60802
Time Sync Update

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Version 0

Agenda for the Week

- Summary of “Consensus Approach” to achieving Time Sync goal
- Drift Measurement TLV
- Normative Requirements & Informative Text
- NRR Algorithm & Simulation
- RR Algorithm & Simulation

Summary of “Consensus Approach”

…or what we hope will be the consensus approach?

Combination of Approaches

1. Sync Interval & pDelay Interval
2. NRR Calculation from Sync Messaging
3. Better NRR Measurement Calculation
4. Mean Link Delay Averaging
5. NRR Drift Tracking & Compensation
6. RR Drift Tracking & Compensation

1 – Sync Interval & pDelay Interval

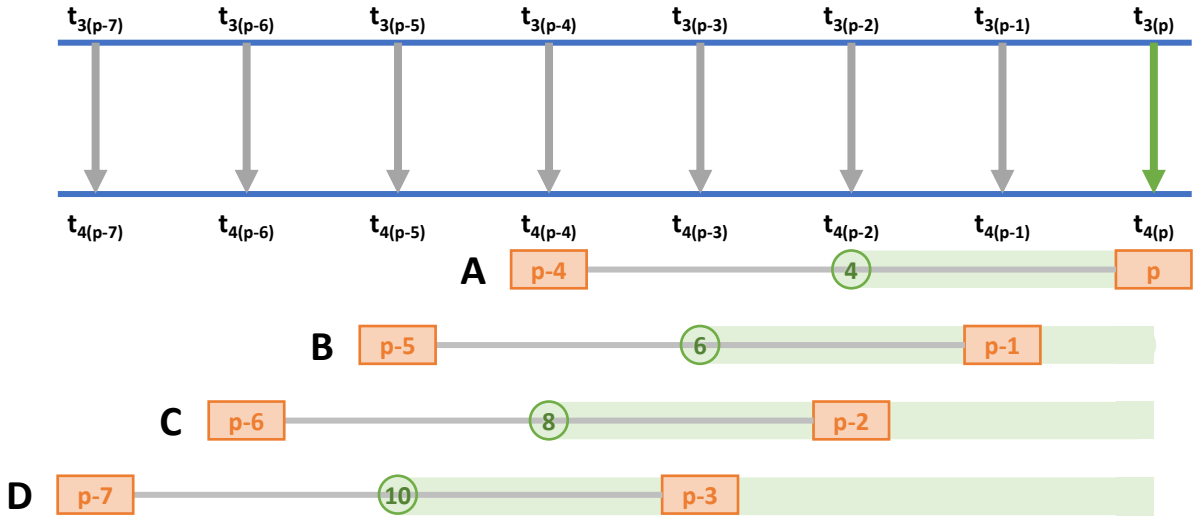
- 125 ms nominal Sync Interval & pDelay Interval
  - Balance between frequent updates vs. message frequency / bandwidth utilisation vs. timestamp / clock drift error balance
  - Min limit 120ms; max limit 130ms
  - Improves timing consistency of NRR calculation which improves error cancellation node-to-node

2 – NRR Calc from Sync Messaging

- New TLV added to Sync or Follow-up Message
  - Includes TX timestamp of Sync message
  - Allows use of same NRR as usual, just using Sync vs. pDelayResp message timestamps
- Limits time between NRR calculation and use during Sync message processing to Mean Link Delay + Residence Time
- Also dramatically reduces timing inconsistency, improving error cancellation node-to-node
- pDelay can still be used…but it will be hard to meet device-level performance requirements if other measures aren't taken (e.g. use of a TCXO)
- pDelay might still be used initially after reconfiguration, before sufficient Sync messages have been transmitted. It is not planned to fully define this behaviour in this version of 60802

3 – Better NRR Measurement Calculation

- Use older Sync (pDelay) messages (N) for initial calculation
- Take an average of previous calculations (A)
- Choose N & A (e.g. 4 & 4) so that each timestamp is only used once…



4 – Mean Link Delay Averaging

- Long average of pDelay-pDelayResp measurements to calculation Mean Link Delay
- IIR filter with, long term, each measurement contributing 1/1000th to the average
- Careful management during startup
  - Need for normative requirements on this point still TBD
- After 40+ meausrements, should eliminate of 95%+ of error

5 – NRR Drift Tracking & Compensation

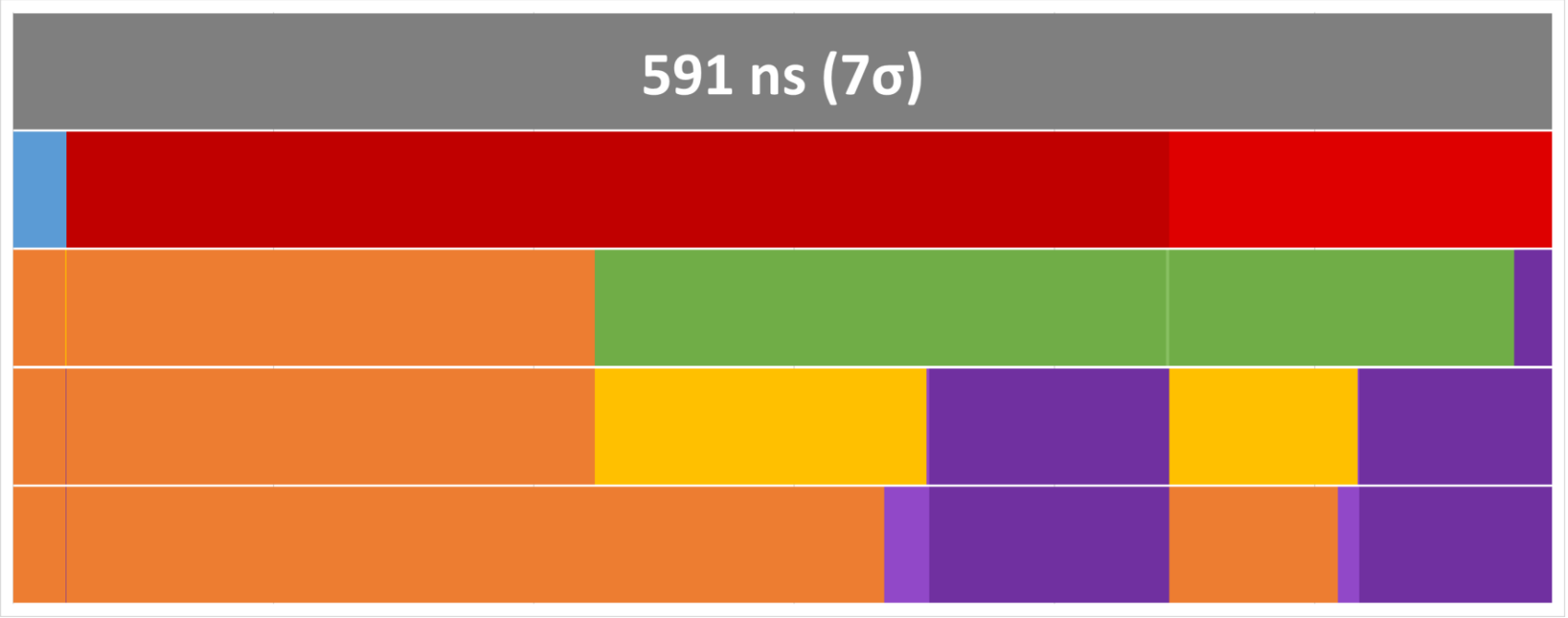
- Separate measurement of NRR, but using similar principle of overlapping N & A values
  - Separate because different balance between Timestamp Error & Clock Drift error is optimal for tracking & compensation vs. calculation of RR
- Then estimate drift from a previous measurement, going back P calculations.
- Known effective measurement times for both measurements…extrapolate to Sync value calculation point.
- Simulations indicate that 90%+ of clock drift error can be eliminated.

6 – RR Drift Tracking & Compensation

- Targeting RR related drift error due to time between calculation of RR at previous node (during Sync TX) and use at current node (during Sync TX)
  - So…current node is tracking RR drift at previous node, i.e. looking only at incoming RR values in Sync message.
  - **Not** tracking it's own RR drift…which does lead to an error in Residence Time measurement…but one orders of magnitude smaller
- Harder to do that NRR measurement due to increasing amounts of Timestamp error that accumulates down the chain
- Info on where node is in the chain (stepsRemoved) would be useful in optimising parameters.
- Also harder to simulate.
  - Not yet clear how effective it will be…but back-of-envelope calculation indicates 50%+
  - Not yet clear if stepsRemoved information & different parameter values at different nodes will be needed (but still think stepsRemoved info in TLV would be useful for optimisation beyond informative text, even if not essential)
- This is where there remains a lot of work to do (between now and March plenary)

Good News

- With current assumptions of algorithm effectiveness…



Input Errors		
Drift Type (Half-sinusoidal Temp Ramp)	4	
GM Clock Drift Max	+1.35	ppm/s
GM Clock Drift Min	-1.35	ppm/s
Fraction of GM nodes w/ Drift	80%	
non-GM Clock Drift Max	+1.35	ppm/s
non-GM Clock Drift Min	-1.35	ppm/s
Fraction of non-GM Nodes w/ Drift	80%	
Temp Max	+85.	°C
Temp Min	-40.	°C
Temp Ramp Rate	±1	°C/s
Temp Ramp Period	125	s
Temp Hold Period	30	s
GM Scaling Factor	100%	
non-GM Scaling Factor	100%	
Timestamp Granularity TX	±4	ns
Timestamp Granularity RX	±4	ns
Dynamic Time Stamp Error TX	±4	ns
Dynamic Time Stamp Error RX	±4	ns
Input Parameters		
pDelay Interval	125	ms
Sync Interval	125	ms
pDelay Turnaround Time	10	ms
residenceTime	10	ms
Input Correction Factors		
Mean Link Delay Averaging	90%	
NRR Drift Rate Correction	90%	
RR Drift Rate Error Correction	50%	
pDelayResp → Sync Type (Gausian)	4	
pDelayResp → Sync Max	100%	
pDelayResp → Sync Min	0%	
pDelayResp → Sync Target	10	ms
mNRR Smoothing N	4	
mNRR Smoothing M	0	
Configuration		
Hops	100	
Runs	1,000,000	

Drift Measurement TLV

Process

- Added to ASdm
- PAR and CSD modification discussion this afternoon
- Comment on next draft of ASdm
  - Including detailed contribution?
- Current intent is that TLV includes…
  - Sync message TX timestamp (similar to pDelayResp)
  - stepsRemoved (same as Announce)
  - Grand Master Identity (same as Announce)

Normative Text

Review Draft…

Thank you!