Derivation of FTM Parameters in 12.6 of 802.1AS-Rev

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Introduction

- This presentation is based on slides 11 – 20 of the earlier presentation [1].
- It was prepared so that the background material on the derivation of the FTM parameters of Tables 12-5 and 12-6 of 12.5 of 802.1AS-Rev could be referenced as a Bibliography reference

Items pertaining to 802.11 FTM -- 3

- The following is Figure 11-37 form IEEE Std 802.11-2016

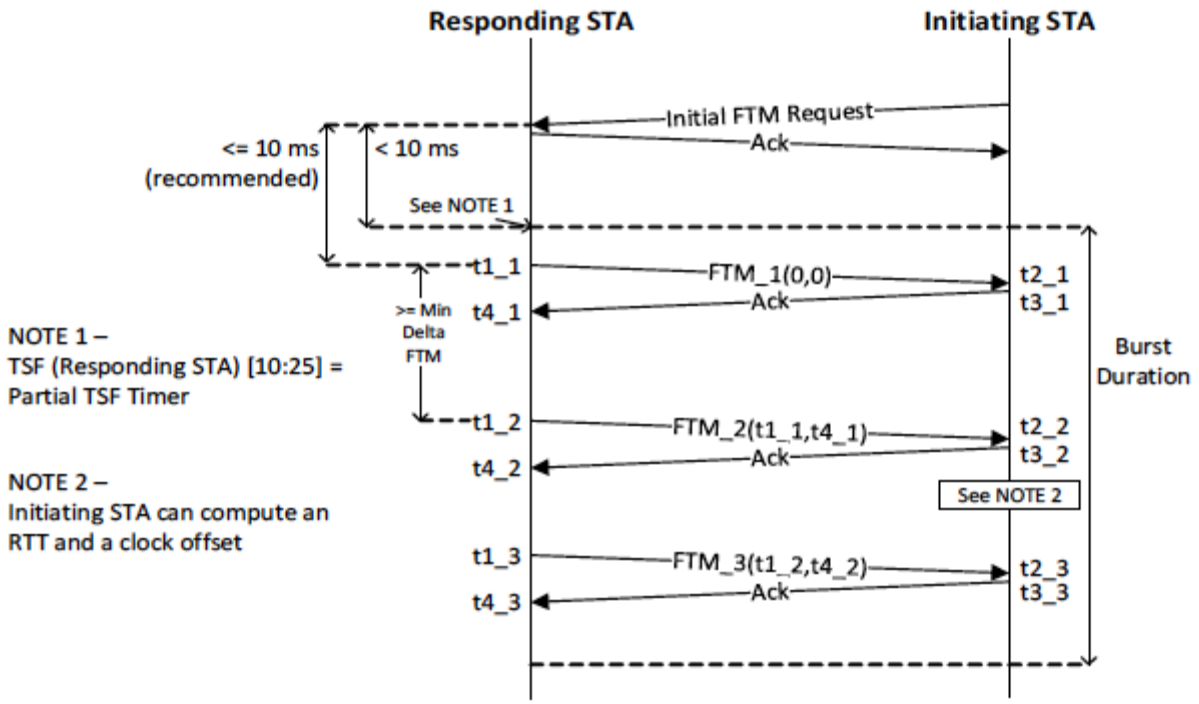

Figure 11-37—Example negotiation and measurement exchange sequence for a single burst instance, ASAP=1, and FTMs per Burst = 3

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- It is assumed below that the exchange shown in the figure on the previous slide is used for FTM in 802.1AS-Rev
- In addition, it is assumed that each session contains a single burst as illustrated in this figure
- With these assumptions, we can begin to suggest values for various FTM parameters, on the following slides

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- The FTM parameters element is (figure taken from [1]):

Fine Timing Measurement Parameters Element

	Category	Public Action	Trigger	LCI Measurement Request (optional)	Location Civic Measurement Request (optional)	Fine Timing Measurement Parameters (Mandatory)
Octets	1	1	1	variable	variable	11

	Status Indication	Value	Reserved	Number of Bursts Exponent	Burst Duration	Min Delta FTM	Partial TSF Timer
Bits	2	5	1	4	4	8	16
	Partial TSF Timer No Preference	ASAP Capable	ASAP	FTMs per Burst	Reserved	Format and Bandwidth	Burst Period
bits	1	1	1	5	2	6	16

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- The following FTM parameter values can be used by the slave when sending the Initial MLME-FINETIMINGMSMTRQ.request:
  - Number of Bursts Exponent = 0
  - Burst Duration: see below
  - Min Delta FTM: see below
  - Partial TSF Timer No Preference = 1
  - Partial TSF Timer is reserved in the Initial FTM request
  - ASAP = 1
  - ASAP Capable is reserved in the Initial FTM Request
  - FTMs per burst = 3
  - Burst Period is reserved when Number of Bursts Exponent = 0

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- From Figure 11-37 of 802.11 (shown on slide 11), which shows the message exchanges in the burst

  - 2*(Min Delta FTM) + SIFS +TXTIME(FTM) + TXTIME(ACK) < Burst Duration Eq. (1)

    where SIFS is the *short interframe spacing*

    - The above is the best you can do

  - A conservative approximation to the above is
    - 3*(Min Delta) < Burst Duration Eq. (2)

  - However, in practice Min Delta ought to be still smaller than is implied by the above equation, to allow for any retransmissions

  - 10 ms + Burst Duration < mean Sync Interval Eq. (3)

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- Mean sync interval, in seconds, must be a power of 2 (requirement of 1588 and 802.1AS)
- Min Delta FTM is a multiple of 100 μs (from 9.4.2.168 of 802.11-2016)
- Burst Duration, in ms, is a power of 2 in ms, ranging from 0.25 ms (250 μs) to 128 ms (see Table 9-257 of 802.11-2016)
  - i.e., 0.25, 0.5, 1, 2, 4, 8, 16, 32, 64, 128 ms

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- It would be desirable (or, at least, convenient) if the user of 802.1AS could choose mean Sync interval, and then values of Min Delta FTM and Burst Duration were computed automatically by the respective 802.1AS state machine(s)
- However, the procedure is not completely straightforward, because only certain values of mean Sync interval, Min Delta FTM, and Burst Duration are allowed

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- As an example, consider the default value of mean sync interval, i.e. 0.125 s (125 ms, with logMessageInterval = -3)
  - Since 10 ms + Burst Duration < mean Sync Interval (i.e., Eq. (3) above), we have
    - Burst Duration < 115 ms
  - If we choose the largest Burst Duration consistent with this, we obtain Burst Duration = 64 ms
  - If we assume the constraint of Eq. (2) above, i.e., 3*(Min Delta FTM) < Burst Duration, we obtain
    - Min Delta FTM < 64/3 ms = 21.333 ms
    - Since Min Delta FTM must be a multiple of 100 μs, the largest value consistent with the above is Min Delta FTM = 213 (corresponding to 21.3. ms)
  - However, it is indicated above that Min Delta FTM ought to be still smaller, to allow for any retransmissions
  - A reasonable value might be Min Delta = 10 ms

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- With the above values, we would have 1 FTM burst per 0.125 ms, assuming the Initial FTM Request for the next burst is made 0.125 ms after the previous Initial FTM Request.
- Note that we get one set of timestamps per single burst because, even though there are 3 FTMs in the burst, only the timestamps from the minimum delay frames will be used
- With the above, the desired mean sync interval is obtained
- Note also that constraints imply that the mean Sync interval cannot be less than 10 ms + Burst Duration.
  - Since the minimum burst duration is 0.25 ms, this means that the mean Sync interval must be at least 10.25 ms, or the largest possible mean Sync rate is approximately 97.6 messages/s
  - Since the logMessageInterval in 1588 and 802.1AS must be a power of 2, this means that the actual largest mean Sync rate is 64 messages/s

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- Possible approaches to setting Min Delta FTM and Burst Duration, given logMessageInterval
- Approach 1: consider all possible values of logMessageInterval, and pre-compute corresponding values of Min Delta FTM and Burst Duration
  - All these values would be specified in 802.1AS-Rev, e.g., in a table that gives values of Min Delta FTM and Burst Duration for each value of logMessageInterval in the allowable range
  - logMessageInterval has data type Integer8, with range -128 through 127
  - However, the values -128 through -125 and 125 through 127 are either reserved or have special meaning; therefore, we need only consider the range -124 through 124
  - In addition, it was shown on the previous slide that the actual maximum rate achievable is 64 messages/s, i.e., mean message interval = 1/64 s, or logMessageInterval = -6
  - Therefore, the actual range that must be considered is -6 through 124
  - It would be possible to compute appropriate values of Min Delta FTM and Burst Duration for each value of logMessageInterval in the above range, using assumptions similar to those on the previous slides
  - Alternatively, if it were decided that mean Sync rates slower than some rate were so slow that they were not practical, then the range could be reduced (e.g., it might be considered that a rate slower than 1 message every 1024 s (17.1 min) is not useful)

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- Approach 2: given a value of logMessageInterval, compute Min Delta FTM and Burst Duration based on Eqs. (1) – (3) above and additional approximations
- For example (this is just an initial example; for now, the main point is to show the general approach)
  - Burst Duration = largest power of 2 multiple of 0.25 ms that is smaller than max(2^logMessageInterval, 128 ms)
  - Min Delta FTM = largest multiple of 100 μs that is smaller than A*(Min Delta FTM / 3), where A is a suitable fraction that allows for the number of expected retransmissions
    - E.g., A = 0.5

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- It was decided to use Approach 1 of the preceding two slides

References

[1] Ganesh Venkatesan, “IEEE 802.1AS REV D5.0 Review Comments” (available via http://www.ieee802.org/1/files/public/docs2017/as-venkatesan-Review-Comments-on-the-use-of-FTM-07-17.pdf)

[2] Geoffrey M. Garner, “Status of 802.1AS-Rev/D5.1 and Questions on Several Items Needing Resolution,” Revision 1, November 8, 2017 (available via http://www.ieee802.org/1/files/public/docs2017/as-garner-802-1as-d5-1-status-and-several-items-needing-resolution-1117-v01.pdf).

Thank you