Draft Supplement to STANDARD FOR Telecommunications and Information Exchange Between Systems - LAN/MAN Specific Requirements -

Part 11: Wireless Medium Access Control (MAC) and physical layer (PHY) specifications:

Medium Access Control (MAC) Enhancements for Quality of Service (QoS)

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Introduction

(This introduction is not part of IEEE P802.11d, Draft Supplement to STANDARD FOR Telecommunications and Information Exchange Between Systems -LAN/MAN Specific Requirements - Part 11: Wireless Medium Access Control (MAC) and physical layer (PHY) specifications: Medium Access Control (MAC) Enhancements for Quality of Service (QoS))

To be added later

Example:

At the time this standard was submitted to Sponsor Ballot, the working group had the following membership:

Current Chair, Chair

Dennis Adam
Greer Wright
The following persons were on the balloting committee:
(To be provided by IEEE editor at time of publication.)

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Draft Supplement to STANDARD FOR Telecommunications and Information Exchange Between Systems - LAN/MAN Specific Requirements -

Part 11: Wireless Medium Access Control (MAC) and physical layer (PHY) specifications:

Medium Access Control (MAC) Enhancements for Quality of Service (QoS)

[This supplement is based on the current edition of IEEE Std 802.11, 1999 Edition and the 802.11a and 802.11b supplements.

NOTE—The editing instructions contained in this supplement define how to merge the material contained herein into the existing base standard to form the new comprehensive standard as created by the addition of IEEE Std 802.11-1999.

The editing instructions are shown in ***bold italic***. Three editing instructions are used: change, delete, and insert. ***Change*** is used to make small corrections in existing text or tables. The editing instruction specifies the location of the change and describes what is being changed either by using strikethrough (to remove old material) or underscore (to add new material). ***Delete*** removes existing material. ***Insert*** adds new material with-out disturbing the existing material. Insertions may require renumbering. If so, renumbering instructions are given in the editing instruction. Editorial notes will not be carried over into future editions.

1.2 Purpose

Insert the following text at the end of 1.2, as part of the indented list:

- Defines the MAC procedures to support LAN applications with Quality of Service requirements, including the transport of voice, audio and video over IEEE 802.11 wireless LANs.

2. Normative References

Insert the following two citations at the appropriate locations in clause 2:

ISO/IEC 15802-3: 1998, Information Technology – Telecommunications and information exchange between systems – Local and metropolitan area networks – Common specifications – Part 3: Media Access Control (MAC) Bridges.

IEEE Std 802.1Q-1998, IEEE Standards for Local and Metropolitan Area Networks: Virtual Bridged Local Area Networks.

3. Definitions

Change the definition of coordination function in 3.13 as follows:

3.13 coordination function

The logical function which determines when a station operating within a Basic Service Set is permitted to transmit and may be able to receive PDUs via the wireless medium. The CF within a BSS may have one PCF or HCF and will have one DCF.

Change the definition of distribution system in 3.20, and insert the informative note, as follows:

3.20 distribution system (DS)

A system used to interconnect a set of basic service sets (BSSs) and portals ~~integrated local area networks (LANs)~~ to create an extended service set (ESS).

NOTE: This correction, and the correction of ESS below, are needed because of a conflict in IEEE Std 802.11-1999 between these definitions and the text clause 5.4.1.2, which states "Messages which are distributed to a portal cause the DS to invoke the integration function (conceptually after the distribution service). The Integration function is responsible for accomplishing whatever is needed to deliver a message from the DSM to the integrated LAN media (including any required media or address space translations)." Clause 5.4.1.2 is correct; whereas the existing definitions, which place the integrated LAN within the DS/ESS, are incorrect. If an integrated IEEE 802.3 LAN (or any other LAN that does not signal user priority) were within the DS/ESS, then QoS traffic from a device on the integrated LAN to an 802.11 station associated in the ESS would not transit a portal, hence there would be no opportunity to regenerate the priority value needed to identify the 802.11 QoS traffic category.

Change the definition of extended service set in 3.25 as follows:

3.25 extended service set (ESS)

A set of one or more interconnected basic service sets (BSSs) and portals ~~integrated local area networks (LANs)~~ that appears as a single BSS to the logical link control sublayer at any station associated with one of those BSSs.

Insert the following new definitions at the appropriate locations in clause 3, renumbering as necessary:

3.51 aggregation

A technique for reducing PHY layer communication overhead by transferring a plurality of sequential MPDUs, addressed to a common destination, in a single, special-format MMPDU known as a *Container* frame. Aggregation preserves the identities of the individual MPDUs, which are extracted from a received Container frame by process known as *disaggregation*. The disaggregated MPDUs are handled in their original sequence by the MAC entity or entities which receive a Container frame. Aggregation may increase the aggregate data throughput within a given basic service area (BSA), but may also cause an increase of latency and/or latency variation (jitter), both for the aggregated MPDUs and for other traffic being transferred within the same BSA.

3.52 bridge portal (BP)

An enhanced station (ESTA) associated in a QoS basic service set (QBSS), but not located at the enhanced access point (EAP), which includes a portal function implemented as, or functionally equivalent to, an IEEE 802.11D MAC bridge or IEEE 802.1Q VLAN bridge. Bridge portals can be used to provide multiple links to the infrastructure within a single QBSS, as well as to provide the sole infrastructure link in cases where the site for physical connection to the infrastructure is a poor location for operation of the EAP or its co-located enhanced point coordinator (EPC).

3.53 contention free burst (CFB)

A technique for reducing MAC layer wireless medium (WM) access overhead and susceptibility to collisions, in which a single station may transfer a plurality of MPDUs during a single transmission opportunity (TXOP), retaining control of the WM by using inter-frame spaces sufficiently short that the entire burst appears to be a single instance of WM activity to contending stations. Burst transfers may increase the aggregate data throughput within a given basic service area (BSA), but may also cause an increase of latency and/or latency variation (jitter) for all traffic being transferred within the same BSA.

3.54 contention free period (CFP)

A time period during operation of a basic service set (BSS) when a point coordination function (PCF) or hybrid coordination function (HCF) is used, and transmission opportunities (TXOPs) are assigned to stations by a point coordinator (PC) or hybrid coordinator (HC), allowing frame exchanges to occur without inter-station contention for the wireless medium (WM).

3.55 contention period (CP)

A time period during operation of a basic service set (BSS) when a distributed coordination function (DCF) or hybrid coordination function (HCF) is used, and transmission opportunities (TXOPs) are either generated locally as stations with pending transfers contend for the WM using a collision sense multiple access algorithm with collision avoidance (CSMA/CA), or are assigned to stations by a hybrid coordinator (HC).

3.56 controlled contention

A contention-based multiple access scheme that may be used by enhanced stations (ESTAs) at QoS level 2 or level 3 to request transmission opportunities (TXOPs) from the enhanced pointhybrid coordinator (HCEPC) without incurring the overhead of periodic polling nor the highly variable delays of DCF-based contention in a busy QBSS. Each instance of controlledcentralized contention occurs solely among a subset of ESTAs that need to send reservation requests which meet criteria defined by the HC, and takes place during a controlledcentralized contention interval (CCI) whose starting time and duration are selected by the HCEPC.

3.57 enhanced access point (EAP)

An access point (AP) that implements the access point functionality required for the optional QoS facility. An EAP can differentiate among at least 8 traffic categories within the traffic to/from each associated ESTA, provides at least 4 transmit queues for differing priorities or other categories of QoS traffic, and supports the enhanced distributed coordination function (EDCF) and hybrid coordination function,.

3.58 enhanced station (ESTA)

A station (STA) that contains an 802.11E conformant medium access control (MAC) sublayer that supports at least QoS levels 0 and 1, and an 802.11 conformant physical (PHY) interface to the wireless medium (WM).

3.59 fragmentation

The process of partitioning a MAC service data unit (MSDU) or MAC management protocol data unit (MMPDU) into a sequence of smaller MAC protocol data units (MPDUs) prior to transmission in order to increase the probability of successful transfer across the WM and/or in order to use available TXOP duration limits efficiently in cases where the remaining TXOP duration is shorter than the time required to transmit the entire pending MSDU. The process of recombining a set of fragment MPDUs into an MSDU or MMPDU is known as defragmentation.

3.60 hybrid coordination function (HCF)

A coordination function that combines aspects of the {enhanced} distributed coordination function and the point coordination function to provide the selective handling of MSDUs required for the optional QoS facility in a manner that is upward compatible from both DCF and PCF, and which uses a uniform set of frame exchange sequences during both the CP and the CFP.

3.61 hybrid coordinator (HC)

A point coordinator, defined as part of the optional QoS facility, that implements the frame exchange sequences and MSDU handling rules defined by the hybrid coordination function, operating during both the CP and CFP. The HC performs bandwidth management including allocating TXOPs to ESTAs and the initiating controlled contention intervals for the sending of reservation requests by ESTAs. An HC is typically collocated with an EAP.

3.62 link

In relation to any IEEE 802.11 MAC entity, a path used to exchange MPDUs with a peer entity, including one or more traversals of the wireless medium and zero or more traversals of non-wireless distribution system media.

3.63 QoS basic service set (QBSS)

A basic service set (BSS) that supports LAN applications with quality of service (QoS) requirements by providing a QoS facility for communication via the wireless medium (WM). A QBSS may also include portals and/or bridge portals that provide QoS-aware integration service.

3.64 QoS facility

The set of enhanced functions, formats, frame exchange sequences and managed objects to support the selective handling of up to 8 traffic categories per direction per bilaterial wireless link. The handling of MSDUs belonging to different traffic categories may vary based on the relative priority indicated for that MSDU, as well as the values of other parameters that may be provided by an external management entity in a traffic specification for the particular traffic category, link and direction.

The priority value is provided with each MSDU at the medium access control service access point (MAC SAP). By default, priority 7 is the highest priority and priority 2 is the lowest priority, with priority 0, which is used for best effort traffic and priority 1 (spare) ordered between priority 3 and priority 2. The resulting default ordering is {7, 6, 5, 4, 3, 0, 1, 2} which matches the recommended priority mapping in IEEE Std 802.1D-1998, Annex H.2.

3.65 remote hybrid coordinator (RHC)

An enhanced station (ESTA) with hybrid coordinator (HC) capability that has been activated to extend the spatial coverage of a QoS basic service set (QBSS) by operating as the enhanced access point (EAP) and HC of a subsidiary QBSS that is linked to the primary QBSS by a wireless distribution system (WDS) link.

3.66 superframe

In the IEEE 802.11E enhanced MAC specification, a contention-free repetition interval in a QBSS, consisting of a single DTIM interval and single beacon interval.

NOTE: The term superframe was used in the initial P802.11 drafts in 1994 to mean a beacon interval that included a CFP and a CP, but was superseded by "contention free repetition interval" in 1995. While superframe is occasionally used informally in material pertaining to IEEE Std 802.11-1999, the term does not appear in the normative text of that standard.

3.67 traffic category (TC)

Any of the identifiers usable for higher-layer entities to distinguish MSDUs to MAC entities that support quality of service (QoS) within the MAC data service.

3.68 traffic specification (TSPEC)

A traffic specification may include quantitative objectives for, or limits on, traffic attributes such as MSDU sizes and arrival rates, traffic characteristics such as constant vs. variable data rate, maximum delivery delay, maximum delay variance (jitter), etc. and/or handling modalies such as acknowledgement policy. The MAC sublayer provides selective handling of MSDUs in a manner which attempts to honor the applicable traffic specifications. However, parameter values in traffic specifications are objectives, not guarantees, and it may be impossible, or may become imposible, for the MAC sublayer to provide the requested bandwidth and/or service quality, even in cases where the requested bandwidth had been indicated as being available and/or the requested service quality has previously been provided

3.69 transmission opportunity (TXOP)

An interval of time when a particular enhanced station (ESTA) has the right to initiate transmissions onto the wireless medium (WM), defined by a starting time and a maximum duration. During the contention period (CP), each TXOP begins either when the medium is determined to be available under the {E}DCF rules or when the ESTA receives a QoS (+)CF-Poll from the HC. The duration of an {E}DCF TXOP is limited by a QBSS-wide TXOP limit distributed in beacon frames, while the duration of a polled TXOP is specified in the frame header that includes the QoS (+)CF-Poll function.. During the contention free period (CFP), the starting time and maximum duration of each TXOP is specified by the HPC, using the QoS {+}CF-Poll function. Within the limits of each TXOP, decisions regarding what to transmit are made locally by the MAC entity at the ESTA.

3.70 wireless station (WSTA)

An enhanced station (ESTA) that is not within an enhanced access point (EAP) nor a bridge portal.

4. Abbreviations and Acronyms

Delete the acronym "CID" from clause 4

~~CID connection identifier~~

Insert the following new acronyms at appropriate locations in clause 4:

BP	bridge portal
CA	collision avoidance
CCI	centralized contention interval
CCOP	centralized contention opportunity
CFB	contention free burst
CSMA	carrier sense multiple access
EAP	enhanced access point
EDCF	enhanced distributed coordination function
ESTA	enhanced station
FEC	forward error correction
HC	hybrid coordinator
HCF	hybrid coordination function
OBSS	overlapping basic service set
PP	permission probability
PSDU	physical {layer} service data unit
QBSS	quality of service basic service set
QC	QoS control
QoS	quality of service
RHC	remote hybrid coordinator
TC	traffic category
TCA	traffic category and association {identifier}
TCID	traffic category identifier
TSPEC	traffic specification
TXOP	transmission opportunity
WSTA	wireless {enhanced} station

5.1.1.2 The Media Impact the Design

Insert the following text at the end of the indented list:

g) May experience interference from logically disjoint 802.11 networks operating in adjacent or overlapping areas.

5.1.1.4 Interaction with Other 802 Layers

Insert the following paragraph at the end of 5.1.1.4:

When used to support applications with quality of service requirements, each IEEE 802.11 LAN is a single link within an end-to-end QoS environment that may be established between, and managed by, higher layer entities. To handle QoS traffic in a manner comparable to other IEEE 802 LANs, despite the enormous differences in characteristics of the underlying media, IEEE 802.11E entities incorporate QoS functionality that is untraditional for QoS support by MAC sublayers. In addition, it may be necessary for certain higher layer management entities to be "WLAN aware" at least to the extent of understanding that the available bandwidth and other QoS characteristics of a WLAN are subject to frequent, and sometimes substantial, dynamic changes due to causes other than traffic load and outside the direct control of network management entities.

Insert the following subclause after 5.2.2.1:

5.2.2.2 QBSS: The Quality of Service Network

IEEE 802.11E provides several, strictly nested levels of optional MAC enhancements to support LAN applications with quality of service (QoS) requirements. The QoS enhancements are available to an enhanced stations (ESTA) associated in a QoS BSS (QBSS), at a level negotiated between the ESTA and enhanced access point (EAP) of the QBSS, at the time the ESTA's association is established. A subset of the QoS enhancements may be available for use between ESTAs that are members of the same (IBSS). Clause 19 provides a description of the optional QoS levels and the services QoS support available at each level.

5.2.3 Area Concepts

Insert the following paragraph at the end of 5.2.3:

The spatial coverage of a BSS is limited, often due to attenuation by intervening structural materials, in ways that cause undesirable discontinuities of LAN connectivity. IEEE 802.11E allows dynamic activation of wireless repeater functionality at preconfigured stations to extend spatial coverage in such cases. The repeater becomes the AP of a subsidiary BSS while also serving as an associated station in the primary BSS. The wireless link between the repeater and the primary AP serves as a wireless distribution system for infrastructure access by stations associated with the secondary BSS. Additional information about wireless repeaters appears in clause 19.

5.2.4 Integration with Wired LANs

Insert the following paragraph at the end of 5.2.4:

A portal is an abstract single point of connection between an IEEE 802.11 LAN and other LANs. In IEEE 802.11E there may be multiple ESTAs in a single QBSS that provide integration services to separate, non-IEEE 802.11 networks. Any such stations that are not the EAP of the QBSS are known as bridge portals (BPs). Additional information about bridge portals appears in clause 19.

Insert the following subclause after 5.2.4:

5.2.5 Integration with Entities that Provide End-to-End Quality of Service

Annex F (informative) presents recommended practices for integration between IEEE 802.11E QoS support and higher layer bandwidth and/or connection management entities.

5.3 Logical Service Interfaces

Insert the following item at the end of the list:

- QoS traffic scheduling

5.3.1 Station Services

Insert the following item at the end of the list:

- QoS traffic scheduling

5.3.2 Distribution System Services

Change the third paragraph as follows:

The DSSs are provided by the DS. They are accessed via a STA that also provides DSSs. A STA in a BSS or IBSS that is providing access to DSS is an AP. In a QBSS, the ESTA that is providing access to DSS is an EAP. In a QBSS, there may also be other ESTAs, called bridge portals (BPs) that provide access to the integration service, but do not provide access to other DSSs.

Insert the following item at the end of the list:

k) QoS traffic scheduling (IEEE 802.11E only)

5.4 Overview of the Services

Change the first paragraph as follows:

There are ten services specified by IEEE 802.11E. Six of the services are used to support MSDU delivery between STAs. Three of the services are used to control IEEE 802.11 LAN access and confidentiality. One of the services are used to support LAN applications with QoS requirements.

5.4.1.1 Distribution

Change the final paragraph as follows:

While IEEE 802.11 does not specify DS implementations, it does recognize and support the use of the WM as the DSM. This is specifically supported by the IEEE 802.11 frame formats. (Refer to Clause 7 for details.) IEEE 802.11E also defines a remote hybrid coordinator (RHC) capability that allows dynamic activation of a subsidiary QBSS, linked to the primary QBSS by a wireless distribution system, to when necessary to extend the spatial coverage of a QBSS.

5.4.1.2 Integration

Insert the following paragraph between the third and fourth existing paragraphs:

IEEE 802.11E includes specific provisions for multiple entities providing integration service at different ESTAs of a QBSS. An ESTA that provides integration service but does not provide distribution service is known as a bridge portal. Bridge portals, like all other ESTAs, obtain distribution services from the EAP of the QBSS.

Insert the following subclause after 5.4.1.2:

5.4.1.3 QoS Traffic Scheduling

QoS traffic scheduling provides intra-QBSS QoS transfers under an enhanced distributed coordination function (EDCF), as well as a hybrid coordination function (HCF). At each transmission opportunity (TXOP), a traffic scheduling entity at the ESTA or EAP selects a frame for transmission, from the set of frames at the heads of a plurality of traffic queues, based on requested MSDU priority and/or parameter values in the traffic specification for the requested traffic category. Additional information is available in clauses 9 and 19.

5.4.2.1 Mobility Types

Insert the following item at the end of the list:

d) *QBSS-transition:* This type is defined as an enhanced station movement from one QoS Basic Service Set in one Extended Service Set to another QoS Basic Service Set within the same Extended Service Set. End-to-end QoS connections are maintained, although user-visible, temporary disruption may occur during handover.

5.4.2.2 Association

Change the second and third paragraphs of 5.4.2.2 as follows:

Before a STA is allowed to send a data message via an AP, it shall first become associated with the AP. The act of becoming associated invokes the association service, which provides the (E)STA to (E)AP mapping to the DS. The DS uses this information to accomplish its message distribution service. How the information provided by the association service is stored and managed within the DS is not specified by this standard.

A STA learns what APs are present and what operational capabilities available from each of those APs, and then requests to establish an association with an AP of appropriate capabilities by invoking the association service. For details of how a station learns about what APs are present, see 11.1.3.

5 Relationships Between Services

Change the definition of class 3 frames as follows:

c) Class 3 frames (if and only if associated; allowed only from within State 3):

1) Data frames

   i) Data subtypes: Data frames allowed. That is, the "To DS" and/or "From DS" FC bits may be set to true to utilize DSSs.
   ii) QoS data subtypes allowed to/from ESTA when associated with EAP.

2) Management frames

i) Deauthentication: Deauthentication notification when in State 3 implies disassociation as well, changing the STA's state from 3 to 1. The station shall become authenticated again prior to another association.
ii) {generic} Management Action
iii) Container

3) Control frames

i) PS-Poll
ii) Reservation Request
iii) Delayed Ack
iv) Contention Control (CC)
v) CF-Multipoll

NOTE: This update does not address the possibility that {generic} Management Action management frames with certain category and action codes might be class 2 or class 1 frames, nor does this update attempt to identify the specific QoS data and control subtypes than might need to be class 1 frames in order to support QoS in an IBSS.

5.6 Differences Between ESS and Independent BSS LANs

Change the final paragraph in this clause as follows:

The services that apply to an IBSS are the SSs. Only limited QoS support is available in an IBSS.

5.7.1 Data

Insert the QoS Data message at the end of 5.7.1 (with appropriate leader characters):

QoS Data Messages
type: Data
Message sub-type: QoS Data
Information Items:
IEEE source address of message.
IEEE destination address of message.
BSS ID
Priority or Traffic Category Identifier
Direction of message: From STA to STA

5.7.2 Association

Insert the following text under "Association request" just after entry for "ESSID" (with appropriate leader character):

Requester's capabilities

Insert the following text under "Association response" just after entry beginning "If the association..."(with appropriate leader character):

Responder's capabilities

5.7.3 Reassociation

Insert the following text under "Reassociation request" just after entry for "ESSID" (with appropriate leader character):

Requester's capabilities

Insert the following text under "Reassociation response" just after entry beginning "If the association..."(with appropriate leader character):

Responder's capabilities

6. MAC service definition

6.1.1 Asynchronous data service

Change the existing paragraph in 6.1.1 as follows:

This service provides peer LLC entities with the ability to exchange MAC service data units (MSDUs). To support this service, the local MAC uses the underlying PHY-level services to transport an MSDU to a peer MAC entity, where it will be delivered to the peer LLC. Such asynchronous MSDU transport is performed on a best-effort connectionless basis. By default, MSDU transport is on a best effort basis, however, the optional QoS facility allows a requested priority or traffic category to be communicated through the MAC SAP on a per-MSDU basis. There are no guarantees that the submitted MSDU will be delivered successfully. Broadcast and multicast transport is part of the asynchronous data service provided by the MAC. Due to the characteristics of the WM, broadcast and multicast MSDUs may experience a lower quality of service, especially with regard to loss rate, compared to that of unicast MSDUs. All STAs will support the asynchronous data service, but only ESTAs differentiate their MSDU delivery according to the requested priority or traffic category of individual MSDUs. Because operation of certain functions of the MAC may cause reordering of some MSDUs, as discussed in more detail below, there are two service classes within the asynchronous data service. By selecting the desired service class, each LLC entity initiating the transfer of MSDUs is able to control whether MAC entities are or are not allowed to reorder those MSDUs.

Insert the following paragraph at the end of 6.1.1:

If the MAC layer entity and its association in a BSS support the optional QoS facility, the MAC will endeavor to deliver MSDUs belonging to traffic categories with higher priority in preference to other MSDUs belonging to traffic categories with lower priority that may be queued for delivery throughout the BSS. If a traffic specification has been provided for a traffic category, via the MAC layer management entity, the MAC will endeavor to deliver MSDUs belonging to that traffic category in accordance with the QoS parameter values contained in the traffic specification. In a QBSS with some ESTAs, which support the optional QoS facility, and some STAs, which do not, the STA MSDU delivery corresponds to ESTA delivery of MSDUs belonging to a traffic category with a priority of best effort.

6.1.3 MSDU ordering

Change the first paragraph of 6.1.3 as follows:

The services provided by the MAC sublayer permit, and may in certain cases require, the reordering of MSDUs. The MAC does not intentionally reorder MSDUs except as may be necessary either to improve the likelihood of successful delivery based on the current operational ("power management") mode of the designated recipient station(s), or to meet the requested priority or traffic category parameter values of individual MSDUs. The sole effect of this reordering (if any), for the set of MSDUs received at the MAC service interface of any single station, is a change in the delivery order of broadcast and multicast MSDUs, relative to unicast~~directed~~ MSDUs, and the reordering of unicast MSDUs belonging to different traffic categories, originating from a single source station address. There is no reordering of unicast MSDUs belonging to the same traffic category. If a higher-layer protocol using the asynchronous data service cannot tolerate this possible reordering, the optional StrictlyOrdered service class should be used. MSDUs transferred between any pair of stations using the StrictlyOrdered service class are not subject to the relative reordering that is possible when the Reorderable~~Multicast~~ service class is used. However, the desire to receive MSDUs sent using the StrictlyOrdered service class at a station precludes simultaneous use of the MAC power management facilities at that station, as well as the use of the optional QoS facility.

Insert the following note at the end of 6.1.3:

NOTE 1: The Reorderable service class is a renaming of the ReorderableMulticast service class defined in IEEE Std 802.11-1999. Reorderable service class in this standard is exactly equivalent to the ReorderableMulticast service class in IEEE Std 802.11-1999. This name change is intended both to reduce confusion about the meaning of "ReorderableMulticast" (The term pertains to the reordering of multicast frames relative to unicast frames, not to the reordering of multicast frames relative to other multicast frames.), and to reflect the fact that the optional QoS facility requires unicast ordering to be maintained only within individual traffic categories, while explicitly allowing the reordering of unicast MSDUs belonging to different traffic categories.

6.2.1.1.2 Semantics of the service primitive

Change the final 3 paragraphs as follows:

The data parameter specifies the MSDU to be transmitted by the MAC sublayer entity. For IEEE 802.11, the length of the MSDU must be less than or equal to 2304 octets. When using certain optional facilities, including the QoS facility, the maximum length of multicast MSDUs, and of unicast MSDUs that are not subject to mandatory fragmentation, is less than 2304 octets. The particular optional facilities and applicable maximum MSDU lengths are defined in clause 7.1.

The priority parameter specifies the priority or traffic category desired for the data unit transfer. IEEE 802.11 allows two values that are supported at all STAs: Contention or ContentionFree, and eight additional values that are supported only at ESTAs which implement the optional QoS facility: the integers between and including 0 and 7.

The service class parameter specifies the service class desired for the data unit transfer. IEEE 802.11 allows two values: Reorderable~~Multicast~~ or StrictlyOrdered.

6.2.1.1.4 Effect of receipt

Change the existing paragraph as follows:

On receipt of this primitive the MAC sublayer entity determines whether the request can be fulfilled according to the requested parameters. A request that cannot be fulfilled according to the requested parameters is discarded and this action is indicated to the LLC sublayer entity using an MA-UNITDATA-STATUS.indication primitive which describes the reason that the MAC was unable to fulfill the request. If the request can be fulfilled according to the requested parameters, ~~The receipt of this primitive causes~~ the MAC sublayer entity ~~to~~ appends all MAC specified fields, including DA, SA, and all fields that are unique to 802.11, and passes the properly formatted frame to the lower layers for transfer to peer MAC sublayer entity or entities, and indicates this action to the LLC sublayer entity using an MA-UNITDATA-STATUS.indication primitive with transmission status set to "Successful." If the request can be fulfilled according to the requested parameters,

6.2.1.2.2 Semantics of the service primitive

Change the final 3 paragraphs as follows:

The reception status parameter indicates the success or failure of the received frame for those frames that IEEE 802.11 reports via a MA-UNITDATA.indication. This MAC only reports "success" ~~when~~ because all failures of reception are discarded without generating MA-UNITDATA.indication.

The priority parameter specifies the receive processing priority or traffic category that was used for the data unit transfer. IEEE 802.11 allows two values that are supported at all STAs: Contention or ContentionFree, and eight additional values that are supported only at ESTAs which implement the optional QoS facility: the integers between and including 0 and 7.

The service class parameter specifies the receive service class that was used for the data unit transfer. IEEE 802.11 allows two values: Reorderable~~Multicast~~ or StrictlyOrdered.

6.2.1.2.3 When generated

Change the existing paragraph as follows:

The MA-UNITDATA.indication primitive is passed from the MAC sublayer entity to the LLC sublayer entity or entities to indicate the arrival of an MSDU~~frame~~ at the local MAC sublayer entity. ~~Frame~~MSDUs are reported only when complete (e.g. after defragmentation if received in fragments), and only if the received data frame(s) ~~they~~ are validly formatted at the MAC sublayer, received without (uncorrectable) error, received with valid (or null) WEP encryption or enhanced security properties according to the security policy at the local MAC sublayer entity, and their destination address designates the local MAC sublayer entity.

6.2.1.3.2 Semantics of the service primitive

Change the final 3 regular paragraphs, including the indented list, as follows:

The transmission status parameter is~~will be~~ used to pass status information back to the local requesting LLC sublayer entity. IEEE 802.11 specifies the following values for transmission status:

a) Successful;

b) Undeliverable (for unacknowledged directed MSDUs when the aShortRetryMax or aLongRetryMax retry limit would otherwise be exceeded) [no longer used, listed because this status may be returned by MAC entities conformant IEEE Std 802.11-1999, see NOTE 2];

c) Excessive data length;

d) Non-null source routing;

e) Unsupported priority (for priorities other than Contention or ContentionFree at an STA; or for priorities other than Contention, ContentionFree or an integer between and including 0 and 7 at an ESTA);

7 Unsupported service class (for service classes other than Reorderable~~Multicast~~ or StrictlyOrdered);

8 Unavailable priority (for ContentionFree when no point coordinator is available, in which case the MSDU is transmitted with, ~~a~~ and the provided priority parameter value is set to, ~~of~~ Contention; or for an integer

between and including 1 and 7 at an ESTA which is not associated in a QBSS, in which case the MSDU is transmitted with, and the provided priority parameter value is set to, 0 to indicate best effort priority);

9 Unavailable service class (for StrictlyOrdered service when the station's power management mode is other than "active" or when the station is associated in a QBSS as a QoS-capable ESTA);

10 Undeliverable (TransmitMSDUTimer reached aMaxTransmitMSDULifetime before successful delivery) [no longer used, listed because this status may be returned by MAC entities conformant IEEE Std IEEE Std 802.11-1999, see NOTE 2];

11 Undeliverable (no BSS available);

12 Undeliverable (the STA MAC sublayer entity cannot encrypt with a null key, or the ESTA MAC sublayer entity does not have the required credentials or other security data to transmit the frame).

In all cases where delivery of the MSDU is attempted, the transmission status parameter returned by the MAC sublayer entity is either (a) or (g). In all cases where no MSDU delivery attempt can be made, the transmission status parameter returned by the MAC sublayer entity is one of (c), (d), (e), (f), (h), (j) or (k).

NOTE2: Transmission status (b) and (i) are never returned by implementations conformant to the present standard. Transmission status (b) and (i) are listed for completeness, since they were defined in IEEE Std 802.11-1999, but are not likely ever to be returned. It is not possible to determine the occurrence of either of these two cases of an MSDU delivery attempt being abandoned (due to excessive retries for status (b) or due to exceeding the limit on transmit lifetime for status (i)) from local state available within the MAC sublayer entity at the time the MA-UNITDATA.request is received from LLC. Because all MAC data service provided within IEEE Std 802.11 is connectionless, return of transmission status (b) or (i) is incompatible with the semantics of the MA-UNITDATA-STATUS.indication primitive. Implementers are advised that the existence of transmission status (b) and (i) should not be interpreted as a requirement that conformant implementations be able to return these status values, and are directed to the absence of any reference to this clause in Annex A.4 of IEEE Std 802.11-1999.

The provided priority parameter specifies the priority that was used for the associated data unit transfer (Contention, ~~or~~ ContentionFree or an integer between and including 0 and 7).

The provided service class parameter specifies the class of service used for the associated data unit transfer (Reorderable~~Multicast~~ or StrictlyOrdered).

7. Frame Formats

Change the text of the pagagraph in 7 as follows:

The format of the MAC frames is specified in this clause. All stations shall be able to ~~properly construct frames for transmission and decode frames upon reception, as specified in this clause.~~validate every received frame using the frame check sequence (FCS), and, for frames received without error, to decode certain from the MAC headers of all frames. In addition, every station shall be able to construct a subset of these frame formats for transmission, and to decode a (potentially different) subset of these frame formats upon validation following reception. The particular subsets of these formats that a station must construct and decode are determined by the functional capabilities supported by that particular station, as specified in 7.4.

7.1.1 Conventions

Insert the following text at the end of 7.1.1:

Reception, in references to frames or fields within frames (e.g. "... beacon frames received by a STA ..." or "... the value of a received Duration/ID field ...") applies to MPDUs or MMPDUs indicated from the PHY layer without error and validated by CRC or other relevant error detection coding within the MAC sublayer. Without further qualification, "reception" by the MAC sublayer implies that the frame contents are valid, and that the protocol version is supported (see 7.1.3.1.1), but implies nothing about frame addressing, nor whether the frame type or other fields in the MAC header are meaningful to the MAC entity that has received the frame.

Reserved values in non-reserved fields and subfields are not transmitted by conformant stations. However, a station conformant to an older revision of this standard may receive frames with what it considers to be reserved values in non-reserved fields and subfields. These fields, along with other fields in the same frame whose interpretation is directly dependent thereon, are ignored on reception.

NOTE: Ignoring reserved values encountered in non-reserved fields is a strict requirement of IEEE 802.11E and subsequent versions of this standard. However, in the case of many fields, this behavior was either explicitly or implicitly required since the release of IEEE Std 802.11-1997. It is strongly encouraged that all future implementations, independent of conformance level, adhere to this convention.

7.1.2 General frame format

Change the text in 7.1.2 and Figure 12 as follows:

The MAC frame format comprises a set of fields that occur in a fixed order in all frames. Figure 12 depcits the general MAC frame format. The fields Address 2, Address 3, Sequence Control, Address 4, Traffic Category Identifier (TCID), and Frame Body are only present in certain frame types and subtypes. Each field is defined in 7.1.3. The format of each of the individual subtypes of each frame type is defined in 7.2. The components which comprise the frame bodies of management type frames are defined in 7.3.

octets: 2	2	6	6	6	2	6	2	0-2312	4
Frame Control	**Duration / ID**	**Address 1**	**Address 2**	**Address 3**	**Sequence Control**	**Address 4**	**TCID**	**Frame Body**	**FCS**

MAC Header

Figure 12 – MAC frame format

7.1.3.1.2 Type and Subtype fields

Change the contents of Table 1 and insert the note below Table 1 as follows:

Table 1 - Valid type and subtype combinations
(numeric values in Table 1 are shown in binary)

Type Value b3 b2	**Type Description**	**Subtype Value** b7 b6 b5 b4	**Subtype Description**
00	Management	0000	Association request
00	Management	0001	Association response
00	Management	0010	Reassociation request

Type Value b3 b2	**Type Description**	**Subtype Value** b7 b6 b5 b4	**Subtype Description**
00	Management	0011	Reassociation response
00	Management	0100	Probe request
00	Management	0101	Probe response
00	Management	0110-0111	Reserved
00	Management	1000	Beacon
00	Management	1001	ATIM
00	Management	1010	Disassociation
00	Management	1011	Authentication
00	Management	1100	Deauthentication
00	Management	1101	{generic} Action
00	Management	1110	Reserved
00	Management	1111	Container
01	Control	0000-0011	Reserved
01	Control	0100	Reservation Request (RR)
01	Control	0101	Delayed Acknowledgement (DlyAck)
01	Control	0110	Contention Control (CC)
01	Control	0111	Reserved
01	Control	1000	Contention-Free Multipoll (CF-Multipoll)
01	Control	1001	Reserved
01	Control	1010	Power Save Poll (PS-Poll)
01	Control	1011	Request To Send (RTS)
01	Control	1100	Clear To Send (CTS)
01	Control	1101	Acknowledgement (ACK)
01	Control	1110	Contention-Free End (CF-End)
01	Control	1111	CF-End + CF-Ack
10	Data	0000	Data
10	Data	0001	Data + CF-Ack
10	Data	0010	Data + CF-Poll
10	Data	0011	Data + CF-Ack + CF-Poll
10	Data	0100	Null (no data)
10	Data	0101	CF-Ack (no data)
10	Data	0110	CF-Poll (no data)
10	Data	0111	CF-Ack + CF-Poll (no data)
10	Data	1000	QoS Data
10	Data	1001	QoS Data + CF-Ack

Type Value b3 b2	**Type Description**	**Subtype Value** b7 b6 b5 b4	**Subtype Description**
10	Data	1010	QoS Data + CF-Poll
10	Data	1011	QoS Data + CF-Ack + CF-Poll
10	Data	1100	QoS Null (no data)
10	Data	1101	QoS CF-Ack (no data)
10	Data	1110	QoS CF-Poll (no data)
10	Data	1111	QoS CF-Ack + CF-Poll (no data)
11	Reserved	0000-1111	Reserved

NOTE: Decoding the subtypes of data type frames can take advantage of the fact that each subtype field bit position is used to indicate a specific modification of the basic data frame (subtype 0). Frame control bit 4 is set to 1 in data subtypes which include +CF-Ack, bit 5 is set to 1 in data subtypes which include +CF-Poll, bit 6 is set to 1 in data subtypes that contain no {MSDU} data, and bit 7 is set to 1 in the "QoS data" subtypes, which have TCID fields in their MAC headers.

7.1.3.1.3 To DS field

Change the text in 7.1.3.1.3 as follows:

The To DS field is one bit in length and is set to 1 in data type frames destined for the DS. This includes all data type frames sent by STAs associated with an AP, all data type frames sent by ESTAs (including BPs) associated with an EAP, and all frames being sent between APs, BPs, or EAPs, using the WM as a wireless distribution system (WDS). The To DS field is set to 0 in all other frames. For additional details, see Table 2.

7.1.3.1.4 From DS field

Change the text in 7.1.3.1.4 and Table 2 as follows:

The From DS field is 1 bit in length and is set to 1 in data type frames exiting the DS. This includes all data type frames sent by APs, BPs or EAPs, including frames sent using the WM as a WDS, as well as data type frames sent by ESTAs addressed to recipients other than the EAP. The From DS field is set to 0 in all other frames.

The permitted To/From DS bit combinations and their meanings are given in Table 2.

Table 2 - To/From DS combinations in data type frames

To/From DS values	Meaning
To DS = 0 From DS = 0	A data type frame direct from one STA to another STA within the same IBSS, as well as all ~~management and~~ control type frames and all management type frames other than Container.
To DS = 1 From DS = 0	A data frame, or management frame of subtype Container, destined for the DS at an AP or EAP.
To DS = 0 From DS = 1	A data frame, or management frame of subtype Container, exiting the DS at an AP or EAP.
To DS = 1 From DS = 1	Wireless distribution system (WDS) data frame being distributed from one AP or EAP to another AP or EAP via the WM; also a data frame direct from one ESTA or BP to another ESTA or BP within the same QBSS.

7.1.3.1.7 Power Management field

Change the text in 7.1.3.1.7 as follows:

The Power Management field is one bit in length and is used to indicate the power management mode of a STA. The value of this field remains constant in each frame from a particular STA within a frame from a particular STA within a frame exchange sequence defined in 9.7. The value indicates the mode the station will be in after successful completion fo the frame exchange sequence. Additional, modal, significance may be applied to the value of this field in certain management type frames sent by ESTAs, as defined in << #.# QoS power save clause >>.

A value of 1 indicates that the STA will be in power-save mode. A value of 0 indicates that the STA will be in active mode. This field is always set to 0 in frames transmitted by an AP, BP, or EAP.

7.1.3.1.8 More Data field

Change the text in 7.1.3.1.8 as follows:

The More Data field is one bit in length and is used to indicate to a STA in power-save mode that more MSDUs, or MMPDUs are buffered for that STA at the AP. The More Data field is valid in directed data or management type frames transmitted by an AP to an STA in power-save mode. A value of 1 indicates that at least one additional buffered MSDU, or MMPDU is present for the same STA.

The More Data field may be set to 1 in directed data type frames transmitted by a contention-free (CF)-Pollable STA to the Point Coordinator (PC) in response to a CF-Poll to indicate that the STA has at least one additional buffered MSDU available for transmission in response to a subsequent CF-Poll. The More Data field shall be set to 1 in all QoS data type frames transmitted by ESTAs to indicate that the ESTA has at least one additional buffered MPDU available for transmission. This includes QoS Null and other QoS (no-data) frames transmitted by ESTAs in cases where the TXOP length was insufficient to send the MPDU selected for transmission by the local frame scheduling entity.

The More Data field shall be set to 1 in directed QoS data type frames and management frames of subtype Container transmitted by an ESTA associated in a QBSS when the ESTA has at least one additional buffered MSDU belonging to the same traffic category that is ready for transmission.

The More Data field is set to 0 in all other directed frames.

The More Data field is set to 1 in broadcast/multicast frames transmitted by the AP, when additional broadcast/multicast MSDUs, or MMPDUs, remain to be transmitted by the AP during this beacon interval. The More Data field is set to 0 in broadcast/multicast frames transmitted by the AP when no more broadcast/multicast MSDUs, or MMPDUs, remain to be transmitted by the AP during this beacon interval and in all broadcast/multicast frames transmitted by non-AP stations.

7.1.3.1.10 Order field

Insert the following note at the end of 7.1.3.1.10:

NOTE: StrictlyOrdered service class is only available for MSDUs presented to the MAC with a priority value of "contention" or "contention-free." StrictlyOrdered service class is not available for MSDUs presented to the MAC with any of the integer priority values 0-7.

7.1.3.2 Duration/ID field

Change the contents of 7.1.3.2 as follows:

The Duration/ID field is 16 bits in length. The contents of the this field ~~are as follows~~vary with frame type, superframe period, and QoS capabilities of the sending station:

a) In control type frames of subtype Power Save (PS)-Poll the Duration/ID field carries the association identity (AID) of the station that transmitted the frame in the 11 least-significant bits (lsb), with the 2 most-significant bits (msb) both set to 1, and the 3 intermediate bits set to 0. The value of the AID is in the range 1-2007.

b) In all other frames sent during the contention period, including frames within CF-Bursts, the Duration/ID field carries a duration value, calculated in the manner specified in Clause 9, or a value of zero, as defined for each frame type and subtype in 7.2. A duration is the preferred content of the Duration/ID field in all frames sent by the HC and ESTAs during the contention free period in a QBSS, although these frames may also use the fixed value as specified in (c).

c) In ~~for~~ frames transmitted by the PC and STAs during the contention free period (CFP), the Duration field is set to a fixed value of 32768 (msb set to 1 and the 15 lsb set to 0) for transmission and ignored on reception. This value may be used by the HC and ESTAs during the contention free period, but implemeners are encouraged to use a duration value in such frames, as specified in (b).

Whenever the contents of a received Duration/ID field, treated as an unsigned integer and without regard for address values, are less than 32768, the duration value is used to update the network allocation vector (NAV) according to the procedures defined in Clause 9.

Whenever the contents of a received Duration/ID field, treated as an unsigned integer, are greater than 32768, the contents are interpreted as appropriate for the frame type and subtype, or ignored if the receiving MAC entity does not have a defined interpretation for that type and subtype.

The encoding of the Duration/ID field is given in Table 3.

Table 3 - Duration/ID field encoding

Bit 15	Bit 14	Bits 13-0	Usage
0	0 - 32767		Duration value (units of microseconds) that shall be used within all frames, other than PS-Poll frames, transmitted during the CP, and may be used under HCF for frames transmitted during the CFP
1	0	0	Fixed value, that shall be used under PCF and may be used under HCF, within frames transmitted during the CFP
1	0	1 - 16383	Reserved
1	1	0	Reserved
1	1	1-2007	AID in PS-Poll frames
1	1	2008 - 16383	Reserved

7.1.3.3.3 BSSID field

Change the first paragraph of 7.1.3.3.3 as shown:

The BSSID field is a 48-bit field of the same format as an IEEE 802 MAC address. This field uniquely identifies each BSS. The value of this field, in an infrastructure BSS, is the MAC address currently in use by the STA in the AP of the BSS. The value of this field, in a QBSS, is the address of the STA at which the MLME-START.request that started the QBSS was executed. The BSSID remains unchanged for the life of a QBSS, even if the EAP and HC functions are transferred to an alternate station.

7.1.3.4.1 Sequence Number field

Change the text of 7.1.3.4.1 as shown:

The Sequence Number field is a 12-bit field indicating the sequence number of an MSDU or MMPDU. Each MSDU or MMPDU transmitted by a STA is assigned a sequence number. Sequence numbers for management type frames, as well as for non-QoS data type frames, are assigned from a single modulo-4096 counter, starting at 0 and incrementing by 1 for each MSDU or MMPDU that is assigned a sequence number using this counter. ESTAs maintain one additional modulo-4096 counter for each traffic category that they source. Sequence numbers for QoS data type frames are assigned using the counter for the traffic category indicated in the TCID field of the frame, and that counter is incremented by 1 for each MSDU or MMPDU assigned a sequence number for that TC. Each frame containing a fragment of a~~n~~ single MSDU or MMPDU contains the ~~assigned~~ same sequence number. The sequence number remains constant in all retransmissions of an MSDU, MMPDU, or fragment thereof.

Insert after 7.1.3.4.2 the following subclauses 7.1.3.5.x and 7.1.3.6, as well as the new fiigures contained therein, and renumber subsequent 7.1.x-subclauses and figures as necessary:

7.1.3.5 QoS Control field

The QoS Control field is 16-bit field that identifies the traffic category to which the frame belongs and various other QoS-related information about the frame that varies by frame type. The QoS Control field is located immediately after the MAC header in QoS data type frames, management frames of subtype Container and in control type frames of subtype RR. The TCID field comprised of 5 subfields, described below and illustrated in Figure 14.5.

Bits 0-9	Bit 10	Bit 11	Bits 12-14	Bit 15	Usage
TXOP limit, units of 16 microseconds (used if frame subtype includes CF-poll)	Non-final	No Ack	TCID	rsrv	QoS data, QoS null and Container frames sent by the HC
TC queue size, units of 128 octets	Non-final	No Ack	TCID	rsrv	QoS data (non-null) and Container frames sent by WSTAs
TS =0: TXOP duration requested, units of 16 microseconds TS =1: TC queue size, units of 128 octets	Non-final	No Ack	TCID	TS	QoS null frames sent by WSTAs
TS =0: TXOP duration requested, units of 16 microseconds TS =1: TC queue size, units of 128 octets	rsrv	rsrv	TCID	TS	RR frames

Figure 14.5 – QoS Control field

NOTE: The presence of the TCID field allows an 802.11E LAN to function as a LAN that is "able to signal the user priority" as this phrase is used in IEEE 802.1D and IEEE 802.1Q.

7.1.3.5.1 TCID field

The TCID field identifes the traffic category to which this frame belongs. The TCID field contains the value of the priority parameter from the MA-UNITDATA.request primitive that provided the MSDU to which the QoS control field applies.

7.1.3.5.2 No Ack field

The No Ack field is one bit in length, and is set to 1 in frames transmitted by ESTAs in a QBSS if the frame being sent is normally followed by an acknowledgement from the recipient and the sending ESTA does not want the recipient to send an acknowledgement to this frame. The No Ack field is set to 0 in all other frames. ESTAs receiving a frame with the No Ack field set to 1 shall not initiate any transmission after a SIFS period, even if such a transmission would otherwise be required according to the applicable frame exchange sequence. In cases where a QoS control field is transmitted with both the No Ack and Non-final bits set to 1 the sending ESTA shall initiate its next transmission a SIFS period after the end of the current frame. If a QoS data type frame or management frame of subtype Container is fragmented, the NoAck field shall be set to the same value in each fragment.

NOTE: Both the name and function of the No Ack field pertain to the non-occurrence of transmission of an acknowledgement starting a SIFS period after the frame being acknowledged, which is the only aspect of "acknowledgement policy" which needs to be indicated explicitly in the frames which traverse the WM. Frames with No Ack set to 1 may be used for MSDUs which do not require acknowledgement because they will not be retransmitted, even if the transmission attempt is unsuccessful; as well as for frames which do require acknowledgement, but for which the acknowledgement will be sent separately using a DlyAck frame. The use of delayed acknowledgements in such cases must be prearranged between the transmitting and receiving ESTAs, typically on a per-traffic category basis.

7.1.3.5.3 Non-final field

The Non-final field is one bit in length and is set to 1 in frames transmitted by ESTAs in a QBSS if that ESTA intends to to transmit another frame during the same TXOP. The Non-final field is set to 0 in the sole or final frame transmitted by an ESTA during each TXOP, as well as in any frame with a QoS data subtype that includes CF-Poll transmitted by the HC. The Non-final field is ignored in received MPDUs or MMPDUs with the More Fragments frame control field set to 1.

7.1.3.5.4 TXOP limit field

The TXOP limit field is a 10-bit field that specifies the time limit on a TXOP initiated by a (+)CF-Poll from an HC in a QBSS. In QoS data type frames with subtypes that include CF-Poll, the addressed ESTA has a TXOP that begins a SIFS period after this frame and lasts no longer than the number of 16-microsecond periods specified by the TXOP limit value. The range of time values is 16 to 16368 microseconds. A TXOP limit of 0 is used for TXOPs without a specified temporal extent. Any ESTA receiving a (+)CF-Poll with TXOP limit =0 shall obey the rules for non-polled TXOPs under HCF, specified in the {E}DCF TXOP usage rules in Clause 9. In QoS control fields of frames transmitted by an HC with subtypes that do not include CF-Poll the TXOP limit field is set to 0 upon transmission and ignored upon reception. The TXOP limit field is also ignored in received MPDUs or MMPDUs with the More Fragments frame control field set to 1.

7.1.3.5.5 TC queue size field

The TC queue size field is a 10-bit field that indicates the amount of buffered traffic for a given traffic category at the ESTA sending this frame. The TC queue size field is present in all QoS data type frames, and management frames of subtype container sent by WSTAs associated in a QBSS. The TC queue size field is also present in QoS null frames and control frames of subtype RR sent by these stations with the TS bit (bit 15) of the QoS control field set to 1. The TC queue size value is the ceiling of the total size (in units of 128 octets) of all MSDUs buffered at the ESTA which belong to the traffic category indicated by the TCID field of this frame.

A TC size value of 0 is used solely to indicate the absence of any buffered traffic for the specified traffic category. A TC size value of 1022 is used for all sizes greater than 130688 octets. A TC size value of 1023 is used to indicate an unspecified or unknown size. If a QoS data type frame or management frame of subtype Container is fragmented, the TC queue size value may remain constant in all fragments even if the amount of queued traffic changes before all fragments have been transmitted.

7.1.3.5.6 TXOP duration requested field

The TXOP duration requested field is a 10-bit field that indicates the duration, in units of 16 microseconds, which the sending station desires for its next TXOP. The TXOP duration requested field is present in QoS null frames and control frames of subtype RR sent WSTAs associated a QBSS with the TS bit (bit 15) of the QoS control field set to 0. A TXOP duration requested field may only be used when the duration value is greater than zero. A value of zero in the TXOP duration requested field is reserved, and shall not be transmitted by ESTAs conformant to this standard.

7.1.3.6 TCA field

The TCA field is 16-bit field that contains a TCID value, which identifies a traffic category; and an association identifier (AID) value, which identifies an ESTA in the QBSS. The TCA field includes 2 subfields, described below and illustrated in Figure 14.6.

0-10 AID
The AID subfield contains the association identifier assigned to the ESTA by the EAP at the time of its most recent (re)association with the present QBSS.

11, 15 Reserved
These two bits are reserved for future use. They are set to 0 upon transmission and ignored upon reception.

12-14 TCID
The TCID subfield identifes the traffic category to which the present frame belongs. For a detailed description of the TCID subfield, see 7.1.3.5.1.

bits 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
AID (1-2007)											**rsvd (0)**	**TCID (0-7)**			**rsvd (0)**

Figure 14.6 – TCA field

Change the text of the subclause presently numbered 7.1.3.5 as shown:

7.1.3.~~5~~7 Frame Body field

The Frame Body is a variable length field and contains information specific to individual frame types and subtypes.. The minimum frame body is zero octets. The maximum length frame body is ~~defined by the maximum length (MSDU + ICV + IV) where ICV and IV are the WEP fields defined~~ 2312 octets, including 2304 octets of MSDU or MMPDU content and 8 octets of MPDU expansion to accommodate the ICV and IV fields of the privacy (WEP) function in 8.2.5. The maximum MSDU or MMPDU length that can be sent in frames with QoS data subtypes is reduced by 2 octets so that the maximum MPDU length remains unchanged despite the presence of the TCID field in the MAC headers of QoS data frames.

7.2.1.1 Request To Send (RTS) frame format

Change the final paragraph of 7.2.1.1 and insert the note below this paragraph as shown:

For all RTS frames the duration value is the time, in microseconds, required to transmit the pending data or management frame, plus one CTS frame, plus one ACK frame, plus three SIFS intervals. If the calculated duration includes a fractional microsecond, that value is rounded up to the next higher integer.

NOTE: The sending of RTS during the CFP is used to ensure that the addressed recipient ESTA is within range and awake, and to elicit a CTS response that will set the NAV at STAs in the vicinity of the addressed recipient. This is useful when there are nearby STAs that are members of other BSSs and are out of range to receive beacons from this BSS. Sending an RTS during the CFP is only useful when the recipient is an ESTA, because a STA in the same BSS will have its NAV set to protect the CFP, hence unable to respond. Using the same duration calculation during the CFP as specified for the CP is directly applicable for all cases except when the RTS is sent by the EPC, and the following frame includes a +CF-Poll. However, even in this EPC case, the same RTS duration calculation can be used, because that duration results in a CTS duration, hence NAV setting the vicinity of the recipient, which lasts until after the beginning of the transmission in response to the +CF-Poll. It is reasonable to assume that STAs which are able to receive the CTS and set their NAVs are also able to defer to CCA(busy) resulting from the ESTA's transmission in response to the +CF-Poll. This avoids the complexity of having the responding ESTA determine in real time the transmit duration of a response to a +CF-Poll which has not yet been received.

7.2.1.2 Clear To Send (CTS) frame format

Change the final paragraph of 7.2.1.2 as shown:

For all CTS frames the duration value is the value obtained from the duration field of the immediately previous RTS frame, minus the time, in microseconds, required to transmit the CTS frame and its SIFS interval. If the calculated duration includes a fractional microsecond, that value is rounded up to the next higher integer.

7.2.1.3 Acknowledgement (ACK) frame format

Change the final paragraph of 7.2.1.3 as shown:

For ACK frames sent by STAs during the contention period, if the More Fragments bit was set to 0 in the Frame Control field of the immediately previous directed data or management frame, the duration value is set to 0. If the More Fragments bit was set to 1 in the Frame Control field of the immediately previous directed data or management frame, as well as for all ACK frames sent by ESTAs associated in a QBSS, the duration value is the value obtained from the duration field of the immediately previous data or management frame, minus the time, in microseconds, required to transmit the ACK frame and its SIFS interval. If the calculated duration includes a fractional microsecond, that value is rounded up to the next higher integer. For ACK frames sent during the contention-free period (CFP) under PCF the Duration/ID field is set to 32768.

7.2.1.4 Power Save Poll (PS-Poll) frame format

Change the final two paragraphs of 7.2.1.4 as shown:

The BSSID is ~~the address of the STA contained in the AP~~defined in 7.1.3.3.3. The TA is the address of the STA transmitting the frame. The AID is the value assigned to the STA transmitting the frame by the (E)AP in the (re)association response frame which established that STA’s current association.

The Duration/ID field contains the AID value ~~always~~ in the 11 least-significant bits, and has ~~its~~the 2 most-significant bits each set to 1. All STAs, upon receipt of a PS-Poll frame, update their NAV settings as appropriate under the coordination function rules and data rate selection rules using a duration value equal to the time, in microseconds, required to transmit one ACK frame plus one SIFS interval.

7.2.1.5 CF-End frame format

Change the second paragraph of 7.2.1.5 as shown:

The BSSID is ~~the address of the STA contained in the AP~~defined in 7.1.3.3.3. The RA is the broadcast group address.

7.2.1.6 CF-End + CF-Ack frame format

Change the second paragraph of 7.2.1.6 and insert a new paragraph at the end of this subclause as shown:

The BSSID is ~~the address of the STA contained in the AP~~defined in 7.1.3.3.3. The RA is the broadcast group address.

The Duration field is set to 0.

An HC shall not use CF-End+CF-Ack to acknowledge a frame received from an ESTA.

Insert after 7.2.1.6 the following 4 subclauses 7.2.1.7 through 7.2.1.10, as well as the new fiigures contained therein, and renumber subsequent figures as necessary:

7.2.1.7 Contention-Free Multipoll (CF-Multipoll)

The frame format of the Contention-Free Multipoll (CF-Multipoll) frame is defined in Figure 21.1.

octets: 2	2	6	2	4*RecordCount		4
Frame Control	**Dur/ID** (32768)	**BSSID**	**Record Count** (1-255)	**Poll Record** (4 octets)		**FCS**
				AID (2 octets)	**TXOP limit** (2)	

MAC Header

Figure 21.1 – CF-Multipoll frame

The BSSID is defined in 7.1.3.3.3. The Duration/ID value is set to 32768.

The Record Count field is set to the number of Poll Records in this CF-Multipoll frame. Valid values are in the range 1-255, with all other values reserved.

Each Poll Record is 4 octets in length and defines a single TXOP. Poll Records contain 2 fields, as defined below.

- AID
  Contains the AID of the ESTA that is receiving a TXOP from this poll record. The ESTA receiving the TXOP is not constrained to send traffic from any particular traffic category, and follows TXOP usage rules defined in << ## EPCF definition, clause 9>>.
- TXOP limit
  Contains an unsigned integer that specifies the maximum length of this TXOP in units of 8 microseconds. The first TXOP starts a SIFS period after the CF-Multipoll frame, and each successive TXOP starts a SIFS period after the predecessor's TXOP limit expires.

7.2.1.8 Delayed Acknowledgement (DlyAck) frame format

The frame format of the Delayed Acknowledgement (DlyAck) frame is defined in Figure 21.3.

octets: 2	2	6	6	2	4*RecordCount		4
Frame Control	**Duration** (0)	**RA**	**TA**	**Record Count** (1-255)	**Ack Record** (4 octets)		**FCS**
					TC-seq (2 octets)	**TC-bitmap** (2 octets)	

MAC Header

Figure 21.3 – DlyAck frame

The Record Count field is set to the number of Ack Records in this frame. Valid values are in the range 1-255. Values greater than 255 are reserved. Each Ack Record is 4 octets in length and contains 2 fields, as defined below:

- TC-seq
  Identifies the traffic category of the MSDU(s) being acknowledged by this record in the high-order 4

bits using the format for TCID in 7.1.3.4.1, and the sequence number of the MSDU reported in bit 0 of the TC-bitmap field in the low-order 12 bits. There may be more than one Ack Record with the same TCID in a given DlyAck frame if more than 16 MSDUs from that traffic category require acknowledgement and/or negative acknowledgement. In such cases the records for a given TC are ordered by ascending sequence number value.

- TC-bitmap
  A a 2-octet field in which each bit indicates the reception status of an MSDU within the specified traffic category. TC-bitmap bit 0 indicates the reception status of the MSDU with the sequence number contained in the TC-seq field, and subsequent bits indicate the reception status of MSDUs within the same TC having the next 15 sequentially-ascending sequence numbers. TC-bitmap bits set to 1 indicate MSDUs that have been received successfully, whereas bits set to 0 indicate MSDUs that have not been received (and which may have not yet been sent if fewer than 16 MSDUs are awaiting delayed acknowledgement for this TC). Fragmented MSDUs which have been partially received (More Fragments=1 in the received MPDU with the highest fragment number) are reported as not received (=0) in the TC-bitmap.

7.2.1.9 Contention Control (CC) frame format

The frame format of the Contention Control (CC) frame is defined in Figure 21.4.

octets: 2	2	6	1	1	1	1	1	1	2*FbCount	4
Frame Control	**Dur/ID**	**BSSID**	**Priority Mask**	**PP**	**CCOP Duration**	**CCI Length**	**rsrv (0)**	**Feed-back Count**	**Feedback TCA** (2 octets)	**FCS**
MAC Header										

Figure 21.4 – CC frame

The BSSID is defined in 7.1.3.3.3. For CC frames that initiate controlled contention, the Duration field contains the time in microseconds for the CCI, plus two PIFS intervals. For CC frames used exclusively to provide feedback the Duration field contains zero.

The Priority Mask field is a single octet which specifies the priority levels for which requests may be transmitted in the CCI which follows this CC frame. Bits 0 through 7 of this octet are set to 1 to enable requests from priority values 0 through 7, respectively. Requests at priority levels corresponding bits set to 0 in the Priority Mask are not permitted during the CCI. For CC frames used exclusively to provide feedback the Priority Mask value is 0.

The Permission Probability (PP) field specifies a probability with which contending ESTAs are permitted to send RR frames in the CCI which follows this CC frame. The PP field is set to the unsigned integer value obtained by multiplying the desired permission probability by 255 and rounding to the nearest integer.

The CCOP Duration field is a single octet that specifies the duration of each CCOP in the CCI that follows this CC frame. This duration is the number of microseconds to send an RR frame at the same data rate, coding and preamble options as used to send the CC frame, plus one SIFS period. If the calculated duration includes a fractional microsecond the value is rounded up to the next higher integer.

The CCI length field is a single octet that specifies the number of CCOPs in the CCI that follows this CC frame. A CCI length value of 0 is used in CC frames used exclusively to provide feedback on previously received RR frames, and do not initiate a new CCI.

The Feedback Count field is set to the number of Feedback TCAs in this CC frame. Valid values are in the range 0-255. Each Feedback TCA is 2 octets in length and contains the TCA (in the format shown in 7.1.3.6) from an RR frame that was successfully received by the HC since the last transmission of a CC frame.

The Duration/ID field is set to two PIFS intervals plus the length of the CCI (CCOP Duration multiplied by CCI Length).

7.2.1.10 Reservation Request (RR) frame format

The frame format of the Reservation Request (RR) frame is defined in Figure 21.6.

octets: 2	2	6	2	2	4
Frame Control	Dur/ID	BSSID	QoS Control	AID	FCS
MAC Header					

Figure 21.6 – RR frame

The BSSID is defined in 7.1.3.3.3. The TA is the address of the STA transmitting the frame. The Duration/ID field is set to 0. The QoS Control field contains the TCID for which the request is being made, along with the requested TXOP duration or queue size, as specified for RR frames in 7.1.3.5. The AID field carries the AID of the station sending the request.

7.2.2 Data frames

Change the text, figures and tables in 7.2.2 as shown, renumber subsequen figures as necessary:

The frame format for the Data frame is ~~in~~dependent ~~of the type and~~on the most significant bit of the subtype. Data frames with subtypes 0-7 are used for basic IEEE 802.11 transfers, and ~~is~~are as depicted in Figure 22.

octets: 2	2	6	6	6	2	*6 or 0*	0-2312	4
Frame Control	Dur/ID	Address 1	Address 2	Address 3	Seq Ctrl	*Address 4*	Frame Body	FCS
MAC Header								

Figure 22 – Basic Data Frame

Data frames with subtypes 8-15 are used for IEEE 802.11E QoS transfers, and use the format defined in Figure 22B. These subtypes are collectively referred to as QoS data type frames. Each of these data subtypes contain "QoS" in their names, and this frame format, distinguished by the presence of a QoS Control field in the MAC header.

octets: 2	2	6	6	6	2	*6 or 0*	2	0-2310	4
Frame Control	Dur/ID	Address 1	Address 2	Address 3	Seq Ctrl	*Address 4*	QoS Control	Frame Body	FCS
MAC Header									

Figure 22B – QoS Data Frame

The content of the Address fields of data and QoS data frames is dependent upon the values of the To DS and From DS bits in the frame control field, and ~~is~~are defined in Table 4. Where the content of a field is shown as not applicable (N/A), the field is omitted. Note that Address 1 always holds the receiver address of the intended receiver (or, in the case of multicast frames, receivers), and that Address 2 always holds the address of the station that is transmitting the frame.

To DS	From DS	Address 1	Address 2	Address 3	Address 4	Usage
0	0	DA	SA	BSSID	N/A	STA-to-STA traffic in an IBSS
0	1	DA	BSSID	SA	N/A	(E)AP-to-(E)STA traffic in a (Q)BSS
1	0	BSSID	SA	DA	N/A	(E)STA-to-(E)AP traffic in a (Q)BSS
1	1	RA	TA	DA	SA	WDS traffic among (E)APs and BPs
		RA	SA	DA	SA	ESTA-to-BP traffic in a QBSS
		DA	TA	DA	SA	BP-to-ESTA traffic in a QBSS
		DA	SA	DA	SA	ESTA-to-ESTA traffic in a QBSS

Table 4 - Address Field Contents

A station uses the contents of the Address 1 field to perform address matching for receive decisions. In cases where the Address 1 field contains a group address, the BSSID also is validated to ensure that the broadcast or multicast originated in the same BSS.

A station uses the contents of the Address 2 field to direct the acknowledgment if an acknowledgment is necessary.

The DA is the destination of the MSDU (or fragment thereof) in the frame body field.

The SA is the address of the MAC entity which initiated the MSDU (or fragment thereof) in the frame body field.

The RA is the address of the STA contained in the (E)AP or BP of the wireless distribution system that is the next immediate intended recipient of the frame.

The TA is the address of the STA contained in the (E)AP or BP of the wireless distribution system that is transmitting the frame.

The BSSID is defined in 7.1.3.3.3.~~ is determined as follows:~~

~~a) If the station is an AP or is associated with an AP, the BSSID is the address currently in use by the STA contained in the AP.~~

~~b) If the station is a member of an IBSS, the BSSID is the BSSID fo the IBSS.~~

The QoS Control field is defined in 7.1.3.5.

The frame body consists of the MSDU or a fragment thereof, and a WEP IV and ICV (if and only if the WEP subfield in the frame control field is set to 1). The frame body is omitted~~null (0 octets in length)~~ in data frames of Subtype Null function (no data), CF-Ack (no data), CF-Poll (no data) and CF-Ack+CF-Poll (no data) as well as the corresponding four QoS data frame subtypes.

Within all data type frames sent by STAs during the CFP under PCF, the Duration/ID field is set to the value 32768. Within all data type frames sent by ESTAs in a QBSS, the Duration/ID field is set as specified in Clause 9. Within all data type frames sent during the contention period under DCF, the Duration/ID field is set according to the following rules:

If the Address 1 field contains a group address, the Duration value is set to 0.

If the More Fragments bit is set to 0 in the Frame Control field of a frame and the Address 1 field contains an individual address, the Duration value is set to the time, in microseconds, required to transmit one ACK frame, plus one SIFS interval.

If the More Fragments bit is set to 1 in the Frame Control field of a frame, and the Address 1 field contains an individual address, the Duration value is set to the time, in microseconds, required to transmit the next fragment of this data frame, plus two ACK frames, plus three SIFS intervals.

The duration value calculation for the data frame is based on the rules in 9.6 that determine the data rate at which the control frames in the frame exchange sequence are transmitted. If the calculated duration includes a fractional microsecond, that value is rounded up to the next higher integer. All stations process Duration field values less than or equal to 32767 from valid data frames to update their NAV settings as appropriate under the coordination function rules.

7.2.3 Management frames

Change the text in 7.2.3 as showns:

The frame format for management frames of subtypes other than Container is independent of frame subtype and is as defined in Figure 23. The frame format for management frames of subtype Container is defined in 7.2.3.13.

octets: 2	2	6	6	6	2	0-2312	4
Frame Control	**Dur/ID**	**DA**	**SA**	**BSSID**	**Seq Ctrl**	**Frame Body**	**FCS**

MAC Header

Figure 23 – Management frame format for subtypes other than Container

The fields in the MAC header of management frames of subtypes other than Container are discussed below.

A STA uses the contents of the Address 1 field to perform the address matching for receive decisions. In the case where the Address 1 field contains a group address and the frame type is other than Beacon, the BSSID also is validated to ensure that the broadcast or multicast originated in the same BSS. If the frame type is Beacon, other address matching rules apply, as specified in 11.1.2.3.

The address fields for management frames of subtypes other than Container do not vary by frame subtype.

The BSSID of the management frame is determined as follows:

a) If the station is an AP or is associated with an AP, the BSSID is the address currently in use by the STA contained in the AP.
b) If the station is a member of an IBSS, the BSSID is the BSSID of the IBSS.
c) In management frames of subtype Probe Request, the BSSID is either a specific BSSID, or the broadcast BSSID as defined in the procedures specified in clause 10.
d) If the ESTA is an EAP or is associated with an EAP, the BSSID is the address of the ESTA at which the MLME-START.request that started the QBSS was executed, and is equal to the BSSID in Beacon, Association Response, Reassociation Response and Probe Response frames sent by this QBSS.
e) In the special case of a Probe Response frame sent by an RPC, the BSSID is the address of the ESTA at which the MLME-START.request that started the primary QBSS to which this RPC is subsidiary

was executed, and is equal to the BSSID in Beacon, Association Response, Reassociation Response and Probe Response frames sent by the EAP of the primary QBSS.

The DA is the destination of the frame.

The SA is the address of the station transmitting the frame.

Within all management type frames sent by STAs during the CFP under PCF, the Duration field is set to the value 32768. Within all management type frames sent by ESTAs in a QBSS the Duration/ID field is set as specified for HCF in Clause 9. Within all management type frames sent during the contention period under DCF, the Duration field is set according to the following rules:

If the DA field contains a group address, the Duration value is set to 0.

If the More Fragments bit is set to 0 in the Frame Control field of a frame and the DA contains an individual address, the Duration value is set to the time, in microseconds, required to transmit one ACK frame, plus one SIFS interval.

If the More Fragments bit is set to 1 in the Frame Control field of a frame, and the DA contains an individual address, the Duration value is the time, in microseconds, required to transmit the next fragment of this Management frame, plus two ACK frames, plus three SIFS intervals.

The duration value calculation for the management frame is based on the rules in 9.6 that determine the data rate at which the control frames in the frame exchange sequence are transmitted. If the calculated duration includes a fractional microsecond, that value is rounded up to the next higher integer. All stations process Duration field values less than or equal to 32767 from valid management frames to update their NAV settings as appropriate under the coordination function rules.

The frame body consists of the fixed fields followed by the information elements defined below for each management frame subtype. All fixed fields and information elements are mandatory unless stated otherwise, and only appear in the specified, relative order. STAs that encounter an element ID they do not recognize in the frame body of a management type frame received without errors ignore that element and continue to scan the remainder of the management frame body (if any) for additional information elements with recognizable element IDs. Element ID codes not explicitly defined in the standard are reserved, and do not appear in any frames.

Change the heading, text and table within 7.2.3.1 as follows:

7.2.3.1 Beacon and Proxy Beacon frame format

The frame body of a management frame of subtype Beacon contains the information shown in Table 5. The Proxy Beacon is a management frame of subtype Beacon, sent by an ESTA associated in a QBSS in order to provide greater spatial distribution of QBSS-related information for use in overlap mitigation by nearby QBSSs. The frame body of the Proxy Beacon is copied from the most recent Beacon frame sent in that QBSS, except that the Timestamp field reports the time of Proxy Beacon transmission. Proxy Beacon frames can be distinguished from Beacon frames by the presence of unequal values in the SA and BSSID fields of Proxy Beacon frames. Additional information about the generation and use of Proxy Beacon frames is given in << ## BSS overlap mitigation >>.

Table 5 - Beacon frame body

Usage	Order	Information	Note
Always present	1	Timestamp	
	2	Beacon interval	
	3	Capability information	
	4	SSID	
	5	Supported rates	
Present if required by PHY type, BSS type, or an active point coordinator (see notes)	6	FH Parameter Set	The FH Parameter Set information element is present within Beacon frames generated by STAs using frequency hopping PHYs.
	7	DS Parameter Set	The DS Parameter Set information element is present within Beacon frames generated by STAs using direct sequence PHYs.
	8	CF Parameter Set	The CF Parameter Set information element is present within Beacon frames generated by APs with an active PC or by EAPs.
	9	IBSS Parameter Set	The IBSS Parameter Set information element is only present within Beacon frames generated by STAs in an IBSS.
	10	TIM	The TIM information element is only present within Beacon frames generated by APs or EAPs.
Multiple regulatory domains	11	Country Information	<< placeholder for 802.11d >>
	12	Hopping Parameters	<< placeholder for 802.11d >>
	13	Hopping Pattern Table	<< placeholder for 802.11d >>
QBSS	14	QBSS Load	The QBSS Load information element is only present within Beacon frames generated by EAPs.
	15	QoS Parameter Set	The QoS Parameter SetEDCF Feedback information element is only present within Beacon frames generated by EAPs.
QBSS that has invoked BSS overlap mitigation procedure	16	Overlap CFP Allocation	The Overlap CFP allocation information element is only present within Beacon frames generated by EAPs that have invoked the BSS overlap mitigation procedure (see <## clause 9, overlap>).
	17	Overlap BSS Report	The Overlap BSS report information element is only present within Beacon frames generated by EAPs that have invoked the BSS overlap mitigation procedure (see <## clause 9, overlap>).
	18	Overlap ESTA List	The Overlap VS list information element is only present within Beacon frames generated by EAPs that have invoked the BSS overlap mitigation procedure (see <## clause 9, overlap>).
	19	Extended Capabilties	The Extended Capabilities information element is only present within Beacon frames sent by EAPs with Capability Information bit 15 =1.

7.2.3.4 Association Request frame format

Change the contents of Table 7 in 7.2.3.4 as shown:

Table 7 – Association Request frame body

Usage	Order	Information
Always present	1	Capability information
	2	Listen interval
	3	SSID
	4	Supported rates
QBSS	5	Listen epoch, requested (only included by ESTAs that want to use power save with QoS)
	6	Extended Capabilities (only if Capability[15]=1)

7.2.3.5 Association Response frame format

Change the contents of Table 8 in 7.2.3.5 as shown:

Table 8 – Association Response frame body

Usage	Order	Information
Always present	1	Capability information
	2	Status code
	3	Association identifier (AID)
	4	Supported rates
QBSS	5	Listen epoch, assigned (only included by EAPs when a listen epoch was requested)
	6	Extended Capabilities (only if Capability[15]=1)

7.2.3.6 Reassociation Request frame format

Change the contents of Table 9 in 7.2.3.6 as shown:

Table 9 – Reassociation Request frame body

Usage	Order	Information
Always present	1	Capability information
	2	Listen interval
	3	Current (E)AP address
	4	SSID
	5	Supported rates
QBSS	6	Listen epoch, requested (only included by ESTAs that want to use power save with QoS)
	7	Extended Capabilities (only if Capability[15]=1)

7.2.3.7 Reassociation Response frame format

Change the contents of Table 10 in 7.2.3.7 as shown:

Table 10 – Reassociation Response frame body

Usage	Order	Information
Always present	1	Capability information
	2	Status code
	3	Association identifier (AID)
	4	Supported rates
QBSS	5	Listen epoch, assigned (only included by EAPs when a listen epoch was requested)
	6	Extended Capabilities (only if Capability[15]=1)

7.2.3.8 Probe Request frame format

Change the text and contents of Table 11 in 7.2.3.8 as shown:

The frame body of a management frame of subtype Probe Request contains ~~the information~~at least the two items, shown in the top section of Table 11. These two items constitute the entire frame body under IEEE 802.11-1999. The optional items in the frame body of Probe Request frames vary depending on whether the frame is being used to request information pertaining to operation in multiple regulatory domains, under IEEE 802.11d, shown in the middle section of Table 11; or to request information pertaining to quality of service, under IEEE 802.11d, shown in the bottom section of Table 11. It is not permitted to use a single Probe Request to perform both the regulator domain and quality of service functions. However, it is permitted for an ESTA to support both IEEE 802.11d and IEEE 802.11e, and to send each of these optional formats in separate Probe Request frames.

Table 11 – Probe Request frame body

Usage	Order	Information
Always present	1	SSID
	2	Supported rates
802.11d optional	3	Request information <<placeholder for 802.11d>>
802.11e optional	3	Listen epoch (only in directed Probe Requests by ESTAs with an assigned listen epoch)

7.2.3.9 Probe Response frame format

Change the text and contents of Table 12 in 7.2.3.9 as shown:

The frame body of a management frame of subtype Probe Response begins with 6 or more common items section of Table 12. These items constitute the mandatory frame body. The additional optional items in the frame body of Probe Response frames vary depending on the items in the frame body of the Probe Request to which this frame is a response. If the Probe Request was requesting information pertaining to operation in multiple regulatory domains, the Probe Response contains additional items as shown in the middle section of Table 12. If the Probe Request was requesting information pertaining to quality of service the Probe Response contains additional items as shown in the bottom section of Table 12. It is not permitted to use a single Probe Request to perform both the regulator domain and quality of service functions. Therefore, no single Probe Response will contain all of the items in Table 12. However, it is permitted for an ESTA to support both multiple regulatory domains and quality of service, and to send each of these optional formats in separate Probe Response frames.

Table 12 - Probe Response frame body

Usage	Order	Information	Note
Always present	1	Timestamp	
	2	Beacon interval	
	3	Capability information	
	4	SSID	
	5	Supported rates	
Present if required by PHY type, BSS type, or an active point coordinator	6	FH Parameter Set	The FH Parameter Set information element is present within Probe Response frames generated by STAs using frequency hopping PHYs.
	7	DS Parameter Set	The DS Parameter Set information element is present within Probe Response frames generated by STAs using direct sequence PHYs.
	8	CF Parameter Set	The CF Parameter Set information element is present within Beacon frames generated by APs with an active PC or by EAPs ~~with an active EPC~~.
	9	IBSS Parameter Set	The IBSS Parameter Set information element is only present within Probe Response frames generated by STAs in an IBSS.
Multiple regulatory domains	10	Country Information	<< placeholder for 802.11d >>
	11	Hopping Parameters	<< placeholder for 802.11d >>
	12	Hopping Pattern Table	<< placeholder for 802.11d >>
	13 - n	Requested Information	<< placeholder for 802.11d >>
QBSS, always present	10	QBSS Load	The QBSS Load information element is only present within Probe Response frames generated by EAPs.
	11	Error Statistics	The Error Statistics information element is only present in Probe Response frames generated by ESTAs in a QBSS.
QBSS, present if required	12	Listen Epoch	The Listen Epoch information element is only present in Probe Response frames generated by ESTAs in a QBSS which have an assigned listen epoch.
	13	Extended Capabilities	The Extended Capabilities information element is only present in Probe Response frames generated by ESTAs with Cabability Information bit 15=1.

Insert following 7.2.3.9 the following two subclauses and the figures and tables included therein, renumbering subclauses, figures and tables as necessary:

7.2.3.12 {generic} Action frame format

The frame body of a management frame of subtype {generic} Action consists of a 4-octet fixed portion that identifies a functional category and a specific management action, followed by a variable-length portion that is interpreted in the context of that category and action. The fields in the fixed portion of an Action request are shown in Figure 23.1, and the fields in the fixed portion of an Action response are shown in Figure 23.2.

octets: 1	1	1	1	0-2300
Category Code	**Action Code** (even)	**Activation Delay**	**Dialog Token**	**Action-specific fixed fields and/or elements**

Figure 23.1 – {generic} Action request frame body

octets: 1	1	1	1	0-2300
Category Code	**Action Code** (odd)	**Action-specific Status**	**Dialog Token**	**Action-specific fixed fields and/or elements**

Figure 23.2 – {generic} Action response frame body

The Category Code field is a single octet whose value identifies a group of actions for a particular function, or, for administrative ease, a group of actions defined by a single task group. Category code assignments are defined in Table 15.1. In the remainder of this document, Action frames of a given category are referred to as <category name> Action frames. For example, frames in the "QoS" category are called "QoS Action frames," "QoS Action Requests," or "QoS Action Responses." ESTAs that receive an Action frame with a category code that they do not understand discard the frame without reporting an error.

Table 15.1 – Category codes

Code	Meaning
0	Reserved
1	QoS management (includes BSS overlap mitigation)
2	Security management
3	Distribution System (DS) management
4	Spectrum management (DFS/TPC)
5 – 255	Reserved

The Action Code field is a single octet whose value specifies a particular management action in the context of the category code. There is no requirement for uniqueness nor uniformity of action code assignments between categories. There is a requirement that all advisory actions (which generate no response) and request actions (which solicit a response) use even action code values; while response actions (generated pursuant to a request action) use the request code value plus 1 as the response code value. ESTAs that receive an Action frame with a recognized category code but an unrecognized request action code return a response action frame using the request action code plus 1, and a status code value of 1, meaning "unrecognized action." ESTAs that receive an Action frame with a recognized category code but an unrecognized response action code discard the frame without reporting an error.

The Activation Delay field is a single octet, present only in Action request frames. The activation delay value is interpreted as an unsigned integer. Action requests received with an activation delay of 0 are processed immediately. Action requests received with an activation delay greater than zero are processed after the specified number of TBTTs have occurred (e.g. an activation delay of 1 delays the action until after the next TBTT, and activation delay of 2 delayes the action until after the second TBTT, etc.). A given Action request frame starting with an activation delay greater than zero will ordinarily be repeated during successive superframes, with its activation delay value decremented by 1 for each superframe until the activation delay reaches 0. Non-zero activation delays may only be used with action codes that are specified to permit or to require such use.

The Dialog Token field is a single octet whose value is copied from each Action request frame into the corresponding Action response frame, but is otherwise ignored. The dialog token may be useful in the implementation of ESTAs that may issue multiple, concurrent Action requests, to simplify the matching of Action responses with particular, outstanding Action requests.

The Status field is a single octet, present only in Action response frames, which indicates the completion status of the corresponding Action request. The status values are interpreted in the context of the category and action codes. There is no requirement for uniqueness nor uniformity of status value assignments between categories. However, there are 2, predefined status values:

Status =0: Action completed successfully
Status =1: Unrecognized Action code

7.2.3.13 Container frame format

Management frames of subtype Container are used to transfer a plurality of MPDUs in a single PSDU, thereby reducing the overhead of PHY preambles and interframe spaces. The format of Container frames is defined in Figure 23.3. The generation of Container frames for transmission is called aggregation, while the extraction of individual MPDUs from received Container frames is called disaggregation. Aggregation and disaggregation procedures are specified in << ## aggregation, clause 9 >>.

octets: 2	2	6	6	6	2	*6 or 0*	2	2	2*mpdu count	<= 2302 - (2*mpduct)	4
Frame Control	**Dur/ID**	**Address 1**	**Address 2**	**Address 3**	**Seq Ctrl**	***Address 4***	**QoS Control**	**MPDU Count**	**MPDU Lengths**	**MPDUs** (no FCS)	**FCS**
MAC header								frame body			

Figure 23.3 – Container management frame

All frame control bits except Order are interpreted in the MAC header of a management frame of type Container. The Protocol Version, Retry, Power Management, and WEP bits are only interpreted in the MAC header of the Container frame, and are ignored in headers of the individual MPDUs in the Container frame body. The remaining frame control bits (Type, Subtype, To DS, From DS, More Data, More Fragments) are interpreted in the MAC headers of individual MPDUs extracted from the Container frame body, as well as in the MAC header of the Container frame itself.

The address field usage and Duration/ID calculation for Container frame MAC headers are identical to those in QoS data frames, specified in 7.2.2. When the Address 1 field of a Container frame contains an individual address, or a non-broadcast group address, all MPDUs in the Container frame body must have the identical Address 1 field value. When the Address 1 field contains the broadcast address, all MPDUs in the Container frame body must have any group address (broadcast or multicast) in their Address 1 fields.

The TCID value in the QoS Control field of the Container frame header indicates the traffic category with the highest priority among the MPDUs present in the Container frame body. The sequence number is set in the manner specified for management frames.

The MPDU Count is a 2-octet fixed field which specifies the number of aggregated MPDUs in the Container frame body. The MPDU Count follows the MAC header of the Container frame if WEP=0, and follows the IV if WEP=1. The MPDU Length field contains the number of 2-octet length values indicated by the MPDU Count. Each MPDU Length value is the number of octets in the MPDU of corresponding relative position within the Container frame.

Each of the aggregated MPDUs includes a full MAC header and frame body, but no IV, ICV, or FCS fields. Both WEP, if used, and FCS validation apply to the Container MMPDU, not to any of the individual, aggregated MPDUs. The first MPDU begins immediately after the MPDU Length field. Successive MPDUs begin on even octet boundaries, separated from the beginning of the preceding MPDU by the indicated MPDU Length value, if that length value is even, or by the indicated MPDU Length value plus 1, if that length value is odd. The necessary pad octets to achieve this alignment are inserted during aggregation and are discarded during disaggregation.

NOTE: Implementers need to be aware that the MAC-level acknowledgement of a directed Container frame is interpreted by the ESTA receiving the acknowledgement as confirming successful transfer of a plurality of MPDUs. Therefore, an ESTA which has received and acknowledged a Container frame must make every reasonable effort to ensure that all of the contained MPDUs are indicated to the MAC SAP, or passed to distribution services, and are not discarded while still within the receiving MAC entity.

7.3.1.4 Capability Information field

Change the contents of the text, Figure 27 and Tables 16 & 17 in 7.3.1.4 as shown:

The Capability Information field contains a number of subfields that are used to indicate requested or advertised capabilities. The length of the Capability Information field is 2 octets. The Capability Information field consists of the following subfields: ESS, IBSS, CF-Pollable, CF-Poll Request, Privacy, PBCC, Channel Agility, QoS, Bridge Portal and Extended Capability Element. The remaining bits in the Capability Information field are reserved. The format of the Capability Information field is as illustrated in Figure 27.

bits: 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
ESS	IBSS	CF-pollable	CF-poll request	Privacy	Short preamble	PBCC	Channel agility	QoS	rsrv (0)	Bridge Portal	rsrv (0)	rsrv (0)	rsrv (0)	rsrv (0)	Extended capability element

Figure 27 – Capability Information fixed field

Each Capability Information subfield is interpreted only in the management frame subtypes for which the transmission rules are defined.

APs and EAPs set the ESS subfield to 1 and the IBSS subfield to 0 within transmitted Beacon or Probe Response management frames. STAs within an IBSS set the ESS subfield to 0 and the IBSS subfield to 1 in transmitted Beacon or Probe Response management frames. ESTAs within a QBSS set the ESS subfield to 1 and the IBSS subfield to 0 within transmitted Probe Response management frames.

STAs set the CF-Pollable and CF-Poll Request subfields in Association and Reassociation Request management frames according to the upper half of Table 16 (QoS subfield set to 0). ESTAs desiring to associate in a QBSS set the CF-Pollable and CF-Poll Request subfields in Association and Reassociation Request management frames according to the lower half of Table 16 (QoS subfield set to 1). ESTAs desiring to associate in a BSS set these bits as if they were STAs.

Table 16 - STA and ESTA Usage of QoS, CF-Pollable and CF-Poll Request

QoS	CF-Pollable	CF-Poll Request	Meaning
0	0	0	STA is not CF-Pollable
0	0	1	STA is CF-Pollable, not requesting to be placed on the CF-Polling list
0	1	0	STA is CF-Pollable, requesting to be placed on the CF-Polling list
0	1	1	STA is CF-Pollable, requesting never to be polled
1	0	0	ESTA requesting association in a QBSS.
1	0	1	reserved
1	1	0	reserved
1	1	1	reserved

APs set the CF-Pollable and CF-Poll Request subfields in Beacon and Probe Response management frames according to the upper half of Table 17 (QoS subfield set to 0). An AP sets the CF-Pollable and CF-Poll Request subfield values in Association Response and Reassociation Response management frames equal to the values in the last Beacon or Probe Response frame that it transmitted, with the QoS subfield always set to 0. EAPs set the CF-Pollable and CF-Poll Request subfields in Beacon and Probe Response management frames to indicate the type of contention free service available to STAs, according to the lower half of Table 17 (QoS subfield set to 1). An EAP sets the CF-Pollable, CF-Poll Request, and QoS subfield values in Association Response and Reassociation Response management frames equal to the values in the last Beacon or Probe Response frame that it transmitted, with the QoS subfield always set to 1.

Table 17 - AP and EAP Usage of QoS, CF-Pollable and CF-Poll Request

QoS	CF-Pollable	CF-Poll Request	Meaning
0	0	0	No Point Coordinator at AP
0	0	1	Point Coordinator at AP for delivery only (no polling)
0	1	0	Point Coordinator at AP for delivery and polling
0	1	1	Reserved
1	0	0	EAP which does not use a CFP for delivery of unicast data type frames
1	0	1	EAP which uses a CFP for delivery, but does not send CF-Polls to STAs
1	1	0	EAP which uses a CFP for delivery, and may send CF-Polls to STAs
1	1	1	Reserved

NOTE: While an EAP may indicate availability of CF-Polls to STAs, and thereby provide non-QoS contention free transfers during the CFP, this is not recommended. Implementers are cautioned that ESTAs are not required to interpret +CF-Ack subtypes in frames addressed to other stations, nor non-QoS (+)CF-Polls, and therefore must **not** be treated as CF-Pollable stations. This requires an EAP that provides non-QoS CF-polling to adhere to frame sequence restrictions considerably more complex than, and less efficient than, those specified for either PCF or HCF. In addition, the achieveable service quality is likely to be degraded when non-QoS STAs are associated and being polled.

APs set the Privacy subfield to 1 within transmitted Beacon, Probe Response, Association Response and Reassociation Response management frames if WEP encryption is required for all data type frames exchanged within the BSS. If WEP encryption is not required, the Privacy subfield is set to 0.

STAs within an IBSS set the Privacy subfield to 1 in transmitted Beacon or Probe Response management frames if WEP encryption is required for for all data type frames exchanged within the IBSS. If WEP encryption is not required the Privacy subfield is set to 0.

APs (as well as STAs in IBSSs) set the Short Preamble subfield to 1 in transmitted Beacon, Probe Response, Association Response and Reassociation Response management frames to indicate that the use of the short preamble option, as described in subclause 18.2.2.2, is allowed within this BSS. To indicate that the use of the short preamble option is not allowed the Short Preamble subfield is set to 0.

STAs set the Short Preamble subfield to 1 in transmitted Association Request and Reassociation Request frames when the MIB attribute dot11ShortPreambleOptionImplemented is true. Otherwise STAs set the Short Preamble subfield to 0.

APs (as well as STAs in IBSSs) set the PBCC subfield to 1 in transmitted Beacon, Probe Response, Association Response and Reassociation Response management frames to indicate that the use of the PBCC modulation option, as described in subclause 18.4.6.6, is allowed within this BSS. To indicate that the use of the PBCC modulation option is not allowed the PBCC subfield is set to 0.

STAs set the PBCC subfield to 1 in transmitted Association Request and Reassociation Request frames when the MIB attribute dot11PBCCOptionImplemented is true. Otherwise STAs set the PBCC subfield to 0.

STAs set the Channel Agility subfield to 1 to indicate the usage of channel agility by the HR/DSSS PHY. Otherwise STAs set the Channel Agility subfield to 0.

ESTAs set the Bridge Portal subfield to 1 within transmitted Association and Reassociation Request management frames if the ESTA includes a bridge portal function and an operational connection to a non-IEEE 802.11 network. EAPs set the Bridge Portal subfield to 1 within transmitted Beacon, Probe Response, Association Response and Reassociation Response management frames if there is at least one bridge portal associated in this QBSS.

The Extended Capability Element subfield is set to 1 to indicate that an Extended Capaability information element is present in this frame.

7.3.1.7 Reason Code field

Change the contents of Table 18 in clause 7.3.1.7 as shown:

Table 18 - Reason codes

Reason code	Meaning
0	Reserved
1	Unspecified reason
2	Previous authentication no longer valid
3	Deauthenticated because sending station is leaving (or has left) the IBSS or ESS
4	Disassociated due to inactivity
5	Disassociated because AP/EAP is unable to handle all currently associated (E)STA
6	Class 2 frame received from non-authenticated station
7	Class 3 frame received from non–associated station
8	Disassociated because sending station is leaving (or has left) the (Q)BSS
9	Station requesting (re)association is not authenticated with responding station
10	Disassociated for unspecified, QoS-related reason
11	Disassociated because EAP lacks sufficient bandwidth for this ESTA
12	Reserved
13	Disassociated because of excessive frame losses and/or poor channel conditions
14	Disassociated because ESTA is transmitting outside of its TXOPs
15	Reserved
16	QBSS reconfiguration is in progress
17	HC handover is in progress
18 - 65535	Reserved

7.3.1.9 Status Code field

Change the contents of Table 18 in clause 7.3.1.9 as shown:

Table 19 - Status codes

Status code	Meaning
0	Successful
1	Unspecified failure
2–9	Reserved
10	Cannot support all requested capabilities in the Capability Information field
11	Reassociation denied due to inability to confirm that association exists
12	Association denied due to reason outside the scope of this standard
13	Responding station does not support the specified authentication algorithm
14	Received an Authentication frame with authentication transaction sequence number out of expected sequence
15	Authentication rejected because of challenge failure
16	Authentication rejected due to timeout waiting for next frame in sequence
17	Association denied because AP/EAP is unable to handle additional associated (E)STA
18	Association denied due to requesting station not supporting all of the data rates in the BSSBasicRateSet parameter
19	Association denied due to requesting station not supporting the short preamble option
20	Association denied due to requesting station not supporting the PBCC modulation option
21	Association denied due to requesting station not supporting the channel agility option
22	Unspecified, QoS-related failure
23	Association denied due to EAP having insufficient bandwidth to handle another ESTA
24	Association denied due to poor channel conditions
25	Association (with QBSS) denied due to requesting station not supporting the QoS option
26	Association denied due to requesting station not supporting the FEC option
27 - 65535	Reserved

7.3.2 Information Elements

Change the text and contents of Table 20 in 7.3.2 as shown:

Elements are defined to have a common general format consisting of a 1 octet Element ID field, a 1 octet length field and a variable-length element-specific information field. Each element is assigned a unique Element ID as defined in this standard. The length field specifies the number of octets in the information field. See Figure 34.

Element ID (1 octet)	Length (1 octet)	Information (*length* octets)

Figure 34 – Element format

The set of valid elements is defined in Table 20.

Table 20 - Element IDs

Information Element	Element ID
SSID	0
Supported rates	1
FH Parameter Set	2
DS Parameter Set	3
CF Parameter Set	4
TIM	5
IBSS Parameter Set	6
Country << placeholder for 802.11d >>	7
Hopping Pattern Parameters << placeholder for 802.11d >>	8
Hopping Pattern Table << placeholder for 802.11d >>	9
Request << placeholder for 802.11d >>	10
QBSS Load	11
QoS Parameter Set	12
Traffic Specification	13
Error statistics	14
Listen Epoch	15
Challenge text	16
Reserved for challenge text extension	17-31
Overlap CFP allocation	32
Overlap BSS report	33
Overlap VS list	34
Extended Capabilities	35
Reserved	36
Reserved	37
Reserved	38
Reserved	39
Reserved	40 - 255

A station that encounters an unknown or reserved element ID value in a management frame received without error shall ignore said element and shall proceed scanning the remainder of the management frame body (if any) for additional information elements with recognizable element ID values. The frame body components specified for many management subtypes results in elements ordered by ascending element ID.

Insert following 7.3.2.12 the 7.3.x subclauses with the figures and tables included therein, renumbering as necessary:

7.3.2.13 QBSS Load element

The QBSS Load element contains information on the current station population and traffic levels in the QBSS. The element information field is comprised of 5 items, the contents of which are defined below. The total length of the information field is 6 octets. See Figure 42.5.

Element ID (11)	**Length** (6)	**Station Count** (2 octets)	**Channel Utilization** (1 octet)	**Frame Loss Rate** (1 octet)	**Overlap Count** (1 octet)	**Overlap Share** (1 octet)

Figure 42.5 – QBSS Load element format

The station count field is 2 octets for an unsigned integer that indicates the total number of STAs and ESTAs currently associated with this QBSS.

The channel utilization field is 1 octet for an unsigned integer that indicates the portion of available WM bandwidth currently used to transport VS data within this QBSS. The value is calculated by taking the integer part of the quotient of <<100 * utilized bits/s>> divided by <<total available bits/s>>.

OPEN ISSUE: Considerably greater precision in needed on the definition of channel utilization, the time period over which the available and utilized bandwidth are measured, and whether any averaging, smoothing, or other forms of hysteresis are employed on the measurements to obtain the value reported in this element.

The frame loss rate field is 1 octet for an unsigned integer that indicates the portion of transmitted MPDUs that require retransmission or are discarded as undeliverable. The value is calculated by taking the integer part of the quotient of <<100 * (total retries + discarded MPDUs and MMPDUs)>> divided by <<total MPDU and MMPDU transmission attempts>>. These totals should be accumulated over the same period used to calculate the channel utilization value.

The overlap count field is 1 octet for an unsigned integer than indicates the number of overlapping BSSs currently known to the BSS overlap mitigation procedure at the EAP of this QBSS.

The overlap share field is 1 octet for an unsigned integer that indicates the portion of total time available to this QBSS for non-silent periods under the BSS overlap mitigation procedure. The value is calculated by taking the integer part of the quotient of <<100 * total non-silent time per superframe>> divided by <<superframe duration>>.

7.3.2.14 QoS Parameter Set element

The QoS Parameter Set element provides information needed by ESTAs for proper operation of the QoS facility during the contention period. This information includes the CP TXOP limit and the contention window values and AIFS values for prioritized EDCF channel access. The format of the QoS Parameter Set element is shown in Figure 42.6.

The QoS Parameter Set element shall be transmitted by a QoS-enabled AP in Beacon Frames and Probe Response Frames although its use is not necessarily limited to those frames. The QoS Parameter Set element is used by the AP to establish policy (by overriding default MIB values), to change policies when accepting new stations or new traffic, or - if an EDCF Link Contention Control function has been provided - to adapt to changes in offered load. In an IBSS network the QoS Parameter Set element may be transmitted by a participating station that has been provided with an EDCF Link Contention Control function.

Element ID (12)	Length (26)	CP TXOP Limit (2 octets)	CWmin[TC] values CWmin[0] ... CWmin[7] (8 octets)	AIFS[TC] values AIFS[0]…AIFS[7] (8 octets)	CWPFactor[TC] values CWPFactor[0]… CWPFactor[7] (8 octets)

Figure 42.6 – QoS Parameter Set element format

The Contention Period TXOP limit is a 2-octet field that specifies the time limit on TXOPs by WSTAs that are not initiated by QoS (+)CF-Polls. All non-polled WSTA TXOPs during the CP last no longer than the number of 16-microsecond periods specified by the CP TXOP limit value. A CP TXOP limit value of 0 indicates that each non-polled TXOP during the CP can be used to transmit a single MPDU any rate in the operational rate set of the QBSS.

The CWmin[TC] values field contains 8 octets which specify 8 contention window values, for traffic categories 0 through 7, respectively. Each contention window value is 1 octet in length and contains an unsigned integer. CWmin[TC] values update the aCWmin[TC] MIB values when received by an EDCF station.

The AIFS[TC] values field contains 8 octets which specify 8 AIFS values, for traffic categories 0 through 7, respectively. Each AIFS value is 1 octet in length and contains an unsigned integer. AIFS[TC] values update the aAIFS[TC] MIB values when received by an EDCF station.

The CWPFactor[i] (Contention Window Persistence Factor) field is one octet in length and indicates the factor in units of 1/16 ths, used in computing new CW[i] values on every unsuccessful attempt to transmit an MPDU or an MMPDU of traffic category i according to the procedure defined in 9.2.4.

7.3.2.15 Traffic Specification (TS) element

The Traffic Specification (TS) element contains parameters that define the characteristics of a given traffic category, in the context of a given wireless station, for use by the EPC and ESTA(s) that support parameterized QoS. The element information field is comprised of 12 items as defined below and illustrated in Figure 42.7. The total length of the information field is 28 octets.

Element ID (13)	Length (28)	Source Address (6 octets)	Destination Address (6 octets)	TCID (2 octets)	TS Info (1 octet)	Retry Interval (1 octet)	Inactivity Interval (1 octet)	Polling Interval (1 octet)	Nominal MSDU Size (2 octets)	Minimum Data Rate (2 octets)	Mean Data Rate (2 octets)	Maximum Burst Size (2 octets)	Delay Bound (1 octet)	Jitter Bound (1 octet)

Figure 42.7 – Traffic Specification element format

The Traffic Specification allows a set of parameters more extensive than may be needed, or may be available, for any particular instance of parameterized QoS traffic. The fields are set to zero for any unspecified parameter values.

The Source Address and Destination address fields are each 6 octets in length and contain MAC addresses of the ESTAs that are the source and destination, respectively, of the traffic subject to this specification.

The QoS Control field is 2 octets in length and contains the TCID value in the format defined in 7.1.3.5. The contents of this field indentify the traffic category, in the context of the WSTA address, to which the traffic specification applies.

The TS Info field is 1 octet which is subdivided as shown in Figure 42.8. The Traffic Type subfield is a single bit which is set to 1 for a continuous or periodic traffic pattern (e.g. traffic which requires TXOPs at approximately uniform intervals such as CBR or variable MSDU size at fixed transmission rate), or is set to 0 for a non-continuous, aperiodic, or unspecified traffic pattern. The Ack Policy subfield is 2 bits that identify the acknowledgement policy for use on MSDUs belonging to this traffic category, with the alternatives specified in the paragraph just below Figure 42.8. The Delivery Priority subfield is 3 bits that hold the actual priority value to use for this traffic in cases where relative prioritization is required. This Delivery Priority value is generally the value that would be used for the MA-UNITDATA.request priority parameter if the same traffic were being sent under level 1 or level 2 QoS. The remaining bits in the TS Info field are reserved.

bits: 0	1	2	3	4	5	6	7
Traffic Type	reserved (0)	Ack Policy		reserved (0)	Delivery Priority (0-7)		

Figure 42.8 – TS Info field

The Ack policy sub-field indicates whether MAC acknowledgement is required for MSDUs belonging to this TC, and the desired form of those acknowledgements. Certain, selectable and/or optional facilities (e.g. FEC) may require the use of a particular Ack policy setting.

0 Normal IEEE 802.11 acknowledgement.
The addressed recipient returns an ACK or (+)CF-Ack frame after a SIFS period, according to the procedures defined in clause 9.

1 Alternate acknowledgement
Reserved for future use.

2 Delayed acknowledgement
The addressed recipient returns a DlyAck frame, during a subsequent TXOP. The DlyAck must be received within the retry period specified in this TSPEC.

3 No acknowledgement
The recipient(s) shall not acknowledge the transmission, and the sender treats the transmission as successful without regard for the actual result.

The Retry Interval field specifies the number of superframes the transmitting station waits before initiating retransmission when using delayed acknowledgements (Ack Policy = 2). A value of 0 causes the transmitting station to wait for a negative acknowledgement, and never to initiate retransmission based on elapsed time.

The Inactivity Interval field specifies the maximum number of superframes permitted between CF-Polls to the WSTA or traffic from the WSTA in this TC. For Traffic Type =0 (aperiodic) the Inactivity Interval is the maximum number of superframes between CF-Polls to the WSTA in the absence of indicated, queued traffic for this TC. For Traffic Type =1 (periodic) the Inactivity Interval isthe maximum number of periodic polls, at the rate specified in the Polling Interval field, which must elapse without transfer of an MSDU belonging to this TC before the periodic polling is discontinued. A value of 0 inhibits the Inactivity Interval function for either traffic type.

The Polling Interval field specifies the nominal number of TU between outgoing MSDUs for this traffic. For Traffic Type=1 (periodic) this duration is the nominal inter-TX interval. Subject to available bandwidth and relative traffic priorities, for an accepted periodic TSPEC the HC attempts to provide polled TXOPs with inter-TXOP spacing equal to the Polling Interval parameter value, plus or minus the Jitter Bound parameter value. For Traffic Type=0 (aperiodic) this duration is the interval during which the minimum and mean data rates and maximum burst size are measured. For aperiodic traffic, this parameter is sometimes referred to as Committed Time (CT).

The Nominal MSDU Size field specifies the nominal size, in octets, of MSDUs sent under this traffic specification.

The Minimum Data Rate field specifies the lowest data rate, in units of octets per Transmit Interval, that is acceptable for transport of MSDUs under this traffic specification.

The Mean Data Rate field specifies the nominal sustained data rate, in units of octets per Transmit Interval, for transport of MSDUs under this traffic specification.

The Maximum Burst Size field specifies the peak data burst, in units of 1024 bytes, that may occur under this traffic specification during a single Transmit Interval.

The Delay Bound field specifies the maximum number of TU that may elapse before an MSDU under this traffic specification is discarded due to excessive delay. For traffic with no defined maximum delay, the Delay Bound value is set to zero, and the value of dot11MaxTransmitMSDULifetime is used for this purpose.

The Jitter Bound field specifies the maximum number of TU by which the actual intervals between MSDU transmissions for this traffic may vary from the nominal value specified in the Polling Interval field. Symmetrical jitter (equal amounts early or late) within the specified bound are assumed to be acceptable. When the Jitter Bound value is zero, there is no attempt to control jitter to less than the Delay Bound.

7.3.2.16 Error Statistics element

The Error Statistics element contains information on the receive errors experienced by an ESTA and up to 8 traffic categories at that ESTA. The element information field is comprised of 2 fixed items, requiring 8 octets, followed by 1 to 8 error records, each requiring 16 octets, for a total length of requiring 24 to 136 octets in increments of 16 octets, as shown in Figure 42.9.

1	1	4	4	16*n			
Element ID (14)	**Length** (8+(16*n)) 0< n <9	**Received Fragments** (4 octets)	**FCS Errors** (4 octets)	**Error Record** (16 octets)			
				WSTA Address (6 octets)	**TCID** (2 octets)	**MPDUs Received** (4 octets)	**Retrys Received** (4 octets)

Figure 42.9 – Error Statistics element format

The Received Fragments field is 4 octets long and contains the value of the dot11ReceivedFragmentCount MIB counter at the source ESTA.

The FCS Errors field is 4 octets long and contains the value of the dot11FCSErrorCount MIB counter at the source ESTA.

The WSTA Address field is 6 octets in length and contain MAC address of the WSTAs that is the context of the TCID for which error statistics are reported.

The TCID field is 2 octets in length and uses the TCID the format defined in 7.1.3.5. The contents of this field indentify the traffic category, in the context of the WSTA address, to which the error statistics are reported.

If the Error Statistics element is sent by an ESTA operating at a QoS level lower than 3, the TS Address field contains the MAC address of that ESTA.

The MPDUs Received field is 4 octets long and contains a count of the total number of MPDUs successfully received for the specified traffic category.

The Retrys Received field is 4 octets long and contains a count of the number of MPDUs successfully received for the specified traffic category with the Retry subfield of the Frame Control field set to 1. This count is based on

MPDU receptions, independent of whether any of those MPDUs are subsequently discarded by the duplicate filtering function.

7.3.2.17 Listen Epoch element

The Listen Epoch element defines the subset(s) of the superframe during which an ESTA that associated with a QBSS while in power save mode is required to be awake to receive transmissions. Power save stations also use a Listen Epoch element in Association or Reassociation Request frames to indicate to the EAP the amount of awake time to allocate per superframe. The element information field is comprised of 5 items, requiring 10 octets, as shown in Figure 42.10.

Element ID (15)	**Length** (10)	**TBTT Awake Limit** (2 octets)	**CFP Awake Start** (2 octets)	**CFP Awake Limit** (2 octets)	**CP Awake Start** (2 octets)	**CP Awake Limit** (2 octets)

Figure 42.10 – Listen Epoch element format

The TBTT Awake Limit field is 2 octets long and specifies, in units of 8 microseconds, the minimum duration that the ESTA remains awake after TBTT. This field may be set non-zero in a Listen Epoch element in a (Re)Association request, but is generally assigned by the EAP, based on its knowledge of data rates in use and the typical amount of broadcast/multicast traffic being sent after Beacons.

The CFP Awake Start field is 2 octets long and specifies, in units of 8 microseconds relative to TBTT, the start of the ESTA's awake period during the CFP. The CFP Awake Limit field is 2 octets long and specifies, in units of 8 microseconds, the minimum duration that the ESTA remains awake after CFP awake start. The CFP Awake Start is requested as 0, and the actual starting time is assigned by the EAP/EPC, based in part on the amount of awake time during the CFP is requested by the ESTA in the Listen Epoch element in its (Re)Association Request frame. If the CFP Awake Limit value in the request is zero, no CFP awake epoch is assigned.

The CP Awake Start field is 2 octets long and specifies, in units of 8 microseconds relative to TBTT, the start of the ESTA's awake period during the CP. The CP Awake Limit field is 2 octets long and specifies, in units of 8 microseconds, the minimum duration that the ESTA remains awake after CP awake start. The CP Awake Start is requested as 0, and the actual starting time is assigned by the EAP, based in part on the amount of awake time during the CP is requested by the ESTA in the Listen Epoch element in its (Re)Association Request frame. If the CP Awake Limit value in the request is zero, no CP awake epoch is assigned.

The EAP/EPC of the QBSS only initiates transmissions to a ESTA in power save mode during its Listen Epoch(s). These time restrictions may result in the power save ESTA receiving lower overall quality of service, for traffic of equivalent priorities or traffic categories, than a non-power-save ESTA in the same QBSS. ESTAs with assigned listen epochs include a Listen Epoch element in Probe Response frames they transmit. This permit other ESTAs in the QBSS to determine the awake times of a power save ESTA, for use when attempting to perform direct STA-to-STA transfers to a power save destination ESTA.

7.3.2.18 Overlap CFP allocation element

The Overlap CFP allocation element contains information about the amounts of time during the CFP that an EPC uses for overlap and non-overlap periods when the BSS overlap mitigation procedure is invoked (see <## clause 9, overlap>). The element information field is comprised of 2 fixed items, and a variable number of sets of 2 other items, as shown in Figure 42.11. The total length of the information field is (7n+2) octets, where n is the number of overlapping BSSs detected, in the {nominal} range 1-31, which yields element lengths of 9 to 219 in increments of 7. In practice, far fewer than 31 overlapping BSSs can be accommodated under the BSS overlap mitigation procedure.

octets: 1	1	1	1	7*n	
Element ID (32)	**Length** (2+(7*n)) 0< n <32	**TNOL(x)**	**TTOL(x)**	**Overlap Allocation** (7 octets)	
				TOL(x,y) (1 octet)	**BSSID(y)** (6 octets)

Figure 42.11 – Overlap CFP Allocation element format

The TNOL(x) field is 1 octet used to specify the number of TU allocated for the non-overlap period in this QBSS.

The TTOL(x) field is 1 octet used to specify the total number of TU allocated for all overlap periods in this QBSS.

Following the TTOL(x) field are 1-31 sets of overlap allocation information comprised of a 1-octet TOL(x,y) field used to specify the number of TU allocated for the overlap period between this QBSS and the BSS designated by the value of the corresponding 6-octet BSSID(y) field.

7.3.2.19 Overlap BSS report element

The Overlap BSS report element contains information that identifies and summarizes CFP usage for QBSSs which have been detected to overlap with this QBSS and which are cooperating under the BSS overlap mitigation procedure (see <<## clause 9, overlap>>). The element information field is comprised of a variable number of sets of 3 items, as shown in Figure 42.12. The length of the information field is (8p) octets, where p is the number of overlapping QBSSs detected, in the {nominal} range 1-31, which yields element lengths of 8 to 248 in increments of 8. In practice, far fewer than 31 overlapping BSSs can be accommodated under the BSS overlap mitigation procedure.

octets: 1	1	8*n		
Element ID (33)	**Length** (8*p) 0< p <32	**Overlapping BSS time and identity** (8 octets)		
		TNOL(y) (1 octet)	**TTOL(y)** (1 octet)	**BSSID(y)** (6 octets)

Figure 42.12 – Overlap BSS Report element format

Each overlapping BSS time and identity set contains a 1-octet TNOL(y) field, a 1-octet TTOL(x) field and a 6-octet BSSID(y) field.

The TNOL(y) field is 1 octet used to specify the number of TU allocated for the non-overlap period in BSS y, as determined from the Overlap CFP allocation element in proxy Beacon management frames received from BSS y.

The TTOL(y) field is 1 octet used to specify the total number of TU allocated for all overlap periods in BSS y, as determined from the Overlap CFP allocation element in proxy Beacon management frames received from BSS y.

The BSSID(y) field is 6 octets which identify BSS y.

7.3.2.20 Overlap ESTA list element

The Overlap ESTA list element identifies the ESTAs which have been determined to be subject to destructive interference from transmissions in other BSSs under the BSS overlap mitigation procedure (see <## clause 9, overlap>). ESTAs in this QBSS must restrict transmissions of MSDUs to those ESTAs to TXOPs within the TOL period of the CFP. MSDUs classified to virtual streams not on the overlap list may be transmitted within either the TOL period or the TNOL period. The element information field is comprised of a variable number of instances of a single item, as shown in Figure 42.13. The length of the information field is (6n) octets, where n is the number of ESTAs in the list, in the range of 1-42, which yields element lengths of 6 to 252 in increments of 6.

1	1	6*n
Element ID (34)	**Length** (2*n) 0<n<43	**ESTA needing TXOP in TOL** (6 octets)

Figure 42.13 – Overlap ESTA List element format

The ESTA Address field is 6 octets in length contains the MAC address of an ESTA. The contents of each instance of this field specify an ESTA whose transmissions must take place during the TOL period.

7.3.2.21 Extended Capabilities element

The Extended Capabilities element is present in any management frame body that includes a Capability Information field with bit 15 set to 1. This element provides additional bits to indicate optional or configurable capabilities. The element information field contains is a positive integer multiple of 2 octets in length, with a default length of 2 octets, as shown in Figure 42.14.

Element ID (35)	**Length** (2*n)	**Extended Capabilties** (2*n octets)

Figure 42.14 – Extended Parameter Set element format

The Extended Capabilities field is (at least) 2 octets in length, and contains capability information bits as defined in Figure 42.15. Once assigned, the positions of individual capability bits within this field remain fixed. This allows the length of this field to be extended over time without ambiguity. The mutually available capabilities for a pair of ESTAs which use Extended Capabilities elements of different lengths are, by definition, capabilities indicated by bits starting with bit 0 of the first octet of the element information field and ending with bit 15 of the last octet pair in the shorter of the two elements.

bits: 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
rsrv (0)	rsrv (0)	rsrv (0)	rsrv (0)	rsrv (0)	rsrv (0)	rsrv (0)	rsrv (0)	rsrv (0)	rsrv (0)	rsrv (0)	rsrv (0)	rsrv (0)	rsrv (0)	rsrv (0)	rsrv (0)

Figure 42.15 – Extended Capabilities field (first 2 octets)

Insert following the last 7.3.x subclause the following 7.4.x subclauses with the figures and tables included therein, renumbering as necessary:

7.4 QoS Management Actions

The management action codes within the QoS category are defined in Table 20.1.

Table 20.1 – QoS Action codes

Code	Meaning
0	Define traffic specification (also used for TSPEC update)
1	Reserved
2	Delete traffic specification
3	Reserved
4	Error and Overlap report
5	Reserved
6	(QBSS configuration request)
7	(QBSS configuration response)
8	(Alternate EPC activation request)
9	(Alternate EPC activation response)
10	(Advanced Power Management request)
11	(Advanced Power Management response)
12 – 255	Reserved

7.4.1 Define Traffic Specification QoS Action frame format

The Define Traffic Specification frame is used in a QBSS operating at QoS level 3 to provide or update traffic specification information at a wireless station that is the source or destination of a particular instance of parameterized QoS traffic. The format of the Define Traffic Specification frame body is shown in Figure 42.16.

octets: 1	1	1	1	30
QoS (category 1)	**Define TSPEC** (action 0)	**0**	**0**	**Traffic Specification Element**

Figure 42.16 – Define Traffic Specification frame body

This frame is used when a higher layer bandwidth management entity provides traffic specification information to the MAC layer management entity at a particular station in the QBSS (typically the EAP). The traffic specification element identifies the trafic and provides the QoS parameters that are to be used for delivery of this traffic. This is an advisory function, so response frame is defined .

7.4.2 Delete Traffic Specification QoS Action frame format

The Delete Traffic Specification frame is used in a QBSS operating at QoS level 3 to reomve traffic specification information at a wireless station that may have been the source or destination of a particular instance of parameterized QoS traffic, allowing the specified traffic category ID to revert to use as a priority value. The format of the Delete Traffic Specification frame body is shown in Figure 42.17.

octets: 1	1	1	1	6	2
QoS (category 1)	**Delete TSPEC** (action 2)	**0**	**0**	**WSTA Address**	**TCID**

Figure 42.17 – Delete Traffic Specification frame body

This WSTA Address and TCID fields designate the traffic specification to be deleted. Upon deletion the specified traffic category at the designated WSTA reverts to being interpreted as a priority until a subsequent traffic specification is defined for the traffic category. This is an advisory function, so response frame is defined.

7.4.3 Error and Overlap Report QoS Action frame format

The Error and Overlap Report frame is used to report on error statistics and observed overlapping BSS activity. All of the information elements are only present in frames transmitted by ESTAs. ESTAs and EAPs may transmit Error and Overlap frames with null frame bodies to solicit Error and Overlap response(s). The format of the Error and Overlap Report frame body is shown in Figure 42.18.

octets: 1	1	1	1	26-138	2-254
QoS (category 1)	**Define TSPEC** (action 4)	**0**	**0**	**Error Statistics Element**	**Overlap BSS Report Element**

Figure 42.18 – Define Traffic Specification frame body

The Error Statistics and Overlap BSS Report information elements are specified in subclauses of 7.3.2.

7.4.4 QBSS Configuration Request QoS Action frame format

<< Placeholder >>

7.4.5 QBSS Configuration Response QoS Action frame format

<< Placeholder >>

7.4.6 Alternate EPC Activation Request QoS Action frame format

<< Placeholder >>

7.4.7 Alternate EPC Activation Response QoS Action frame format

<< Placeholder >>

7.4.8 Advanced Power Management Request QoS Action frame format

<< Placeholder >>

7.4.9 Advanced Power Management Response QoS Action frame format

<< Placeholder >>

Insert after the last 7.4.x subclause the following new subclause, including figures and tables therein, renumber items as appropritate:

7.5 MAC-Level FEC and FEC Frame Formats

MAC-Level FEC is an option to support low error rate frame transfer. It is used in parameterized QoS (Level 3). The following conditions apply to the use of MAC-Level FEC:

- The MAC FEC operation is contingent on the assumption that error correction is expected to take longer than a SIFS time. As such, all FEC frames must be sent with an acknowledgment policy that does not include immediate acknowledgment.

- A valid FCS must result on an error corrected frame in order to forward the corrected MSDU to higher layers**.** When the FCS check is failed the MAC does not send up errored MSDUs to higher layers.

- The maximum MPDU that may be conveyed in non-fragmented FEC frames is 2080 octets,. However, if fragmentation is used, then larger MSDU sizes can be accommodated.

- Any encryption that may be performed is done prior to FEC encoding.

MAC-LevelFEC is performed on a given traffic category. The MAC MLME, based on requests for parameterized QoS, instantiates the use of MAC-Level FEC. STAs announce their FEC capability via bit 11 of the Capability Information Field (7.3.1.4 and Figure 27). Activation of FEC for a subset of streams to/from an FEC-capable ESTA is accomplished by using bit 4, of the Traffic Specification Element. (7.3.2.15 & figure42.8), via a management frame.

The AID, and the TCID are sufficient to indicate that the MPDU is FEC encoded. The AID, identifies that the ESTA is FEC capable, and the TCID indicates that a particular stream from the station is FEC encoded. ESTAs that are not capable of FEC decoding will still be able to read the MPDU, since the code is a systematic code, and, via management frames, the receiving station is made aware of the flow's encoding. A non-FEC capable ESTA can therefore interpret the MAC header, and FCS, and discard frames based on an erroneous FCS result. A non-FEC ESTA will ignore the parity check fields in the FEC frame. A legacy station will not be able to interpret FEC fields, and therefore FEC encoding shall not be used to send frames to legacy STAs.

The format of MAC-Level FEC MPDU's is given in Figure XXX. The MAC Layer FEC uses a (224,208) Reed-Solomon code for decoding the MSDU's, which are broken up into 208 octet blocks. The code is capable of correcting up to 8 octet errors. The MAC header is encoded via a (48,32) Reed Solomon code, which is a shortened version of the (224, 208) code, and therefore 16 octets of parity are included. For QoS data frames of types ToDS/From DS not equal to '11,', (i.e., for QoS data frames that do not utilize an Address 4 field) in order to facilitate decoding and separation of the header from the frame body, a 6 octet field of zeros is used between the Sequence Control field and the TCID field. The security header integrity vector (if present) and frame body, as well as the FCS are all encoded within the frame body. The presence of the Frame Control field of the corrected MAC header can be used to determine whether the security field is the first 4 or 32 octets of the frame body This allows non-FEC capable ESTAs to recognize the header and FCS. The frame body is encoded in 208 octet blocks. If the unencoded frame body is not an in integral multiple of 208 octets (i.e m < 208), then the last MSDU portion of the frame body is encoded with (208-m) zeros being (vurtual) padded at the beginning of the last FEC-block. , with 16 octets of parity. The ICV, in the last block, is coded as part of the frame body. Also, in order for non-FEC capable ESTAs to perform parity check, the FCS is done on the entire MPDU, parity check bits included. However, in the last field of the frame body (prior to FEC parity check), denoted "$MSDU_N$ + ICV + 'FEC FCS'" in the figure, the last 4 octets in that field denote the FCS of the fields of the frame body that are not the parity check octets, and not the FCS block (the last 4 octets of the MPDU). . In this way, error correction can be performed, and a FCS can be done on the error corrected MSDU's, to determine whether to forward the error corrected frame up to the SAP. Both the FEC FCS and the MPDU FCS are computed as in section 7.1.3.6.

The RS encoding and decoding on the header is done as follows: The received header is treated as though it were the first 32 octets of a 208 octet field. The remaining octets are assumed to be zeros; but they are not transmitted. This 208 octet sequence is encoded with (224, 208) Reed-Solomon code, and decoded appropriately.

MAC Header		**Frame Body** (1-10 blocks)								**FCS**
Header	Header FEC	Security IV + $MSDU_1$+ ICV	FEC	$MSDU_2$	FEC	$MSDU_N$ + ICV + “FEC FCS”	FEC			FCS
32	16	208	16	208	16	4 to 208	16			4

Figure XXX Proposed Coding Scheme

All the FEC computations are based on the polynomial operations in GF(2) and GF(256). In addition, the GF(256) is generated by a polynomial *f(x)* in GF(2). The polynomial *f(x)* for the GF(256) is:

$$f(x) = x^8 + x^4 + x^3 + x^2 + 1$$

Each code (a code space with collection of all code words) contains a unique nonzero code word of smallest degree polynomial with the coefficient of highest degree equals to 1. This polynomial is called ***generator polynomial***. All code words can be constructed using generator polynomial for the Reed-Solomon code:

$$g(x) = \prod_{i=1}^{2t} (x - \beta^i) = \sum_{j=0}^{2t} g_j * x^j$$

t = the number of correctable errors
n = the size of code block
β = roots of g(x) on GF(256)

The generator polynomials coefficiencts are given by the following, with the a^m as primitive roots of *f*(x):

g_{15} : a^{121}
g_{14} : a^{106}
g_{13} : a^{110}
g_{12} : a^{113}
g_{11} : a^{107}
g_{10} : a^{167}
g_9 : a^{83}
g_8 : a^{11}
g_7 : a^{100}
g_6 : a^{201}
g_5 : a^{158}
g_4 : a^{181}
g_3 : a^{195}
g_2 : a^{208}
g_1 : a^{240}
g_0 : a^{136}

The decimal values of the roots of g(x) are given in Table Y.

Table Y. Roots of Reed-Solomon Polynomial g(x)

Primitive Roots a^m represented as a[m]	Decimal Value
a[121]	118
a[106]	52
a[110]	103
a[113]	31
a[107]	104
a[167]	126
a[83]	187
a[11]	232
a[100]	17
a[201]	56
a[158]	183
a[181]	49
a[195]	100
a[208]	81
a[240]	44
a[136]	79

To obtain the parity check octets, the message block is represented as a polynomial c(x) over GF(256), with the leftmost octet corresponding to the lowest order coefficient. The highest order coefficients, the first 31 octets of FEC-block, or in the case of the header, first 223 octets, are set to zero. The 16 parity check octets are the coefficients of the remainder polynomial $b(x)$, formed by dividing $x^{16}c(x)$ by the generator polynomial g(x).

Insert after 7.5 the following new subclause, including the table therein, renumber items as appropritate:

7.6 Frame Usage Guidelines

Table 20.2 – Frame subtype usage by BSS type, MAC entity type, and coordination function

Frame Type	IBSS	non-QoS				QoS	
	CP	CP		CFP		CP & CFP	
	STA	STA	AP	STA	PC	ESTA	EPC
{Re}Association Request	- - -	T	R	- - -	- - -	T	R
{Re}Association Response	- - -	R	T	- - -	- - -	R	T
Probe Request	T, Rbe	T	R	- - -	- - -	T, R	R
Probe Response	Tbe, R	R	T	- - -	- - -	T, R	T
Beacon	Tb, R	R	T	R	T	R	T, R
Proxy Beacon	(R)	(R)	(R)	(R)	(R)	T, (R)	(R)
ATIM	T, R	- - -	- - -	- - -	- - -	- - -	- - -
Disassociation	T, R	T, R	T, R	T, R	T, R	T, R	T, R
Authentication	T, R	T, R	T, R	T, R	T, R	T, R	T, R
Deauthentication	T, R	T, R	T, R	T, R	T, R	T, R	T, R
{QoS} Action Req/Rsp	- - -	- - -	- - -	- - -	- - -	T, R	T, R
Container	- - -	- - -	- - -	- - -	- - -	T, R	T, R
RR	- - -	- - -	- - -	- - -	- - -	Tcc	R
DlyAck	- - -	- - -	- - -	- - -	- - -	T, R	T, R
CC	- - -	- - -	- - -	- - -	- - -	R	T
CF-Multipoll	- - -	- - -	- - -	- - -	- - -	R	T
PS-Poll	- - -	T	R	- - -	- - -	T	R
RTS	T, R	T, R	T, R	- - -	- - -	T, R	T, R
CTS	T, R	T, R	T, R	- - -	- - -	T, R	T, R
ACK	T, R	T, R	T, R	T, R	T, R	T, R	T, R
CF-End{+CF-Ack}	(R)	(R)	(R)	R	T	R	T
Null	T, R	T, R	T, R	T, R	T, R	T, R	T, R
Data	T, R	T, R	T, R	T, R	T, R	T, R	T, R
{Data+}CF-Poll+{CF-Ack}	- - -	- - -	- - -	R	T	- - -	- - -
{Data+}CF-Ack	- - -	- - -	- - -	T, R	T, R	- - -	- - -
QoSNull	- - -	- - -	- - -	- - -	- - -	T, R	T, R
QoSData	- - -	- - -	- - -	- - -	- - -	T, R	T, R
{QoSData+}Cf-poll	- - -	- - -	- - -	- - -	- - -	R	T
{QoSData+}Cf-poll+Cf-Ack	- - -	- - -	- - -	- - -	- - -	Rda	Tda
{QoSData+}Cf-Ack	- - -	- - -	- - -	- - -	- - -	T, Rda	Tda, R

Symbols:

T	frame subtype for row is transmitted by MAC entity for column
R	frame subtype for row is received by MAC entity for column
(R)	frame subtype for row is received, but only from other BSSs, by MAC entity for column
Tb, Tbe	frame subtype for row is transmitted by station that most recently won beacon arbitration if "Tbe" is also transmitted by an ESTA in an IBSS pursuant to receiving directed request
Rbe	frame subtype for row is received by station that most recently won beacon arbitration, also received as directed request by an ESTA in an IBSS

Tcc frame subtype for row is transmitted only during controlled contention intervals.
Tda frame subtype for row is transmitted only if recipient of +Cf-Ack function is addressee.
Rda frame subtype for row is received if ESTA is addressee
- - - frame subtype for row is neither received nor transmitted by MAC entity for column

9. MAC sublayer functional description

Change the text in 9 as shown below:

Here, the MAC functional description is presented. Clause 9.1 introduces the architecture of the MAC sublayer, including the distributed coordination function, the point coordination function and their coexistence in an 802.11 LAN. Clauses 9.2 and 9.3 expand on this introduction and provide a complete functional description of each. Clauses 9.4 and 9.5 cover fragmentation and defragmentation. Multirate support is addressed in clause 9.6. Clause 9.7 lists the allowable frame exchange sequences. Clause 9.8 describes a number of additional restrictions to limit the cases in which MSDUs are reordered or discarded Clause 9.10 describes the hybrid coordination function that is part of the optional QoS facility.

9.1 MAC architecture

Update Figure 47 to show both EDCF and HCF when these functions are sufficiently stable.

Change the text in 9.1.1 as shown below:

9.1.1 Distributed Coordination Function (DCF) and Enhanced DCF (EDCF)

The fundamental access method of the 802.11 MAC is a distributed coordination function known as carrier sense multiple access with collision avoidance, or CSMA/CA. The distributed coordination function shall be implemented in all stations, for use within both IBSS and infrastructure network configurations.

A station wishing to transmit shall sense the medium to determine if another station is transmitting. If the medium is not determined to be busy (see 9.2.1), the transmission may proceed. The CSMA/CA distributed algorithm mandates that a gap of a minimum specified duration exist between continuous frame sequences. A transmitting station shall ensure that the medium is idle for this required duration before attempting to transmit. If the medium is determined to be busy, the station shall defer until the end of the current transmission. After deferral, or prior to attempting to transmit again immediately after a successful transmission, the station shall select a random backoff interval and shall decrement the backoff interval counter while the medium is idle. A refinement of the method may be used under various circumstances to further minimize collisions — here the transmitting and receiving station exchange short Control frames (RTS and CTS frames) after determining that the medium is idle and after any deferrals or backoffs, prior to data transmission. The details of CSMA/CA, deferrals, and backoffs are described in 9.2. RTS/CTS exchanges are also presented in 9.2.

The Enhanced Distributed Coordination Function (EDCF) provides differentiated DCF access to the wireless medium for prioritized traffic categories (TCs). There are 8 traffic categories. An EDCF station will have at most 8 prioritized output queues, one for each traffic category. A station may implement fewer than 8 physical queues and provide a mapping from traffic categories to the available queues. An EDCF AP shall provide at least 4 physical queues. Each output queue competes for TxOPs using an enhanced DCF wherein (1) the minimum specified idle duration time is not the constant value (DIFS) as defined for DCF but is a distinct value (TxAIFS[TC], see sections 9.2.3 and 9.2.10) assigned to each TC either by default, as in the case of an IBSS, or by an EDCF-aware access point (EAP), (2) the contention window CWmin from which the random backoff is computed is not fixed as with DCF but is a variable window, assigned for each TC by default or by an EAP, (3) lower priority queues defer to higher priority queues within the same station, (4) collisions between competing queues within a station are resolved within the station such that the higher priority queue receives the TxOP and the lower priority colliding queue(s) behave as if there were an external collision on the wireless medium.

9.1.3 Hybrid coordination function (HCF)

The optional QoS facility includes an additional access method called a hybrid coordination function, which is only usable in infrastructure QoS network configurations (QBSSs). The HCF combines functions from the {E}DCF and PCF with some additional, QoS-specific functions to allow a uniform set of frame exchange sequences to be used during both the CP and CFP. The HCF uses a QoS-aware point coordinator, called a hybrid coordinator (HC), that operates under different rules than the point coordinator of the PCF. The HC, which by default is collocated with the enhanced access point (EAP) of the QBSS, uses the point coordinator's higher priority of access to the WM to allocate transmission opportunities (TXOPs) to WSTAs so as to provide limited-duration contention free bursts (CFBs) to transfer QoS data. TXOPs may be allocated at appropriate times to meet predefined service rate, delay and/or jitter requirements of particular traffic flows. TXOPs and contention free transfers of QoS traffic from the EAP/HC can be based on the HC's QBSS-wide knowledge of the amounts of queued traffic belonging to traffic categories with different pirorities and subject to QBSS-specific QoS policies. The HC can also initiate *controlled contention intervals* during which contention occurs only among ESTAs needing to request new TXOPs, and which can further be limited by request priority and/or a permission probability. The HCF protects each TXOP using the virtual carrier sense mechanism, rather than depending on having all STAs in the BSA setting their NAVs to dot11CFPMaxDuration at TBTT.

Change the heading and text of clause 9.1.3 (now 9.1.4) as follows:

9.1.4 Coexistence of DCF, ~~and~~ PCF and HCF

The distributed coordination function and ~~the~~a point coordination function (either PCF or HCF) shall coexist in a manner that permits both to operate concurrently within the same (Q)BSS. When a point coordinator is operating in a BSS, the two access methods alternate, with a contention-free period followed by a contention period. This is described in greater detail in 9.3. When a hybrid coordinator is operating in a QBSS, the two access methods alternate between sets of frame exchange sequences, under rules described in 9.10.

Change the heading and text of clause 9.1.5 (now 9.1.6) as follows:

9.1.6 MAC Data Service

The MAC Data Service shall translate MAC service requests from LLC into input signals utilized by the MAC State Machines. The MAC Data Service shall also translate output signals from the MAC State Machines into service indications to LLC. The translations are given in the MAC Data Service State Machine defined in Annex C.

The MAC Data Service for EDCF stations shall incorporate a traffic category (TC) indication with each output service request. This TC indication will associate the output data with the proper output queue for the indicated TC.

9.2.3 Inter-Frame Space (IFS)

Change the text and figure 49 in clause 9.2.3 as follows:

The time interval between frames is called the inter-frame space. A STA shall determine that the medium is idle through the use of the carrier sense function for the interval specified. Five~~Four~~ different IFSs are defined to provide priority levels for access to the wireless media; they are listed in order, from the shortest to the longest. Figure 49 shows some of these relationships.

a) SIFS Short Interframe Space
b) PIFS Point Coordination Function (PCF) Interframe Space
c) DIFS Distributed Coordination Function (DCF) Interframe Space
d) AIFS Arbitration Interframe Space
e~~d~~) EIFS Extended Interframe Space

The different IFSs shall be independent of the station bit rate. The IFS timings shall be defined as time gaps on the medium, and shall be fixed for each PHY (even in multi-rate capable PHYs). The IFS values are determined from attributes specified in the PHY MIB.

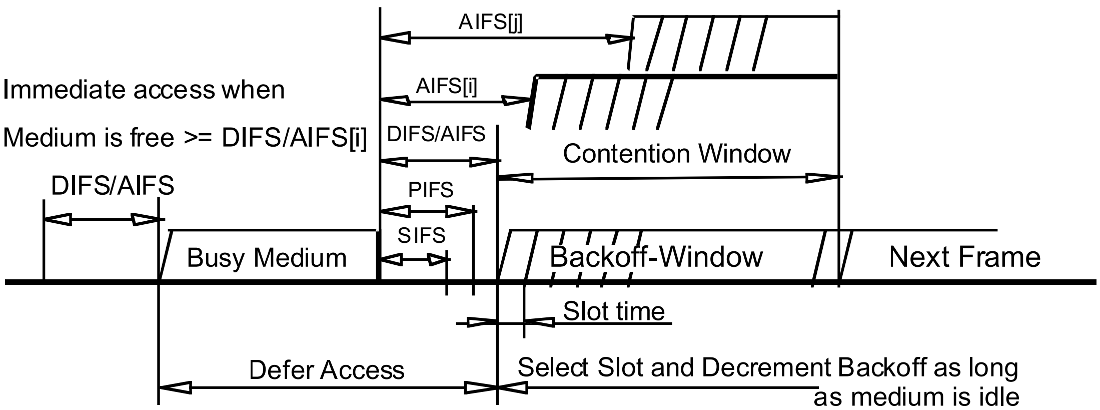


Figure 49 - Some IFS Relationships

Insert after 9.2.3.3 the following subclause and renumber the current 9.2.3.4 as 9.2.3.5

9.2.3.4 Arbitration IFS (AIFS)

The Arbitration Interframe Space shall be used by Enhanced DCF stations to transmit Data frames (MPDUs) and Management frames (MMPDUs). A STA using the EDCF shall be allowed a transmit opportunity (TxOP) for a particular Traffic Class (TC) if its carrier sense mechanism (see 9.2.1) determines that the medium is idle at the TxAIFS[TC] slot boundary (see 9.2.10) after a correctly-received frame, and the backoff time for that TC has expired. An EDCF station that provides fewer than 8 output queues shall use the TxAIFS[TC] slot boundary for queue[i] where TC is the highest priority TC assigned to queue[i]. A STA using the EDCF shall not transmit within an EIFS after it determines that the medium is idle following reception of a frame for which the PHYRXEND.indication primitive contained an error or a frame for which the MAC FCS value was not correct, unless subsequent reception of an error-free frame resynchronizes the station, allowing it to transmit using the TxAIFS[TC] following that frame.

9.2.4 Random Backoff Time

Change the text of 9.2.4 as follows:

A STA desiring to initiate transfer of Data MPDUs and/or management MMPDUs shall the carrier sense mechanism (see 9.2.1) to determine the busy/idle state of the medium. If the medium is busy, the STA shall defer until the medium is determined to be idle without interruption for a period of time equal to DIFS when the last frame detected on the medium was received correctly, or after the medium is determined to be idle without interruption for a period of time equal to EIFS when the last frame detected on the medium was not received correctly. After this DIFS or EIFS medium idle time, the STA shall then generate a random backoff period for an additional deferral time before transmitting, unless the backoff timer already contains a non-zero value, in which case the selection of a random number is not needed and not performed. This process minimizes collisions during contention between multiple STA that have been deferring to the same event.

Backoff Time = Random() x aSlotTime

where:

Random() = Pseudo random integer drawn from a uniform distribution over the interval [0,CW], where CW is an integer within the range of values of the MIB attributes aCWmin and aCWmax, aCWmin <= CW <= aCWmax. It is important that designers recognize the need for statistical independence among the random number streams among stations.

aSlotTime = The value of the correspondingly-named MIB attribute

An EDCF station calculates and maintains a Backoff Time and Contention Window for each queue i when there are Data MPDUs and/or management MMPDUs to be transmitted for that queue. The backoff calculation uses the DCF method, but draws from differentiated intervals and replicates the contention window state for each queue i as follows:

Backoff Time[i] = Random(i) x aSlotTime

Where:

Random(i) = Pseudo random integer drawn from a uniform distribution over the interval [1,CW[i]+1], where CW[i] is an integer within the range of values of the MIB attributes aCWmin[i] and aCWmax (or optionally aCWmax[i] if available), aCWmin[i] <= CW[i] <= aCWmax.

The Contention Window (CW) parameter shall take an initial value of aCWmin. Every station shall maintain a Station Short Retry Count (SSRC) as well as a Station Long Retry Count (SLRC), both of which shall take an initial value of zero. The SSRC shall be incremented whenever any Short Retry Count associated with any MSDU is incremented. The SLRC shall be incremented whenever any Long Retry Count associated with any MSDU is incremented. The CW shall take the next value in the series every time an unsuccessful attempt to transmit an MPDU causes either Station Retry Counter to increment, until the CW reaches the value of aCWmax. A retry is defined as the entire sequence of frames sent, separated by SIFS intervals, in an attempt to deliver an MPDU, as described in 9.7. Once it reaches aCWmax the CW shall remain at the value of aCWmax until it is reset. This improves the stability of the access protocol under high load conditions. See Figure 50.

EDCF stations shall maintain a Contention Window plus Short and Long Retry Counts for each queue i: CW[i], QSRC[i] and QLRC[i]. The retry procedure for each TC shall be the same as for DCF, substituting CW[i], QSRC[i] and QLRC[i] for CW, SSRC and SLRC respectively, where the CW[i] are calculated as described below EDCF stations may choose to provide differentiated CWMax[i] values although this is not required. The aCWmin[i] values and related MIB values may be updated by a QoS Parameter Set element (see section 7.3.2.14).

To compute the new CW[i] value, denoted CWnew[i], from the old CW[i] value, denoted CWold[i], in the event of a collision, an EDCF station shall choose a value of CWnew[i] which meets the following criterion:

CWnew[i] >= ((CWold[i]+1) * PF) – 1

Where the persistence factor, PF, is computed using the following procedure:

The CWPFactor[i] (Contention Window Persistence Factor) corresponding to each queue[i] is distributed in the EDCF parameter set element described in 7.3.2.14. Each CWPFactor[i] field is one octet in length and indicates a scaling factor in units of 1/16 ths. PF is CWPFactor[i] divided by 16 and optionally rounded up to the nearest convenient fractional resolution.

The CW shall be reset to aCWmin after every successful attempt to transmit an MSDU or MMPDU, when SLRC reaches aLongRetryLimit, or when SSRC reaches aShortRetryLimit. The SSRC shall be reset to 0 whenever a CTS frame is received in response to an RTS frame, whenever an ACK frame is received in response to an MPDU or MMPDU transmission, or whenever a frame with a group address in the Address1 field is transmitted. The SLRC shall be reset to 0 whenever an ACK frame is received in response to transmission of an MPDU or MMPDU of length greater than aRTSThreshold, or whenever a frame with a group address in the Address1 field is transmitted.

The set of CW values shall be sequentially ascending integer powers of 2, minus 1, beginning with a PHY-specific aCWmin value, and continuing up to and including a PHY-specific aCWmax value.

9.2.5.1 Basic Access

Change the text and Figure 51 in 9.2.5.1 as follows:

Basic access refers to the core mechanism a STA uses to determine whether it may transmit.

In general, a STA may transmit a pending MPDU when it is operating under the DCF access method, either in the absence of a Point Coordinator, or in the Contention Period of the PCF access method, when the STA determines that the medium is idle for greater than or equal to a DIFS period, or an EIFS period if the immediately-preceding medium-busy event was caused by detection of a frame that was not received at this STA with a correct MAC FCS value. If, under these conditions, the medium is determined by the carrier sense mechanism to be busy when a STA desires to initiate the initial frame of one of the frame exchanges described in 9.7, exclusive of the CF period, the Random Backoff algorithm described in 9.2.5.2 shall be followed. There are conditions, specified elsewhere in 9, where the Random Backoff algorithm shall be followed even for the first attempt to initiate a frame exchange sequence.

An EDCF station operates according to the same general rules defined for DCF by providing separate output queues, where each queue[i] instantiates a DCF state machine that contends for the wireless medium with AIFS[i] (see sections 9.2.3 and 9.2.10) rather than DIFS and employs aCWmin[i] rather than aCWmin. Contention between queues within a station is resolved within that station (see state machine description in informative annex).

In a station having an FH PHY, control of the channel is lost at a dwell time boundary and the station shall have to contend for the channel after the dwell boundary. It is required that stations having an FH PHY complete transmission of the entire MPDU and associated acknowledgment (if required) before the dwell time boundary. If, when transmitting or retransmitting an MPDU, there is not enough time remaining in the dwell to allow transmission of the MPDU plus the acknowledgment (if required), the station shall defer the transmission by selecting a random backoff time, using the present CW (without advancing to the next value in the series). The Short Retry Counter and Long Retry Counter for the MSDU are not affected.

The basic access mechanism is illustrated in Figure 51.

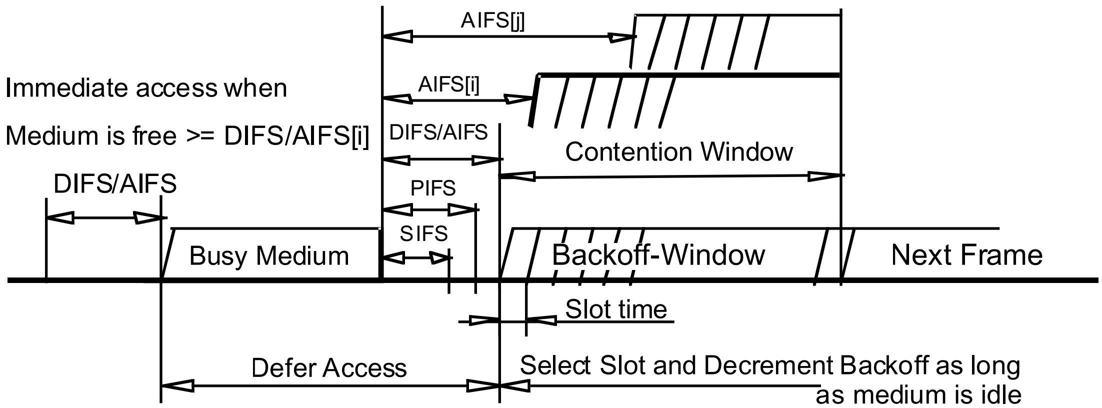


Figure 51 - Basic Access Method

9.2.5.2 Backoff Procedure

Change the text in 9.2.5.2 as follows (Figure 52 is unchanged):

The backoff procedure shall be invoked whenever a STA desires to transfer a frame and finds the medium busy as indicated by either the physical or virtual carrier sense mechanism (see Figure 52). The backoff procedure shall also be invoked when a transmitting STA infers a failed transmission as defined in clauses 9.2.5.7 or 9.2.8.

To begin the backoff procedure, the STA shall set its Backoff Timer to a random backoff time using the equation in 9.2.4. All backoff slots occur following a DIFS period during which the medium is determined to be idle for the duration of the DIFS period, or following an EIFS period during which the medium is determined to be idle for the duration of the EIFS period following detection of a frame that was not received correctly, or for EDCF stations for each queue[i] during and following a AIFS[i] period during which the medium is determined to be idle for the duration of the AIFS[i] period, the first slot time occurring during the last slot interval of the AIFS[i] period.

A STA performing the backoff procedure shall use the carrier sense mechanism (9.2.1) to determine whether there is activity during each backoff slot. If no medium activity is indicated for the duration of a particular backoff slot, then the backoff procedure shall decrement its backoff time by aSlotTime.

If the medium is determined to be busy at any time during a backoff slot, then the backoff procedure is suspended, that is, the backoff timer shall not decrement for that slot. The medium shall be determined to be idle for the duration of a DIFS period or EIFS or AIFS[i], as appropriate (see 9.2.3), before the backoff procedure is allowed to resume. Transmission shall commence whenever the Backoff Timer reaches zero.

For EDCF stations if several Backoff Timers reach zero at the same slot, then the highest priority frame shall transmit, and any lower priority frame(s) shall defer and shall execute the retry procedure, as specified in 9.2.5.3 and setting their CW[i] values for the deferred frames as specified in 9.2.4, as if they had experienced a transmit failure.

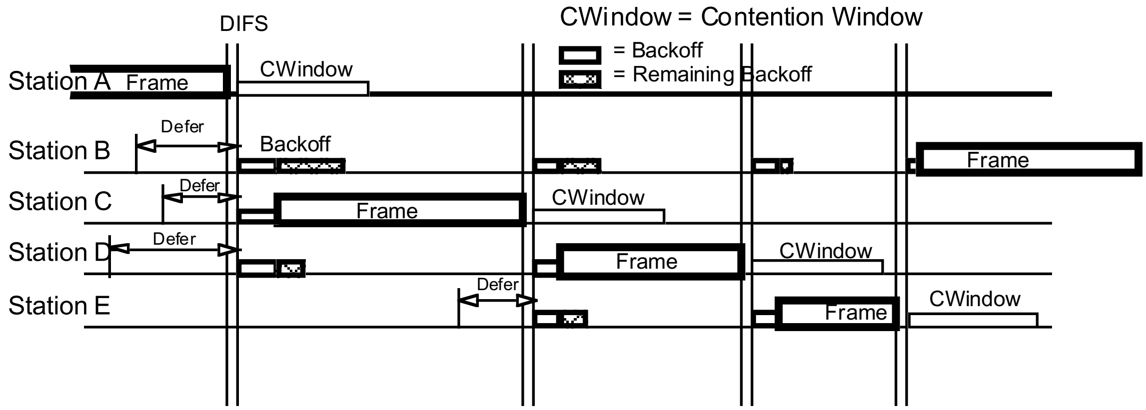


Figure 52 - Backoff Procedure

A backoff procedure shall be performed immediately after the end of every transmission with the More Fragments bit set to 0 of an MPDU of type Data, Management, or Control with subtype PS-Poll, even if no additional transmissions are currently queued. In the case of successful acknowledged transmissions, this backoff procedure shall begin at the end of the received ACK frame. In the case of unsuccessful transmissions requiring acknowledgment, this backoff procedure shall begin at the end of the ACK timeout interval. If the transmission was successful, the CW value reverts to aCWmin before the random backoff interval is chosen, and the Station Short Retry Count and/or Station Long Retry Count are updated as described in 9.2.4. EDCF stations use CW[i], aCWmin[i], SSRC[i] and/or SLRC[i] as specified in 9.2.4 rather than CW, aCWmin, SSRC and SLRC. This assures that transmitted frames from a station are always separated by at least one backoff interval.

The effect of this procedure is that when multiple stations are deferring and go into random backoff, then the station selecting the smallest backoff time using the random function will win the contention.

In an IBSS, the backoff time for a pending non-Beacon or non-ATIM transmission shall not decrement in the period from the Target Beacon Transmission Time (TBTT) until the expiration of the ATIM window and the backoff time for a pending ATIM Management frame shall decrement only within the ATIM window. (See clause 11). Within an IBSS, a separate backoff interval shall be generated to preceed the transmission of a Beacon, as described in 11.1.2.2.

9.2.5.3 Recovery Procedures and Retransmit Limits

Change the text in 9.2.5.3 as follows:

Error recovery is always the responsibility of the STA which initiates a frame exchange sequence, as defined in 9.7. Many circumstances may cause an error to occur which requires recovery. For example, the CTS frame may not be returned after an RTS frame is transmitted. This may happen due to a collision with another transmission, due to interference in the channel during the RTS or CTS frame, or because the station receiving the RTS frame has an active virtual carrier sense condition (indicating a busy medium time period).

Error recovery shall be attempted by retrying transmissions for frame exchange sequences which the initiating station infers have failed. Retries shall continue, for each failing frame exchange sequence, until the transmission is successful, or until the relevant retry limit is reached, whichever occurs first. Stations shall maintain a Short Retry Count and a Long Retry Count for each MSDU or MMPDU awaiting transmission. These counts are incremented and reset independently of each other.

ESTAs shall maintain a transmit MSDU timer for each MSDU passed to the MAC. The MIB value aMSDULifetime[i] specifies the maximum amount of time allowed to transmit an MSDU of traffic category i. If an ESTA implements these optional MIB parameters, an MSDU timer shall be started when the MSDU is passed to the

MAC. If a timer exceeds its associated aMSDULifetime[i] then all remaining fragments of that MSDU shall be discarded by the source STA and no attempt is made to complete transmission of that MSDU.

After an RTS frame is transmitted, the STA shall perform the CTS procedure, as defined in 9.2.5.7. If the RTS transmission fails, the Short Retry Count for the MSDU or MMPDU and the Station Short Retry Count are incremented. This process shall continue until the number of attempts to transmit that MSDU or MMPDU reaches aShortRetryLimit.

After transmitting a frame which requires acknowledgment, the STA shall perform the ACK procedure, as defined in 9.2.8. The Short Retry Count for an MSDU or MMPDU and the Station Short Retry Count shall be incremented every time transmission of a MAC frame of length less than or equal to aRTSThreshold fails for that MSDU or MMPDU. This Short Retry Count and the Station Short Retry Count shall be reset when a MAC frame of length less than or equal to aRTSThreshold succeeds for that MSDU or MMPDU. The Long Retry Count for an MSDU or MMPDU and the Station Long Retry Count shall be incremented every time transmission of a MAC frame of length greater than aRTSThreshold fails for that MSDU or MMPDU. This Long Retry Count and the Station Long Retry Count shall be reset when a MAC frame of length greater than aRTSThreshold succeeds for that MSDU or MMPDU. All retransmission attempts for an MSDU or MMPDU that has failed the ACK procedure one or more times shall be made with the Retry field set to 1 in the Data or Management Type frame.

Retries for failed transmission attempts shall continue until the Short Retry Count for the MSDU or MMPDU is equal to aShortRetryLimit or until the Long Retry Count for the MSDU or MMPDU is equal to aLongRetryLimit. When either of these limits is reached, retry attempts shall cease, and the MSDU or MMPDU shall be discarded.

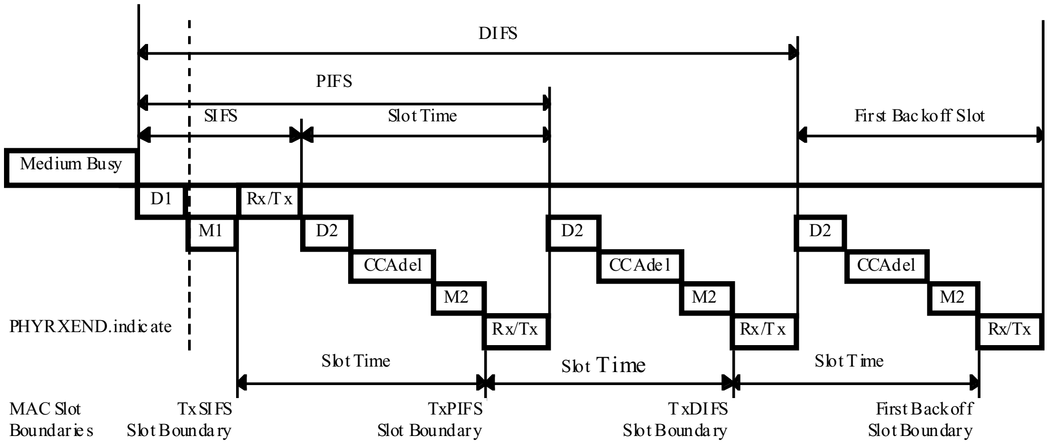
An EDCF station uses the same algorithm defined here to retry failed transmission attempts from queue[i] by substituting aQSRC[i] and aQLRC[i] for the Short Retry Count and Long Retry Count.

A station in power save mode, in an ESS, initiates a frame exchange sequence by transmitting a PS-Poll frame to request data from an AP. In the event that neither an ACK frame or a Data frame is received from the AP in response to a PS-Poll frame, then the station shall retry the sequence, by transmitting another PS-Poll frame, at its convenience. If the AP sends a Data frame in response to a PS-Poll frame, but fails to receive the ACK frame acknowledging this Data frame, the next PS-Poll frame from the same station may cause a retransmission of the last MSDU. This duplicate MSDU shall be filtered at the receiving station using the normal duplicate frame filtering mechanism. If the AP responds to a PS-Poll by transmitting an ACK frame, then responsibility for the Data frame delivery error recovery shifts to the AP because the data is transferred in a subsequent frame exchange sequence, which is initiated by the AP. The AP shall attempt to deliver one MSDU to the station which transmitted the PS-Poll, using any frame exchange sequence valid for a directed MSDU. If the power save station which transmitted the PS-Poll returns to Doze state after transmitting the ACK frame in response to successful receipt of this MSDU, but the AP fails to receive this ACK frame, the AP will retry transmission of this MSDU until the relevant retry limit is reached. See Clause 11 for details on filtering of extra PS-Poll frames.

9.2.10 DCF Timing Relations

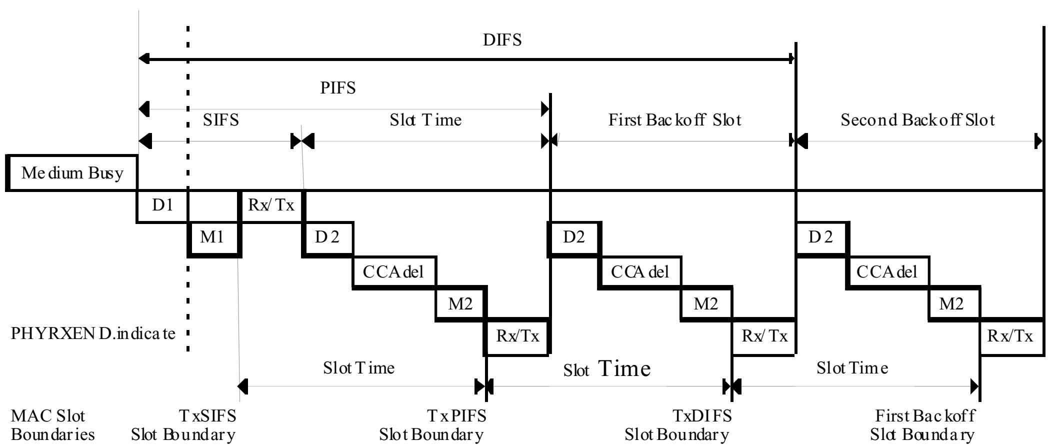
Change the text and add Figure 58.1 (Figure 58 unchanged) in 9.2.10 as follows, renumber figures as necessary:

The relationships between the IFS specifications are defined as time gaps on the medium. The associated attributes are provided by the specific PHY (see Figures 58 and 58.1).



D1 = aRxRFDelay + aRxPLCPDelay (referenced from the end of the last symbol of a frame on the medium)
D2 = D1 + Air Propagation Time
Rx/Tx = aRXTXTurnaroundTime (begins with a PHYTXSTART.request)
M1 = M2 = aMACPrcDelay
CCAdel = aCCATime - D1

Figure 58 - DCF Timing Relationships



D1 = aRxRFDelay + aRxPLCPDelay (referenced from the end of the last symbol of a frame on the medium)
D2 = D1 + Air Propagation Time
Rx/Tx = aRXTXTurnaroundTime (begins with a PHYTXSTART.request)
M1 = M2 = aMACPrcDelay
CCAdel = aCCATime - D1

Figure 58.1 - EDCF Timing Relationships for the Example Case in Which AIFS = DIFS

All timings that are referenced from the end of the transmission are referenced from the end of the last symbol of a frame on the medium. The beginning of transmission refers to the first symbol of the next frame on the medium.

aSIFSTime and aSlotTime are defined in the MIB, and are fixed per PHY.

aSIFSTime is: aRxRFDelay + aRxPLCPDelay + aMACPrcDelay + aRxTxTurnaroundTime.

aSlotTime is: aCCATime + aRxTxTurnaroundTime + aAirPropagationTime
+ aMACProcessingDelay

The PIFS and DIFS are derived by the following equations, as illustrated in Figure 7.

PIFS = aSIFSTime + aSlotTime

DIFS = aSIFSTime + 2 x aSlotTime

The EIFS is derived from the SIFS and the DIFS and the length of time it takes to transmit an ACK Control frame at ~~1 Mbit/s~~at the PHY's lowest mandatory rate by the following equation:

EIFS = aSIFSTime + (8 x ACKSize) + aPreambleLength + aPLCPHeaderLngth+ DIFS
where ACKSize is the length, in bytes, of an ACK frame and
(8 x ACKSize)+ aPreambleLength + aPLCPHeaderLngth
is expressed in microseconds required to transmit at the PHY's lowest mandatory rate.

Figure 7 illustrates the relation between the SIFS, PIFS and DIFS as they are measured on the medium and the different MAC Slot Boundaries TxSIFS, TxPIFS and TxDIFS. These Slot Boundaries define when the transmitter shall be turned on by the MAC to meet the different IFS timings on the medium, after subsequent detection of the CCA result of the previous slot time.

The following equations define the MAC Slot Boundaries, using attributes defined in the MIB, which are such that they compensate for implementation timing variations. The starting reference of these slot boundaries is again the end of the last symbol of the previous frame on the medium.

TxSIFS = SIFS - aRxTxTurnaroundTime

TxPIFS = TxSIFS + aSlotTime

TxDIFS = TxSIFS + 2 x aSlotTime.

TxAIFS[TC] = TxSIFS + aAIFS[TC] x aSlotTime.

The tolerances are specified in the PHY MIB, and shall only apply to the SIFS specification, so that tolerances shall not accumulate.

Note: the default value for aAIFS[TC] is 2 for each Traffic Class (TC). Therefore the default settings for TxAIFS[TC] are equivalent to DIFS for each TC.

Insert the following subclause, including tables and figures included therein, after 9.9 (which is added by 802.11d), renumbering tables and figures as necessary:

9.10 HCF

The hybrid coordination function (HCF) manages allocation of WM data transfer bandwidth, using higher medium access priority than ESTAs in order to allocate transmission opportunities (TXOPs) to ESTAs. The hybrid coordinator (HC) is a type of point coordinator, but differs from the point coordinator used in PCF in several significant ways. Most improtant is that HCF frame exchange sequences may be used among ESTAs associated in a

QBSS during both the CP and the CFP. Another significant difference is that QoS CF-Polls initate a TXOP with duration specified in the (+)CF-Poll frame. ESTAs may transmit multiple frame exchange sequences within these TXOPs, as well as in {E}DCF TXOPs under HCF, subject to the limit of TXOP duration. All STAs and ESTAs inherently obey the medium access rules of the HCF, because these rules are based on the {E}DCF, and because each QoS CF-Poll, as well as each QoS frame exchange sequence transmitted within the TXOPs contain duration values to cause STAs and ESTAs in the BSA to set their NAV to protect each TXOP. All ESTAs are able to respond to QoS CF-Polls received from a an HC. The HC performs delivery of queued broadcast and multicast frames following DTIM beacons in a CFP. The HC may use a longer CFP for QoS delivery and/or QoS polling by continuing with HCF frame exchange sequences after broadcast/multicast delivery for a duration not exceeding dot11CFPMaxDuration. The HC may also operate as a PC, providing (non-QoS) CF-Polls to associated CF-Pollable STAs using the frame formats, frame exchange sequences, and other applicable rules for PCF specified in 9.3. Implementers are cautioned that attempting to intersperse HCF frame exchange sequences and PCF frame exchange sequences in a single CFP can be extremely complex, and that the achievable service quality may be adversely impacted in a QBSS which attempts to provide contention-free support for CF-Pollable (non-QoS) STAs.

A HC may perform a backoff following an interruption of a frame exchange sequence due to lack of an expected response or detection of CCA busy within a CFP or CFB. This backoff occurs under the rules of the{E}DCF, using CWmin {or the corresponding value for the adopted EDCF}.

9.10.1 HCF access procedure

The HCF transfer protocol is based on a polling scheme controlled by an HC operating at a single ESTA of the QBSS. This ESTA is typically the EAP, but is not required to be the EAP nor to remain at a fixed ESTA throughout the existence of the QBSS. Mechanisms to control transfer of HC function between ESTAs are defined in << TBD, clause 20>>. The HC gains control of the WM as needed to send QoS traffic to ESTAs and to issue QoS (+)CF-Polls to ESTAs by waiting a shorter time between transmissions than the stations using the {E}DCF access procedure. The duration values used in QoS frame exchange sequences reserve the medium for slightly longer than the end of the sequence to permit continuation of a NAV-protected CF transfer in the form of a CFB because STAs and all ESTAs other than the TXOP holder and the HC will not be able to begin contending until a DIFS interval later than end of the last transfer within the TXOP.

Because the HC is a type of point coordinator, and includes a CF Parameter Set element in the Beacon frames it generates, a QBSS appears to be a point-coordinated BSS to STAs. This causes all STAs as well as all ESTAs (other than the HC) to set their NAVs to the dot11CFPMaxDuration value at TBTT, as specified in 9.3.3.2. This prevents most contention with the CFP by preventing non-polled transmissions by STAs and ESTAs whether or not they are CF-Pollable.

9.10.1.1 Fundamental access

When the HC needs access to the WM to start a CFB or CFP the HC shall sense the WM. When the WM is determined to be idle for one PIFS period, the HC shall transmit the first frame of any permitted frame exchange sequence, with the duration value set as provided in <<HCF NAV Rules>>.

During a CFB or CFP, after each data, QoS data or management type frame with a group address in the Address1 field as well as after the CCI following a control frame of subtype CC, the HC shall wait for one PIFS period, and shall only continue to transmit if CCA is idle. The final frame of every other frame exchange sequence that is not the sole or final sequence in a TXOP the HC or holder of the current TXOP shall wait for one SIFS period and then commence transmitting the first frame of the next frame exchange sequence.

9.10.1.2 Recovery from the absence of an expected reception

ESTAs, including the HC, are required to respond within any frame exchange sequence after a SIFS period. If the beginning of reception of an expected response, as detected by the occurrence of PHY-CCA.indicate(busy) at the ESTA to which the response is directed, does not occur during the slot following SIFS, that ESTA may may initiate a recovery by transmitting after PIFS from the end of the last transmission. This recovery after PIFS also applies to the HC when the HC initiated the frame exchange sequence within which the response was missing. In the case of a polled TXOP, if the holder of the TXOP does not initiate transmission after a PIFS period, as detected by the occurrence of PHY-CCA.indicate(busy) at the HC, the HC may initiate a recovery by transmitting after DIFS from the end of the last transmission. If, following a non-response during the CP, neither the TXOP holder nor the HC initiate recovery, the CFB ends and {E}DCF contention resumes after DIFS.

ESTAs receiving a QoS (+)CF-Poll are required to respond within a SIFS period. If the polled ESTA has no queued traffic to send, or if the MPDUs available to send are all too long to transmit within the specified TXOP limit, the ESTA shall send a QoS Null frame. In the case of no queued traffic this QoS Null has a QoS control field that reports a TC queue size of 0 for any TCID. In the case of excessive size, this QoS Null has a QoS control field that reports the requested TXOP duration and TCID for the highest priority MPDU which is ready for transmission.

OPEN ISSUE: In the case of a TC with an accepted TSPEC which specifies periodic traffic type, with non-zero parameter values for both Polling Interval and Jitter Bound, the non-receipt of a periodic CF-Poll at intervals of Polling Interval plus/minus Jitter Bound is also a detectable non-occurrence of an expected reception which can have important consequences for QoS within the effected TC. It is appropriate to add the rules under which the ESTA can, after non-receipt of some number of these expected periodic polls, use a higher priority means of obtaining medium access during the CP to continue the periodic transmissions for this TC. This case was not covered in previous proposals because there was not sufficient specified relationship between TSPEC paarameters and TXOP timing to detect this situation.

9.10.1.3 CFP generation by the HC

Every HC functions as a point coordinator that uses the CFP for delivery, generating a CFP as shown in Figure 59, with the restriction that the CFP initiated by an HC always ends with a CF-End frame. Only an HC which issues (non-QoS) CF-Polls to associated CF-Pollable (non-QoS) STAs may end a CFP with a CF-End+CF-Ack frame, and only in the case where the +CF-Ack is acknowledging a reception from a CF-Pollable STA.

9.10.2 TXOP structure and timing

Under HCF the basic unit of allocation of the right to transmit onto the WM is the TXOP. Each TXOP is defined by a particular starting time, relative to the end of a preceding frame, and a defined maximum length. The TXOP may be obtained by an ESTA receiving a QoS (+)CF-Poll during the CP or CFP, or by the ESTA winning an instance of {E}DCF contention during the CP. In the case of a polled TXOP, the entire TXOP is protected by the NAV set by the duration of the frame that contained the QoS (+)CF-Poll function, as shown in Figure hcf.1.

In any QoS data type frame of a subclass that includes CF-Poll contains the TXOP duration limit in the QoS control field. For TXOPs resulting from {E}DCF contention the TXOP limit from the QoS information element in the most recent Beacon frame applies. Within a TXOP an ESTA may initiate the transmission of one or more frame exchange sequence, with all such sequences nominally separated by a SIFS interval. The ESTA must not iniitate a frame exchange sequence which cannot complete by the end of the TXOP duration. Furthermore, no TXOP, nor transmission within a TXOP, can extend across TBTT, dot11CFPMaxDuration (if during CFP), dot11MaxDwellTime (if using an FH PHY) or dot11MediumOccupancyLimit. Subject to these limitations, all decisions regarding what MPDUs and/or MMPDUs are transmitted during any given TXOP are made by the ESTA which holds the TXOP.

Figure hcf.1 – TXOP

Any frame exchange sequence containing a management type frame of subtype other than Container, as well as any frame exchange sequence containing a data type frame of any subtype that does not include QoS, must the the sole or final frame exchange sequence in the TXOP. Multiple frame exchange sequences containing only control frames and QoS data type frames or management frames of subtype Container can be sent in a single TXOP, with the Non-final bit in the QoS control fields of all but the final such frame exchange sequence set to 1 to indicate that the ESTA intends to send another frame during the TXOP. If an expected Ack response does not occur to a frame with Non-Final set to 1, the ESTA awaiting the Ack should send either its next frame exchange sequence, or a QoS Null, starting a PIFS period after the end of the last transmission.

9.10.2.1 NAV operation during a TXOP

The Duration/ID field in any QoS data frame of a subclass that includes CF-Poll contains a value which exceeds the TXOP duration limit specified in the QoS control field by the duration of one DIFS period. The Duration/ID field in a control frame of subclass CF-Multipoll exceeds the TXOP duration limit in the first Poll Record by one DIFS period. The duration value in the first transmission of each TXOP initiated pursuant to the CF-Multipoll contains the duration of that ESTA's TXOP limit plus one DIFS period.

When an ESTA updates its NAV setting due to receipt of a larger duration value than the present NAV setting, using the duration value from a (+)CF-Poll containing the BSSID of this QBSS, that ESTA also saves the MAC address from the RA field of the frame containing the (+)CF-Poll. If, prior to expiration of this NAV setting, an RTS, Probe, data type or QoS data type frame is received with an SA value which matches this saved MAC address the ESTA sends the appropriate response after SIFS, without regard for, and without resetting, the NAV. This saved MAC address is cleared whenever the NAV is updated by accepting a duration value from any other source, when the NAV counts down to 0, when a QoS data type frame or management type frame of subtype Container is received with an SA value which matches the saved MAC address and has Non-final bit in the QoS control field set to 0, or when a data type frame of subtype not including QoS or a management frame of subtype other than Container is received. When the ESTA receives a CF-End frame containing the BSSID of this QBSS, that ESTA clears its NAV.

If the NAV is set when an ESTA receives a QoS data type frame which requires acknowledgement, the response after SIFS shall be a QoS CF-Ack (no data) frame, even if the frame being acknowledged was of a subtype including (+)CF-Poll. In this manner the responding ESTA indicates that it is unable to accept the TXOP conveyed by the (+)CF-Poll.

9.10.2.2 Updating of duration values within TXOPs

The Duration/ID value in each of the second and subsequent frames sent by an ESTA during a TXOP is the Duration/ID value of the preceding frame in the sequence, diminished by the time required to send the response frame plus one SIFS period.

The initial frame of a non-final frame exchange sequence sent by an ESTA within a TXOP contains a duration value which is the remaining duration of the TXOP. The initial frame of the sole or final frame exchange sequence of the TXOP has a duration value which covers the actual remaining time needed for this frame exchange sequence plus DIFS period.

9.10.3 HCF transfer rules

A TXOP obtained by winning EDCF contention can be used to send a single MPDU or MMPDU with total medium occupancy time not exceeding the TXOP limit from the QoS information in the beacon. A TXOP pursuant to a (+)CF-Poll uses the specified TXOP limit, resulting in a CFB consists of one or more frame exchange sequences with the sole restriction being that the final sequence must end not later than the TXOP limit. MSDUs may be fragmented in order to fit within TXOPs.

OPEN ISSUE: It appears that the current fragmentation rules are unnecessarily restrictive, in particular that all fragment sizes must be equal. Fragmentation should not be arbitrary, and fragments other than the last should be of even lengths, but it may be appropriate to relax some of the legacy restrictions.

ESTAs shall use QoS data type frames all MPDU transfers to/from an HC, EAP and/or BP, and should use QoS data type frames for direct ESTA-to-ESTA transfers. The TCID in the QoS control fields of these frames shall indicate the TC to which the MPDU belongs, and the TC queue size field shall indicate the amount of queued traffic present in the ESTA's queue for that TC when this MPDU was ready for transmission. QoS data types with subtypes which include CF-Ack need not be used, and are permitted only when the ESTA to which the acknowledgement is directed is the same as the ESTA addressed by the Address1 field of the QoS data type frame. The HC's traffic monitor function assumes that all ESTA transfers using non-QoS frames are best effort traffic

9.10.3.1 TXOP requests

ESTAs may send TXOP requests during polled TXOPs or {E}DCF TXOPs as well as during CCIs. The RR frame may only be used to send requests during CCIs (see 9.9.4), but similar functionality during ordinary TXOPs is achieved using a QoS Null frame with the request duration or TC size and TCID value to the HC. If the No Ack bit in the QoS control field of this QoS Null frame is =0 the HC shall respond to this QoS Null with a CF-Poll+CF-Ack frame, but the HC is not required to grant a TXOP of the requested length in this frame.

9.10.3.2 Use of RTS/CTS

ESTAs may send an RTS as the first frame of any frame exchange sequence for which improved NAV protection is desired, independent of whether in the CP or CFP and without regard for dot11RTSThreshold. If NAV protection is desired for a transmission to the HC in response to a QoS data frame with a subtype that includes CF-Poll, the ESTA is allowed to send a CTS frame with both RA and TA containing its own MAC address in order to set the NAV in its own vicinity without the extra time to send an RTS (which is unnecessary because the NAVs in vicinity of the HC was set by the (+)CF-Poll frame).

9.10.3.3 Autonomous bursts

An ESTA which receives a QoS data type frame from another ESTA as the sole or final transfer in a TXOP, the recipient ESTA may transmit a single MPDU after SIFS, provided that the received QoS data type frame has Non-final=0, ToDS=0, FromDS=0, a value in the Address2 field which is equal to the value of the RA of the most recent (+)CF-Poll, and that said (+)CF-Poll was received since the last detected instance of the WM being idle for DIFS. By requiring the ESTA to have heard the (+)CF-Poll makes it likely that the HC will be able to hear the autonomous burst transmission and thereby not mistakenly assume that it is appropriate to initiate recovery from an instance of non-response during a CFB. In addition, the priority of the MPDU sent in the autonomous burst must not be lower than the priority of the MPDU received by this ESTA, and there must be sufficient time to complete this transmission and its acknowledgement (if Non-Ack =0) prior to TBTT or any relevant medium occupancy boundaries. If the Address1 of the pending frame is equal to the Address2 of the received frame, a QoS Data+CF-Ack may be used. Otherwise the outgoing QoS data frame is sent a SIFS period after sendingan Ack frame to the sender of the reception requiring acknowledgment.

Autonomous bursts may also be used for ESTA-to-ESTA transfers within an IBSS. In this case there is no requirement regarding CF-Polls, but there is a requirement that this is the sending ESTA's first transmission since its last {E}DCF TXOP to limit each ESTA to sending no more than once per autonomous burst.

9.10.4 Controlled Contention

The HCF controlled contention mechanism allows WSTAs to request the allocation of HC-managed TXOPs without having to contend with {E}DCF traffic. These requests may be for periodic polled TXOPs to handle traffic under an accepted TSPEC that specifies periodic traffic type, as well as for one-time TXOPs to handle a traffic burst or to create an initial TXOP for a new ESTA or newly active TC.

9.10.4.1 CC Transmission

Each instance of controlled contention occurs during a controlled contention interval (CCI) which begins a PIFS interval after the end of a CC control frame. Only the HC is permitted to transmit CC control frames. CC frames may be transmitted during both the CP and CFP, subject to the restriction that the entirety of the CC frame and the

CCI which follows that CC frame must fit within a single CP or CFP, as well as a single instance of medium occupancy pursuant to dot11MaxDwellTime and/or dot11MediumOccupancyLimit.

When initiating controlled contention, the HC generates and transmits a control frame of subtype CC that includes the contention filtering values, the duration of each CCOP and the number of CCOPs within the CCI. The contention filtering values allow the HC to limit contention within individual CCIs to occur among requests for a specific set of priority values and to further exclude a randomly-selected proportional subset of the contending ESTAs in order to further reduce the likelihood of collisions under high load conditions. The HC sets the Priority Mask field to specify the priorities for which responses may be sent during the CCI, and the Permission Probability to the proportion of ESTAs with requests of the specified priorities that are intended to be allowed to contend during this this CCI. The default value is 255 for both fields, to allow the sending of all requests for all priorities. The HC also can adjust the likelihood of collisions when selecting the number of CCOPs in the CCI (Nccop) which can vary over the range 1 to 255.

Figure hcf.2 shows an instance of controlled contention, including the CC frame and the individual CCOPs within the CCI.

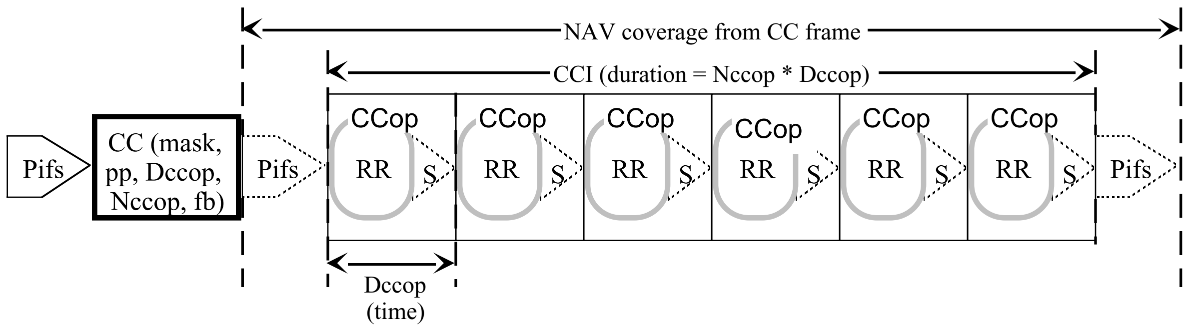


Figure hcf.2 – Controlled contention interval

9.10.4.2 CCI response procedure

Upon receipt of a control frame of subtype CC with the BSSID of the QBSS with which they are associated, ESTAs perform the CCI response procedure as specified below.

- If the CCI Length value in the received CC frame is 0, or if the ESTA has no pending request, that ESTA proceeds to step (e), otherwise the ESTA continues with step (b).

- If the priority of the traffic belonging to the TC for which the request is pending corresponds to a bit position which is set to 0 in the Priority Mask field of the CC frame, no request shall be transmitted for that TC during the current CCI. Each ESTA may transmit no more than one request during each CCI; however, an ESTA with multiple TCs in need of a new or modified TXOP is permitted to select the TC for which a request is sent based on the value in the Priority Mask field of the CC frame. At the end of this step (a) of the CCI response procedure, each potential contending ESTA proceeds to step (b) with selected exactly one request that might be transmitted during the current CCI; while all other ESTAs proceed to step (e).

- Each ESTA shall compare the PP value from the received CC frame against a random integer drawn from a uniform distribution over the interval [0, 255] and shall continue to step (c) only if the random value is less than or equal to the permission probability. If the random value exceeds the permission probability the ESTA does not transmit a request during the current CCI and proceeds to step (e).

- The ESTA shall transmit a control frame of subtype RR with values in the QoS Control field that identify the traffic category and either TXOP duration or TC queue size of the request in accordance with the frame and field formats specified in clause 7. The start of this transmission shall follow the end of the CC frame by

number of microseconds calculated using the following formula:
(aSIFSTime + aSlotTime) + (R x (CCOP Duration value from CC frame))
where R is a random integer drawn from a uniform distribution over the interval [0, ((CCI Length value from CC frame)-1)]. This transmission shall only occur if the ESTA's NAV, without update from the Duration/ID field of the CC frame, indicates the WM is idle. Because of the possibility of transmissions by other contending ESTAs during the preceding CCOP, contending ESTAs ignore CCA in determining whether to initiate this transmission.

- The ESTA makes no further transmissions until after the CCI, determined by an elapsed time, following the end of the CC frame, equal to the number of microseconds indicated in the Duration/ID field of that CC frame.

9.10.4.3 CCI feedaback procedure

Successful receipt of RR frames is acknowledged in the Feedback field of the next sequential CC frame transmitted by the HC. The HC may transmit a CC frame exclusively for the purpose of providing feedback by specifying a CCI Length of zero.

A TXOP request for a particular TC at an ESTA remains pending until occurrence of any of the following

- Detection of this ESTA's AID in the feedback field of the next CC frame received after transmission of an RR for that request.
- Receipt of an acknowledgement to transmission of a QoS data type frame with the same TCID as the the pending request, independent of whether this transmission occurs during a polled TXOP or an {E}DCF TXOP.
- Discarding, by the ESTA, of the MPDU for which the request was pending, due to exceeding dot11MaxTransmitMSDULifetime or other, TC-specific or TSPEC-defined criteria.
- The end of the ESTA's association in the QBSS.

A previously transmitted request that remains unacknowledged after inspection of the Feedback field of the next CC frame may be retried by the ESTA if that request satisfies the criteria for transmission during the new CCI as specified by the CCI response procedure.

9.10.4.4 CCI generation by HC

The HC may send a CC in the CP or CFP. Every HC shall initiate at least one instance of controlled contention, usable for requests of each priority level, per DTIM interval. The number of CCOPs in the CCI shall be at least
max(4, ceiling(0.25 * (#Assoc_ESTAs - #ESTAs_with_TXOPs)))
Multiple CCIs, following CC frames with differing subsets of the priority levels enabled by the priority mask may be used if a single CC with all priorities is not used.

If collisions are inferred in more than half of the CCOPs in a CCI, the subsequent CC frame should reduce contention and/or increase CCI length to reduce contention. A collision is inferred when the HC detects the channel to be busy throughout the CCOP, but the PHY does not generate a PHY-RXSTART.indicate.

9.10.5 HCF frame exchange sequences

This table uses the same notation as table 21.

NOTE: A better notation, which showed applicable limits and allowable concatenations of sequences within a CFB is highly desirable, and the editor is attempting to develop one for replacement of this table in a subsequent revision of this document.

HCF Frame Sequence (in CP or CFP unless noted)	Frames in Sequence	Usage
Beacon(CF)	1	beacon during CF period
Data(bc/mc)	1	broadcast or multicast MSDU
Mgmt(bc)	1 or 2	broadcast MMPDU
Mgmt(dir) – ACK	2 or 3	directed MMPDU
CC <CCI>	1 + CCI	controlled contention
[RTS – CTS –] QoS Data(dir) – {QoS}CF-Ack(no data)	2 or 4	frame delivery by ESTA or HC, continuation of TXOP
[RTS – CTS –] QoS Data(dir)+CF-Poll{+CF-Ack} – {ACK –} QoS Data(dir){+CF-Ack} –	2, 3 or 5	piggybacked start of TXOP

10. Layer management

Change 10.3.2 as shown below:

10.3.2 Scan

10.3.2.1 MLME-SCAN.request

10.3.2.1.1 Function

This primitive requests a survey of potential (Q)BSSs which the (E)STA may later elect to try to join.

10.3.2.1.2 Semantics of the Service Primitive

The primitive parameters are as follows:

```
MLME-SCAN.request    (
                      BSSType,
                      BSSID,
                      SSID,
                      ScanType,
                      ProbeDelay,
                      ChannelList,
                      MinChannelTime,
                      MaxChannelTime
                      )
```

Name	Type	Valid Range	Description
BSSType	Enumeration	INFRASTRUCTURE, INDEPENDENT, ANY_BSS, ONLY_QOS	Determines whether Infrastructure BSS, Independent BSS, or both are included in the scan. These scans will report QBSSs of the appropriate type. Under IEEE 802.11E the ONLY_QOS value may be specified to limit the reeport to QBSSs that support a QoS

			level of in the range 1-3..
BSSID	MACAddress	any valid individual or broadcast MAC address	Identifies a specific or broadcast BSSID.
SSID	octet string	0 - 32 octets	Specifies the desired SSID or the broadcast SSID.
ScanType	Enumeration	ACTIVE, PASSIVE	Indicates either Active or Passive scanning.
ProbeDelay	integer	N/A	Delay (in µs) to be used prior to transmitting a Probe frame during active scanning
ChannelList	Ordered Set of Integer	Each channel will be selected from the valid channel range for the appropriate PHY and Carrier Set.	Specifies a list of channels which are examined when scanning for a BSS.
MinChannelTime	integer	greater than or equal to ProbeDelay	The minimum time (in Kµs) to spend on each channel when scanning
MaxChannelTime	integer	greater than or equal to MinChannelTime	The maximum time (in Kµs) to spend on each channel when scanning

10.3.2.1.3 When Generated

This primitive is generated by the SME when a (E)STA wishes to determine if there are other (Q)BSSs which it may join.

10.3.2.1.4 Effect of Receipt

This request initiates the scan process when the current frame exchange sequence is completed.

10.3.2.2 MLME-SCAN.confirm

10.3.2.2.1 Function

This primitive returns the descriptions of the set of (Q)BSSs detected by the scan process.

10.3.2.2.2 Semantics of the Service Primitive

The primitive parameters are as follows:

MLME-SCAN.confirm (
BSSDescriptionSet,
ResultCode
)

Name	Type	Valid Range	Description
BSSDescriptionSet	Set of BSSDescription	N/A	The BSSDescriptionSet is returned to indicate the results of the scan request. It is a set containing zero or more instances of a BSSDescription.
ResultCode	enumeration	SUCCESS,	Indicates the result of the MLME-

		INVALID_ PARAMETERS	SCAN.confirm.

Each BSSDescription consists of the following elements:

Name	Type	Valid Range	Description
BSSID	MACAddress	N/A	The BSSID of the found BSS
SSID	octet string	1 - 32 octets	The SSID of the found BSS
BSSType	Enumeration	INFRASTRUCTURE, INDEPENDENT	The type of the found BSS
Beacon Period	integer	N/A	The Beacon period of the found BSS (in Kμs)
DTIM Period	integer	As defined in Frame Format	The DTIM Period of the BSS (in Beacon Periods)
Timestamp	integer	N/A	The timestamp of the received frame (probe response/beacon) from the found BSS
Local Time	integer	N/A	The value of the station's TSF timer at the start of reception of the PHY symbol which contains the first bit of the first octet of the timestamp field of the received frame (probe response or beacon) from the found BSS.
PHY parameter set	As defined in Frame Format	As defined in Frame Format	The parameter set relevant to the PHY
CF parameter set	As defined in Frame Format	As defined in Frame Format	The parameter set for the CF periods, if found BSS supports CF mode.
IBSS parameter set	As defined in Frame Format	As defined in Frame Format	The parameter set for the IBSS, if found BSS is an IBSS.
CapabilityInformation	As defined in Frame Format	As defined in Frame Format	The advertised capabilities of the BSS.
BSSBasicRateSet	set of integers	1 through 127 inclusive (for each integer in the set)	The set of data rates (in units of 500kbit/s) that must be supported by all STAs that desire to join this BSS. The STAs must be able to receive at each of the data rates listed in the set.
QBSSLoad (QoS only)	As defined in Frame Format	As defined in Frame Format	The values from the QBSS Load information element if such an element was present in the probe response or beacon, else null.
ErrorStatistics (QoS only)	As defined in Frame Format	As defined in Frame Format	The values from the Error Statistics information element if such an element was present in the probe response or beacon, else null.
ListenEpoch (QoS only)	As defined in Frame Format	As defined in Frame Format	The values from the Listen Epoch information element if such an element was present in the probe response or beacon, else null.

ExtendedCapabilities (QoS only)	As defined in Frame Format	As defined in Frame Format	The values from the Extended Capabilites information element if such an element was present in the probe response or beacon, else null.

10.3.2.2.3 When Generated

This primitive is generated by the MLME as a result of an MLME-SCAN.request to ascertain the operating environment of the STA.

10.3.2.2.4 Effect of Receipt

The SME is notified of the results of the scan procedure.

Change 10.3.6.1 as shwon below:

10.3.6.1 MLME-ASSOCIATE.request

10.3.6.1.1 Function

This primitive requests association with a specified peer MAC entity that is acting as an AP.

10.3.6.1.2 Semantics of the Service Primitive

The primitive parameters are as follows:

```
MLME-ASSOCIATE.request     (
                            PeerSTAAddress,
                            AssociateFailureTimeout,
                            CapabilityInformation,
                            ListenInterval,
                            ListenEpoch,
                            ExtendedCapabilities
                            )
```

Name	Type	Valid Range	Description
PeerSTAAddress	MACAddress	any valid individual MAC address	Specifies the address of the peer MAC entity with which to perform the association process.
AssociateFailureTimeout	integer	greater than or equal to 1	Specifies a time limit (in Kμs) after which the associate procedure will be terminated.
CapabilityInformation	As defined in Frame Format	As defined in Frame Format	The operational capability definitions to be used by the MAC entity.
ListenInterval	Integer	Greater than or equal to 0	Specifies the number of Beacon intervals which may pass before the station awakens and listens for the next beacon.
ListenEpoch (QoS only)	As defined in Frame	As defined in Frame	Specifies the requested amounts of time for the listen epoch if this ESTA is requesting

	Format	Format	the assignment of a listen epoch by the EAP. If all fields contain zeros no Listen Epoch information element is included in the Association Request.
ExtendedCapabilities (QoS only)	As defined in Frame Format	As defined in Frame Format	The extended operational capability definitions to be used by the ESTA.

10.3.6.1.3 When Generated

This primitive is generated by the SME when a (E)STA wishes to establish association with an (E)AP.

10.3.6.1.4 Effect of Receipt

This primitive initiates an association procedure. The MLME subsequently issues a MLME-ASSOCIATE.confirm that reflects the results.

Change 10.3.7.1 as shwon below:

10.3.7.1 MLME-REASSOCIATE.request

10.3.7.1.1 Function

This primitive requests a change in association to a specified new peer MAC entity that is acting as an AP.

10.3.7.1.2 Semantics of the Service Primitive

The primitive parameters are as follows:

```
MLME-REASSOCIATE.request    (
                             NewAPAddress,
                             ReassociateFailureTimeout,
                             CapabilityInformation,
                             ListenInterval,
                             ListenEpoch,
                             ExtendedCapabilities
                            )
```

Name	Type	Valid Range	Description
NewAPAddress	MACAddress	any valid individual MAC address	Specifies the address of the peer MAC entity with which to perform the reassociation process.
ReassociateFailureTimeout	integer	greater than or equal to 1	Specifies a time limit (in Kμs) after which the reassociate procedure will be terminated.
CapabilityInformation	As defined in Frame Format	As defined in Frame Format	The operational capability definitions to be used by the MAC entity.
LlistenInterval	Integer	Greater than or equal to 0	Specifies the number of Beacon intervals which may pass before the station awakens and listens for the next

			beacon.
ListenEpoch (QoS only)	As defined in Frame Format	As defined in Frame Format	Specifies the requested amounts of time for the listen epoch if this ESTA is requesting the assignment of a listen epoch by the EAP. If all fields contain zeros no Listen Epoch information element is included in the Association Request.
ExtendedCapabilities (QoS only)	As defined in Frame Format	As defined in Frame Format	The extended operational capability definitions to be used by the ESTA.

10.3.7.1.3 When Generated

This primitive is generated by the SME when a (E)STA wishes to change association to a specified new peer MAC entity that is acting as an (E)AP.

10.3.7.1.4 Effect of Receipt

This primitive initiates a reassociation procedure. The MLME subsequently issues a MLME-REASSOCIATE.confirm that reflects the results.

Replace 10.3.10.1 with the updated subclause below:

10.3.10.1 MLME-START.request

10.3.10.1.1 Function

This primitive requests that the MAC entity start a new BSS.

10.3.10.1.2 Semantics of the Service Primitive

The primitive parameters are as follows:

```
MLME-START.request          (
                             SSID,
                             BSSType,
                             BeaconPeriod,
                             DTIMPeriod,
                             CF parameter set,
                             PHY parameter set,
                             IBSS parameter set,
                             ProbeDelay.
                             CapabilityInformation,
                             BBSBasicRateSet,
                             OperationalRateSet,
                             ExtendedCapabilities,
                             QoS parameter set
                             )
```

Name	Type	Valid Range	Description

SSID	octet string	1 - 32 octets	The SSID of the BSS.
BSSType	Enumeration	INFRA-STRUCTURE, INDEPEN-DENT	The type of the BSS.
Beacon Period	integer	greater than or equal to 1	The Beacon period of the BSS (in Kμs).
DTIM Period	integer	As defined in Frame Format	The DTIM Period of the BSS (in Beacon Periods)
CF parameter set	As defined in Frame Format	As defined in Frame Format	The parameter set for CF periods, if the BSS supports CF mode. aCFPPeriod is modified as a side effect of the issuance of a MLME-START.request primitive.
PHY parameter set	As defined in Frame Format	As defined in Frame Format	The parameter set relevant to the PHY.
IBSS parameter set	As defined in Frame Format	As defined in Frame Format	The parameter set for the IBSS, if BSS is an IBSS.
ProbeDelay	integer	N/A	Delay (in μs) to be used prior to transmitting a Probe frame during active scanning
CapabilityInformation	As defined in Frame Format	As defined in Frame Format	The capabilities to be advertised for the BSS.
BSSBasicRateSet	set of integers	1 through 127 inclusive (for each integer in the set)	The set of data rates (in units of 500 kbit/s) that must be supported by all STAs that desire to join this BSS. The STA that is creating the BSS must be able to receive at each of the data rates listed in the set.
OperationalRateSet	set of integers	1 through 127 inclusive (for each integer in the set)	The set of data rates (in units of 500 kbit/s) that the STA desires to use for communication within the BSS. The STA must be able to receive at each of the data rates listed in the set. The OperationalRateSet is a superset of the BSSBasicRateSet advertised by the BSS.
ExtendedCapabilities	As defined in Frame Format	As defined in Frame Format	The extended operational capability definitions to be used by the ESTA.
QoS parameter set (QoS only)	As defined in Frame Format	As defined in Frame Format	The initial QoS parameter set values to be used in the QBSS.

10.3.10.1.3 When Generated

This primitive is generated by the SME to start either an infrastructure BSS (with the MAC entity acting as an AP), or start an Independent BSS (with the MAC entity acting as the first STA in the IBSS).

The MLME-START.request primitive must be generated after a MLME-RESET.request primitive has been used to reset the MAC entity and before an MLME-JOIN.request primitive has been used to successfully join an existing infrastructure BSS or Independent BSS.

The MLME-START.request primitive must not be used after successful use of the MLME-START.request primitive or sucessful use of the MLME-JOIN.request without generating an intervening MLME-RESET.request primitive.

10.3.10.1.4 Effect of Receipt

This primitive initiates the BSS initialization procedure once the current frame exchange sequence is complete. The MLME subsequently issues a MLME-START.confirm that reflects the results of the creation procedure.

Insert after 10.3.10.2.4 the following subclauses:

10.3.11 Traffic Specification update

The following primitives describe how a traffic specification is added, deleted or modified within a QBSS.

10.3.11.1 MLME-TSUPDATE.request

10.3.11.1.1 Function

This primitive requests definition (including redefinition) or deletion of a traffic specification.

10.3.11.1.2 Semantics of the service primitive

The primitive parameters are as follows:

```
MLME-TSUPDATE.request    (
                          TSAction,
                          WSTAAddress,
                          TCID,
                          TrafficSpecification
                          )
```

Name	Type	Valid Range	Description
TSAction	Enumerated	DEFINE, DELETE	Specifies the action (define, delete) to be performed on the designated traffic specification.
WSTAAddress	MACAddress	any valid MAC address	Specifies the MAC address of the WSTA that is the context of the traffic category for which the traffic specification is being defined or deleted.
TCID	Integer	0-7	Specifies the traffic category for which the traffic specification is being defined or deleted.
TrafficSpecification	As defined in Frame Format	As defined in Frame Format	The parameter values that specify the QoS for the designated traffic category. If the TSAction is delete this parameter is ignored.

10.3.11.1.3 When generated

This primitive is generated by the SME at an ESTA when a higher-layer QoS management entity wishes to define, redefine or delete a traffic specification.

10.3.11.1.4 Effect of receipt

This primitive initiates a define traffic specification or delete traffic specification procedure, depending upon the TSAction specified. The MLME subsequently issues a MLME-TSPECUPDATE.confirm that reflects the results.

10.3.11.2 MLME-TSUPDATE.confirm

10.3.11.2.1 Function

This primitive reports the results of a traffic specification update attempt.

10.3.11.2.2 Semantics of the service primitive

The primitive parameters are as follows:

```
MLME-TSUPDATE.confirm      (
                              ResultCode
                              )
```

Name	Type	Valid Range	Description
ResultCode	enumeration	SUCCESS, INVALID_ PARAMETERS, INSUFFICIENT_ BANDWIDTH, TIMEOUT	Indicates the result of the MLME-TSUPDATE.request.

10.3.11.2.3 When generated

This primitive is generated by the MLME as a result of an MLME-TSUPDATE.request to define, redefine or delete a specified traffic specification within the QBSS.

10.3.11.2.4 Effect of receipt

The SME is notified of the results of the traffic specification update procedure.

10.3.11.3 MLME-TSUPDATE.indication

10.3.11.3.1 Function

This primitive reports the occurrence of an update to a traffic specification within the QBSS at the WSTA that is the source of the stream, or at a bridge portal that needs to forward traffic of that stream to the WSTA.

10.3.11.3.2 Semantics of the service primitive

The primitive parameters are as follows:

```
MLME-TSUPDATE.indication   (
                             TSAction,
                             WSTAAddress,
                             TCID,
                             TrafficSpecification
                             )
```

Name	Type	Valid Range	Description
TSAction	Enumerated	DEFINE, DELETE	Specifies the action (add, delete, modify) to be performed on the designated traffic specification.
WSTAAddress	MACAddress	any valid MAC address	Specifies the MAC address of the WSTA that is the context of the traffic category for which the traffic specification is being defined or deleted.
TCID	Integer	0-7	Specifies the traffic category for which the traffic specification is being defined or deleted.
TrafficSpecification	As defined in Frame Format	As defined in Frame Format	The parameter values that specify the QoS for the designated traffic category. If the TSAction is delete this parameter is ignored.

10.3.11.3.3 When generated

This primitive is generated by the MLME as a result of the occurrence of receipt of a Define Traffic Specification QoS action frame or a Delete Traffic Specification QoS action frame as part of a define traffic specification or delete traffic specification procedure that effects a traffic specification whose WSTA address designates this ESTA or an ESTA to which this bridge portal forwards traffic.

10.3.11.3.4 Effect of receipt

The SME is notified of the occurrence of the traffic specification update procedure and action and virtual stream parameters for that update.

10.3.12 Medium Status update

The following primitives describe how a traffic specification is added, deleted or modified within a QBSS.

10.3.12.1 MLME-WMSTATUS.request

10.3.12.1.1 Function

This primitive requests information on the state of the wireless medium.

10.3.12.1.2 Semantics of the service primitive

The primitive parameters are as follows:

MLME-WMSTATUS.request ( )

10.3.12.1.3 When generated

This primitive is generated by the SME at an ESTA when a higher-layer QoS management entity wishes to obtain information on the state of the wireless medium.

10.3.12.1.4 Effect of receipt

This primitive causes generation of a MLME-WMSTATUS.confirm that reports on the state of the wireless medium.

10.3.12.2 MLME-WMSTATUS.confirm

10.3.12.2.1 Function

This primitive reports the results of a traffic specification update attempt.

10.3.12.2.2 Semantics of the service primitive

The primitive parameters are as follows:

MLME-WMSTATUS.confirm (
ResultCode,
<< additional parameter values >>
)

Name	Type	Valid Range	Description
ResultCode	enumeration	SUCCESS, NOT_AVAILABLE	Indicates the result of the MLME-WMSTATUS.request.

10.3.12.2.3 When generated

This primitive is generated by the MLME as a result of an MLME-WMSTATUS.request to report on the state of the wireless medium.

10.3.12.2.4 Effect of receipt

The SME is notified of the state of the wireless medium.