Updates for IPPM's Framework: Timestamping and Use Cases

draft-fabini-ippm-2330-time-00

J. Fabini, A. Morton

mailto:draft-fabini-ippm-2330-time@ietf.org

Motivation

- **Timestamps fundamental to measurements**
  - Time synchronization accuracy has improved
  - Critical infrastructures: need for accurate measurements
- Network evolution
  - Decreasing one-way delay
  - Networks become session-stateful at layers below IP
- Increasing software contribution
  - Virtualized hosts and measurements

- IPPM Framework RFC 2330
  - Extensive discussion on time and clocks

Motivation (ctd.)

- **Observations wrt. RFC2330**
  - Approved 1998 – one year before first IEEE 802.11 standard.
  - **Focused on wired networks**

- RFC 2330 considers two timestamp alternatives
  - **Wire time**
    - Explicit definitions for **wire exit time** and **wire arrival time**
  - **Host time**
    - Mentioned but no definition

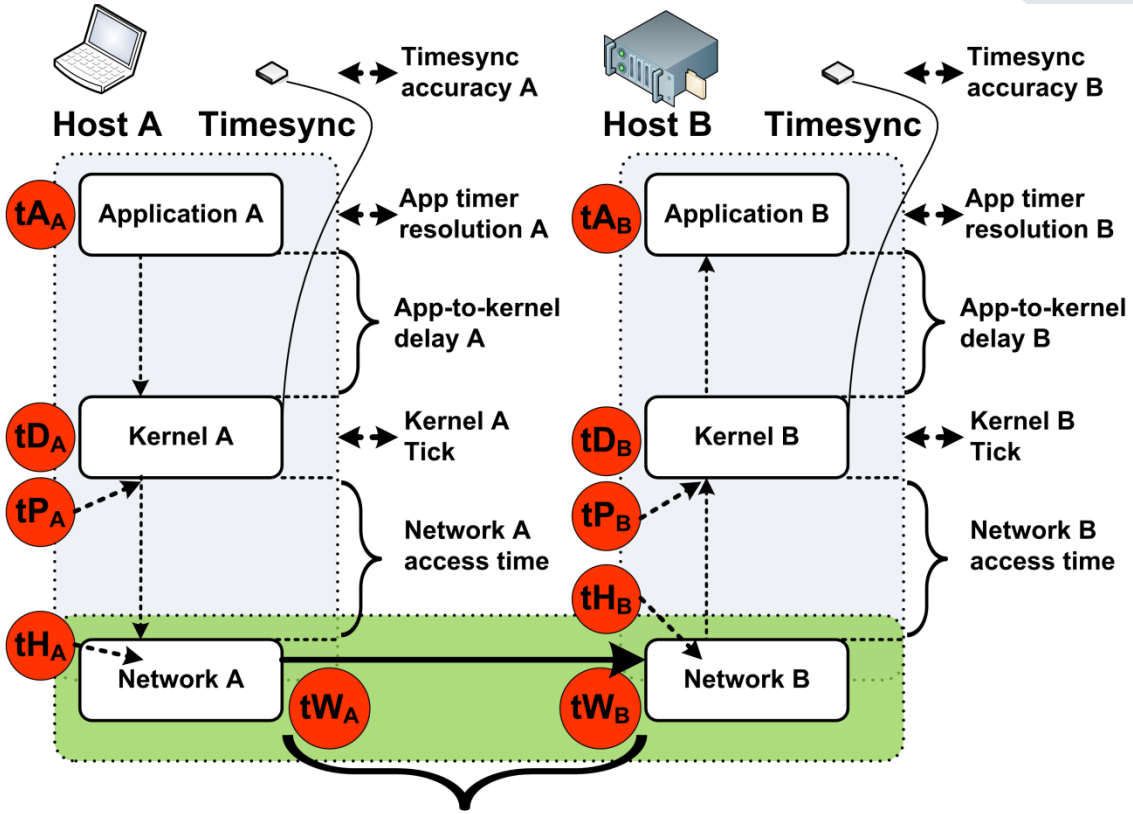
Draft Topics

Main aim: Revisit time-related RFC 2330 definitions

- **Wire** time (update for wireless networks, extra slides)
- **Host time** (extra slides)
  - New terms to allow for more accurate timestamp specs.
  - Differentiate between systematic delays and uncertainties
- **Virtualized Systems, Networks, Measurements**
  - New concepts, layered software structures
  - Hypervisor vs. VM
- Influence on Protocol Design
  - How security architecture (TLS/SSL/IPsec) can influence protocol design and timestamp accuracy; Driver or HW time?
- (outside IPPM scope)
  Improve time synchronization in Virtual Machines.

Uncertainty Factors in Measurements

- **Host**
  - Timestamps
    - Resolution
    - Host vs. wire time
  - Clock synchronization
  - App-to-network delay
- **Network**
  - Time-slotting
  - Reactive networks
  - Optimizers
  - Security mechanisms



[1] J.Fabini, T.Zseby, "M2M communication delay challenges: Application and measurement perspectives," in IEEE *Instrumentation and Measurement Technology Conference (I2MTC), 2015,* doi: 10.1109/I2MTC.2015.7151564

Consequences (1): Wire Time

Wire (exit, arrival) time

- How to define these for wireless networks?
- Draft proposal: „**Media time**“

- 3GPP: „reference point is antenna connector“

Consequences (2): Host time

Host time (used according to RFC2330):

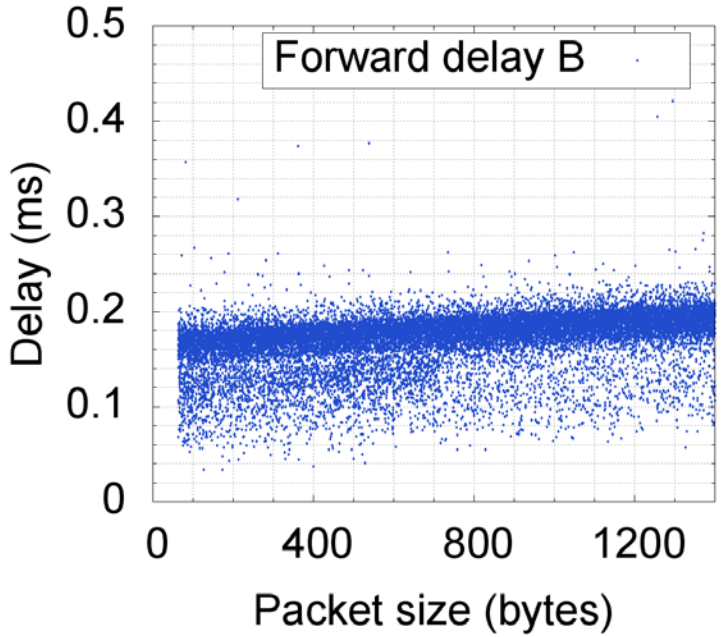
- Can be any timestamp between Application timestamp tA and Network hardware timestamp tH
- According to RFC2330: „measurement error“

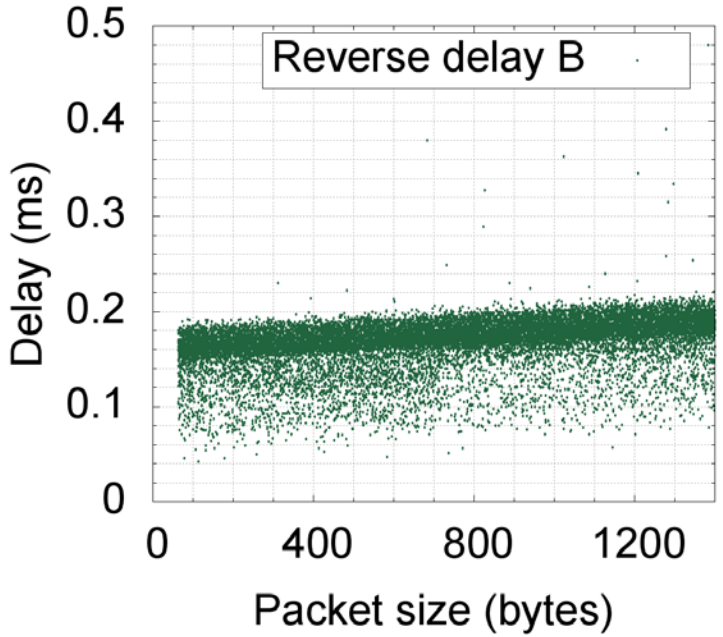
> **RFC 2330, sec.6.3, p.8:**
> …”consider the timing error due to measurement overheads within the computer making the measurement, as opposed to delays due to the Internet component being measured. The former is a measurement error, while the latter reflects the metric of interest”…

- What does this mean in practice?

Measurement Results

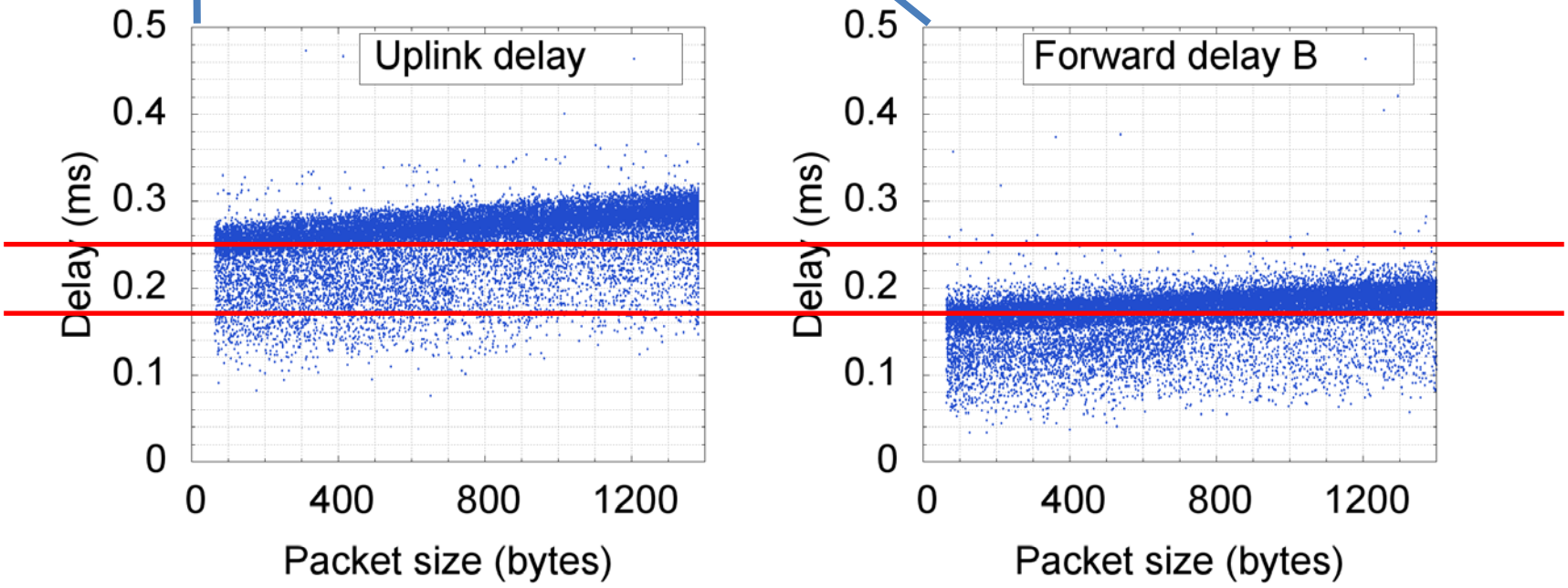
- Network: **Ethernet, crossed patch cable**
  - **100 Mb** interface
  - One-way delay computed from tcpdump timestamps, 10K samples
  - ICMP round-trip delay





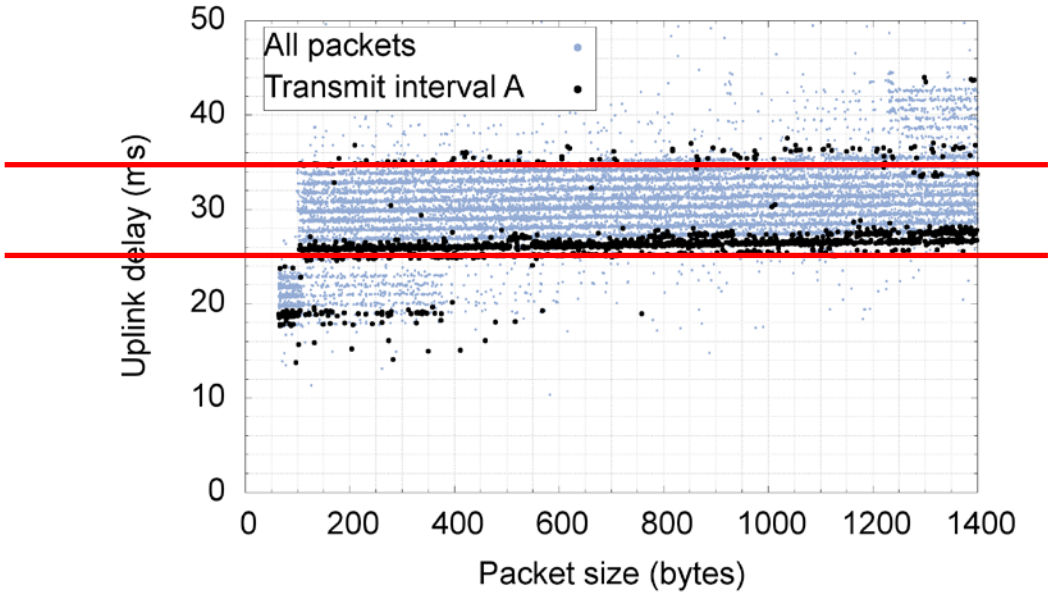
Measurement Results (1)

- Network: **Ethernet, crossed patch cable**
  - Receiver timestamps: tcpdump (Left and Right)
  - Sender timestamp: Application (left) vs. Tcpdump (right)
  - Difference: +80µs (vs. 175µs tcpdump timestamp difference)



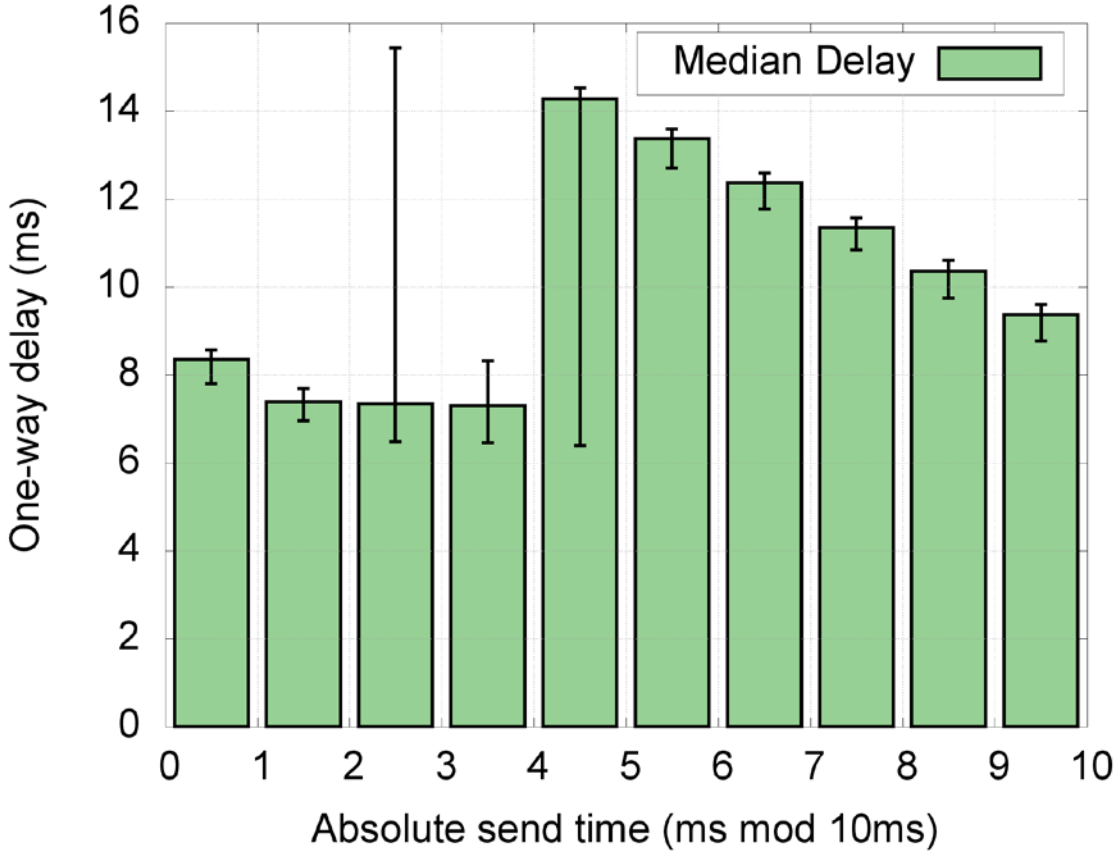
Measurement Results (2)

- Network: **LTE Uplink,** live network
  - Periodic network service time (10ms)
  - But: wait time spent in software stack
  - „Host time uncertainty“ vs. „Access network delay“: 10ms

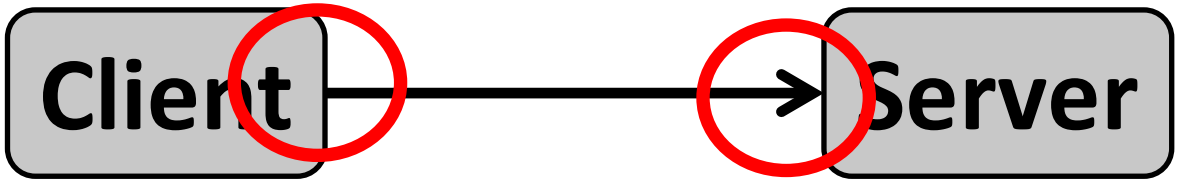


[2]: J.Fabini and T.Zseby: „The The Right Time: Reducing Effective End-to-End Delay in Time-Slotted Packet-Switched Networks“, *IEEE/ACM Transactions on Networking* (2015) doi:10.1109/TNET.2015.2451708

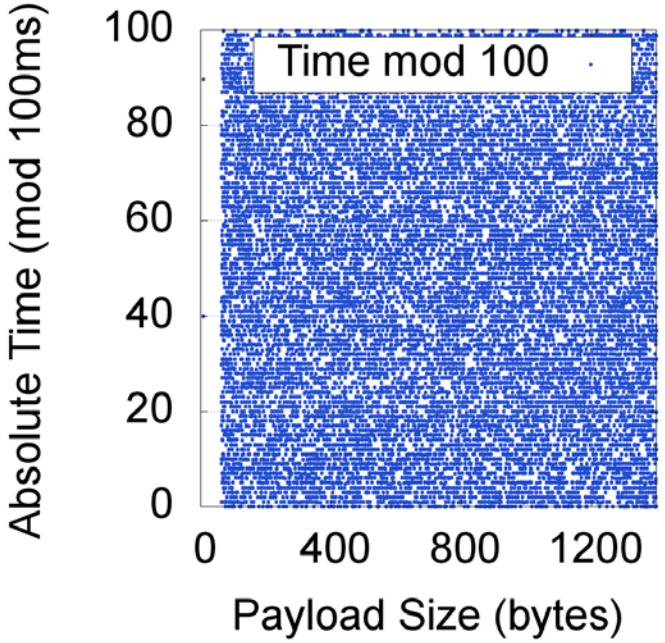
Measurement Results (2a)



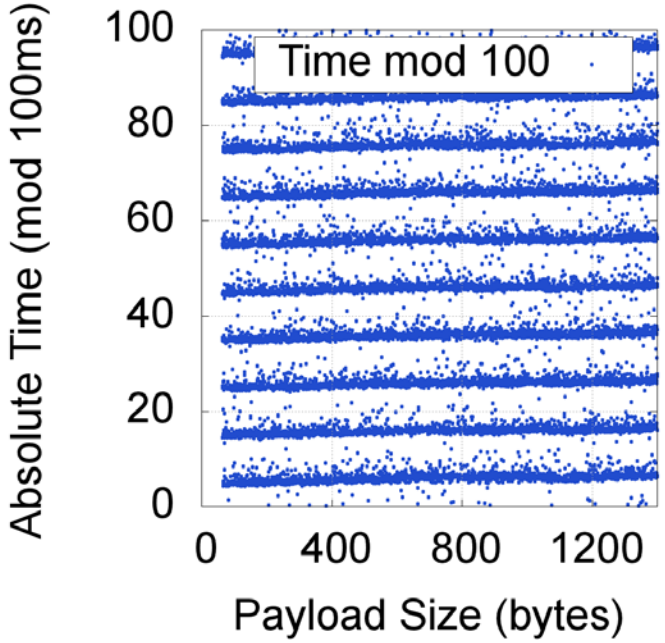
Measurement Results (4)



- **State and history**: time-slotted links



(a) Send time (client)



(b) Receive time (server)

[3] J.Fabini and M.Abmayer**: "Delay Measurement Methodology Revisited: Time-slotted Randomness Cancellation",** *IEEE Transactions on Instrumentation and Measurements*, 2013, doi:10.1109/TIM.2013.2263914

Challenges in updating RFC2330 timing

- Large measurement uncertainties <-> generality
  - Framework must not make assumptions on networks and architecture
  - Systematic factors aggregate/influence along network path

Possible scope of draft:

- Define more specific terms related to timestamps
  - Equivalent to tcpdump timestamps?
  - Virtualization (tcpdump in hypervisor, VM, …)
- Differentiate between **systematic** and **transient impairments (uncertainties).**
  - Isolate systematic uncertainty factors and their timing
- Host vs. Network delay
- Improve systems and measurement methodologies

Bibliography

Contact: Joachim.Fabini@tuwien.ac.at

Delay Measurement Methodology and Measurement Accuracy:

[1] J.Fabini and M.Abmayer: "Delay Measurement Methodology Revisited: Time-slotted Randomness Cancellation", *IEEE Transactions on Instrumentation and Measurements*, 10/2013, doi:10.1109/TIM.2013.2263914

[2] J.Fabini, T.Zseby, "M2M communication delay challenges: Application and measurement perspectives," in IEEE *Instrumentation and Measurement Technology Conference (I2MTC), 2015,* doi: 10.1109/I2MTC.2015.7151564

Measurement methodology standardization:

[3] J.Fabini and A.Morton: IETF RFC 7312 "Advanced Stream and Sampling Framework for the IP Performance Metrics Framework (IPPM)", Internet Engineering Task Force, 08/2014

Tools:

[4] J.Fabini and M.Hirschbichler: „Representative Delay Measurements (RDM): Facing the Challenge of Modern Networks", Proceedings of the 8th International Conference on Performance Evaluation Methodologies and Tools (VALUETOOLS '14), doi:10.4108/icst.Valuetools.2014.258181

Delay optimization:

[5] J.Fabini and T.Zseby: „The The Right Time: Reducing Effective End-to-End Delay in Time-Slotted Packet-Switched Networks", *IEEE/ACM Transactions on Networking* (2015) doi:10.1109/TNET.2015.2451708

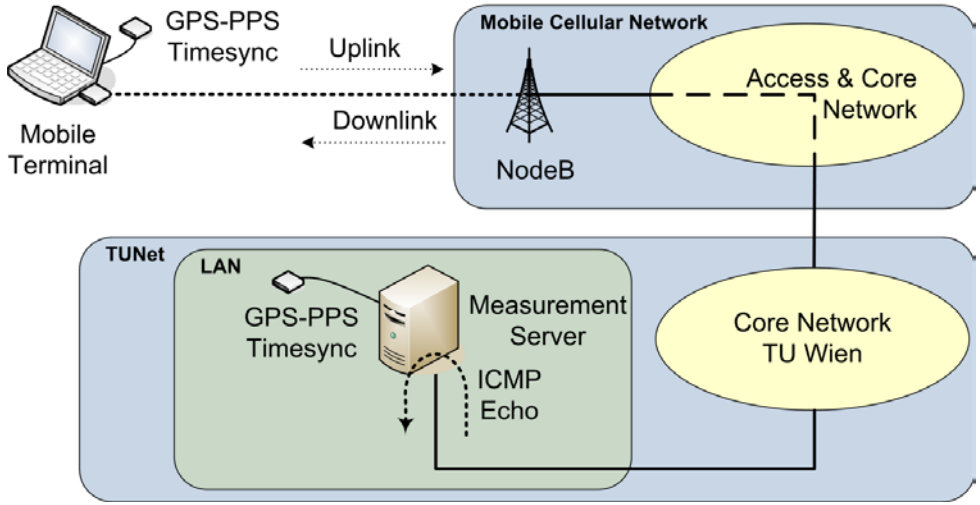
Please provide feedback!
Thank you for your attention and support!

Contact (all draft authors):

mailto:draft-fabini-ippm-2330-time@ietf.org

Measurement Methodology

- Send random-payload samples at random inter-departure times (independent processes)
  - ICMP(++), add timestamps to payload: one-way delay
  - Randomness re-generation in server
- UTC-synchronized nodes (GPS/PPS)



J.Fabini, T.Zseby and M.Hirschbichler: **„Representative Delay Measurements (RDM): Facing the Challenge of Modern Networks“,** VALUETOOLS 2014, doi:10.4108/icst.Valuetools.2014.258181