

Explorative Analysis of One-way Delays in a Mobile 3G Network

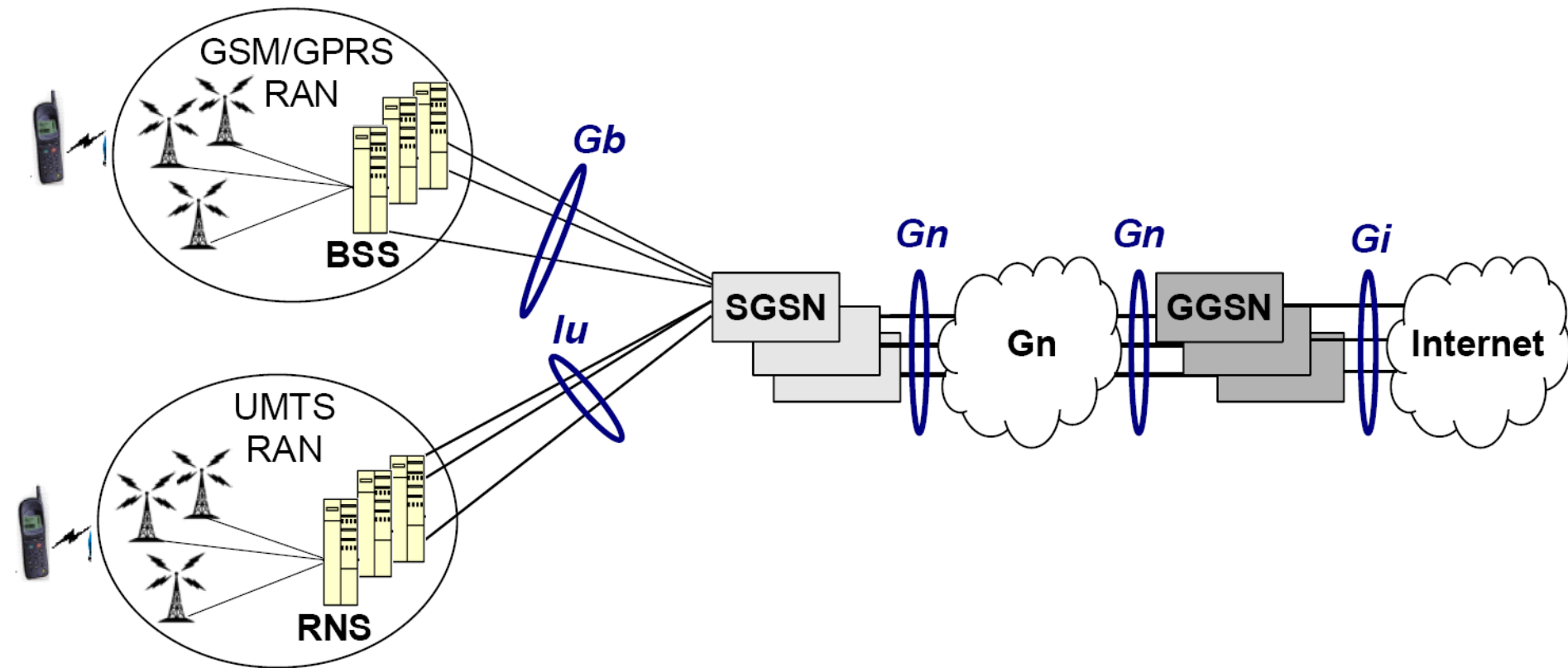
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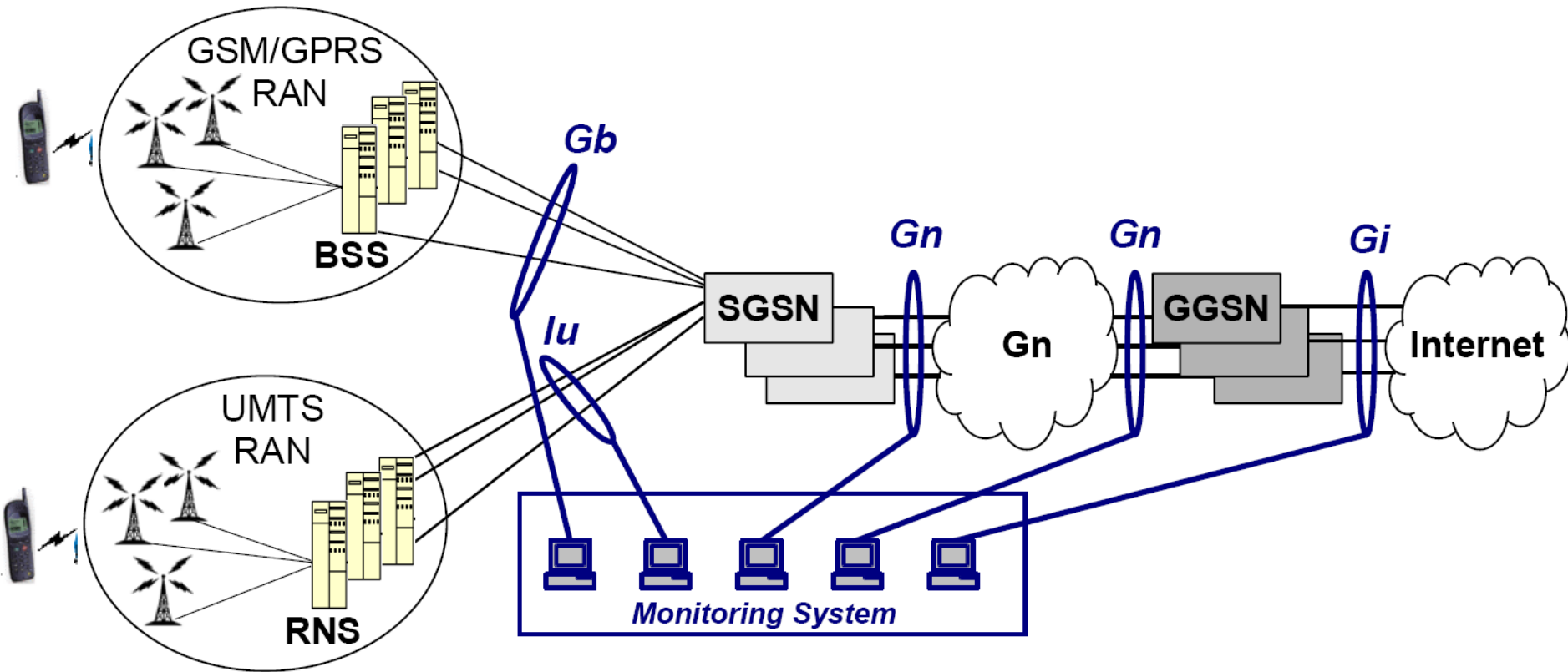
Roadmap

- Structure of a 3G cellular network
- Measurement setup
- Preliminary observations
 - Delay distribution at GGSNs
 - Delay distribution at GPRS-SGSNs
- Lessons learned & next steps

Structure of 3G Cellular Network

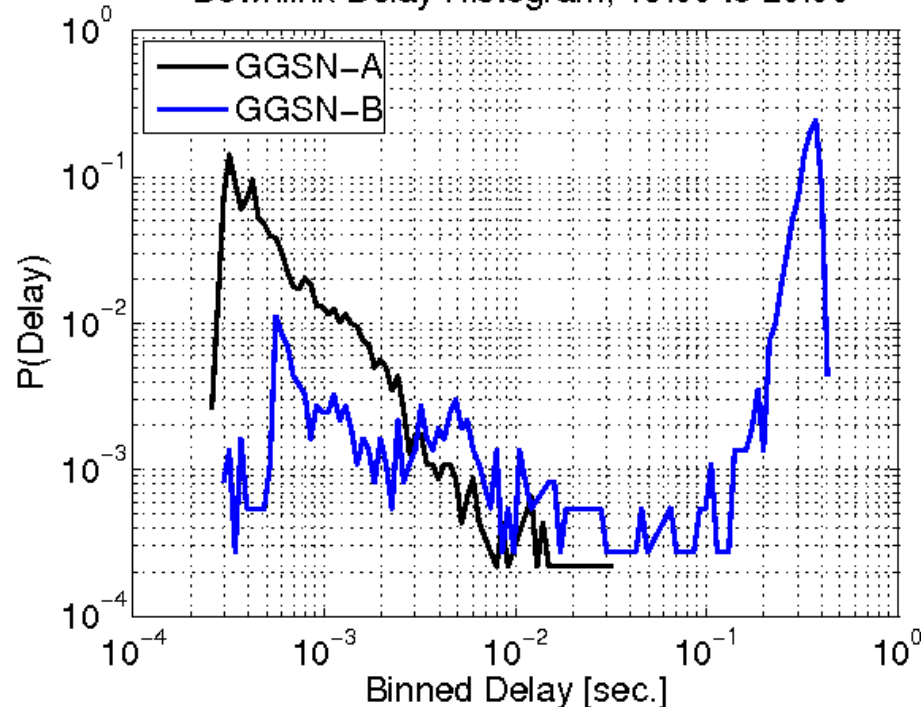


Measurement Setup

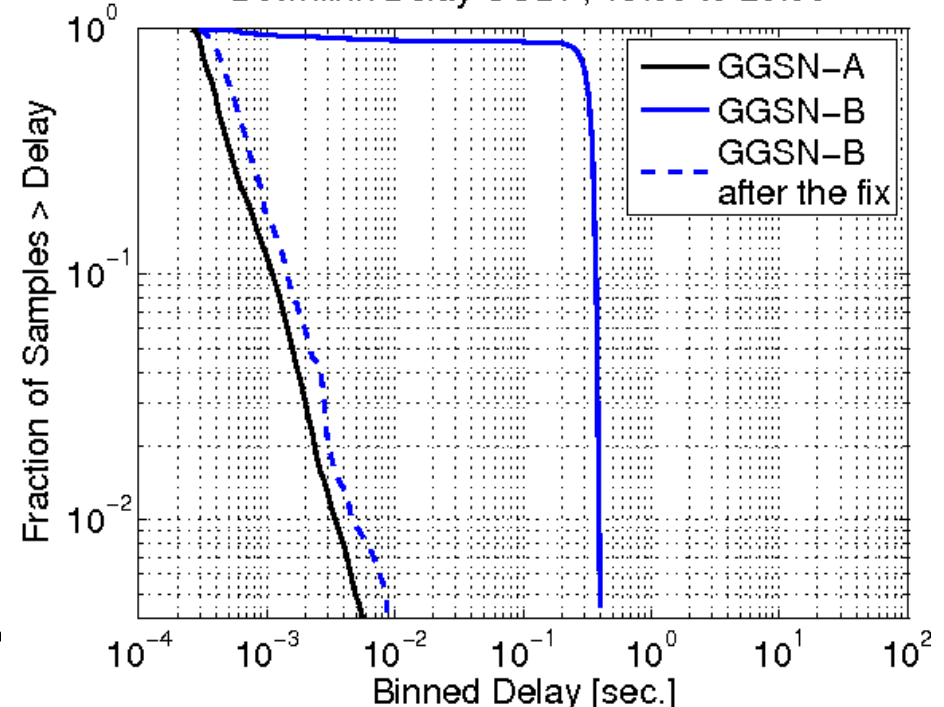


Single-hop Delay at Two GGSNs

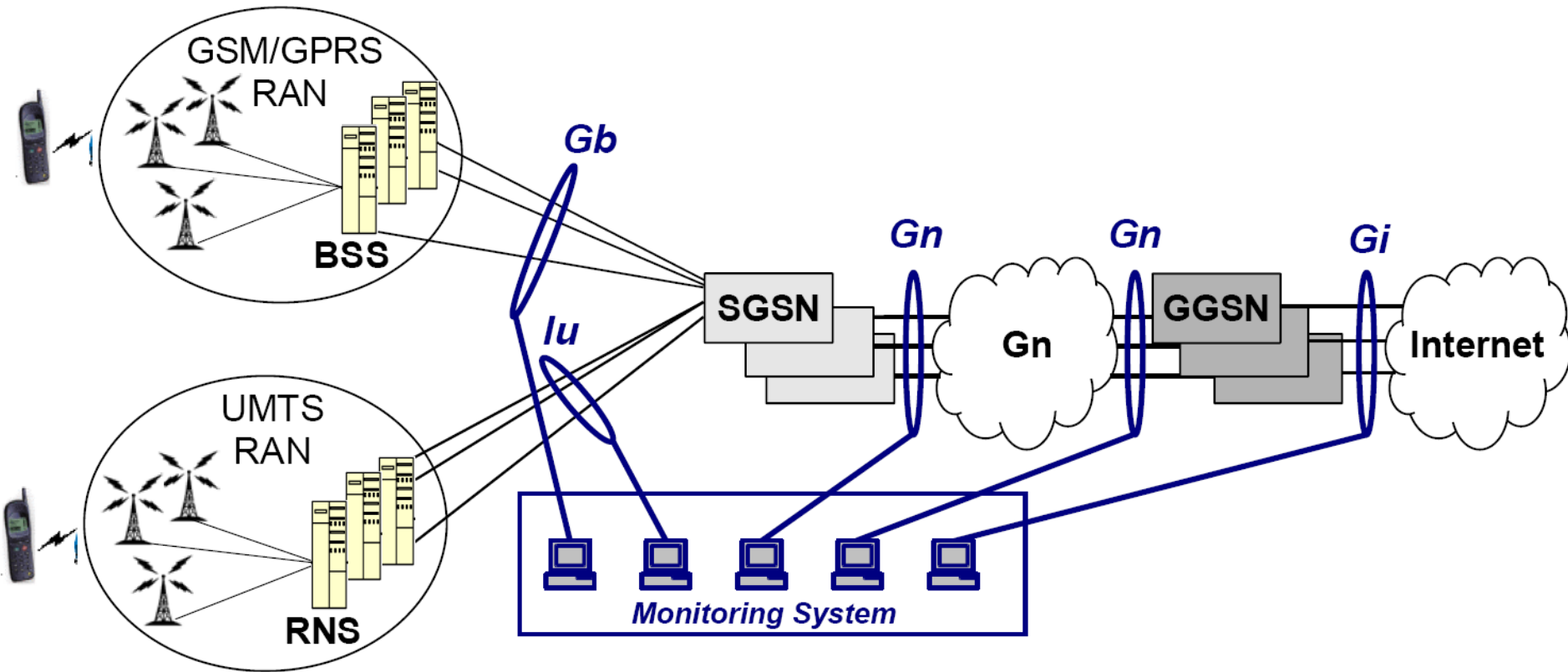
Downlink Delay Histogram, 19:00 to 20:00



Downlink Delay CCDF, 19:00 to 20:00

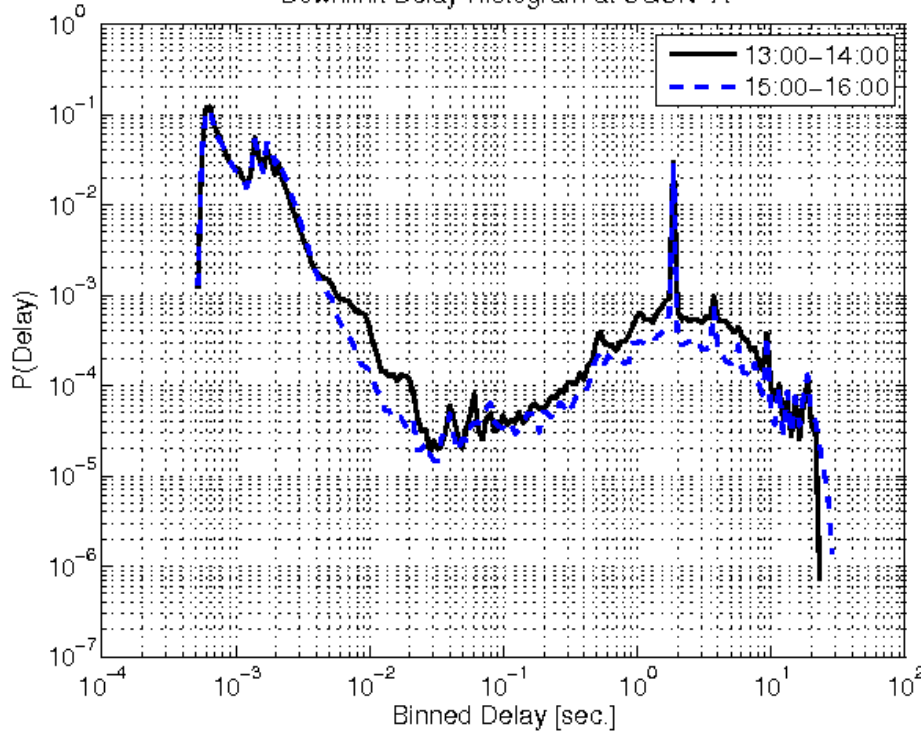


Measurement Setup

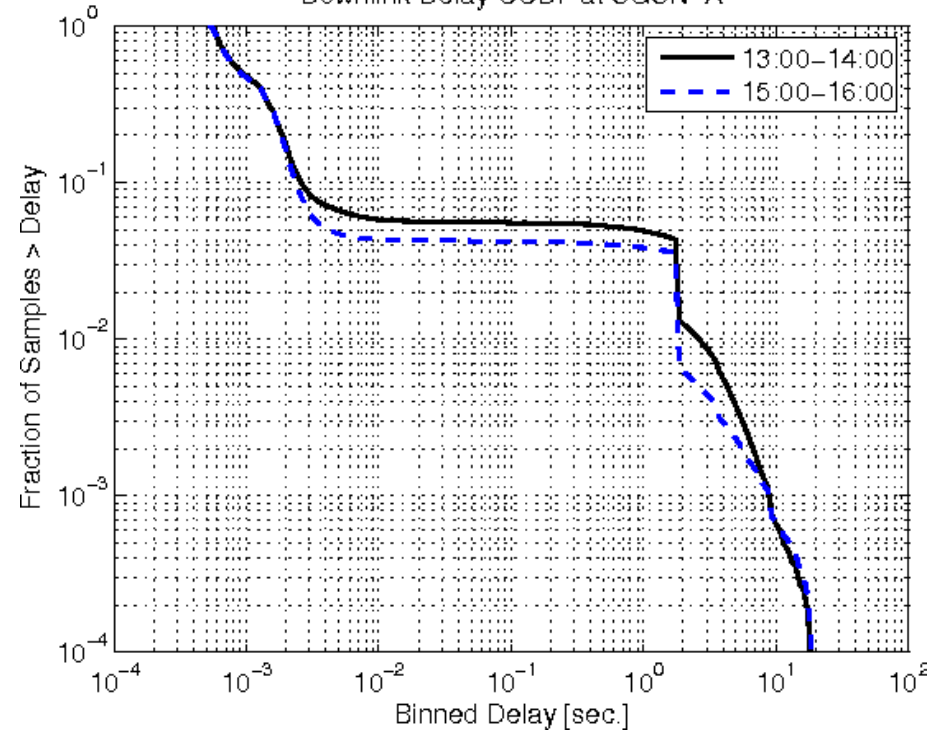


Downlink Delay at a GPRS-SGSN

Downlink Delay Histogram at SGSN-A

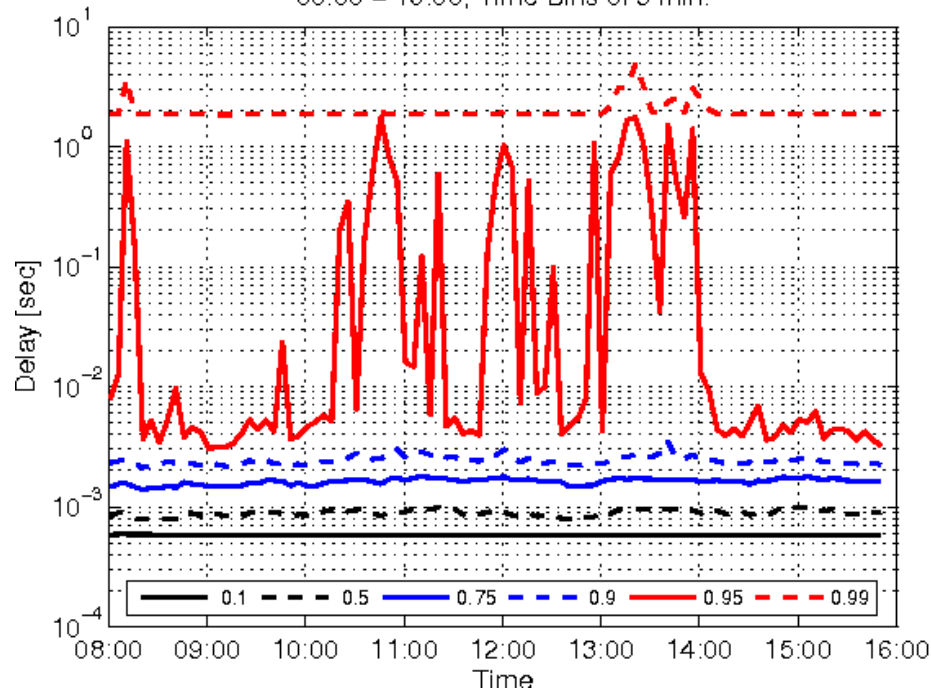


Downlink Delay CCDF at SGSN-A

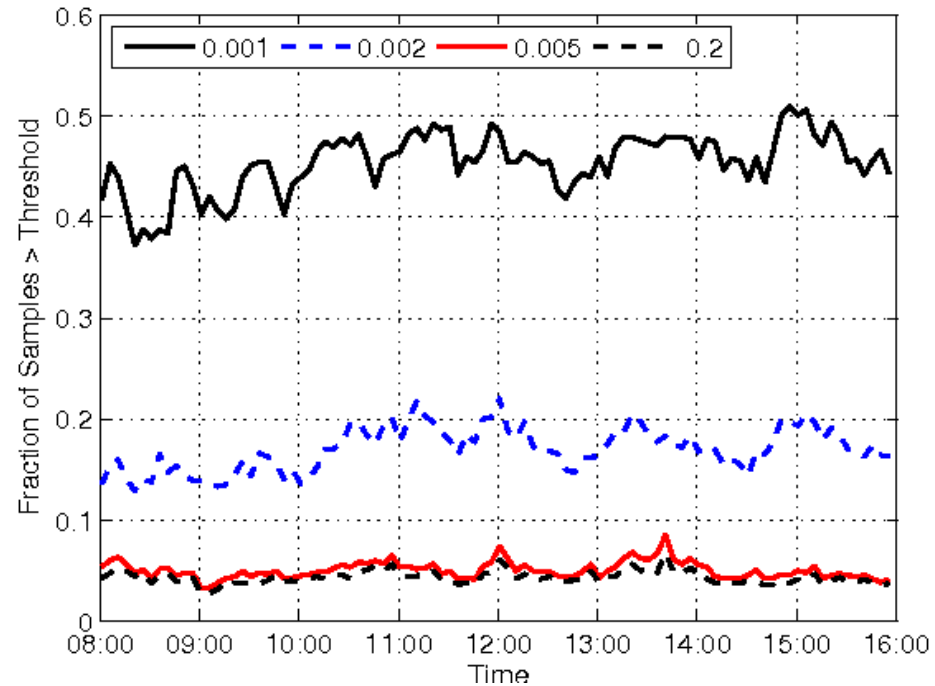


Stability over Time

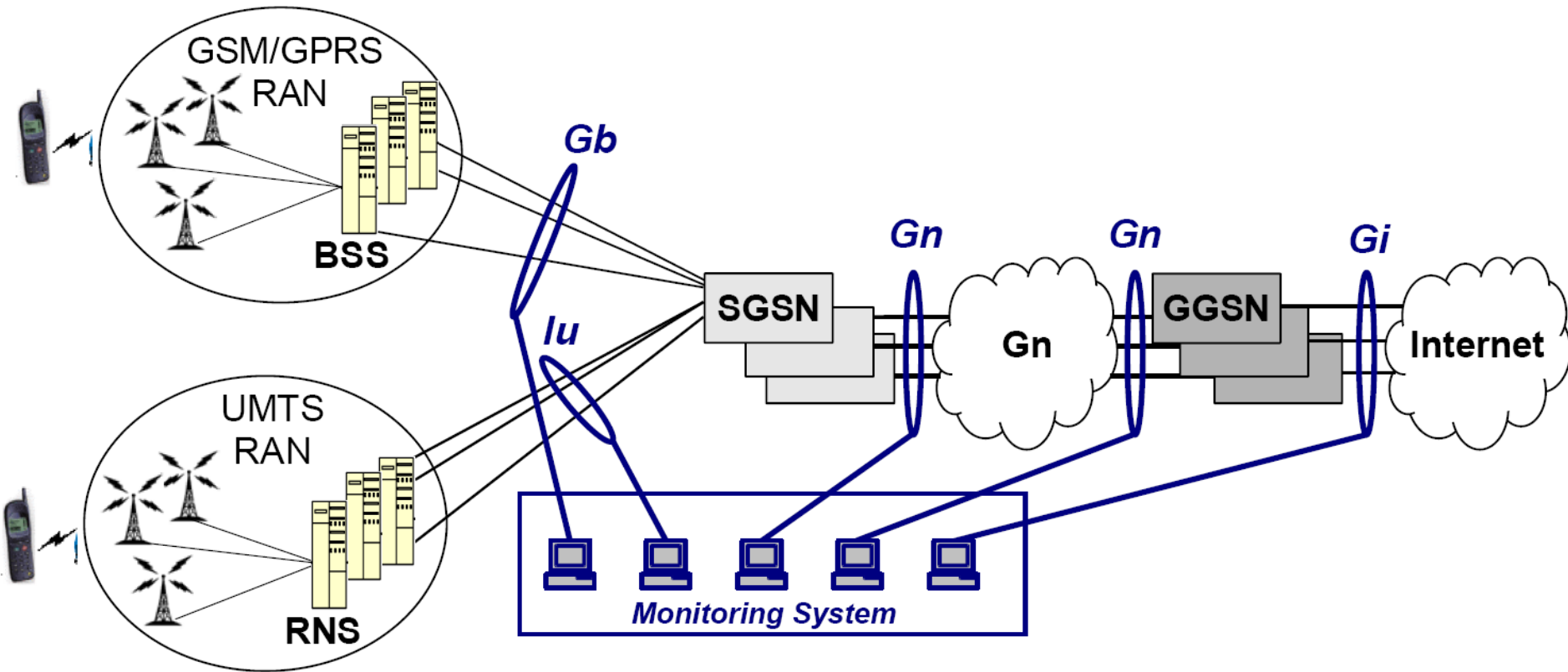
DL Percentiles vs. Time at SGSN-A
08:00 – 16:00, Time Bins of 5 min.



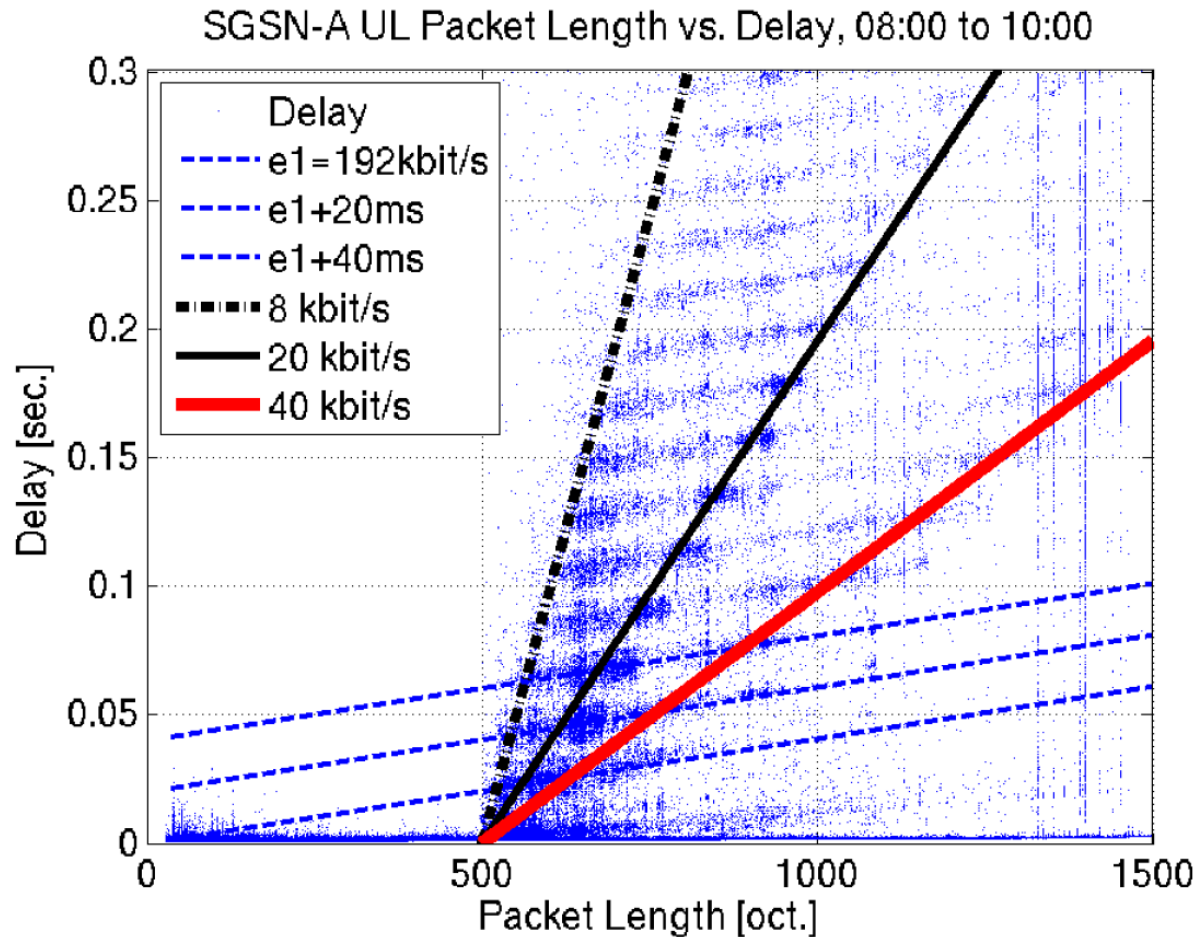
Delay Population vs. Time at SGSN-A
08:00 to 16:00; Time Bins of 5 min.



Measurement Setup



Uplink Delay at a GPRS-SGSN



Lessons Learned

- Queuing not the only source of delay at SGSNs
- Delay variation part of the normal delay process
- Impact of packet fragmentation in the Radio Access Network

Next Steps

- Expand analysis to other network elements
- Develop distributed delay measurement system
- Investigate the delay process at the long-term
- Implement online anomaly detection system

Thanks for your attention!