MAFE evaluation of networks for IP over Iub

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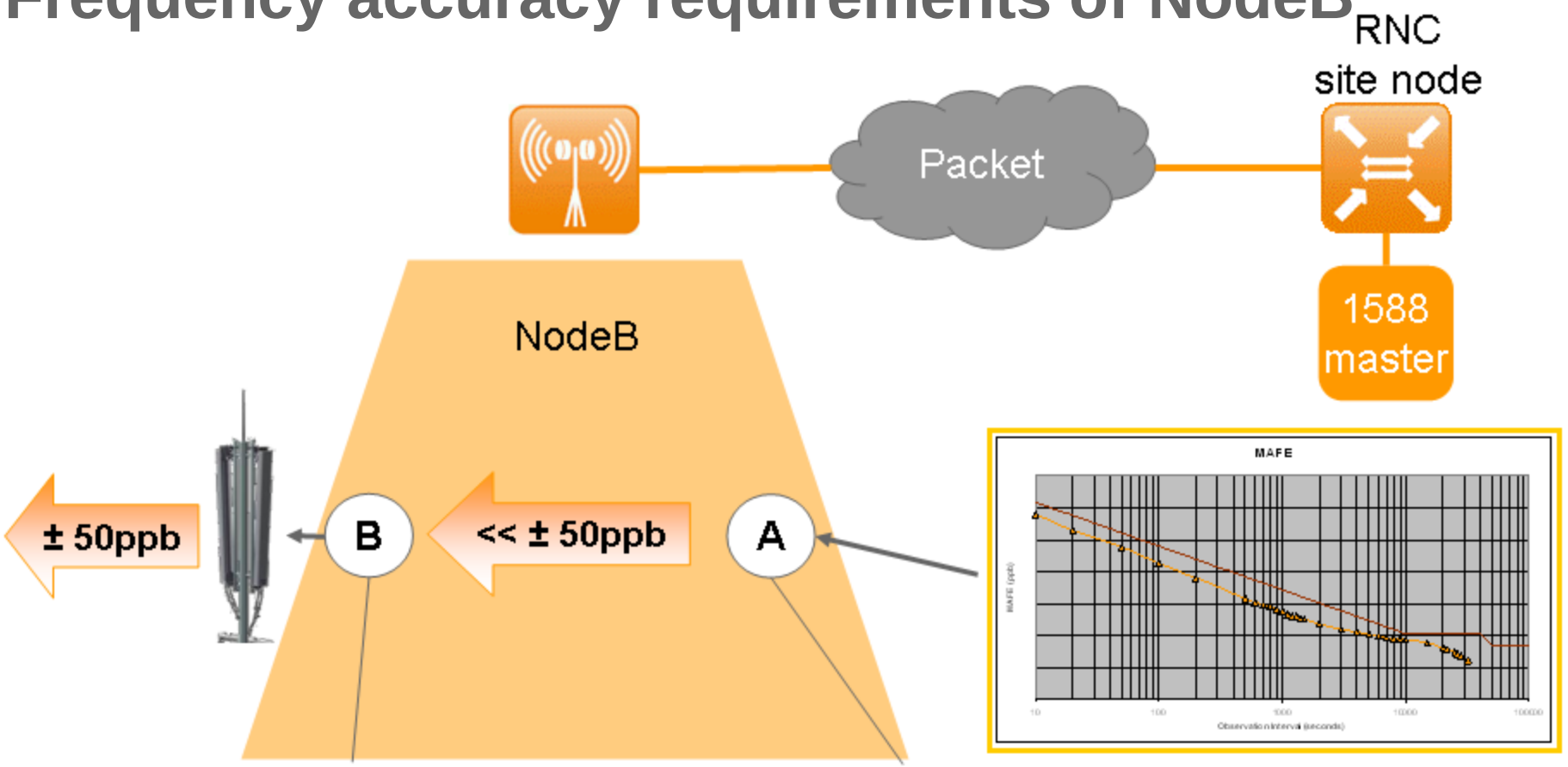
Agenda

1. Overview
2. MAFE algorithm
3. Test results
    1. Munich – Dusseldorf
    2. City Carrier
    3. DSL Lab
4. Network assessment scenarios

Introduction

- This contribution presents measurements based on the MAFE (Maximum Average Frequency Error) algorithm as an evaluation method for the suitability of a network for Timing over Packet.
- The MAFE measurement can be taken during the implementation of the RAN as pre-qualification before putting into operation of the Mobile network but as well during network run time as monitoring and fault analysis.

Motivation of Timing Mask and Frequency accuracy requirements of NodeB



B. The recovered BTS clock has to comply with the requirement to be better than 50 ppb

A. Which delay variation might timing packets experience?
Pre-defined MAFE Masks answer these questions.

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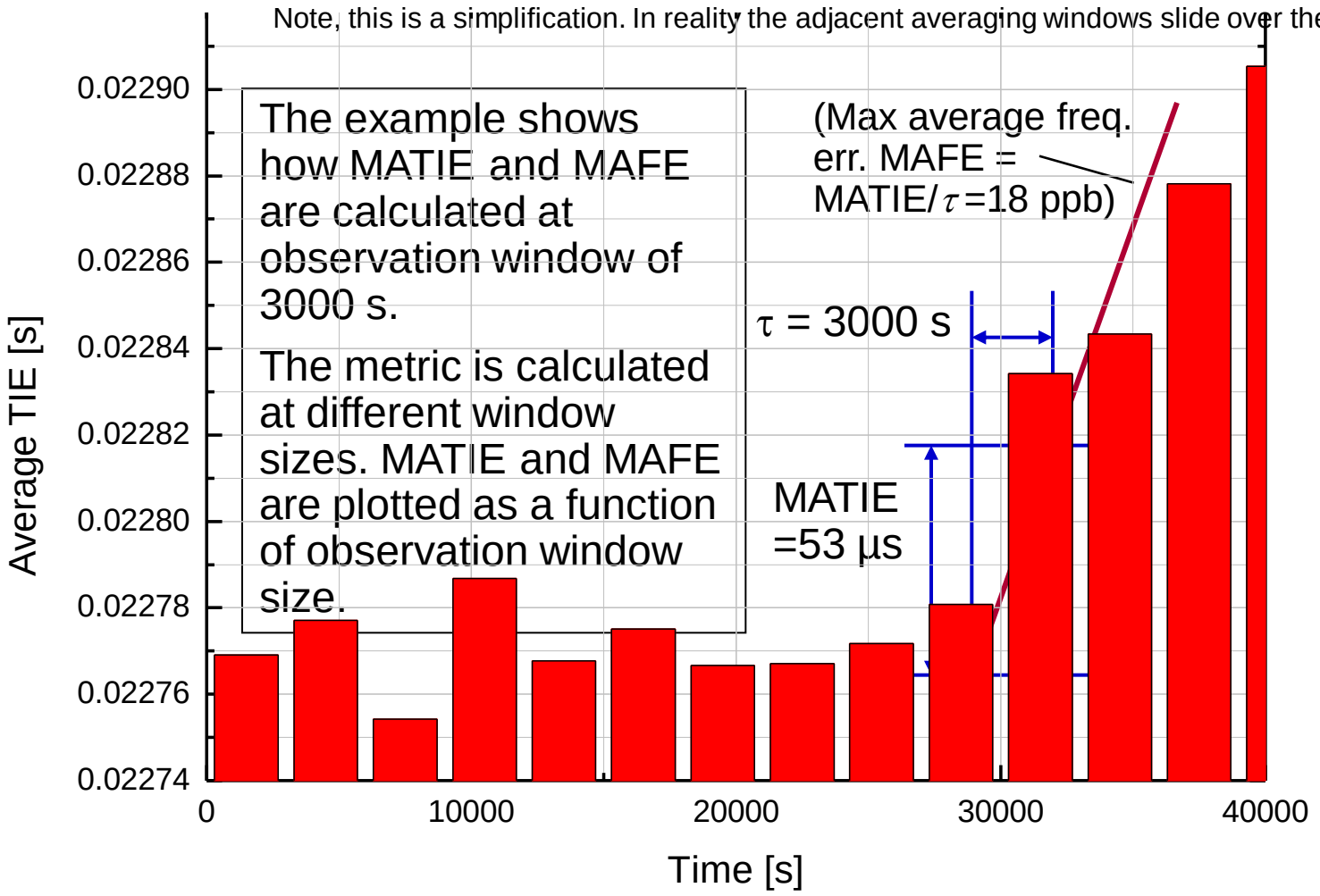
Determining the maximum average time interval error MATIE and max. average frequency error MAFE at τ = 3000s.

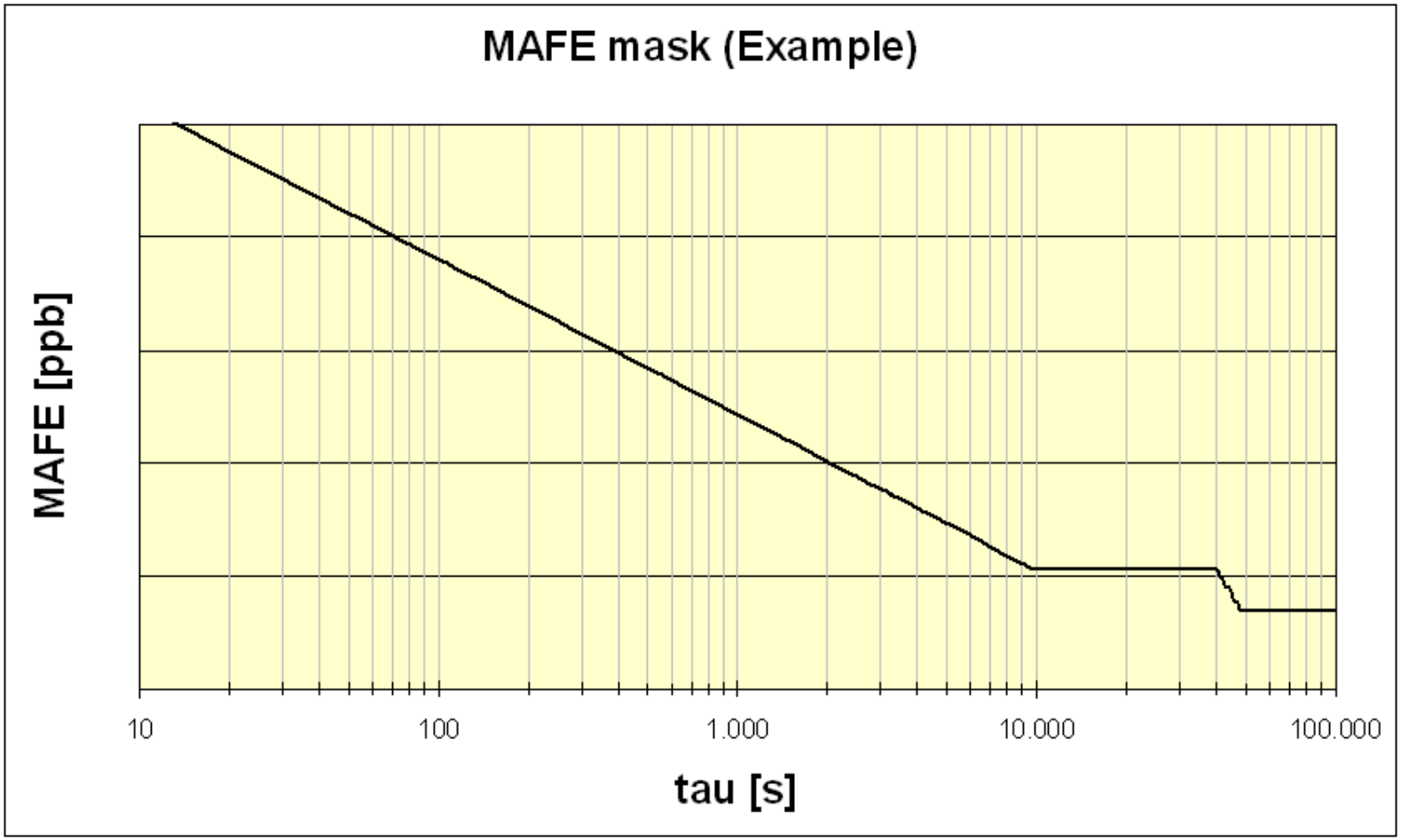
TIE (time interval error) is averaged over a given observation window. Then the maximum change between two consecutive windows is determined.



The function estimates achievable worst-case stability over the whole TIE measurement as a function of the averaging time of the clock algorithm.

Example: Packet Delay variation Mask

MAFE curves: Maximum Average Frequency Error



ToP recovered clock works correctly as base station synchronization source if the MAFE curve based on the measured PDV data lies below the mask and the packet loss is smaller than 2%.

Derived Engineering Rules

- Clock packet stream should have the highest priority or at least the same priority as the real-time traffic
- Sync packets should have expedited forwarding QoS (EF)
- A maximum of 10 - 20 hops (depending on FE/GE interfaces) with packet switching
- Maximum 6 delay jumps per day
- Packet loss < 2%

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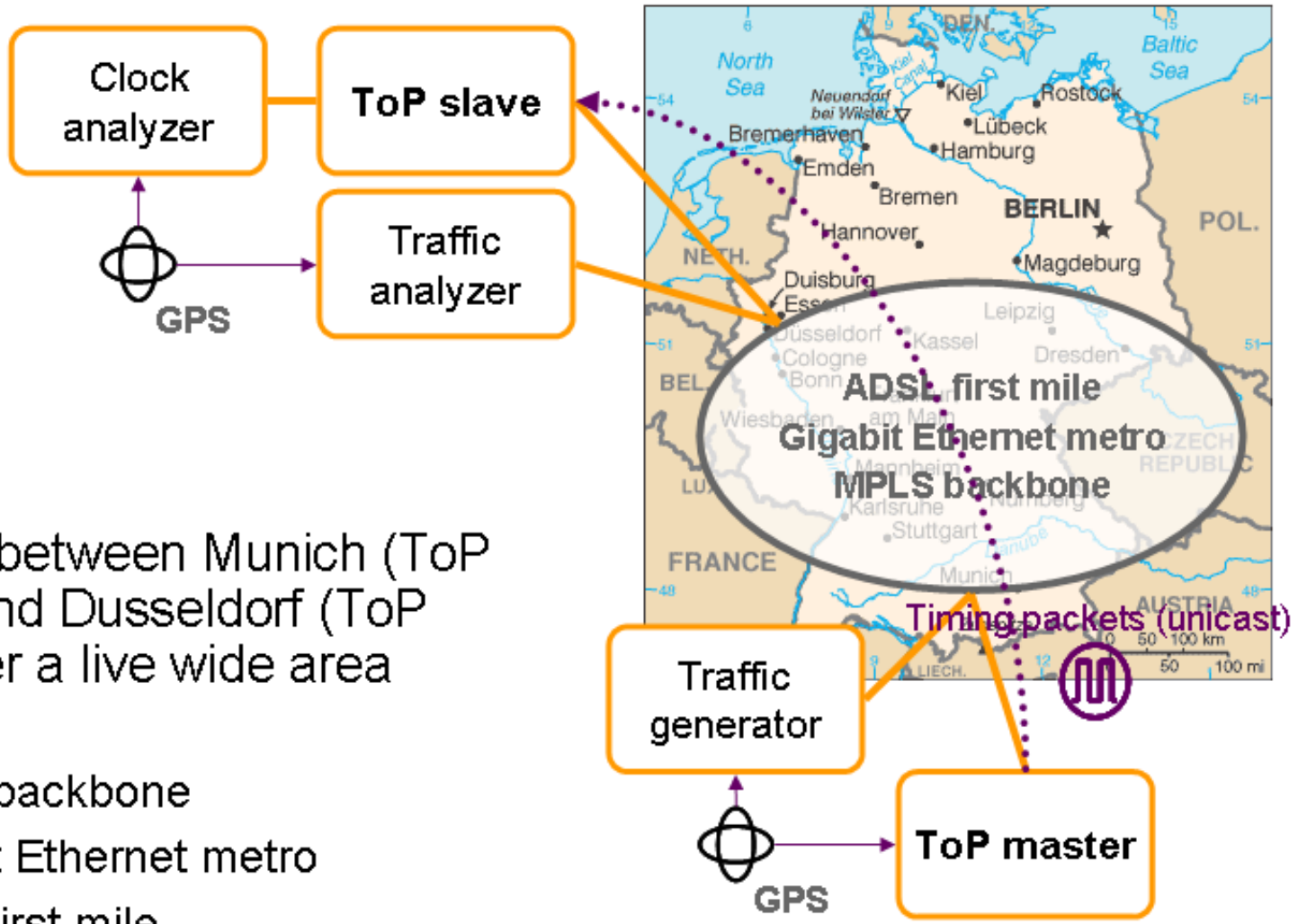
Munich Dusseldorf Trial

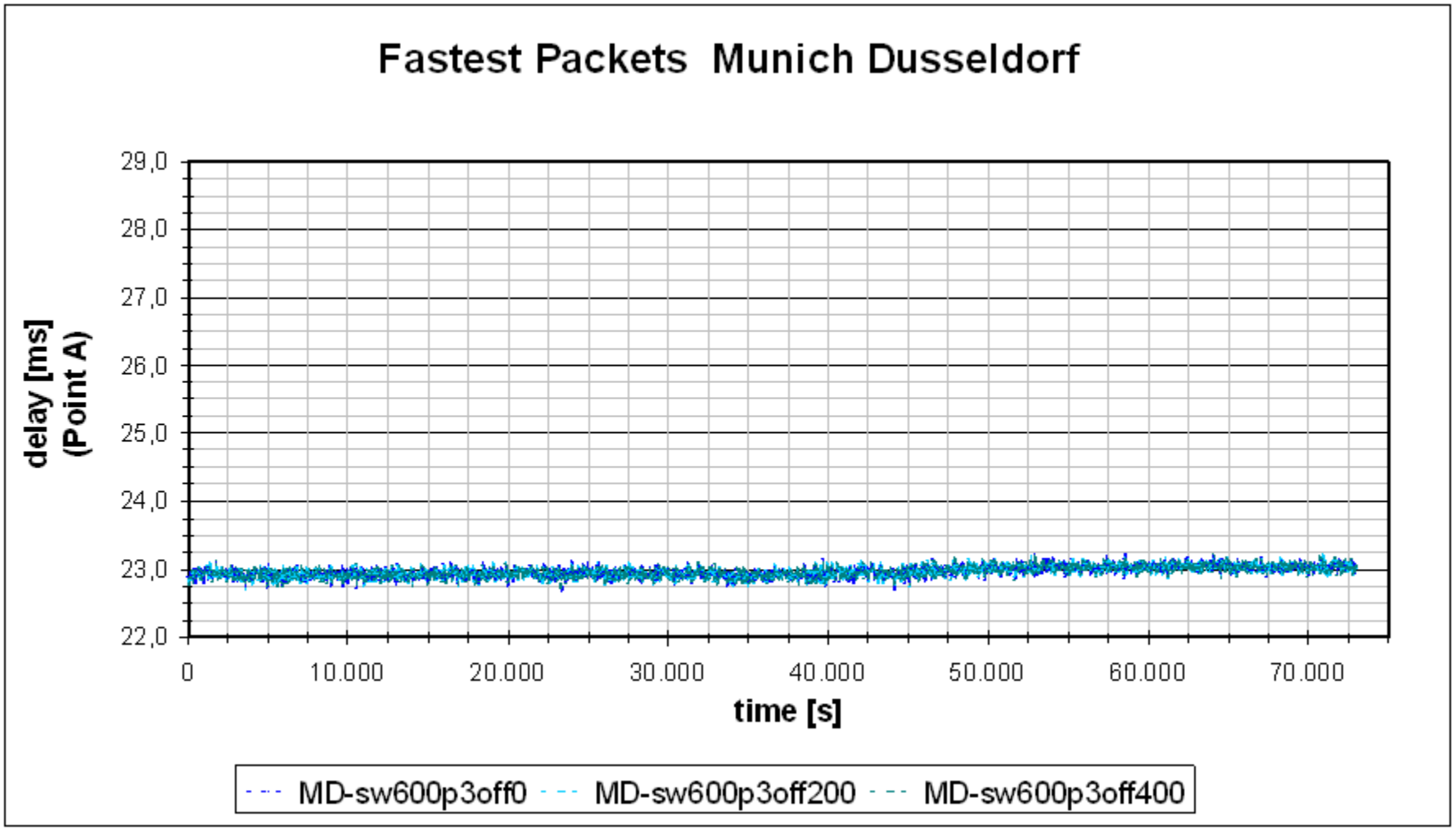
ToP over a live MPLS Backbone, Ethernet Metro, DSL Access



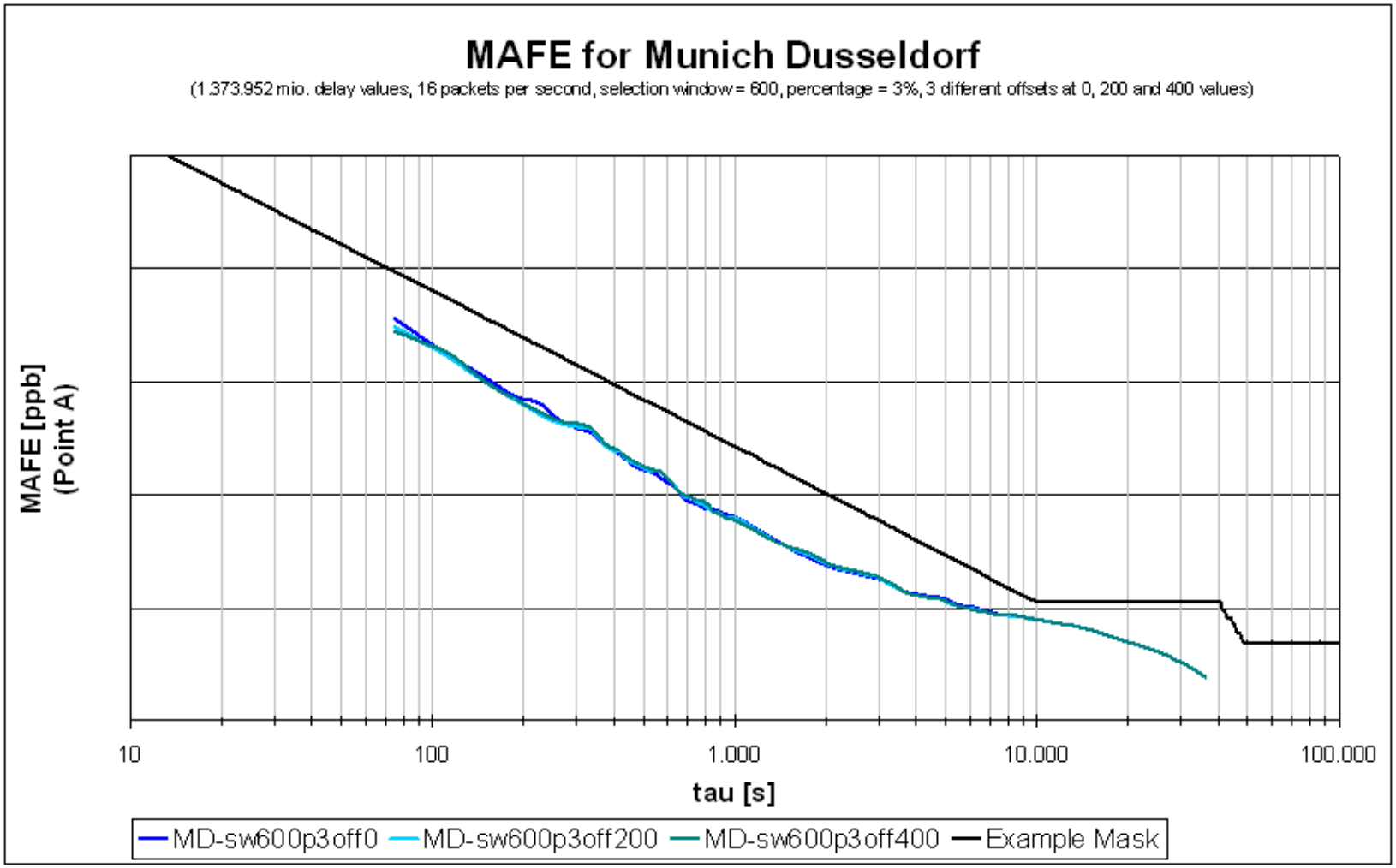
- Field trial between Munich (ToP master) and Dusseldorf (ToP slave) over a live wide area network
  - MPLS backbone
  - Gigabit Ethernet metro
  - ADSL first mile

Munich-Dusseldorf Trial (I)

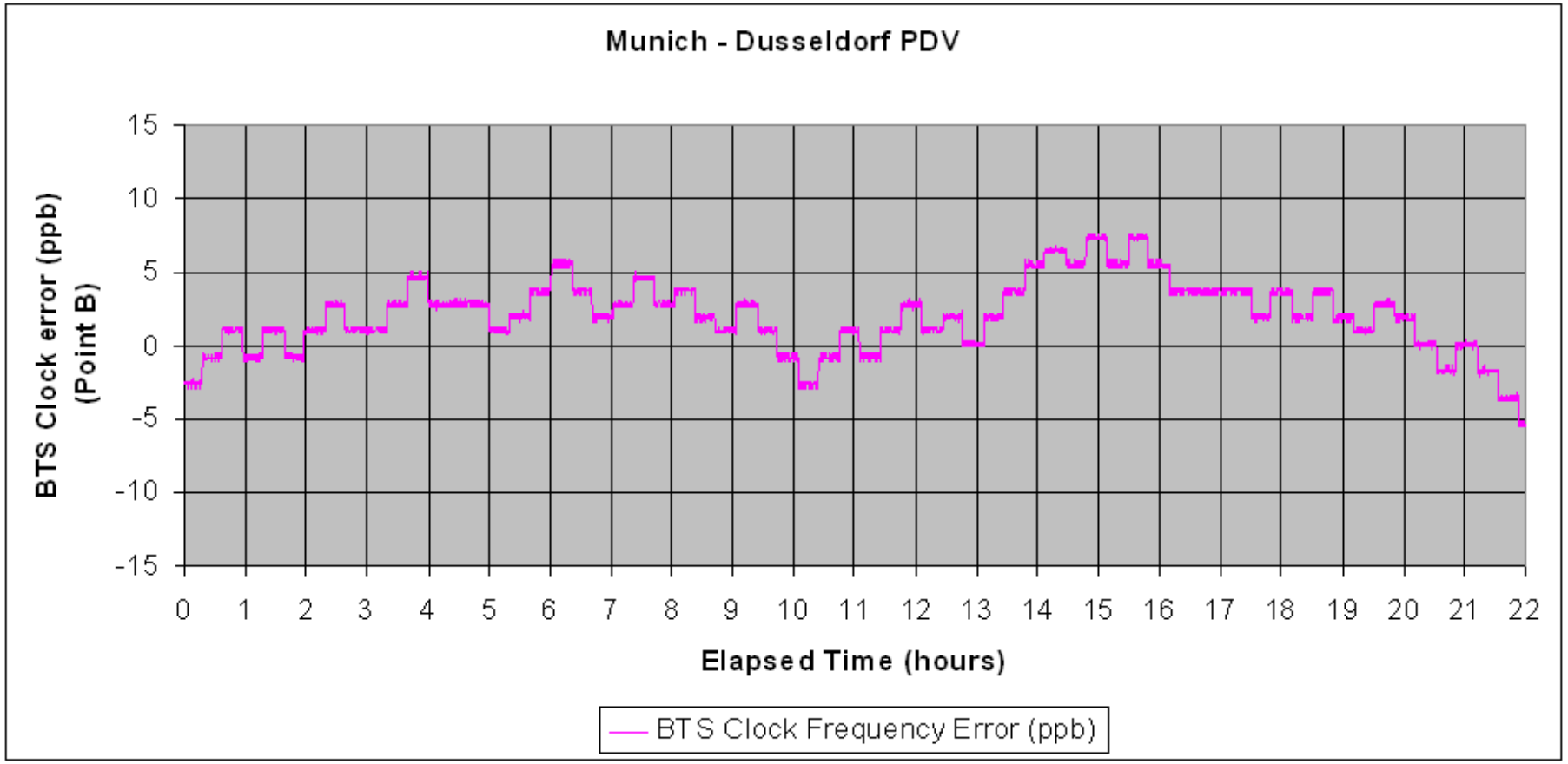
3 percent fastest packets with selection window 600



Munich-Dusseldorf Trial (II)
MAFE Plots

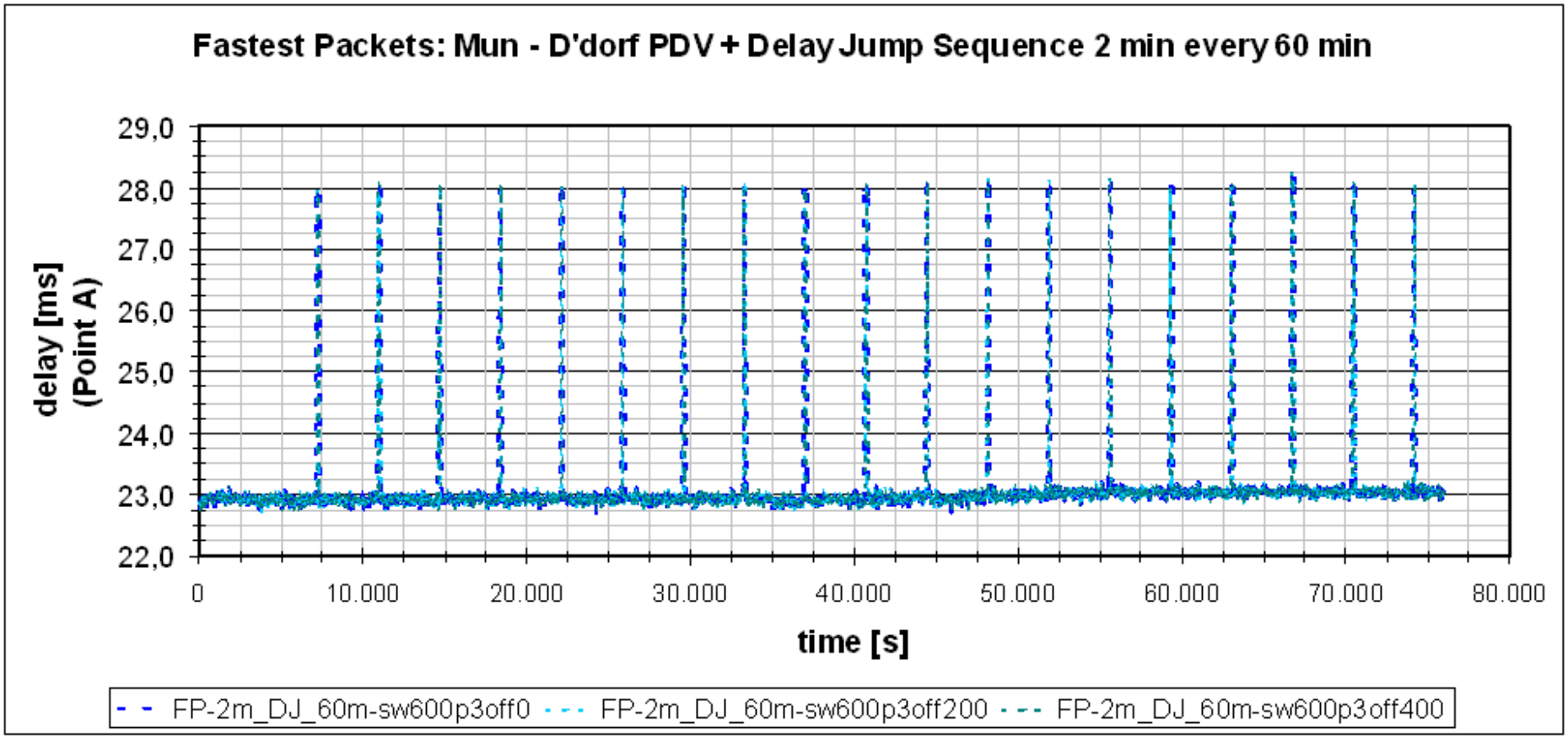


Munich-Dusseldorf Trial (III)
BTS Clock Frequency Error

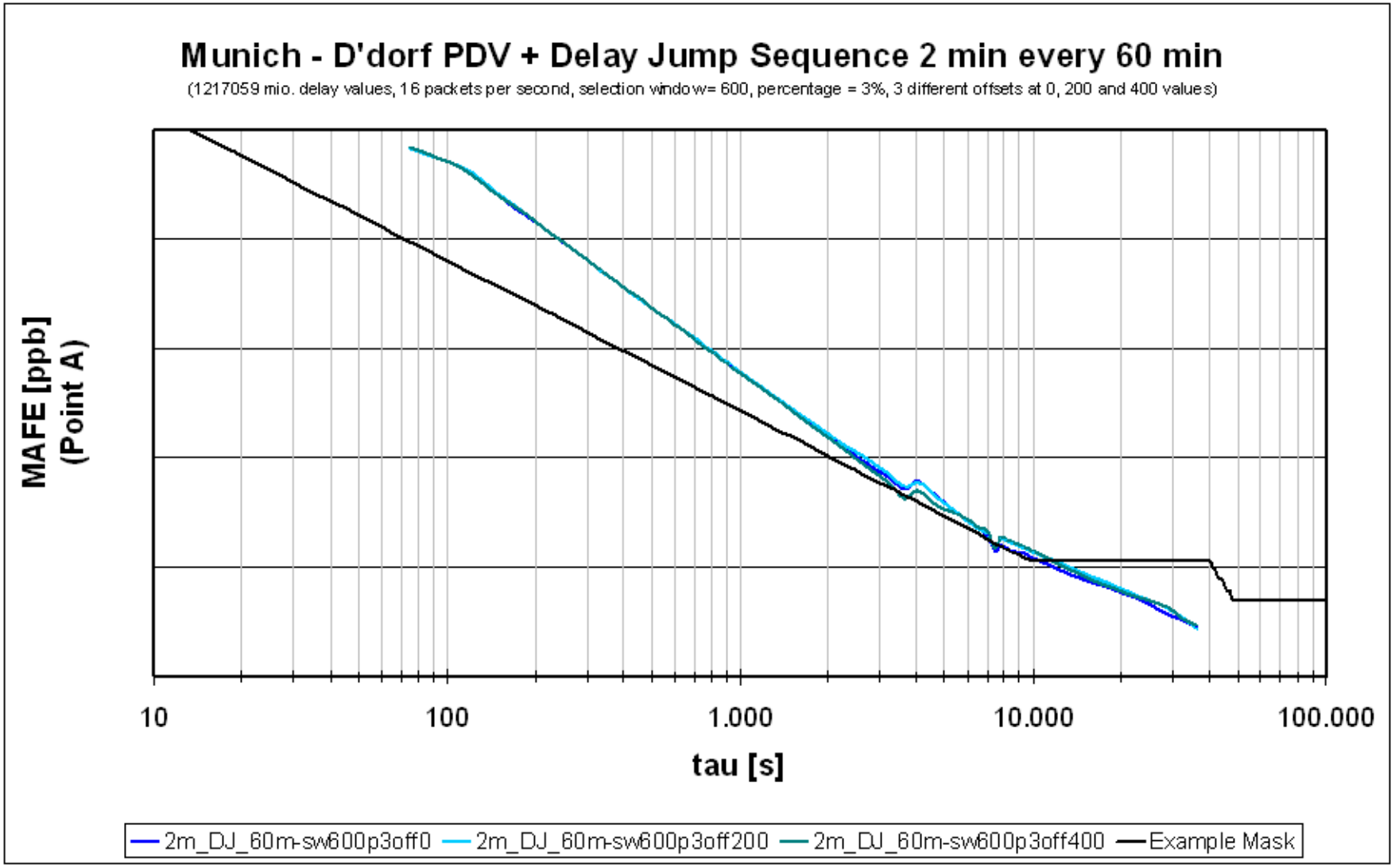


Trial with 2 min delay jumps every 60 minutes (I)

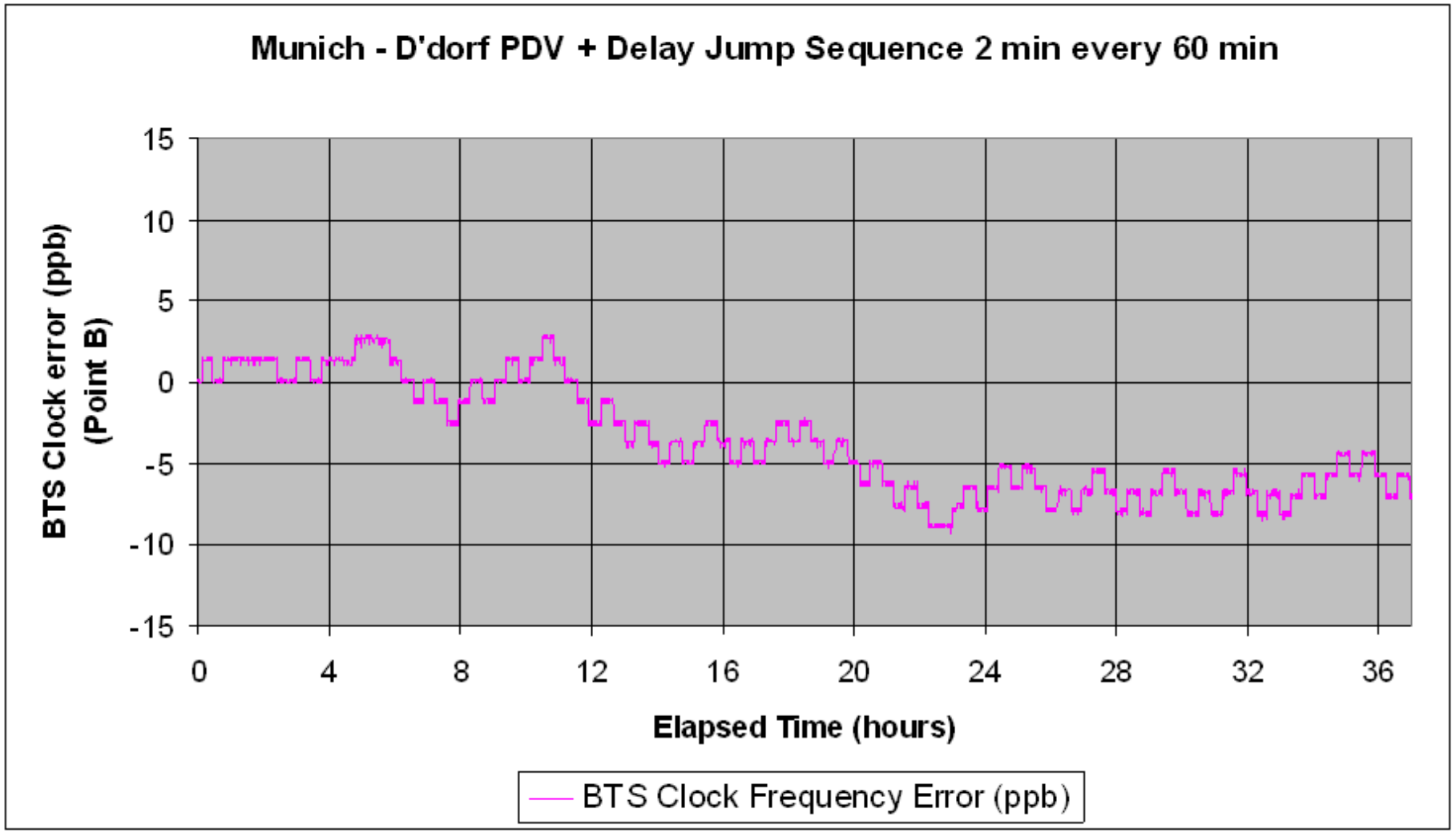
3 percent fastest packets with selection window 600



Trial with 2 min delay jumps every 60 minutes (II)
MAFE Plots

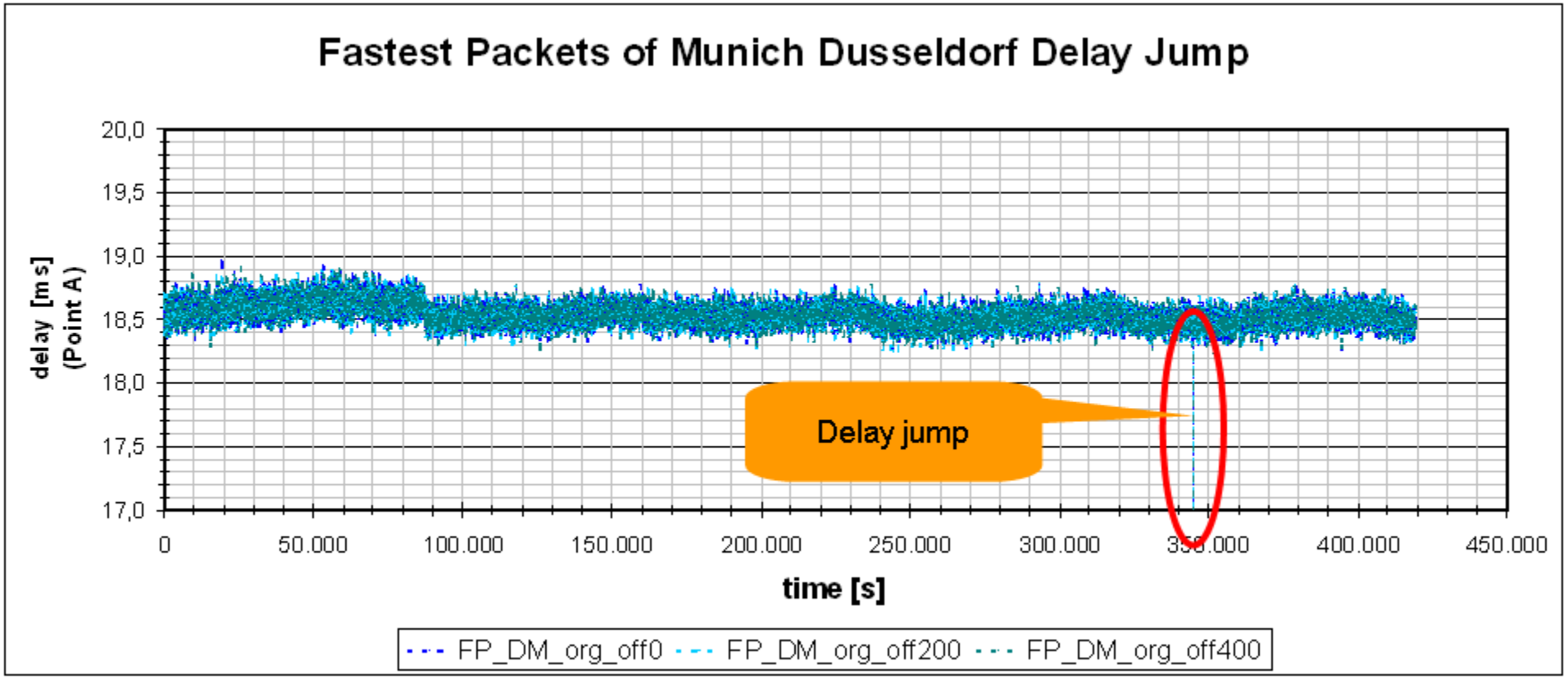


Trial with 2 min delay jumps every 60 minutes (III)
BTS Clock Frequency Error



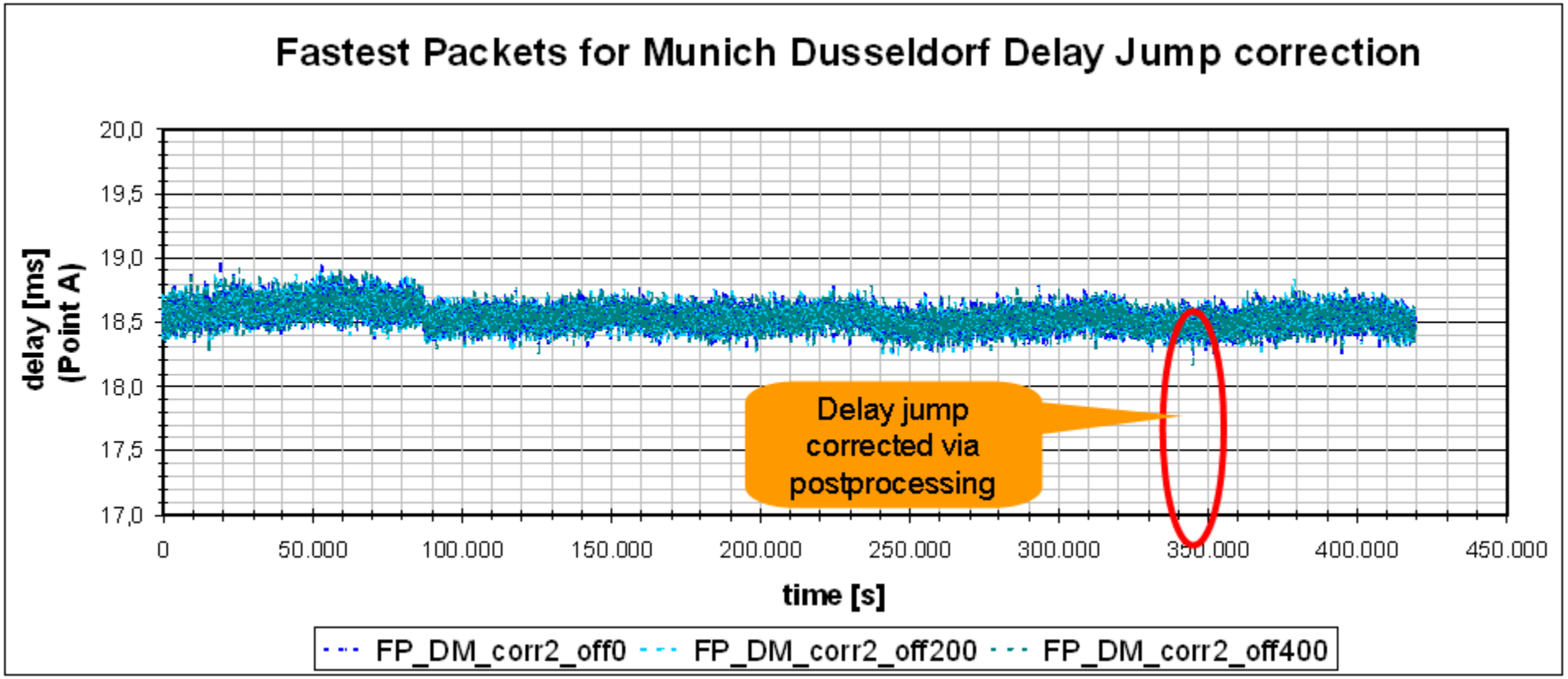
Munich-Dusseldorf Trial with delay jump

3 percent fastest packets with selection window 600

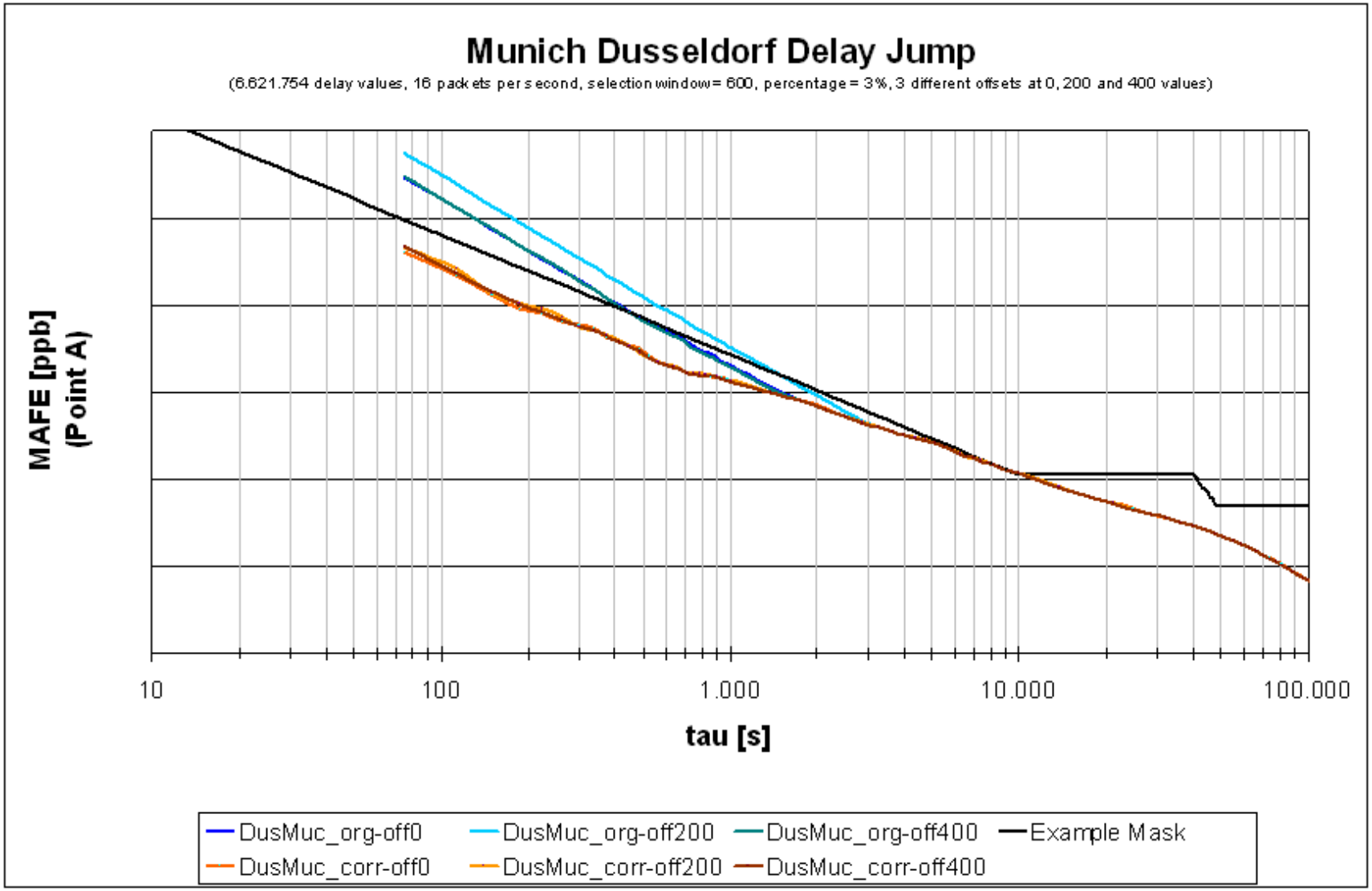


Munich-Dusseldorf with delay jump correction

3 percent fastest packets with selection window 600



Munich-Dusseldorf with delay jump (II)
MAFE Plots



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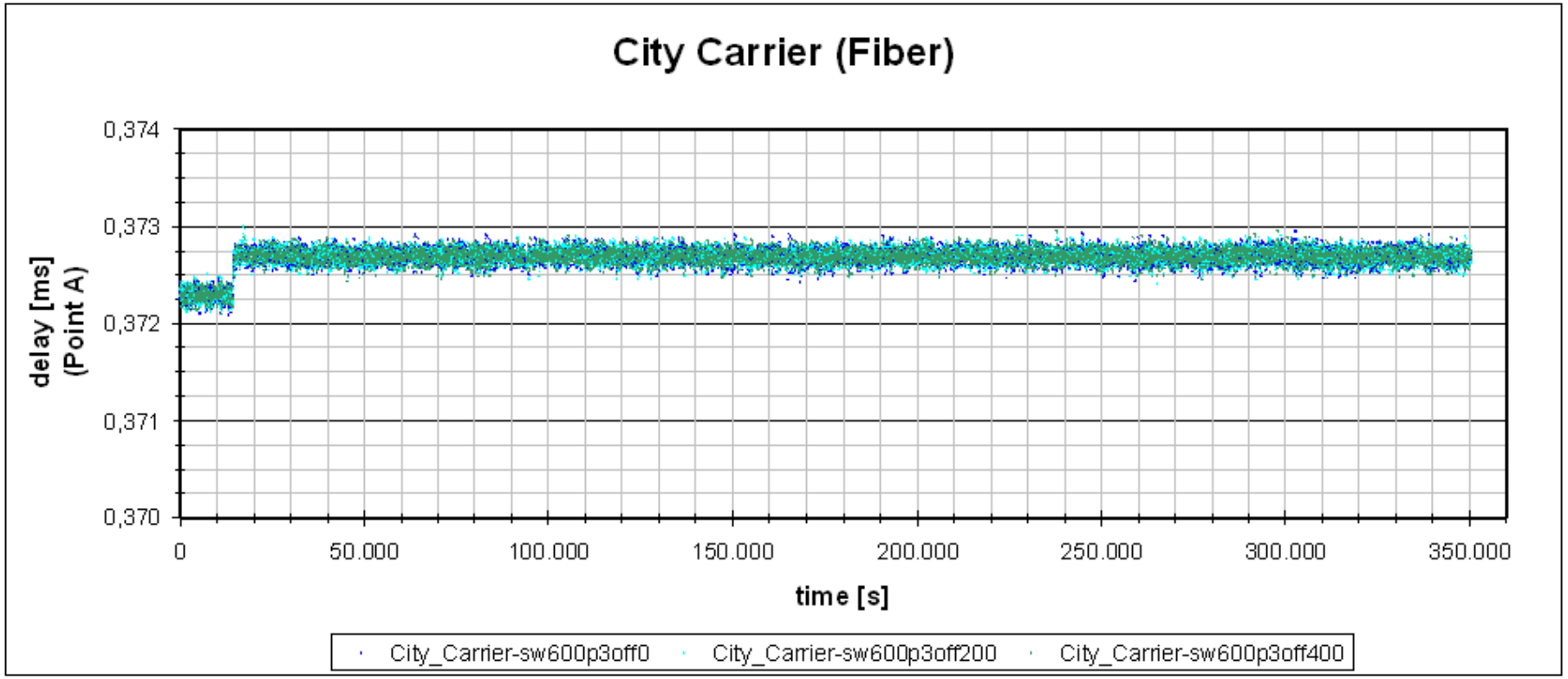
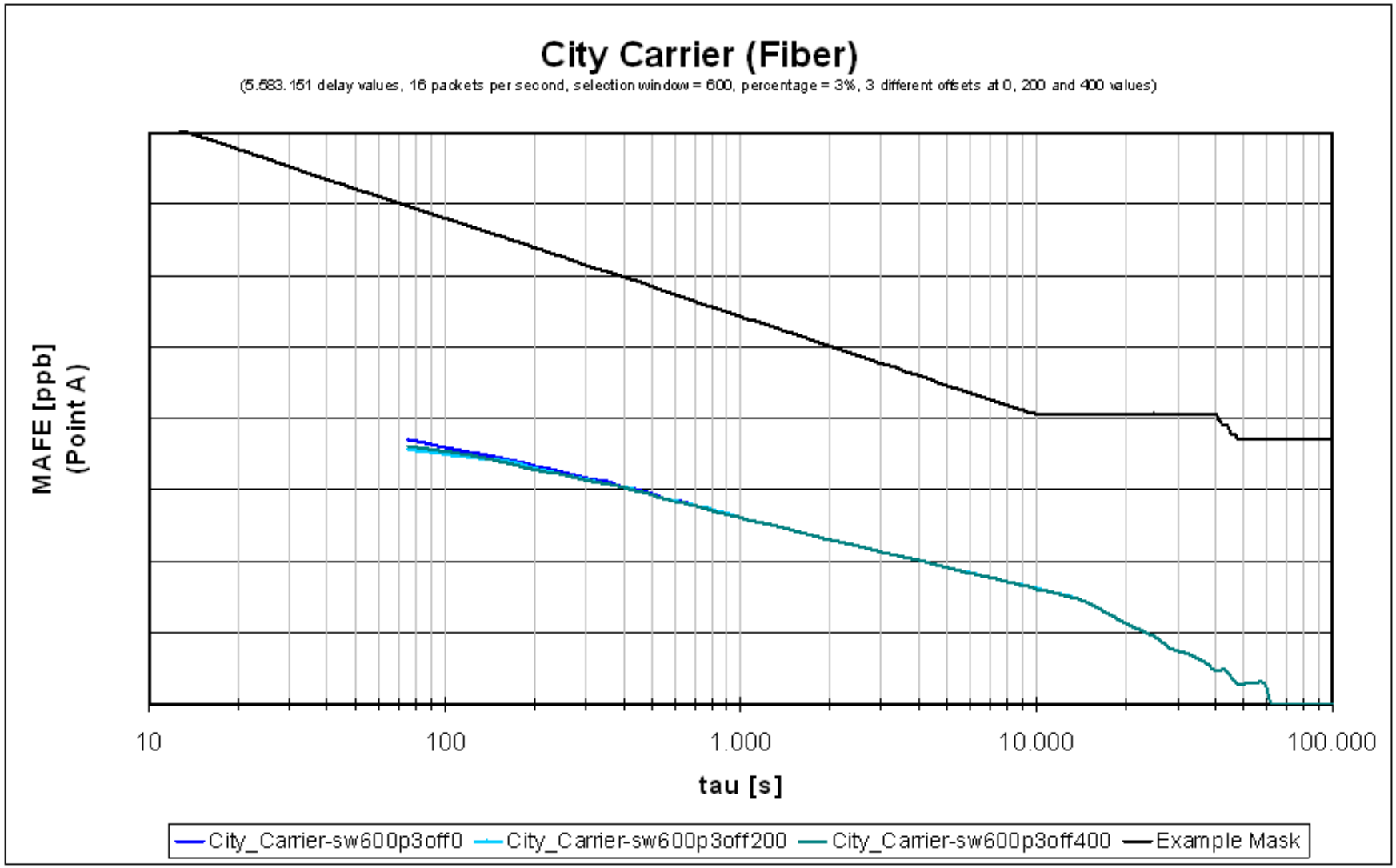
Nokia Siemens Networks

City Carrier (I)
3 percent fastest packets with selection window 600



City Carrier (II)
MAFE Plots



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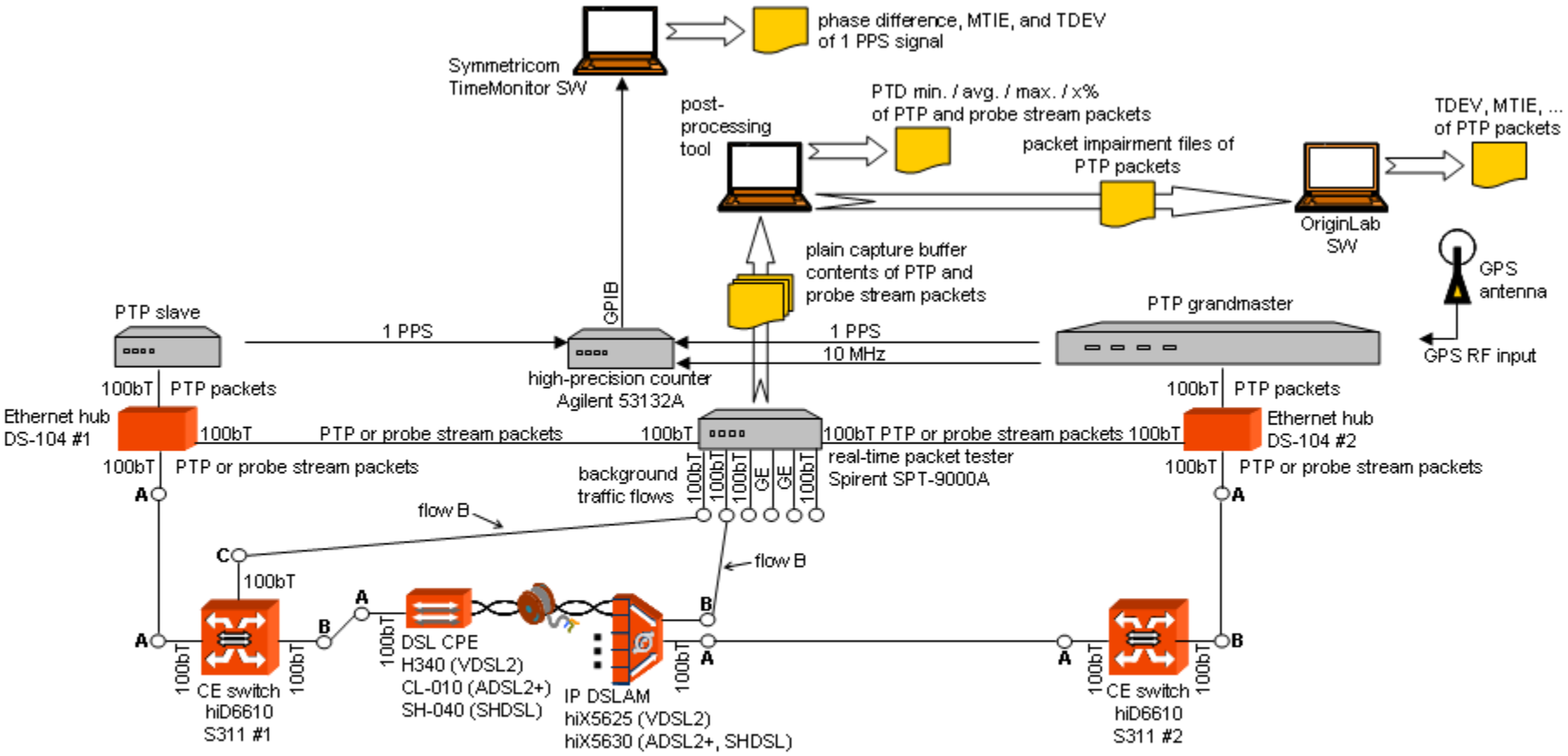
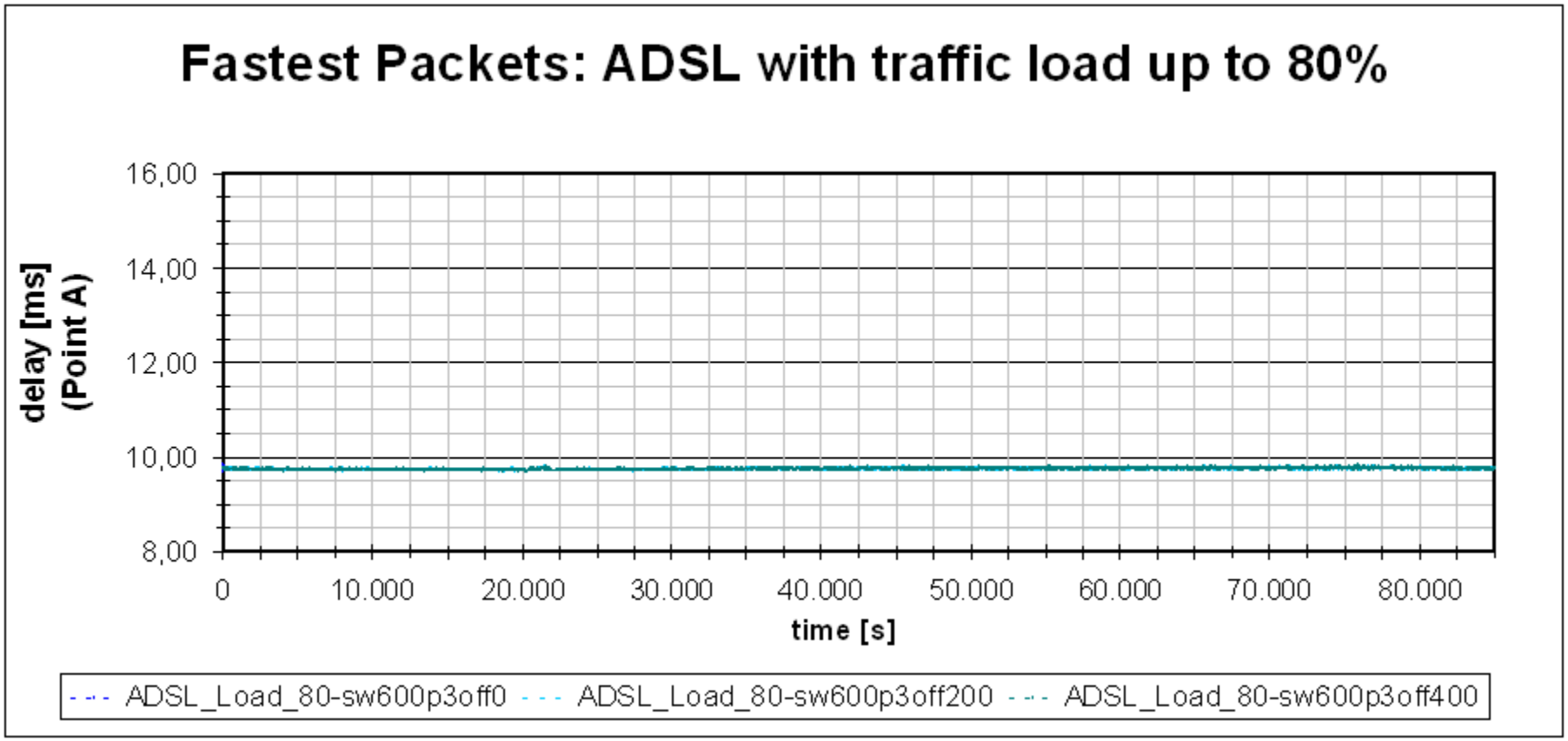
ADSL2 Test Set-Up



Traffic flows

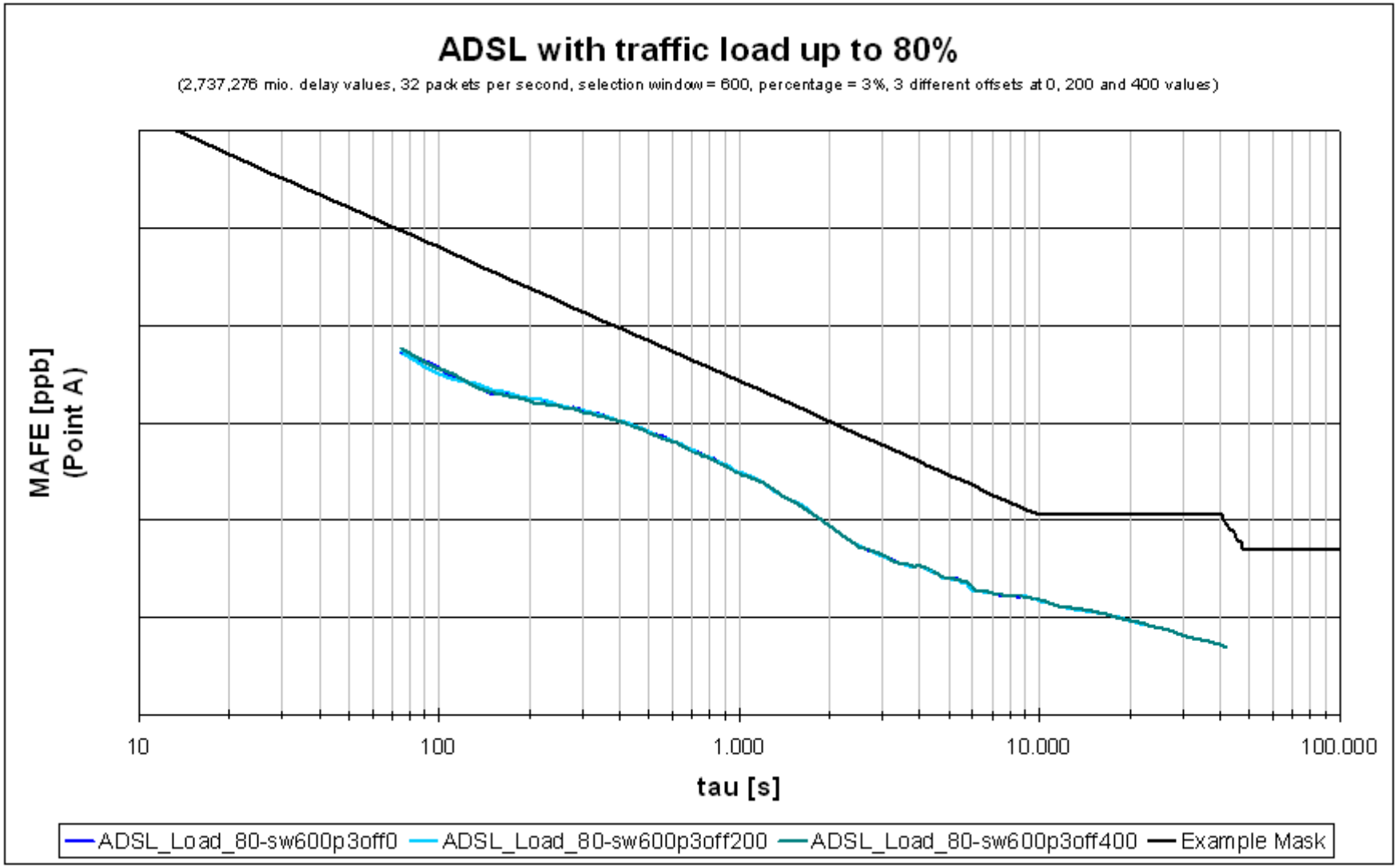
- PTP packet flow DL = (32 + 2 + 1) pps * 94 * 8 bits per packet (only BE)
- PTP packet flow UL = 2 pps * 94 * 8 bits per packet (only BE)
- probe stream packet flows = 100 pps * 94 * 8 bits per packet (either EF or BE)
- flow B DL/UL = 100% of x% of VDSL2 / ADSL2+ / SHDSL DS/US link capacity

ADSL with load up to 80% (I)
3 percent fastest packets with selection window 600

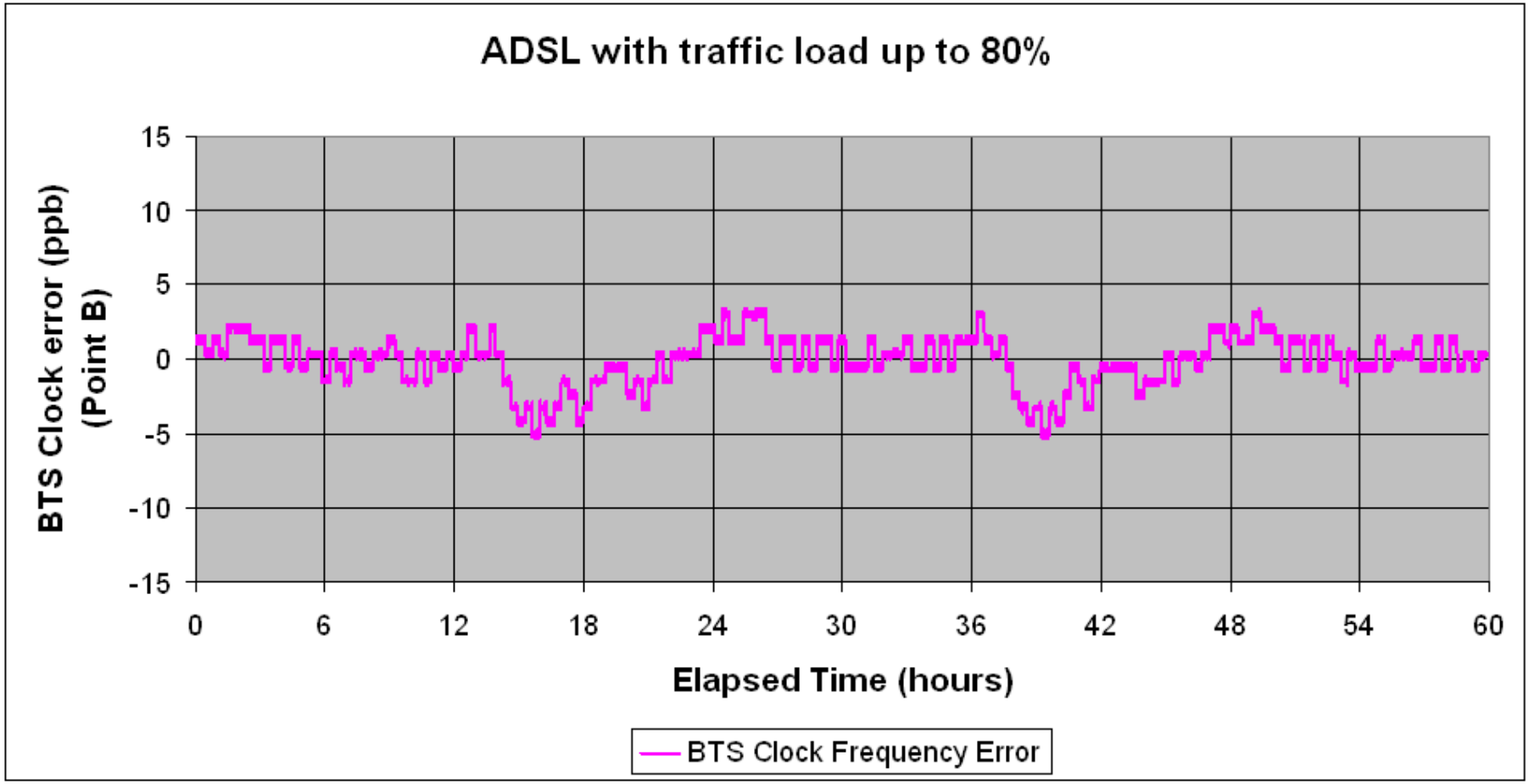


ADSL with load up to 80% (II)

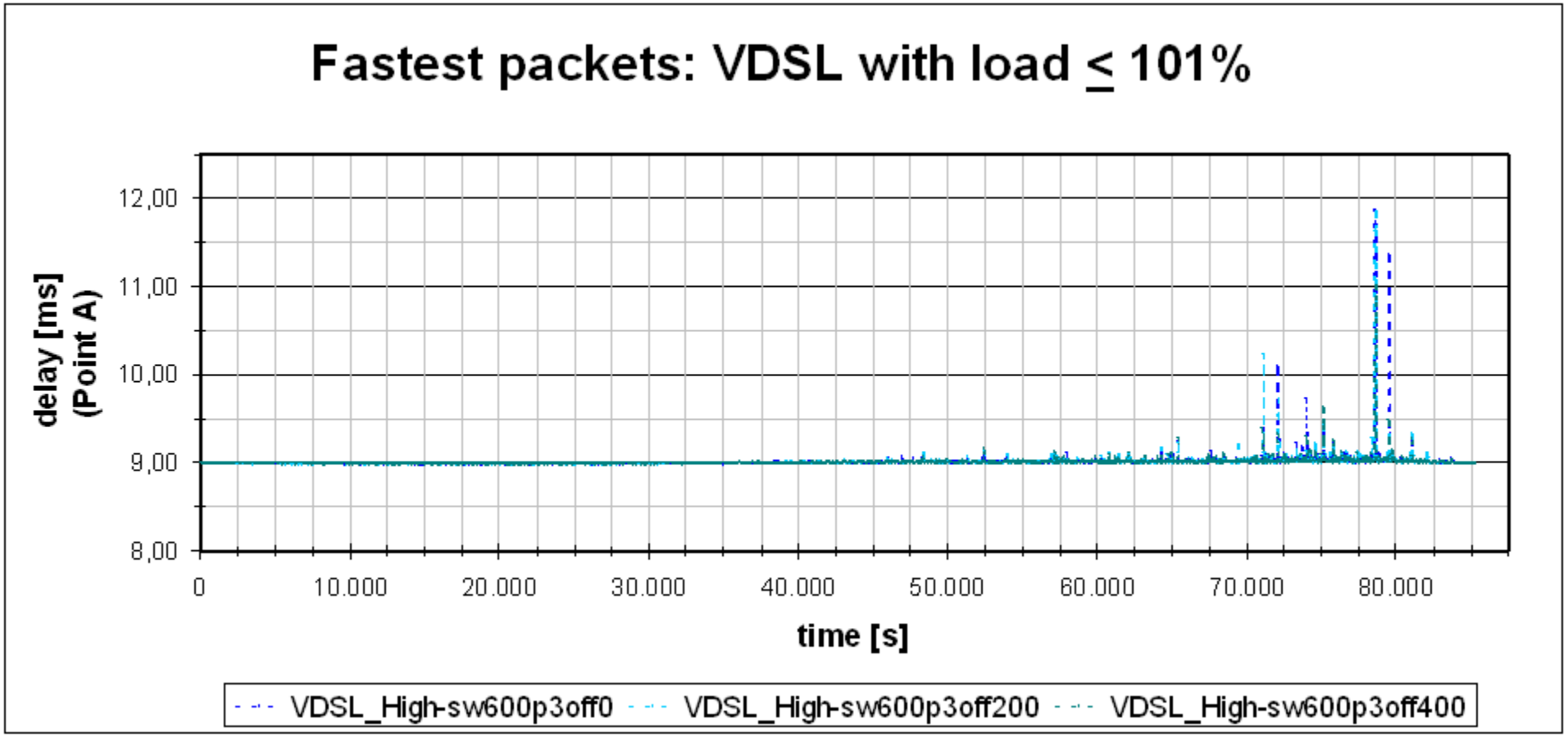
MAFE Plots



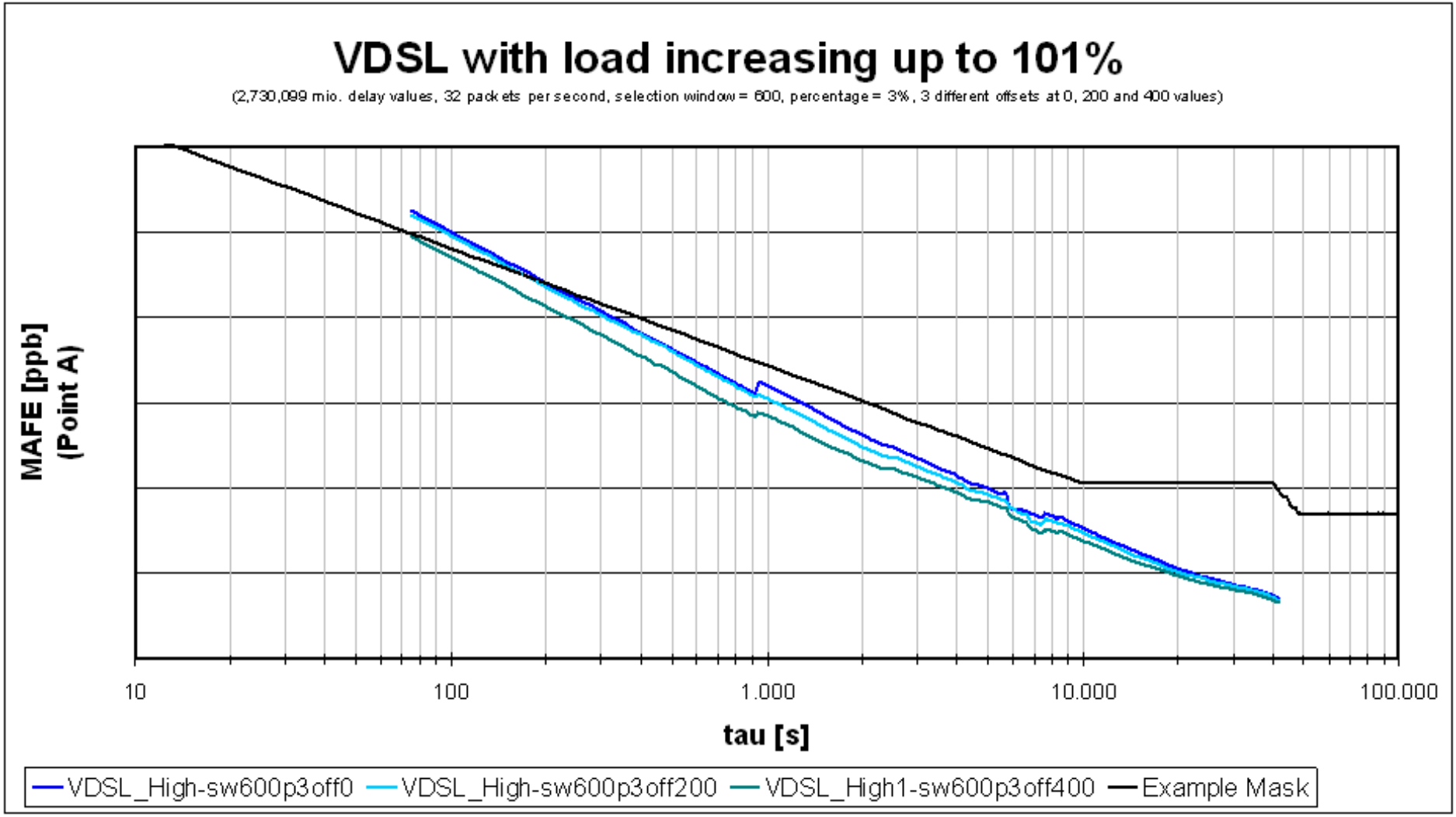
ADSL with load up to 80% (III)
BTS Clock Frequency Error



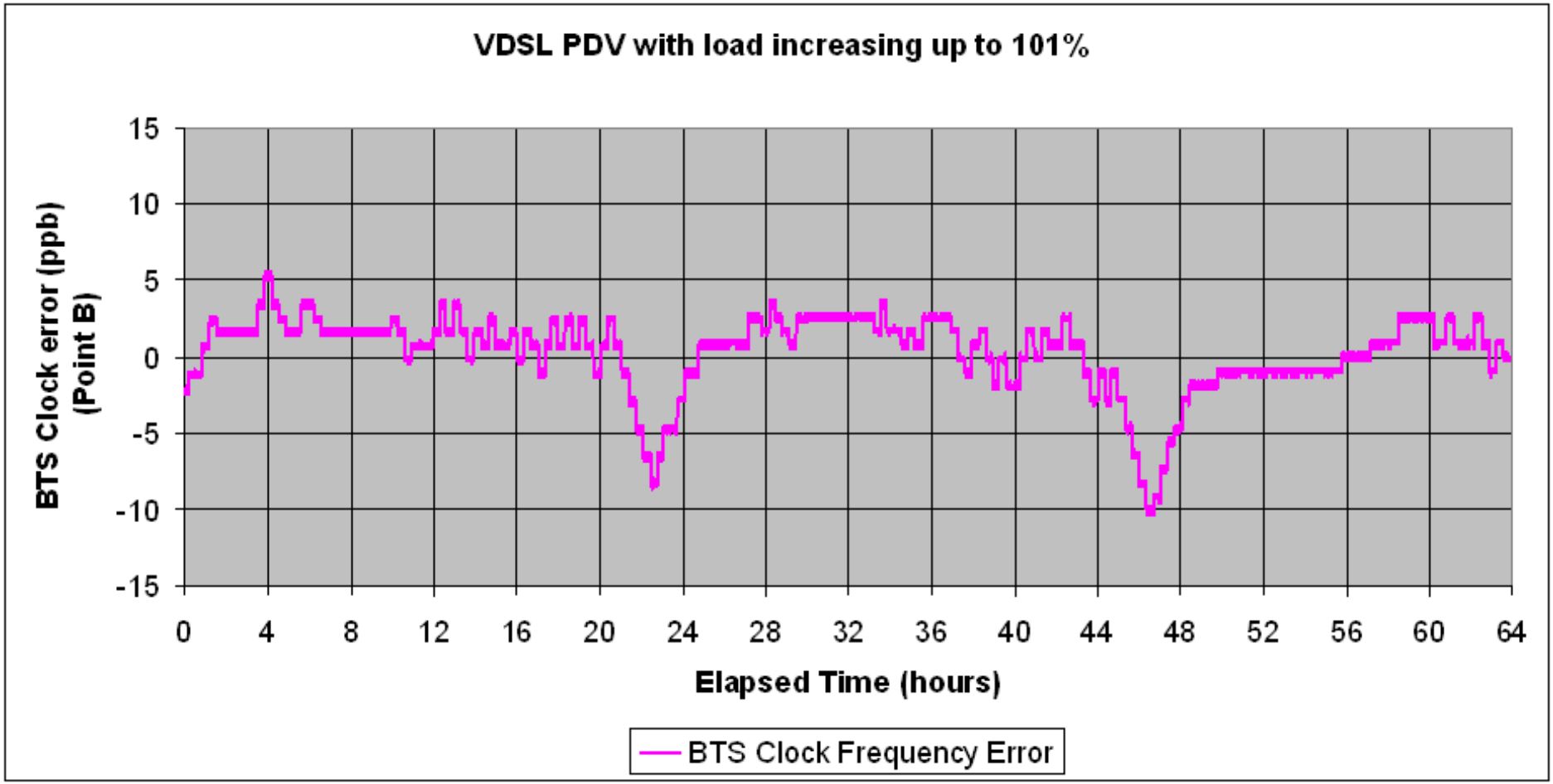
VDSL with load increasing up to 101% (I)
3 percent fastest packets with selection window 600



VDSL with load increasing up to 101% (II)
MAFE Plots



VDSL with load increasing up to 101% (III)
BTS Clock Frequency Error



Rating of the measurement results

- In case the measured MAFE curve is below the defined mask the network is suitable for base station synchronization via ToP according IEEE1588-2008.

- In case the measured MAFE curve violates the MAFE mask further investigations are needed to determine whether the network is able to support ToP synchronization of base stations or whether an optimization of the network is needed.

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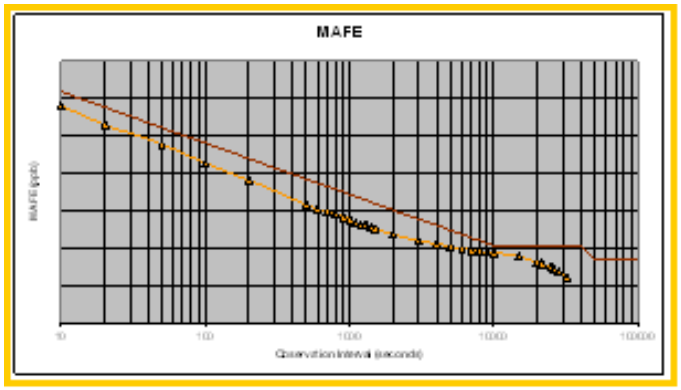
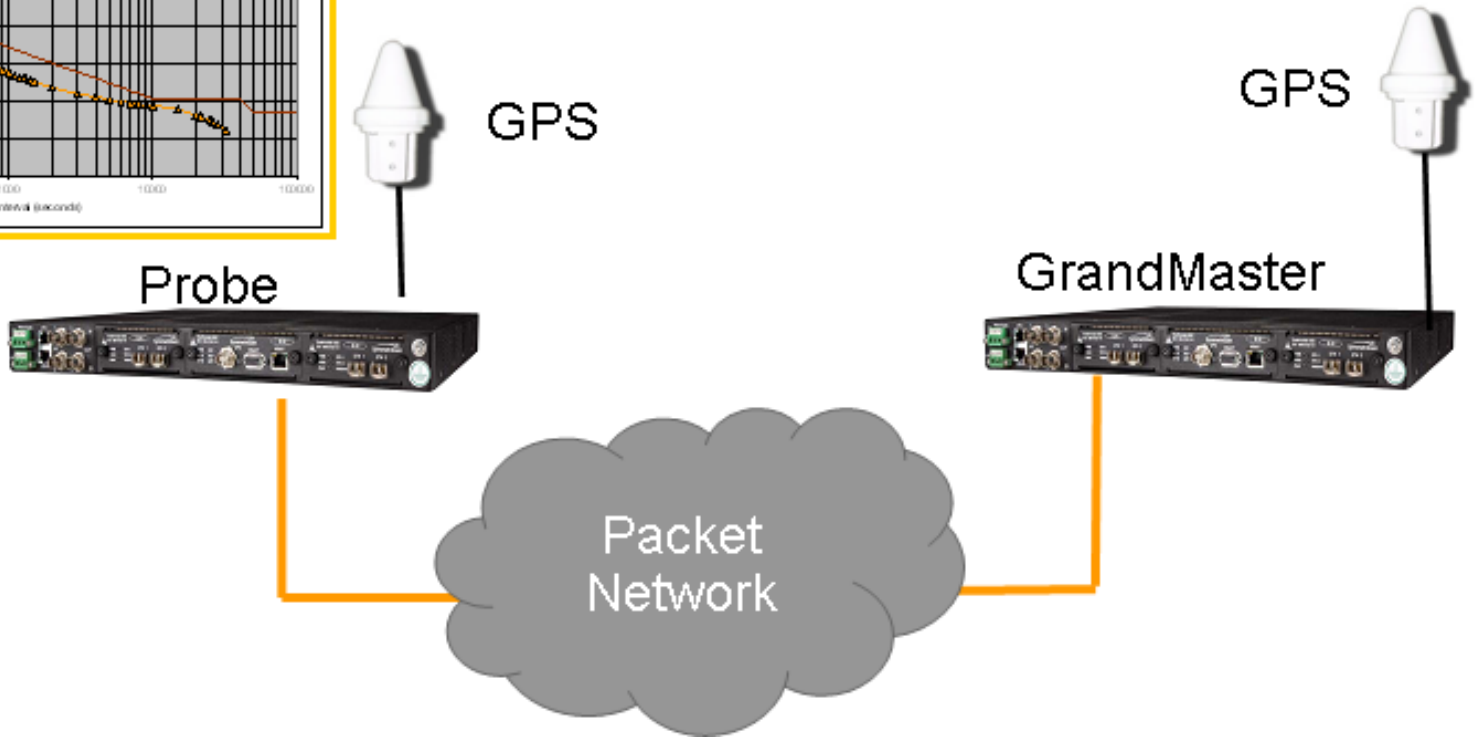
Network usability evaluation

- The measurement described above can be taken during the implementation of the RAN as pre-qualification before putting into operation the Mobile network.
- The measurement can be also used in the live network as permanent monitoring solution and for fault location.

Packet network assessment – Scenario I

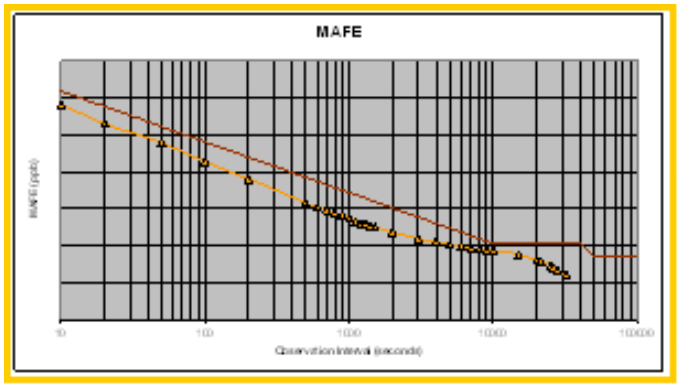
MAFE measurement as network pre-qualification

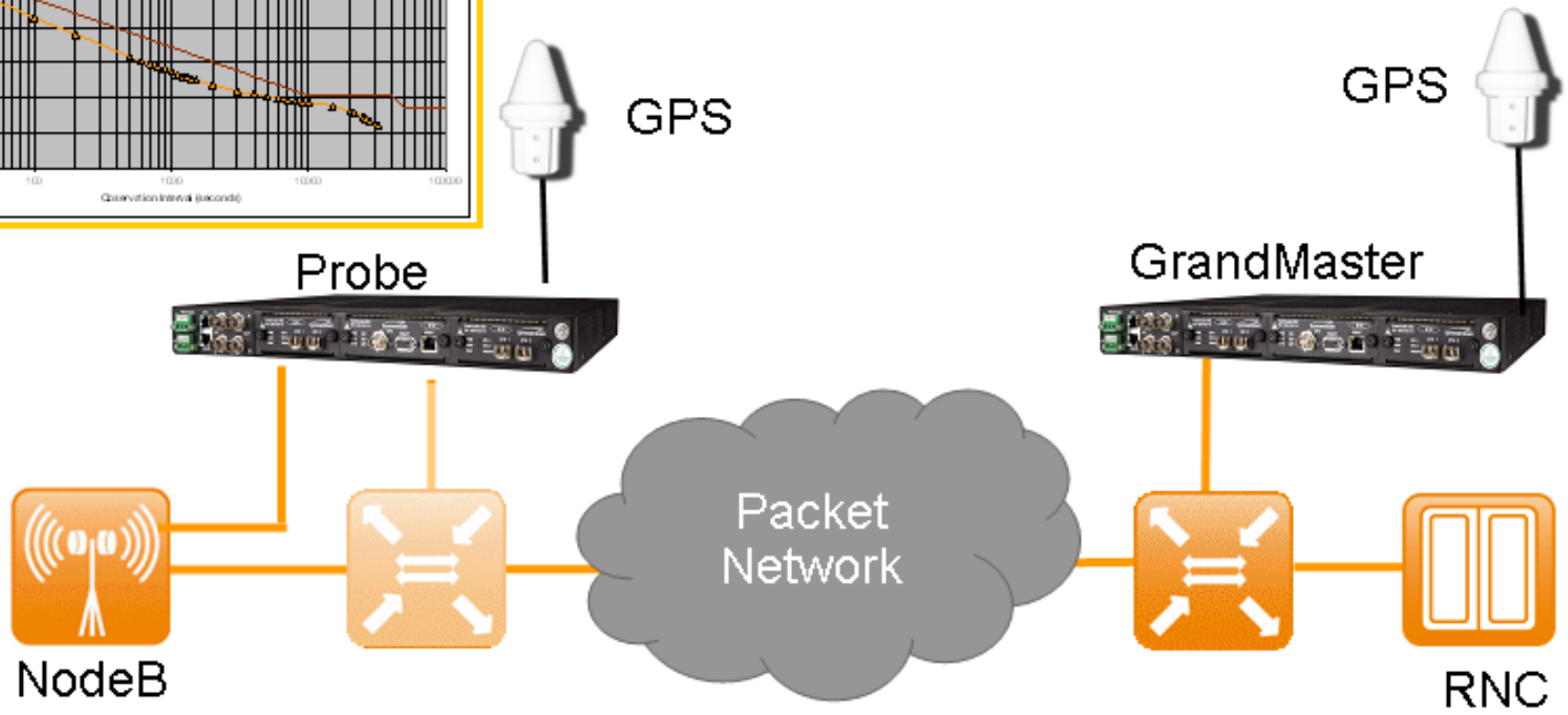




Packet network assessment – Scenario II

MAFE measurement for network monitoring and fault location





Network improvement

- Based on the results of the MAFE measurement improvement of the network behavior might be necessary to become compliant with the MAFE mask if possible.
- After the network improvement has be done the measurement can be repeated to check whether the network behavior is now compliant with the requirement.

Thank you

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