meaning only in the context of that domain

3.7
flexible domain
used in conjunction with Unique_Node_ID and broadcast addressing. A node responds to a Unique_Node_ID-addressed message if the address matches, regardless of the domain on which the message was sent. To respond so that the sender receives it, the response shall be sent on the domain in which it was received. Furthermore, this domain shall be remembered for the duration of the transaction so that duplicate detection of any retries is possible. This transitory domain entry at a node is called the flexible domain. How many flexible domain entries a node supports depends on the implementation. However, a minimum of 1 is required

3.8
subnet
set of nodes accessible through the same link layer protocol; a routing abstraction for a channel; in this standard subnets are limited to a maximum of 127 nodes

3.9
node
abstraction for a physical node that represents the highest degree of address resolvability on a network. A node is identified (addressed) within a subnet by its (logical) node identifier. A physical node may belong to more than one subnet; when it does, it is assigned one (logical) node number for each subnet to which it belongs. A physical node may belong to at most two subnets; these subnets shall be in different domains. A node may also be identified (absolutely) within a network by its Unique_Node_ID

3.10
group
uniquely identifiable set of nodes within a domain. Within this set, individual members are identified by their member number. Groups facilitate one-to-many communication and are intended to support functional addressing

3.11
router
device that routes data packets to their respective destinations by selectively forwarding from subnet to subnet; a router always connects two (sets of) subnets; routers may modify network layer address fields. Routers may be set to one of four modes: repeater mode, bridge mode, learning mode, and configured mode. In repeater mode, packets are forwarded if they are received with no errors. In bridge mode, packets are forwarded if they are received with no errors and match a domain that the router is a member of. Routers in learning mode learn the topology by examining packet traffic, while

routers that are set to configured mode have the network topology stored in their memory and make their routing decisions solely upon the contents of their configured tables

3.12
(application) gateway
interconnects networks at their highest protocol layers (often two different protocols). Two domains can also be connected through an application gateway

3.13
Beta1
period immediately following the end of a packet cycle. A node attempting to transmit monitors the state of the channel, and if it detects no transmission during the Beta1 period, it determines the channel to be idle

3.14
Beta2
randomising slot. A node wishing to transmit generates a random delay T. This delay is an integer number of randomising slots of duration Beta2

3.15
network variable
variable in an application program whose value is automatically propagated over the network whenever a new value is assigned to it

3.16
Standard Network Variable Types (SNVTs)
variables with agreed-upon semantics. These variables are interpreted by all applications in the same way, and are the basis for interoperability. Definition of specific SNVTs is beyond the scope of this European Standard

3.17
manual service request message
network management message containing a node's Unique_Node_ID. Used by a network management device that receives this message to install and configure the node. May be generated by application or system code. May be triggered by external hardware event, e.g., driving a "manual service request" input low

3.18
transaction
sequence of messages that are correlated together. For example, a request and the responses to the request are all part of a single transaction. A transaction succeeds when all the expected messages from every node involved in the transaction are received at least once. A transaction fails in this European Standard if any of the expected messages within the transaction are not received. Retries of messages within a transaction are used to increase the probability of success of a transaction in the presence of transient errors

4 Symbols and abbreviations

4.1 Symbols and graphical representations

Figure 1 shows the basic topology of networks based on this protocol and the symbolic representations used in this European Standard.

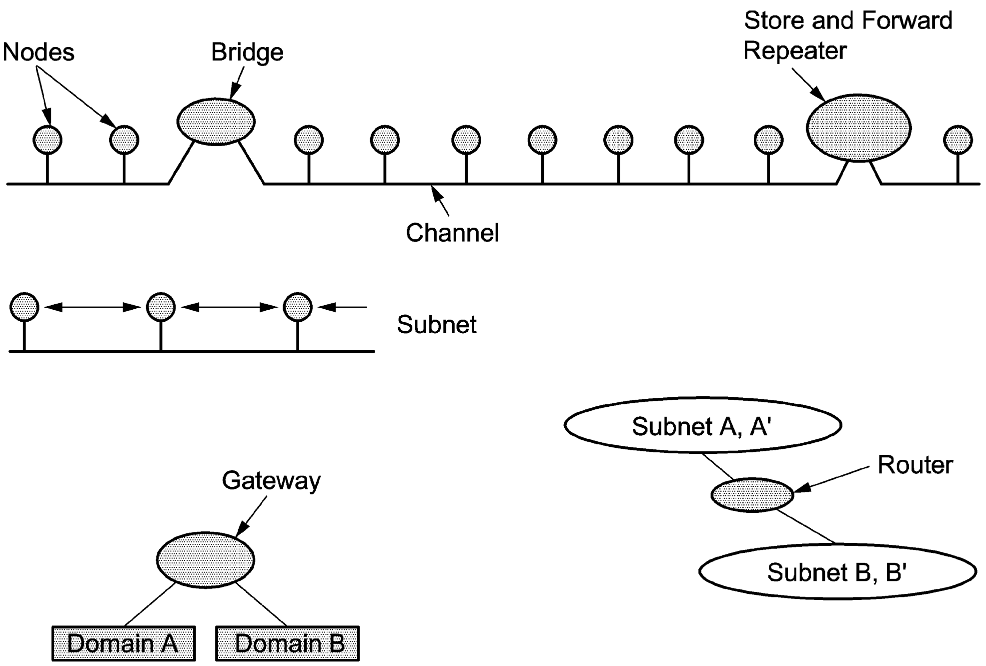

Figure 1 — Network topology & symbols

The layering of this protocol is described using standard OSI terminology, as shown in Figure 2.

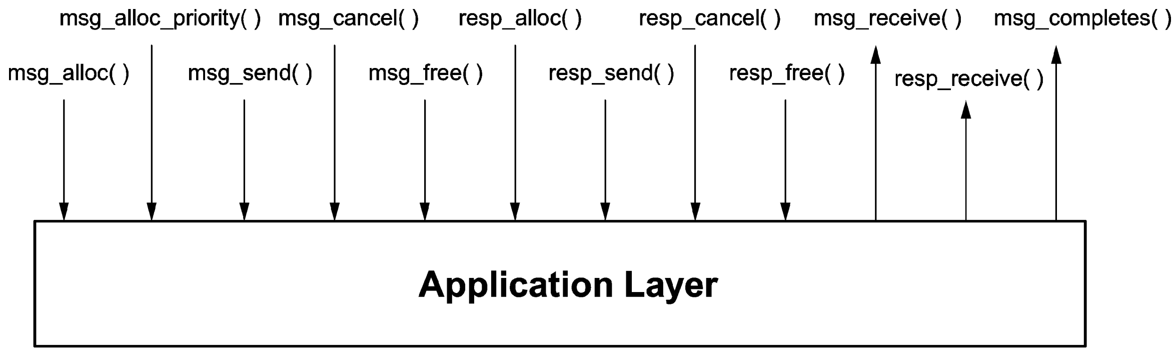

Figure 2 — Protocol terminology

4.2 Abbreviations

CNP Control Network Protocol

The Protocol Data Unit (PDU) abbreviations used throughout this Standard are:

PPDU Physical Protocol Data Unit, or frame

MPDU MAC Protocol Data Unit, or frame

LPDU Link Protocol Data Unit, or frame

NPDU Network Protocol Data Unit, or packet

TPDU Transport Protocol Data Unit, or a message/ack

SPDU Session Protocol Data Unit, or request/response

NMPDU Network Management Protocol Data Unit

DPDU Diagnostic Protocol Data Unit

APDU Application Protocol Data Unit

FSM Finite State Machine (diagram)

Annex D (PDU Summary) contains the details of these PDUs.

5 Overview of protocol layering

The protocol specified by this Standard consists of the layers shown in Figure 3. Each layer is described below.

Multiple physical layer protocols and data encoding methods are allowed in systems based on this European Standard. Each encoding scheme is medium-dependent.

The *MAC* (Medium Access Control) sublayer employs a collision avoidance algorithm called Predictive *p*-persistent CSMA (Carrier Sense, Multiple Access). For a number of reasons, including simplicity and compatibility with the multicast protocol, the link *layer* supports a simple connectionless service. Its functions are limited to framing, frame encoding, and error detection, with no error recovery by re-transmission.

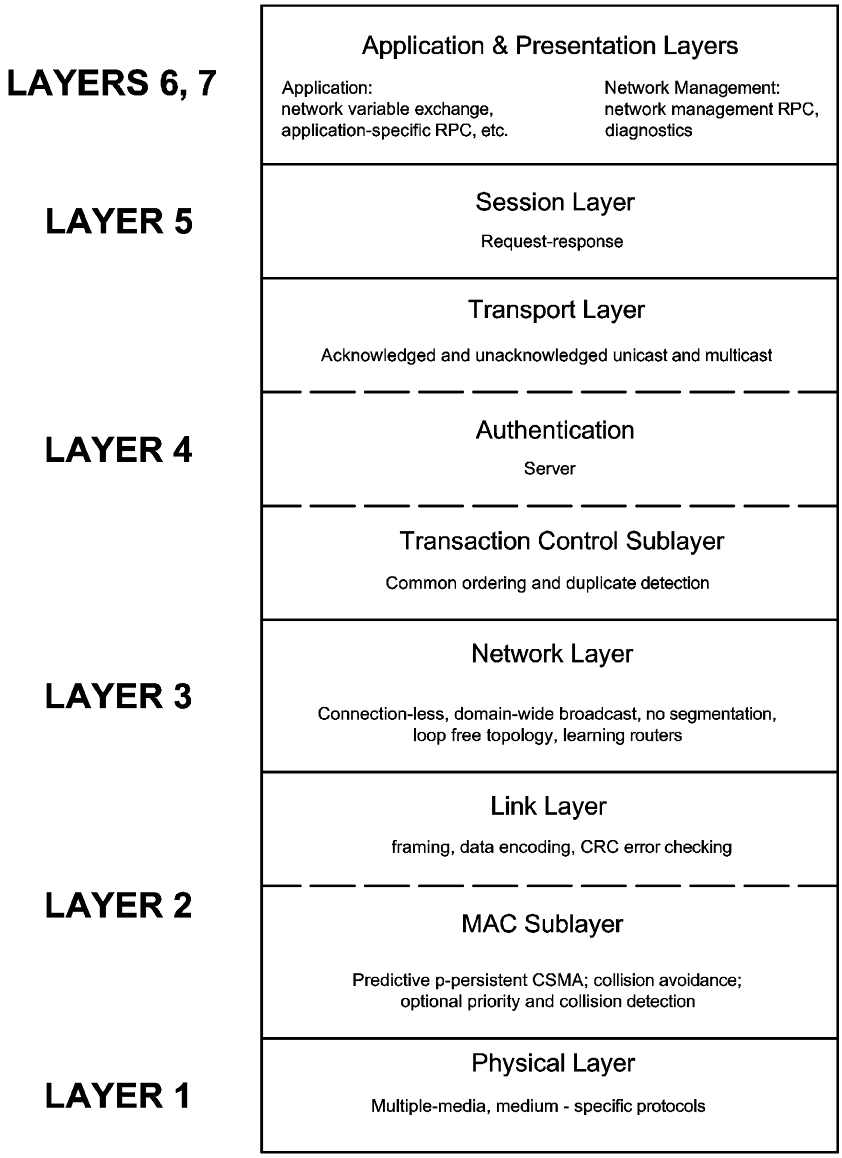

Figure 3 — Protocol layering

The *Network* layer handles packet delivery within a single domain, with no provisions for inter-domain communication. The Network service is connection-less, unacknowledged, and supports neither segmentation nor re-assembly of messages. The routing algorithms employed by the network layer to learn the topology assumes a tree-like network topology; routers with configured tables may operate on topologies with physical loops, as long as the communication paths are logically tree-like. In this topology, a packet may never appear more than once at the router on the side on which the packet originated. The unicast routing algorithm uses learning for minimal over-head and no additional routing traffic. Use of configured routing tables is supported for both unicast and group addresses, although in many applications a simple flooding of group addressed messages is sufficient.

The heart of the protocol hierarchy is the *Transport* and *Session* layers. A common *Transaction Control Sublayer* handles transaction ordering and duplicate detection for both. The *Transport* layer is connection-less and provides reliable message delivery to both single and multiple destinations. Authentication of the message sender's identity is included as a transport layer service, for use when the security of sender authentication is required. The authentication server requires only the

Transaction Control Sublayer to accomplish its function. Thus Transport and Session layer messages may be authenticated using all of the addressing modes other than broadcast.

The session layer provides a simple Request-Response mechanism for access to remote servers. This mechanism provides a platform upon which application specific remote procedure calls can be built. The network management protocol, for example, depends upon the Request-Response mechanism in the Session layer.

A transport layer acknowledged message expects indication of message delivery from remote destination(s). A session layer request message expects indication that application-specific remote task(s) have been completed. A given message uses only one or the other type of service, but not both.

This specification includes the *Presentation Layer* and the lowest level of the *Application Layer*. These layers provide services for sending and receiving application messages including network variables, and other types of messages such as network management and diagnostic messages and foreign frames (see Clause 13). For a network variable update, the APDU header provides information on how to interpret the APDU. This application-independent interpretation of the data allows data to be shared among nodes without prior arrangement.

6 MAC sublayer

6.1 General

In this European Standard the following Media Access Control sublayer is defined. If there is a need for other MAC sublayers they are defined in additional parts of this European Standard.

6.2 Service provided

The Media Access Control (MAC) sublayer facilitates media access with optional priority and optional collision detection/collision resolution. It uses a protocol called Predictive *p*-persistent CSMA (Carrier Sense, Multiple Access), that has some resemblance to the *p*-persistent CSMA protocol family.

Predictive *p*-persistent CSMA is a *collision avoidance* technique that randomises channel access using knowledge of the expected channel load. A node wishing to transmit always accesses the channel with a random delay in the range (0..w). To avoid throughput degradation under high load, the size of the randomising window, w, is a function of estimated channel backlog BL:

$$\mathrm{w} = (\mathrm{BL} \times \mathrm{W}_{\mathrm{base}}) - 1, \quad (1)$$

where

W_{base} is the base window size. W_{base} is measured in time. Its duration, derived from Beta2 (see 6.8), equals 16 Beta2 slots.

6.3 Interface to the link layer

The MAC sublayer is closely coupled to the Link layer, described in Clause 7. With the MAC sublayer being responsible for media access, the Link layer deals with all other layer 2 issues, including framing and error detection. For explanatory purposes, the interface between the two layers is described in the form shown in Figure 4.

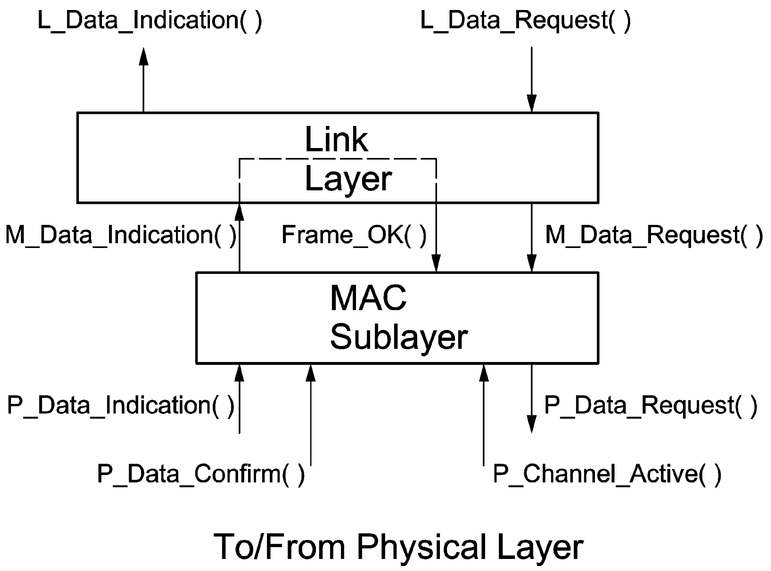

Figure 4 — Interface between the MAC and the link layers

Although the service interface primitives are defined using a syntax similar to programming language procedure calls, no implementation technique is implied. Frame reception is handled entirely by the Link layer, that notifies the MAC sublayer about the backlog increment via the Frame_OK() primitive.

The following service interface primitives facilitate the interface between the Link and the MAC layers:

M_Data_Request (Priority, delta_BL, ALT_Path, LPDU)

This primitive is used by the Link layer to pass an outbound LPDU/MPDU to the MAC sublayer. Priority defines the priority with which the frame is to be transmitted; delta_BL is the backlog increment expected as a result of delivering this MPDU. ALT_Path is a binary flag indicating whether the LPDU is to be transmitted on the primary or alternate channel, baud rate, etc. See 6.5 for how ALT_Path is set.

Frame_OK (delta_BL)

On receiving a frame and verifying that its CRC is correct, the Link layer invokes this primitive to notify the MAC sublayer about the backlog increment associated with the frame just received.

M_Data_Indication()

The MAC sublayer provides this indication to the link layer once per incoming LPDU/MPDU.

6.4 Interface to the physical layer

The physical layer handles the actual transmission and reception of binary data. Multiple physical layer protocols are supported by the control network protocol. The bit error rate presented to the link layer shall be equal to or better than 1 in 10^{-4}. For compatibility with the higher layers, all physical protocols shall support the defined service interface (see Figure 4):

P_Data_Indication (Frame)

Physical layer provides this indication to the MAC sublayer and the link layer once per in-coming LPDU/MPDU.

P_Data_Request (Frame)

The MAC sublayer uses this primitive to pass the Frame, the encoded LPDU/MPDU, to the physical layer for immediate transmission. The bit transmission order is defined in Annex D.

P_Data_Confirm (Status)

The physical layer returns Status as to whether the frame was transmitted. Status has three possible values: success—indicating the frame was transmitted, request_denied—indicating that activity was detected on the line prior to transmission, and collision—indicating that transmission began, but a collision was detected. Whether or not the transmission is aborted depends on when the collision is detected (see 6.11).

P_Channel_Active ()

The physical layer uses this primitive to pass the status of the channel to the MAC sublayer. This is an indication of activity, not necessarily of valid data.

6.5 MPDU format

The combined MPDU/LPDU format is shown in Figure 5. (Annex D contains the details of the NPDU frame).

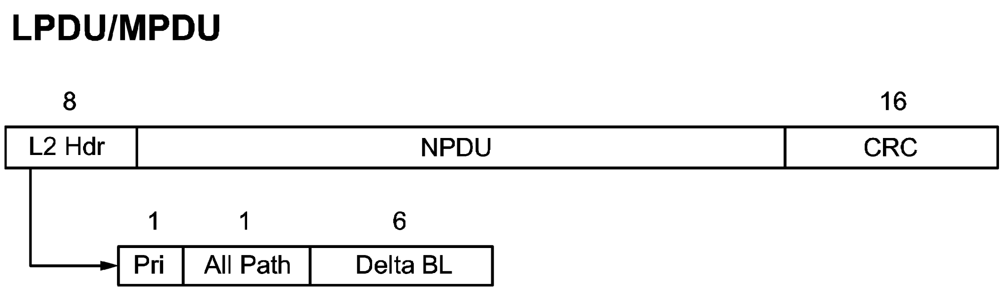

Figure 5 — MPDU/LPDU format

The MAC sublayer uses the L2Hdr field, that has the following syntax and semantics:

Pri	1-bit field specifying the priority of this MPDU: 0 = Normal, 1 = High.
Alt_Path	1-bit field specifying the channel to use. This is a provision for transceivers that have the ability to transmit on two different channels and receive on either one without the need to instruct the transceiver to explicitly receive on a specific channel. The transport layer sets this bit for the last two attempts (for acknowledged and request/response services), unless requested to specify the alternate path for every transmission. For any packet received that has the alt_path bit set and that requires an acknowledgement, response, challenge, or reply, the alt_path bit shall be set in the corresponding acknowledgement, response, challenge, or reply.
Delta_BL	6-bit unsigned field (≥ 0); specifies channel backlog increment to be generated as a result of deliver-ing this MPDU.

6.6 Predictive *p*-persistent CSMA — overview description

Like CSMA, Predictive *p*-persistent CSMA senses the medium before transmitting. A node attempting to transmit monitors the state of the channel (see Figure 6), and determines the channel to be idle if it detects no transmission during the Beta1 period. Nodes without a packet to transmit during this Beta1