Hybrid coordinator simplifications:
Queue State element and Express traffic

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TSPECs today

- More detail than a scheduler requires
  - Retry, inactivity and polling intervals; nominal and maximum MSDU; minimum and mean data rates; delay and jitter bounds
- Most fields adapted from RSVP—and are more suited to admissions control
- Policing responsibilities (if any) of the MAC remain unclear

TSPECs tomorrow: gone!

- Transfer TSPEC information to an L3 entity that manages bandwidth and admissions
- Define new "Queue state"element
  - Measures queue size in units of time, not payload
  - Simplifies scheduler in either PC or HC
- Extend categories to include "express" traffic
  - Except for external interference, ***access*** to the channel is guaranteed
  - No guarantees of channel quality

Queue state element

TCID	Schedule Window	TXOP Limit	Minimum TXOP	Maximum TXOP

- TCID identifies flow transmitted by a station
  - Traffic category, “express”, ACK policy and FEC
- Schedule window (for express traffic)
- Aggregate data queued—now or periodically
- Minimum and maximum bound any single TXOP granted by the hybrid coordinator
- Traffic parameterized in time units, not bytes

Queue state element (express)

TCID	Schedule Window	TXOP Limit	Minimum TXOP	Maximum TXOP

- Schedule Window and TXOP Limit together specify the reservation
  - Arbitrarily select the start of a time period that is Schedule Window TU long
  - During that window, the station expects an aggregate grant of TXOPs equal to TXOP Limit times 16 μs
- Minimum and maximum TXOP are also measured in units of 16 μs

Queue state element (non-express)

TCID	Schedule Window	TXOP Limit	Minimum TXOP	Maximum TXOP

- Schedule Window meaningless
- TXOP Limit is the instantaneous queue size (expressed in units of 16 μs) at the station
- Minimum and maximum TXOP limit any single transmit opportunity
  - Maximum TXOP may be zero (“don’t care”)

Simplify the scheduler

- Admissions control relocated to L3 entity
- Queue sizes measured in units of 16 μs
  - Scheduler doesn't have to monitor channel quality
  - Scheduler may find it difficult to monitor channel quality in "look-aside" flows that bypass the HC
  - Scheduler doesn't have to calculate appropriate TXOP size based upon flow characteristics
- Complexity left to the end-point applications, not the scheduler!

Normative scheduler behavior

- Express traffic relies on reservations
  - L3 entity manages total time available
  - Transmitting stations are trusted to stay within the limits they have negotiated
  - In over-crowded situations, established flows continue and newcomers are denied admission
- Scheduler's obligations
  - Grant TXOPs for express traffic before other
  - Grant aggregate TXOP time reserved

"Guaranteed" channel access?

- As we all know, there is no such thing
- How may scheduler compliance with normative requirements be measured?
- Only in an ideal environment
  - Certifies correctness of the algorithm implemented
  - Does ***not*** guarantee channel access in the real world
- Normative specifications rely upon externally visible behavior, not implementation details

Contact information

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FROM: Peter Johansson

TO: IEEE P802.11 Task Group E

DATE: November 10, 2001

RE: Normative text for MAC enhancements for AV QoS

The preceding slides introduced the concept of the proposed changes; the remainder of the document contains the suggested normative text for the P802.11e working draft.

The essential components are:

a) the elimination of the Traffic Specification. All of this information is much more suited to the entities that manage admissions control. The MAC may be simplified if the scheduler is entitled to assume that admissions control is already in force and that the only thing the scheduler has to do is schedule!

b) the addition of the Queue State element to describe transmit queues at stations in terms of TIME, not bytes. Again, the belief is that this can greatly simplify the scheduler—as well as permit the description of a category of "guaranteed channel access" (express) traffic necessary for streaming applications.

c) normative descriptions of scheduler BEHAVIOR (not implementation) with respect to express traffic.

Clock synchronization is not addressed within the draft, since it may be effected without any changes to the MAC.

3.64 QoS facility

The set of enhanced functions, formats, frame exchange sequences and managed objects to support the selective handling of 8 traffic categories per direction per bilateral 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~~ queue state element for the particular traffic category, link and direction.

NOTE—There are numerous instances throughout P802.11e Draft 1.4 where “traffic specification element” is to be replaced by “queue state element”. Not all are explicitly mentioned in this proposal, but it adopted the Editor is requested to make the necessary changes.

~~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 modalities 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 impossible, 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.~~

7.3.2 Information elements

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

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	7
Hopping Pattern Parameters	8
Hopping Pattern Table	9
Request	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
Reserved	32
Reserved	33
Reserved	34
Extended Capability	35
Reserved	36 - 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:

7.3.2.15 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 HC and ESTA(s) that support parameterized QoS. The element information field comprises 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)	TCA (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 TCA field is 2 octets in length and contains the TCID and AID values in the format defined in 7.1.3.6. The contents of this field identify 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 FEC subfield is 1 bit which is set to 1 if FEC coding is to be applied to MPDUs used to convey MSDUs belonging to this traffic category. 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 the value should be used for the MA-UNITDATA.request priority parameter when transmitting MSDUs belonging to this traffic category.

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

Figure 42.8 – TS Info field

The Ack Policy sub field is 2 bits in length and 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. The encoding of the Ack Policy field is shown in Table 20.1.

Table 20.1 – Ack Policy field encoding

Bit 2	Bit 3	Usage
0	0	Normal IEEE 802.11 acknowledgement. The addressed recipient returns an ACK or QoS (+)CF-Ack frame after a SIFS period, according to the procedures defined in 9.2.8, 9.3.3 and 9.10.3.
1	0	Alternate acknowledgement Reserved for future use, interpreted as normal IEEE 802.11 acknowledgement if received.
0	1	Delayed acknowledgement The addressed recipient returns a DlyAck frame, during a subsequent TXOP. In order to avoid retransmission, the DlyAck confirming receipt of any MPDU needs to be received by the source ESTA prior to the end of the retry interval specified in this TSPEC following the end of transmission of that MPDU.
1	1	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 is 1 octet in length and specifies the minimum number of superframes the transmitting station waits to receive a DlyAck response to frames transmitted using delayed acknowledgement (Ack Policy = 2) before initiating retransmission in lieu of such response. A value of 0 causes the transmitting station to wait for non-receipt to be indicated in a DlyAck frame, and never to initiate retransmission based on elapsed time without receiving a response.

The Inactivity Interval field is 1 octet in length and 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 is the maximum number of periodic polls, at the rate specified in the Polling Interval field, which can 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 is 1 octet in length and 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.

The Nominal MSDU Size field is 2 octets in length and specifies the nominal size, in octets, of MSDUs sent under this traffic specification. A value of 0 is used to indicate unspecified or variable size.

The Minimum Data Rate field is 2 octets in length and specifies the lowest data rate, in units of octets per Polling Interval, that is acceptable for transport of MSDUs under this traffic specification. A value of 0 is used to indicate unspecified minimum data rate.

~~The Mean Data Rate field is 2 octets in length and specifies the nominal sustained data rate, in units of octets per Polling Interval, for transport of MSDUs under this traffic specification. A value of 0 is used to indicate unspecified mean data rate.~~

~~The Maximum Burst Size field is 2 octets in length and specifies the peak data burst, in units of octets, that may occur under this traffic specification during a single Polling Interval. A value of 0 is used to indicate unspecified maximum burst size.~~

~~The Delay Bound field is 1 octet in length and specifies the maximum number of TU that may elapse before an MSDU under this traffic specification is discarded due to excessive delay. A value of 0 is used to disable the TC specific delay bound, in which case MSDUs belonging to this TC are only discarded for exceeding the general MSDU lifetime limits of the STA, as specified in 9.4.~~

~~The Jitter Bound field is 1 octet in length and 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.~~

7.3.2.19 Queue State element

The Queue State element contains parameters that describe the state of the transmit queue for the identified traffic category at a wireless station. The HC makes use of the information to schedule channel access during contention-free periods (including contention-free bursts). The element information field is comprised of five items as defined below and illustrated in Figure 42.15a. The total length of the information field is five octets.

Element ID (TBD)	Length (5)	TC Info (1 octet)	Schedule Window (1 octet)	TXOP Limit (1 octet)	Minimum TXOP (1 octet)	Maximum TXOP (1 octet)

Figure 42.15a – Queue State element format

The TC Info field identifies the traffic category to which the Queue State information pertains and provides additional parametric information; it is subdivided as shown in Figure 42.15b.

bits: 0	1	2	3	4	5	6	7
reserved (0)		ACK Policy	FEC	Express	Traffic category (0 – 7)		

Figure 42.15b – TC Info field

The ACK policy bit indicates whether MAC acknowledgement is required for MSDUs belonging to this traffic category and the desired form of those acknowledgements. A zero value indicates 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. When the ACK policy bit is one the recipient(s) shall not acknowledge the transmission.

The FEC bit is zero when transmitted data packets for this traffic category do not use forward error correction (FEC) while a value of one indicates FEC is active.

The Express bit is zero for best-effort traffic and one for express traffic. It is possible for a station to maintain separate transmit queues for the same traffic category, one for best-effort and the other for express traffic.

When the TC Info field identifies best-effort traffic, the Schedule Window field shall be zero; this indicates that the scheduler is not obligated to attempt to provide express for the traffic category. Otherwise, for express traffic, the Schedule Window field specifies the duration, in TU, of an interval used to manage channel access for the traffic category at this station. In this case, the Schedule Window and TXOP Limit together specify the amount of channel access time reserved *a priori* for the traffic category.[1]

The usage of the TXOP Limit field depends upon the value of Schedule Window. When the Schedule Window field is zero, TXOP Limit specifies the quantity of data, in units of 16 µs, buffered by the station for this traffic category. Otherwise, when Schedule Window is nonzero, the TXOP Limit field specifies the maximum aggregate TXOP time, in units of 16 µs, that should be granted the requesting ESTA during any period whose duration is equal to Schedule Window.

NOTE— Under theoretically ideal operating conditions, the TXOP Limit for express traffic is an upper limit not to be exceeded. However, when the channel has been inaccessible for some interval (perhaps due to external interference), an otherwise compliant scheduler may exceed this limit.

[1] The means by which admissions control manages the amount of theoretically available channel access time is beyond the scope of the MAC defined by this standard.

The Minimum TXOP field specifies the shortest TXOP time, in units of 16 µs, that shall be offered to the requesting ESTA when it is polled for data by the HC. The station indicates that it is unable to use a smaller TXOP.

The Maximum TXOP field specifies the longest TXOP time, in units of 16 µs, that shall be offered to the requesting ESTA when it is polled for data by the HC. The station indicates that it is unable to make use of any TXOP time offered in a single CF-Poll in excess of this limit.

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 20.2.

Table 20.2 – QoS Action codes

Code	Meaning
0	~~Define traffic specification (also used for TSPEC update)~~ Report queue state
1	Reserved
2	~~Delete traffic specification~~ Reserved
3 – 255	Reserved

~~7.4.1 Define Traffic Specification QoS Action frame format~~

~~The Define Traffic Specification frame is used 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 traffic and provides the QoS parameters that are to be used for delivery of this traffic. This is an advisory function, no response frame is defined .~~

7.4.1 Report Queue State frame format

The Report Queue State frame is used in a QBSS to describe the state of one or more QoS traffic queues at a wireless station that is the source of particular instances of QoS traffic. The format of the Report Queue State frame body is shown in Figure 42.16.

octets: 1	1	1	1	*n*
QoS (category 1)	**Report Queue State** (action 0)	**0**	**0**	**Queue State Element(s)**

Figure 42.16 – Report Queue State frame body

This frame is used by a station to provide the HC with current state information for one or more of the stations' Q0S transmit queues. Bandwidth management and admissions control for QoS traffic are performed

by an entity whose scope is outside of the MAC; as a consequence, no response frame for the Report Queue State element is necessary.

~~7.4.2 Delete Traffic Specification QoS Action frame format~~

~~The Delete Traffic Specification frame is used to remove 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**~~	~~**TCA**~~

~~**Figure 42.17 – Delete Traffic Specification frame body**~~

~~The WSTA Address and TCA 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, no response frame is defined.~~

Insert the following subclause, including tables and figures included therein, after 9.10.1.3 (which is added by P802.11e Draft 1.4), renumbering tables and figures as necessary:

9.10.1a Schedule management by the HC

When the HC performs point coordination functions it is responsible to schedule channel access for traffic categories identified in Queue State elements provide by stations within the QBSS. Individual traffic categories are either a) express or b) best-effort.[2] These traffic categories are subject to admissions control, the details of which are beyond the scope of this standard.

NOTE— Express data attempts to provide "guaranteed channel access", which phrase describes an achievable goal when the wireless medium operates free of external interference. The nature of wireless communications, particularly over unregulated frequencies, precludes absolute guarantees of channel access—however, the normative behaviors of a compliant scheduler may be observed and verified in an ideal environment that eliminates interference. Correct operation of the scheduler under ideal conditions should not be interpreted to mean that the scheduler is able to guarantee channel access under all conditions.

With express traffic (for which the scheduler attempts to provide guaranteed channel access), the normative responsibilities of the scheduler are summarized below:

a) If any express traffic is eligible to be scheduled, it shall be scheduled as soon as the HC is able to obtain channel access;

b) Higher priority traffic categories eligible to be scheduled shall be granted TXOPs before lower priority traffic categories; and

c) The scheduler shall be implemented so that, under ideal operating conditions, all stations with pending express traffic are offered TXOPs whose aggregate time is not less than TXOP Limit in any arbitrarily selected Schedule Window period.

The above requirements are behavioral requirements; they permit different scheduler implementations so long as scheduler behavior observable from the wireless medium conforms. A portion of a compliant scheduler implementation is illustrated by the pseudo-code in the table below:

```
typedef struct {
   QUEUE_STATE next;                  /* Link to another Queue State entry */
   unsigned scheduleWindow;           /* Denominated in TU (1024 ìs) */
   unsigned txopLimit;                /* Aggregate TXOP per window (units of 16 ìs) */
   unsigned minTXOP;                  /* Smallest usable TXOP (units of 16 ìs) */
   unsigned maxTXOP;                  /* Largest usable TXOP (units of 16 ìs) */
   unsigned accruedTXOP;              /* Total TXOP (units of 16 ìs) available */
   unsigned accrualInterval;          /* Time, in ìs, required to earn 16 ìs TXOP */
   unsigned leftoverTime;             /* Fractional accrual interval, in ìs */
} QUEUE_STATE;

BOOLEAN initiateCFP = FALSE;          /* Global variable available to scheduler */

/* The procedure below is invoked once every 1024 ìs. Its function is to increase the
total TXOP time accrued for each express traffic category at participating stations at
a rate calculated from the most recently received Queue State element. */

updateNextTXOP(QUEUE_STATE *queueState) {
```

[2] Best effort traffic is assumed to use a distributed contention function not managed by the scheduler at the HC.

```
    adjustedTime;                       /* Time since last TXOP accrual, in ìs */

    do {
        adjustedTime = 1024 + queueState->leftoverTime; /* Time since last invocation */
        while (adjustedTime >= queueState->accrualInterval) {
            queueState->accruedTXOP++;                  /* Accumulate another 16 ìs */
            adjustedTime -= queueState->accrualInterval;
        }
        queueState->leftoverTime = adjustedTime;       /* Save fractional remainder */
        if (queueState->accruedTXOP >= queueState->minTXOP)
            initiateCFP = TRUE;
    } while ((queueState = queueState->next) != NULL);

}
```

For each express traffic category at each participating station, the scheduler maintains queue state information described as QUEUE_STATE type above. The first four fields in the structure are transcribed directly from their corresponding fields in the Queue State element (see 7.3.2.22) each time such an element is received. The first time a Queue State element is received from a particular station for a particular express traffic category, `accrualInterval` is calculated as (Schedule Window * 1024) / TXOP Limit (rounding is permitted); the calculated value represents the number of microseconds that shall elapse before the station earns a 16 µs TXOP credit for the express traffic category. At the same time, the `accruedTXOP` field is zeroed; subsequent updates occur each time `updateNextTXOP()` is invoked.

The information stored upon receipt of a Queue State information is used by the `updateNextTXOP()` procedure, which (in this example) the scheduler invokes once every 1024 µs. This procedure manages the queue state information to provide the requested quantity of TXOPs during the schedule window defined for each station and express traffic category.[3] Whenever there is at least one express traffic category at any of the stations eligible to be granted a TXOP, the `initiateCFP` variable is set TRUE to cause a contention-free period or burst to be initiated. When the HC commences a contention-free period or burst, it shall offer TXOPs to all stations with eligible express traffic, subject to the maximum duration of a contention-free period or burst. If the HC is unable to offer TXOPs to all eligible stations, it shall initiate a subsequent contention-free period as soon as possible subsequent to the ensuing distributed contention period. A express traffic category queue at a station is eligible if `accruedTXOP` is greater than or equal to `minTXOP`, in which case the HC shall poll the station and provide a TXOP whose duration is equal to the lesser of `maxTXOP` or `accruedTXOP`. The value of `accruedTXOP` shall be decreased by the size of the TXOP offered by the CF-Poll whether or not the station makes use of the entire time.

[3] For the sake of simplicity, the procedure shown is applicable to a single traffic category but is easily generalized to multiple traffic categories.

Insert after 10.3.10.2.4 the following subclauses:

10.3.11 ~~Traffic Specification~~ Queue state update

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

10.3.11.1 ~~MLME-TSUPDATE~~MLME-QUPDATE.request

10.3.11.1.1 Function

This primitive requests update ~~definition (including redefinition) or deletion~~ of ~~a traffic specification~~ queue state.

10.3.11.1.2 Semantics of the service primitive

The primitive parameters are as follows:

```
~~MLME-TSUPDATE~~
MLME-QUPDATE.request        (
                              ~~TSAction,~~
                              WSTAAddress,
                              TC,
                              ~~TrafficSpecification~~ Queue State
                              )
```

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~~ queue state is being updated ~~defined or deleted~~.
TC	Integer	0-7	Specifies the traffic category for which the ~~traffic specification~~ queue state is being updated ~~defined or deleted~~. Note that the MA-UNITDATA primitives that handle MSDUs for the specified queue ~~that are subject to this TSPEC~~ use a priority parameter value of (TC+8).
~~TrafficSpecification~~ Queue State	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 update queue state ~~define, redefine or delete a traffic specification~~.

10.3.11.1.4 Effect of receipt

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

10.3.11.2 ~~MLME-TSUPDATE~~MLME-QUPDATE.confirm

10.3.11.2.1 Function

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

10.3.11.2.2 Semantics of the service primitive

The primitive parameters are as follows:

~~MLME-TSUPDATE~~
MLME-QUPDATE.confirm (
ResultCode
)

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

10.3.11.2.3 When generated

This primitive is generated by the MLME as a result of an ~~MLME-TSUPDATE~~MLME-QUPDATE.request to ~~define, redefine or delete~~ update state information for a specified ~~traffic specification~~ queue within the QBSS.

10.3.11.2.4 Effect of receipt

The SME is notified of the results of the ~~traffic specification~~ queue state element update procedure.

10.3.11.3 ~~MLME-TSUPDATE~~MLME-QUPDATE.indication

10.3.11.3.1 Function

This primitive reports the occurrence of an update to ~~a traffic specification~~ queue state within the QBSS at the HC ~~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~~
MLME-QUPDATE.indication (
~~TSAction,~~
WSTAAddress,
TC,
~~TrafficSpecification~~Queue State
)

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~~ queue state is being updated ~~defined or deleted~~.
TC	Integer	0-7	Specifies the traffic category for which ~~the traffic specification~~ queue state is being updated ~~defined or deleted~~. Note that the MA-UNITDATA primitives that handle MSDUs for the specified queue ~~that are subject to this TSPEC~~ use a priority parameter value of (TC+8).
~~TrafficSpecification~~ Queue State	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~~Report Queue State 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~~ queue state update procedure and action and virtual stream parameters for that update.