PACKET SYNCHRONIZATION IN IP RADIO ACCESS NETWORKS

Experiences From a Mobile Vendor Perspective From the Deployment of Packet-Based Synchronization Solutions for the Mobile Backhaul.

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PURPOSE

- Present characteristics from live networks and the performance of synchronization over packets in IP Radio Access Networks.

- Data is collected from commercial networks deployed since 2008
  - 40 000+ RBS's
  - 25+ operators
  - Different technologies (Ethernet, Microwave links, etc.)

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AGENDA

- Introduction to packet synchronization in Radio Access Networks
- Experiences and measurements from live networks
- Conclusion
- Questions

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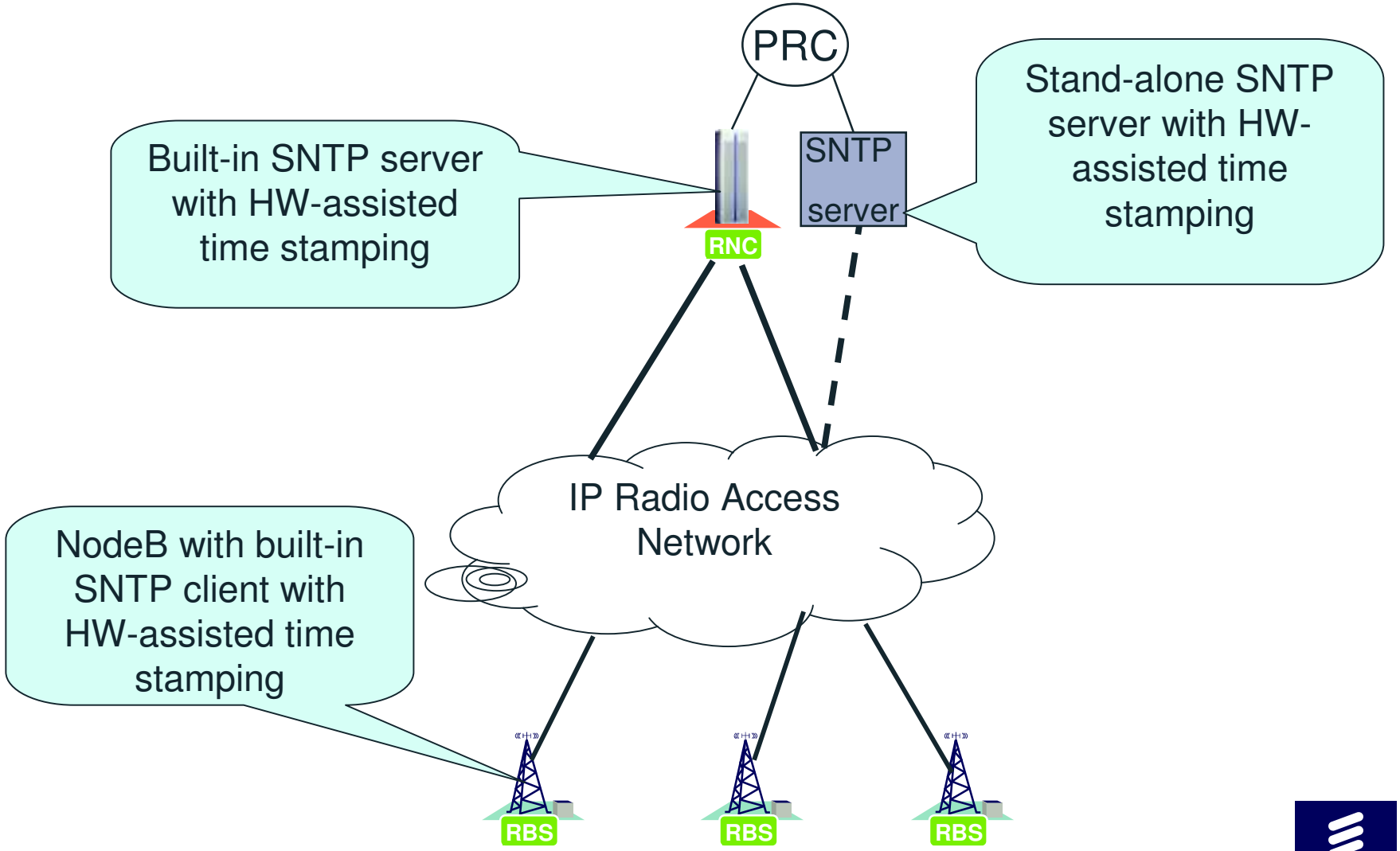
IP RADIO ACCESS NETWORK OVERVIEW



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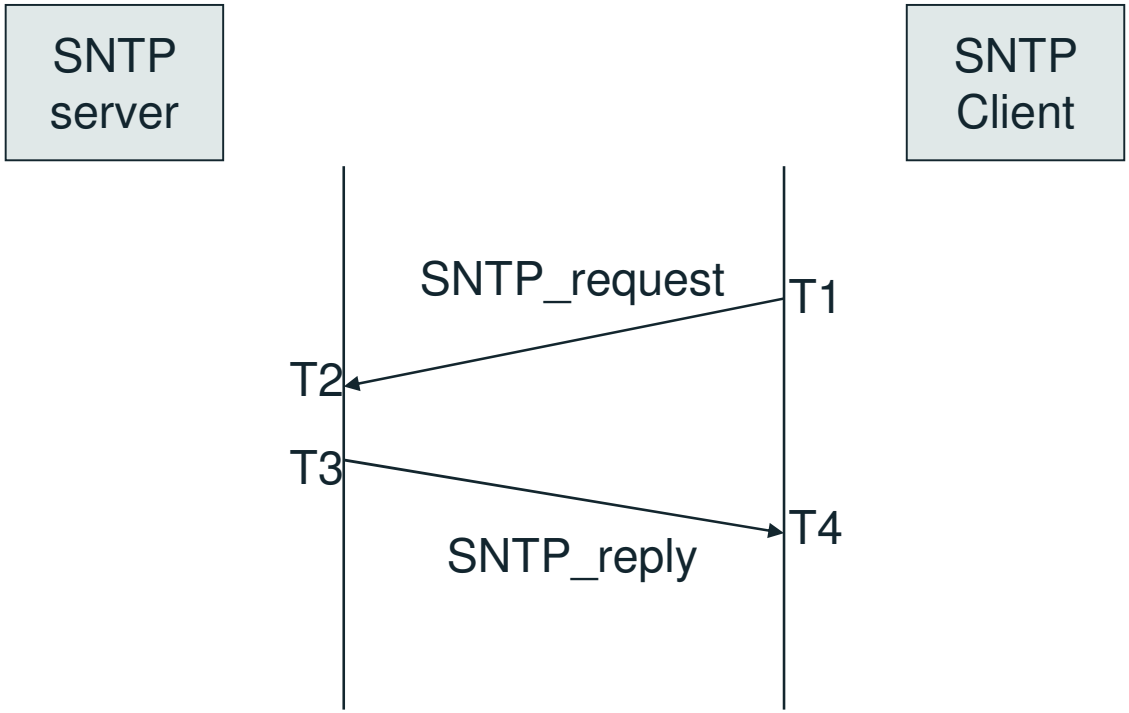
SNTP PROTOCOL



IP RADIO ACCESS NETWORKS

- Network characteristics are hard to determine, e.g. Packet Delay Variation (PDV).
- Limited information of the network topology.
- Often unclear whether Quality of Service is used in the network.
- If quality of service is used it's often unclear what Quality of Service is assigned to the synchronization packets.

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SNTP CHARACTERISTICS

- The SNTP client should at least be able to frequency lock if the delay variation for 99% of the packets does not exceed 10 ms.
  - 3GPP TS 23.203 table 6.1.7 Standardized QCI characteristics
- The HW is based on an OCXO oscillator.
- In a large Radio Access Network the SNTP traffic is typically less than 1000 packets per second.

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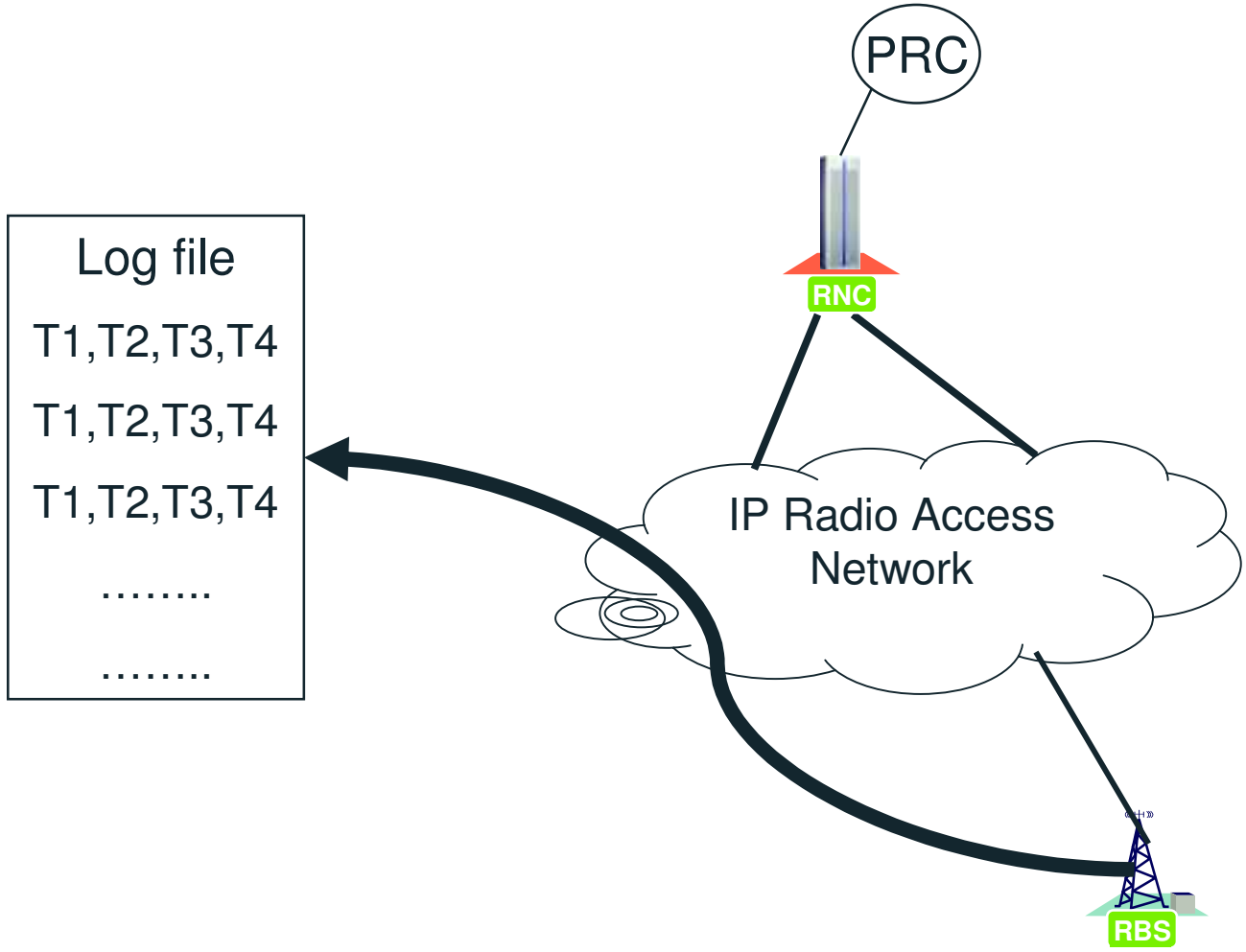
DATA COLLECTION FROM COMMERCIAL IP RADIO ACCESS NETWORKS



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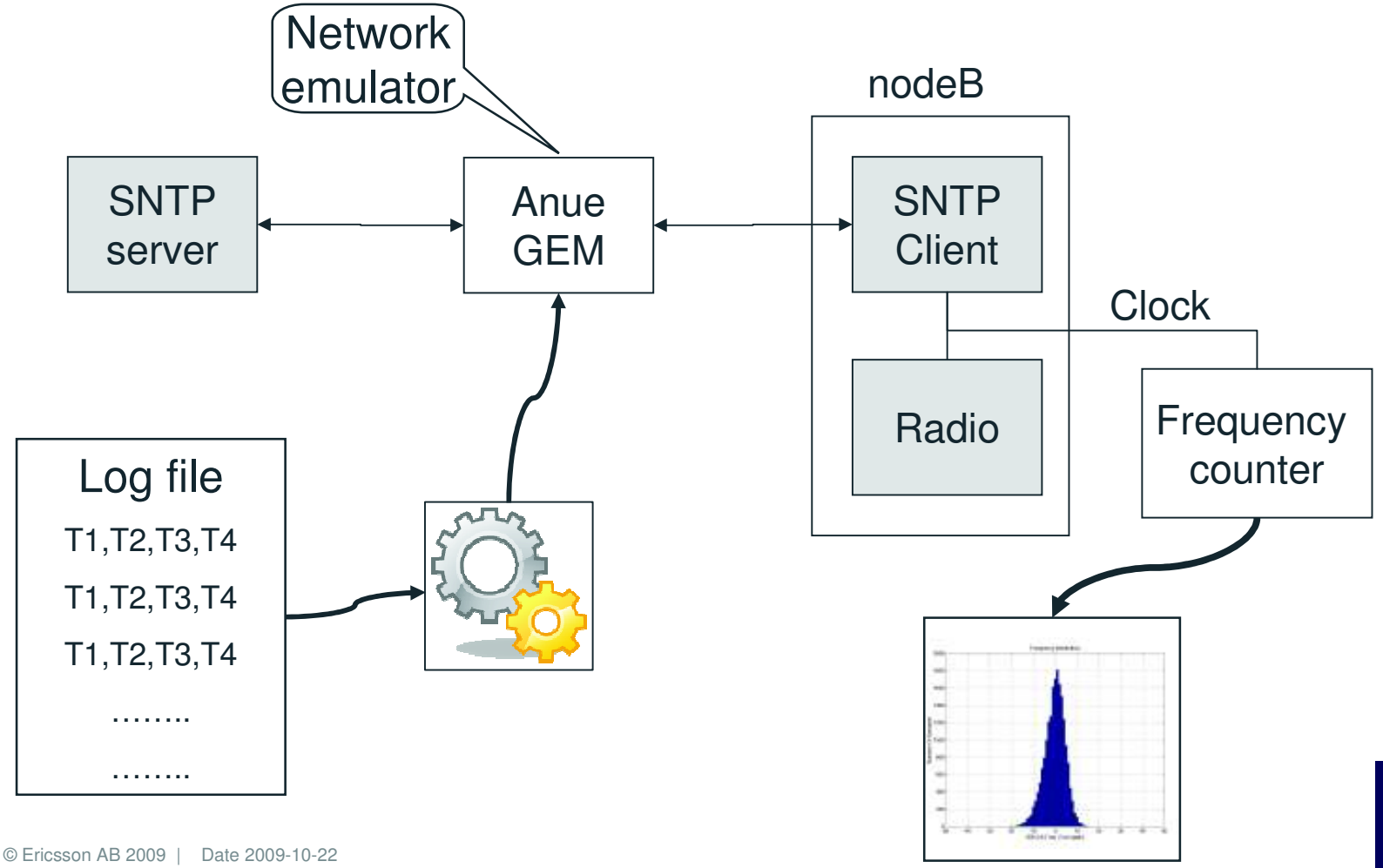
TEST SETUP (EMULATE IP RADIO ACCESS NETWORK)



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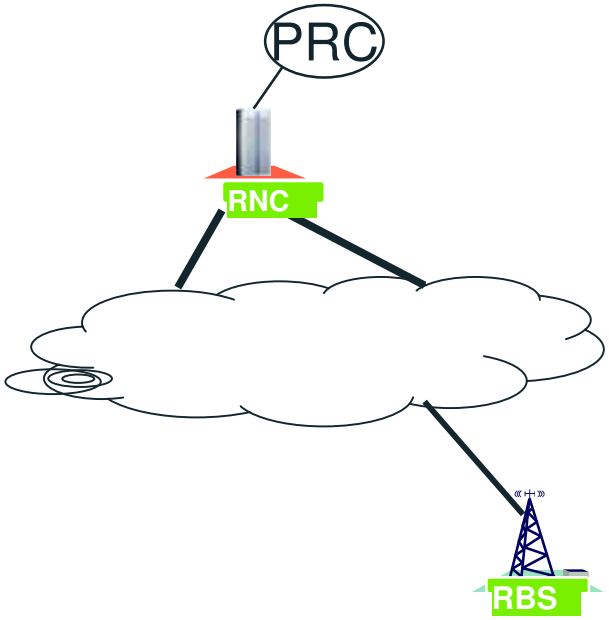
NETWORK 1

- Typical network characteristics for a Radio access network.
- In commercial operation
- Time to lock: 6 minutes



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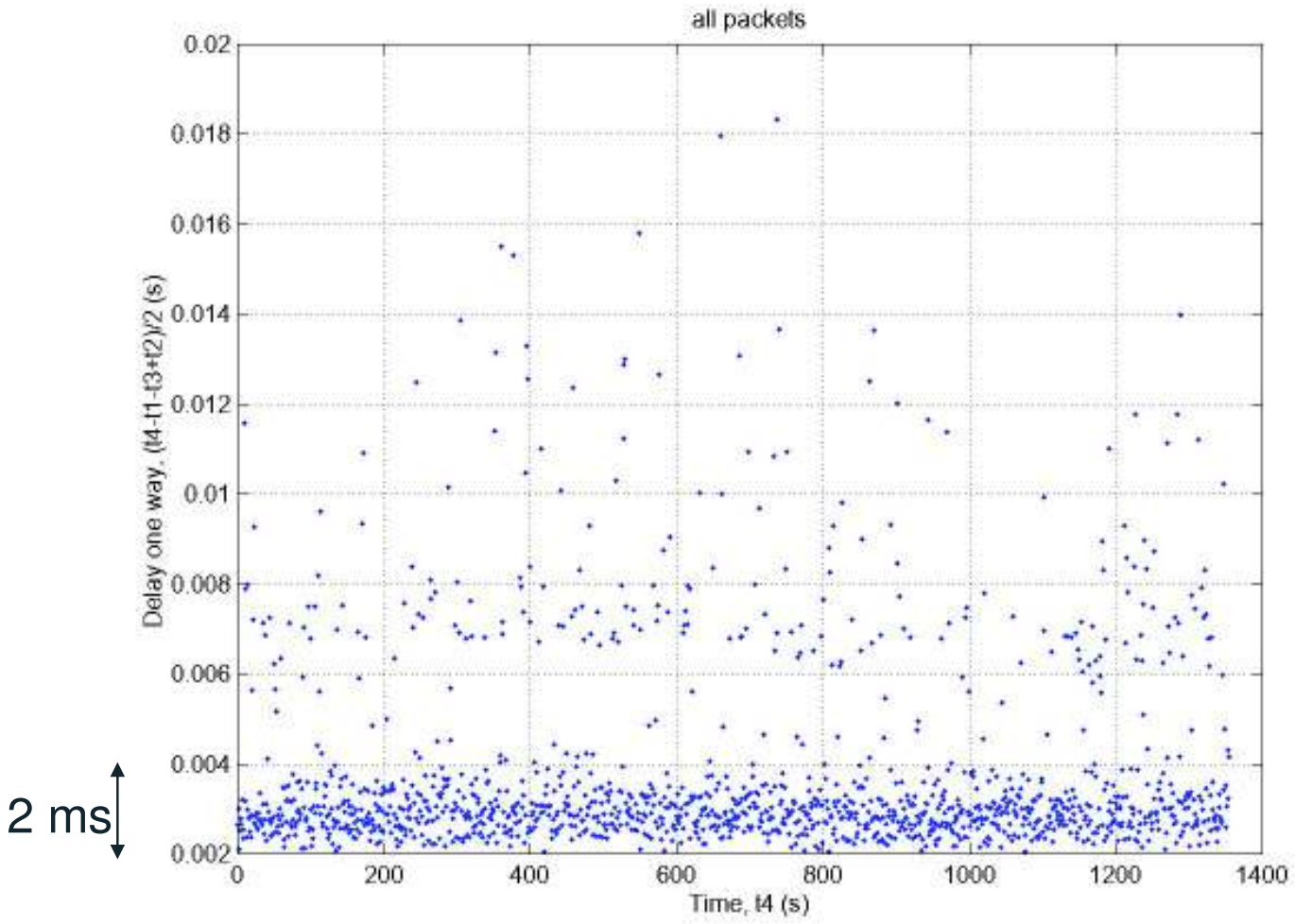
NETWORK 1 , DELAY ONE WAY



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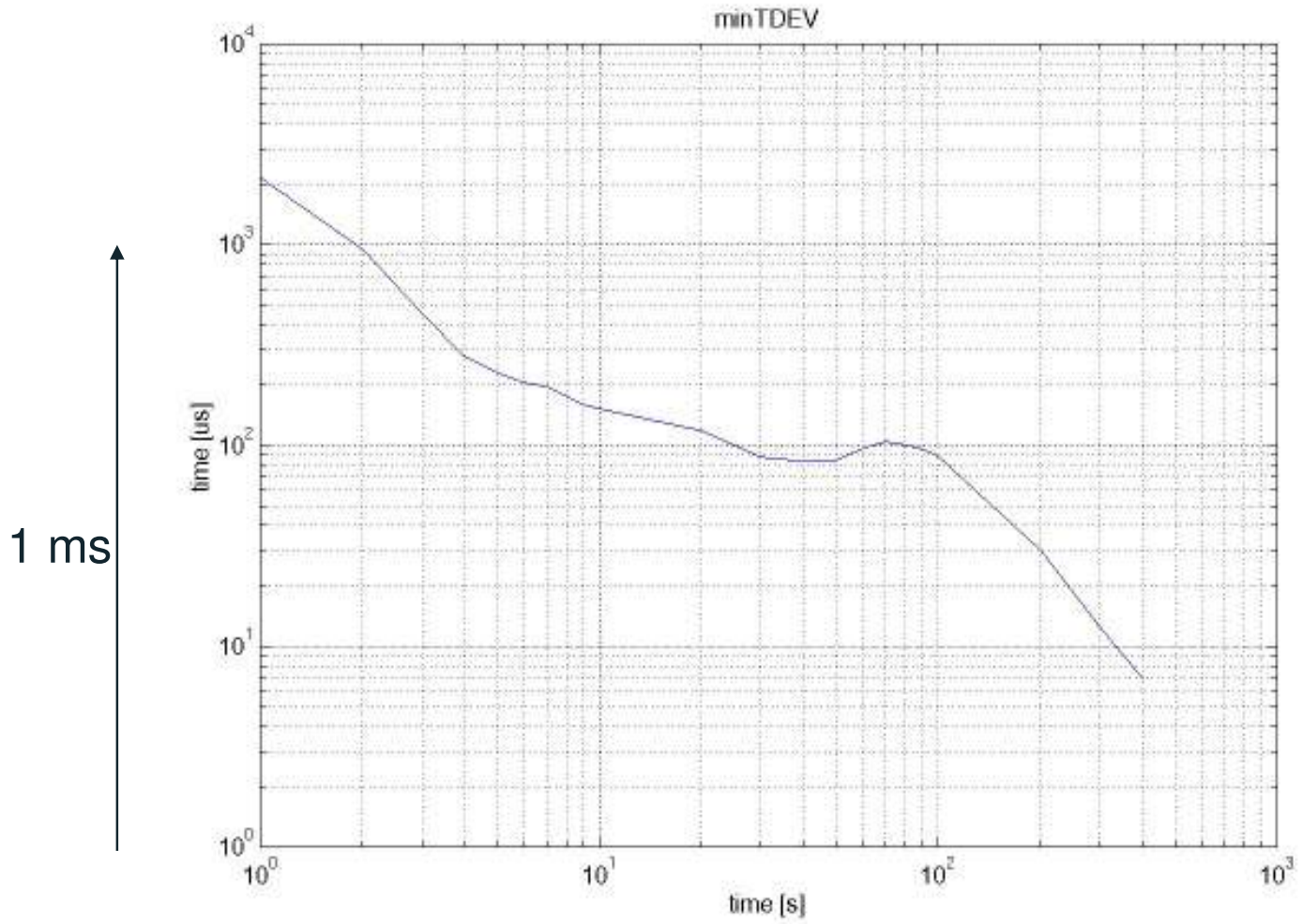
NETWORK 1, MIN TDEV



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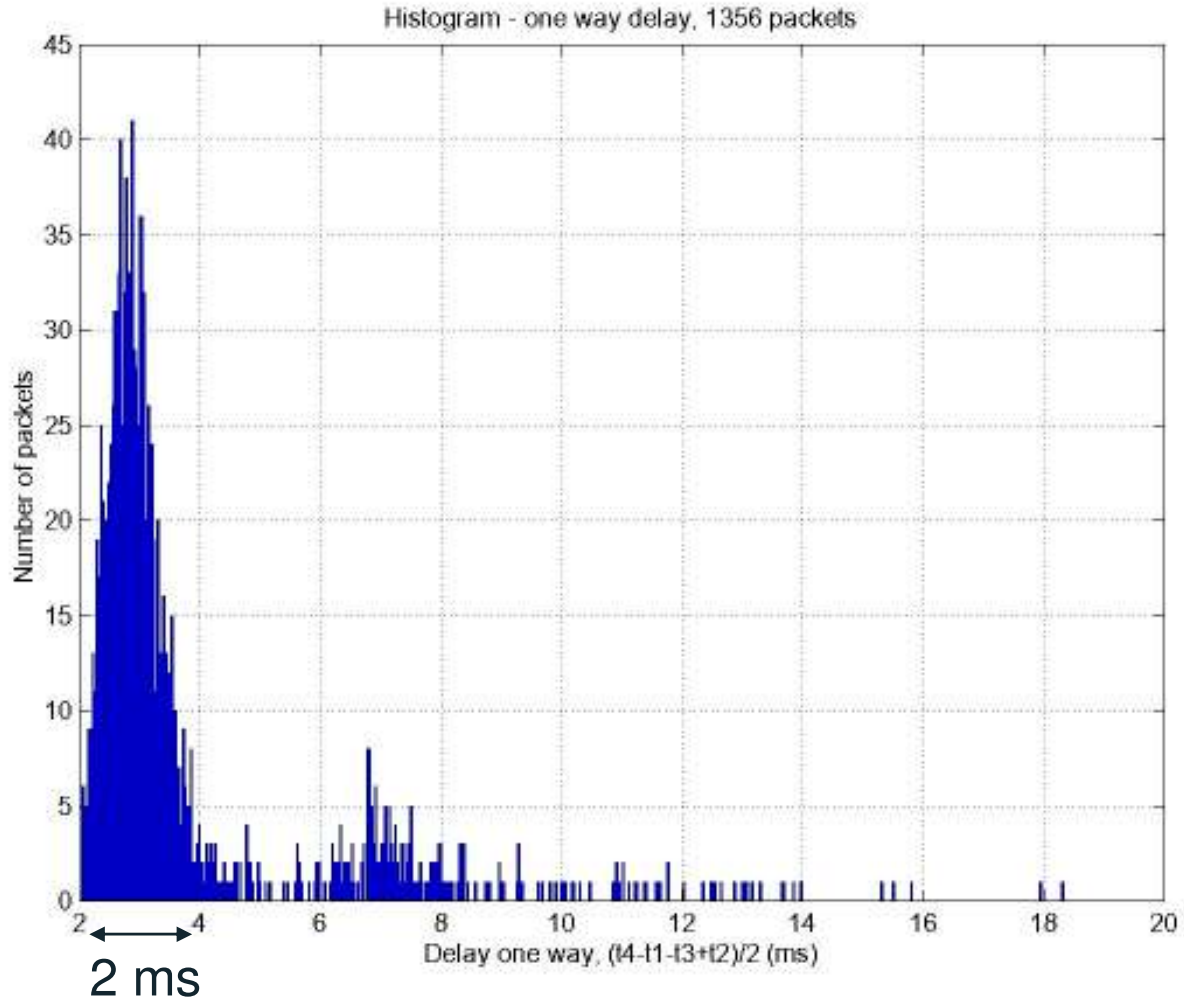
NETWORK 1 , DELAY ONE WAY HISTOGRAM



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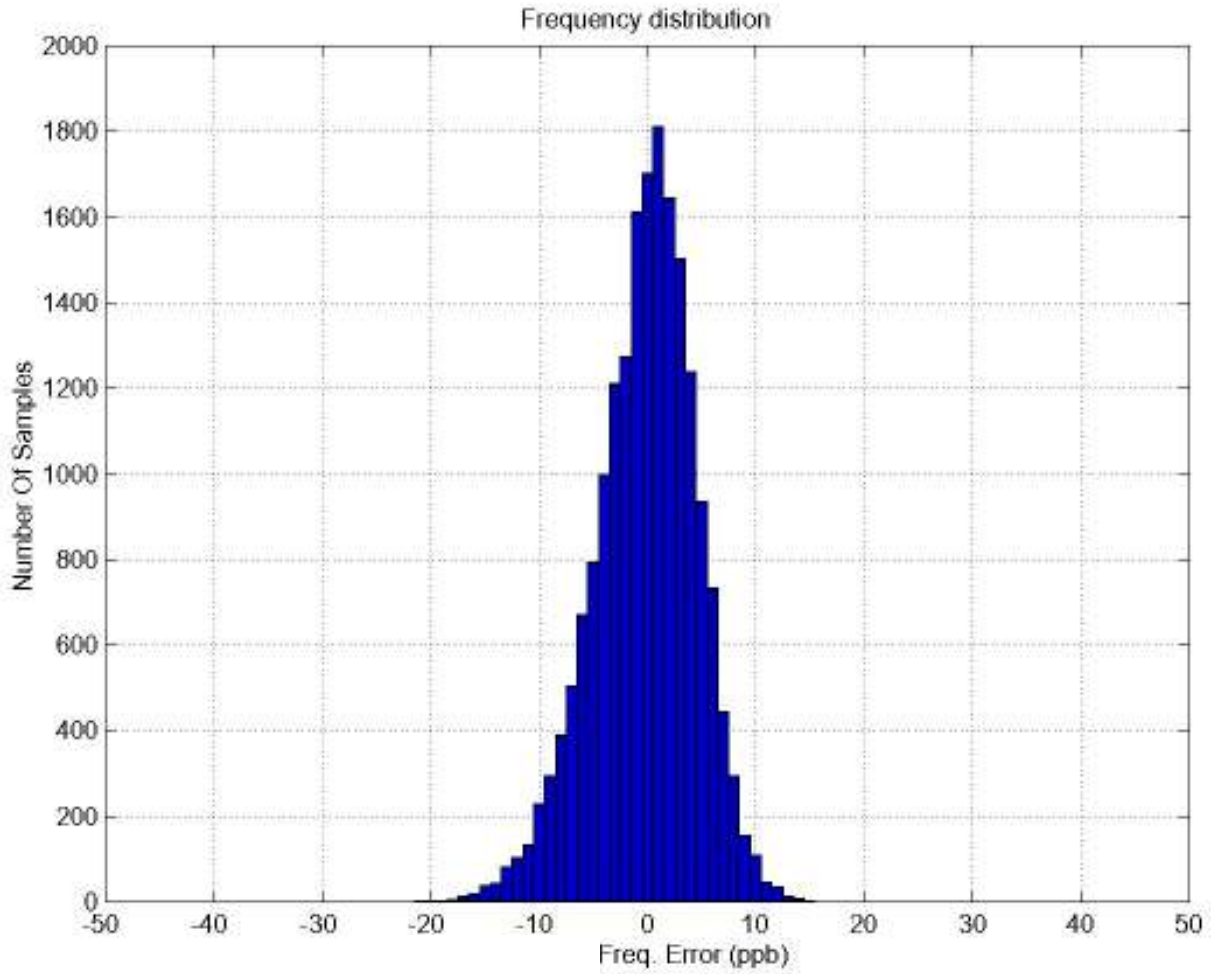
NETWORK 1, FREQUENCY DISTRIBUTION



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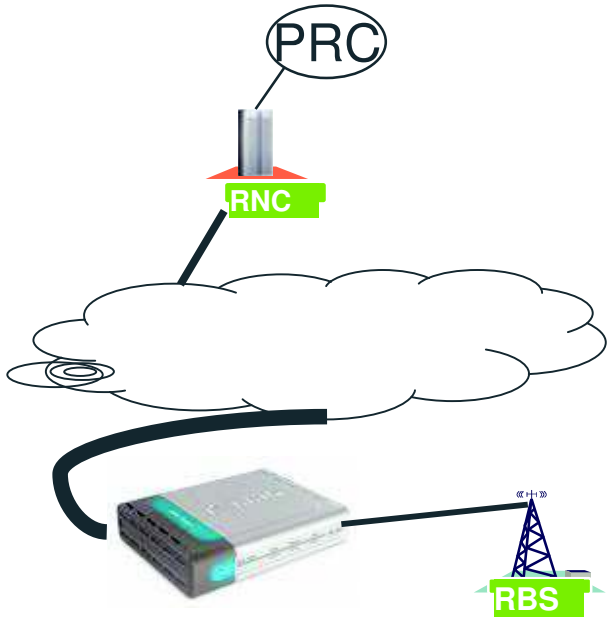
NETWORK 2

- Network using ADSL
- In commercial operation, tried to use Synchronization over IP.
- Time to lock: Too high PDV



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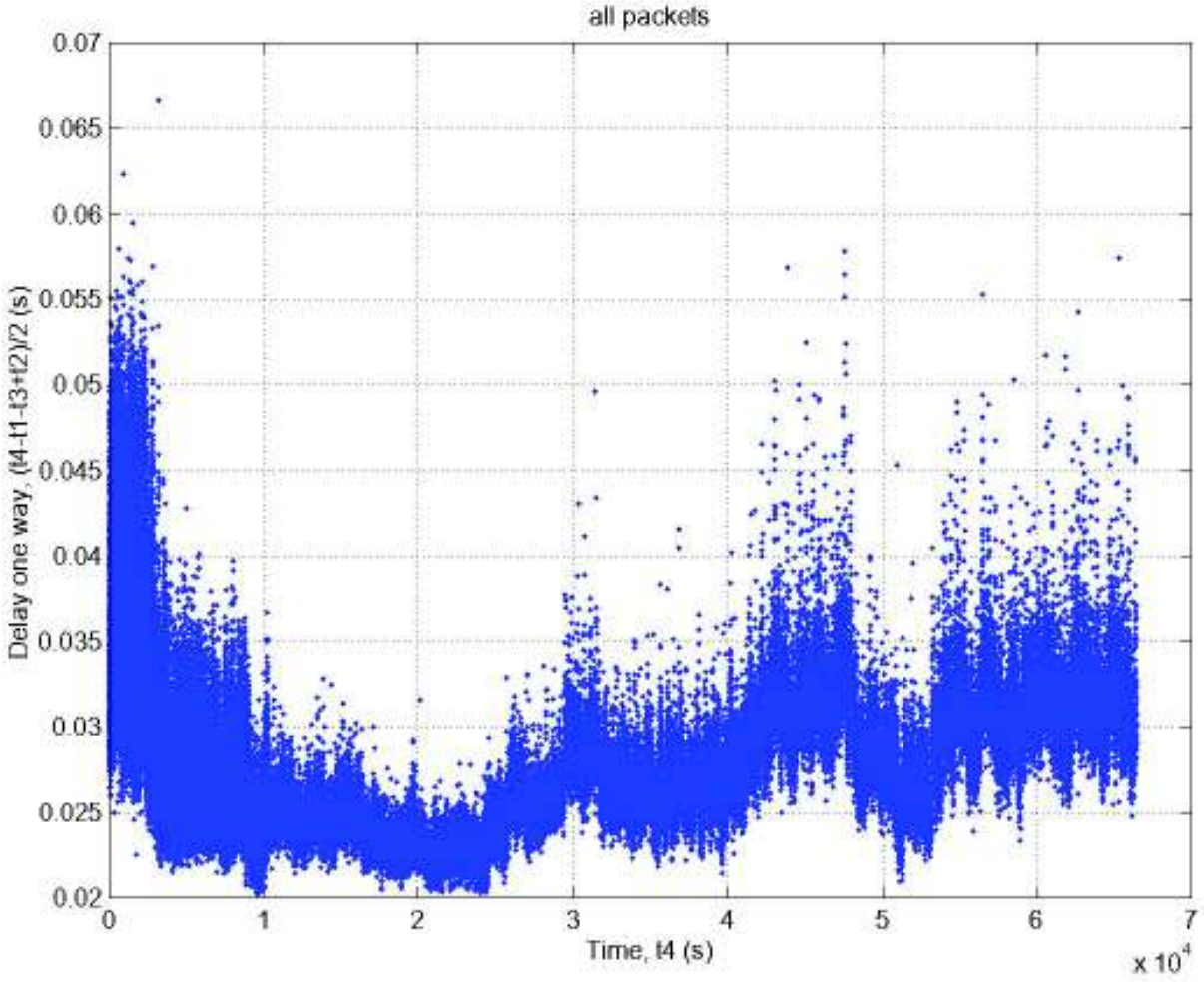
NETWORK 2 , DELAY ONE WAY



5 ms

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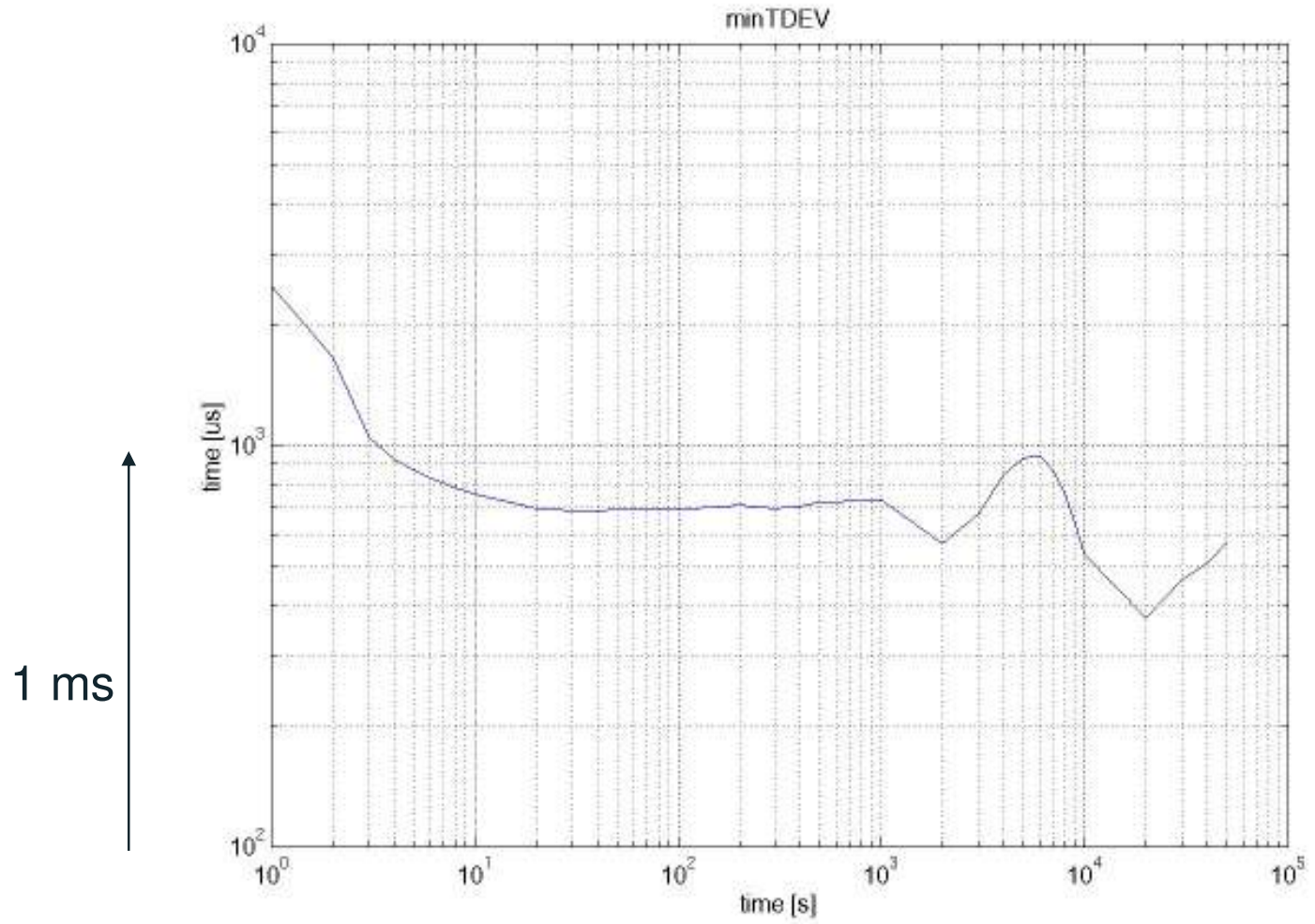
NETWORK 2, MIN TDEV



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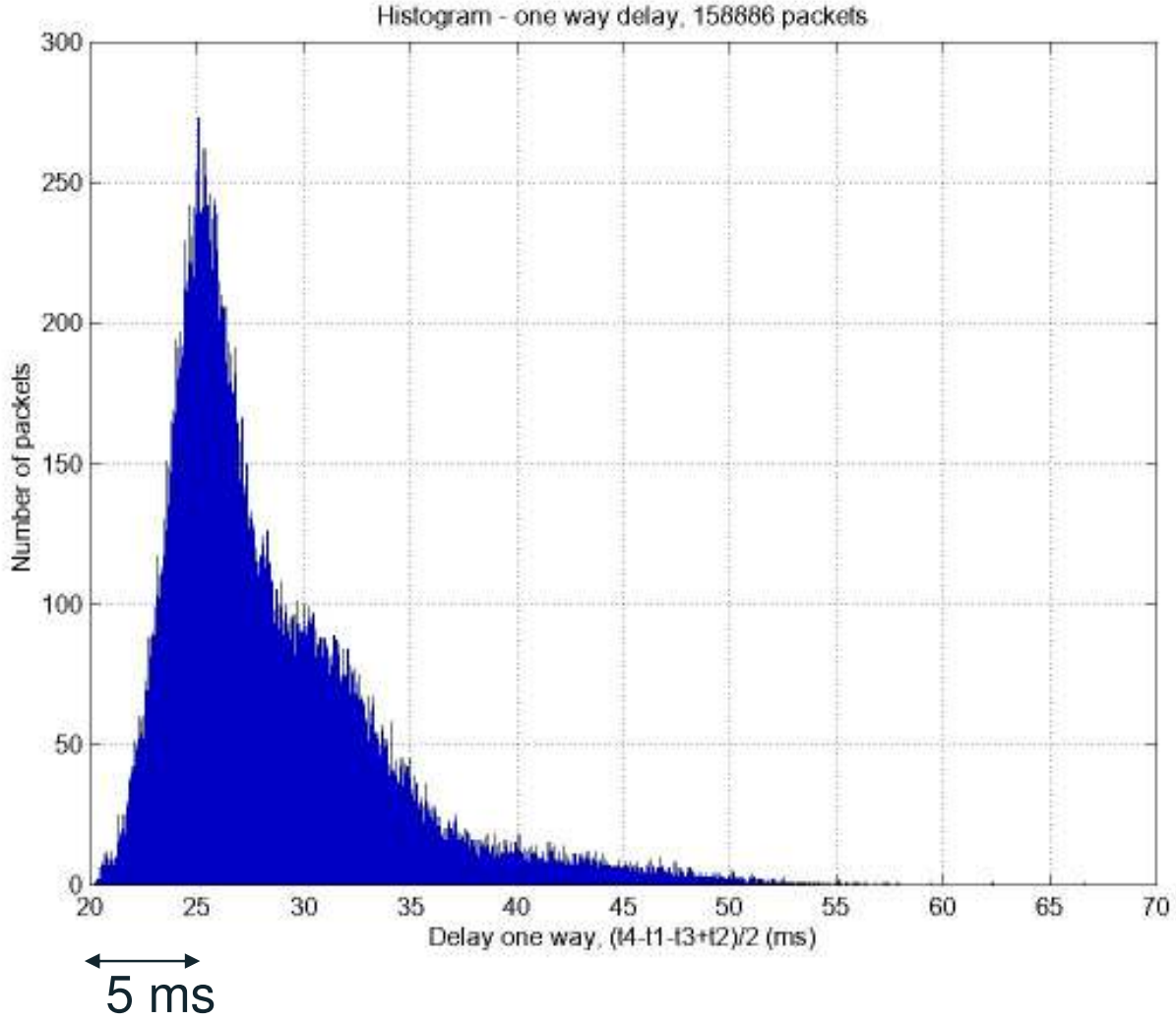
NETWORK 2 , DELAY ONE WAY HISTOGRAM



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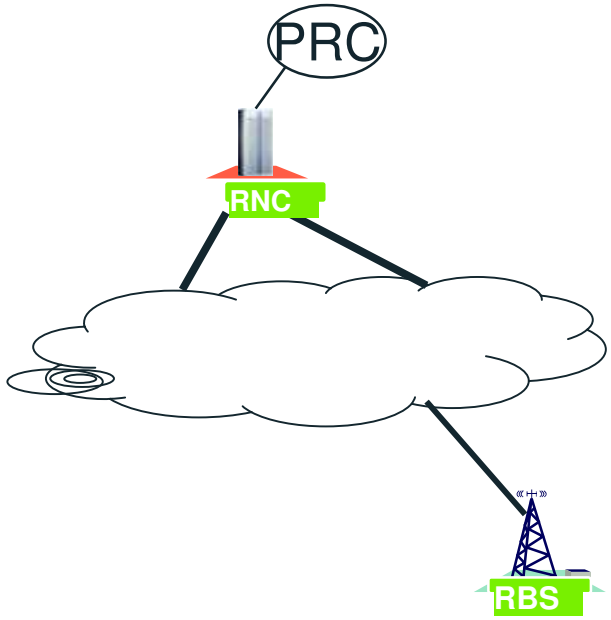
NETWORK 3

- Minimum delay difficult to quantify
- In commercial operation
- Time to lock: 10 Minutes



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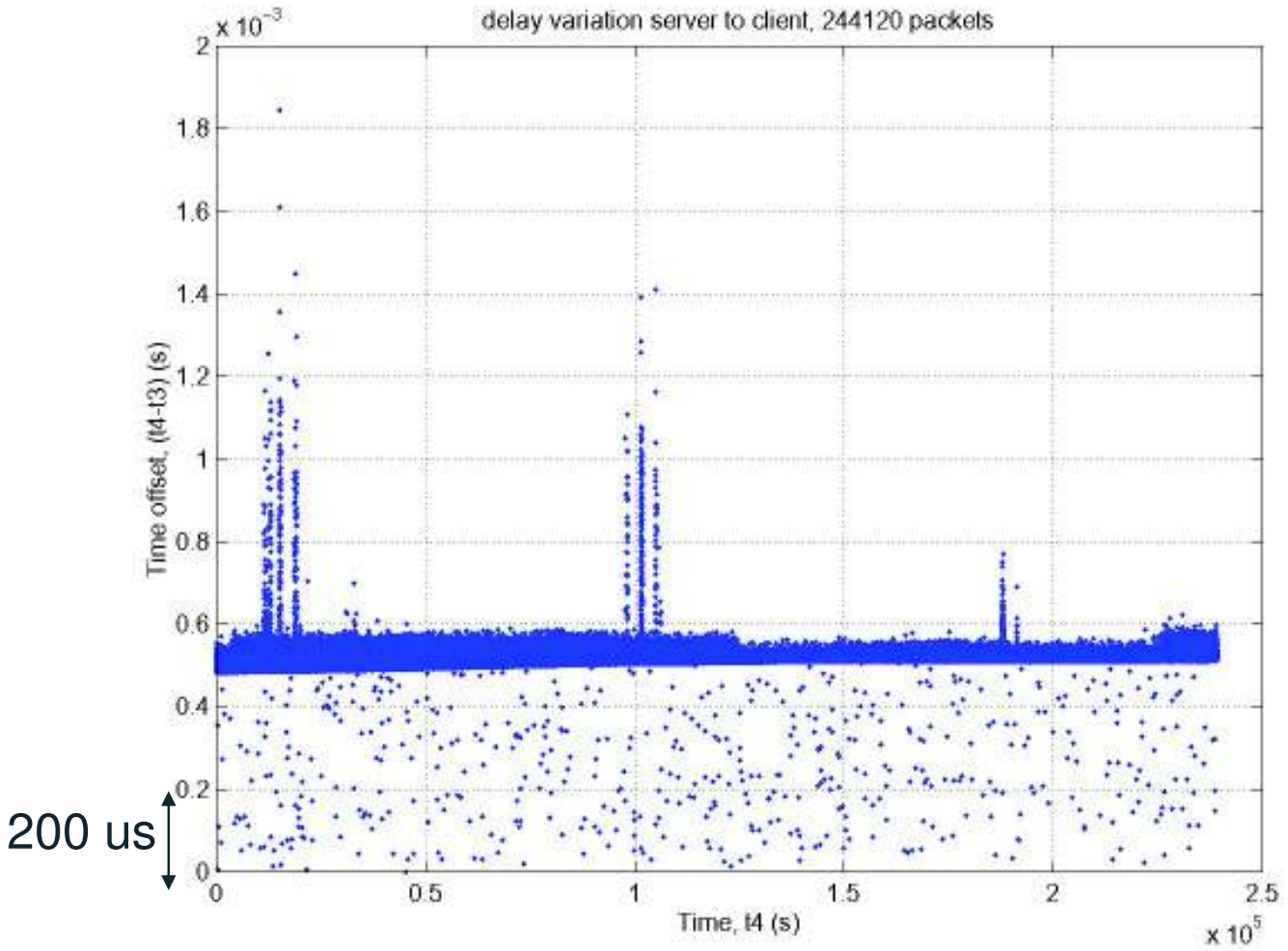
NETWORK 3, DELAY SERVER TO CLIENT



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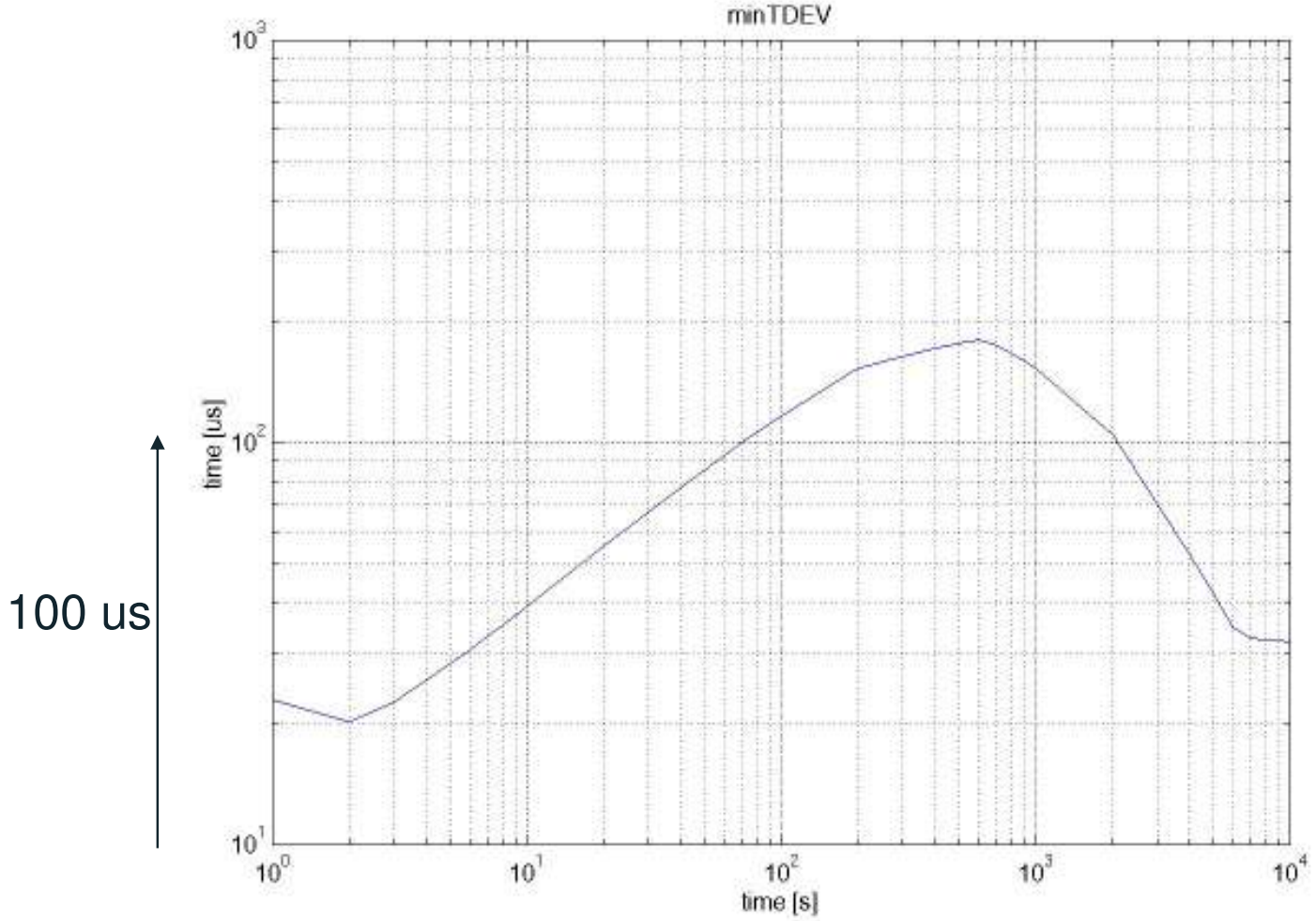
NETWORK 3, MIN TDEV



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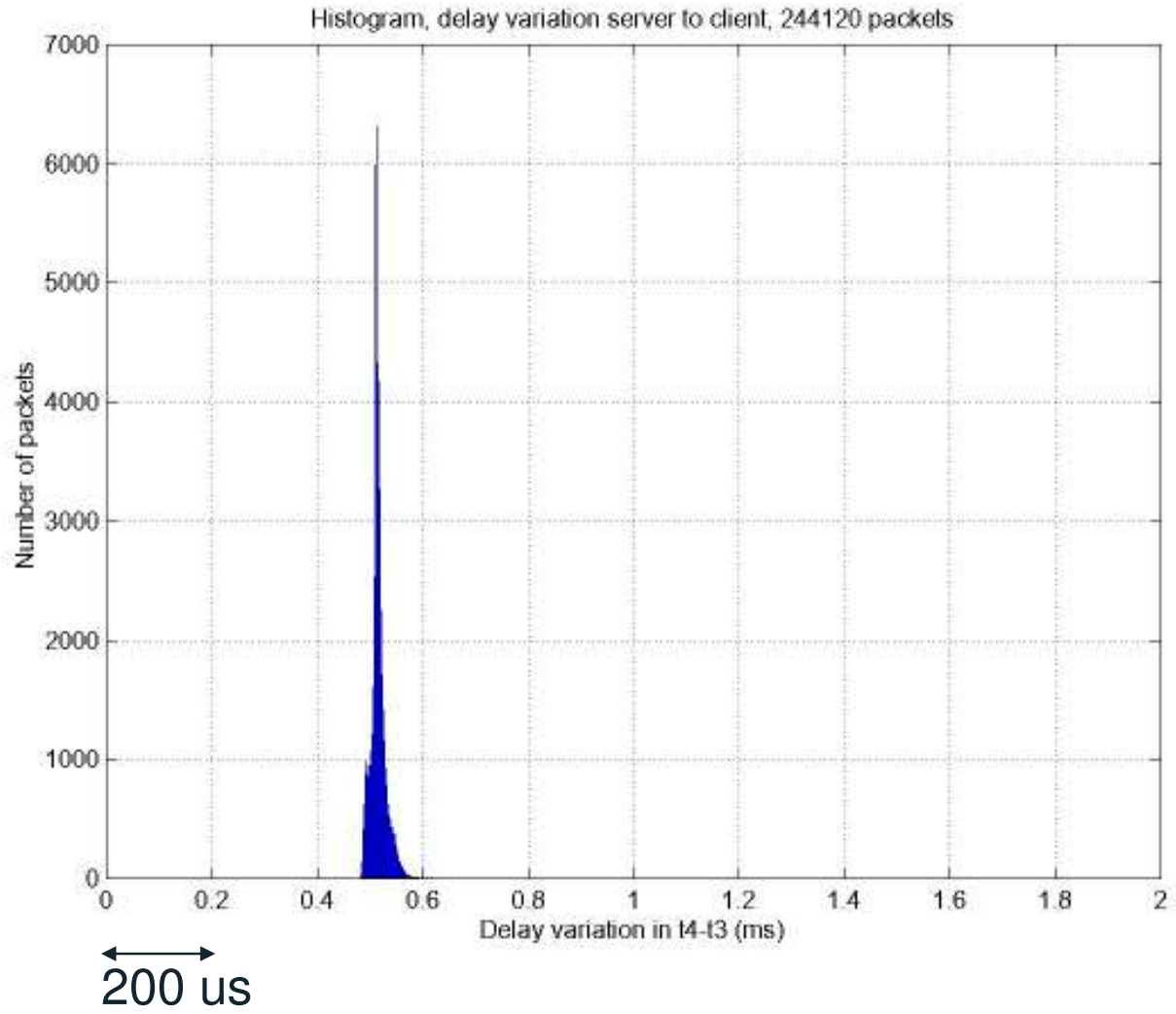
NETWORK 3, DELAY SERVER TO CLIENT HISTOGRAM



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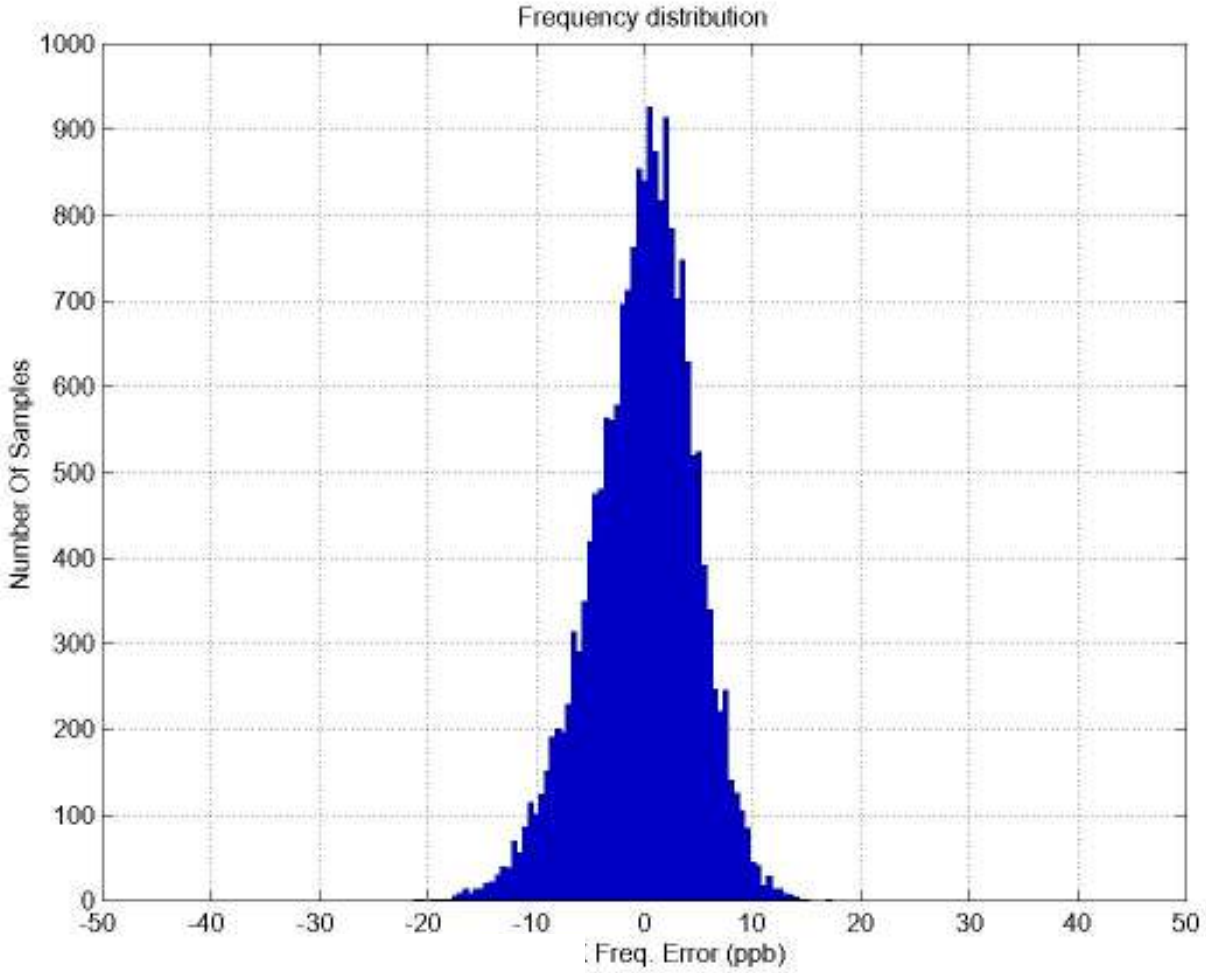
NETWORK 3, FREQUENCY DISTRIBUTION



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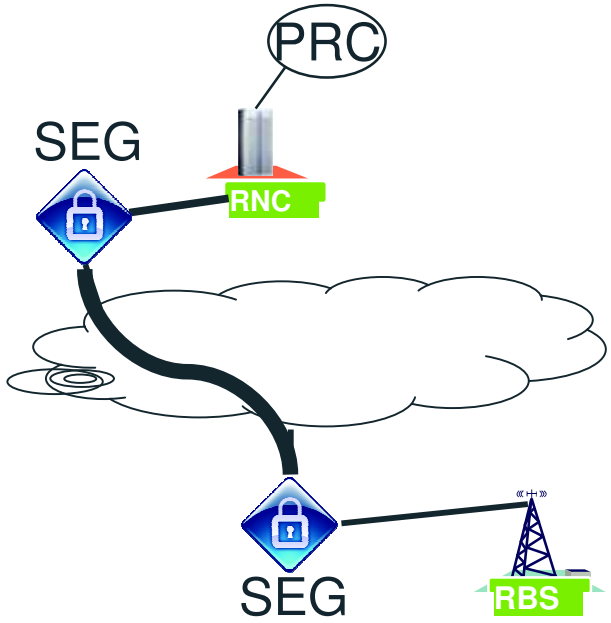
NETWORK 5

- Synchronization packets sent via an IPsec tunnel
- A majority of the packets in two sharp peaks
- Test network
- Time to lock: 15 Minutes



SEG – Security gateway

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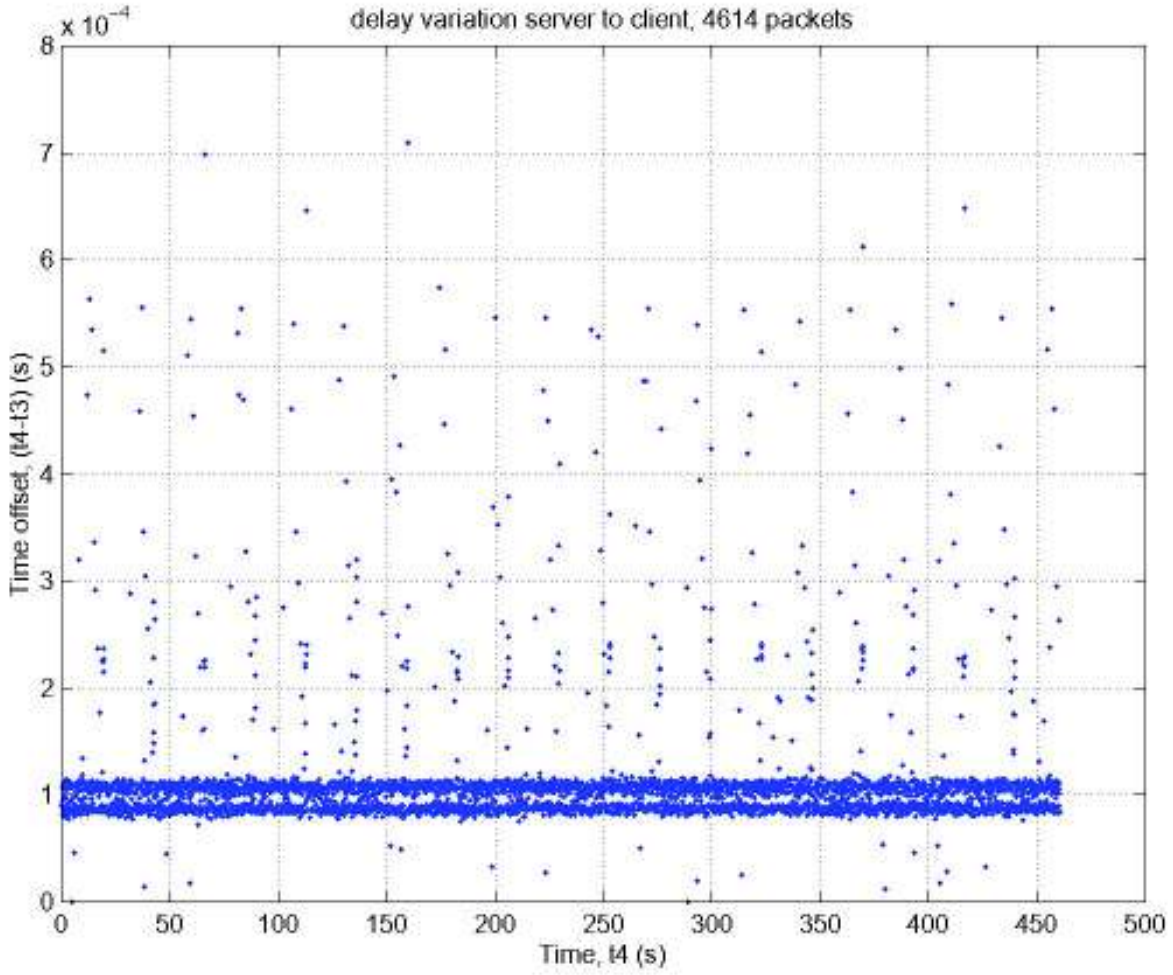
NETWORK 5 , DELAY SERVER TO CLIENT



100 us

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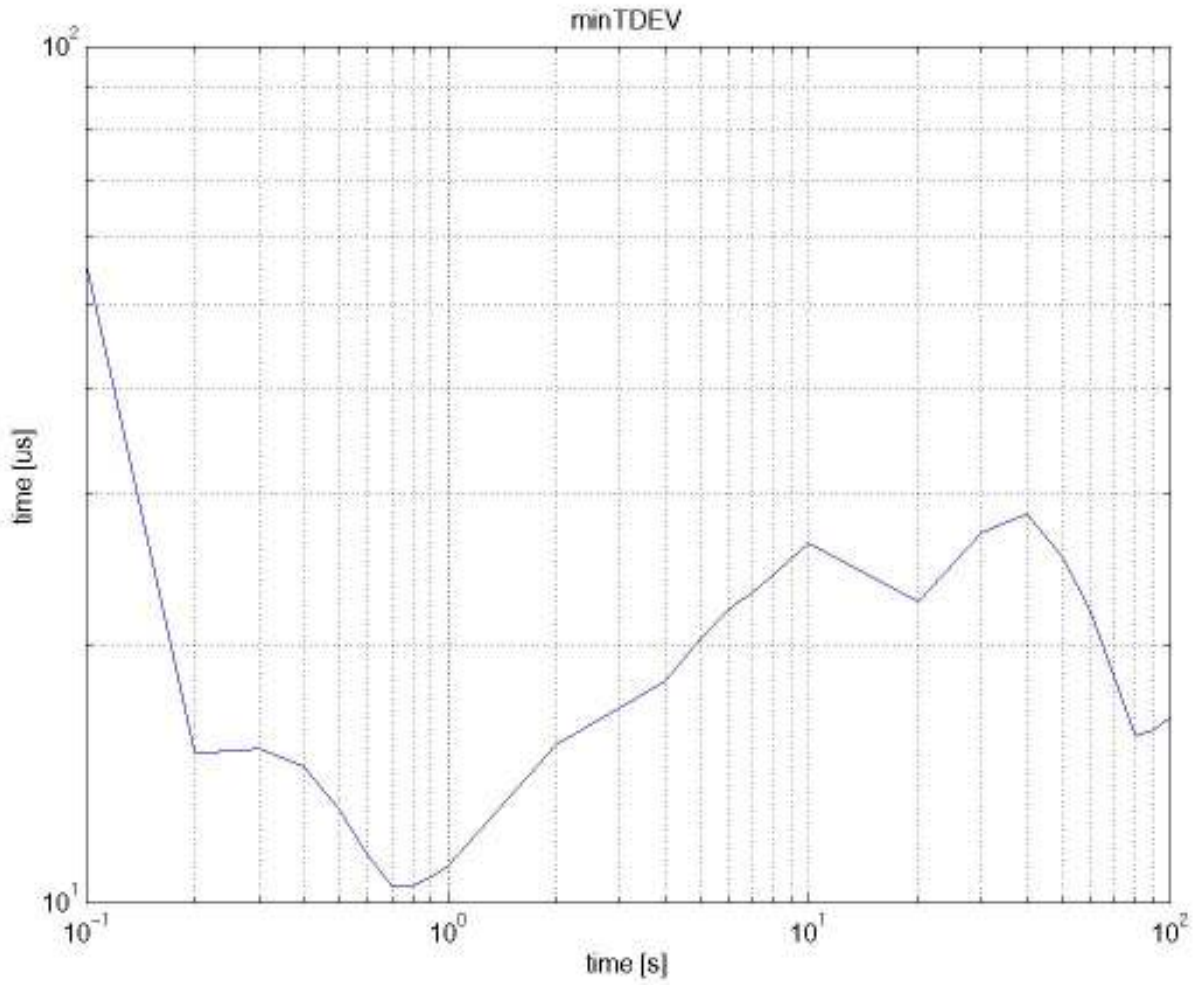
NETWORK 5, MIN TDEV

100 us



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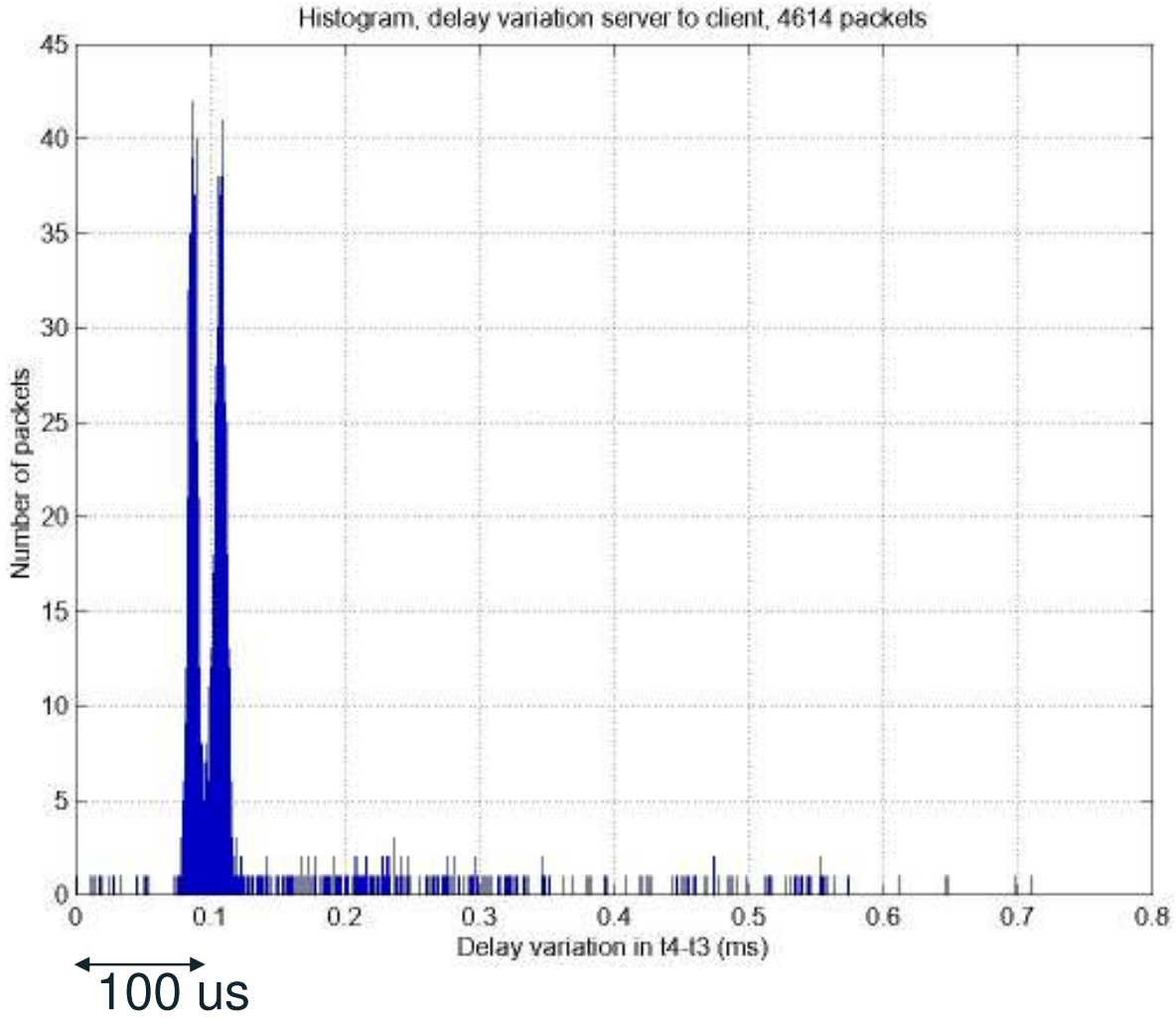
NETWORK 5 , DELAY SERVER TO CLIENT HISTOGRAM



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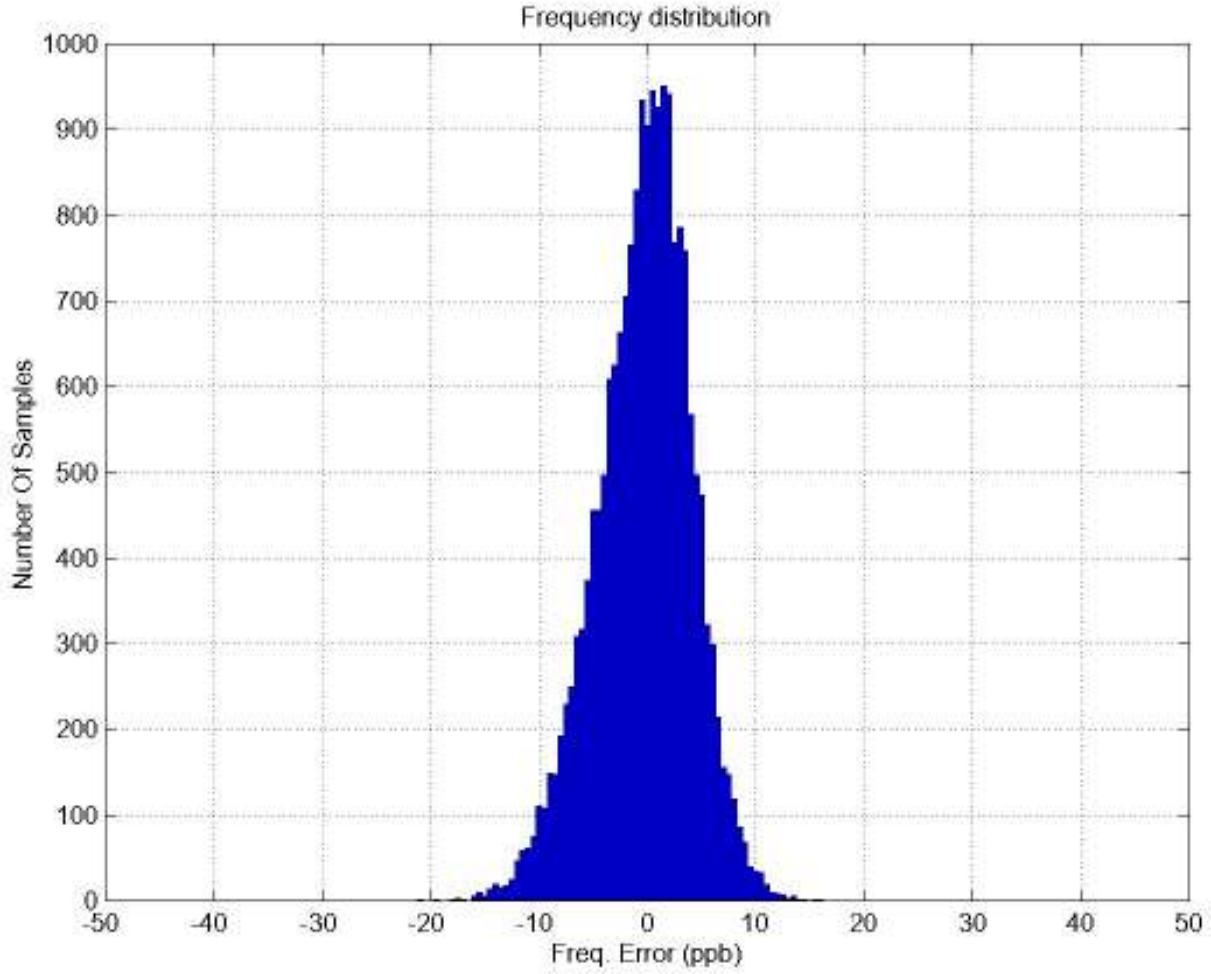
NETWORK 5, FREQUENCY DISTRIBUTION



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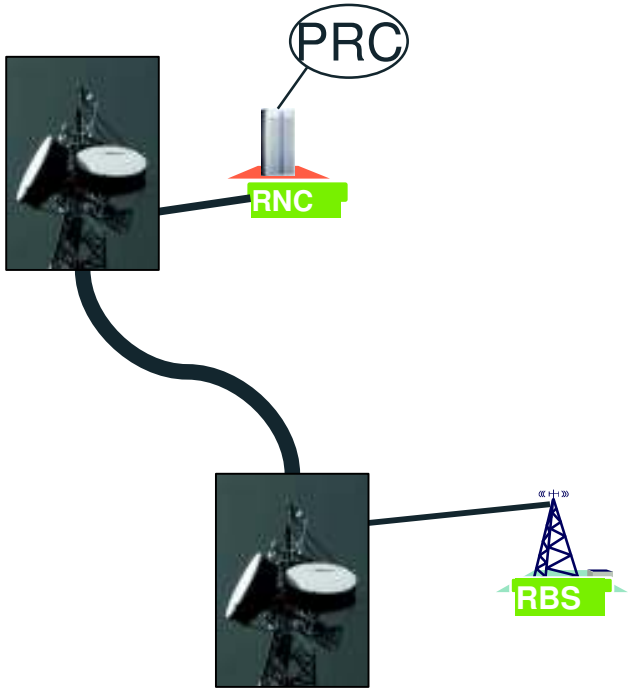
NETWORK 6

- Network using Microwave links (Minilink)
- In commercial operation
- Time to lock: 15 minutes



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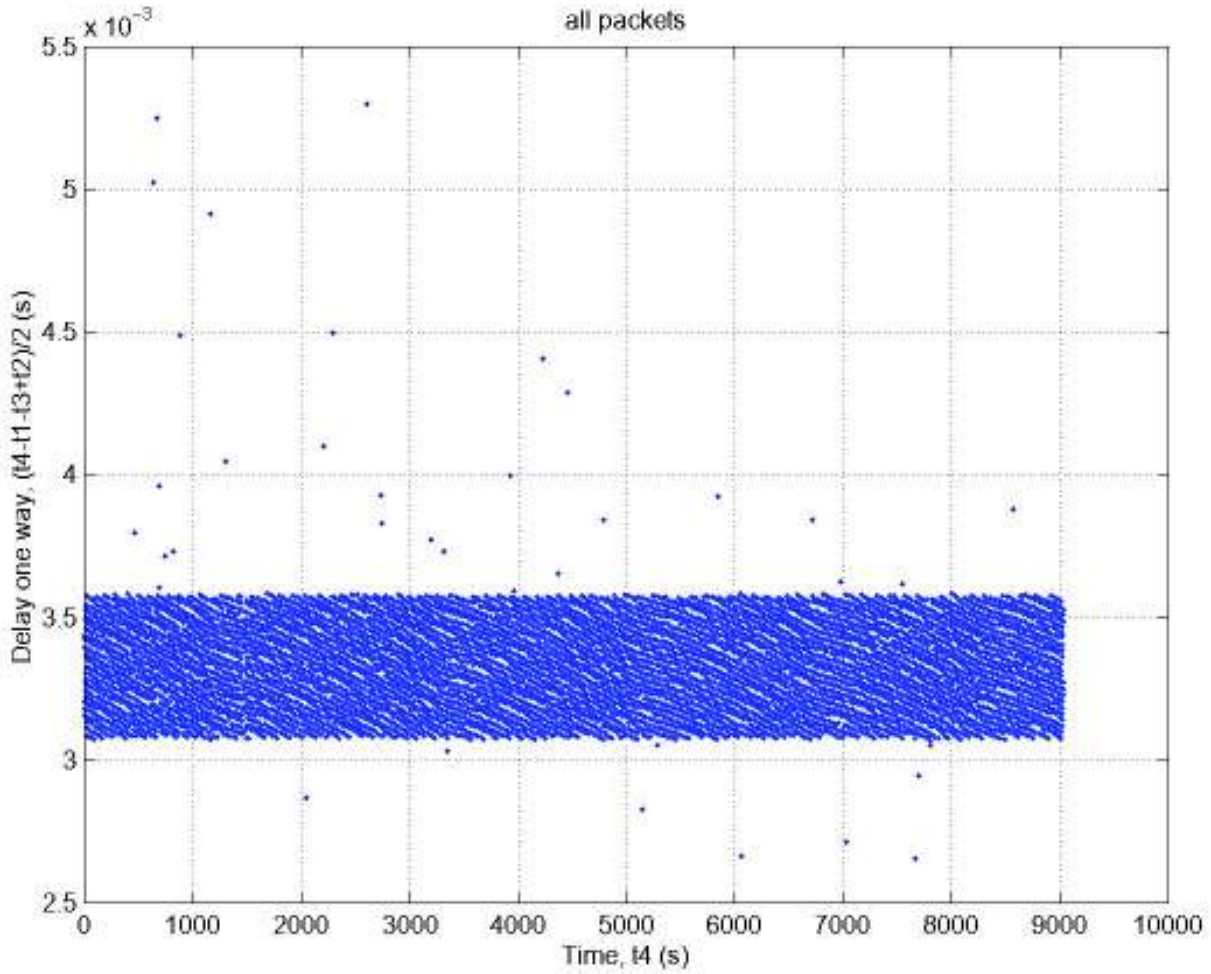
NETWORK 6 , DELAY ONE WAY



0.5 ms

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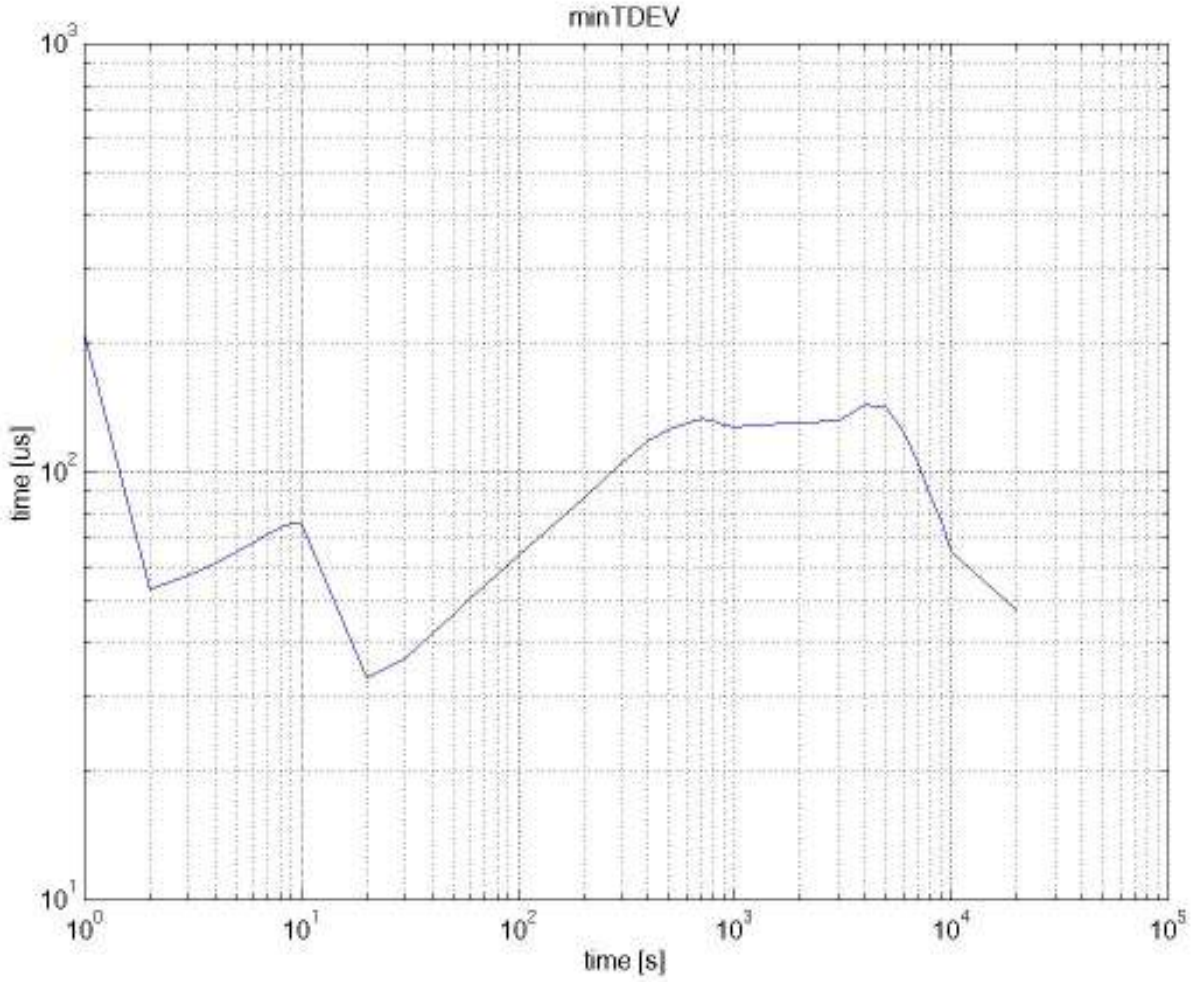
NETWORK 6, MIN TDEV



100 us

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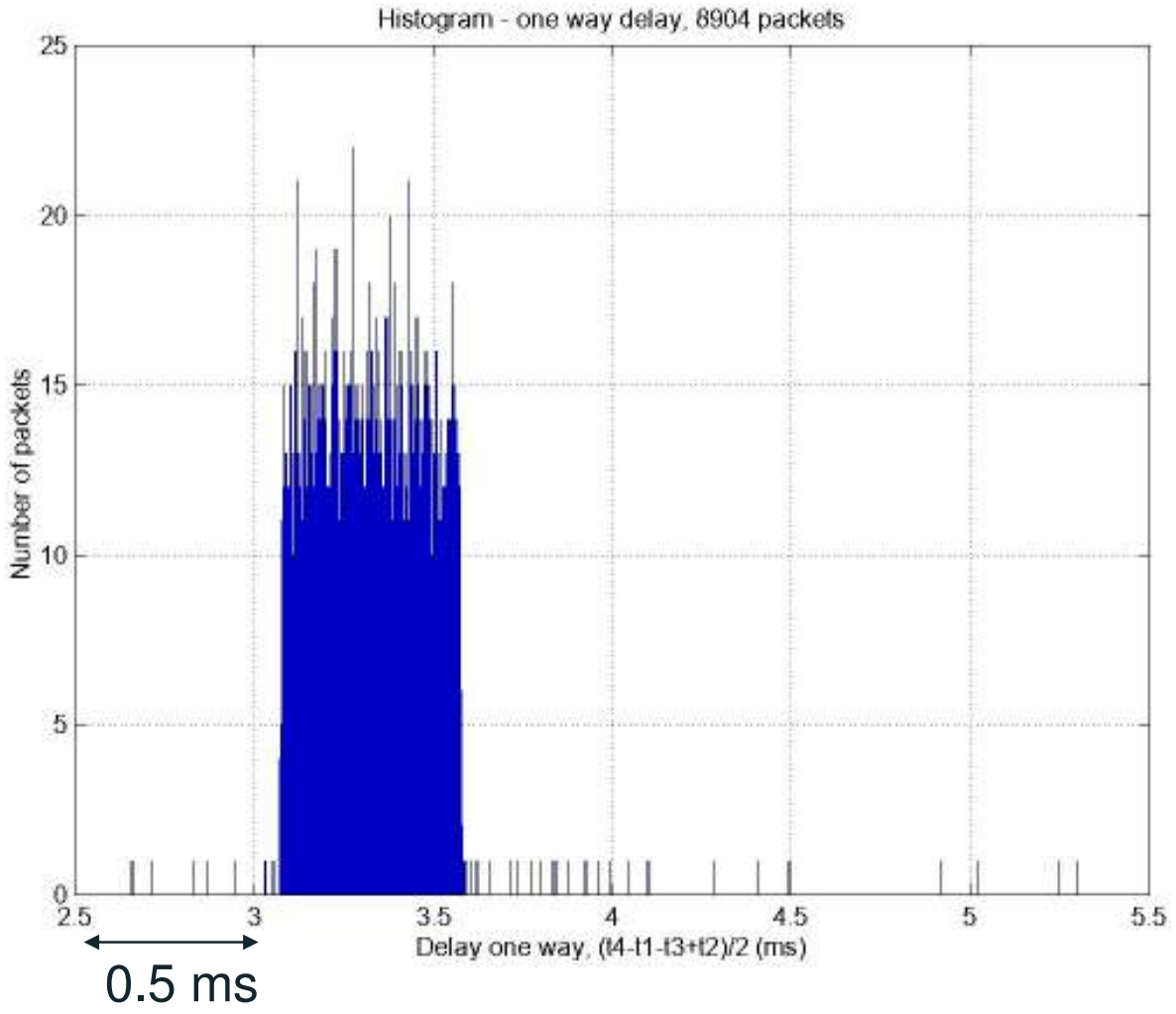
NETWORK 6 , DELAY ONE WAY HISTOGRAM



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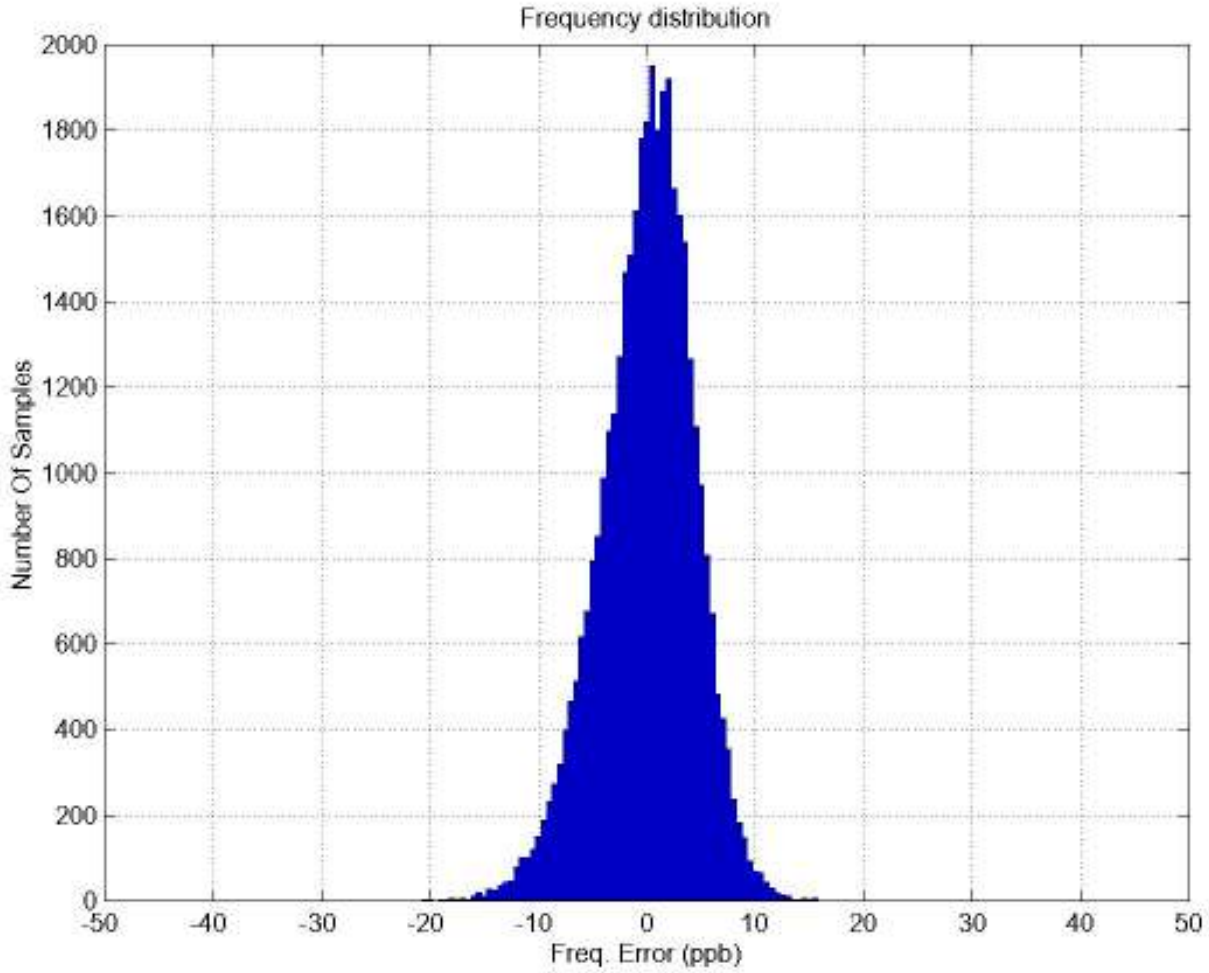

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PTP

- PTP is standardized (IEEE1588-2008) and, eventually, the Telecom profile (G.8264.1*) will be settled.
- Will enhance the performance with the introduction of
  - Boundary clocks
  - Transparent clocks
- Complex but well thought through.

* Number may change in the future

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SYNCHRONIZATION OVER IP CONCLUSION

- The SNTP solution works well for frequency synchronization in Radio Access Networks with the exception for ADSL.
- A key factor is to use a stable oscillator (OCXO).
- With a more stable OCXO, packet synchronization over ADSL is technically possible.
- The same performance (as with SNTP) is expected when using PTP without support from the network, i.e. Transparent/Boundary clocks.

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QUESTIONS ?

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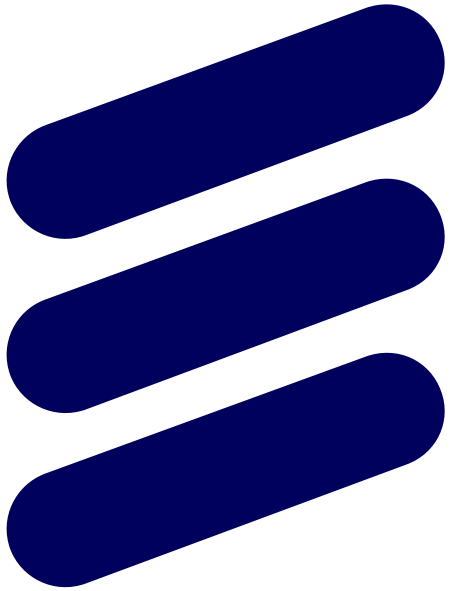

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