



60802 Dynamic Time Sync Error – Recommended Parameters & Correction Factors

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March IEEE 802 Plenary – 802.1 TSN – IEC/IEEE 60802

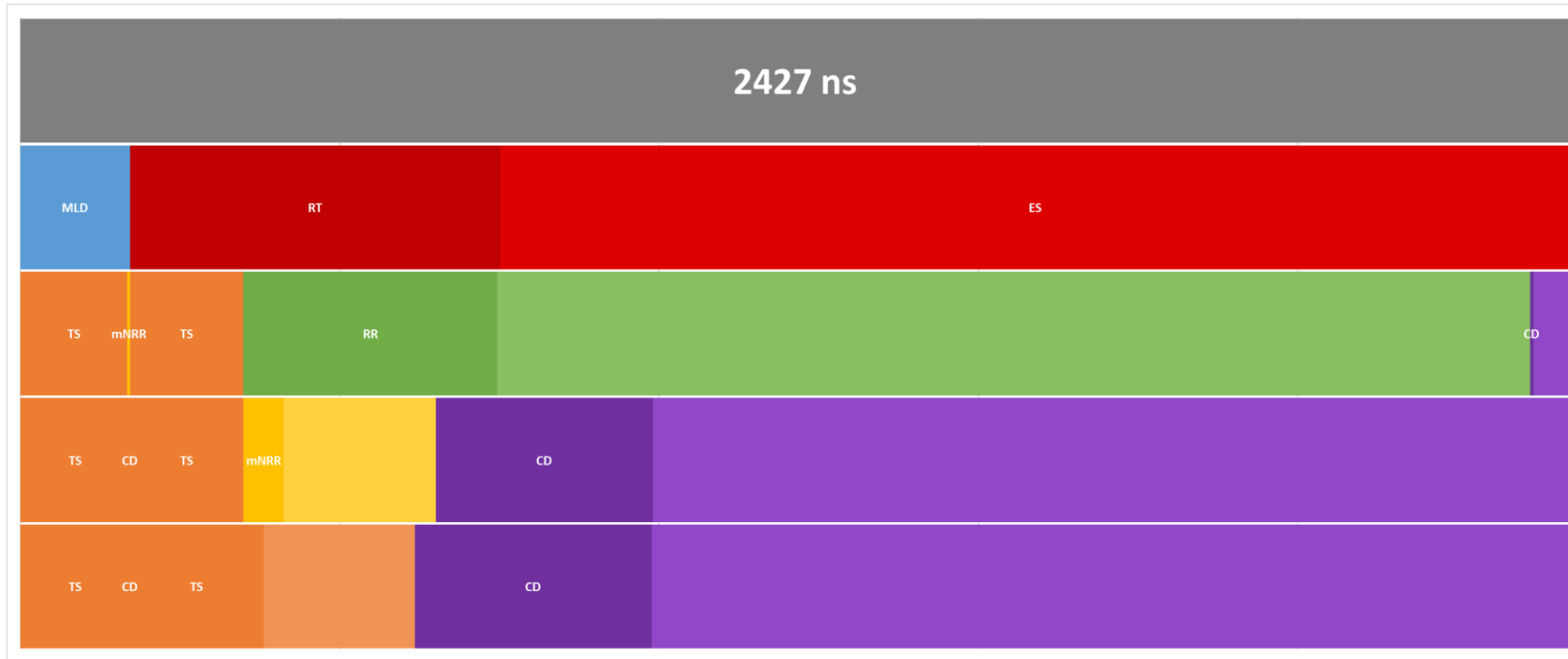
Abstract

- The Monte Carlo Analysis approach to modelling Dynamic Time Error (DTE) across long chains of networked devices was developed to assist the IEC/IEEE 60802 group meet the target of 1us Time Sync Error across 100 hops.
- Previous presentations...
 - [60802-McCall-et-al-Time-Sync-Error-Model-0921-v03.pdf](#)
 - [60802-McCall-Stanton-Time-Sync-Error-Model-and-Analysis-2021-11-v02.pdf](#)
 - [60802-McCall-Stanton-Time-Sync-Error-Model-and-Analysis-0222-v03.pdf](#)
 - [60802-McCall-Stanton-Time-Sync-Error-Model-and-Analysis-0322-v01.pdf](#)
 - [60802-McCall-Time-Sync-Monte-Carlo-Results-for-Time-Series-Comparison-0322-v01.pdf](#)
- In this contribution we:
 - Provide recommended parameters and correction factors to achieve the group's goals along; additional background information; suggested Time Series Simulations to validate the goals; and a suggested approach to normative and informative test for the specification.

Content

- Recommended parameters & correction factors
- Background – why these are the recommended settings
- Time Series Simulations to validate recommendations
- Normative & Informative text for the specification

Error Breakdown Charts - Example



Using MAXabs values for top level and breakdown as several of the distributions are not gaussian so 7σ doesn't work well.

Input Errors		
GM Clock Drift Max	+1.5	ppm/s
GM Clock Drift Min	-1.5	ppm/s
GM Nodes w/ Clock Drift	80%	
Clock Drift Max (non-GM)	+1.5	ppm/s
Clock Drift Min (non-GM)	-1.5	ppm/s
Non-GM Nodes w/ Clock Drift	80%	
Timestamp Granularity TX	4	±ns
Timestamp Granularity RX	4	±ns
Dynamic Time Stamp Error TX	8	±ns
Dynamic Time Stamp Error RX	8	±ns
Input Parameters		
pDelay Interval	31.25	ms
Sync Interval	125	ms
pDelay Turnaround Time	1	ms
residenceTime	1	ms
Input Correction Factors		
Mean Link Delay Averaging	0	%
NRR Drift Rate Correction	0	%
RR Drift Rate Error Correction	0	%
pDelayResponse → Sync	0	%
mNRR Smoothing N	1	
mNRR Smoothing M	1	
Configuration		
Hops	100	
Runs	100,000	

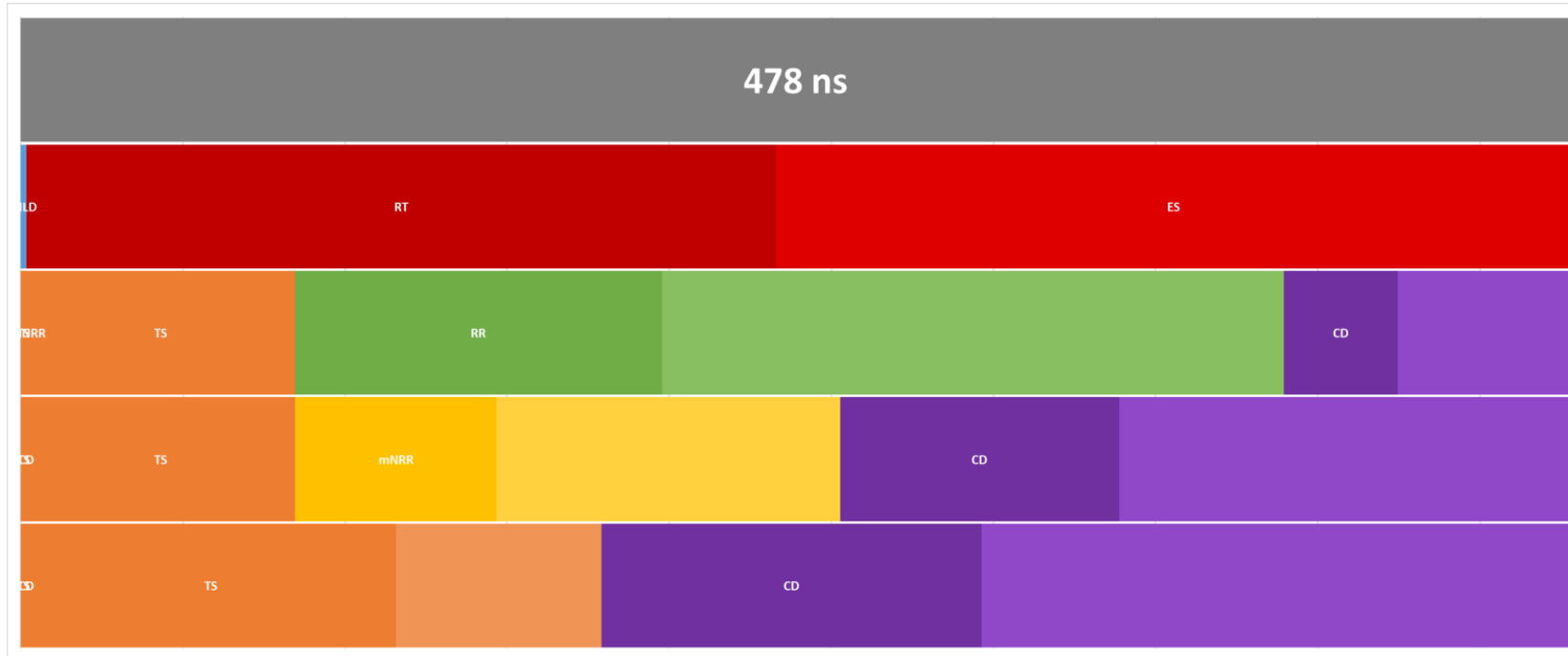
Notes

- Added “Fraction of Nodes with Drift” factor
- In Time Series Simulation temp ramps up...is held stable...ramps down...is held stable.
- % of time stable, i.e. no Clock Drift, is 20%
- This factor matches Monte Carlo more closely to Time Series

Recommended Settings

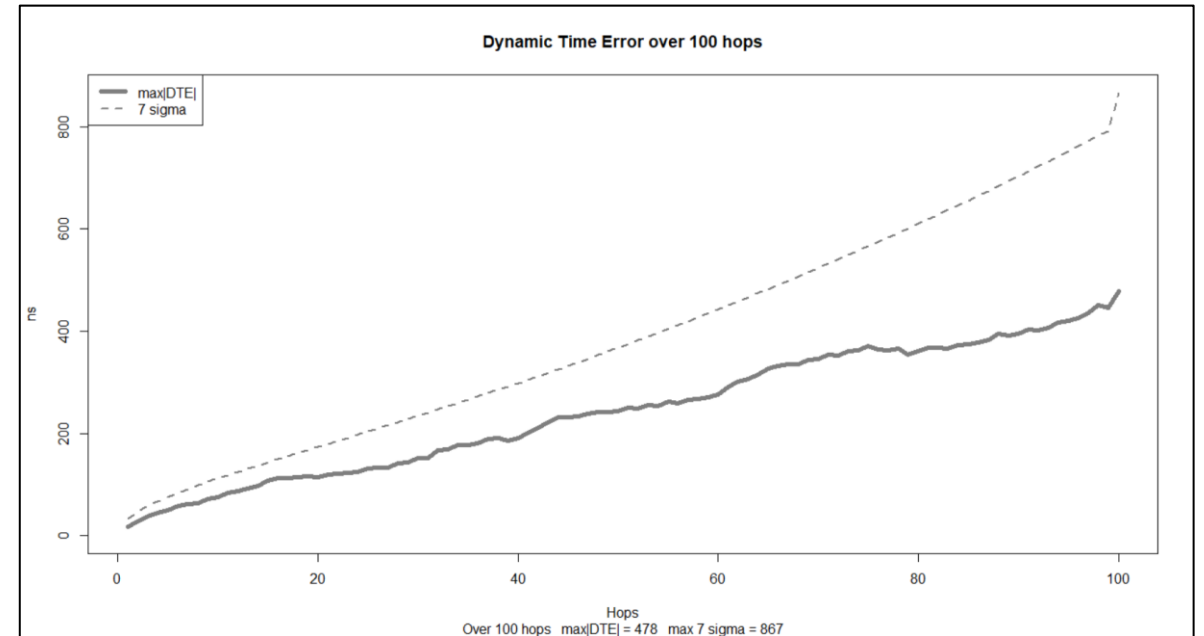
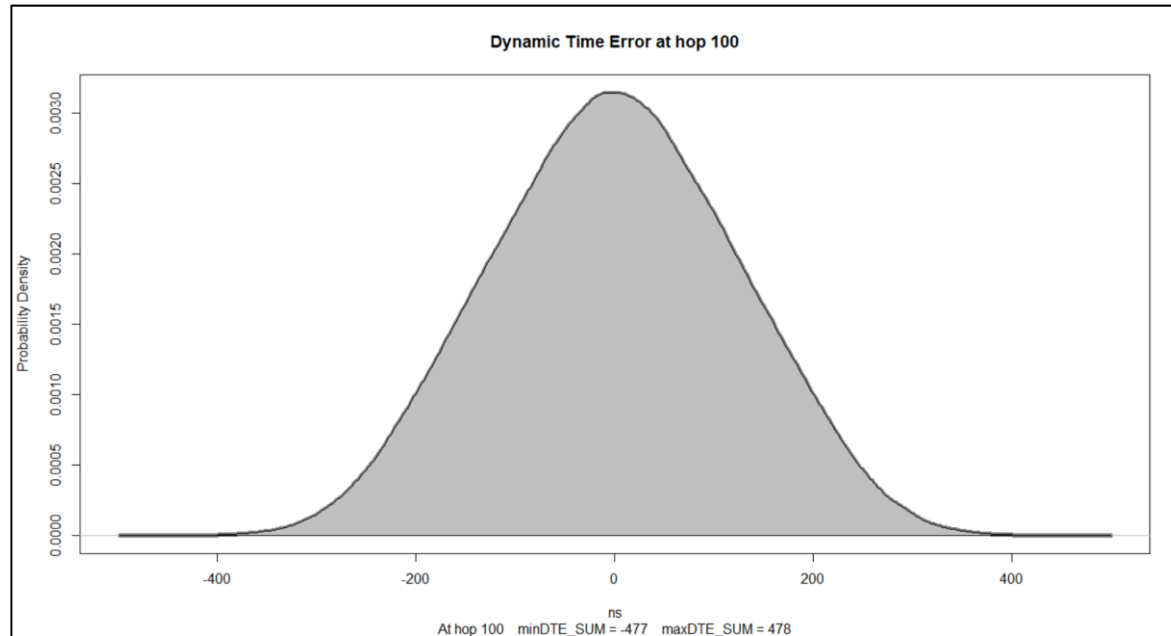
Input parameters & correction factors

Recommended Settings



Input Errors		
GM Clock Drift Max	+1.5	ppm/s
GM Clock Drift Min	-1.5	ppm/s
GM Nodes w/ Clock Drift	80%	
Clock Drift Max (non-GM)	+1.5	ppm/s
Clock Drift Min (non-GM)	-1.5	ppm/s
Non-GM Nodes w/ Clock Drift	80%	
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	98	%
NRR Drift Rate Correction	90	%
RR Drift Rate Error Correction	90	%
pDelayResponse → Sync	0	%
mNRR Smoothing N	3	
mNRR Smoothing M	1	
Configuration		
Hops	100	
Runs	100,000	

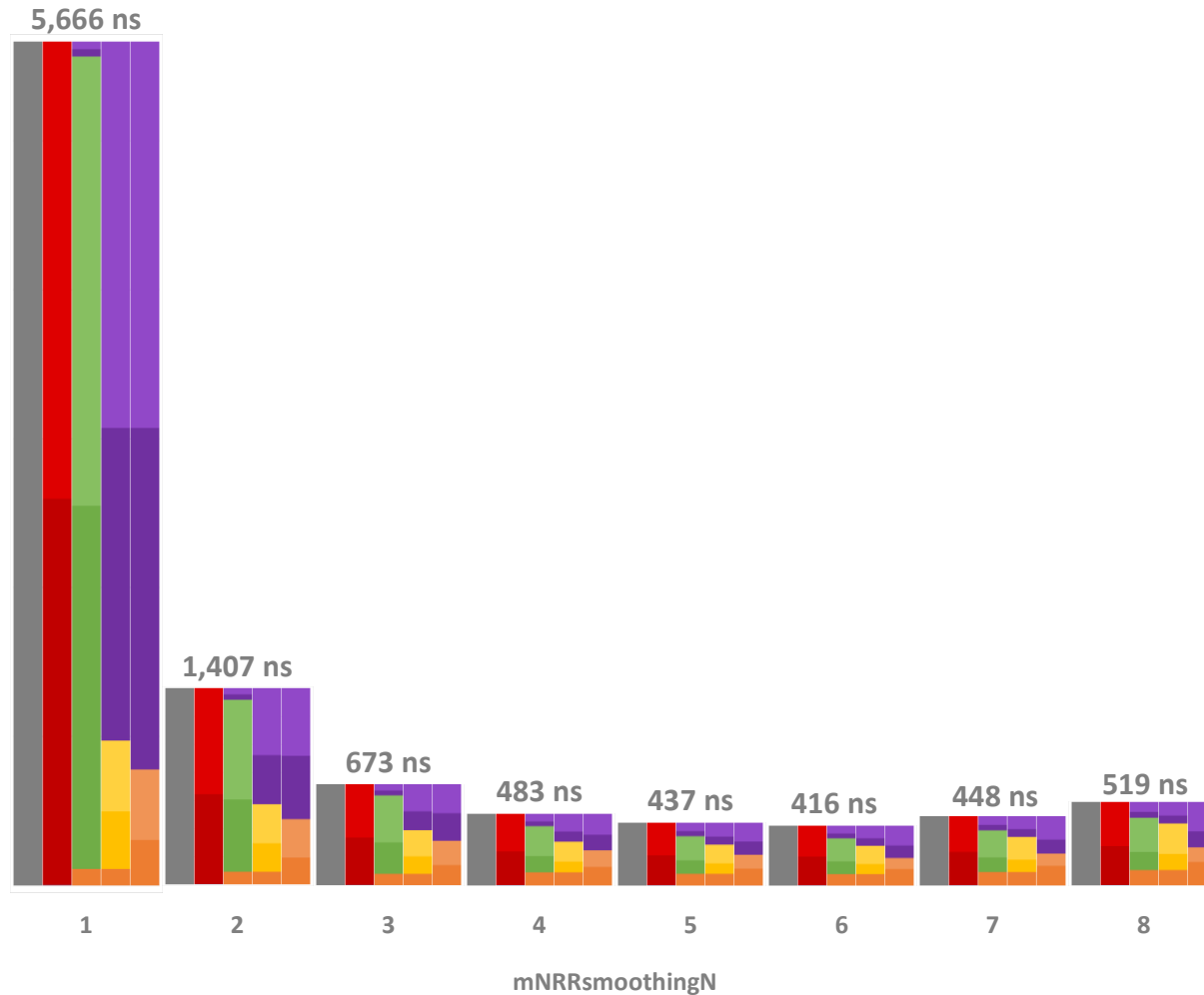
DTE



Background Information

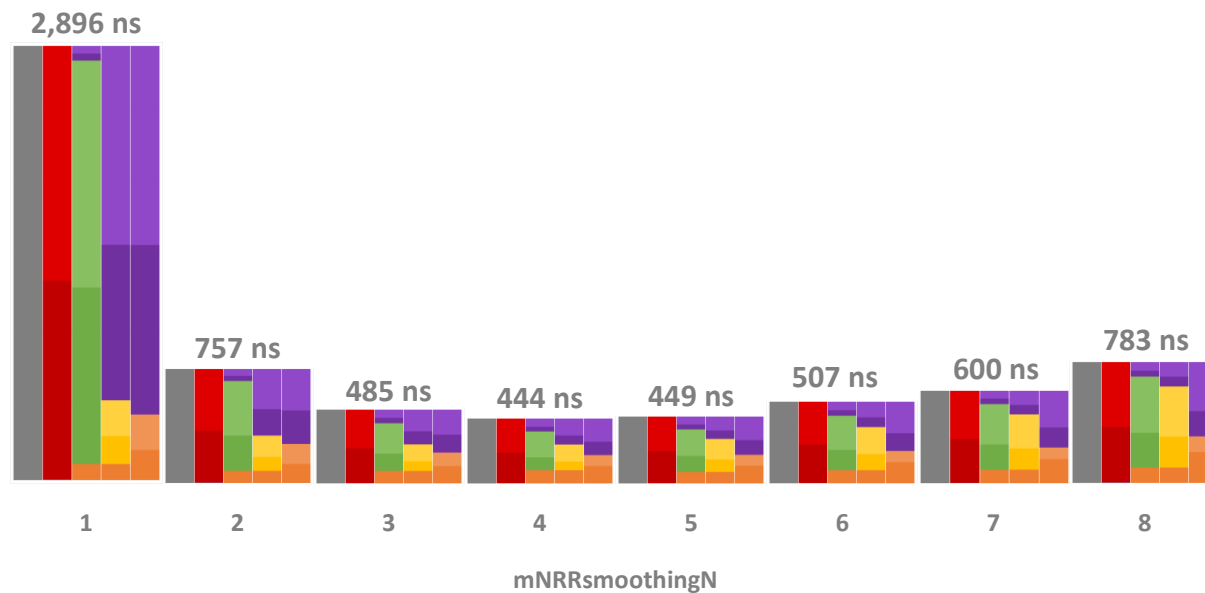
Why these recommended settings?

pDelay Interval 31.25ms



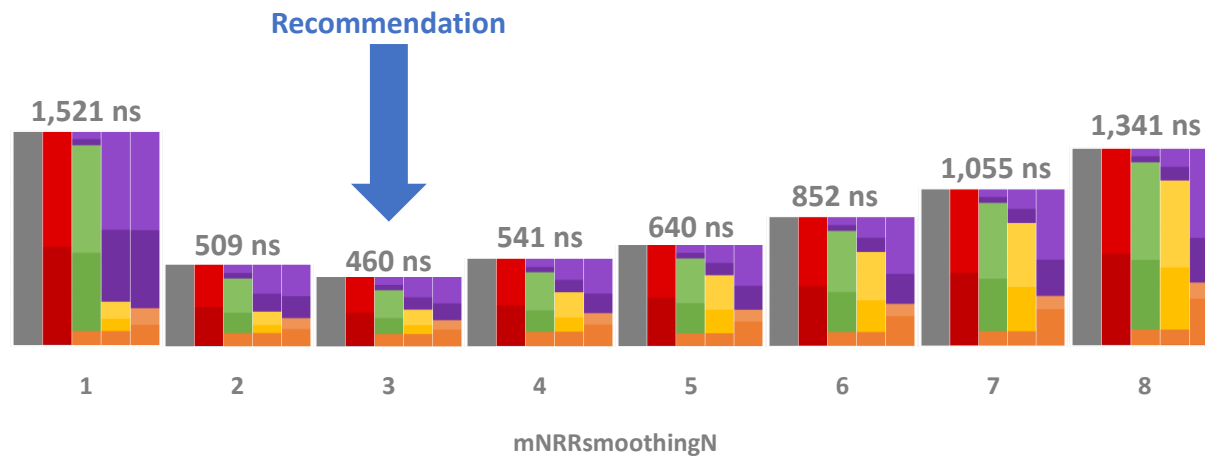
Input Errors		
GM Clock Drift Max	+1.5	ppm/s
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Dynamic Time Stamp Error RX	4	±ns
Input Parameters		
pDelay Interval	31.25	ms
Sync Interval	125	ms
pDelay Turnaround Time	10	ms
residenceTime	10	ms
Input Correction Factors		
Mean Link Delay Averaging	98	%
NRR Drift Rate Correction	90	%
RR Drift Rate Error Correction	90	%
pDelayResponse → Sync	0	%
mNRR Smoothing N	Variable	
mNRR Smoothing M	1	
Configuration		
Hops	100	
Runs	100,000	

pDelay Interval 62.5ms



Input Errors		
GM Clock Drift Max	+1.5	ppm/s
GM Clock Drift Min	-1.5	ppm/s
GM Nodes w/ Clock Drift	80%	
Clock Drift Max (non-GM)	+1.5	ppm/s
Clock Drift Min (non-GM)	-1.5	ppm/s
Non-GM Nodes w/ Clock Drift	80%	
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	62.5	ms
Sync Interval	125	ms
pDelay Turnaround Time	10	ms
residenceTime	10	ms
Input Correction Factors		
Mean Link Delay Averaging	98	%
NRR Drift Rate Correction	90	%
RR Drift Rate Error Correction	90	%
pDelayResponse → Sync	0	%
mNRR Smoothing N	Variable	
mNRR Smoothing M	1	
Configuration		
Hops	100	
Runs	100,000	

pDelay Interval 125ms



Input Errors		
GM Clock Drift Max	+1.5	ppm/s
GM Clock Drift Min	-1.5	ppm/s
GM Nodes w/ Clock Drift	80%	
Clock Drift Max (non-GM)	+1.5	ppm/s
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mNRR Smoothing N	Variable	
mNRR Smoothing M	1	
Configuration		
Hops	100	
Runs	100,000	

Other pDelay Intervals

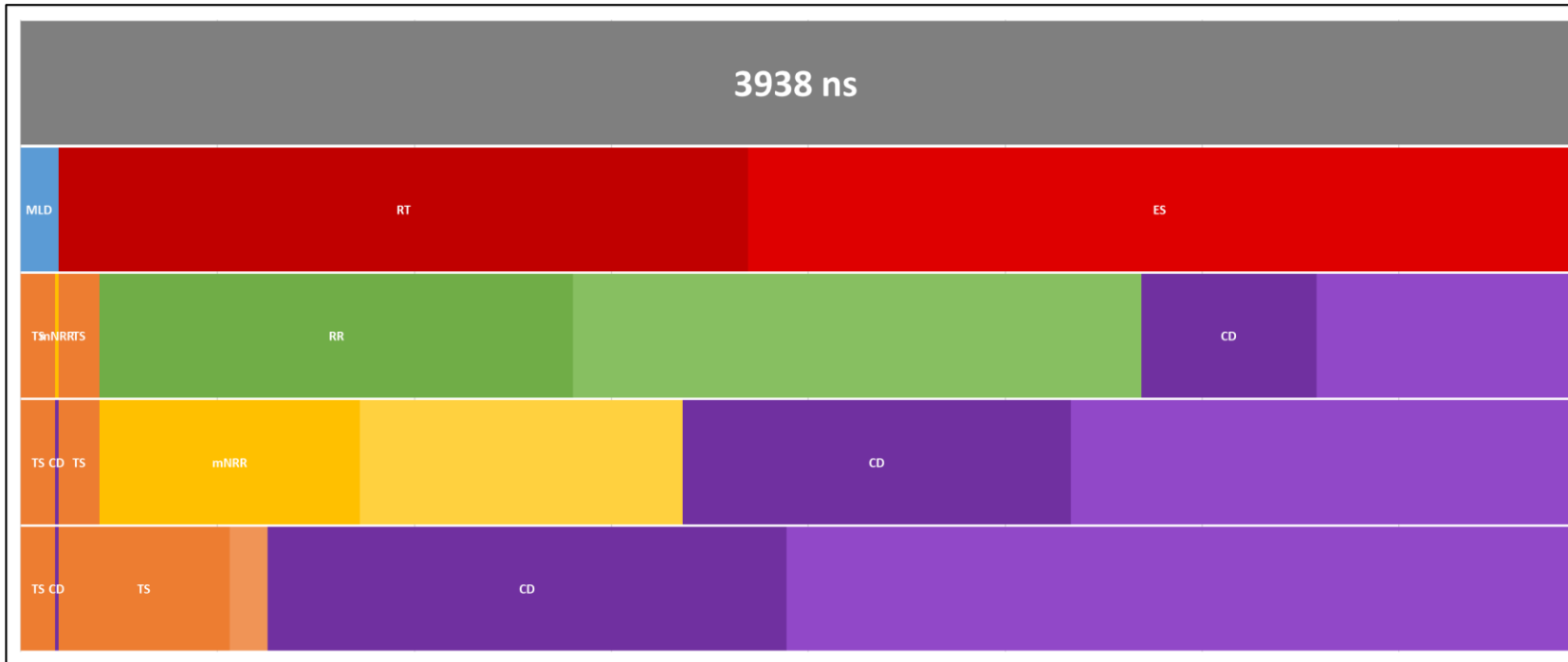
- Best maxABS DTE with 250ms pDelayInterval: 533ns (N = 2)
- Best maxABS DTE with 500ms pDelayInterval: 852ns (N = 1)

Time Series Simulations To Validate Recommendation

Time Series Simulations to Validate Recommendation

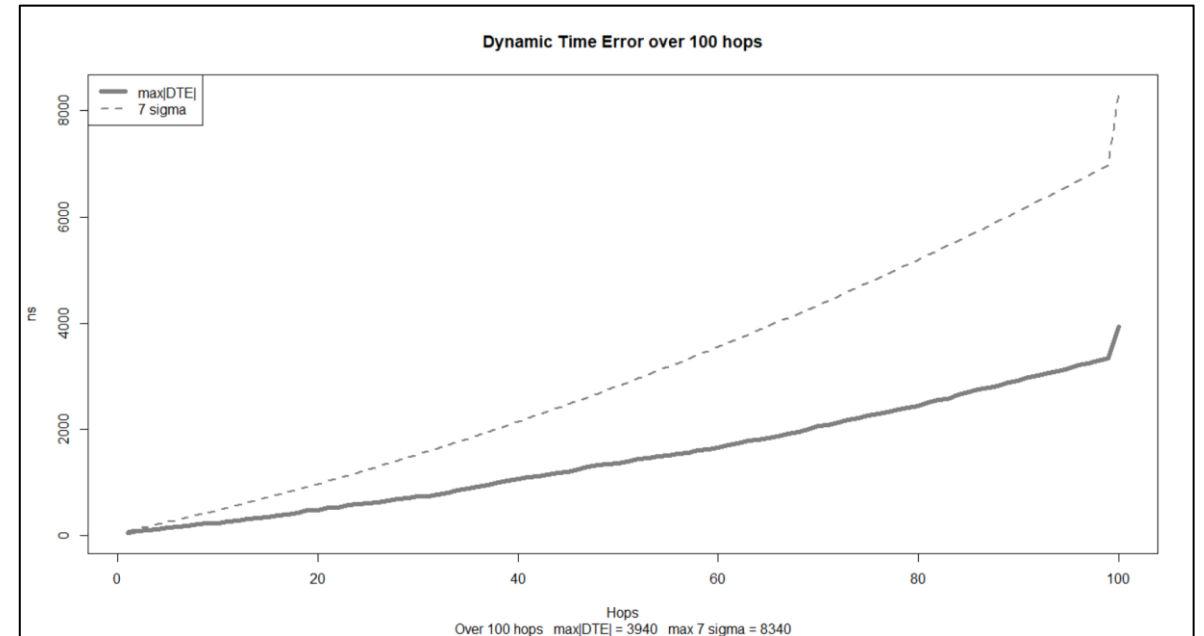
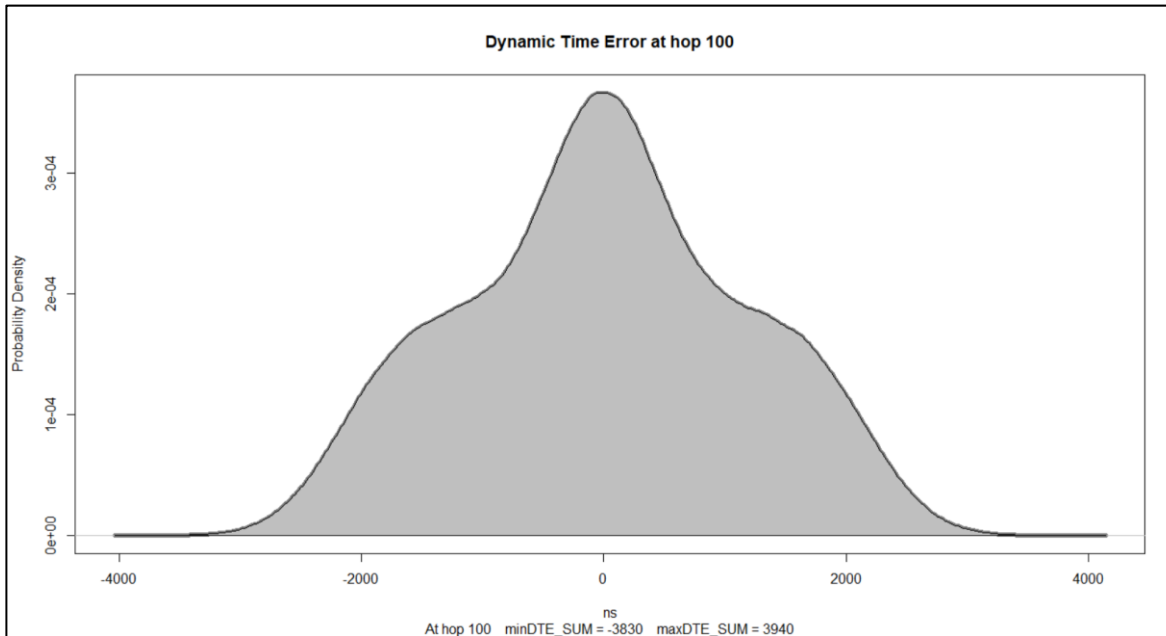
- Start with same settings, but no algorithmic compensation
- Add algorithmic compensation
 - mNRRsmoothing
 - mRRsmoothing
 - Mean Link Delay Averaging...in that order.
- Detail on next slides

No Algorithms

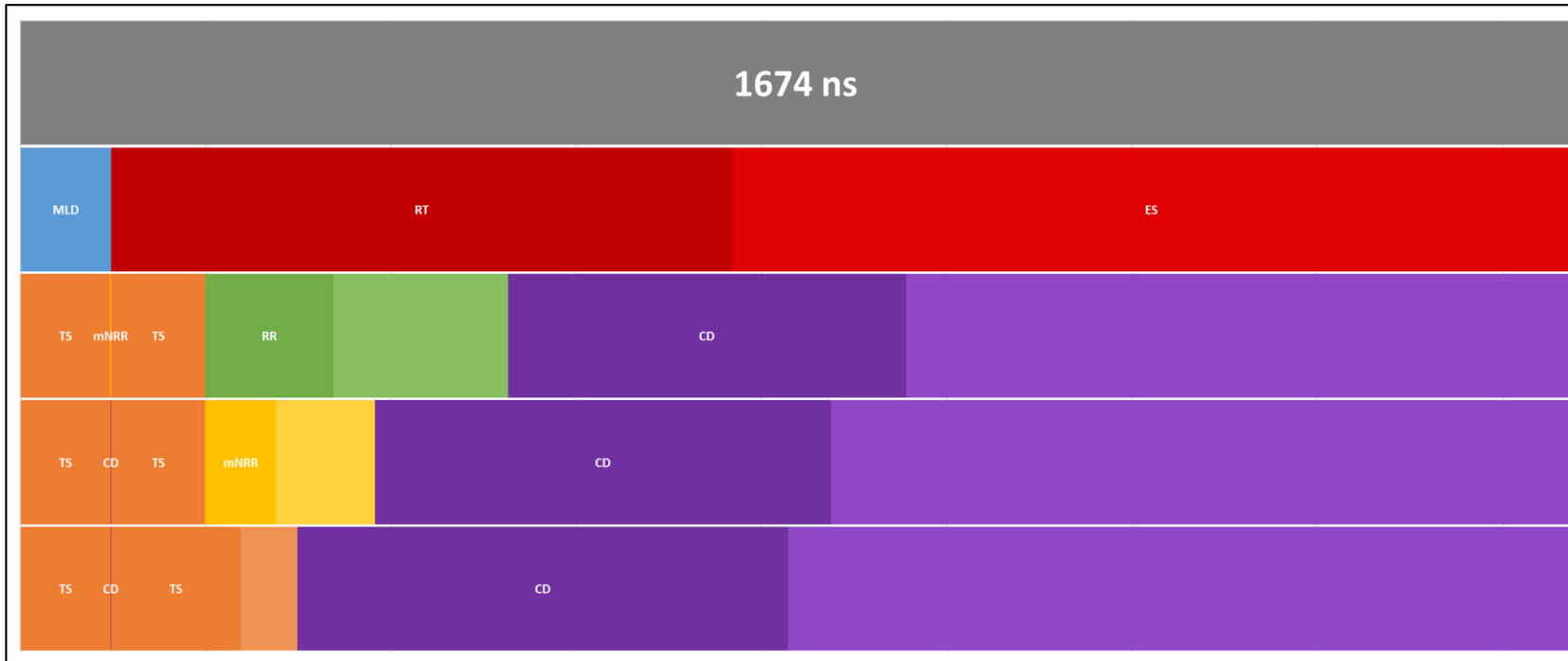


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mNRR Smoothing N	3	
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No Algorithms

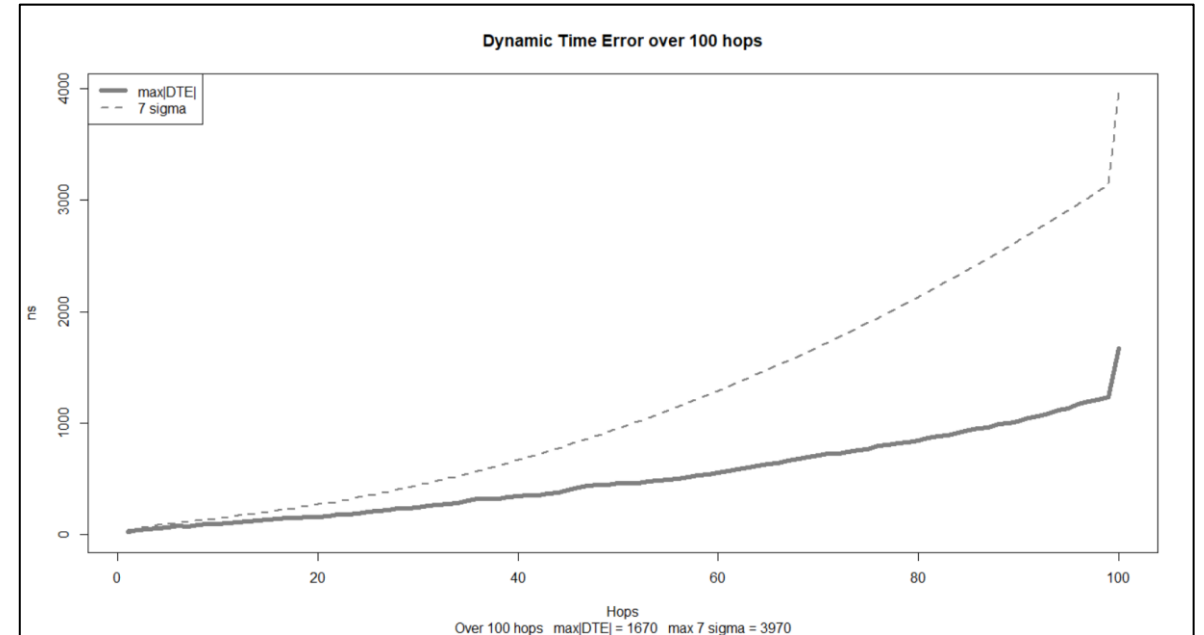
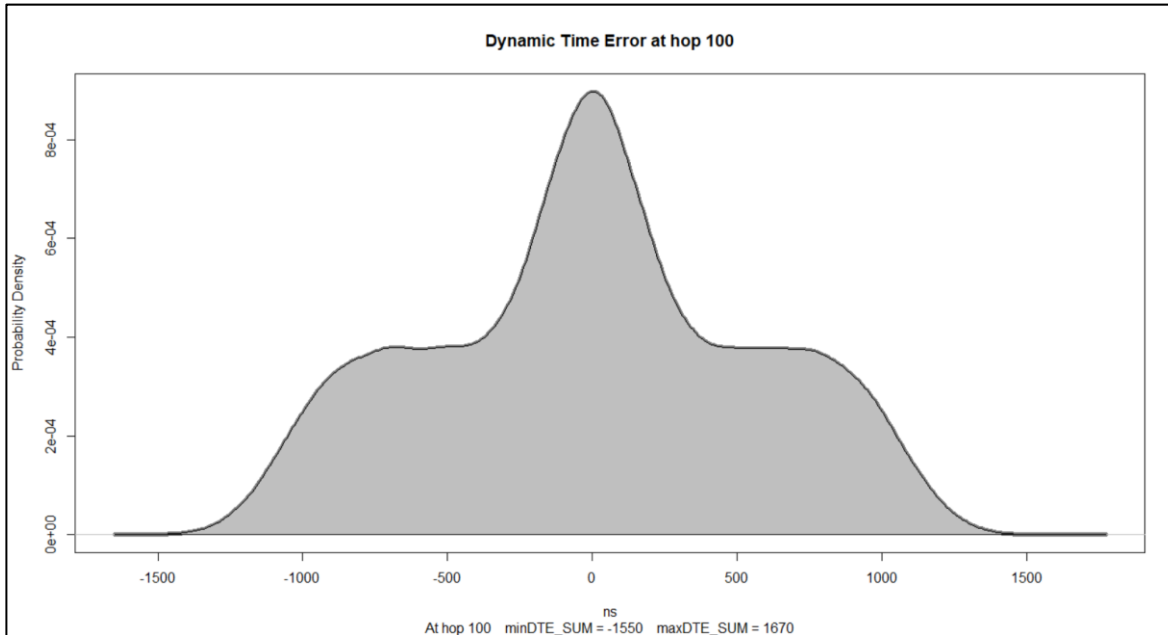


Add NRR Drift Compensation

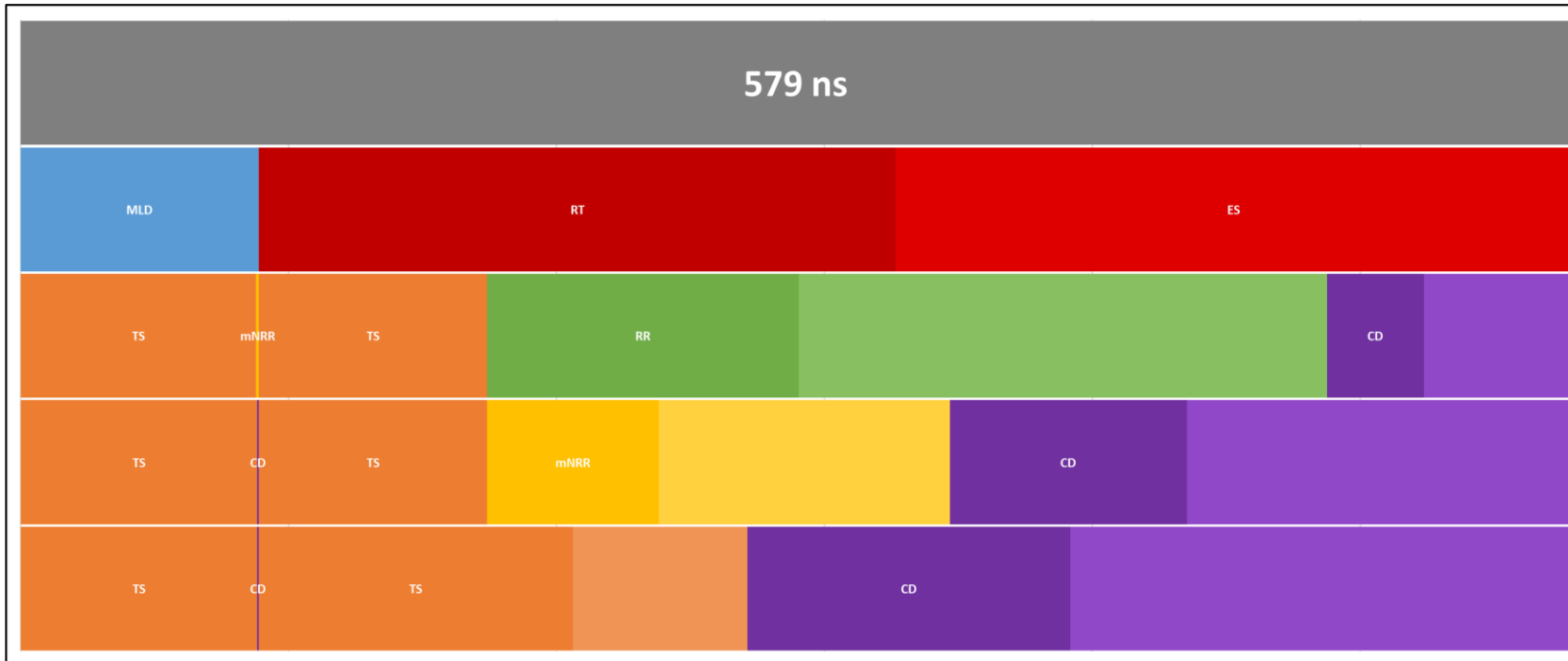


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mNRR Smoothing M	1	
Configuration		
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Add NNR Drift Compensation

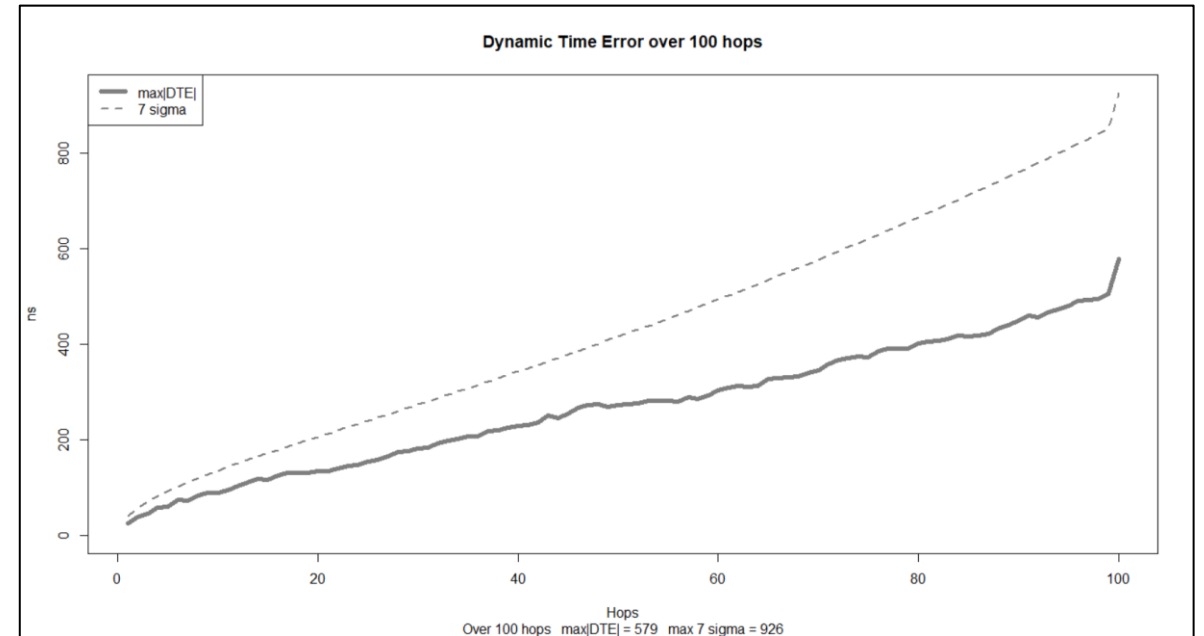
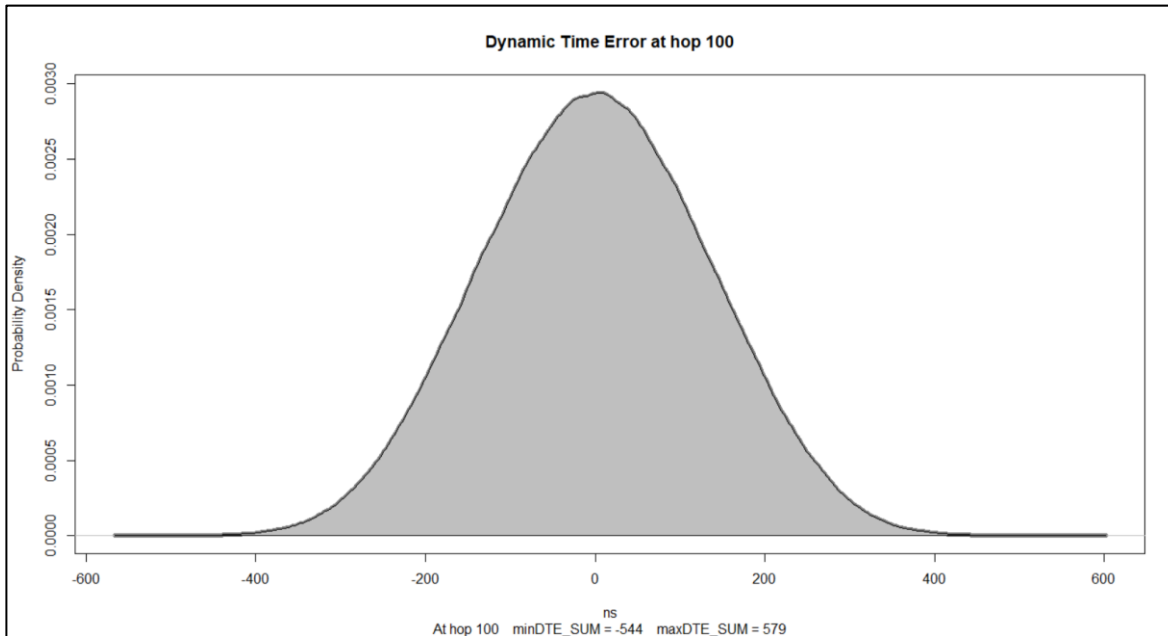


Add RR Drift Compensation

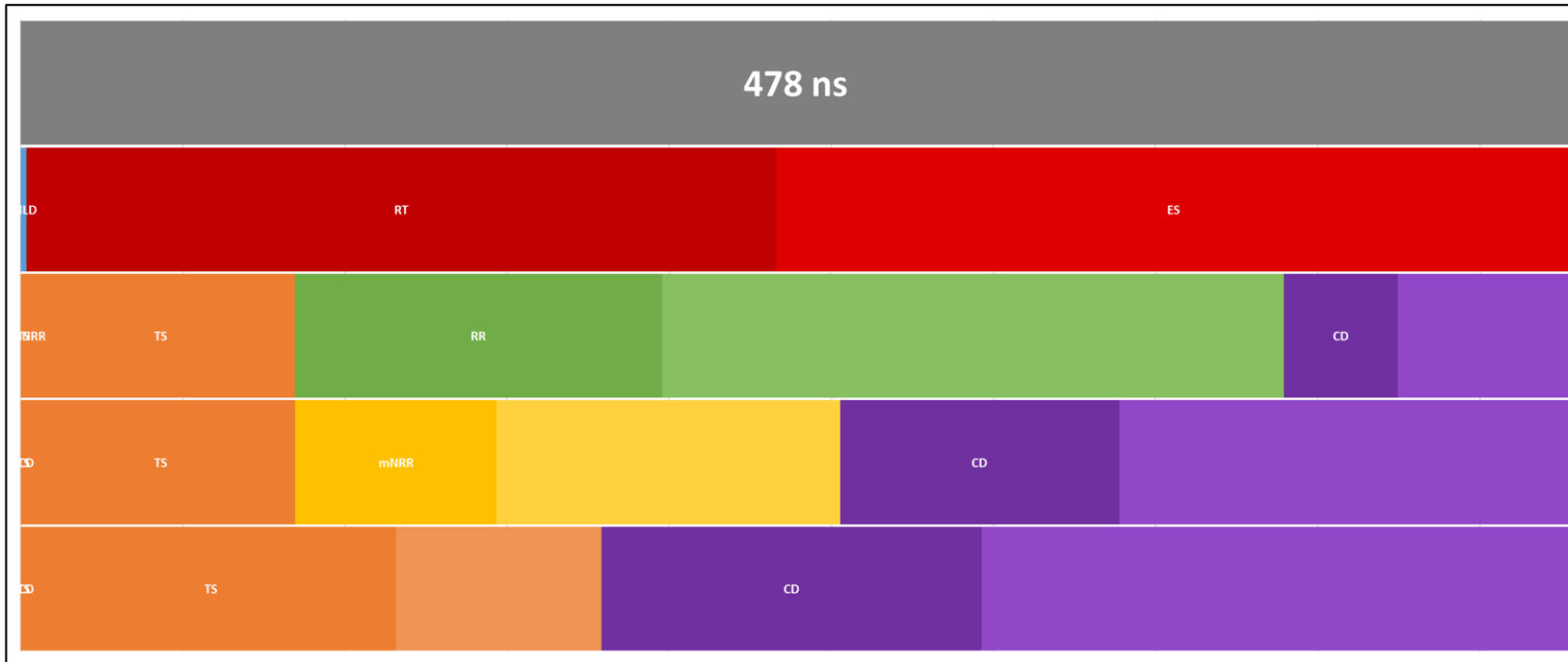


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mNRR Smoothing M	1	
Configuration		
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Runs	100,000	

Add RR Drift Compensation

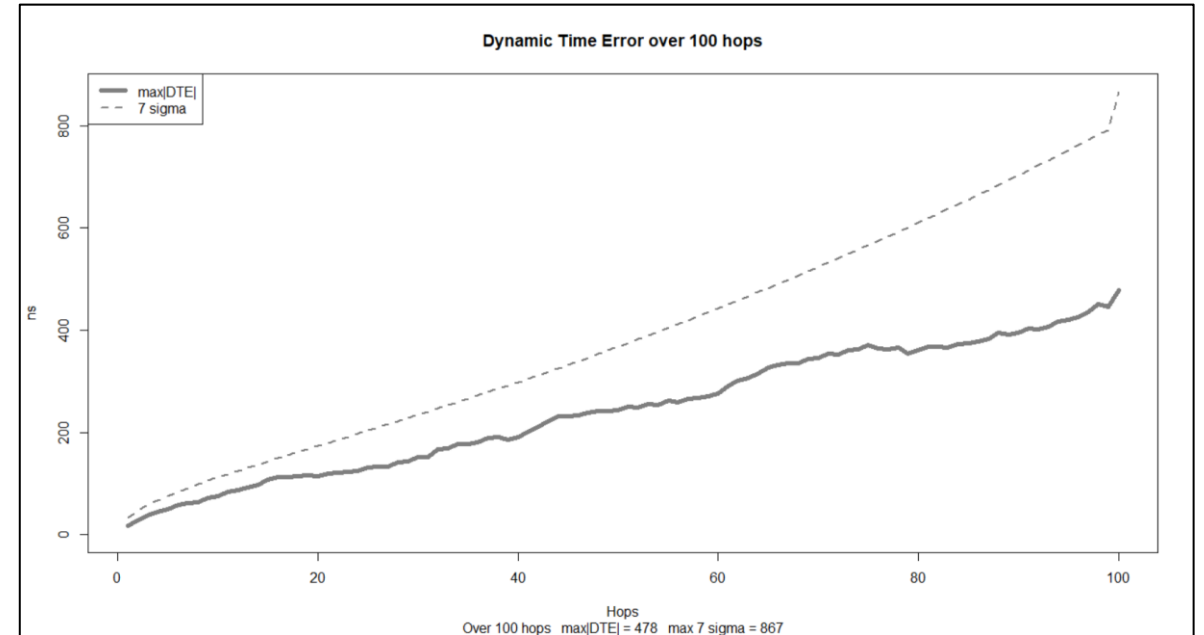
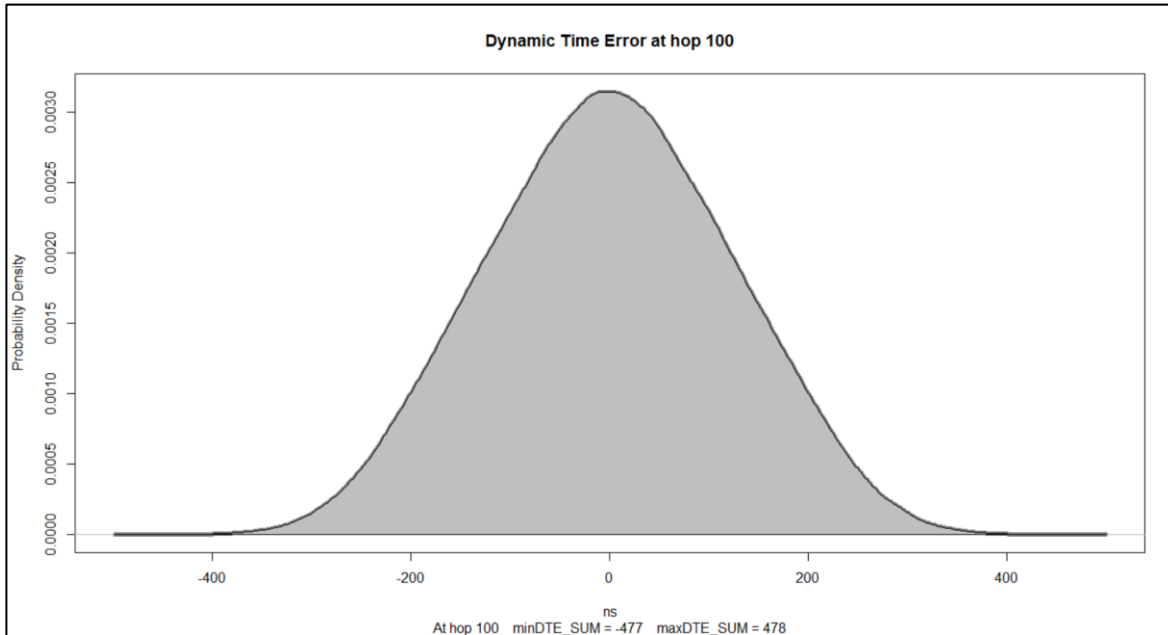


Add MLD Averaging – Recommended Settings



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mNRR Smoothing M	1	
Configuration		
Hops	100	
Runs	100,000	

Add MLD Averaging – Recommended Settings



Normative & Informative Text

Normative Text

- Normative requirement on Local Clock drift relative to TAI: 1.5 ppm/s
 - Already in Günter's planned submission
- Normative requirement on “tolerance” of upstream drift of...
 - Local Clock of upstream node (NRRsmoothing)
 - GM (RRsmoothing)
- For tolerance...
 - Vary upstream Local Clock or GM with sinusoidal variation
 - ± 20 ppm with maximum slope of ± 1.5 ppm/s
 - No more than 10% of DTE error at individual node vs amount of error without algorithmic correction

Informative Text

- Description of algorithms that allow the requirements to be met.
- Based on prior contribution.
- Is this needed for draft 1.4?

Thank You