Packet Clock Output Stability Specification vs. PDV Tolerance Specification

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Output limits, candidate packet metrics, and test cases

Output limits	**Metric**
• G.823 2.048 Mbit/s traffic interface	MTIE
• 16 ppb	FFO
• G.824 1.544 Mbit/s network interface	MTIE
• G.8261 EEC/G.823 SEC limits	MTIE

Input metric candidates in draft revision G.8260

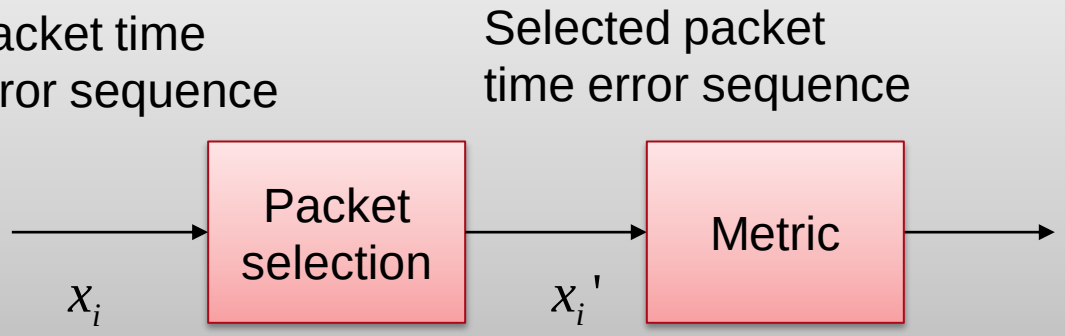
- 1) MAFE/MATIE
- 2) pktfilteredMTIE
- 3) Minimum floor delay packet population

Test cases

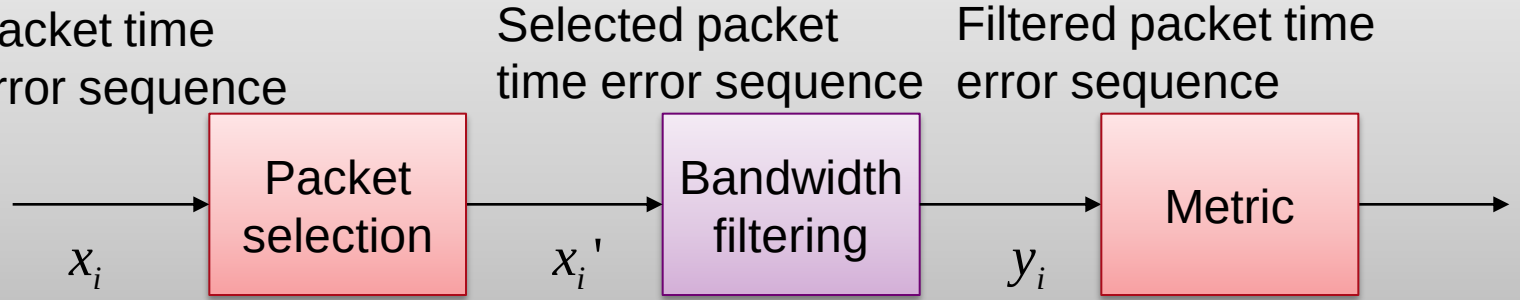
- ITU test case 13
- Core network + ADSL

Metric classification

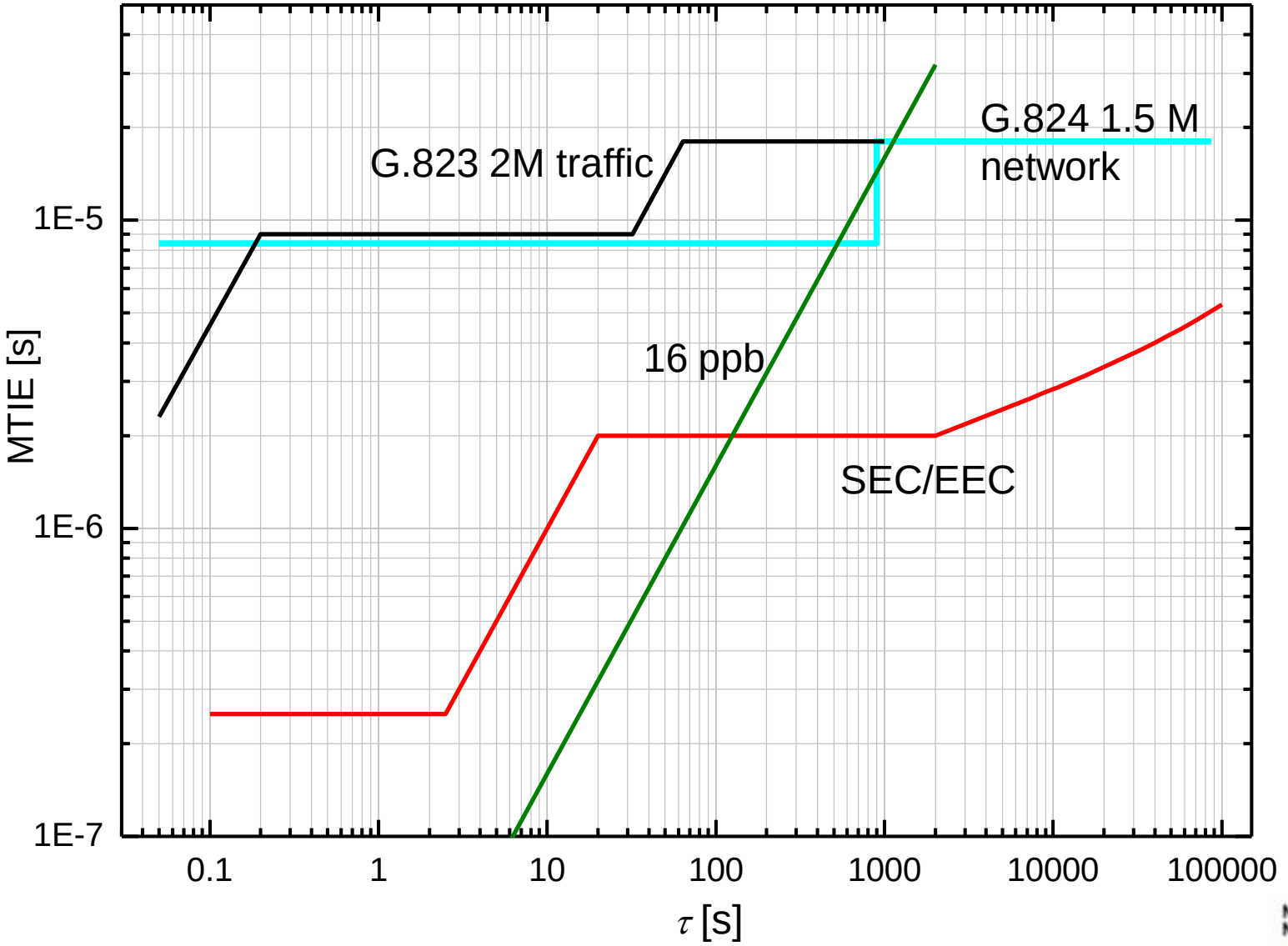
- MAFE
- Minimum floor delay packet population



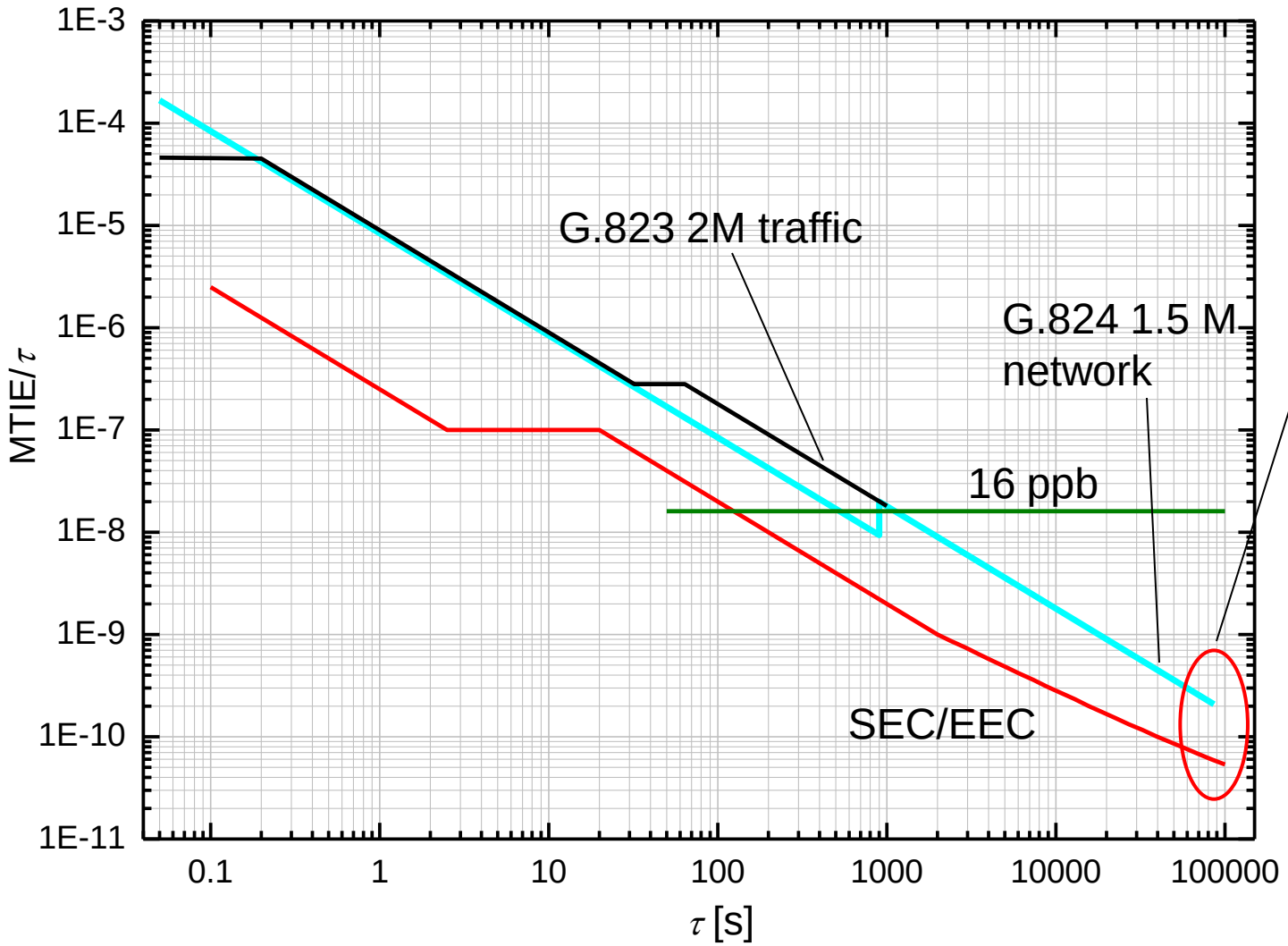
- pktfilteredMTIE



MTIE (maximum time interval error) limits of clock output

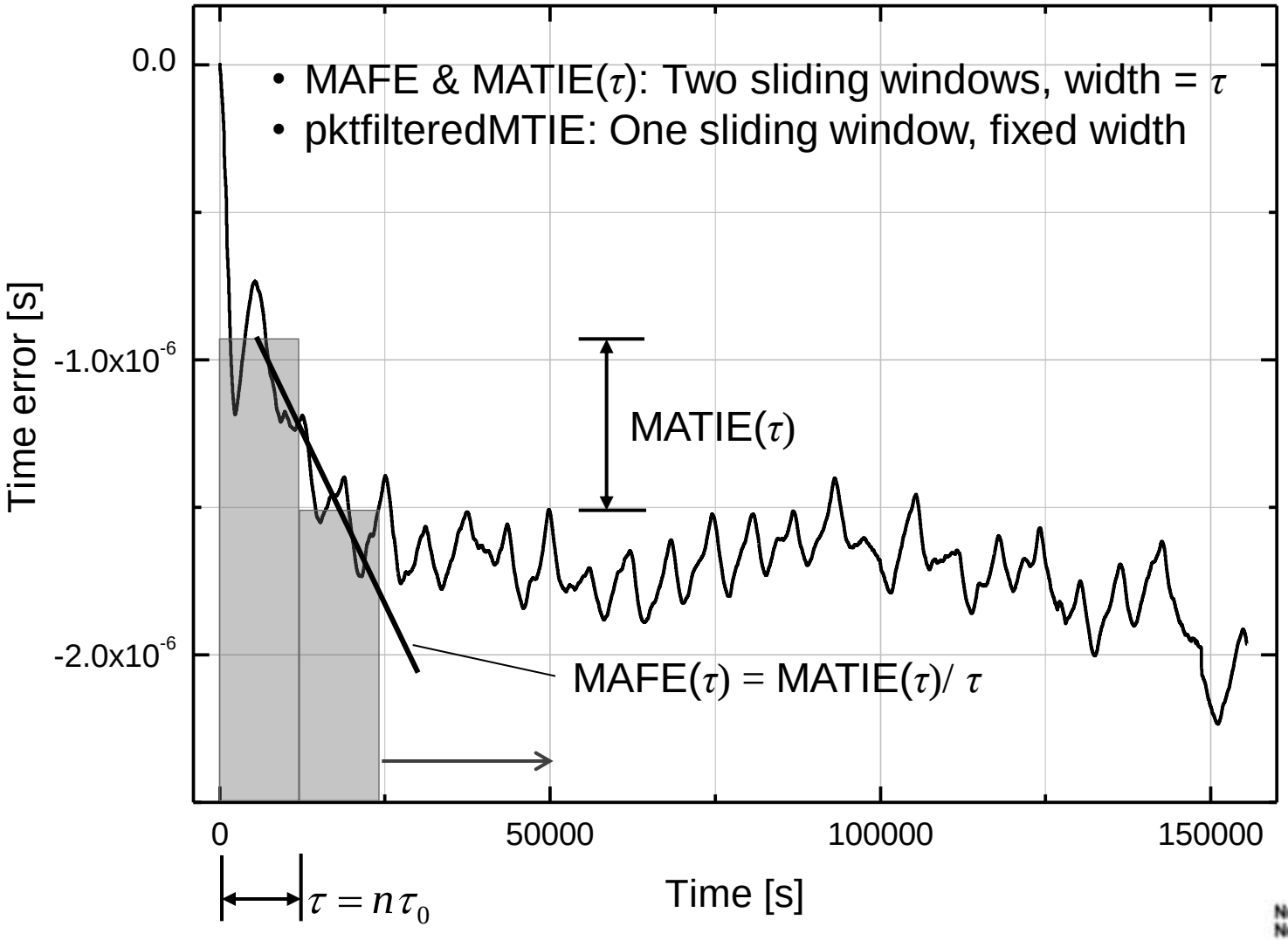


G.824 1.5 M & SEC/EEC masks require 2…2.5 orders of magnitude better long-term accuracy than G.823 2 M mask or 16 ppb frequency error

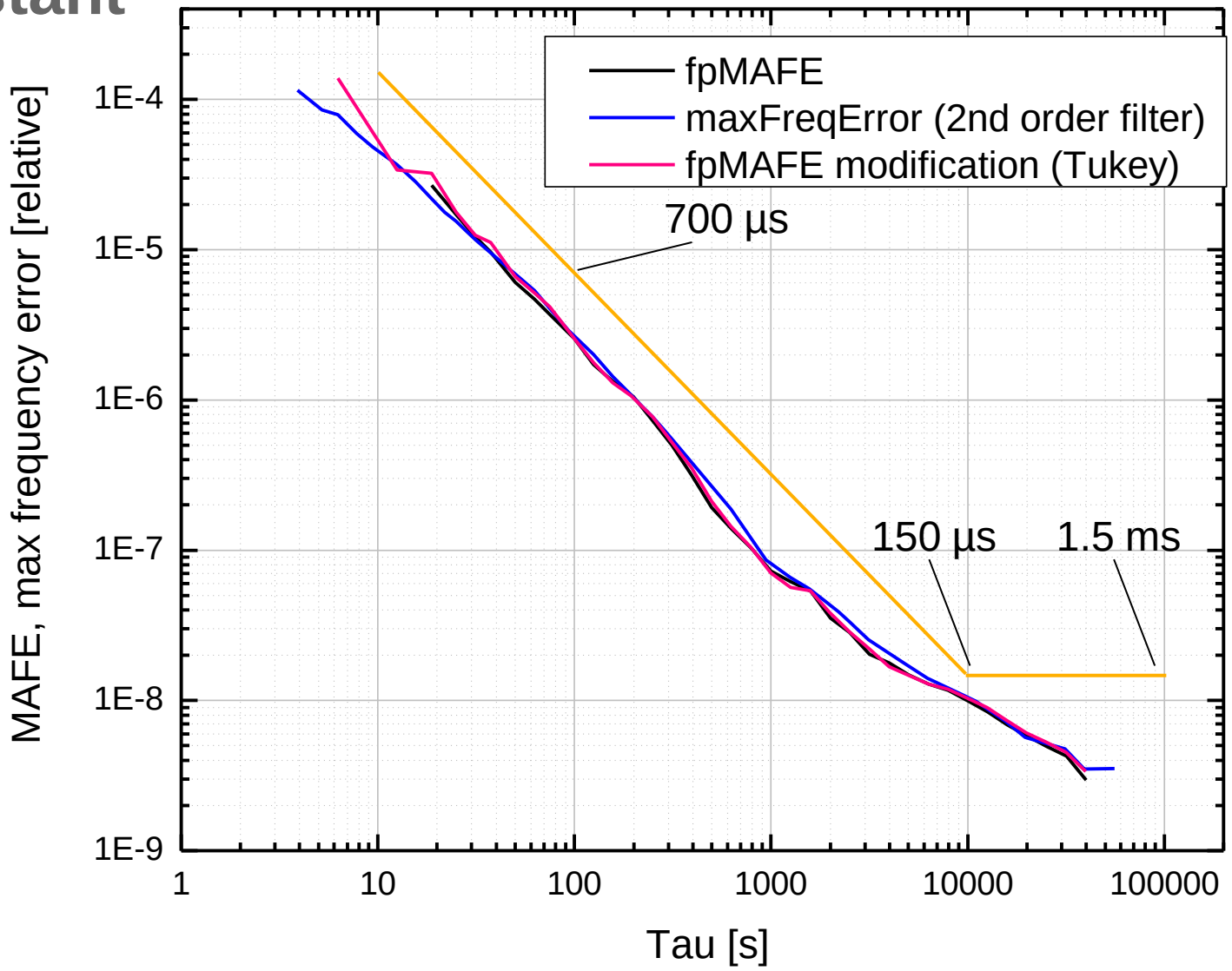


Introduction to
- MAFE (Maximum average frequency error),
- MATIE (Maximum average time interval error),
- pktfilteredMTIE, and
- Minimum floor delay packet population

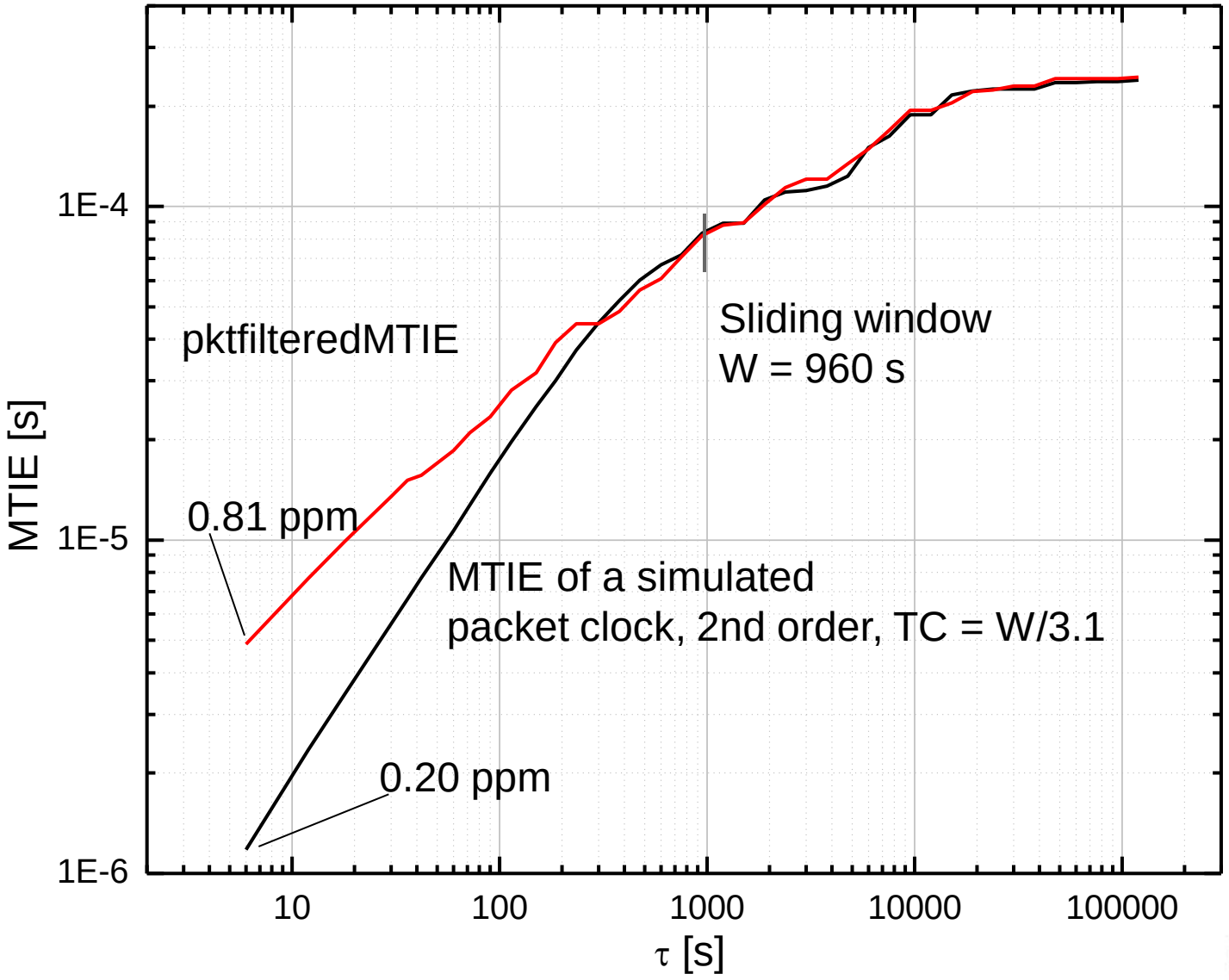
MAFE, MATIE, and pktfilteredMTIE



MAFE estimates maximum frequency error as a function of time constant when τ = 2.0 x filter time constant

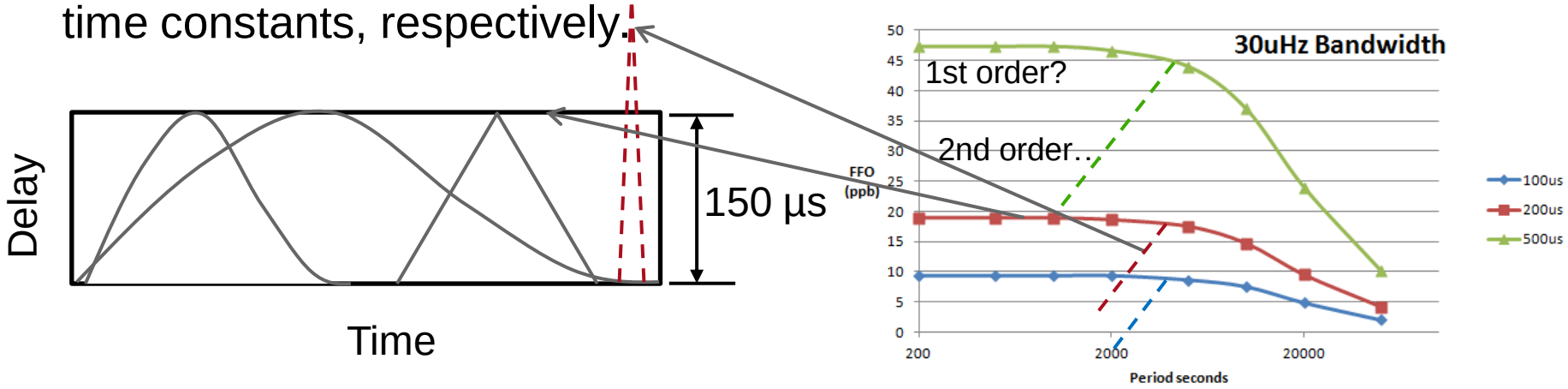


pktFiltered MTIE estimates MTIE very well except at τ << W.



Minimum floor delay packet population as designed for 16-ppb clock output limit

- Frequency error for any waveform below 150-µs amplitude must remain below 16 ppb.
- Bandwidth of clock filter must be maximally ~33 µHz for triangular and ~16 µHz for sinusoidal patterns, corresponding to 5000-s and 10000-s time constants, respectively.

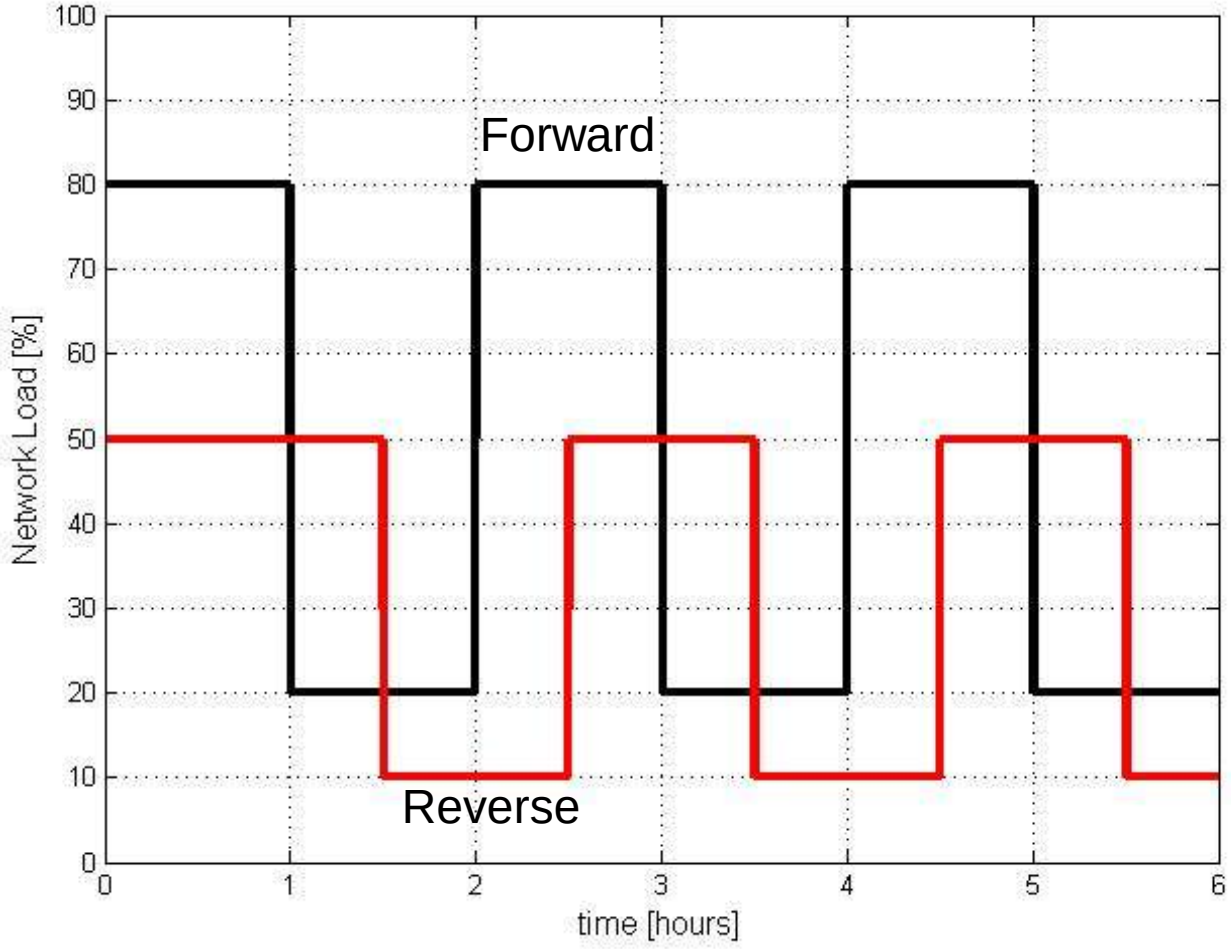


- Pass criterion proposed in ITU Q13 for Hypothetical reference model 1: 1 % of packets in 200-s selection windows must remain within 150-µs delay of the fastest observed packet in the measurement.

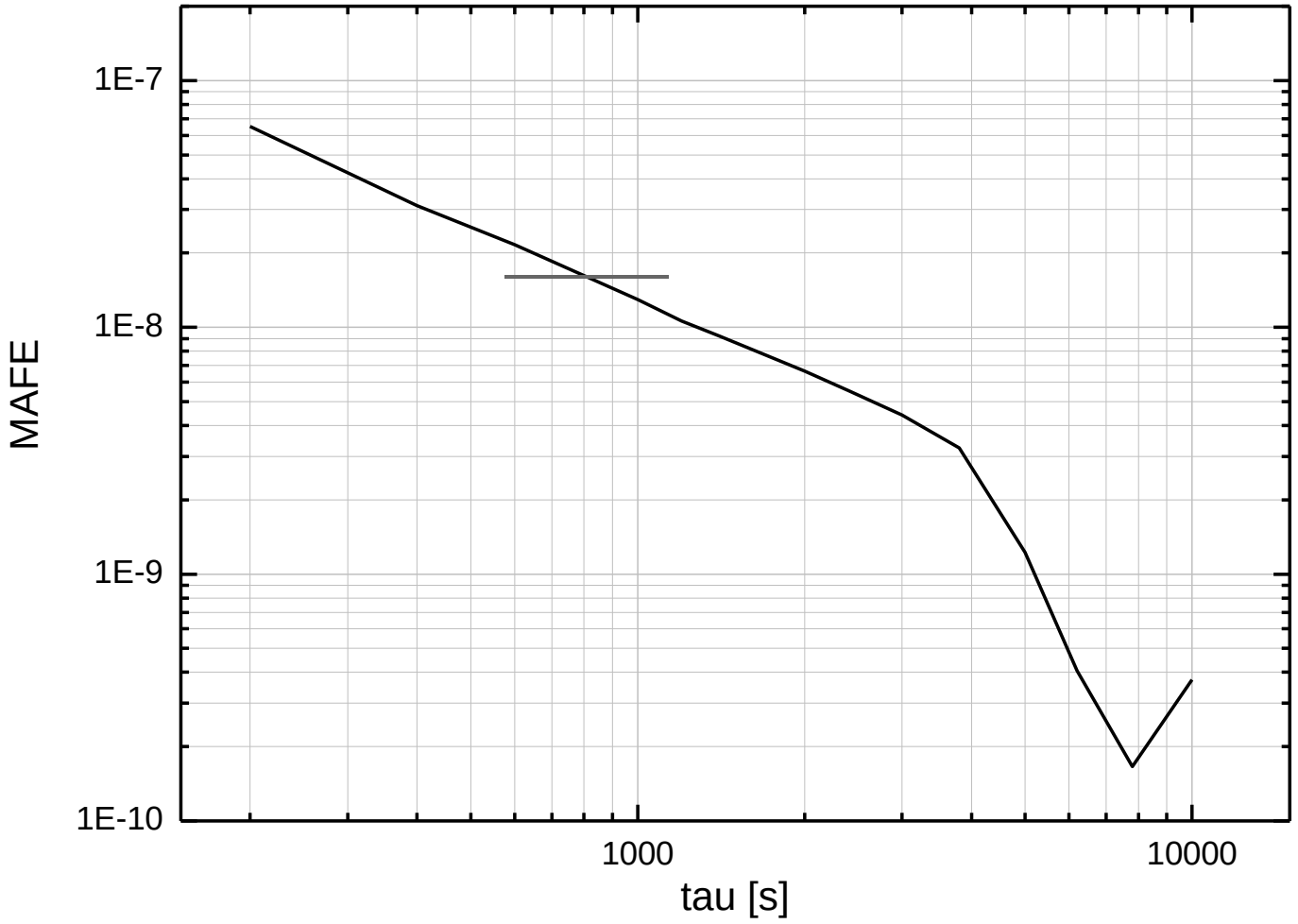
Minimum floor delay population window method based on 1st order filter simulation?

Case analysis
- ITU-T G.8261 Test case 13
- Core network and ADSL

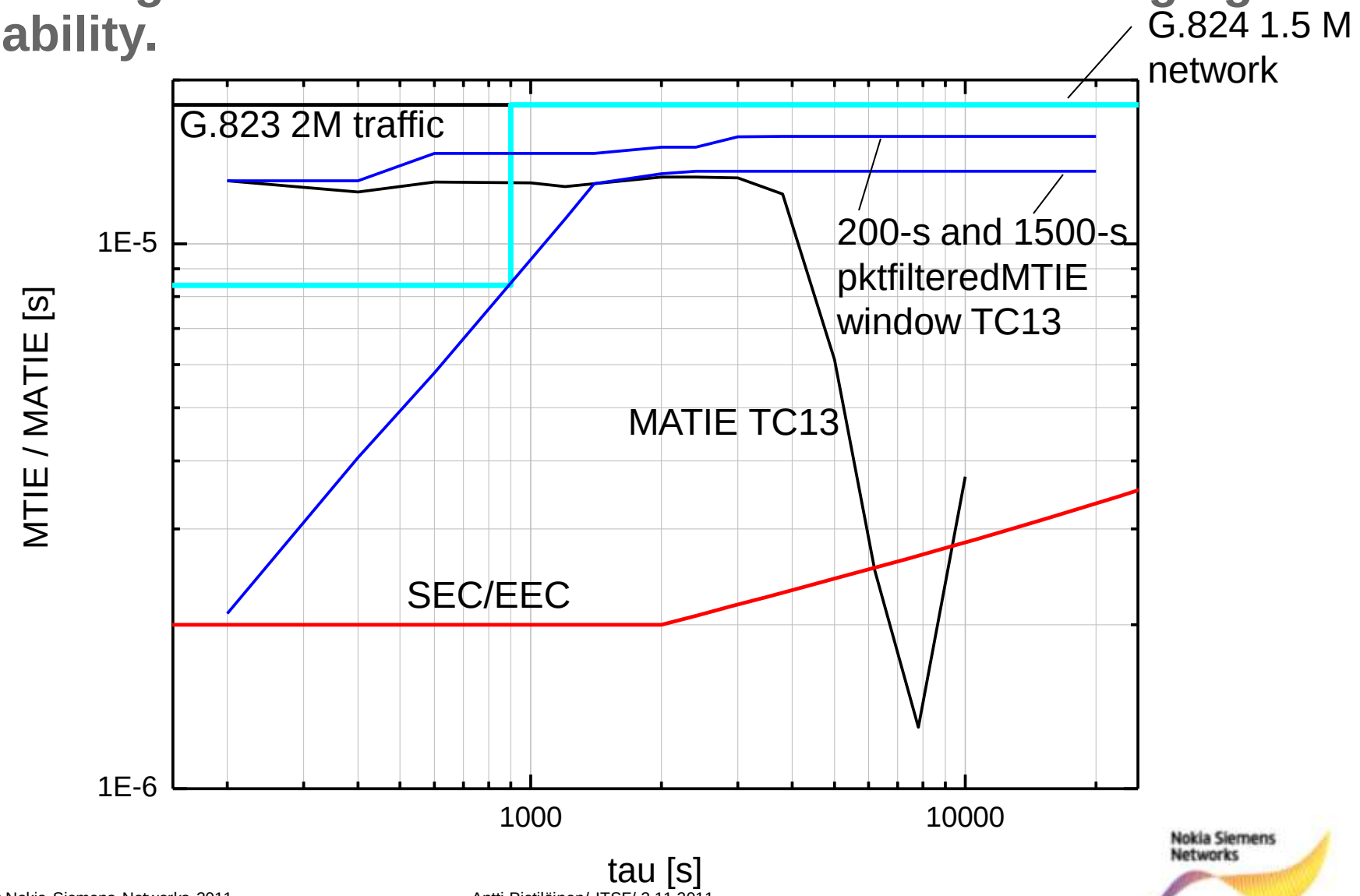
ITU test case 13. Only forward direction is considered (2-3 times harder than 2-way)
- Preselection: 1 % of 200 s (also in Core + ADSL)



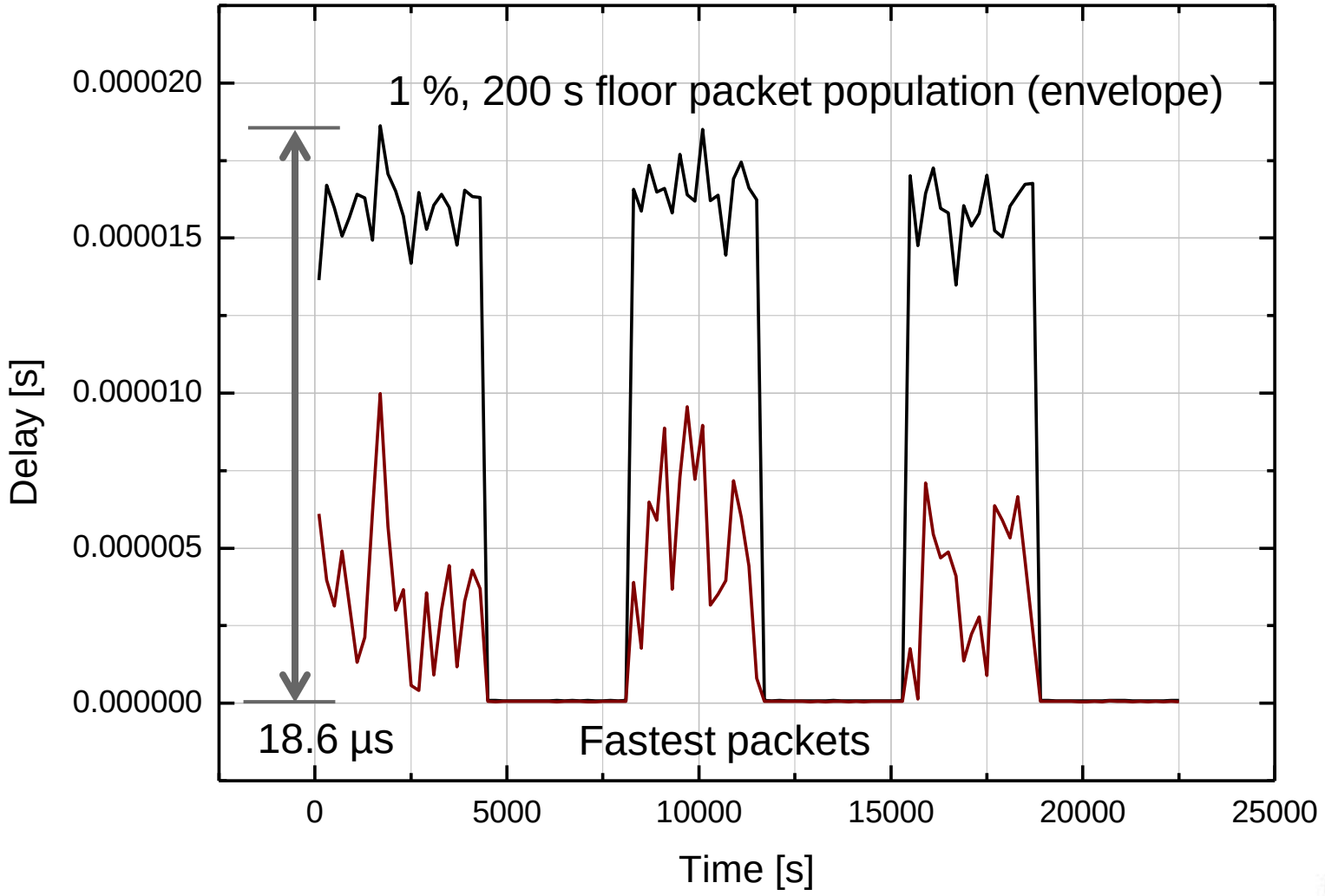
MAFE: 16 ppb & 2M traffic interface can be achieved with 800-s averaging corresponding to ~400-s clock filter time constant.



pktfilteredMTIE: TC13 passes G.823 with no additional averaging and G.824 with 1500-s averaging. No guarantees of passing SEC/EEC masks even with 10000-s averaging capability.

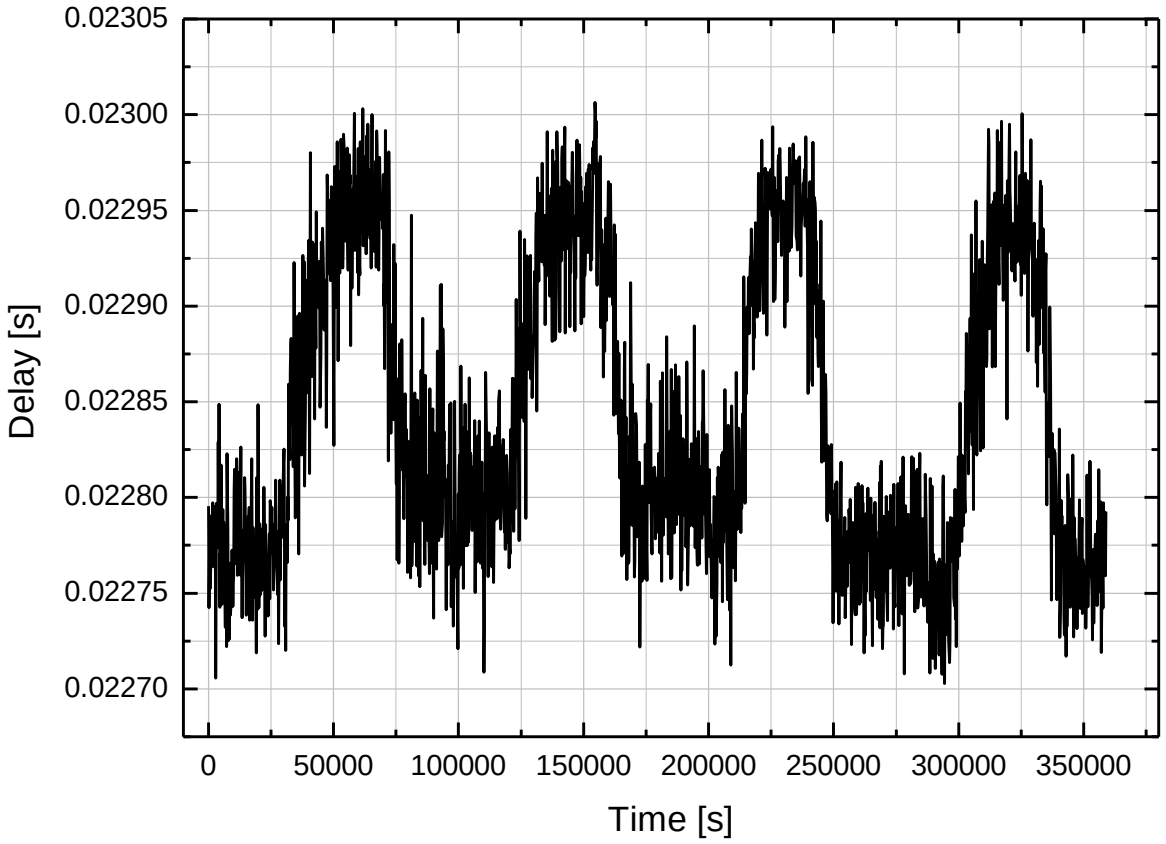


TC 13 passes minimum floor delay packet population criterion of 150 µs by 8 times



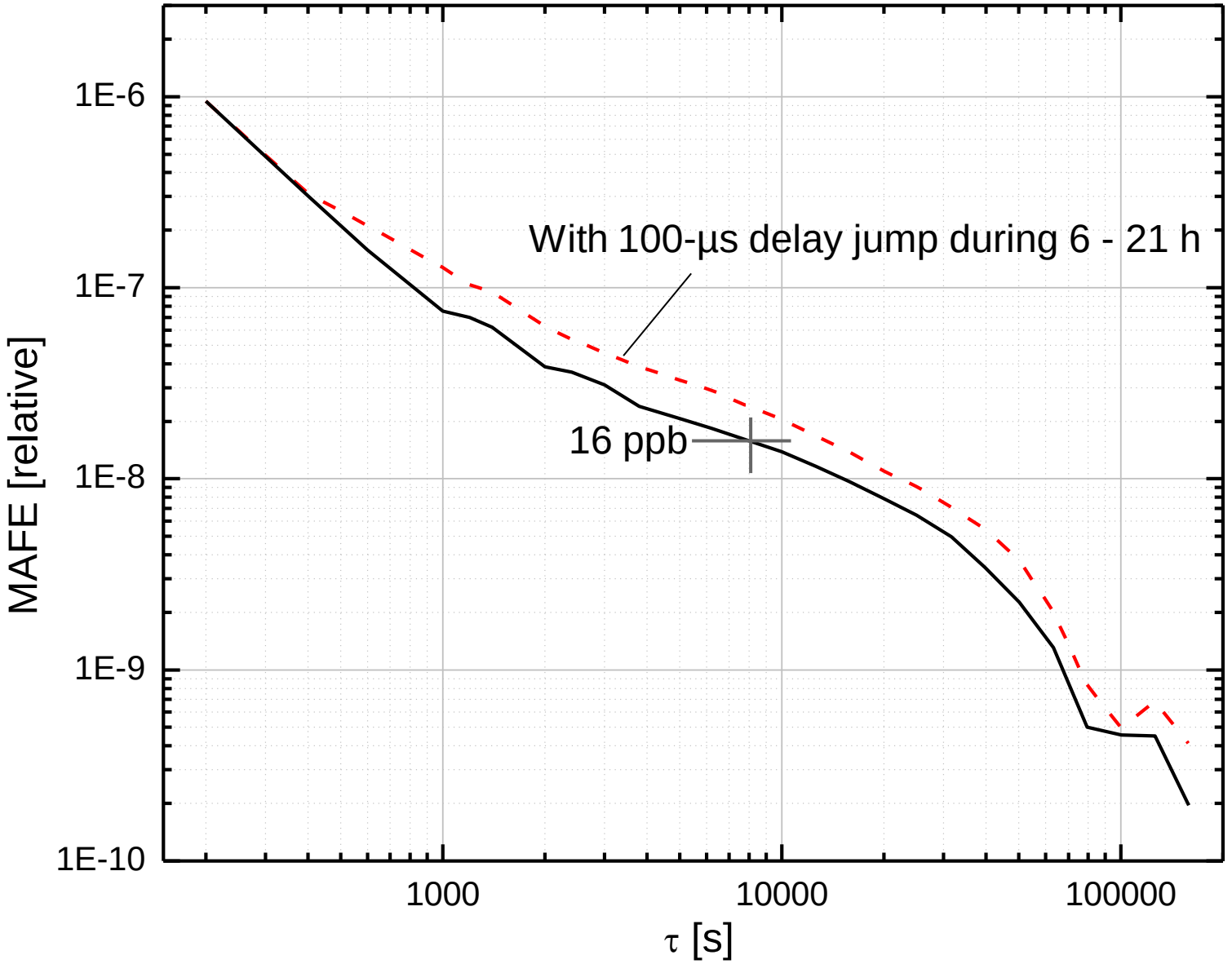
Second case: Core network and ADSL

- Nationwide core network and aggregation network loaded with real traffic.
- ADSL link (2.7 Mbit/s) medium load for one day. The following 3 days no load in ADSL link.

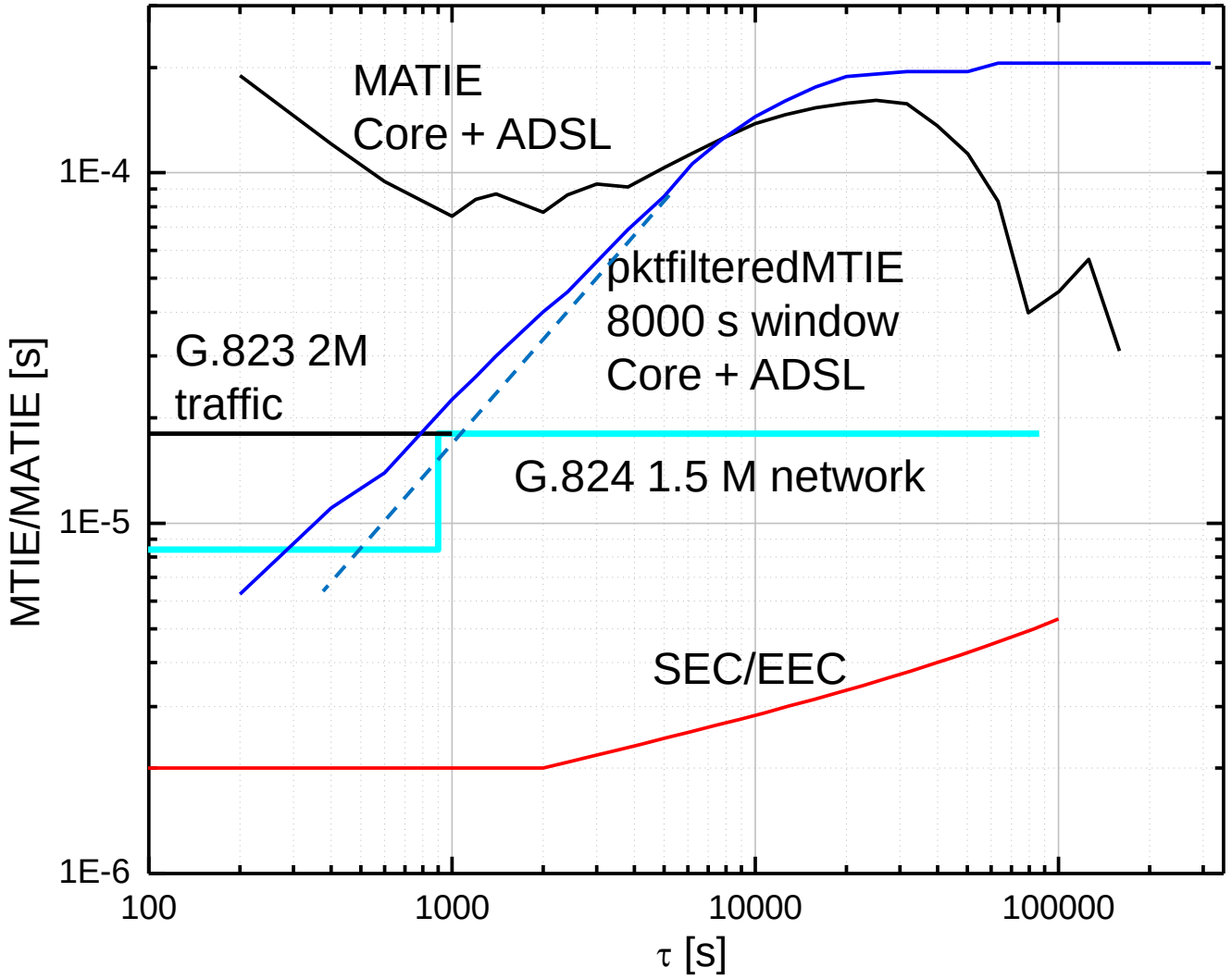


Average delay of fastest 1 % of packets in 200-s windows

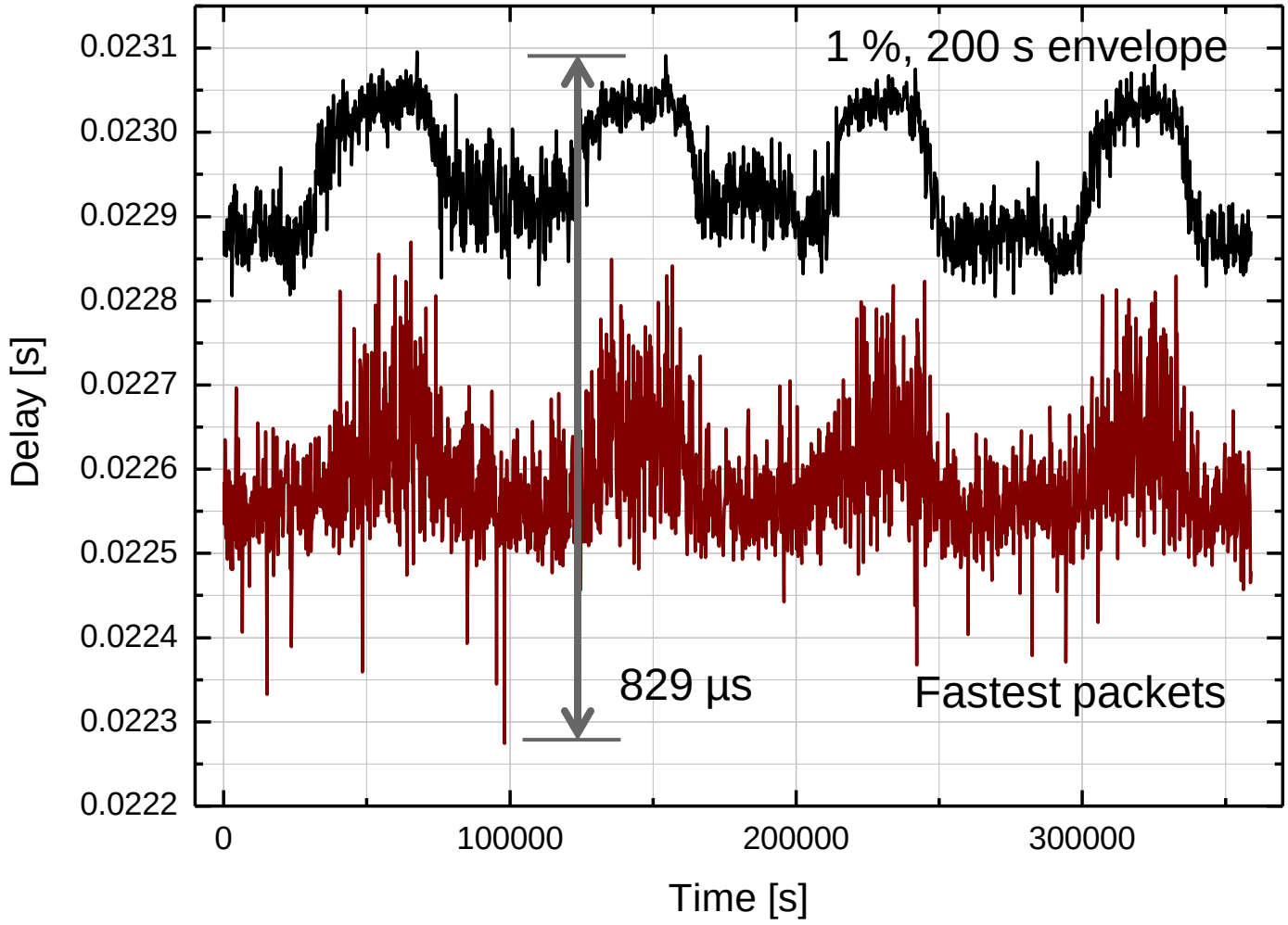
MAFE: 16-ppb can be reached at 8000-s averaging



G.823 2M traffic mask achieved with 8000-s averaging (remember small error of pktfilteredMTIE). No other masks can be satisfied.



Minimum floor delay packet population: Backbone + ADSL case fails criterion of 150 µs by 5 ½ times



Conclusions

- If the averaging capability required from the clock is larger than the MTIE mask width (e.g. 2 Mbit/s traffic mask = 1000 s), then usually MAFE is most useful because of the additional information about the short-term delay noise.
- If the averaging capability required from the clock is smaller than the MTIE mask width, then pktfilteredMTIE needs to be used (e.g. SEC mask).
- Minimum floor delay packet population does not give consistent results because it is not able to handle either short-term noise or long-term phenomena, such as the daily wander pattern.

For reaching 16 ppb:

	MAFE τ	**pktfilteredMTIE** τ	**Minimum floor level**	**2nd order filter TC ***
TC13	800 s	800 s	18.6 µs	340 s
Core + ADSL	8000 s (x 10)	~10000 s (x 12.5)	829 µs (x 45)	3900 s (x 11.25)

* Estimate based on Tukey window analysis