FTM Parameters for 802.1AS

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Background

- Now is the time to add the use of [FINE_]TIMING_MSMT_REQ to MD state machines as FTM Request frames are mandatory

- We would like to consider if there is a preferred FTM mode 802.1AS would like to add to the draft.
  - May want to consider the wakeup schedule of 802.11 power-management

FTM session with ASAP=1, Single Burst (e.g. 3 FTMs per Burst)

- Matches control flow of 802.1as.
- Similar to what we have today in TM.
- Only difference is that initial FTM Request frame is mandatory.
  - This initial FTM Request frame contains FTM Parameters that are negotiated with the master.
    The Initiating STA is expected to be awake for the Burst Duration period. Not friendly towards power sensitive devices. Most efficient.
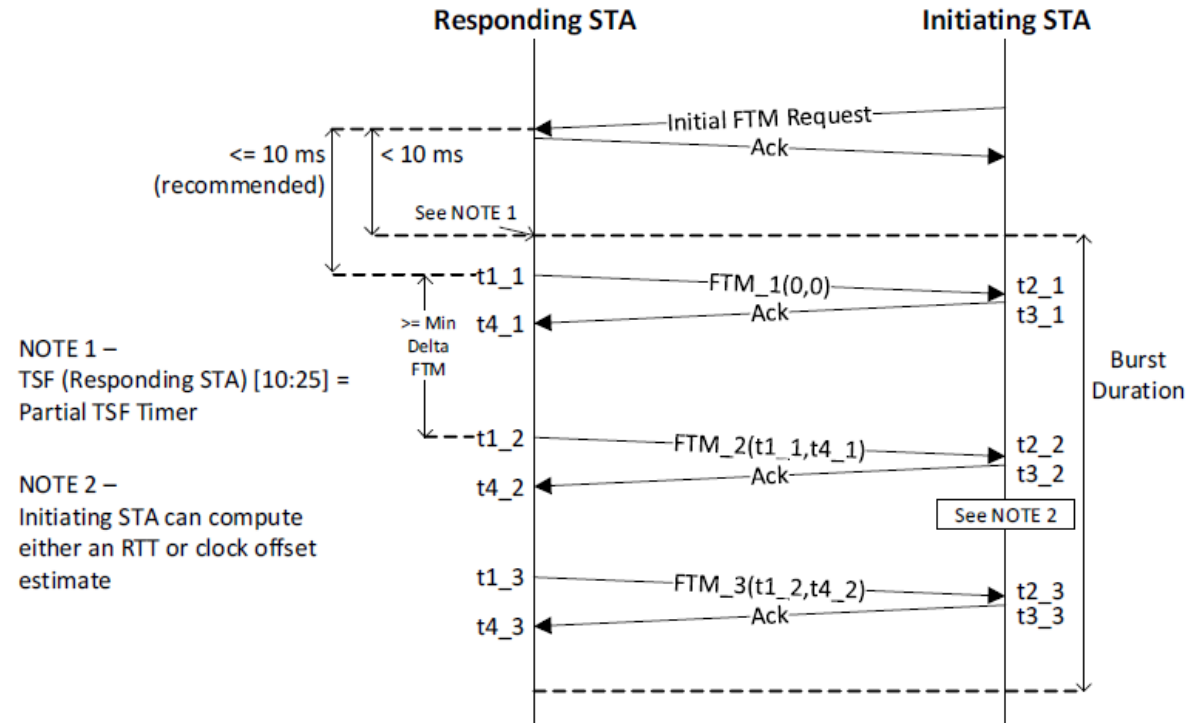
Figure 10-36—Example negotiation and measurement exchange sequence for a sir burst instance, ASAP=1, and FTMs per Burst = 3(Ed)(#2164)(#5174)(#6778)

FTM Session with ASAP=0, Multiple Bursts (e.g. 2 FTMs per Burst)

- Burst Period is in units of 100ms

- FTM Request (Trigger) is mandatory and serves as an indication to the master that the slave is awake and is present at the master' s channel. For every burst, it must be sent before the Burst Duration expires. Requires TSF synchronization information at the slave.

- Good for power sensitive devices that need immediate timing information and don't want to wait for the following Burst Period.

- No Synchronization issues here since the first FTM of every burst instance contains TSF information.

- Burst Duration can be as small as 250us and as large as 128ms

- Burst Period can be as small as 100ms and as large as 1.8 hours.
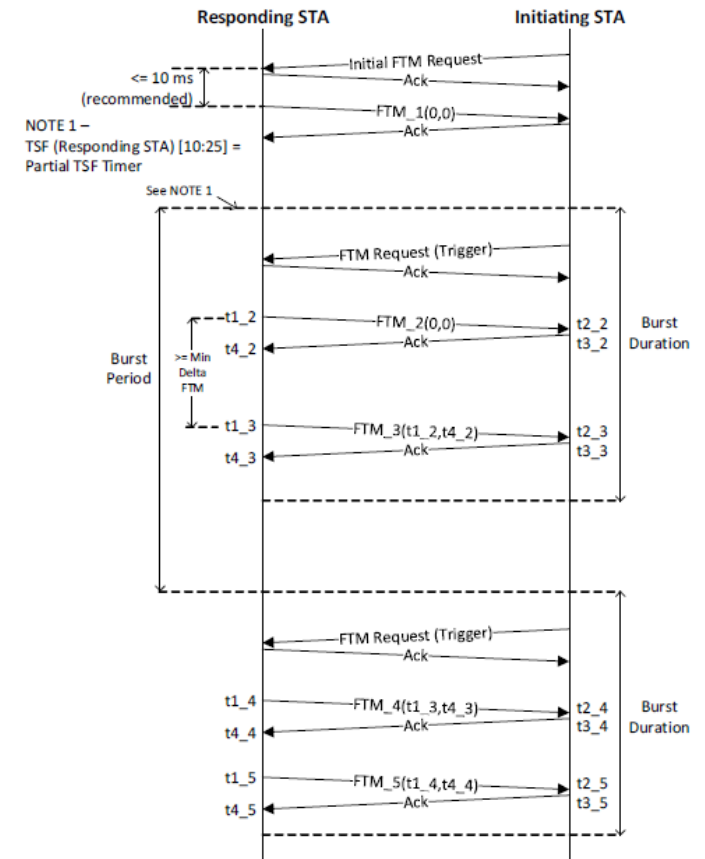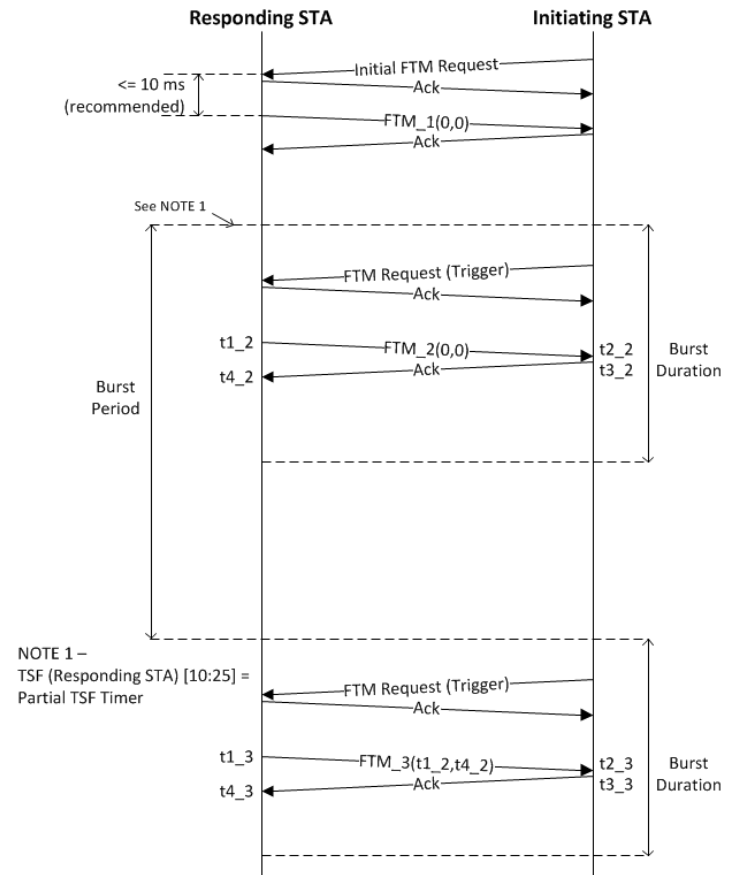
- 67% medium efficiency

Figure 10-34—Example negotiation and measurement exchange sequence, ASAP=0, and FTMs per Burst = 2(Ed)(#2164)(#3206)(#5174)(#6778)

FTM Session with ASAP=0, Multiple Bursts (e.g. 1 FTM per Burst)

- Good for low power devices that can wait Burst Period before receiving next timing information.
- No longer depends on Min Delta FTM
- 50% medium efficiency

Different Options with current 802.11 REVmc protocol (see 8.4.2.166 in Draft 4.3)

Single Burst, max FTMs per Burst=31, with x=25.5ms	Number of Bursts Exponent = 15, 1 FTM per Burst, Burst Period=100ms	Single Burst, K FTMs per Burst (see next slide) repeated every 125 ms
Even though max value of Min Delta FTM = 25.5ms, we agree to use 125 ms as default spacing between consecutive FTM frames	32768 Bursts	
With this default, Max FTM session duration ~30*125=3.75 s	Max FTM session duration ~ 3276.8 seconds	Max FTM session duration depends on K and Min Delta FTM.
125ms delay	100 ms delay	~10 ms delay

What if no changes to 802.11 are made? Parameters to be Negotiated in Single Burst Case

	iFTMR (requested by slave)	FTM_1 (allocated by master)
Number of Bursts Exponent	0 (Single Burst)	0
Burst Duration	z=250us to 128ms (depends on Min Delta FTM) or No preference	250us to 128ms
Min Delta FTM	x=TBD	>=max(x,1)
Partial TSF Timer	0 (Reserved)	PTSF that is within 10ms from iFTMR
Partial TSF Timer No Preference	1	0 (Reserved)
ASAP Capable	0 (Reserved)	1
ASAP	1	1
FTMs per Burst	K	K
FTM Format And Bandwidth	y	y
Burst Period	0 (Reserved)	0 (Reserved)

Are there changes we would like 802.11 to consider?

Option 1: Use one of the Reserved bits to signal Infinite FTMs per Burst (Single Burst)

- Bit 7 is a Reserved bit that could be used to signal this. Bit 7 is set to 1 to request infinite FTMs per Burst when Number of Bursts Exponent is set to 0 and ASAP is set to 1. It is set to 1 in FTM_1 if responding STA accepts it. When this bit is set, it also implicitly means for a Request for Infinite Burst Duration.

  Synchronization issues may be possible.

  10ms drift after 200 seconds (50ppm)

iFTMR (request)	FTM_1 (response)	Outcome
Infinite FTMs per Burst with Burst Duration set to No preference (value = 15)	Infinite FTMs per Burst, Infinite Burst Duration (value 14 – Reserved)	Responder Agrees
Infinite FTMs per Burst with Burst Duration set to No preference (value = 15)	Finite FTMs per Burst, Finite Burst Duration	Responder disagrees

B0	B1	B2	B6	B7	B8	B11	B12	B15	B16	B23	B24	B39
Status Indication		Value		Reserved	Number of Bursts Exponent		Burst Duration		Min Delta FTM		Partial TSF Timer	

Bits: 2   5   1   4   4   8   16

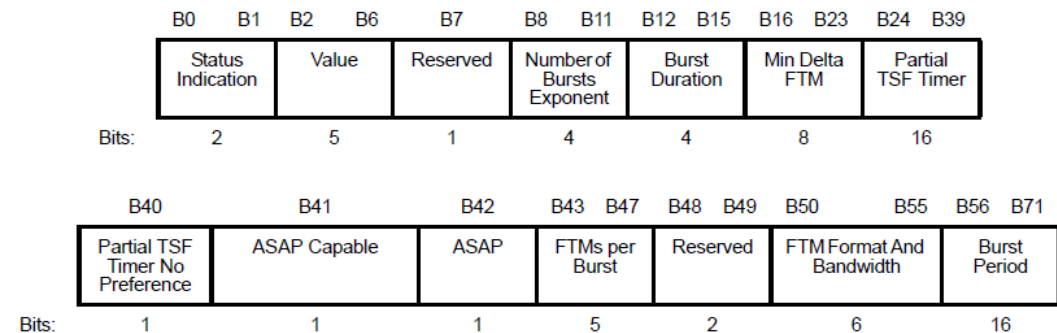| B40	B41	B42	B43	B47	B48	B49	B50	B55	B56	B71
Partial TSF Timer No Preference	ASAP Capable	ASAP	FTMs per Burst		Reserved		FTM Format And Bandwidth		Burst Period	

Bits: 1   1   1   5   2   6   16

Figure 9-572—Fine Timing Measurement Parameters field format

How to Signal Infinite Burst Duration?

- Use value 0,1,12,13, or 14 in this table to signal it. This is part of the FTM Parameters (bits 12-15).

Table 9-252—Burst Duration field encoding

Value	Represents
0-1	Reserved
2	250 µs
3	500 µs
4	1 ms
5	2 ms
6	4 ms
7	8 ms
8	16 ms

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IEEE P802.11-R

Table 9-252—Burst Duration field encoding

Value	Represents
9	32 ms
10	64 ms
11	128 ms
12–14	Reserved
15	No preference

Option 2:Use the Burst Duration field to signal infinite Burst Duration (Single Burst)

iFTMR (request)	FTM_1 (response)	Outcome
Infinite Burst Duration with FTMs per Burst = 0 (No Preference)	Infinite FTMs per Burst, Infinite Burst Duration (value 14 ?)	Responder Agrees
Infinite Burst Duration with FTMs per Burst = 0 (No preference)	Finite FTMs per Burst, Finite Burst Duration	Responder disagrees

Option 3: allow 1 more bit for Number of Bursts Exponent (Multiple Bursts)

- Allows for initiating STA to go to sleep
- Bit 7 in Figure 9-572 (in REVmc Draft 5.0) is Reserved and could be used for this purpose
- 2^{31}= 2147483648 Bursts
- Max Duration = 6.8 years (assuming 100ms Burst Period)
- Question : The standard specifies the Burst Period to be in units of 100ms? 802.1AS default value is 125 ms. Is this a problem?
- Another potential issue is that the slave is required to send an FTM Request frame. Is this be a problem?

Option 4: Make the base of the exponent be K (K>2), instead of 2 (Multiple Bursts)

- Allows for initiating STA to go to sleep
- Max Duration = K^15 Bursts, where K>2
  - If K=10, this means an FTM session lasts 3.2 million years
  - If K=4, this is equivalent to 3.4 years
  - If K=8, this is equivalent to 110,000 years
- Standards change:
- *The Number of Bursts Exponent field indicates how many burst instances, defined in 10.24.6.4 are requested 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 ~~2~~ $K^{Number\ of\ Bursts\ Exponent}$.*
- Another potential issue is that the slave is required to send an FTM Request frame. Would this be a problem?

Option 5: Change the definition of value 15 for Number of Bursts Exponent (Multiple Bursts)

- Standards change to Section 9.4.2.167:

- The value 14 in an initial Fine Timing Measurement Request frame indicates no preference by the initiating STA and is valid (indicating 2^{14} infinite burst instances)when set by the responding STA. The value 15 in an initial Fine Timing Measurement Request frame indicates ~~no preference~~ a preference for infinite burst instances by the initiating STA and is valid (indicating ~~2^{15}~~ infinite burst instances)when set by the responding STA.

- Green means addition to the spec and red means deletion

Strawpoll

- We would like 802.11 to consider the following change
  - Option 1 (Single Burst fix)
  - Option 2 (Single Burst fix)
  - Option 3 (Multiple Burst fix)
  - Option 4 (Multiple Burst fix)
  - Option 5 (Multiple Burst fix)
  - No change
  - Abstain