IEEE P802.11
Wireless LANs

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| --- |
| High Resolution FTM |
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|  |  |  |  |  |

Abstract

Current FTM defines resolution of 100ps for the time-stamps, which is insufficient for many use-cases. This contribution adds a high resolution mode to the FTM specifications to address this issue.

It uses REVmcDraft 4.0 as baseline.

***Discussion:*** *In current FTM specification, there is only a single resolution for reporting the time stamps. To fix, the reserved bit B7 is used to signal high resolution for the time-stamps of 1ps (instead of 100ps) at the negotiation stage. If this bit is set to 1 in both request and initial frames, the stamps in the FTM session will use the high resolution units, otherwise the base FTM resolution is used. This means that negotiation won’t fail due to high resolution request.
During the FTM session, each frame is signaling high resolution using reserved bit B159. In the range reporting, increased resolution is signaled using reserved bit B112. This change requires additions in the service primitives (6.3.58.X), FTM range reporting (8.4.2.21.18), FTM IE (8.4.2.166), FTM frame format (8.6.8.33), FTM procedure negotiation (10.24.6.3) and FTM measurement exchange (10.24.6.4) sections.*

***Note : Shown in black is the existing draft text from REVmcDraft 4.0, in red the additional text, and in strikethrough red the deleted text. Instructions to the editor are written in black italic. This is to help the reader of this submission understand the scope of the changes.***

***To the editor: Please change the primitive description in 6.3.58.2.2, on P340-341 as follows:***

* Semantics of the service primitive

The primitive parameters are as follows:

MLME-FINETIMINGMSMT.request(

Peer MAC Address,
Dialog Token,
Follow Up Dialog Token,
t1,
Max t1 Error,
t4,
Max t4 Error,
LCI Report,(M55)
Location Civic Report,(M55)
Fine Timing Measurement Parameters(#3465)s(#3465),(M55)
VendorSpecific
)

|  |  |  |  |
| --- | --- | --- | --- |
| Name | Type | Valid range | Description |
| Peer MAC Address | MACAddress | Any valid individual addressed MAC Address | The address of the peer MAC entity to which the Fine Timing Measurement frame is sent. |
| Dialog Token | Integer | 0–255 | The dialog token to identify the Fine Timing Measurement transaction. A value of 0 indicates the end of the transaction. |
| Follow Up Dialog Token | Integer | 0–255 | The dialog token of a Fine Timing Measurement frame which the current frame follows. See 10.24.6 (Fine timing measurement procedure). |
| t1 | Integer | 0–(248–1) | Set to the value of t1 (see Figure 6-17 (Fine timing measurement primitives and timestamps capture)) expressed in 0.1 ns units in case High Resolution bit is set to 0 and in 1 ps units in case High Resolution bit is set to 1. |
| Max t1 Error | Integer | 0–32 767 | Maximum error in the t1 value expressed in 0.1 ns units in case High Resolution bit is set to 0 and in 1 ps units in case High Resolution bit is set to 1.; see 8.6.8.33 (Fine Timing Measurement frame format). A value of 0 indicates that the upper bound on the error is unknown. A value of 32 767 indicates that the upper bound on the error is greater than or equal to 3.2767 µs in case High Resolution bit is set to 0 and to 32.767 ns in case High Resolution bit is set to 1.  |
| t4 | Integer | 0–(248–1) | Set to the value of t4 (see Figure 6-17 (Fine timing measurement primitives and timestamps capture)) expressed in 0.1 ns units in case High Resolution bit is set to 0 and in 1 ps units in case High Resolution bit is set to 1. |
| Max t4 Error | Integer | 0–32 767 | Maximum error in t4 value expressed in 0.1 ns units in case High Resolution bit is set to 0 and in 1 ps units in case High Resolution bit is set to 1. A value of 0 indicates that the upper bound on the error is unknown. A value of 32 767 indicates that the upper bound on the error is greater than or equal to 3.2767 µs in case High Resolution bit is set to 0 and to 32.767 ns in case High Resolution bit is set to 1. |
| LCI Report | As defined in 8.6.8.33 (Fine Timing Measurement frame format) | As defined in 8.6.8.33 (Fine Timing Measurement frame format) | Optional element to report LCI information of sender |
| Location Civic Report | As defined in 8.6.8.33 (Fine Timing Measurement frame format) | As defined in 8.6.8.33 (Fine Timing Measurement frame format) | Optional element to report location civic information of sender |
| Fine Timing Measurement Parameters | As defined in 8.4.2.166 (Fine Timing Measurement Parameters element) | As defined in 8.4.2.166 (Fine Timing Measurement Parameters element) | Optional element containing the proposed fine timing measurement configuration |
| VendorSpecific  | A set ofelements | As defined in 8.4.2.25 (Vendor Specific element) | Zero or more elements. |

***To the editor: Please change the primitive description in 6.3.58.3.2, on P342 as follows:***

* Semantics of the service primitive

The primitive parameters are as follows:

MLME-FINETIMINGMSMT.confirm(

Peer MAC Address,

Dialog Token,

t1,

Max t1 Error,

t4,

Max t4 Error(#1015)(#3060)

)

|  |  |  |  |
| --- | --- | --- | --- |
| Name | Type | Valid range | Description |
| Peer MAC Address | MACAddress | Any valid individual addressed MAC Address | The address of the peer MAC entity to which acknowledges the receipt of the Fine Timing Measurement frame. |
| Dialog Token | Integer | 0–255 | The dialog token to identify the Fine Timing Measurement transaction. A value of 0 indicates the end of the transaction. |
| t1 | 48-bit unsigned Integer | 0–(248–1) | Set to the value of t1 (see Figure 6-17 (Fine timing measurement primitives and timestamps capture)) expressed in 0.1 ns units in case High Resolution bit is set to 0 and in 1 ps units in case High Resolution bit is set to 1. |
| Max t1 Error | Integer | 0–32 767 | Maximum error in the t1 value expressed in 0.1 ns units in case High Resolution bit is set to 0 and in 1 ps units in case High Resolution bit is set to 1. A value of 0 indicates that the upper bound on the error is unknown. A value of 32 767 indicates that the upper bound on the error is greater than or equal to 3.2767 µs in case High Resolution bit is set to 0 and to 32.767 ns in case High Resolution bit is set to 1. |
| t4 | 48-bit unsigned Integer | 0–(248–1) | Set to the value of t4 (see Figure 6-17 (Fine timing measurement primitives and timestamps capture)) expressed in 0.1 ns units in case High Resolution bit is set to 0 and in 1 ps units in case High Resolution bit is set to 1. |
| Max t4 Error | Integer | 0–32 767 | Maximum error in t4 value expressed in 0.1 ns units in case High Resolution bit is set to 0 and in 1 ps units in case High Resolution bit is set to 1. A value of 0 indicates that the upper bound on the error is unknown. A value of 32 767 indicates that the upper bound on the error is greater than or equal to 3.2767 µs in case High Resolution bit is set to 0 and to 32.767 ns in case High Resolution bit is set to 1. |

***To the editor: Please change the primitive description in 6.3.58.4.2, on P343-344 as follows:***

* Semantics of the service primitive

The primitive parameters are as follows:

MLME-FINETIMINGMSMT.indication(

Peer MAC Address,

Dialog Token,

Follow Up Dialog Token,

t1,

Max t1 Error,

t4,

Max t4 Error,

t2,

Max t2 Error,

t3,

Max t3 Error,

LCI Report,(M55)(#3060)

Location Civic Report,(M55)

Fine Timing Measurement Parameters(#3465),(M55)

VendorSpecific

)

|  |  |  |  |
| --- | --- | --- | --- |
| Name | Type | Valid range | Description |
| Peer MAC Address | MACAddress | Any valid individual addressed MAC Address | The address of the peer MAC entity from which the Fine Timing Measurement frame was sent. |
| Dialog Token | Integer | 0–255 | The dialog token to identify the Fine Timing Measurement transaction. A value of 0 indicates the end of the transaction. |
| Follow Up Dialog Token | Integer | 0–255 | The dialog token of a Fine Timing Measurement frame which the current frame follows. See 10.24.6 (Fine timing measurement procedure). |
| t1 | 48-bit unsigned integer | 0–(248–1) | Set to the value of t1 (see Figure 6-17 (Fine timing measurement primitives and timestamps capture)) expressed in 0.1 ns units in case High Resolution bit is set to 0 and in 1 ps units in case High Resolution bit is set to 1. |
| Max t1 Error | Integer | 0–32 767 | Maximum error in the t1 value expressed in 0.1 ns units in case High Resolution bit is set to 0 and in 1 ps units in case High Resolution bit is set to 1. A value of 0 indicates that the upper bound on the error is unknown. A value of 32 767 indicates that the upper bound on the error is greater than or equal to 3.2767 µs in case High Resolution bit is set to 0 and to 32.767 ns in case High Resolution bit is set to 1. |
| t4 | 48-bit unsigned integer | 0–(248–1) | Set to the value of t4 (see Figure 6-17 (Fine timing measurement primitives and timestamps capture)) expressed in 0.1 ns units in case High Resolution bit is set to 0 and in 1 ps units in case High Resolution bit is set to 1. |
| Max t4 Error | Integer | 0–32 767 | Maximum error in t4 value expressed in 0.1 ns units in case High Resolution bit is set to 0 and in 1 ps units in case High Resolution bit is set to 1. A value of 0 indicates that the upper bound on the error is unknown. A value of 32 767 indicates that the upper bound on the error is greater than or equal to 3.2767 µs in case High Resolution bit is set to 0 and to 32.767 ns in case High Resolution bit is set to 1. |
| t2 | 48-bit unsigned Integer | 0–(248–1) | Set to the value of t2 (see Figure 6-17 (Fine timing measurement primitives and timestamps capture)) expressed in 0.1 ns units in case High Resolution bit is set to 0 and in 1 ps units in case High Resolution bit is set to 1. |
| Max t2 Error | Integer | 0–32 767 | Maximum error in t2 value expressed in 0.1 ns units in case High Resolution bit is set to 0 and in 1 ps units in case High Resolution bit is set to 1. A value of 0 indicates that the upper bound on the error is unknown. A value of 32 767 indicates that the upper bound on the error is greater than or equal to 3.2767 µs in case High Resolution bit is set to 0 and to 32.767 ns in case High Resolution bit is set to 1. |
| t3 | 48-bit unsigned integer | 0–(248–1) | Set to the value of t3 (see Figure 6-17 (Fine timing measurement primitives and timestamps capture)) expressed in 0.1 ns units in case High Resolution bit is set to 0 and in 1 ps units in case High Resolution bit is set to 1. |
| Max t3 Error | Integer | 0–32 767 | Maximum error in t3 value expressed in 0.1 ns units in case High Resolution bit is set to 0 and in 1 ps units in case High Resolution bit is set to 1. A value of 0 indicates that the upper bound on the error is unknown. A value of 32 767 indicates that the upper bound on the error is greater than or equal to 3.2767 µs in case High Resolution bit is set to 0 and to 32.767 ns in case High Resolution bit is set to 1. |
| LCI Report | As defined in 8.6.8.33 (Fine Timing Measurement frame format) | As defined in 8.6.8.33 (Fine Timing Measurement frame format) | Optional element to report LCI information of sender |
| Location Civic Report | As defined in 8.6.8.33 (Fine Timing Measurement frame format) | As defined in 8.6.8.33 (Fine Timing Measurement frame format) | Optional element to report location civic information of sender |
| Fine Timing Measurement Parameters | As defined in 8.4.2.166 (Fine Timing Measurement Parameters element) | As defined in 8.4.2.166 (Fine Timing Measurement Parameters element) | Optional element containing the proposed fine timing measurement configuration |
| VendorSpecific  | A set ofelements | As defined in 8.4.2.25 (Vendor Specific element) | Zero or more elements.  |

***To the editor: Please change the primitive description in 6.5.4.2, on P533-536 as follows:***

* Semantics of the service primitive

The primitive provides the following parameters:

PLME-CHARACTERISTICS.confirm(

aSlotTime,

aSIFSTime,

aSignalExtension,

aCCATime,

aCCAMidTime,(11ac)

aRxPHYStartDelay(#1486),

aRxTxTurnaroundTime,

aTxPHYDelay,(#61)

aRxPHYDelay,(#61)

aRxTxSwitchTime,

aTxRampOnTime,(#1589)

aAirPropagationTime,

aMACProcessingDelay,

aPreambleLength,

aRIFSTime,

aSymbolLength,

aSTFOneLength,

aSTFTwoLength,

aLTFOneLength,

aLTFTwoLength,

aPHYHeaderLength,(#61)

aPHYSigTwoLength,(#61)

aPHYServiceLength,(#61)

aPHYConvolutionalTailLength,(#61)(#1585)(#3211)

aPSDUMaxLength,

aPPDUMaxTime,

aIUSTime,

aDTT2UTTTime,

aCWmin,

aCWmax,

aMaxCSIMatricesReportDelay

aMaxTODError,

aMaxTOAError,

aTxPHYTxStartRFDelay,(#61)

aTxPHYTxStartRMS,(#61)

aMaxTODFineError,(#46)

aMaxTOAFineError(#46)

)

The values assigned to the parameters is as specified in the PLME SAP interface specification contained within each PHY subclass of this standard. Not all parameters are used by all PHYs defined within this standard.(#1644)

|  |  |  |
| --- | --- | --- |
| Name | Type | Description |
| aSlotTime | integer | The Slot Time (in microseconds) that the MAC uses for defining the PIFS and DIFSs. See 9.3.7 (DCF timing relations). |
| aSIFSTime | integer | The nominal time (in microseconds) that the MAC and PHY require in order to receive the last symbol of a frame at the air interface, process the frame, and respond with the first symbol on the air interface of the earliest possible response frame. See 9.3.7 (DCF timing relations). |
| aSignalExtension | integer | Duration (in microseconds) of the signal extension (i.e., a period of no transmission) that is included at the end of certain PPDU formats; see 20.3.2 (PPDU format) and 9.3.8 (Signal Extension). |
| aCCATime | integer | For Clause 16 (DSSS PHY specification for the 2.4 GHz band designated for ISM -applications) through Clause 19 (Extended Rate PHY (ERP) specification) PHYs and Clause 21 (Directional multi-gigabit (DMG) PHY specification) PHYs, the maximum time (in microseconds) the CCA mechanism has available to assess the medium to determine whether the medium is busy or idle.For Clause 20 (High Throughput (HT) PHY specification) and Clause 22 (Very High Throughput (VHT) PHY specification) PHYs, the maximum time (in microseconds) that the CCA mechanism has available to detect the start of a valid IEEE 802.11 transmission within the primary channel and to assess the energy on the medium within the primary, secondary, secondary40 (Clause 22 (Very High Throughput (VHT) PHY specification) PHY only), and secondary80 (Clause 22 (Very High Throughput (VHT) PHY specification) PHY only) channels that fall inside the operating channel, in order to determine the values of the STATE and channel-list parameters of the PHY-CCA.indication primitive. |
| aCCAMidTime | integer | For Clause 22 (Very High Throughput (VHT) PHY specification) PHYs, the maximum time (in microseconds) the CCA mechanism has available to assess the medium to determine whether an IEEE 802.11 transmission is present on a nonprimary channel. |
| aRxPHYStartDelay | integer | The delay, in microseconds, from a point in time specified by the PHY to the issuance of the PHY-RXSTART.indication primitive. |
| aRxTxTurnaroundTime | integer | The maximum time (in microseconds) that the PHY requires to change from receiving to transmitting the start of the first symbol. The following equation is used to derive the RxTxTurnaroundTime:aTxPHYDelay + aRxTxSwitchTime + aTxRampOnTime |
| aTxPHYDelay | integer | The nominal time (in microseconds) that the PHY uses to deliver a symbol from the MAC interface to the air interface. |
| aRxPHYDelay | integer | The nominal time (in microseconds) that the PHY uses to deliver the last bit of a received frame from end of the last symbol at the air interface to the MAC. |
| aRxTxSwitchTime | integer | The nominal time (in microseconds) that the PHY takes to switch from Receive to Transmit. |
| aTxRampOnTime | integer | The maximum time (in microseconds) that the PHY takes to turn the Transmitter on. |
| aAirPropagationTime | integer | Twice the propagation time (in microseconds) for a signal to cross the maximum distance between the most distant allowable STAs that are slot synchronized. |
| aMACProcessingDelay | integer | The maximum time (in microseconds) available for the MAC to issue a PHY-TXSTART.request primitive pursuant to a PHY-RXEND.indication primitive (for response after SIFS) or PHY-CCA.indication(IDLE) primitive (for response at any slot boundary following a SIFS). This constraint on MAC performance is defined as a PHY-specific parameter because of its use, along with other PHY-specific time delays, in calculating the two PHY characteristics of primary concern to the MAC: aSlotTime and aSIFSTime. The relationship between aMACProcessingTime and the IFS and slot timing is described in 9.3.7 (DCF timing relations) and illustrated in Figure 9-19 (DCF timing relationships). |
| aPreambleLength | integer | The current PHY’s preamble length (in microseconds). If the actual value of the length of the modulated preamble is not an integral number of microseconds, the value is rounded up to the next higher value. |
| aRIFSTime | integer | Value of the reduced interframe space (in microseconds), which is the time by which multiple transmissions from a single transmitter may be separated, when no SIFS-separated response transmission is expected. See 9.3.2.3.2 (RIFS) |
| aSymbolLength | integer | The current PHY’s Symbol length (in microseconds). If the actual value of the length is not an integral number of µs, the value is rounded up to the next higher value. |
| aSTFOneLength | integer | Length of the non-HT-STF (L-STF) for HT-mixed format, and the HT-greenfield STF (HT-GF-STF) for HT-greenfield format (in microseconds) |
| aSTFTwoLength | integer | Length of the HT-STF (in microseconds) |
| aLTFOneLength | integer | Length of the First HT-LTF (in microseconds)  |
| aLTFTwoLength | integer | Length of the Additional HT-LTFs (in microseconds)  |
| aPHYHeaderLength | integer | The current PHY’s header length (in microseconds), excluding aPHYSigTwoLength if present. If the actual value of the length of the modulated header is not an integral number of microseconds, the value is rounded up to the next higher value. |
| aPHYSigTwoLength  | integer | Length of the HT SIGNAL field (HT-SIG) (in microseconds). |
| aPHYServiceLength  | integer | The length of the PHY SERVICE field (in number of bits). |
| aPHYConvolutionalTailLength  | integer | The length of the sequence of convolutional code tail bits (in number of bits). |
| aPSDUMaxLength  | integer | The maximum number of octets in a PSDU that can be conveyed by a PPDU. |
| aPPDUMaxTime  | integer | The maximum duration of a PPDU in milliseconds. |
| aIUSTime  | integer | The minimum time between the end of a PSMP-UTT and the start of the following PSMP-UTT in the same PSMP sequence. |
| aDTT2UTTTime  | integer | The minimum time between the end of a PSMP-DTT and the start of the PSMP-UTT addressed to the same STA. |
| aCWmin | integer | The minimum size of the CW, in units of aSlotTime. |
| aCWmax | integer | The maximum size of the CW, in units of aSlotTime. |
| aMaxCSIMatriesReportDelay  | integer | The maximum time (in milliseconds) between the reception of a frame containing a CSI Feedback Request or an NDP announcement and the transmission of the first CSI frame containing channel state information measured from the received Sounding Complete frame. See 9.32.2.4.4 (CSI reporting for calibration). |
| aMaxTODError | Integer | An estimate of the maximum error (in 10 ns units) in the TX\_START\_OF\_FRAME\_OFFSET value in the PHY-TXSTART.confirm(TXSTATUS) primitive. The estimated maximum error includes any error due to implementation component and environmental (including temperature) variability. |
| aMaxTOAError | Integer | An estimate of the maximum error (in 10 ns units) in the RX\_START\_OF\_FRAME\_OFFSET value in the PHY-RXSTART.indication(RXVECTOR) primitive. The estimated maximum error includes any error due to implementation component and environmental (including temperature) variability. |
| aTxPHYTxStartRFDelay  | Integer | The delay (in units of 0.5 ns) between a PHY-TXSTART.request primitive being issued and the first frame energy sent by the transmitting port, for the current channel. |
| aTxPHYTxStartRMS  | Integer | The RMS time of departure error (in units of 0.5 ns), where the time of departure error equals the difference between TIME\_OF\_DEPARTURE and the time of departure measured by a reference entity using a clock synchronized to the start time and mean frequency of the local PHY entity’s clock. |
| aMaxTODFineError  | Integer | An estimate of the maximum error (in 0.1 ns units, in case High Resolution bit is set to 0 or in 1 ps units in case High Resolution bit is set to 1) in the TX\_START\_OF\_FRAME\_OFFSET value in the PHY-TXSTART.confirm(TXSTATUS) primitive. The estimated maximum error includes any error due to implementation component and environmental (including temperature) variability. |
| aMaxTOAFineError  | Integer | An estimate of the maximum error (in 0.1 ns units in case High Resolution bit is set to 0 or in 1 ps units in case High Resolution bit is set to 1) in the RX\_START\_OF\_FRAME\_OFFSET value in the PHY-RXSTART.indication(RXVECTOR) primitive. The estimated maximum error includes any error due to implementation component and environmental (including temperature) variability. |

* Fine Timing Measurement (#3637)Range report(#2403)

The format of the Measurement Report field corresponding to a Fine Timing Measurement (#3637)Range report is shown in Figure 8-245 (Measurement Report field format for a Fine Timing Measurement Range report).

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Range Entry Count | Range Entry | Error Entry Count | Error Entry | Optional Subelements |
| Octets: | 1 | *M* x 15(#3201) | 1 | *N* x 11 | variable |
| * Measurement Report field format for a Fine Timing Measurement Range report(#2403)
 |

The Range Entry Count field indicates the number of Range Entry fields (i.e., *M* in Figure 8-245 (Measurement Report field format for a Fine Timing Measurement Range report)).

The Range Entry field indicates parameters relating to a successful(M56) range measurement with a single AP, and is formatted according to Figure 8-246 (Range Entry field format).

***To the editor: Please change Figure 8-246 as follows:***

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | B0 B31 | B32 B79 | B80 B95 | B96 B111 | B112  | B113 B119 |
|  | Measurement Start Time | BSSID | Range | Max Range Error | High Resolution | Reserved |
| Bits: | 32 | 48 | 16 | 16 | 1 | 7 |
| * Range Entry field format
 |  |

The Measurement Start Time field contains the least significant 4 octets of the TSF (synchronized with the associated AP) at the time (± 32 µs) at which the initial(M56) Fine Timing Measurement frame was transmitted where the timestamps of both the frame and response frame were successfully measured.

The BSSID field contains the BSSID of the AP whose range is being reported.

***To the editor: Please change the following paragraphs in P814L50-60:***

The High Resolution field when set to 1 indicates high resolution range reporting.

The Range field indicates the estimated range between the requested STA and the AP using the fine timing measurement procedure, in units of 1/64 m, in case High Resolution field is set to 0, and in units of 1/4096 m otherwise. A value of 216–1 indicates a range of (216–1)/64 m or higher, in case High Resolution field is set to 0, and a range of (216–1)/4096 m or higher otherwise. See 10.11.9.11 (Fine Timing Measurement Range report).

The Max Range Error field contains an upper bound for the error in the value specified in the Range field, in units of 1/64 m, in case High Resolution field is set to 0, and in units of 1/4096 m otherwise. A value of zero indicates an unknown error. A value of 216–1 indicates a maximum range error of (216–1)/64 m or higher, in case High Resolution field is set to 0, and a range of (216–1)/4096 m or higher otherwise. For instance, a value of 128 in the Max Range Error field with High Resolution field set to 0 indicates that the value in the Range field has a maximum error of ± 2 m.

* Fine Timing Measurement Parameters(#3465) element(#2164)

The Fine Timing Measurement Parameters(#3465) element contains a number of fields that are used to advertise the requested or allocated(M56) fine timing measurement configuration from one STA to another. The Fine Timing Measurement Parameters(#3465) element is(#3267) included in the initial Fine Timing Measurement Request frame, as described in 8.6.8.32 (Fine Timing Measurement Request frame format), and the initial Fine Timing Measurement frame, as described in 8.6.8.33 (Fine Timing Measurement frame format). The use of the Fine Timing Measurement Parameters(#3465) element is described in 10.24.6 (Fine timing measurement procedure).

The format of the Fine Timing Measurement Parameters(#3465) element is shown in 8-568 (Fine Timing Measurement Parameters element format).

|  |  |  |  |
| --- | --- | --- | --- |
|  | Element ID | Length | Fine Timing Measurement Parameters(#3465)(M56) |
| Octets: | 1 | 1 | 9 |
| * Fine Timing Measurement Parameters(#3465)(Ed) element format(#2164)
 |

The format of the Fine Timing Measurement Parameters(#3465)(Ed) field is shown in 8-569 (Fine Timing Measurement Parameters field format).

***To the editor: Please change Figure 8-569 as follows:***

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | B0 B1 | B2 B6 | B7 | B8 B11 | B12 B15 | B16 B23 | B24 B39 |
|  | Status Indication | Value | High Resolution | Number of Bursts Exponent | Burst Duration | Min Delta FTM | Partial TSF Timer |
| Bits: | 2 | 5 | 1 | 4 | 4 | 8 | 16 |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | B40 | B41 | B42 | B43 B47 | B48 B49 | B50 B55 | B56 B71 |
|  | Reserved  | ASAP Capable | ASAP | FTMs per Burst | Reserved | FTM Format And Bandwidth | Burst Period |
| Bits: | 1 | 1 | 1 | 5 | 2 | 6 | 16 |
| * **Fine Timing Measurement Parameters field format**
 |

The Element ID and Length fields are defined in 8.4.2.1 (General).

(#3267)The Status Indication field indicates the responding STA’s response to the Fine Timing Request. The encoding of the Status Indication field is shown in Table 8-245 (Status Indication field values).

|  |
| --- |
| * Status Indication field values(#2164)
 |
| Value | Description |
| 0 | Reserved |
| 1 | Successful (some requested parameters might have been overridden)(#3267). Measurement exchanges are (M56) about to begin.(#3267) |
| 2 | Request incapable (Do not send same request again)(#3267). FTM session ends.(#3112) |
| 3 | Request failed. Do not send new request for Value seconds. FTM session ends.(#3112) |

When the Status Indication field equals 3(#3267),(#3112)(M56) the Value field contains a duration in units of seconds; otherwise the Value field is reserved.

***To the editor: Please add the following paragraph in P1052L4:***

High Resolution field set to 1 indicates the request to use 1 ps resolution time stamps and time stamp errors for the FTM session if set to 1 in the initial Fine Timing Measurement Request frame, and indicates the use of 1 ps resolution time stamps and time stamp errors in the FTM session if the field is set to 1 in both the initial Fine Timing Measurement Request and the initial Fine Timing Measurement frames. In case the High Resolution field in either the initial Fine Timing Measurement Request frame or the initial Fine Timing Measurement frame or in both is set to 0, the normal FTM resolution of 0.1 ns for the time stamps and the time stamp errors shall be used.

The Number of Bursts Exponent field indicates how many burst instances, defined in 10.24.6.4 (Measurement exchange),(Ed) are requested (M56)for the FTM session if included in an initial Fine Timing Measurement Request frame, or allocated for the FTM session if included in an initial Fine Timing Measurement frame respectively, where the number of burst instances is 2Number of Bursts Exponent. The value 15 in an initial(M56) Fine Timing Measurement Request frame indicates no preference by the initiating STA and is valid (indicating 215 burst instances)(Ed)(M56) when set by the responding STA.

* Fine Timing Measurement frame format(#46)

The Fine Timing Measurement frame is used to support the fine timing measurement procedure described in 10.24.6 (Fine timing measurement procedure). The format of the Fine(Ed) Timing Measurement Action field(#2042) is shown in Figure 8-664 (Fine Timing Measurement Action field format). ***To the editor: Change Figure 8-664 as follows:***

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | B0 B7 | B8 B15 | B16 B23 | B24 B31 | B32 B79 | B80 B127 |
|  | Category | Public Action | Dialog Token | Follow Up Dialog Token | TOD | TOA |
| Bits: | 8 | 8 | 8 | 8 | 48 | 48 |
|  | B128 B143 | B144 B158 | B159 | B160  |  |  |
|  | TOD Error | TOA Error | High Resolution | LCI Report(optional) | Location Civic Report (optional) | Fine Timing Measurement Parameters (optional) |
| Bits: | 16 | 15 | 1 | variable  | variable  | variable |
| * Fine Timing Measurement Action field format
 |

The (M56)Category field is set to the value for Public, specified in Table 8-46 (Category values).

The Public Action field is defined in 8.6.8.1 (Public Action frames).(#3403)

The TOD Error field is structured as shown in Figure 8-665 (Format of the TOD Error field).

|  |  |  |
| --- | --- | --- |
|  | B0 B14(M56) | B15(M56) |
|  | Max TOD Error | TOD Not Continuous |
| Bits: | 15 | 1 |
| * Format of the TOD Error field(#2164)
 |

***To the editor: please remove the following line P1138L52, and Figure 8-666***

~~The TOA Error field is structured as shown in 8-666 (Format of the TOA Error field).~~

|  |  |  |
| --- | --- | --- |
|  | ~~B0 B14(M56)~~ | ~~B15(M56)~~ |
|  | ~~Max TOA Error~~ | ~~TOA Not Continuous~~ |
| ~~Bits:~~ | ~~15~~ | ~~1~~ |
| * ~~Format of the TOA Error field(#2164)~~
 |

The Dialog Token field is a nonzero value chosen by the responding(#2164) STA to identify the Fine(M56) Timing Measurement frame as the first of a pair, with the second or follow-up Fine(M56) Timing Measurement frame to be sent later. The Dialog Token field is set to 0 to indicate that the Fine(M56) Timing Measurement frame will not be followed by a subsequent follow-up Fine(M56) Timing Measurement frame.

The Follow Up Dialog Token field(Ed) is the nonzero value of the Dialog Token field of the last(#2164) transmitted Fine(M56) Timing Measurement frame to indicate that it is the follow up Fine(Ed) Timing Measurement frame and that the TOD, TOA, Max TOD Error and Max TOA Error fields contain the values of the timestamps captured with the first Fine Timing Measurement frame of the pair. The Follow Up Dialog Token field(Ed) is 0 to indicate that the Fine Timing Measurement frame is not a follow up to a last(#2164) transmitted Fine Timing Measurement frame. The value 0 in this field also indicates that TOD, TOA, (#3267)TOD Error, and (#3267)TOA Error fields are reserved. See 10.24.6 (Fine timing measurement procedure).

***To the editor: Please add the following paragraph to P1139L13:***

For all the Fine Timing Measurement frames transmitted during the FTM session, the High Resolution field is set to 1, to indicate 1 ps resolution, once the High Resolution field is set to 1 in both initial Fine Timing Measurement Request and the initial Fine Timing Measurement frames, and to 0, to indicate 0.1 ns resolution, otherwise.

***To the editor: Please change the following paragraph in P1139L14-15:***

The TOD, TOA, Max TOD Error, and Max TOA Error fields are expressed in units of 1 ps in case High Resolution field is set to 1 in the Fine Timing Measurement frame, and are expressed in units of 0.1 ns otherwise.

The TOD field contains a timestamp that represents the time, with respect to a time base,(#3267) at which the start of the preamble of the last(#2164) transmitted Fine(M56) Timing Measurement frame appeared at the transmit antenna connector(#1410).

The TOA field contains a timestamp that represents the time, with respect to a time base,(#3267) at which the start of the preamble of the (#190)(#1198)Ack frame to the last(#2164) transmitted Fine(M56) Timing Measurement frame arrived at the receive antenna connector(#1410).

NOTE—The values specified in the TOD and TOA fields are described in 6.3.70 (Fine timing measurement request).

The TOD Not Continuous field indicates that the TOD value is with respect to a different underlying time base than the last transmitted TOD value. It is set to 1 when a discontinuity is present. (#3267)Otherwise, it is set to 0.(#2164)

The Max TOD Error field contains an upper bound for the error in the value specified in the TOD field.

***To the editor: Please change the following paragraphs in P1139L35-41:***

NOTE—For instance, a value of 2 in the Max TOD Error field indicates that the value in the TOD field has a maximum error of ± 0.2 ns, unless the High Resolution field is set to 1 and then this value indicates a maximum error of ± 2 ps.

~~The TOA Not Continuous field indicates that the TOA value is with respect to a different underlying time base than the last transmitted TOA value. It is set to 1 when a discontinuity is present. (#3267)Otherwise, it is set to 0.~~ The High Resolution field, if set to 1, indicates that the reported times are expressed in units of 1 ps instead of 0.1 ns otherwise. ~~(#2164)~~

The Max TOA Error field contains an upper bound for the error in the value specified in the TOA field. (#2164)

***To the editor: Please change the following paragraph in P1139L46-49:***

A value of 0 for the Max TOD Error or the Max TOA Error field indicates that the upper bound on the error in the corresponding TOD or TOA value is unknown. A value of 32 767(M56) indicates that the upper bound on the error is greater than or equal to 3.2767 µs in case High Resolution bit is set to 0 and to 32.767 ns in case High Resolution bit is set to 1. (M56)

* Fine timing measurement procedure negotiation(#2164)(#3110)

In order to initiate a fine timing measurement procedure, a STA that supports the fine timing measurement procedure as an initiator (referred to as an initiating STA)(M91) shall transmit a Fine Timing Measurement Request frame.(#3033) This frame is called the initial Fine Timing Measurement Request frame.(M91)

A STA that supports the fine timing measurement procedure as a responder(M56) (referred to as a responding STA)(M91) shall not transmit Fine Timing Measurement frames addressed to a peer STA unless the peer STA(M91) supports(#3033) the fine timing measurement procedure as initiator and the responding STA has received an initial Fine Timing Measurement Request frame from the peer STA.(M91)(M56)

The initial Fine Timing Measurement Request frame shall have:(M91)

* the Trigger field set to 1,
* a set of scheduling parameters in a Fine Timing Measurement Parameters element that describe the initiating STA’s availability for measurement exchange.

The first Fine Timing Measurement frame in the FTM session is called the initial Fine Timing Measurement frame. The responding STA should transmit an initial Fine Timing Measurement frame within 10 ms in response to the initial Fine Timing Measurement Request frame. This initial Fine Timing Measurement frame shall include the Fine Timing Measurement Parameters(#3465) element. The value of the Status Indication field indicates if(Ed) the request was successful, incapable or failed(#3033).

NOTE—In an initial Fine Timing Measurement frame, the responding STA might indicate that the a request for an FTM session is successful, even if the initial Fine Timing Measurement frame includes at least one of (#3208)

* a Measurement Report element that indicates an unknown LCI or
* a Measurement Report element that indicates an unknown civic(#3616) location.

***To the editor: Please add the following paragraph to P1736L48:***

If the High Resolution field in both the initial Fine Timing Measurement Request and the initial Fine Timing Measurement frames are set to 1, then FTM session shall use units of 1 ps for the values in the time stamps and the time stamps errors. If the High Resolution field in either the initial Fine Timing Measurement Request frame or the initial Fine Timing Measurement frame is set to 0, then the FTM session shall use units of 0.1 ns for the values in the time stamps and the time stamps errors.

If the request was successful(#3033)

* If the responding STA is ASAP capable, the(#3110) responding STA’s selection of ASAP should be the same as that requested by the initiating STA.(M56)
* The responding STA’s selection of the Min Delta FTM value shall be greater than or equal to the corresponding value requested by the initiating STA.
* The responding STA's selection of the Number of Bursts Exponent value shall be 0 when the initiating STA requests it to be 0.(M56)

**10.24.6.4 Measurement exchange**

**…**

A responding STA transmits Fine Timing Measurement frames in overlapping pairs of consecutive frames(#3206). For example, in Figure 10-35 (Example negotiation and measurement exchange sequence, ASAP=1), FTM\_1 and FTM\_2, FTM\_2 and FTM\_3, and FTM\_3 and FTM\_4 are overlapping pairs of consecutive frames.(#3206) The first Fine Timing Measurement frame of a pair of consecutive Fine Timing Measurement frames(#3206) contains a nonzero value in the(M56) Dialog Token field. The follow up Fine Timing Measurement frame contains a Follow Up Dialog Token field(M56) set to the value of the Dialog Token field(M56) in the first frame of the consecutive(#3206) pair. Dialog Tokens field values(M56) of consecutive Fine Timing Measurement frames shall(#3206) be consecutive, except when the value wraps around to 1.(#3206) With the first Fine Timing Measurement frame, both STAs capture timestamps. The responding STA captures the time at which the Fine Timing Measurement frame is transmitted (*t1*). The initiating STA captures the time at which the Fine Timing Measurement frame arrives (*t2*) and the time at which the Ack response is transmitted (*t3*). The responding STA captures the time at which the Ack frame arrives (*t4*). See Figure 6-17 (Fine timing measurement primitives and timestamps capture).(Ed) In the follow up Fine Timing Measurement frame, in the same or the subsequent burst(#3206), the responding STA transfers the timestamp values it captured (*t1* and *t4*) to the initiating STA. In this follow up Fine Timing Measurement frame, the timestamp values (*t1* and *t4*) shall be the measurement according to the responding STA’s clock (i.e., without correcting the clock offset).

***To the editor: Please add the following paragraph to P1741L9:***

If High Resolution field in both the initial Fine Timing Measurement Request and the initial Fine Timing Measurement frames are set to 1, the FTM session shall use high resolution of 1 ps for the units of the time stamps and the time stamps errors. When using high resolution time stamps and time stamp errors in the Fine Timing Measurement session, each STA shall set the High Resolution field to 1 in each Fine Timing Measurement frame; otherwise, it shall be set to 0. (#3112)

NOTE—A Fine Timing Measurement frame can contain nonzero values in both the Dialog Token and Follow Up Dialog Token fields, meaning that the Action frame contains follow up information from a previous measurement, and new Timestamp values are captured to be sent in a future follow up Fine Timing Measurement frame.