Characterization of accuracy problems in NetFlow data and approaches to handle them

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Outline

Motivation: why looking at accuracy of data?
Accuracy issues
Handling problems with exporter profile
Conclusion and Outlook
Motivation

Scenario

Global Enterprise Network, MPLS-VPN
- Flow data from several (1..5) routers on path
- Own routers (full control)
- CE-Routers of carrier ("read only")

→ Netflow-based (v5) view on traffic at several points in the network
→ Correlation of Flow data for extraction of network characteristics
Motivation

Extraction of network characteristics

Extractable characteristics are e.g. one-way-delay, RTT, packet loss, flow contention
→ Requires matching flow records
  - For the same 6-Tuple (src/dst address, src/dst port, protocol, ToS)
  - Exported from different observation points (exporter + input interface)
Motivation

Extraction of network characteristics

Matching

First try (very strict rules)

– Take flows exported in one record only
– Drop implausible records
– Match records, match forward and reverse, drop implausible data

→ 12,500 bidirectional trajectories left from 22 million records (10 samples per path and hour)

→ Two questions

1. **Precision** of characteristics obtained from flow-data wrt. timings, bytes, packets
2. What do we have to consider in consistency and plausibility checks in order to get a high amount of samples?
Accuracy issues

Overview of issues (not all shown in detail)
- Record loss (the simplest one)
- Duplicates
- Packet counters
- Byte counters
- Clock accuracy
  - Granularity
  - "Noise"
  - Jumps
  - Clock offset, clock skew

Different reasons
- Inaccuracies at exporters
- Configuration issues
- Middle boxes
Accuracy issues

Comparing trace to NetFlow: scenario

- Path between two European cities
- 5 day packet trace, filtered on two endpoints: application probe and server
- Flow data from three exporters (two of them CE)
Accuracy issues

Comparing trace to NetFlow: byte count

Byte count Issue

– Byte count different at one observation point, but packet count consistent
– Here: router rounds byte count up to 46 Bytes
– Side note: Similar effects from some middle boxes (WAN optimizers)

Histogram of byte difference: exporter 3

forward: trace bytes – netflow bytes
reverse: trace bytes – netflow bytes

frequency

byte difference
Accuracy issues

Comparing trace to NetFlow: clocks

Clock Offset and Skew (CE-Routers)
Accuracy issues

Comparing trace to NetFlow: clocks

Distribution of time difference

- "Signal to Noise Ratio" depends on exporter
- On good exporters (left) accuracy around +/- 10 ms. Right: much more noise.
- Note: difference between start and end time diff of reverse-flow
  → granularity issue?
Accuracy issues

From NetFlow data only: granularity of clocks

Determination of granularity
- calculate difference between record start times, duration, end times, ...
- and/or calculate greatest common divisor

Results
- start/end time granularity: 4 ms or 1 ms (see following slides)
- duration granularity: 4 ms on all exporters
- nsecs-granularity: 15,258 (1e9/2^16)
Accuracy issues

From Netflow data only: granularity of clocks

This exporter: 1ms granularity
Accuracy issues

From Netflow data only: granularity of clocks

Another exporter: 4 ms granularity
Accuracy issues

from Netflow data only: granularity of clocks

Yet another one: 4 ms granularity (simple calculation would reveal 1 ms)
Accuracy issues

From NetFlow data only: duplicates

Definition of "Duplicates"
More than one record for the same key within a time interval.

What to do?
→ depends on type of duplicate

\[ r_1 \]
\[ r_2 \]
merge \( r_1 \) and \( r_2 \)

\[ r_1 \]
\[ r_2 \]
take \( r_1 \) instead of \( r_2 \)
Handling problems using an exporter profile

Observation
- Routers behave differently wrt. accuracy of timestamps, bytecount, duplicates,...
- Knowing these effects can lead to more/better results
→ Exporter profile that describes effects and accuracy for each exporter

Exporter profile
- Exporter-specific par
  • Timestamp granularity, Timestamp accuracy and behavior
  • How to handle duplicates
  • Bytecount problems
- Configuration/scenario-specific part
  • Clock offsets/skew
  • Middlebox locations

How to obtain exporter profiles?
- Manufacturer (?)
- "Calibration" using packet trace
- Using NetFlow data only (e.g. more accurate data from off-peak times)
Conclusion and Outlook

Conclusion

• Accuracy issues wrt. timestamps, byte count, duplicates identified
• Effects depend on router
• NetFlow data from "good" routers is suitable for estimating one-way-delays with at least +/- 20 ms accuracy

Outlook

• Exporter Profile
  – Profile format and relation to other (configuration) items
  – Methods to create exporter profile
  – Evaluate improvements wrt. accuracy from different features in the Exporter Profile
  – Load dependency?

Discussion: More accuracy issues known?