



**IEEE Standard for Information Technology—
Telecommunications and Information Exchange between Systems
Local and Metropolitan Area Networks—
Specific Requirements**

**Part 11: Wireless LAN Medium Access Control
(MAC) and Physical Layer (PHY) Specifications**

Amendment 7: Enhanced Broadcast Services

IEEE Computer Society

Developed by the
LAN/MAN Standards Committee

IEEE Std 802.11bc™-2023

(Amendment to IEEE Std 802.11™-2020
as amended by IEEE Std 802.11ax™-2021,
IEEE Std 802.11ay™-2021,
IEEE Std 802.11ba™-2021,
IEEE Std 802.11az™-2022,
IEEE Std 802.11™-2020/Cor 1-2022, IEEE Std 802.11bb™-2023,
IEEE Std 802.11bd™-2023, and IEEE Std 802.11™-2020/Cor 2-2024)

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IEEE SA Standards Board

Abstract: Modifications to the IEEE 802.11 medium access control layer (MAC) for the enhanced transmission and reception of broadcast content, both while associated with an infrastructure basic service set (BSS) and while not associated with an infrastructure BSS, are defined in this amendment.

Keywords: Enhanced Broadcast Services (EBCS), IEEE 802[®], IEEE 802.11[™], IEEE 802.11bc[™]

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Introduction

This introduction is not part of IEEE Std 802.11bc-2023, IEEE Standard for Information Technology—Telecommunications and Information Exchange between Systems—Local and Metropolitan Area Networks—Specific Requirements—Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications—Amendment 7: Enhanced Broadcast Services.

This amendment specifies modifications to the IEEE 802.11 medium access control (MAC) specifications that enable enhanced transmission and reception of broadcast data both in an infrastructure BSS where there is an association between the transmitter and the receiver(s) and in cases where there is no association between transmitter(s) and receiver(s).

This amendment introduces origin authenticity protection for broadcast data frames.

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IEEE Standard for Information Technology—
Telecommunications and Information Exchange between Systems
Local and Metropolitan Area Networks—
Specific Requirements

Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications

Amendment 7: Enhanced Broadcast Services

NOTE—The editing instructions contained in this amendment define how to merge the material contained therein into the existing base standard and its amendments to form the comprehensive standard.⁶

The editing instructions are shown in ***bold italic***. Four editing instructions are used: change, delete, insert, and replace. ***Change*** is used to make corrections in existing text or tables. The editing instruction specifies the location of the change and describes what is being changed by using ~~striketrough~~ (to remove old material) and underscore (to add new material). ***Delete*** removes existing material. ***Insert*** adds new material without disturbing the existing material. Insertions may require renumbering. If so, renumbering instructions are given in the editing instruction. ***Replace*** is used to make changes in figures or equations by removing the existing figure or equation and replacing it with a new one. Editing instructions, change markings, and this NOTE will not be carried over into future editions because the changes will be incorporated into the base standard.

⁶ Notes in text, tables, and figures of a standard are given for information only and do not contain requirements needed to implement this standard.

1. Overview

1.1 Supplementary information on purpose

Insert the following new list item at the end of the dashed list:

- Defines a mechanism to enable IEEE 802.11 stations to transmit and receive broadcast content, both in cases when the transmitter(s) and the receiver(s) are associated in an infrastructure BSS and when they are not; and a mechanism to enable uplink content to be relayed to a specified destination typically within an external network.

2. Normative references

Insert the following references in alphanumeric order:

IETF RFC 1112, Host Extensions for IP Multicasting, S. Deering, Aug. 1989.

IETF RFC 2464, Transmission of IPv6 Packets over Ethernet Networks, M. Crawford, Dec. 1998.

IETF RFC 4082, Timed Efficient Stream Loss-Tolerant Authentication (TESLA): Multicast Source Authentication Transform Introduction, June 2005.

IETF RFC 6979, Deterministic Usage of the Digital Signature Algorithm (DSA) and Elliptic Curve Digital Signature Algorithm (ECDSA), Aug. 2013.

IETF RFC 8017, PKCS #1: RSA Cryptography Specifications Version 2.2, Nov. 2016.

3. Definitions, acronyms, and abbreviations

3.2 Definitions specific to IEEE Std 802.11

Insert the following definitions in alphabetical order:

content identifier (ID): An identifier of an enhanced broadcast services (EBCS) traffic stream.

enhanced broadcast services (EBCS): Services that enable the relaying of uplink broadcast traffic to a specified destination and enhanced broadcasting of downlink streams to both associated and unassociated stations (STAs).

enhanced broadcast services (EBCS) access point (AP): An AP that has enabled EBCS.

enhanced broadcast services (EBCS) access point (AP) group: A group of one or more EBCS APs such that all EBCS APs in the group use common EBCS content identifiers (IDs). An EBCS AP group is a subgroup of an EBCS certificate group if the member APs use AP certificates.

enhanced broadcast services (EBCS) access point (AP) group identifier (ID): An identifier (ID) of an EBCS AP group that can be used by EBCS receivers to filter EBCS traffic streams.

enhanced broadcast services (EBCS) certificate group: A group of one or more EBCS access points (APs) such that all EBCS APs in the group use a common certificate for EBCS traffic streams.

enhanced broadcast services (EBCS) content MAC address: A MAC address used in a frame header to identify an EBCS Data or EBCS uplink (UL) frame. See 33.2.

enhanced broadcast services (EBCS) Data frame: A Data frame used to carry data for an EBCS downlink traffic stream.

enhanced broadcast services (EBCS) downlink (DL): A broadcast from an EBCS access point (AP) carrying an EBCS traffic stream.

NOTE—This broadcast can be received by another EBCS AP.

enhanced broadcast services (EBCS) downlink (DL) content server: An entity reachable via the distribution system (DS) that is the source of an EBCS DL traffic stream.

enhanced broadcast services (EBCS) info MAC address: A MAC address used in a frame header to identify an EBCS Info frame. See 33.2.

enhanced broadcast services (EBCS) proxy: A logical component affiliated with an EBCS relaying station (STA), which might be collocated with the EBCS relaying STA, that can relay a higher layer protocol (HLP) payload carried in an EBCS uplink (UL) frame received by the EBCS relaying STA to a destination specified in the frame, typically within an external network.

enhanced broadcast services (EBCS) receiver: A station (STA) that can receive and process EBCS Data frames or EBCS uplink (UL) frames.

enhanced broadcast services (EBCS) relaying station: An EBCS receiver that is affiliated with an EBCS proxy and provides a relaying service as described in 4.5.12.3 and 33.4.

NOTE—An EBCS relaying station (STA) can be an access point (AP) that has established its own infrastructure basic service set (BSS) or a STA that provides a relaying service without establishing an infrastructure BSS.

enhanced broadcast services (EBCS) service period: A period of time during which an EBCS access point (AP) intends to conduct EBCS transmissions associated with one or more content identifiers (IDs).

enhanced broadcast services (EBCS) traffic stream: A traffic stream that carries content on EBCS.

enhanced broadcast services (EBCS) transmitter: A station (STA) that can transmit EBCS Data frames or EBCS uplink (UL) frames.

enhanced broadcast services (EBCS) uplink (UL): A broadcast from an EBCS non-access point (non-AP) station (STA) carrying higher layer protocol (HLP) payload intended to be relayed by one or more EBCS relaying STAs to a destination specified in the broadcast.

NOTE—An EBCS relaying STA might not be in range.

3.4 Abbreviations and acronyms

Insert the following abbreviations/acronyms in alphabetical order:

EBCS enhanced broadcast services

HCFA hash chain frame authentication

HLSA higher layer source authentication

PKFA public key frame authentication

4. General description

4.5 Overview of the services

4.5.4 Access control and data confidentiality services

4.5.4.6 Data origin authenticity

Change the second paragraph as follows:

Data origin authenticity is applicable only to individually addressed Data frames, ~~and individually addressed robust Management frames, and group addressed EBCS Data, EBCS Info, and EBCS UL frames. The protocols do not guarantee data origin authenticity for group addressed frames, as this cannot be accomplished using symmetric keys and public key methods are too computationally expensive. The protocols do not guarantee data origin authenticity for group addressed frames that are not EBCS Data, EBCS Info, or EBCS UL frames.~~

4.5.11 Wake-up radio (WUR) services

Insert a new subclause 4.5.12 after 4.5.11 as follows:

4.5.12 Enhanced broadcast services

4.5.12.1 General

Enhanced broadcast services (EBCS) provide the enhanced transmission and reception of broadcast content, both while associated with an infrastructure BSS and while not associated with an infrastructure BSS. EBCS provides a service in which an EBCS proxy affiliated with an EBCS relaying STA can relay the contents of a higher layer protocol (HLP) payload received from an EBCS non-AP STA to a destination typically within an external network. The relaying EBCS proxy can embed additional information.

When there is an association, EBCS provides additional means for protecting broadcast traffic and the privacy of the stations receiving that traffic, including data origin authenticity.

4.5.12.2 EBCS DL service

4.5.12.2.1 General

The EBCS DL service provides a mechanism for an EBCS AP to broadcast one or more EBCS traffic streams. The service allows the receiver of an EBCS traffic stream to authenticate the transmitter irrespective of whether the receiver and transmitter are associated with the EBCS AP.

4.5.12.2.2 EBCS traffic stream mapper

The EBCS traffic stream mapper is used to map multicast traffic arriving from an EBCS DL content server to EBCS traffic streams. The EBCS traffic stream mapper exists only in an EBCS AP. The location of the EBCS traffic stream mapper is shown in Figure 5-1. It inspects the inbound traffic and assigns the content ID and the corresponding EBCS content MAC address according to dot11EBCSTrafficStreamTable.

4.5.12.2.3 EBCS filter

The EBCS filter exists only in an EBCS receiver. The EBCS filter is located in the MAC data plane as shown in Figure 5-1. It filters the received EBCS traffic streams by their EBCS content MAC address according to dot11EBCSTrafficStreamTable. Details are described in 33.3.3.

4.5.12.2.4 Example of EBCS DL operation

Figure 4-20a provides an example of EBCS DL operation.

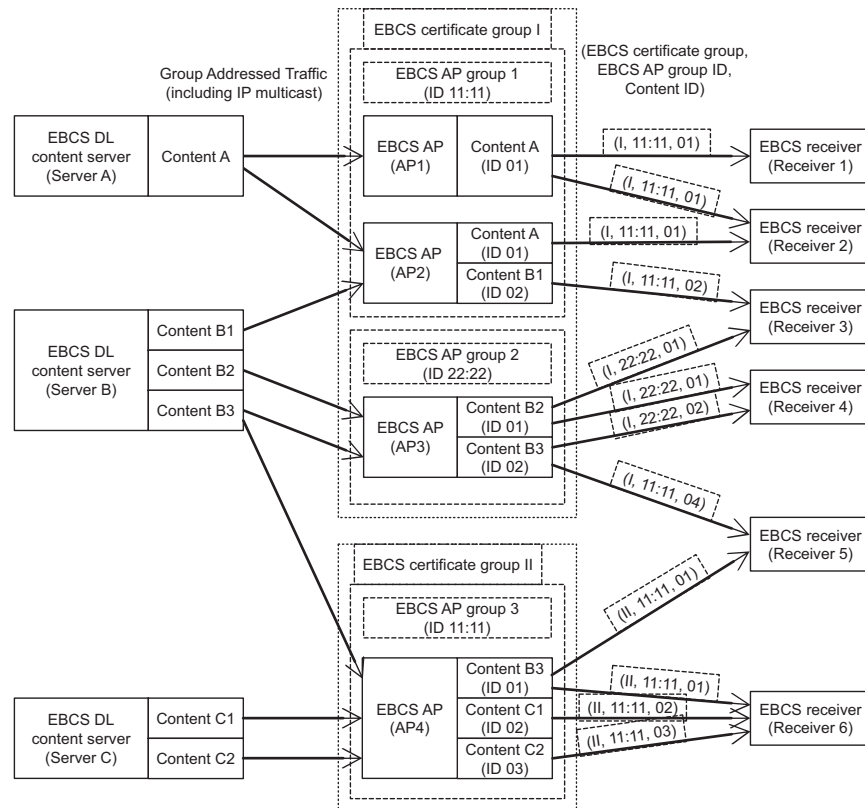


Figure 4-20a—Example of EBCS DL operation

EBCS DL content servers are distributing group addressed traffic streams. Each EBCS DL content server can distribute multiple traffic streams that can be identified by the source MAC address and the destination MAC address. If a traffic stream is an IP multicast traffic stream, the traffic stream is identified by the source IP address, the destination IP address, and the destination UDP port.

Server A in Figure 4-20a distributes Content A. Server B distributes Content B1, Content B2, and Content B3. Server C distributes Content C1 and Content C2.

An EBCS AP can receive multiple traffic streams from one or more EBCS DL content server(s). The SME in an EBCS AP selects traffic streams to be broadcast by setting the appropriate values in dot11EBCSTrafficStreamTable. An EBCS AP broadcasts the selected traffic streams as EBCS traffic streams. An EBCS AP can add authentication information to the streams.

AP1, AP2, and AP3 belong to the EBCS certificate group I. AP1 and AP2 belong to EBCS AP group 1 with an AP group ID of 11:11. AP3 belongs to the EBCS AP group 2 with a group ID of 22:22. AP4 belongs to

the EBCS certificate group II and the EBCS AP group 3 with an AP group ID of 11:11. Although both the EBCS AP group 1 and EBCS AP group 3 use the EBCS AP group ID of 11:11, they are different EBCS AP groups as they belong to different EBCS certificate groups.

AP1 in Figure 4-20a receives and broadcasts Content A. AP2 receives and broadcasts Content A and Content B1. AP3 receives and broadcasts Content B2 and Content B3. AP4 receives and broadcasts Content B3, Content C1, and Content C2.

An EBCS receiver can receive multiple EBCS traffic streams from one or more EBCS AP(s). An EBCS receiver filters EBCS traffic streams to be consumed using the EBCS filter. Each EBCS traffic stream can be authenticated if the transmitting EBCS AP adds authentication information.

Receiver 1 in Figure 4-20a can receive Content A from AP1. Receiver 2 can receive Content A from both AP1 and AP2. Receiver 3 can receive Content B1 from AP2 and Content B2 from AP3. Receiver 4 can receive both Content B2 and Content B3 from AP3. Receiver 5 can receive Content B3 from both AP3 and AP4. Receiver 6 can receive Content B3, Content C1, and Content C2 from AP4.

Receiver 2 can potentially recognize the presence of multiple copies of Content A by receiving from 2 APs as both EBCS traffic streams from AP1 and AP2 belong to the same EBCS certificate group and the same EBCS AP group, and have the same Content ID. Receiver 5 cannot recognize the presence of multiple copies of Content B3 as the EBCS traffic streams from AP3 and AP4 belong to the different EBCS certificate groups and different EBCS AP groups. Receiver 5 has to assume the two versions include different content.

4.5.12.3 EBCS relaying service

4.5.12.3.1 General

The EBCS relaying service facilitates EBCS UL operation (as described in 33.4) by providing a mechanism for an EBCS non-AP STA to transmit an EBCS UL frame containing an HLP payload that is intended to be relayed by one or more EBCS relaying STAs to a destination specified in the frame.

4.5.12.3.2 EBCS proxy operation

An EBCS proxy, as a part of providing relaying service, evaluates certain criteria before relaying the HLP payload carried in an EBCS UL frame to the destination specified in the frame. Such criteria can include, but are not limited to, verifying the STA certificate, if present, to determine whether the STA transmitting the frame is authorized to send an HLP payload to the specified destination, performing replay checking, and limiting the per destination amount (e.g., octets) or per destination frequency (e.g., packets per second) of HLP payload that is relayed to the specified destination. The evaluation of the criteria can be based on local policies installed at the EBCS proxy and/or based on a relationship established with an entity at the specified destination. The establishment of such a relationship is out of scope of this standard.

An EBCS proxy can establish more than one relationship, each relationship with entities residing at a different destination and potentially requiring different evaluation criteria. An EBCS proxy can establish more than one relationship with the same entity, each matching a different destination URI and requiring evaluation of different criteria.

An EBCS proxy can also embed additional information before it relays the HLP payload. The format and content of the information embedded are based on the agreement with the specified destination. The relaying service is best effort and the EBCS proxy can decide not to relay the HLP payload if any of the implemented criteria for relaying are not satisfied or for any other reason.

For example, an AP vendor (or an operator) that has one or more APs deployed at a certain venue (such as an airport or a hotel) can establish a business relationship with one or more cloud providers (such as the one that specializes in baggage tracking or logging of sensor data). The AP vendor (or the operator) can configure (default) rules at an EBCS proxy (which is affiliated with the APs at the venue) for providing the relaying service while additional (destination specific) rules are set up based on the service agreement with the cloud provider. Based on these rules an EBCS proxy determines whether to relay the HLP payload carried in an EBCS UL frame that it receives. For example, if it receives an EBCS UL frame with a destination that is not part of any agreement, then based on local policies, it will not relay the HLP payload carried in the frame. Similarly, if the authentication of the EBCS UL frame fails, then based on the relationship with the entity at the specified destination, it will not relay the HLP payload carried in the frame.

NOTE 1 —The communication between an EBCS relaying STA and its affiliated EBCS proxy and the communication between an EBCS proxy and a specified destination are out of scope of this standard.

NOTE 2 —An EBCS proxy evaluating various criteria before it relays an HLP payload helps reduce the likelihood of a DoS attack on the specified destination.

NOTE 3—An operator can install one or more EBCS relaying STAs at a certain location with the intention of only providing relaying service. In such a deployment scenario, the EBCS relaying STAs will not beacon or establish an infrastructure BSS.

4.5.12.3.3 Example configurations for EBCS proxy

The figures in this subclause show EBCS APs each affiliated with their respective EBCS proxy providing relaying service. However, the same explanation would apply if any of the EBCS APs is replaced with an EBCS relaying STA that does not transmit a Beacon frame.

Figure 4-20b provides an example of the relaying service based on a relationship with a specified destination.

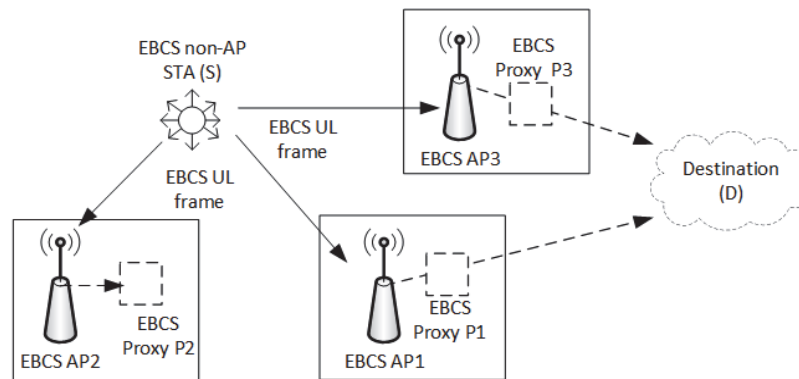


Figure 4-20b—Illustration of relaying operation at EBCS APs with collocated EBCS proxy

In this figure, EBCS proxies P1, P2 and P3 are collocated with EBCS APs A1, A2, and A3, respectively. EBCS proxy P1 and EBCS proxy P3 have established a relationship with a destination (D). An EBCS non-AP STA (S) transmits an EBCS UL frame that is received by EBCS APs in the neighborhood (i.e., AP1, AP2, and AP3). The EBCS UL frame carries the HLP payload, a field carrying the address of D and other fields for security. P1 and P3 verify the certificate of S based on their agreement with D and perform a replay check to determine whether the criteria for relaying the HLP payload to D are met. If the local policy or the agreement with D requires limiting the amount or frequency of payloads being sent to D, then P1 and P3 determine whether or not to relay their received payloads to D, based on whether or not prior transmissions have reached the limit. If the agreement with D requires the inclusion of additional

information, P1 and P3 embed appropriate information, before relaying the HLP payload. In Figure 4-20b, EBCS AP2 discards the EBCS UL frame. This could be for any number of reasons such as that the AP does not provide a relaying service, that the AP's collocated proxy has not established a relationship with D, or that one or more criteria for relaying have not been satisfied.

NOTE—If an entity at a destination has relationships with multiple EBCS proxies, it might, as part of the agreement with each proxy, set a relaying limit (e.g., amount or frequency of relaying per proxy) so that the aggregate from all the proxies is below a certain threshold. In addition, EBCS proxies might collaborate to limit the aggregate payload being relayed to the specified destination. Such mechanisms are out of scope of this standard.

In another example, depicted in Figure 4-20c, the EBCS proxy (P) is not collocated with either EBCS AP1 or EBCS AP3, but resides on an entity (such as a network controller) in the LAN that AP1 and AP3 belong to. EBCS AP1 and EBCS AP3 send the contents of the EBCS UL frame to P, which evaluates whether the criteria for relaying are met before it relays a single copy of the HLP payload to the specified destination.

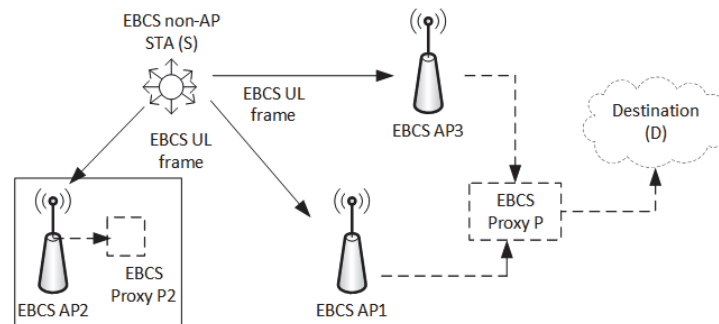


Figure 4-20c—Illustration of relaying when EBCS proxy is not collocated within an EBCS AP

The configuration shown in Figure 4-20c could be prevalent in commercial deployments, such as airports, train stations, malls, or a warehouse, where multiple EBCS APs are likely to be connected to a single entity on a common LAN (such as a network controller), which provides access to destinations outside the LAN. In such a configuration, the EBCS proxy resides on an entity in the LAN. On the other hand, the configuration shown in Figure 4-20b could be prevalent in residential deployments where an EBCS AP has direct connectivity to destinations outside the LAN.

5. MAC service definition

5.1.4 MSDU format

Insert the following new item into the list and renumber item g) as shown:

f) If the transmitting mesh STA peers only with an EPD mesh STA, use EPD.

g) For EBCS transmissions, use EPD.

~~gh)~~ For all other cases, use LPD.

5.1.5 MAC data service architecture

Change Figure 5-1 as follows:

IEEE Std 802.11bc-2023
IEEE Standard for Information Technology—Local and Metropolitan Area Networks—Specific Requirements
Part 11: Wireless LAN MAC and PHY Specifications—
Amendment 7: Enhanced Broadcast Services

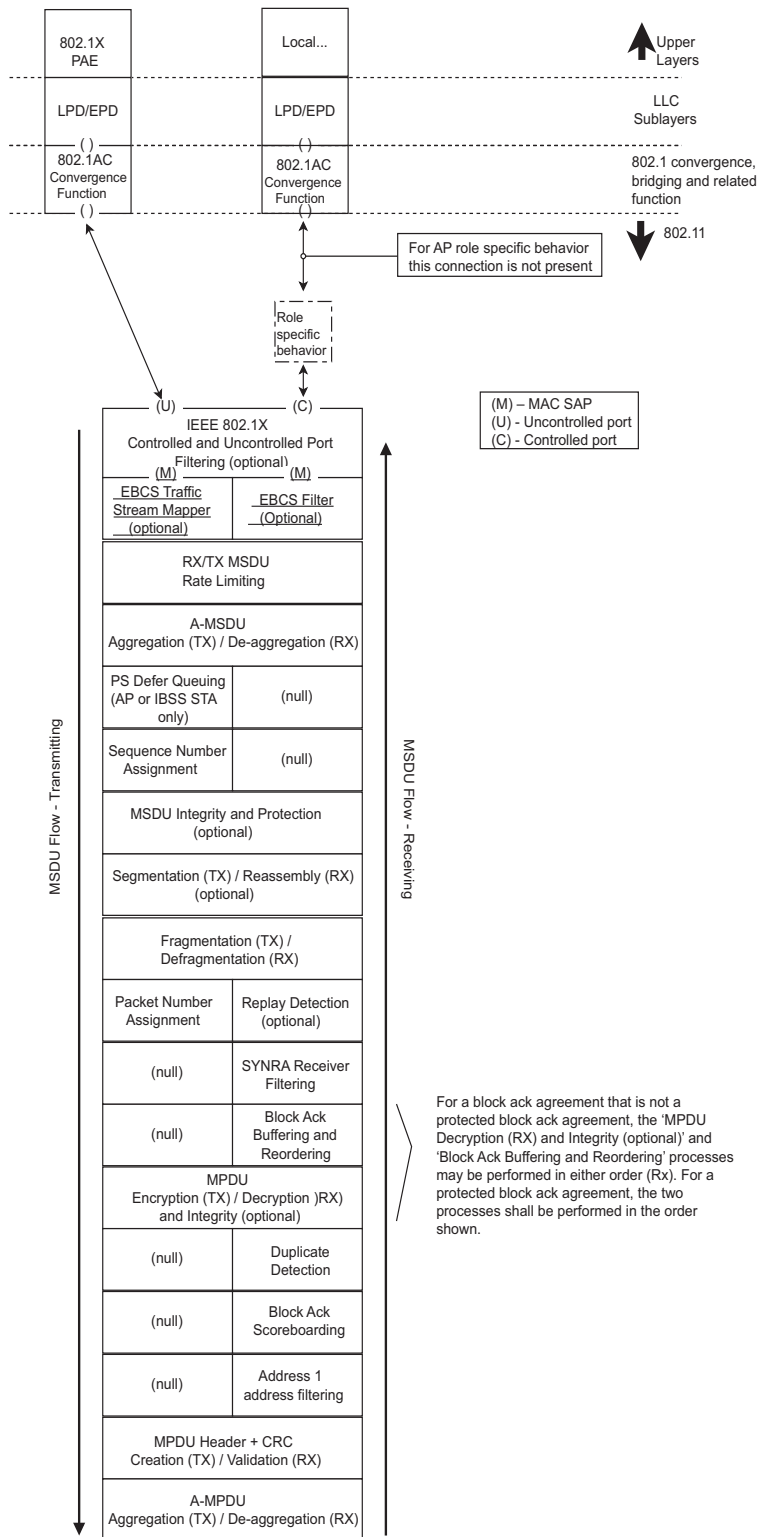


Figure 5-1—MAC data plane architecture

5.1.5.2 Non-GLK non-AP role

Change the text in paragraph 1, insert a new paragraph 2, number the existing note as Note 1, and insert a new Note 2 as follows:

The MAC data plane architecture of a non-GLK non-AP STA is completed by replacing the role-specific behavior block with ~~that~~ the block shown in Figure 5-3. The function of this block in a non-AP STA is to perform destination address filtering as described in 10.2.7.

In the context of EBCS DL, the EBCS filter fills the source address and the destination address in MA-UNITDATA.indication according to 33.2.

NOTE 1—In implementations, the DA address filtering function may be done “lower in the stack.” It is shown in the role-specific behavior block location for simplicity, and any implementation choice needs to provide equivalent behavior.

NOTE 2—Since the IEEE 802.1X Controlled and Uncontrolled Port Filtering block shown in Figure 5-1 does not exist in an unassociated non-AP STA, an EBCS DL traffic stream passes through the IEEE 802.1X Controlled and Uncontrolled Port Filtering block shown in Figure 5-1.

5.1.5.3 Non-GLK AP role

Insert a new paragraph preceding the existing note, number the existing note as Note 1, and add a new Note 2 as shown.

The assigned Content ID and the configured EBCS AP group ID are encoded into the Address fields in the MAC header by the EBCS traffic stream mapper according to 33.2.

NOTE 1—This behavior block indicates that there is no access through the controlled port to or from the local upper-layers (the LLC sublayer) at an AP. Any such access is logically achieved in the architecture via transition of the DS and Portal to an integrated LAN. In actual implementations, this is likely to be optimized, and Data frames appear to be delivered directly to one or more local LLC sublayer entities on the same physical device as the AP. Such optimization is effectively distributing the functions of the DS and Portal, and it is the responsibility of the implementation to ensure the logical behavior of these entities is maintained.

NOTE 2—The EBCS DL traffic stream might originate from another STA in the ESS or from a device outside the ESS, through a portal.

6. Layer management

6.3 MLME SAP interface

6.3.129 MLME-EBCSINFO procedures

Insert the following new subclauses, 6.3.129.1 to 6.3.132, after 6.3.129:

6.3.129.1 General

This subclause describes the management procedures associated with EBCS Info frames.

6.3.129.2 MLME-EBCSINFO.request

6.3.129.2.1 Function

This primitive requests the transmission of an EBCS Info frame. It is valid only at an EBCS transmitter.

6.3.129.2.2 Semantics of the service primitive

The primitive parameters are as follows:

```
MLME-EBCSINFO.request(  
    EBCSInfoAuthenticationAlgorithm,  
    PrivateKey,  
    Certificate,  
    EBCSTIM,  
    ContentInformationSet  
)
```

Name	Type	Valid range	Description
EBCSInfoAuthenti- cationAlgorithm	Integer	As defined in 9.6.7.54	Specifies the authentication algorithm of the EBCS Info frame.
PrivateKey	Sequence of octets	As defined in 12.14.1	Specifies the private key for signature generation.
Certificate	Sequence of octets	As defined in 9.6.7.54	Specifies the certificate to be included in the EBCS Info frame. Present if the EBCS Info Authentication Algorithm subfield indicates that a certificate is present.
EBCSTIM	EBCS TIM element	As defined in 9.4.2.310	The information for the EBCS TIM.
ContentInforma- tionSet	Set of Content Information fields as defined in the EBCS Info frame format	As defined in 9.6.7.54	A set of Content Information fields, each representing a content information EBCS transmitter advertised.

6.3.129.2.3 When generated

This primitive is generated by the SME to request the transmission of an EBCS Info frame.