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P802.15.6ma

November 11th, 2024

Draft IEEE Standard for Body Area Networks—

Media Access Control (MAC) Service Definition

Support for IEEE 802.1ACea

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The text proper of this draft begins with the title page (1). The cover pages (a), (b), (c) etc. are for 802.15 WG information, and will be removed prior to Sponsor Ballot.

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1. MAC service definition

1.1 Overview of MAC services

1.1.1 Data service

1.1.1.1 General

The MAC data service provides the ability to exchange MSDUs per LLC sublayer entities or IEEE 802.1Q bridge ports. To support this service, the local MAC uses the underlying PHY-level services to transport an MSDU to a peer MAC entity, where it is delivered to the corresponding LLC sublayer or bridge port.

The MSDU transport is on a best-effort basis by default. However, the QoS facility uses a traffic identifier (TID) to specify differentiated services on a per-MSDU basis.

Group-addressed transport is part of the data service provided by the MAC. Due to the characteristics of group communication, group-addressed MSDUs might experience a lower QoS, compared to that of individually addressed MSDUs.

All coordinators differentiate their MSDU delivery according to the designated traffic category of individual MSDUs. The access category of each MPDU is designated by the current QoS policy.

In coordinators, the MAC uses a set of rules that tends to cause higher UP MSDUs to be sent before lower UP MSDUs. The MAC sublayer entities determine the UPs for MSDUs based on the TID values provided with those MSDUs.

1.1.1.2 Determination of UP

Complying IEEE Std 802.15.6 devices support QoS with eight priority values, referred to as User Priorities (Ups). The values a UP may take are the integer values from 0 to 7 and are identical to the IEEE 802.1D™ priority tags.

An MSDU with a particular UP is said to belong to a traffic category (TC) with that UP. The UP is provided with each MSDU at the medium access control service access point (MAC SAP in the UP parameter.

For the transmission of an MSDU that was provided to the Internal Sublayer Service SAP, the UP is determined by the convergence function based on the priority parameter of the UNITDATA.request primitive (recommended mappings depend on targeted use cases).

1.1.2 MSDU ordering

The services provided by the MAC support the reordering of MSDUs. However, the MAC does not intentionally reorder MSDUs except when is necessary to improve the likelihood of successful delivery based on the current operational mode.

The MSDUs are reordered to improve the likelihood of successful delivery based on the current operational mode of the designated recipient device and to fulfill the priority parameters specified in the MA-UNITDATA.request primitive of the individual MSDUs.

The effects of this reordering for the set of MSDUs received at the MAC service interface of any device are:

— A change in the delivery order of group-addressed MSDUs, relative to individually addressed MSDUs originating from a single source device address

— The reordering of MSDUs with different Traffic ID (TID) values originating from a single source address.

— There shall be no reordering of individually addressed MSDUs with the same TID value and addressed to the same destination.

— The coordinator shall meet the MSDU (“object”) reordering requirements of IEEE Std 802.1AC-2012.

— If MSDUs are reordered, the recipients shall reorder the MSDUs such that the integrity of the information is maintained.

1.1.3 MSDU format

Logical Link Control (LLC) sublayer entities use the MAC sublayer service to exchange MSDUs with other LLC sublayer entities. The standard uses the Ethertype Protocol Discrimination (EPD) (see IEEE Std 802.2–2025).

1.1.4 MAC service interface role

The MAC service interface performs destination-address filtering, access to the convergence function, and, access to the bridge ports if enabled as shown in Figure 1.

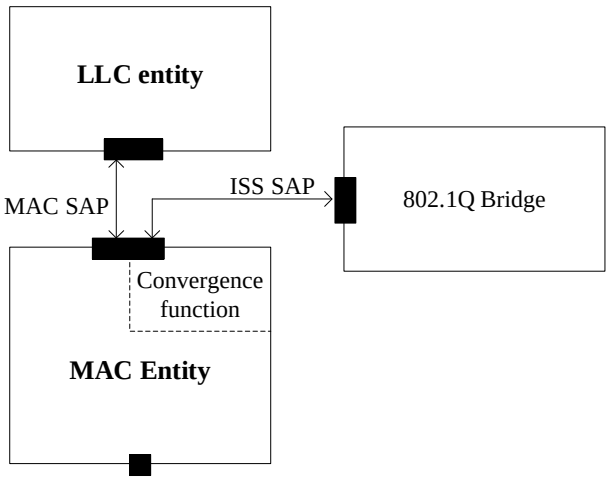

Figure 1—Reference model of IEEE 802.15.6 Convergence Function.

1.1.5 Provision of the MAC service

MAC service data unit (MSDU) delivery services in an IEEE Std 802.1Q network can be supported by the IEEE 802.1ACea MAC service. IEEE Std 802.15.6 coordinators conform with an IEEE 802.1ACea compliant 802.15.6 convergence function, to provide access to the wireless medium via one or more Internal Sublayer Service SAPs. The routing of all MSDUs provided by an IEEE Std 802.1Q relay entity via IEEE 802.15.6 coordinators is controlled by the routing protocols of the IEEE 802.1Q network to which the IEEE 802.15.6 coordinator is attached. This enables the routing protocols to use all the links available at the IEEE 802.15.6 coordinator.

An IEEE Std 802.15.6 coordinator can give access to the wireless medium to an IEEE 802.1Q network. Figure 2 shows an example involving an IEEE Std 802.15.6 coordinator and other generic IEEE 802 LAN or WAN. The coordinator provides MAC services at the MAC SAP, including the services mapped onto one or more Internal Sublayer Service SAPs by the IEEE 802.1ACea Convergence Function. Each Internal Sublayer Service SAP is then mapped onto an Enhanced Internal Sublayer Service (EISS) SAP by the IEEE 802.1Q Media Independent Function. The EISS SAP provides EISS services to the MAC relay entity of a VLAN bridge component (IEEE 802.1Q MAC Relay Entity). The MAC SAP provides services to the LLC entity as well.

NOTE—IEEE Std 802.15.6 does not specify the details of the IEEE 802.1ACea Convergence Function, the IEEE 802.1Q Media Independent Function, the Internal Sublayer Service to MAC SAP function, the IEEE 802.1Q MAC Relay Entity, and the LLC layer. These entities are specified in other documents such as IEEE P802.1ACea and IEEE Std 802.1Q-2022. These entities are shown with dashed outlines in Figure 2. Entities specified by IEEE Std 802.15.6 are shown with solid outlines.

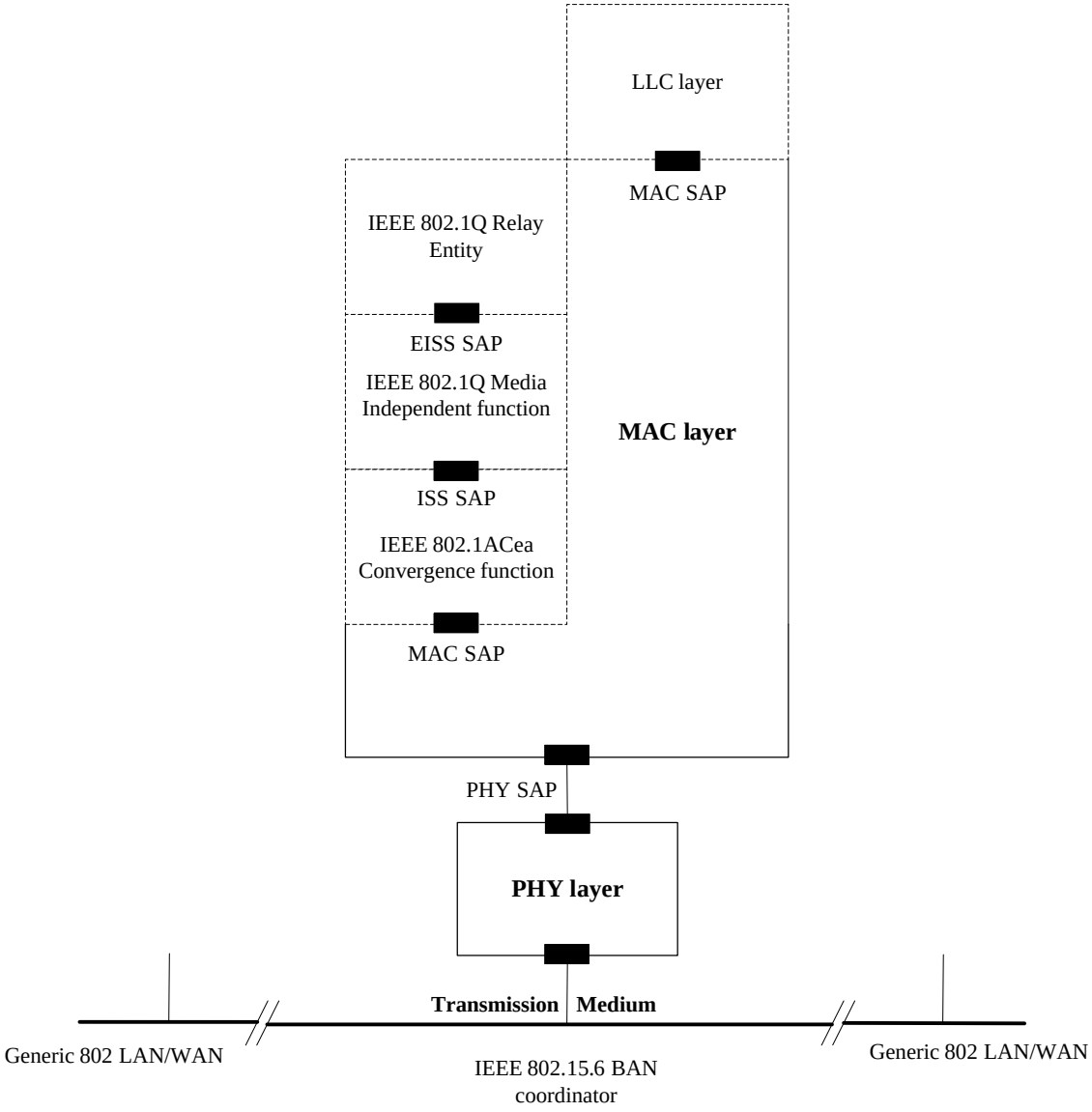

Figure 2—Example of bridging with a BAN coordinator.

1.2 MAC data service specification

1.2.1 General

The MAC supports the following service primitives:

UNITDATA.request

UNITDATA.indication

UNITDATA-STATUS.indication

1.2.2 UNITDATA.request

1.2.2.1 Purpose

The primitive requests a transfer of an MSDU from the local LLC entity to another LLC entity, or multiple peer LLC entities (in the case of group addresses) or bridge port.

The parameters of the primitive are as follows:

```
UNITDATA.request(
        source address,
        destination address,
        routing information,
        data,
        priority,
        drop eligible,
        service class
)
```

The *source address* (SA) parameter specifies the MAC address of the entity transmitting the MSDU.

The *destination address* (DA) parameter specifies either an individual MAC address (unicast) or a group MAC address (multicast) receiving an MSDU.

The *routing information* parameter specifies the route for the data transfer (a null value indicates source routing is not used). For IEEE Std 802.15.6, the *routing* parameter shall be null.

The *data* parameter specifies the MSDU transmitted by the MAC entity. The length of the MSDU shall be less than or equal to the value shown in Table x.

The *priority* parameter specifies the requested priority of the *data* to transfer. The allowed values of priority are described in 5.x.

NOTE—For a bridge, the bridge port provides the priority. That priority might have been derived from a priority tag in the frame arriving on another port of the bridge or from the configuration of that port if the frame arrived untagged.

The *drop eligible* parameter if TRUE indicates weather the MSDU can be discarded in preference to other MSDUs for which the *drop eligible* is FALSE, when there are insufficient resources in the coordinator.

The *service class* parameter specifies the requested service class of the *data* to transfer. The allowed values of service class are described in 5.x and 5.x.

1.2.2.2 When generated

The LLC entity generates the primitive when an MSDU is to be transferred to a peer LLC entity or entities or to a peer bridge or bridges.

1.2.2.3 Effect of receipt

On receipt of this primitive, the MAC entity determines whether it can fulfill the request according to the requested parameters.

A request that cannot be fulfilled according to the requested parameters is indicated to the LLC entity using the UNITDATASTATUS.indication primitive that describes why the MAC was unable to fulfill the request.

If the request can be fulfilled under the requested parameters and according to the current state of the BAN, the MAC entity properly formats a frame and passes it to the PHY layer for transfer to a peer MAC entity or entities and indicates this action to the LLC entity or bridge port using the UNITDATASTATUS. indication primitive with transmission status set to Successful.

1.2.3 MA-UNITDATA.indication

1.2.3.1 Purpose

The primitive defines the transfer of an MSDU from the MAC entity to the LLC entity or bridge port, or entities or bridge ports in the case of group addresses. In the absence of error, the contents of the data parameter are logically complete and unchanged relative to the data parameter in the associated UNITDATA.request primitive.

The parameters of the primitive are as follows:

```
UNITDATA.indication(
                source address,
                destination address,
                routing information,
                data,
                reception status,
                priority,
                drop eligible,
                service class
)
```

The *source address* parameter is the MAC address specified by the SA field of the incoming MAC frame.

The *destination address* parameter is either a MAC address or a group address as specified by the DA field of the incoming MAC frame.

The *routing information* parameter specifies the route that was used for the data transfer. The MAC entity shall set this field to null.

The *data* parameter indicates the MSDU received in the incoming MAC frame, or *data* transfer.

The *reception status* parameter is set to SUCESSS (all failures of reception are discarded by the MAC entity and consequently without generating the UNITDATA.indication primitive).

The *priority* parameter specifies the receive processing priority that was used for the *data* transfer.

The *drop eligible* indicates whether the received MSDU was designated as drop eligible indicated in the control field of the incoming MAC frame.

The *service class* parameter specifies the received service class that was used for the *data* transfer.

1.2.3.2 When generated

The MAC entity carries the UNITDATA.indication primitive to the LLC entity, LLC entities, or bridge port or bridge ports to indicate the successful arrival of a MAC frame at the local MAC entity. MAC frames are reported successfully received only if they are validly formatted by the MAC entity, received without error, received with valid (or null) security and integrity information, and their destination address designates the local MAC entity.

1.2.3.3 Effect on receipt

The effect of receipt of this primitive by the LLC entity or bridge port depends on the content of the MSDU.

If the DA field in the incoming MAC frame contains a valid group (multicast) address, the coordinator shall perform rate limiting to enforce the resource utilization limit in MaxSourceMulticastRate (MIB). The specific mechanism to perform rate limiting is outside the scope of the standard.

At the coordinator, upon receipt of an individually addressed MAC frame with the Type subfield equal to Data, for which the priority is an integer in the range 0 to 7, then the coordinator's MAC entity shall derive the access category from the priority using the mapping in Table X. The coordinator's MAC entity shall retrieve the MIB attributes and perform the following operations:

— If the access category is AC_VO, then the coordinator shall perform rate limiting to enforce the resource utilization limit in MaxVoiceRate. The specific mechanism to perform rate limiting is outside the scope of this standard.

  If the rate-limiting mechanism does not discard the MAC frame, the VoiceMSDUCount shall be incremented by one, and the VoiceOctetCount shall be incremented by the number of octets in the MSDU. If the rate-limiting mechanism discards the MAC frame, the DroppedVoiceMSDUCount shall be incremented by one and the DroppedVoiceOctetCount shall be incremented by the number of octets in the MSDU.

— If the access category is AC_VI, then the coordinator shall perform rate limiting to enforce the resource utilization limit in MaxVideoRate. The specific mechanism to perform rate limiting is outside the scope of this standard.

  If the rate-limiting mechanism does not discard the MAC frame, the VideoMSDUCount shall be incremented by one, and the VideoOctetCount shall be incremented by the number of octets in the MSDU. If the rate-limiting mechanism discards the MAC frame, the DroppedVideoMSDUCount shall be incremented by one and the DroppedVideoOctetCount shall be incremented by the number of octets in the MSDU.

— If the access category is AC_BE, then the coordinator shall perform rate limiting to enforce the resource utilization limit in MaxBestEffortRate. The specific mechanism to perform rate limiting is outside the scope of this standard.

  If the rate-limiting mechanism does not discard the MAC frame, the BestEffortRateMSDUCount shall be incremented by one, and the BestEffortRateOctetCount shall be incremented by the number of octets in the MSDU. If the rate-limiting mechanism discards the MAC frame, the DroppedBestEffortRateMSDUCount shall be incremented by one and the DroppedBestEffortRateOctetCount shall be incremented by the number of octets in the MSDU.

— If the access category is AC_BK, then the coordinator shall perform rate limiting to enforce the resource utilization limit in MaxBackgroundRate. The specific mechanism to perform rate limiting is outside the scope of this standard.

If the rate-limiting mechanism does not discard the MAC frame, the BackgroundRateMSDUCount shall be incremented by one, and the BackgroundRateOctetCount shall be incremented by the number of octets in the MSDU. If the rate-limiting mechanism discards the MAC frame, the DroppedBackgroundMSDUCount shall be incremented by one and the DroppedBackgroundRateOctetCount shall be incremented by the number of octets in the MSDU.

1.2.4 UNITDATA-STATUS.indication

1.2.4.1 Purpose

The primitive provides the LLC entity or bridge port with status information for the corresponding preceding UNITDATA.request primitive.

1.2.4.2 Semantics of the service primitive

The parameters of the primitive are as follows:

```
UNITDATA-STATUS.indication(
                source address,
                destination address,
                transmission status,
                provided priority,
                provided service class
)
```

The *source address* parameter is a MAC address as specified in the associated UNITDATA.request primitive.

The *destination address* parameter is either an individual or group MAC address as specified in the associated UNITDATA.request primitive.

The *transmission status* parameter is used to pass status information back to the local requesting LLC entity or bridge port with the following values for transmission status:

a) Successful.

b) Undeliverable (excessive data length).

c) Undeliverable (non-null source routing).

d) Undeliverable: unsupported priority.

e) Undeliverable: unsupported service class.

f) Undeliverable: unavailable service class.

g) Undeliverable (no coordinator available).

h) In a coordinator. Undeliverable (violation of limit specified by the MaxVoiceRate identified by the destination address of the UNITDATA.request primitive.

i) In a coordinator. Undeliverable (violation of limit specified by MaxVideoRate identified by the destination address of the UNITDATA.request primitive.

j) In a coordinator. Undeliverable (violation of limit specified by the MaxBestEffortRate identified by the destination address of the UNITDATA.request primitive.

k) In a coordinator. Undeliverable (violation of limit specified by the MaxBackgroundRate identified by the destination address of the UNITDATA.request primitive.

If the transmission status parameter is Successful, the provided priority parameter specifies the priority used for the associated data transfer. Otherwise, the provided priority parameter is not present.

If the transmission status parameter is Successful, the provided service class parameter specifies the class of service for the associated data transfer. Otherwise, the provided service class parameter is not present.

1.2.4.3 When generated

The MAC entity carries the UNITDATA-STATUS.indication primitive to the LLC entity or bridge port to indicate the status of the service provided for the corresponding UNITDATA.request primitive.

1.2.4.4 Effect of receipt

The effect of receipt of the primitive by the LLC sublayer or bridge port depends upon the type of operation employed by the LLC entity or bridge port.

Annex A

(Normative)

TBD