A Measurement Study on the Impact of Routing Events on End to End Internet Path Performance

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Overview

- Routing Events vs Path Performance
  - **Routing events** such as *link failures* or *link repairs* happen frequently as indicated by high volumes of routing updates.
  - **Path performance**, such as *loss*, *delay* and *out-of-order packets*.
- The impacts of routing events on path performance remained poorly understood (2005).
Experiment Setting

- Use a multi-homed BGP Beacon
- This Beacon has two tier-1 providers: ISP 1 and ISP 2.
- To emulate the routing events, the Beacon sends a route withdrawal or announcement to one or both providers according to the time schedule:
Emulating Routing Events

• Four types of routing events

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<th>BGP updates</th>
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• Active Probing:
  • At every hour, every probing source sends a UDP packet stream marked by sequence numbers to the BGP Beacon host at 50 m sec interval.
Terminologies: Network congestion vs Routing Failure

- Network Congestion
- Routing Failures
  - Temporary route loss: identified by correlating loss bursts with ICMP network unreachable message.
  - Forwarding loop: can be identified if TTL value exceeds the maximum value.
  - Since ICMP packets can be lost, the number of loss bursts due to routing failures may be underestimated.
Failover Events: Data Plane Performance

- The experiment divide the time period into three intervals:
  - Before path change;
  - During path change;
  - After path change.

- The result shows:
  - During path changes packets suffer most
  - Failure events have the most impact on loss burst length.
Root Causes of Loss Bursts

- More than half of failure events can be verified having routing failure (routing dynamic).
- The loss bursts that are verified as caused by routing failure last longer than those unverified loss bursts.
- The loss caused by forwarding loops last longer than those caused by loop-free routing failures.
Explanation

- Two gaps both can be correlated to ICMP -> routing failure
- Explanation:
  - RR1 in ISP1 cannot reach Beacon at the first gap (04:00:01);
  - After RR1 found alternative path, this cannot announce to RR4 in ISP3 because of “no-valley” routing policy, result in RR3 lose route at the second gap (04:00:19).
Experiment focus on multiple loss bursts

In over 75% of the cases, a host experiences fewer than two loss bursts.

Among the first two loss bursts, around 60% of the first loss bursts can be verified caused by routing failures, while 40% for the second bursts.
Data Plane Performance

- More packets dropped during after path change, which is most likely due to congestion.
- Recovery events have impacts on packet round-trip delay and the degree of reordering, though the impacts are smaller compared to failure events.
- The loss burst length are not different from that for failover events.
Further Analysis for Recovery Events

- Fewer packet loss verified to be caused by routing failure
- Latency:
  Unverified loss bursts during recovery events
  < Routing failure verified loss bursts during recovery events
  < Routing failure verified loss bursts during previous failure events
- Forwarding loops are also quite common during recovery events.
How Routing Failures Occur

- First, R3 receives the new path and waits for the expiration of MRAI timer to send new path to R1 and R2.
- The new path send to R2, before to R1.
- R2 switches to new route, but cannot forward new route to other iBGP.
- R2 send a withdrawal message to R1 to poison its previous route, result in R1 loss burst.
The Last Regards

- The raw experimental result is quite straight and intuitive:
  - Routing events influence path performance
  - Routing changing causes longer latency than forward loops do.
- The new findings:
  - Recovery events indeed affects path performance, though limited
  - Multiple loss bursts can occur at different ASes.
- But through topology explanation:
  - Common iBGP configuration and MRAI timer values play a major role in causing packet loss
  - Extending BGP to accommodate routing redundancy may eliminate majority of end-to-end path failures caused by routing events