

Lessons learnt from the Beijing Olympic Games Website Measurement

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Motivations

- Test and compare our measurement system (OneProbe) with other methods.
- Compare and evaluate the web performance at different sites for this global event.
- Discover new and interesting results about Internet path and web performance.

Outline

- Measurement methodology
- Measurement results
 - Overall results
 - A measurement tool comparison
 - Correlation of loss and delay peak
 - Asymmetric loss patterns
 - Effects of network configuration changes
- Conclusions and future works

Measurement methodology

- Uncooperative methods
 - Ping (ICMP)
 - Pping (TCP SYN-ACK)
 - HTTPing (TCP SYN-ACK and HTTP data)
 - OneProbe (TCP data)
 - Traceroute on forward path
 - Changes in TTL on reverse path
- Measuring points
 - A data center in Hong Kong
 - Three Beijing origin servers, three Chinacache sites, and three Akamai/Quest sites

The three sets of network paths

- Three Chinacache sites
 - One of the went through the Korea Network Information Center.
 - They all went through the CNC Group Backbone.
 - The servers were located in three different provinces: Henan, Hebei, and Shandong.
- Three Beijing sites
 - The paths were very similar (going through the same subnets).
- Three Akamai/Quest sites
 - The first four of the five hops were the same.
 - The sites were located in Hong Kong.

Measurement parameters

- **Measurement period**
 - During the entire Olympic Games period and one week after the Games
- **Sampling rate**
 - OneProbe: sending a probe every 0.5 secs
 - Others: sending a probe every sec.
- **Probe packet size**
 - OneProbe: 1500 bytes
 - Ping: 100 and 1500 bytes
 - Pping: 40 bytes
 - HTTPing: variable

Path metrics

- Ping, Pping, and HTTPing
 - RTT and round-trip loss rate
- OneProbe
 - RTT
 - One-way loss rates
 - One-way reordering rates
 - One-way capacity

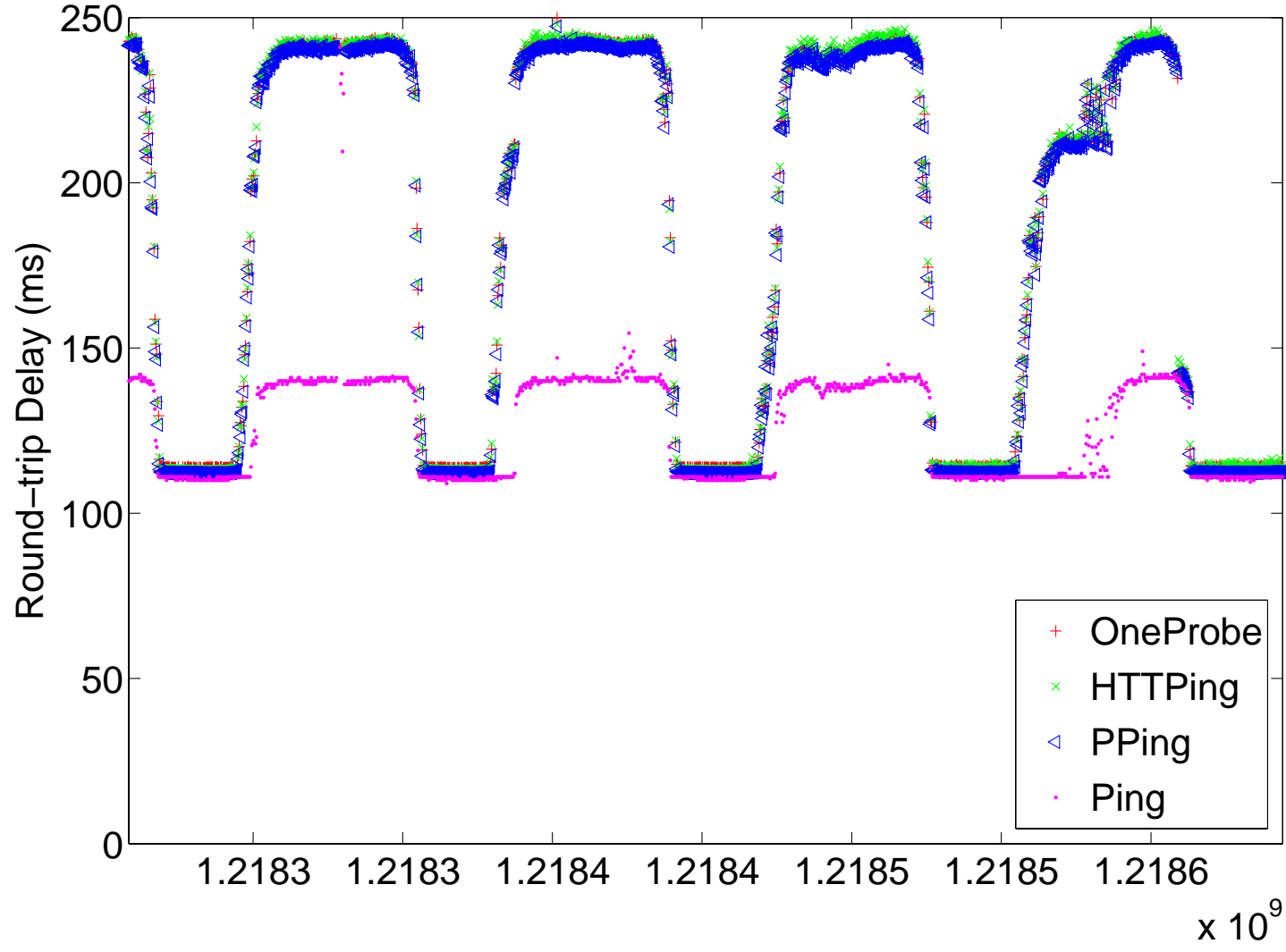
Overall path quality

- Chinacache:
 - RTT: 87ms-260ms
 - Loss rate: $\leq 10\%$
- Beijing
 - RTT: 78ms-132ms
 - Loss rate: $\leq 20\%$
- Akamai/Quest
 - RTT: 3.4ms-4.9ms
 - Loss rate: $\leq 10\%$
- No reordering events observed
- Mostly stable forward-path routes and reverse-path hop counts
 - Detected configuration changes
 - Some persistent load-balancing

RTT measurement

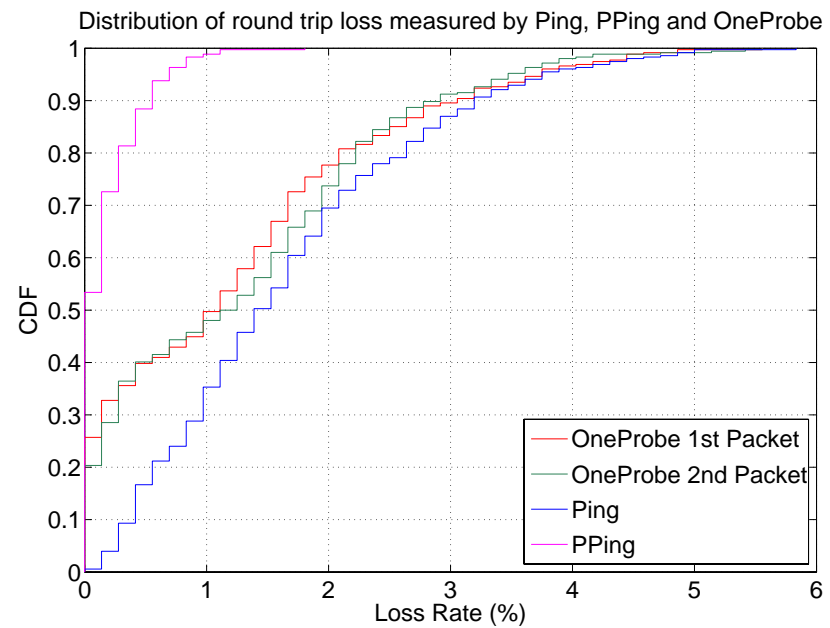
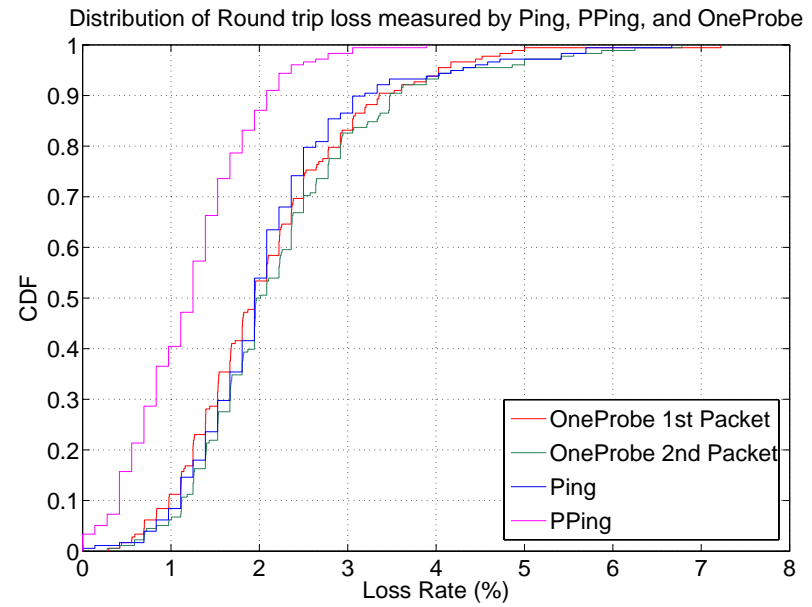
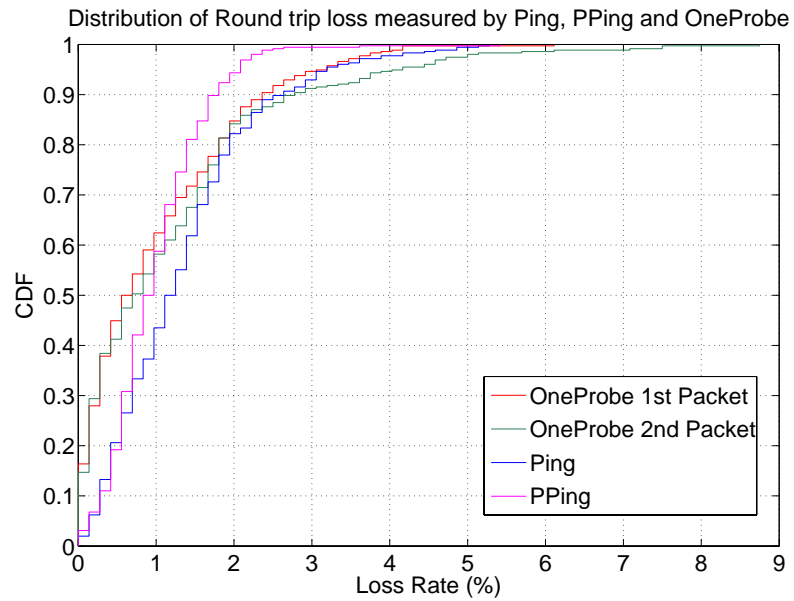
- Diurnal patterns
 - Weekdays and weekends
- HTTPing's and PPing's results are compatible with OneProbe's.
 - HTTPing's RTTs are slightly higher.
- ICMP Ping RTTs do not always match with OneProbe's.

Round-trip delay observed by different tools

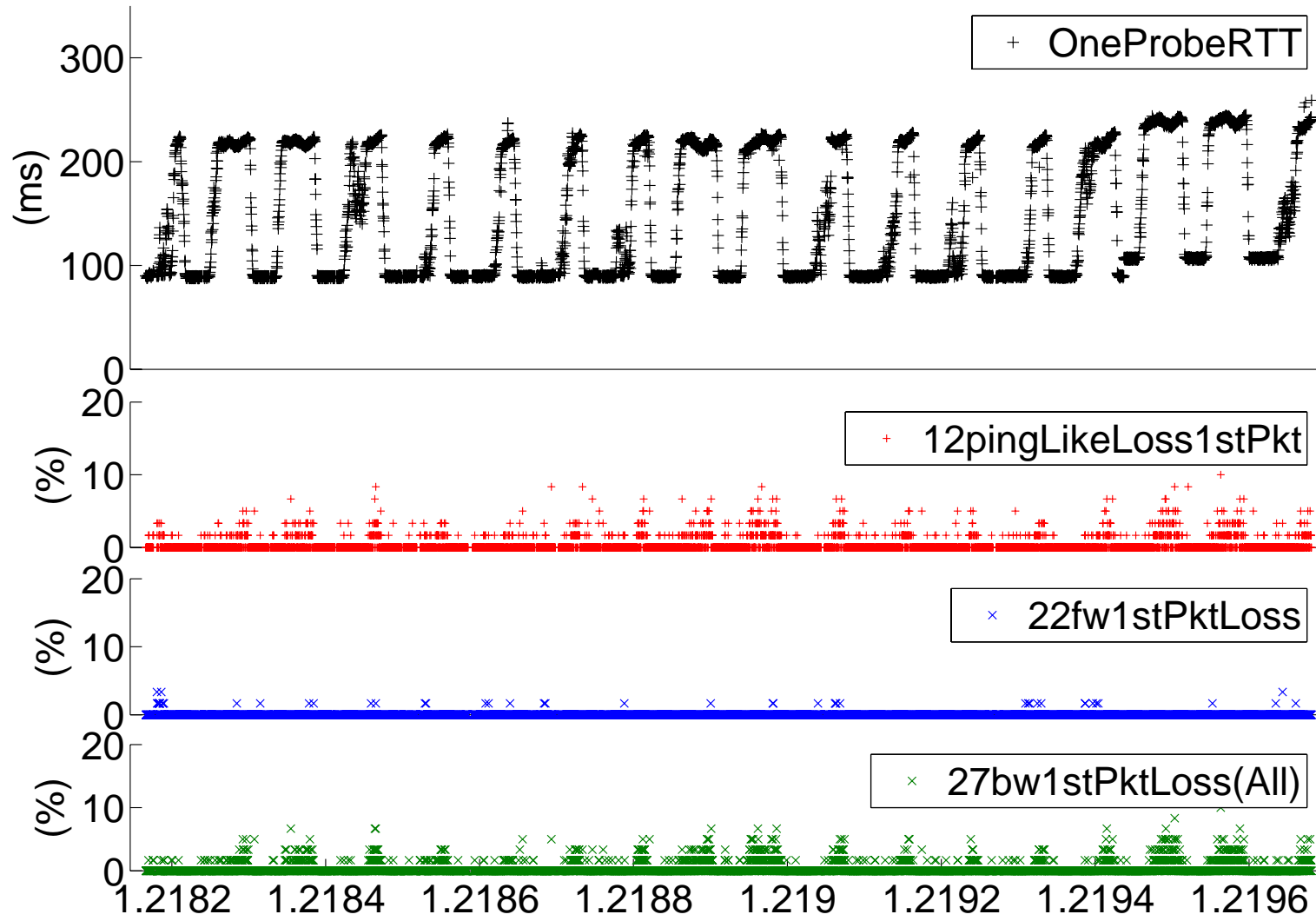


Packet loss patterns

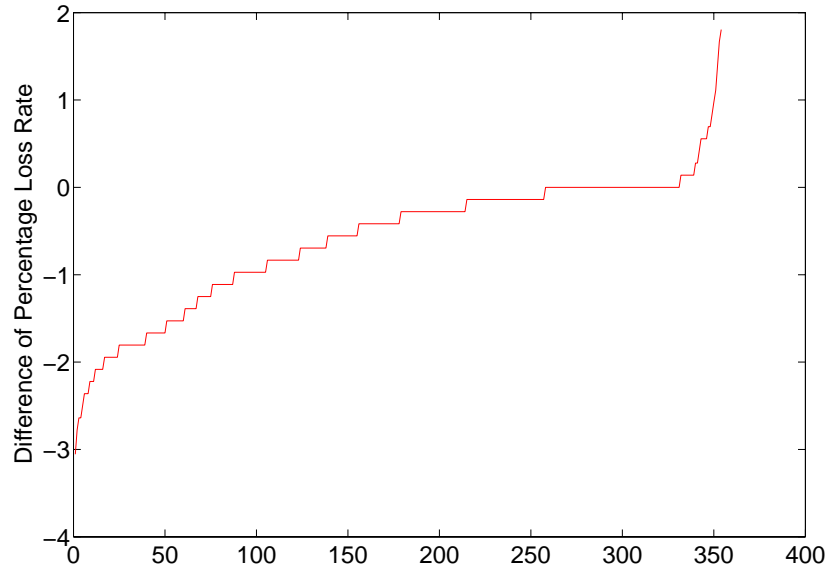
- Diurnal patterns
- Correlation of the RTT peaks with the round-trip packet losses
- Ping's packet loss' accuracy
- Dominance of the reverse-path loss for the Chinacache and Beijing sites



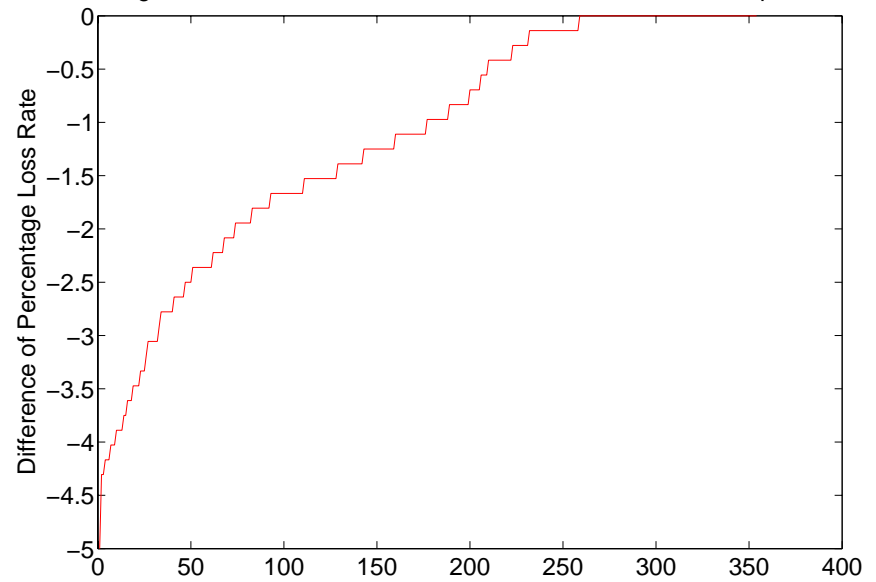
Timeseries of Round-trip delay and loss rates



Ranking of difference between measured forward and backward packet loss



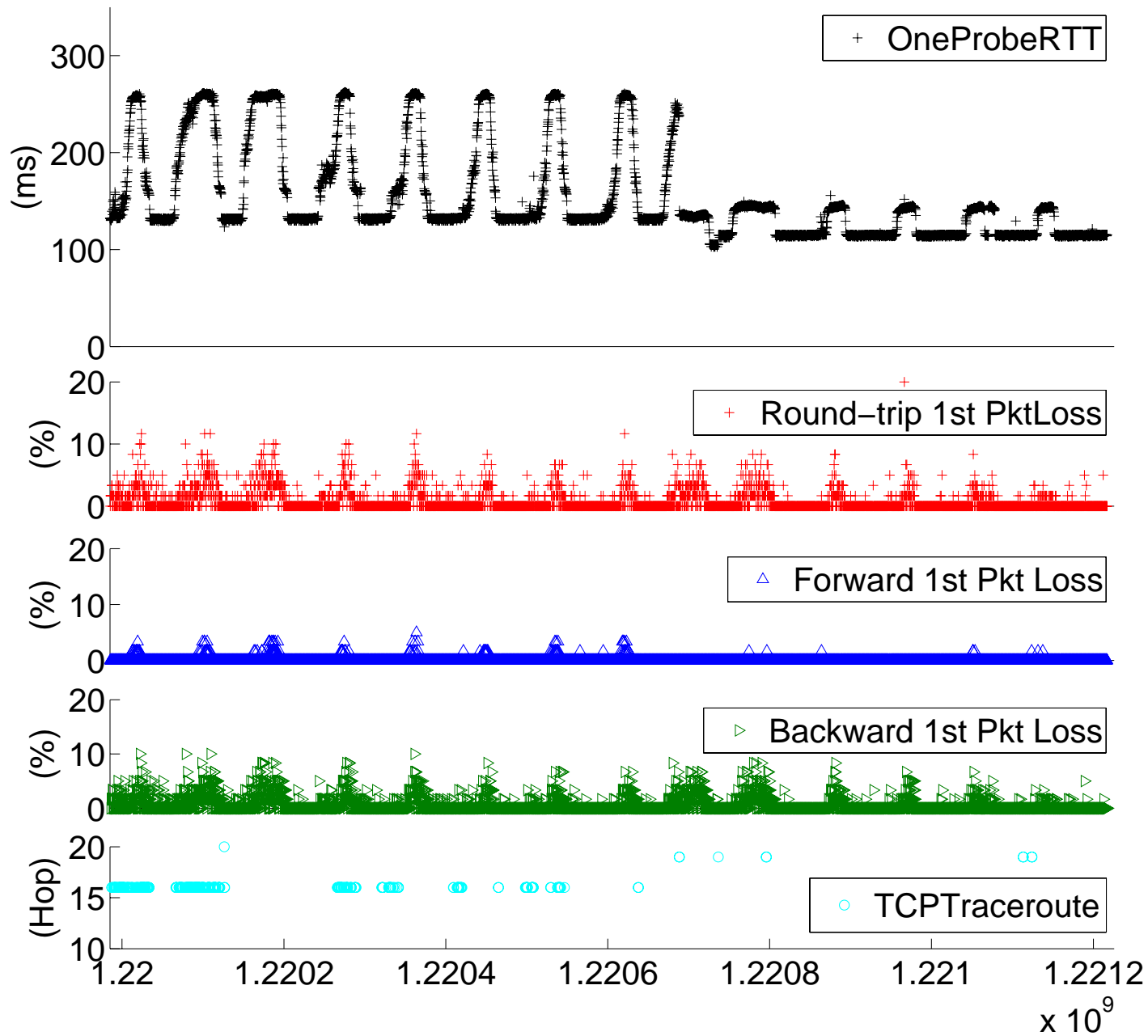
Ranking of difference between measured forward and backward packet loss



Special cases

- Effects of detectable route changes on the path performance
- Effects of undetectable route changes on the path performance

Timeseries of RTT, loss rate and route change



Conclusions

- Ping is not reliable for RTT measurement.
 - It could significantly underestimate the delay experienced by TCP data.
- Ping, Pping, and HTTPping cannot measure beyond round-trip loss rates.
 - E.g., cannot detect highly asymmetric path losses.
- The protocol used in the probes should match with the protocol under measurement.
- A careful measurement study can reveal configuration changes on the path.

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