60802 Time Sync – Effect on dTE of Varying Local Clock Frequency (TSGE)

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Version 1

Background

- Simulations – both Monte Carlo and Time Series – have been run with nominal Local Clock frequencies of 125 MHz with a consequent Timestamp Granularity Error (TSGE) of 0 ns to 8 ns.
- This contributions contains results from Monte Carlo simulations with various Local Clock frequencies:
  - 125 MHz
  - 50 MHz
  - 25 MHz

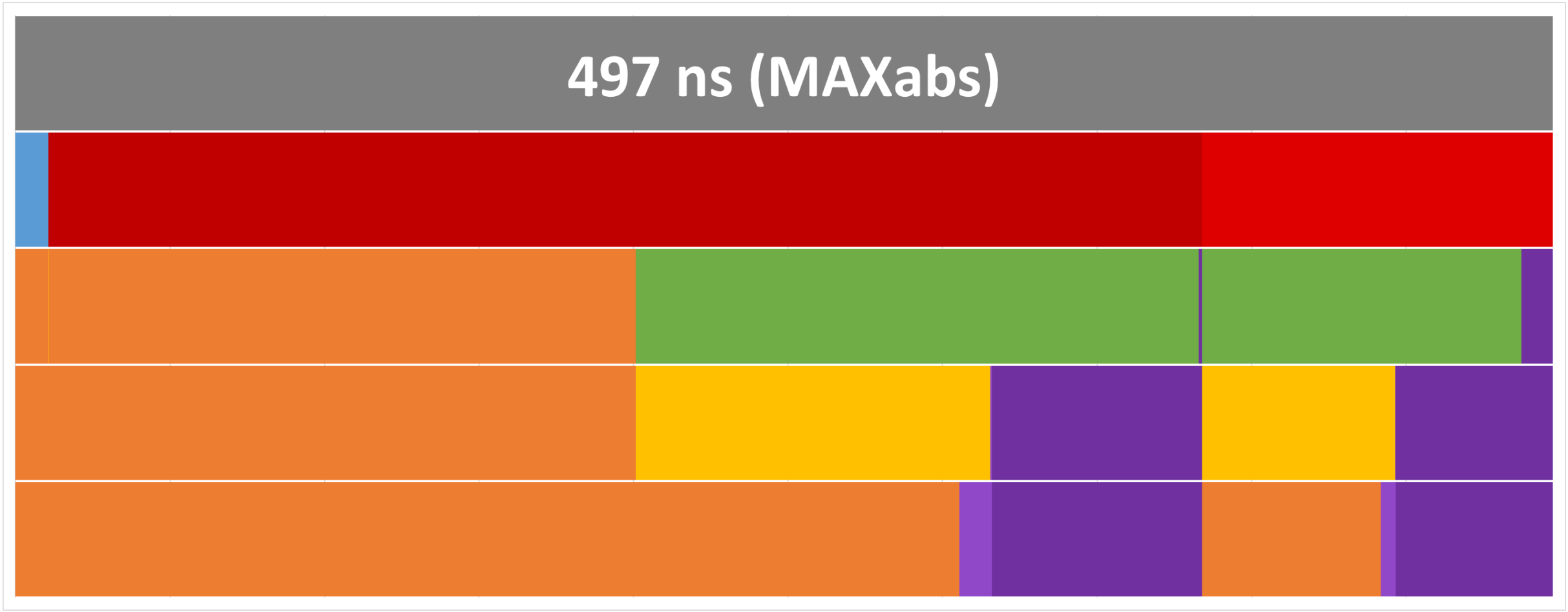
Monte Carlo Simulation Configuration

- The simulator is the “old” multi-hop simulator which does not include full simulation of NRR and RR drift tracking and error compensation.
- Instead, the simulator includes two “percent effective” factors, one for the NRR algorithm and one for the RR algorithm. Both remove the stated percentage of the relevant error, i.e. if the NRR algorithm is 90% effective, only 10% of each relevant error remains.
  - Uses NRR algorithm 95% effective; RR algorithm 60% effective.
- The simulator does include use of the new TLV so that NRR is calculated via Sync messages.
  - Detail: it still uses pDelayInterval for the interval between Sync messages, but pDelayInterval is configured to match Sync Interval behaviour. The end effect is the same.

Simulation Parameters

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	**VAR**	ns
Timestamp Granularity RX	**VAR**	ns
Dynamic Time Stamp Error TX	±6	ns
Dynamic Time Stamp Error RX	±6	ns
Input Parameters		
pDelay Interval	125	ms
Sync Interval	125	ms
pDelay Turnaround Time	15	ms
residenceTime	15	ms
Input Correction Factors		
Mean Link Delay Averaging	95%	
NRR Drift Rate Correction	95%	
RR Drift Rate Error Correction	60%	
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 (or 64)**	
Runs	1,000,000	

Local Clock 125 MHz – 0-8ns TSGE – 100 hops



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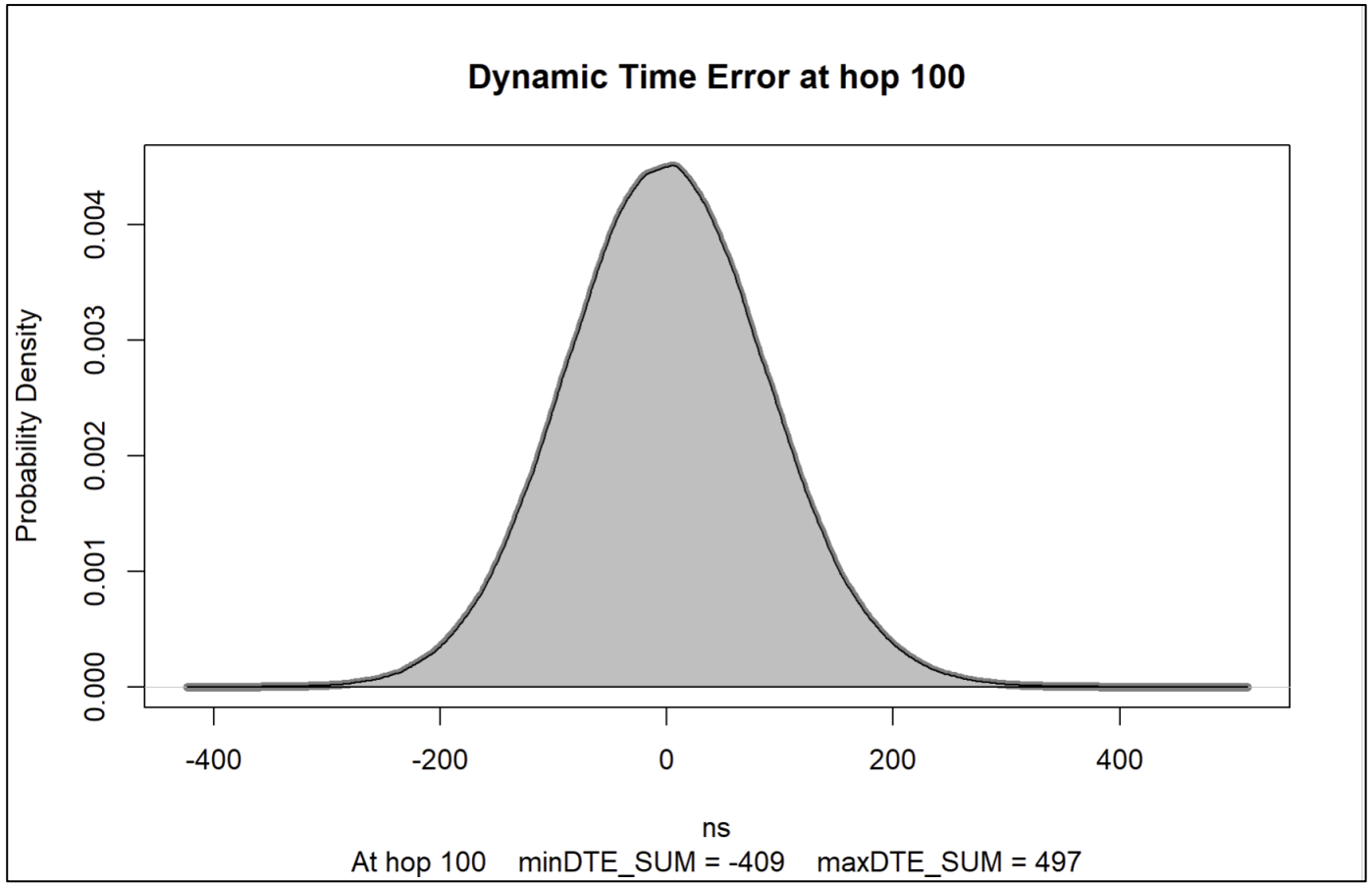
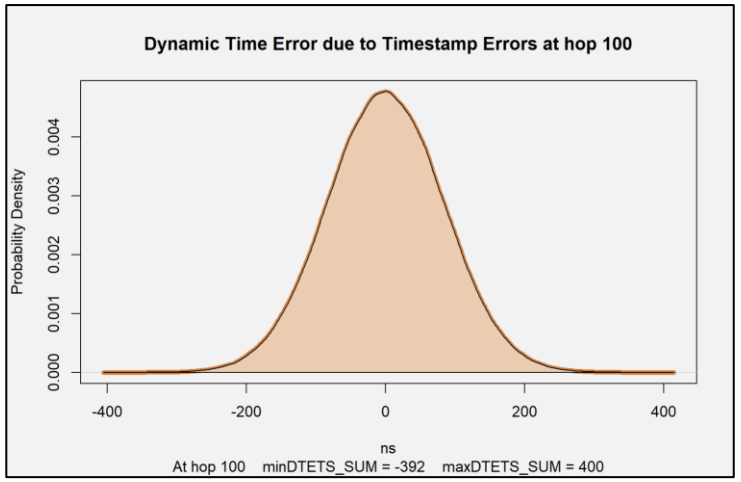
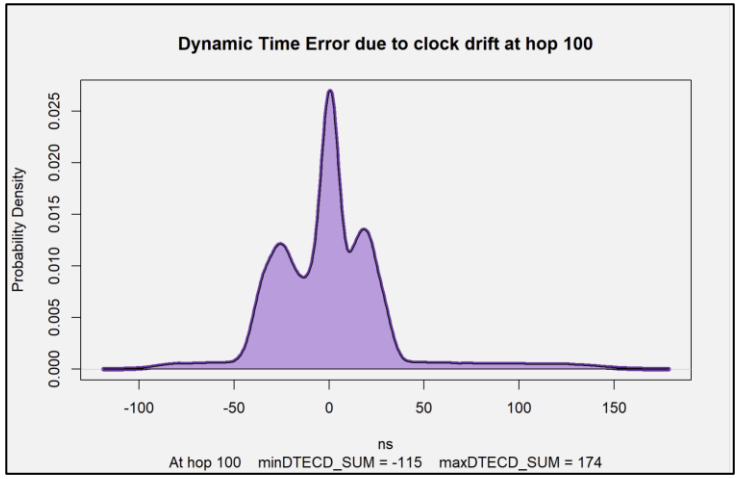
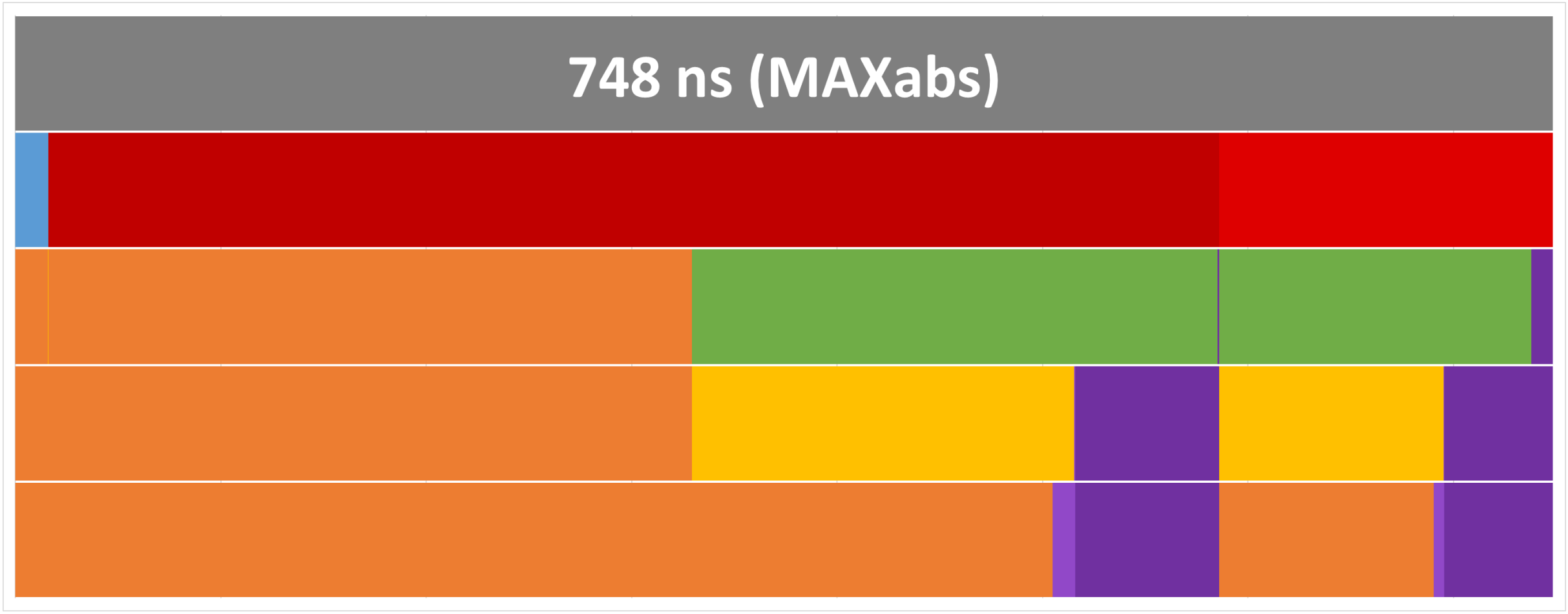






Local Clock 50 MHz – 0-20ns TSGE – 100 hops



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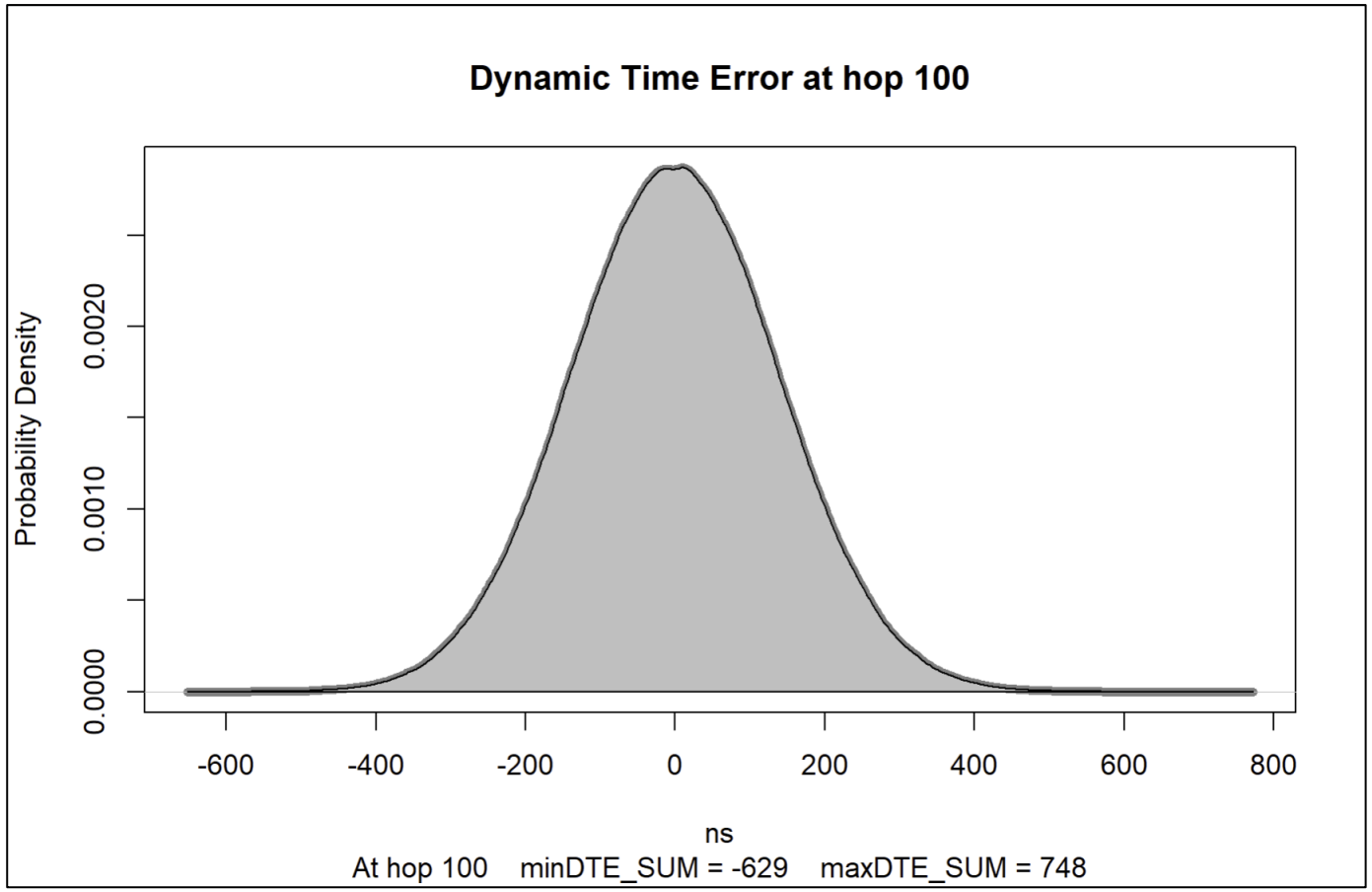
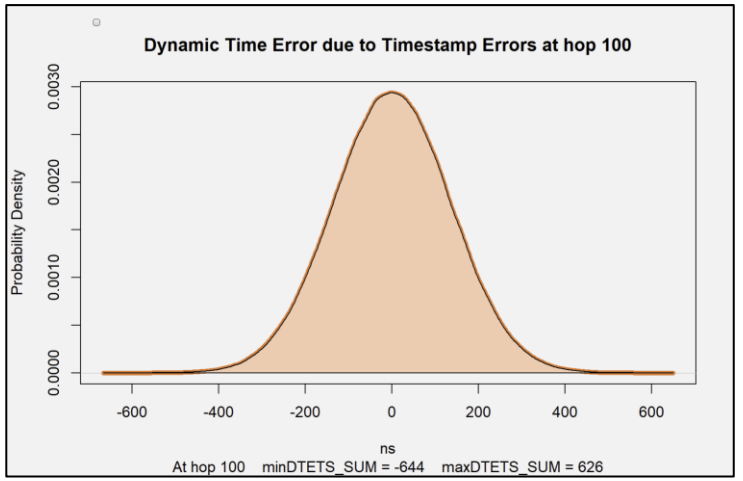
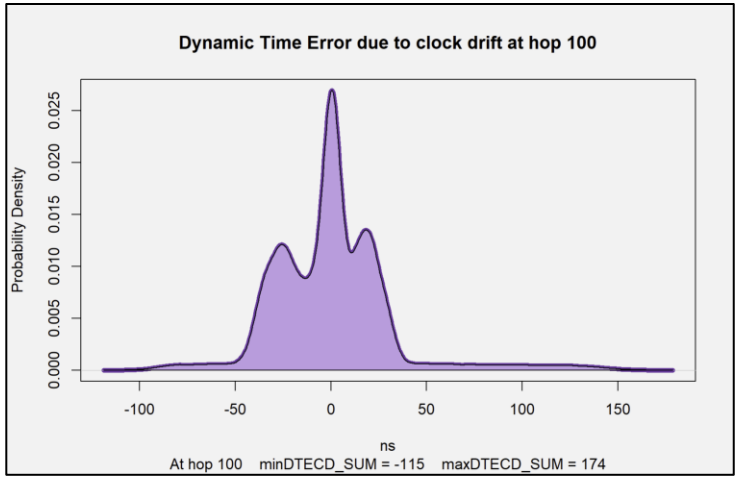
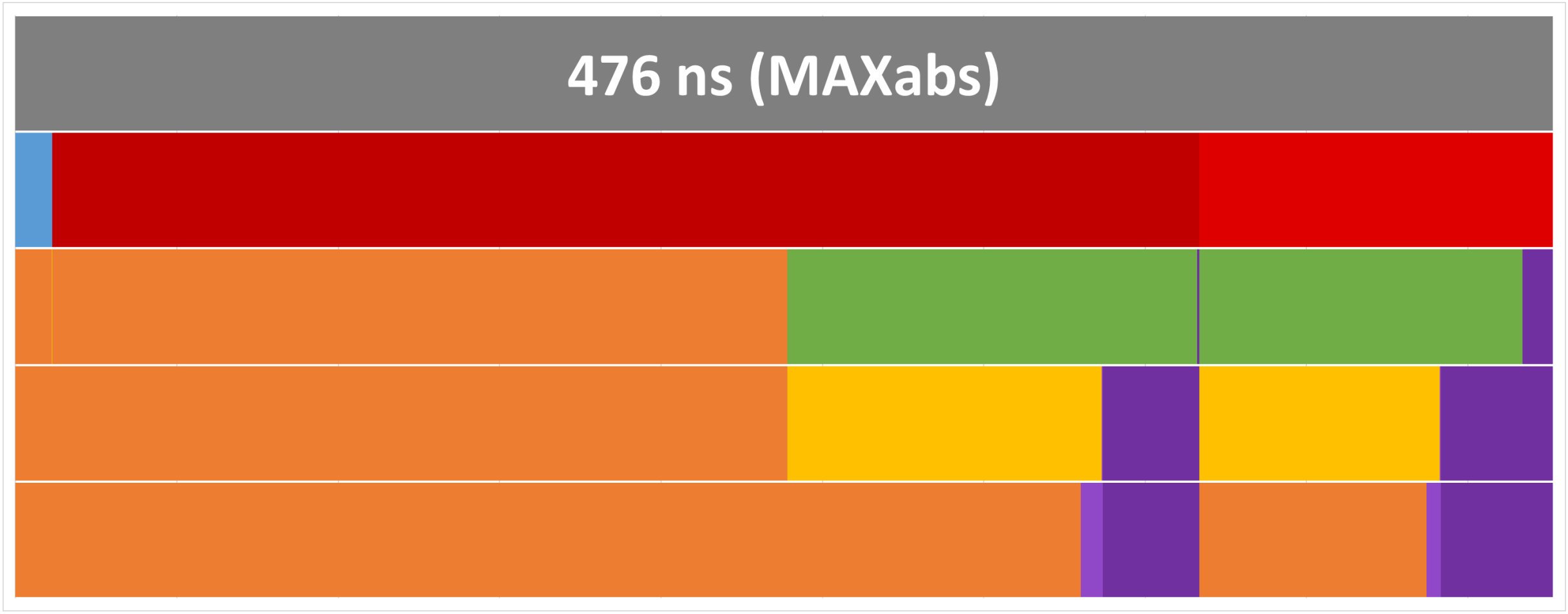






Local Clock 50 MHz – 0-20ns TSGE – 64 hops



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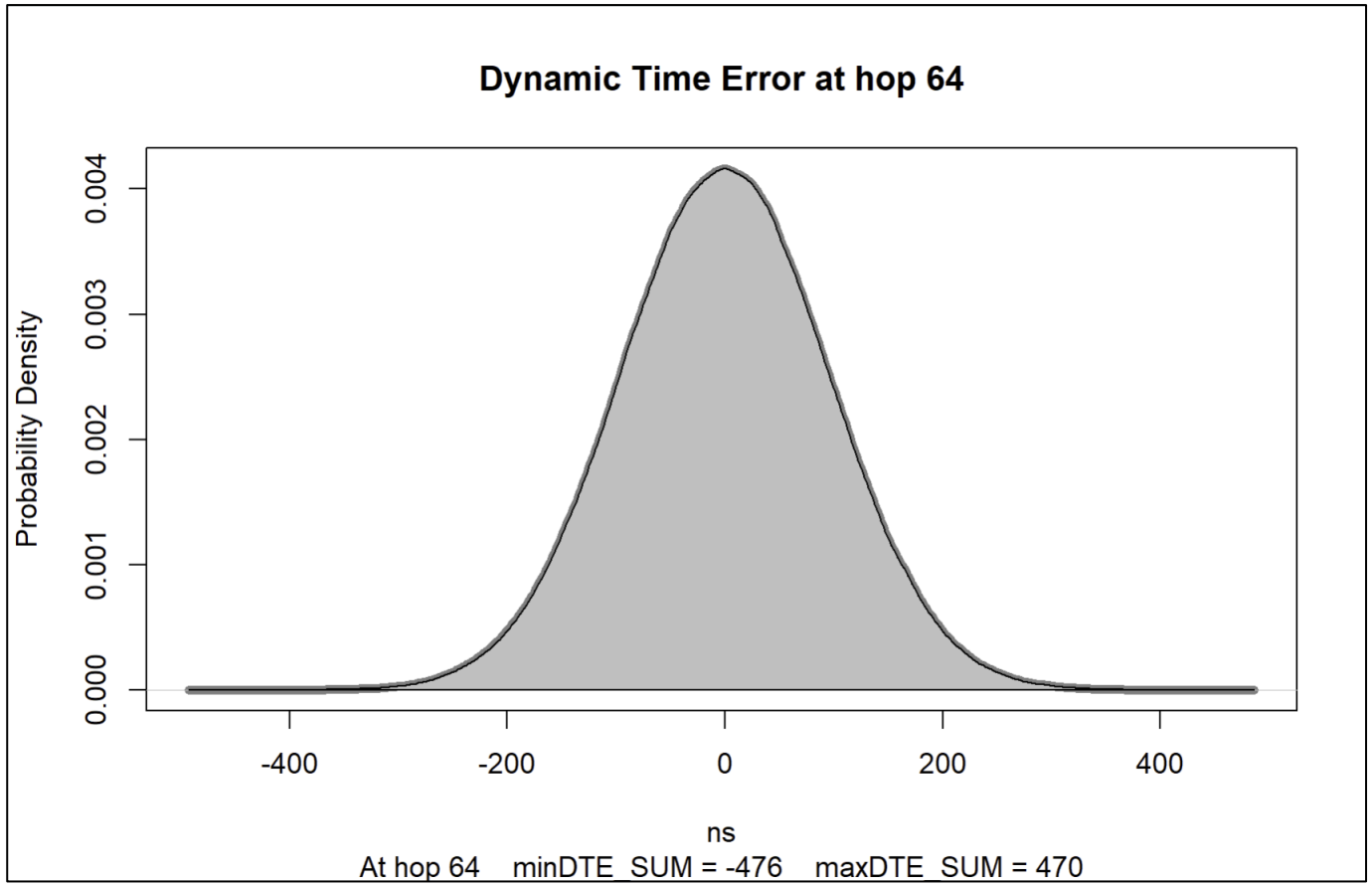
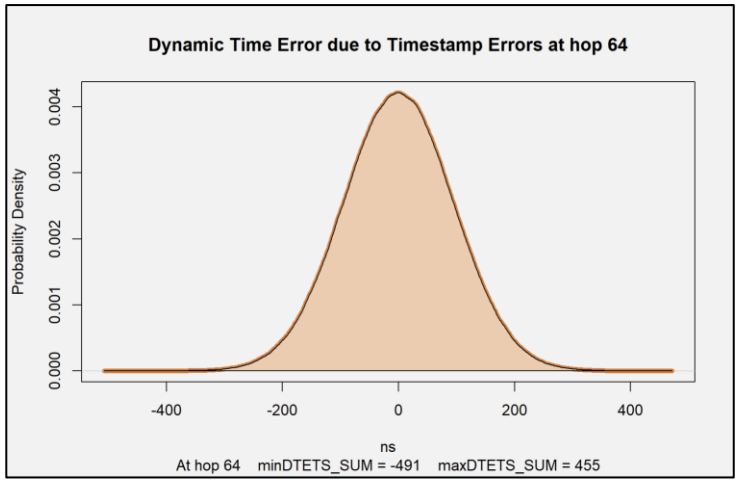
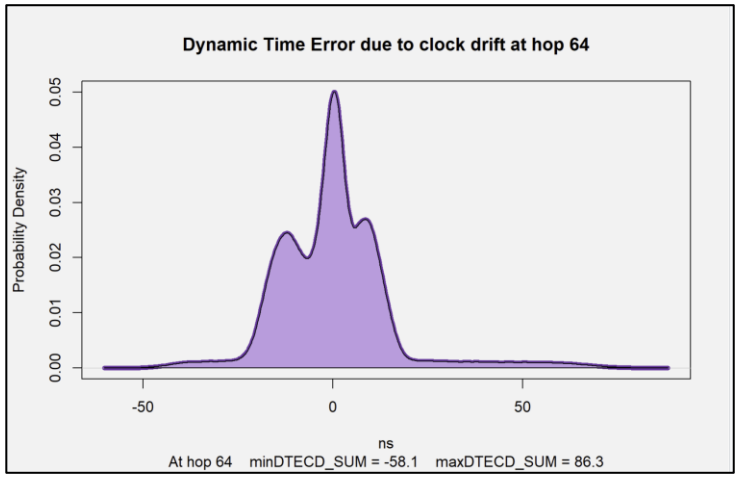
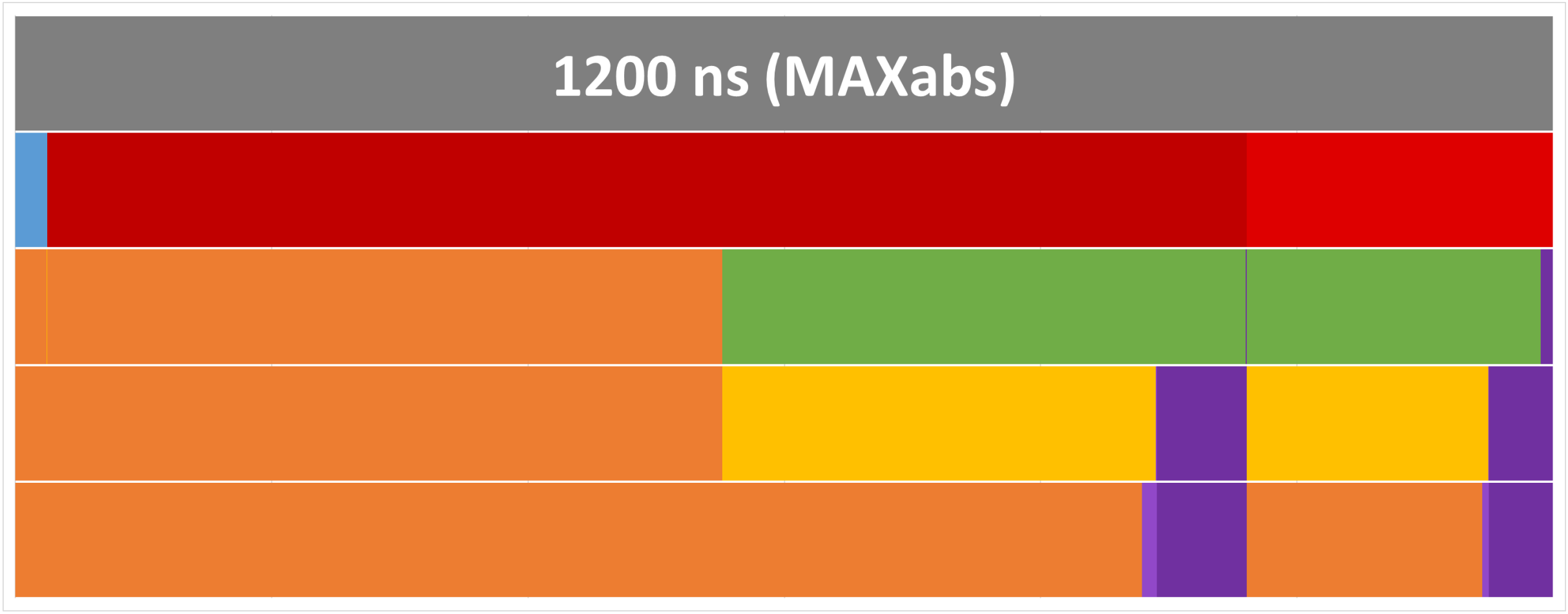


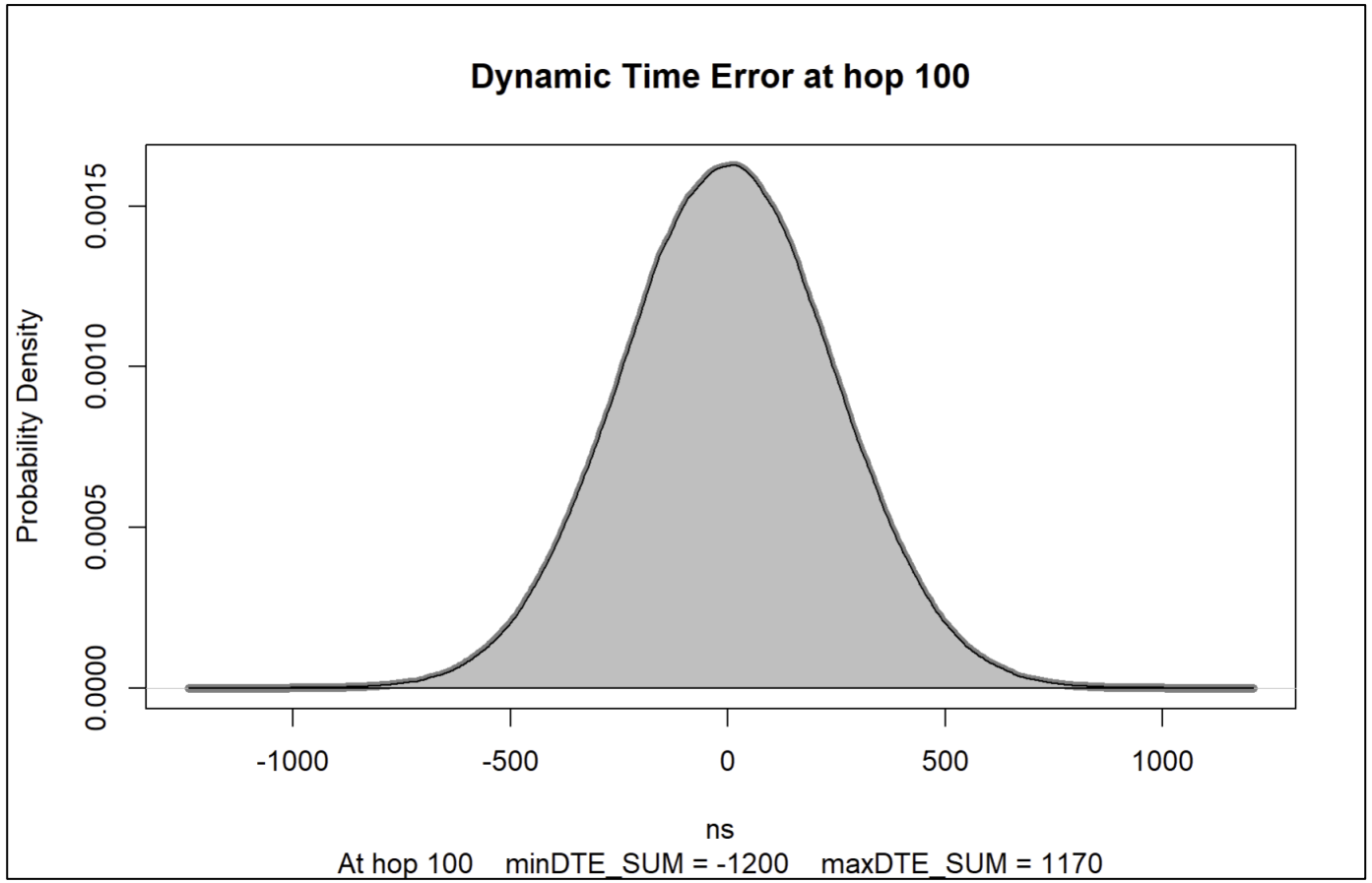


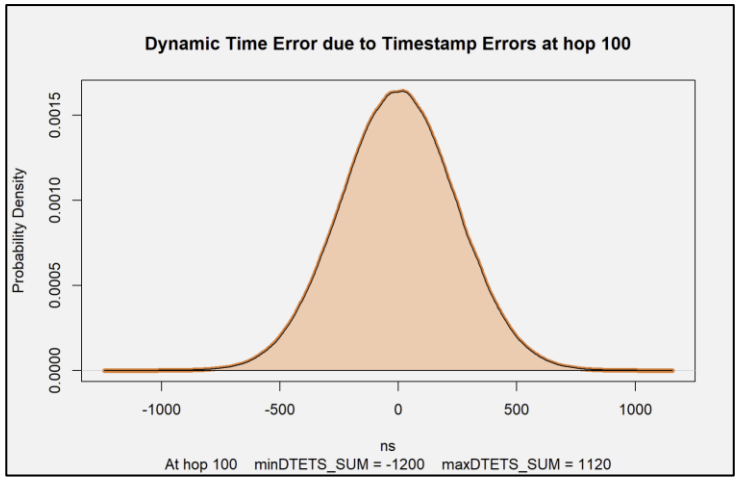


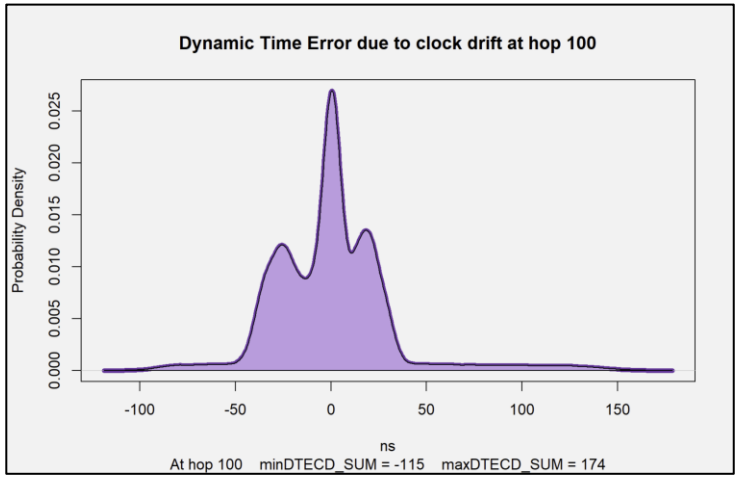
Local Clock 25 MHz – 0-40ns TSGE – 100 hops



Local Clock 50 MHz – 0-40ns TSGE – 100 hops

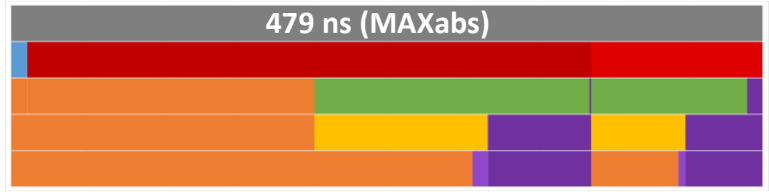






Comparison

125 MHz
0-8 ns TSGE
100 hops



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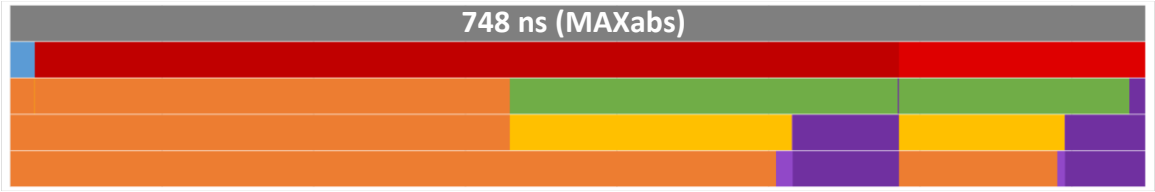
0-20 ns TSGE
100 hops



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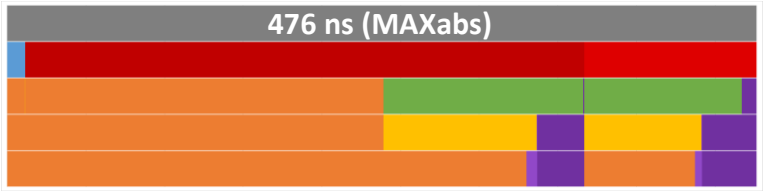
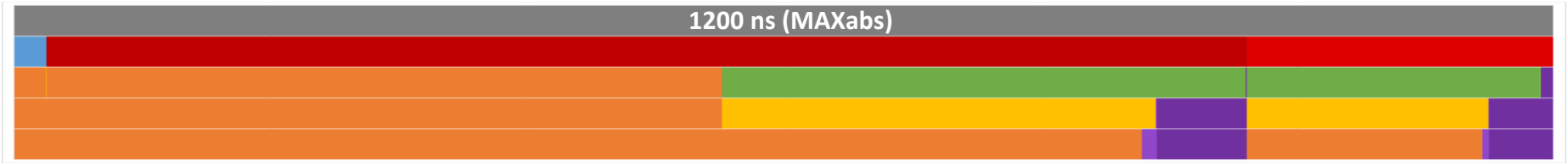
64 hops



25 MHz
0-40 ns TSGE
100 hops



Thank you!