Happy Packets to You!

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Outline

• Why this study?
• Methodology
• Results and analysis
• Open issues
• Conclusions

Why This Study?

• We frequently hear comments about Internet control plane quality, such as
  – Internet routing is fragile and collapsing,
  – Yesterday was a bad routing day on the Internet,
  – BGP is broken or is not working well,
  – Changing protocol X to Y will improve routing, or
  – Internet routing has been severely affected by event X
    (e.g. power blackout, worm outbreak)
• But what measurement can really tell the quality of control plane?
  – Number and frequency of BGP updates?

Happy Packets

• What ultimately counts is whether the customer's packets can reach their intended destination with good performance
  – Namely, the performance at data plane
  – And after all, this is the functionality of the control plane
• We call them happy packets

Our Goal

• Answer this question: Are packets happy under routing changes?
  – Basically, we evaluate Internet control plane quality by measuring the data plane performance

Methodology

• How to measure packet happiness at the data plane?
  – Use the PlanetLab
• How to introduce routing changes into the control plane
  – Use a BGP Beacon
Happiness over the PlanetLab

- A set of geographically and topologically diverse PlanetLab nodes are selected as probe sites.
- A site from Seattle is selected as a sink.
- Every probe site continuously sends testing UDP streams toward the sink site.
- While the routing toward the sink changes.
- Over a period of four months.

Metrics of Happiness

- Using well-established metrics (DDJ&R):
  - Delay, drop, jitter, and reordering.
- Delay: the relative to the mean one-way delay.
- Loss rate: % of packets dropped per second.
- Loss duration: the length of a time window with exceptionally high loss rate.
- Jitter: delta between delays.
- Reordering rate: % of reordered packets per second.

BGP Beacon

- An unused globally visible IP address prefix.
- With a schedule of BGP announcements and withdrawals regarding reaching the prefix.
- We use a multi-homed BGP Beacon 192.83.230.0/24.
- The test stream sink has a specific IP address from this prefix.

Collecting Control Plane Data

- Oregon RouteViews Project archive BGP updates.
- Can help observe BGP updates related to the BGP Beacon prefix.
  - Thus BGP duration and BGP update number during an event can be measured.
What Did We Find?

• Average and worst case DDJ&R results of individual streams
• Aggregated results of DDJ&R
• Control plane data

Results of an Average Stream

• Stream from 128.95.219.192 as an example
• Under four different routing changes over 20 min: AB-B, AB-A, A-AB, B-AB
• Performed well in general, either during or outside routing changes
  – Most times packet delays are acceptable
  – No reordering was detected
  – Thus jitter is also acceptable
  – A 30-sec loss duration in the AB-A case
Results of a Worst-Case Stream

- Stream from lcs-bgp.vineyard.net
- Under four different routing changes over 20 min: AB-B, AB-A, A-AB, B-AB
- Performed the worst compared to other streams
  - Longer delay than others
  - Longest loss duration
    - 10s in AB-B w/ 91 drops & 8 reorders
- However, not significantly worse than its own normal period

Aggregated Results

- Delay CDF
- Jitter CDF
- Loss rate
- Reordering
  - not plotted (close to 0)
CDF of (Relative) Delay

Results for AB-B, A-AB, B-AB are similar

Jitter CDF

Results for AB-B, A-AB, B-AB are similar

Loss Rate

Loss Rate

DDJ&R Summary

- Acceptable during injected routing changes
  - Although generally worse than normal periods
- In most cases, BGP performs well
- Can also approximate closely the packet delivery performance between two routers
  - DDJ&R of each UDP stream from end to end is also close to the BGP Beacon router and the router for the probe site

Misconception in Inferring Packet Happiness

- Can control plane data, such as those from RouterViews or RIPE, predict packet performance, thus equivalent to measuring DDJ&R?
- Answer: No!
Loss duration vs. BGP update duration

Loss duration vs. BGP update number

White Blood Cells
- Perhaps BGP announcements are like white blood cells
- Their presence may signal a problem
- But they are often part of the cure, not necessarily part of the problem

Summary
- No clear correlation between loss duration and BGP duration, or loss duration and number of BGP updates
- RouteViews archives only provide partial knowledge of the control plane
- One should be cautious in using BGP updates to analyze control plane quality

Open Issues
- Large-scale control plane events
- Congestion effects on DDJ&R
- Usage of partial control plane knowledge
  - . . .

Conclusions
- Data plane performance is the best measure of control plane effectiveness
- Not only for BGP, but also other routing protocols
- We’ve found little proof that BGP is not resilient or performing poorly during routing changes
- And we should be critical about using partial control plane data for study
Questions?

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