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Peeling Away Timing Error in NetFlow Data

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Common Sense in Flow Data Analysis

- "Everyone knows you don't use NetFlow for timing."
  - Export and cache delays – unfit for "real-time".
  - Poor synchronization among routers – correlation is hard.
- "We measure the world in *n*-second bins."
  - Works for billing!
- But: the protocol advertises milliseconds
  - Good for initiator biflow matching [RFC 5103]…
  - …or approximate passive RTT…
- …So let's try it anyway.

Overview

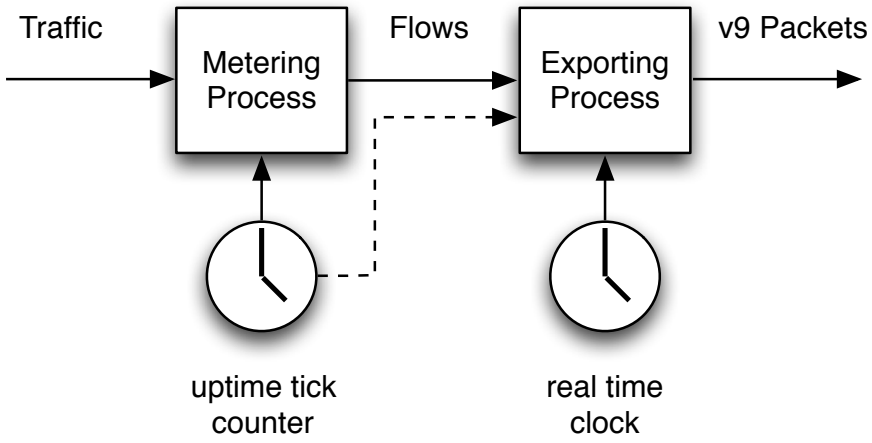
- Timing in NetFlow v9
  - How it works
  - How it breaks
- Basetime distribution and correction
- Validation
- Conclusions

Acknowledgments

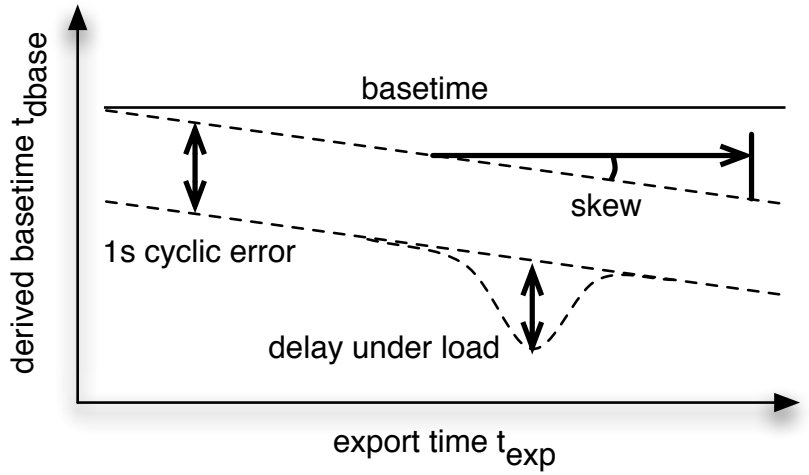
Thanks to the DEMONS project [http://fp7-demons.eu] for its support of this work, and to SWITCH for access to the dataset used in this study.

How does NetFlow timing work?

- Metering process generates flows, notes timestamps as *ticks* (timer interrupts since start)
- Export process ties ticks to real time with an *export timestamp* in epoch time

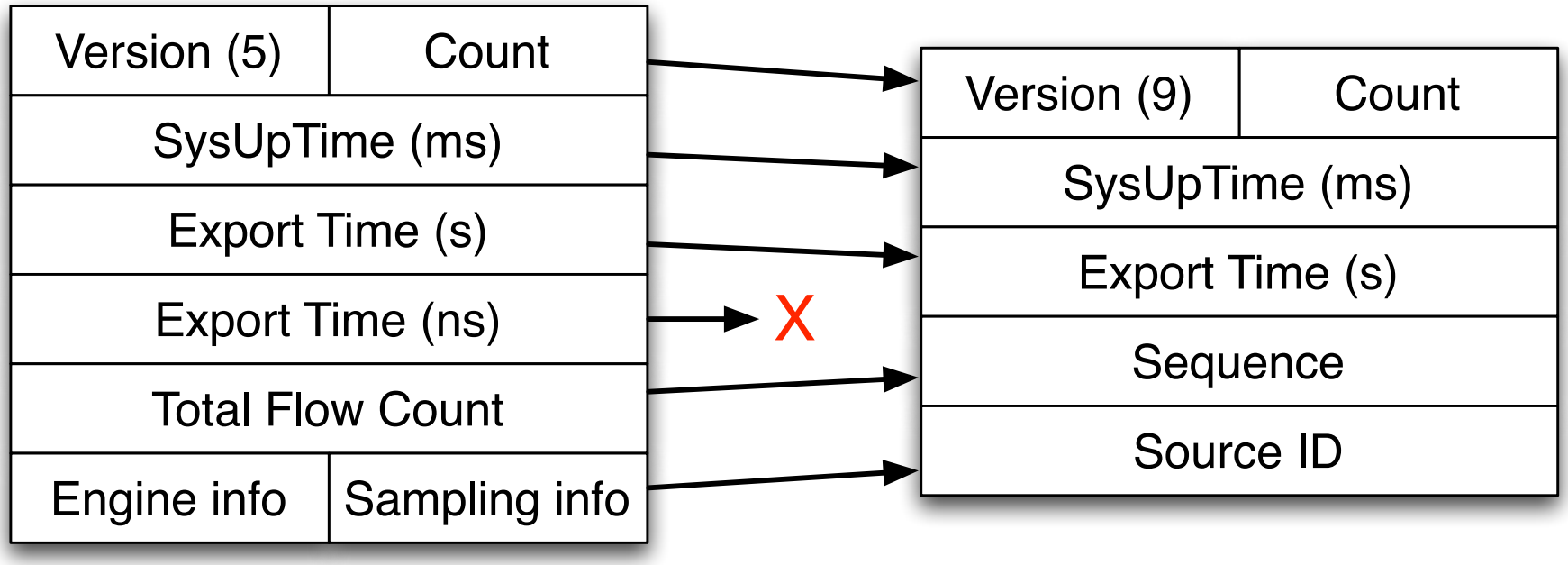


How does NetFlow timing break?



- Flow timestamps in ticks converted to real time by adding a *basetime* (i.e. real time of tick 0)
- Export clock and tick counter not in sync, leading to skew
- Export can be delayed
- Basetime export is *flawed by design*

Header evolution, v5 to v9



Cyclic basetime error

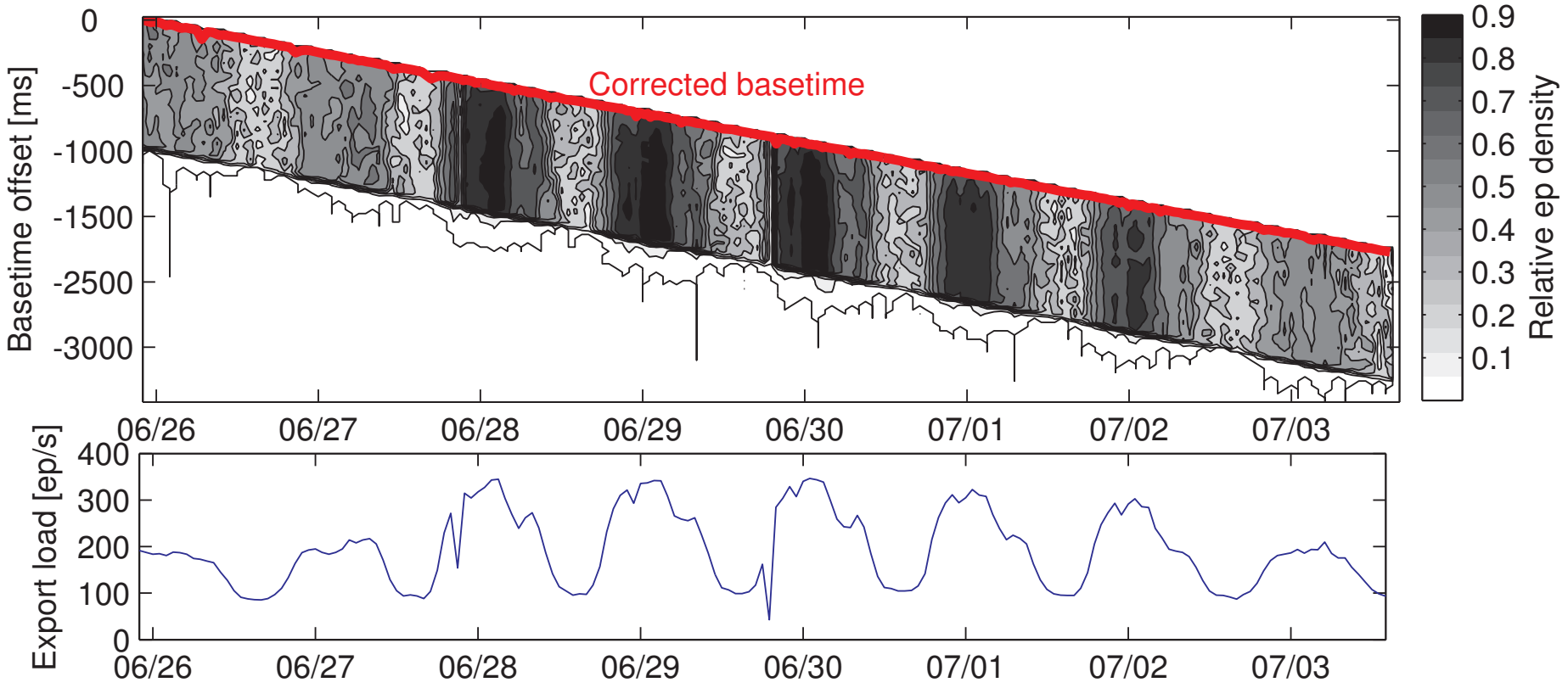
- Basetime can be independently derived from each export packet.
- NetFlow v9 header truncates nanoseconds portion of export time, present in v5.
- → Up to one second of error, repeating

$$t_{base} = t_{export} + t_{uptime}$$

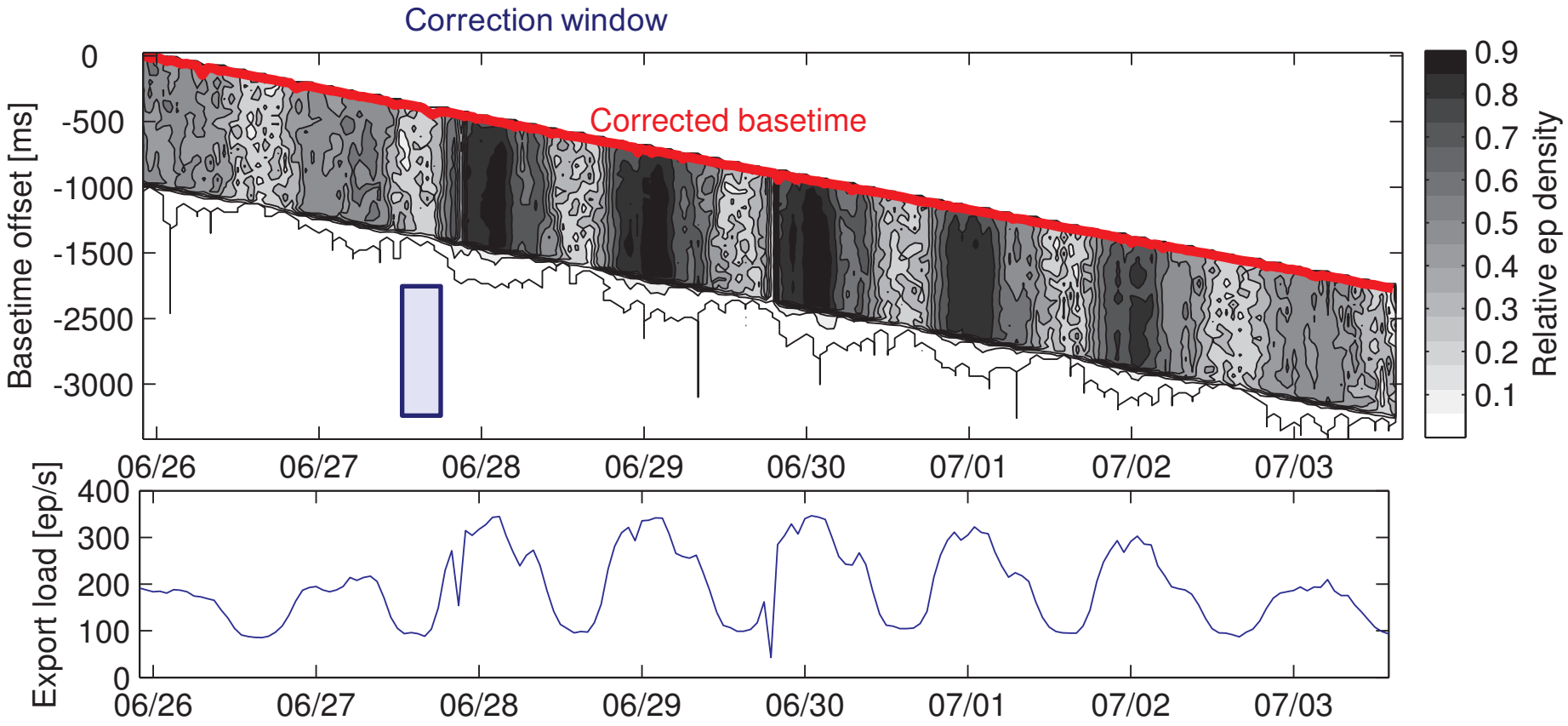
$$t_{base} = \lfloor t_{export} \rfloor + t_{uptime}$$

$$E_{cyclic} = \lfloor t_{export} \rfloor - t_{export}$$

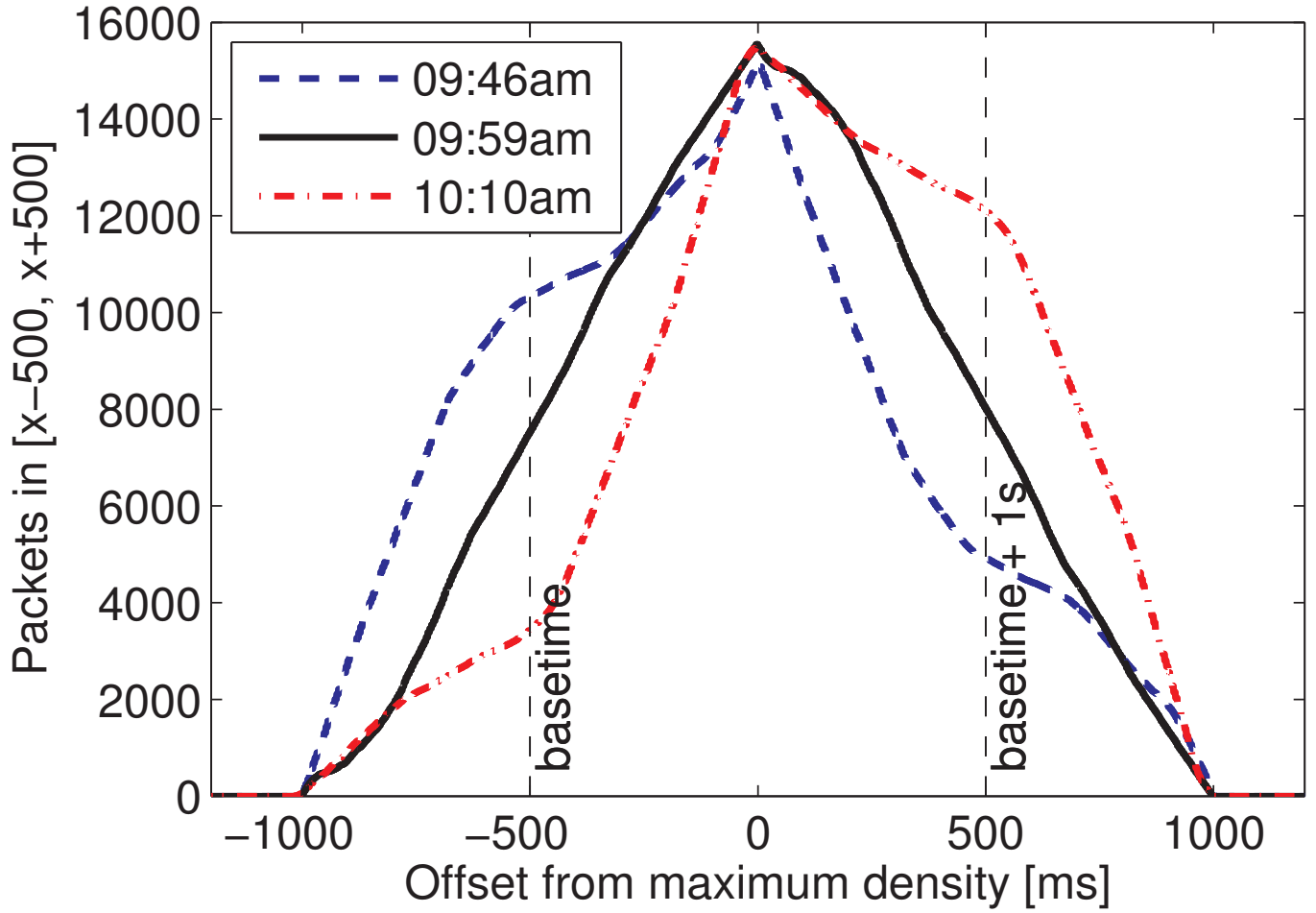
Basetime distribution



Basetime correction

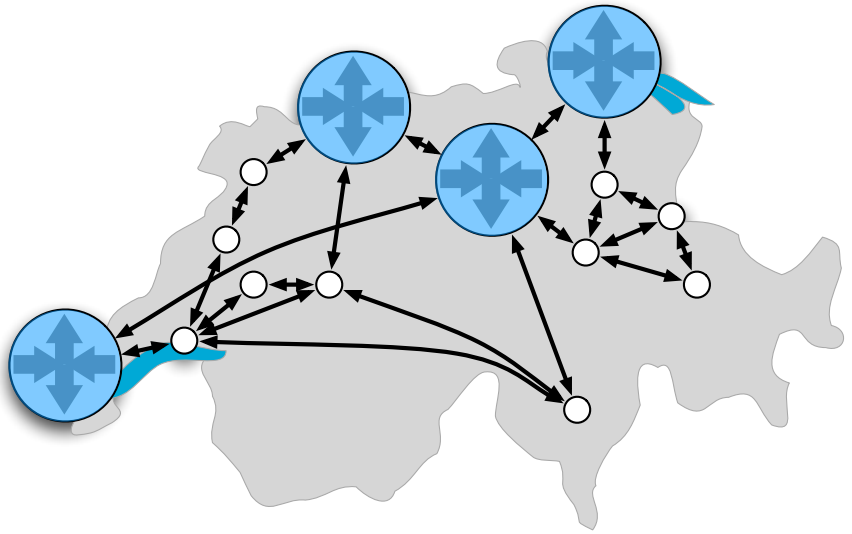


Basetime correction



SWITCH flow data repository

- Swiss Research and Education Network
- ~2¼M addresses (IPv4)
- Unsampled v9 from 6 border routers at 4 POPs
  - Cisco 6500, 7600
- Stored as raw v9 packet stream, .bz2



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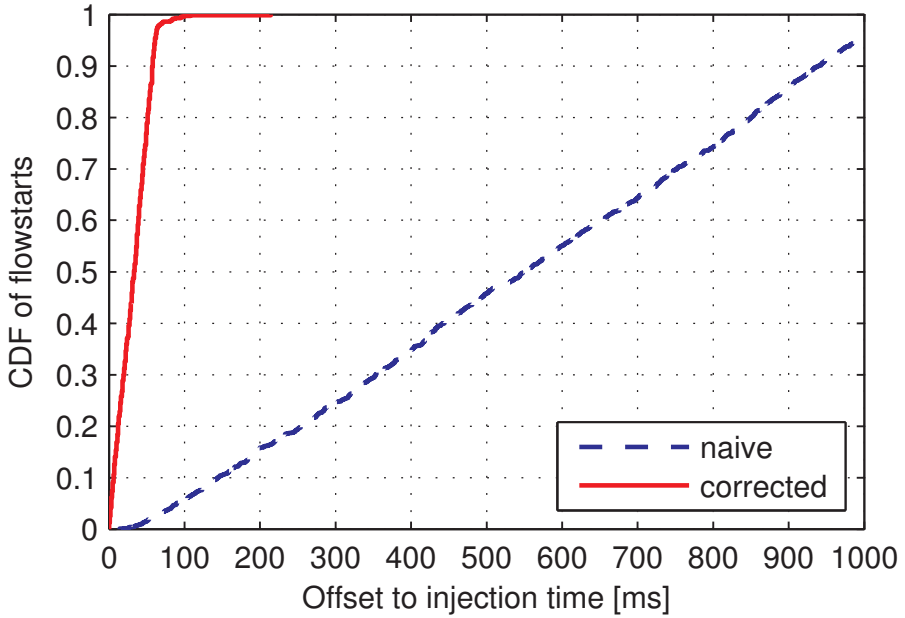
Validation

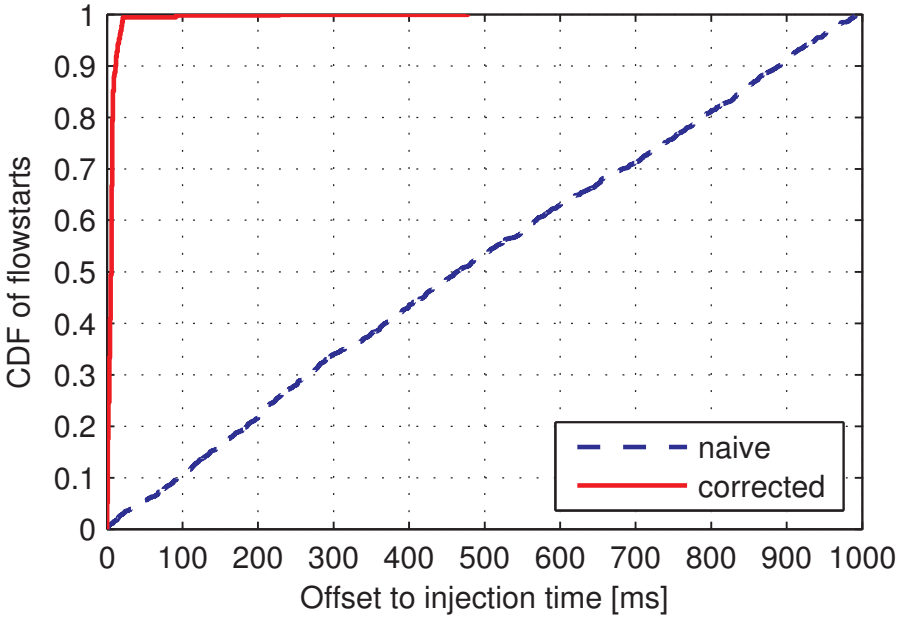
- Injection of known single-packet flows to known hosts via known routes over the SWITCH network
- Comparison of known timing to flow timestamps using uncorrected and corrected basetimes
- Comparison to non-Cisco implementation on an experimental local network

Validation

Cisco (SWITCH)



softflowd



Conclusions

- NetFlow v9…
  - …advertises 1ms accuracy, delivers 1s accuracy
  - …correctable to ~1ms accuracy in general case
  - …***but*** only correctable to ~64ms accuracy on Cisco
    - Insufficient for RFC 5103 biflows, insufficient for passive RTT.
  - ∴ for precision timing, consider dedicated flow meters.
- Keeping raw data essential for research
  - This study used metadata that would be lost with conversion to another format.
  - Implementation details matter in network measurement.

Questions?

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