
**Telecommunications and exchange
between information technology
systems — Requirements for local and
metropolitan area networks —**

**Part 11:
Wireless LAN medium access control
(MAC) and physical layer (PHY)
specifications**

**AMENDMENT 4: Enhancements for
transit links within bridged network**

*Télécommunications et échange entre systèmes informatiques —
Exigences pour les réseaux locaux et métropolitains —*

*Partie 11: Spécifications du contrôle d'accès du milieu sans fil (MAC)
et de la couche physique (PHY)*

*AMENDEMENT 4: Améliorations pour les liaisons de transit dans un
réseau ponté*



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IEEE Std 802.11ak™-2018

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as amended by IEEE Std 802.11aj™-2016,
IEEE Std 802.11ah™-2016,
and IEEE Std 802.11aj™-2018)

**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 4: Enhancements for Transit Links
Within Bridged Networks**

Sponsor
**LAN/MAN Standards Committee
of the
IEEE Computer Society**

Approved 8 March 2018
IEEE-SA Standards Board

Abstract: Protocols, procedures, and managed objects to enhance the ability of IEEE 802.11™ media to provide transit links internal to IEEE 802.1Q™ bridged networks are specified in this amendment to IEEE Std 802.11™-2016.

Keywords: bridged, bridging, EPD, GCR, GLK, GLK-GCR, IEEE 802.11™, IEEE 802.11ak™, IEEE 802.1Q™, LPD, priority code point, SYNRA, transit link

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Introduction

This introduction is not part of IEEE Std 802.11ak-2018, IEEE Standard for Information technology—Local and metropolitan area networks—Specific requirements—Part 11: Wireless LAN MAC and PHY Specifications—Amendment 3: Enhancements for Transit Links Within Bridged Networks.

IEEE Std 802.11™ was originally designed with the assumption that non-access point (non-AP) non-mesh stations (STAs) would be leaf nodes of the network. This amendment extends IEEE Std 802.11 so that communication links can be established between general link (GLK) STAs that are usable as transit links inside an IEEE 802.1Q™ network.

Areas of extension and related improvements include the following:

- a) Optional support of IEEE 802[®] length/type (EPD) frame encoding, as opposed to ISO/IEC 8802-2: 1998 logical link control (LLC) encoding (LPD).
- b) Facilities for GLK APs to send group addressed Data GLK frames to a subset of receiving GLK STAs.
- c) Priority code points in IEEE Std 802.1Q™ have a different default meaning than they do in IEEE Std 802.1D™. For example, in IEEE Std 802.1Q, priority 2 is, by default, higher priority than priority 1, while in IEEE Std 802.1D, it is lower. Thus it is suggested in Annex V that GLK associations use a Priority code point to user priority mapping in their corresponding IEEE 802.1Q bridge port.
- d) Accessibility to the wireless medium via one or more Internal Sublayer Service service access points (SAPs) that map to attached bridge ports.
- e) Improvement of groupcast with retries (GCR) setup to extend GCR to GLK STAs.

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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 4: Enhancements for Transit Links
Within Bridged Networks**

(This amendment is based on IEEE Std 802.11™-2016 as amended by IEEE Std 802.11ai™-2016, IEEE Std 802.11ah™-2016, and IEEE Std 802.11aj™-2018.)

NOTE—The editing instructions contained in this amendment define how to merge the material contained here into the base document and its other amendments to form the new comprehensive standard.

Editing instructions are shown ***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 either ~~strike through~~ (to remove old material) or 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 large changes in existing text, subclauses, tables, or figures by removing existing material and replacing it with new material. Editorial notes will not be carried over into future editions because the changes will be incorporated into the base standard.¹

1. Overview

1.3 Supplementary information on purpose

Insert the following item at the end of the dashed list in 1.3:

- Defines the mechanisms for communications over the wireless medium used as a link in an IEEE 802.1Q™ bridged network.

¹ Notes in text, tables, and figures are given for information only and do not contain requirements needed to implement the standard.

2. Normative references

Insert the following normative reference into Clause 2 in alphanumeric order:

IEEE Std 802.1AC™-2016, IEEE Standard for Local and metropolitan area networks—Media Access Control (MAC) Service Definition.

3. Definitions, acronyms, and abbreviations

3.1 Definitions

Change the following definition in 3.1 as shown:

distribution system access function (DSAF): A function within an access point (AP) or mesh gate that uses the medium access control (MAC) service and distribution system service (DSS) to provide access between the distribution system (DS) and the wireless medium (WM). Within a general link (GLK) AP or GLK mesh station (STA), the DSAF also switches GLK traffic to the GLK convergence function and from there to the IEEE 802.1Q bridge port.

3.2 Definitions specific to IEEE Std 802.11

Insert the following definitions into 3.2 in alphabetic order:

attached bridge: An IEEE 802.1Q bridge that has one or more bridge port Enhanced Internal Sublayer Service (EISS) interfaces supported by general links (GLKs) provided by a GLK access point (AP), GLK non-AP station (STA), GLK mesh STA, or GLK independent basic service set (IBSS) STA.

general link (GLK): A point-to-point connection between two instances of the IEEE 802.1D Internal Sublayer Service that uses an IEEE 802.11 wireless link between stations (STAs). A general link is suitable for use in an IEEE 802.1Q bridged network.

general link (GLK) convergence function: The convergence function defined in IEEE Std 802.1AC between an IEEE 802.11 medium access control (MAC) and an IEEE 802.1Q bridge.

general link groupcast with retries (GLK-GCR): A variant of GCR that specifies the use of GCR for general link.

general link (GLK) station (STA): A STA that implements GLK functionality.

Change the following definition in 3.2 as shown:

medium access control (MAC) service tuple: The collection of a MAC service data unit (MSDU) along with the associated source address, destination addresses, priority, ~~and~~ service class, optional set of service access point identifiers, and optional indication of whether the supplied associated with the MSDU is in EtherType Protocol Discrimination (EPD) or Logical link control (LLC) Protocol Discrimination (LPD) format, which are all passed as parameters across the MAC service access point (SAP) and are all except the service access point identifiers delivered across the distribution system between access points (APs), mesh gates, and the portal of an extended service set (ESS).

Insert the following definitions into 3.2 in alphabetic order:

method-specific service access point (SAP) (MS-SAP): The point at which an instance of the IEEE 802.11 method-specific medium access control (MAC) service is offered.

synthetic receiver address (SYNRA): A constructed group address used by a general link (GLK) access point (AP) as a receiver address to forward frames to a subset of GLK non-AP stations (STAs), as required by IEEE 802.1Q bridges.

3.4 Abbreviations and acronyms

Insert the following abbreviations into 3.4 in alphabetic order:

GLK	general link
GLK-GCR	general link groupcast with retries
MS-SAP	method specific service access point
SYNRA	synthetic receiver address

4. General description

4.2 How wireless local area networks (WLANs) are different

4.2.5 Interaction with other IEEE 802[®] layers

Change the first sentence of the first paragraph of 4.2.5 as follows:

IEEE Std 802.11 is required to appear to higher layers [logical link control (LLC) sublayer] as a general-purpose IEEE 802 LAN.

4.3 Components of the IEEE 802.11 architecture

4.3.5 Distribution system (DS) concepts

4.3.5.1 Overview

Change the second paragraph of 4.3.5.1 as follows:

Instead of existing independently, an infrastructure BSS might also form a component of an extended form of network that is built with multiple BSSs. The architectural component used to interconnect infrastructure BSSs is the DS for non-general link (non-GLK) operation. The DS and extended service set (ESS) are mechanisms for expanding connectivity for non-GLK operation. For GLK operation, an IEEE 802.1Q bridge might be used to form an extended network (see 4.3.27).

4.3.7 Integration with non-IEEE 802.11 LANs

Change the first paragraph of 4.3.7 as follows:

To integrate the IEEE 802.11 non-GLK architecture with a non-IEEE 802.11 LAN, including a traditional wired LAN, a final logical architectural component is introduced—a *portal*. The IEEE 802.11 GLK architecture (see 4.3.27) does not include the concept of a portal.

4.3.20 Mesh BSS

4.3.20.4 IEEE 802.11 components and mesh BSS

Change the second and third paragraphs of 4.3.20.4 as follows:

However, instead of existing independently, an MBSS might also interconnect with other BSSs through access the distribution system (DS) or a bridged LAN. The MBSS interconnects with other BSSs through the DS. Then, mesh STAs can communicate with nonmesh STAs. ~~Therefore, a~~ A logical architectural component is introduced in order to integrate the non-GLK mesh STA MBSS with the DS—the mesh gate. Data move between a non-GLK ~~an~~ MBSS and the DS via one or more mesh gates. Thus the mesh gate is the logical point at which MSDUs from ~~an~~ a non-GLK MBSS enter the ~~IEEE 802.11 DS, via the DSAP. In a~~ GLK MBSS, mesh STAs can communicate with nonmesh STAs via a GLK mesh STA with an attached bridge port and from there to the bridged LAN. Once an MBSS contains a mesh gate that connects it to the ~~IEEE 802.11 DS or a GLK mesh STA that connects it to a bridge port,~~ the MBSS can be integrated with other infrastructure BSSs ~~too,~~ given that their APs connect to the same DS or bridged network. Several mesh gates are shown in Figure 4-9 connecting different MBSSs to the DS.

When an MBSS accesses the ~~IEEE 802.11 DS or a bridged network through its mesh gate,~~ the MBSS can be integrated with a non-IEEE-802.11 LAN. To integrate ~~the IEEE 802.11 a DS to which this MBSS connects,~~ the DS needs to contain a portal. See 4.3.7. Consequently, mesh gate and portal are different entities. The portal integrates the IEEE 802.11 architecture with a non-IEEE-802.11 LAN (e.g., a traditional wired LAN), ~~whereas the~~ The mesh gate integrates the MBSS with the ~~IEEE 802.11 DS. A GLK mesh STA integrates the MBSS with a bridged network.~~

Insert the following subclauses (4.3.27 and 4.3.28, including Figure 4-13a, Figure 4-13b, and Figure 4-13c) after 4.3.26:

4.3.27 General link (GLK)

4.3.27.1 General

GLK STAs establish general links with other GLK STAs. These general links are suitable to be used as links inside an IEEE 802.1Q network. For an infrastructure general link example, see Figure 4-13b (in 4.3.27.3.3).

A GLK STA coordinates with a GLK convergence function to provide the Internal Sublayer Service, as defined in IEEE Std 802.1AC, to an IEEE 802.1Q bridge for each peer GLK STA with which it is communicating. GLK STAs also provides link metrics for the use of external path selection protocols such as spanning tree protocol.

A GLK STA that starts a BSS uses membership selector values to set the BSS policy of requiring or not requiring general link or Ethertype protocol discrimination (EPD) support for any STA that joins the BSS.

A non-AP STA acts as either a GLK STA or a non-GLK STA. A GLK AP might permit associations from non-GLK STAs and acts as a non-GLK AP for those associated non-GLK STAs. GLK DMG STAs can establish a general link through a DMG relay. GLK S1G STAs cannot use or be a S1G relay.

The four-address MAC header can be used in GLK transmissions of Data frames. The use of the four-address MAC header or basic A-MSDU format is necessary for such MPDUs if the frame's SA, TA, RA, and DA fields (source address, transmitter address, receiver address, and destination address, respectively) are all different from each other. The three-address frame format can be used, as defined by Table 9-3, provided the addresses are consistent with Table 9-26.

A SYNRA is a group address RA used by a GLK AP to forward frames to a subset of GLK non-AP STAs, as required by IEEE 802.1Q bridges. The use of a SYNRA can improve bandwidth usage in some cases. SYNRAs are used in GLK AP transmissions.

As described in 4.3.27.2, when a GLK AP transmits a Data frame with a four-address MAC header whose RA contains a group address, the contents of the RA is a synthetic receiver address (SYNRA), and therefore its RA and DA values will not be equal. A GLK non-AP STA supports selective reception of group addressed frames by supporting SYNRA reception.

4.3.27.2 Selective reception of group addressed frames

For the reasons given below, when transmitting a data MPDU that has a group address RA to a set of receiving STAs, the GLK transmitter needs to transmit those MSDUs so that they are accepted by a specified subset of the associated GLK STAs indicated by the IEEE 802.1Q bridge.

The reason for such selective reception is to support requirements of IEEE 802.1Q bridges and can include the MAC service requirements that, when an MSDU is sent, it is not subsequently received and processed by the transmitting station or to break loops in the network topology. When a GLK STA associated with a GLK AP sends an MSDU to that AP with a group address destination, the AP retransmits it and uses the selective reception facility to stop the originating GLK STA from accepting it. Also, since the AP Internal Sublayer Service SAPs are mapped to IEEE 802.1Q bridge ports, loop prevention might need the traffic to be blocked to one or more of the associated GLK STAs. Such blocking can be implemented by the selective reception facility.

Implementation of this selective reception facility in a BSS case includes use of a synthetic group address RA (SYNRA addressing, see 9.3.2.1.2). As an alternative to the use of a SYNRA, selective reception includes sending a copy of the Data frame to each intended receiver using individually addressed MPDUs. In either case, an appropriate address format is needed because the DA is different from the RA (since the RA is either the SYNRA or a serial individual RA). SYNRA addressed MPDUs are transmitted by APs only.

All GLK non-AP STAs in an infrastructure BSS support receipt of SYNRA (see 9.3.2.1.2 and 10.66). A GLK AP that is requested to deliver an MPDU to multiple GLK STAs can choose to construct and transmit a SYNRA addressed MPDU, use a sequence of unicast MPDUs, or both.

Parameters exchanged during the association (or reassociation) of a GLK STA with a GLK AP determine the mechanism used by the GLK AP to enable selective reception at the GLK STA of group addressed frames transmitted by the GLK AP. One such mechanism is GLK-GCR, which is a subset of GCR customized for general links (see 11.24.16). In GLK-GCR the group address is a SYNRA. Features of GCR that do not apply to GLK-GCR are as follows:

- a) DMS Request and DMS Response frame exchange to set up GLK-GCR service
- b) ADDBA Request/Response frame exchange to setup block ack agreement
- c) GCR-SP delivery method
- d) Unsolicited DMS Response frame for “GCR Advertise”
- e) Concealment address

4.3.27.3 GLK Service Sets

4.3.27.3.1 Provision of the MAC service

MAC service data unit (MSDU) delivery services in an IEEE 802.1Q network can be supported by the IEEE 802.1AC MAC service. GLK STAs coordinate with an IEEE 802.1AC-compliant GLK convergence function, to provide access to the WM via one or more Internal Sublayer Service SAPs. The routing of all MSDUs that are provided by an IEEE 802.1Q relay entity via GLK STAs is controlled by the routing protocols of the IEEE 802.1Q network to which the GLK STA is attached. This enables the routing protocols to use all the general links available to the GLK STA.

4.3.27.3.2 GLK IBSS and PBSS

A GLK IBSS or GLK PBSS can provide access to the WM via general links that are suitable for use in an IEEE 802.1Q network. Figure 4-13a shows an example of a GLK IBSS (or equivalently a PBSS) involving three GLK non-AP STAs. Each participating STA provides MAC services at the MS-SAP, with the inclusion of a station vector that is then mapped to one or more Internal Sublayer Service SAPs by the IEEE 802.1AC GLK Convergence Function. Three general links are shown that connect three pairs of Internal Sublayer Service SAPs in a point-to-point manner. Each of the Internal Sublayer Service SAPs is then mapped to either an Enhanced Internal Sublayer Service (EISS) SAP or MAC-SAP, by the IEEE 802.1Q Media Independent Function or the Internal Sublayer Service to MAC-SAP function, respectively. 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 Sublayer.

NOTE—IEEE Std 802.11 does not specify the details of the IEEE 802.1AC GLK 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 Sublayer. These entities are specified in other documents such as IEEE Std 802.1AC™-2016 and IEEE Std 802.1Qbz™-2016 [B24a]. These entities are shown with dashed outlines in the figure. Entities that IEEE Std 802.11 does specify are shown with solid outlines and are within the box labeled “802.11 GLK IBSS/PBSS.”

A difference from a non-GLK STA's IEEE 802.11 IBSS/PBSS is that either or both MAC-SAPs could directly connect to an IEEE 802.1Q bridge.

For example, each of the STAs and attached bridges (including the IEEE 802.1Q MAC Relay Entities) shown could be at the top of a rack in a data center to provide inter-rack connectivity. The two MAC-SAPs shown could even be safely connected to the same IEEE 802.1Q network, since such a network provides protection from loops.

Also, shown in the figure is the possibility to provide a point-to-point link between two LLC Sublayer entities that are each attached to a GLK non-AP STA. For example, this link could allow a computer attached to a GLK STA to directly connect to a network attached storage device attached to a GLK STA.

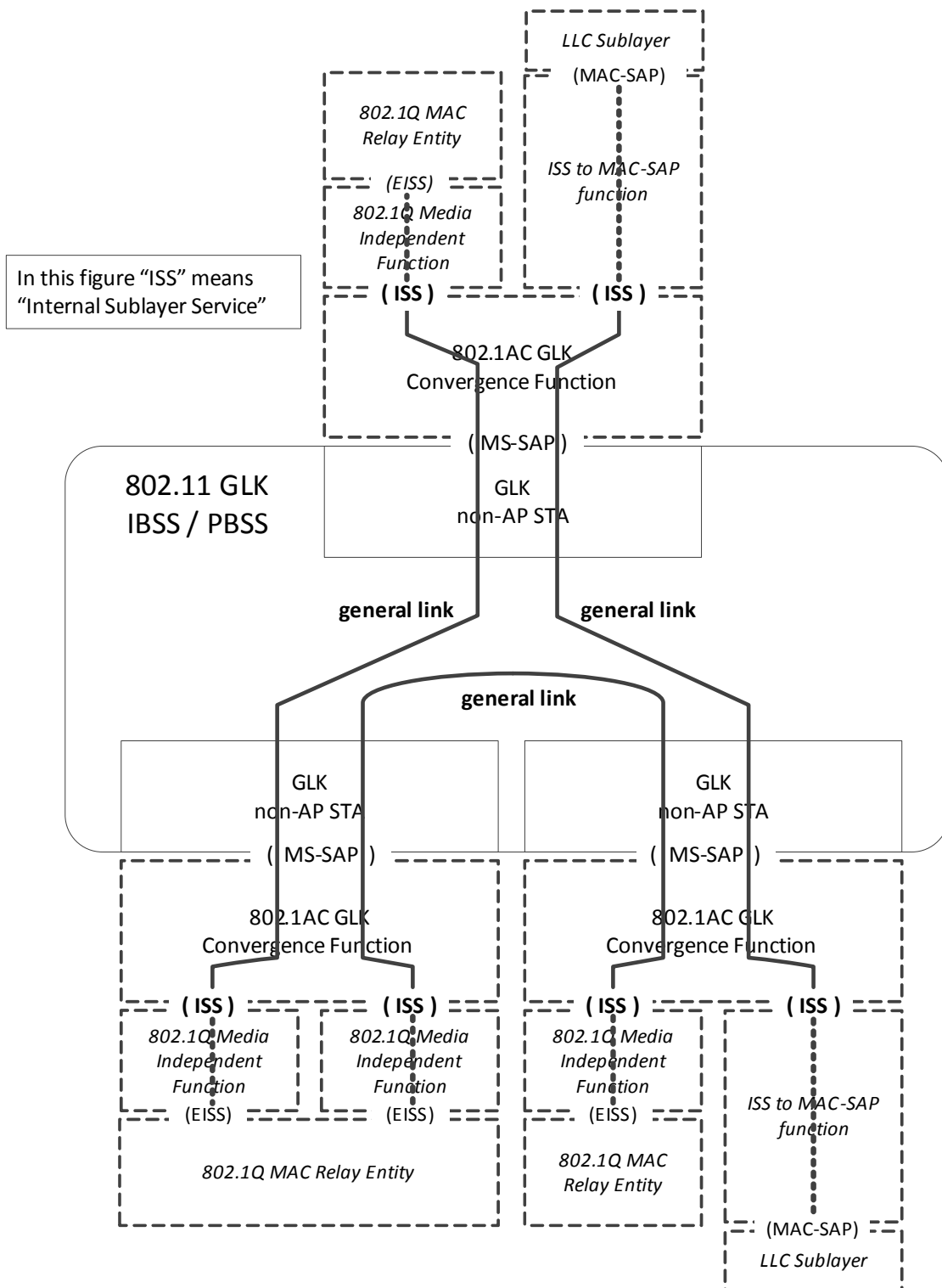


Figure 4-13a—Example of GLK IBSS or PBSS

4.3.27.3.3 Infrastructure BSS with general links

A GLK infrastructure BSS can provide access to the WM via general links that are suitable for use in an IEEE 802.1Q network. Figure 4-13b shows an example of a GLK infrastructure BSS with three GLK non-AP STAs and one GLK AP. Each participating STA provides MAC services at the MS-SAP, with the inclusion of a station vector that is then mapped to one or more Internal Sublayer Service SAPs by the IEEE 802.1AC GLK Convergence Function. Four general links are shown that connect four pairs of Internal Sublayer Service SAPs in a point-to-point manner. Each of the Internal Sublayer Service SAPs is then mapped, by the IEEE 802.1Q Media Independent Function or the Internal Sublayer Service to MAC-SAP function, to either an EISS SAP or a MAC-SAP, respectively. 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 Sublayer.

NOTE—IEEE Std 802.11 does not specify the details of the IEEE 802.1AC GLK 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 Sublayer. These entities are specified in other documents such as IEEE Std 802.1AC-2016 and IEEE Std 802.1Qbz-2016 [B24a]. These entities are shown with dashed outlines in the figure. Entities that IEEE Std 802.11 does specify are shown with solid outlines and are within the box labeled “802.11 BSS.”

Although transmissions by an AP are typically received by all STAs associated with that AP, the service provided by a GLK infrastructure BSS might be considered as separate point-to-point links between the corresponding Internal Sublayer Service SAPs. Provisioning of such apparent point-to-point links is natural for MPDUs with an individually addressed RA. In order to provide such apparent point-to-point links for group addressed frames, the GLK AP can transmit them so that they are accepted by a subset of the associated GLK STAs. Such selective transmission can be provided through the GLK SYNRA addressing facility (see 4.3.27.2) or by serial transmissions to the desired receivers.

Three types of example general links are shown in Figure 4-13b:

- The first type is an infrastructure general link that connects a non-AP GLK STA attached bridge port of an IEEE 802.1Q MAC Relay Entity with an GLK AP attached bridge (two of these general links are shown in the figure). These links could be used to enhance the reliability and routing options of an IEEE 802.1Q-compliant LAN by providing redundant wireless links between the bridges in the LAN.
- The second type is a non-AP GLK STA to non-AP GLK STA link that connects the STAs’ attached bridges (IEEE 802.1Q MAC Relay Entities). This type of general link is similar to the IBSS or PBSS STA to STA link.
- The third type of general link is a “leaf-node” type of general link that connects entities in the LLC layer attached to a non-AP GLK STA via a general link and an IEEE 802.1Q bridge attached to the GLK AP to another entity available via the IEEE 802.1Q network attached to the GLK AP. Such a general link could provide a connection between a network printer attached to the LAN and a computer attached to the non-AP GLK STA.

A difference between a GLK AP’s IEEE 802.11 links and a non-GLK AP’s IEEE 802.11 links, which can only be connected to an Internal Sublayer Service SAP via a DS and portal, is that an Internal Sublayer Service SAP could directly connect to an IEEE 802.1Q bridge.

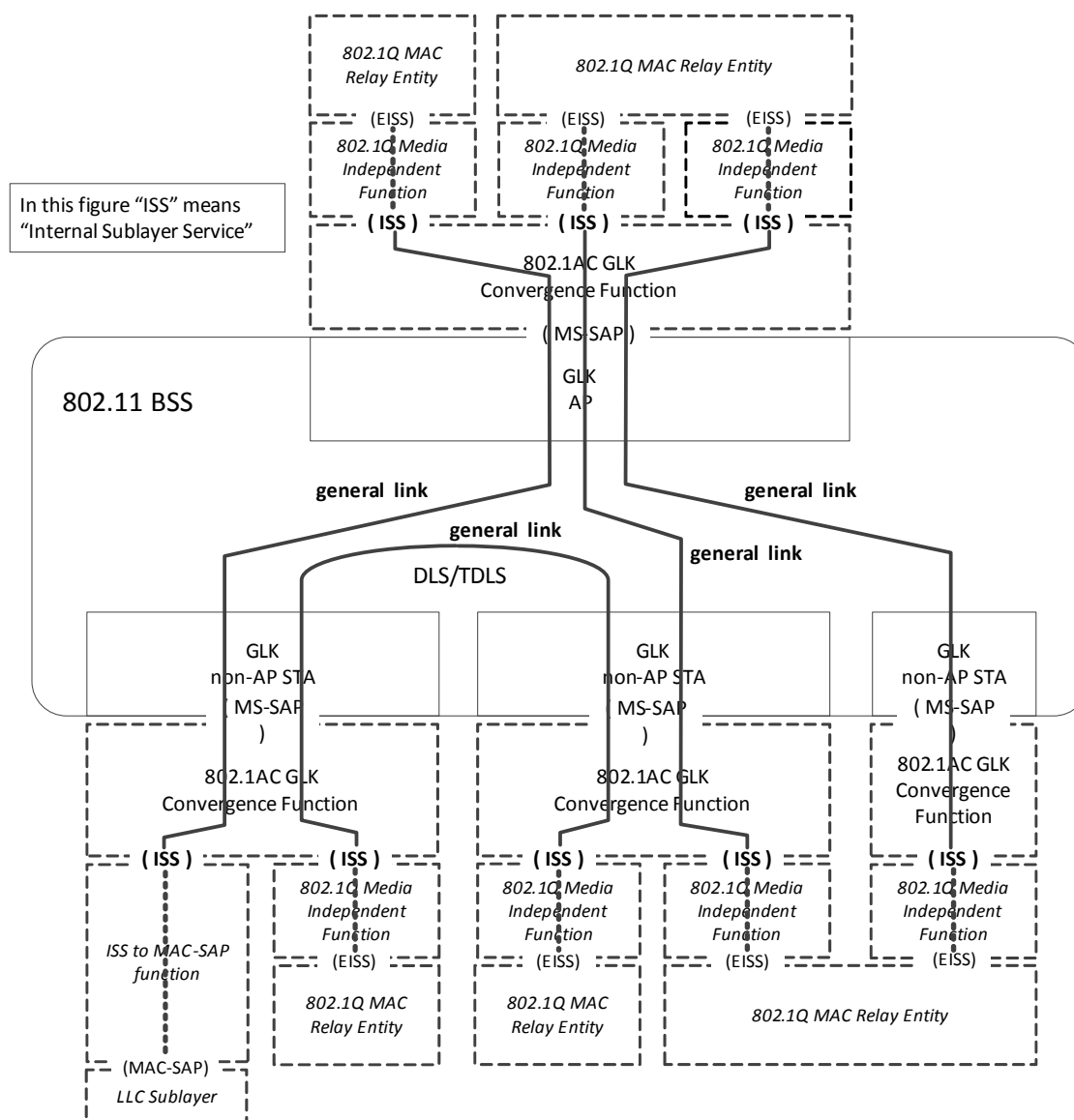


Figure 4-13b—Example of infrastructure BSS with general links

4.3.27.3.4 Infrastructure BSSs with general links in the presence of an ESS

BSSs that support general links can be components of an extended form of network by using the general links within an IEEE 802.1Q bridged network. In such a bridged network, the concept of the DS in a non-GLK ESS is replaced by the other components of the IEEE 802.1Q network. However, such a GLK topology is more general than the non-GLK infrastructure mode. For example, Figure 4-13c shows a network consisting of three types of BSSs: a GLK infrastructure BSS (with only GLK STAs), an infrastructure BSS (with both GLK and non-GLK STAs), and an infrastructure BSS (containing only non-GLK STAs). The example ESS shown in the figure consists of all the non-GLK non-AP STAs, the non-GLK AP, and the portion of the GLK AP that has associated non-GLK non-AP STAs. In the ESS the portal