Towards Capturing Representative AS-Level Internet Topologies

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Objective

- How complete & how representative is the BGP-derived AS graph?

Background

- BGP-inferred AS graph: Highly-variable node degree distribution, characterized by $d = a^n$ (where $a$ is a constant). (Figure showing a power-law distribution)

Local view vs. non-local view

- Question: How well is my connectivity observed by others?
- Dataset: full BGP dumps of 41 different ASs, Looking Glass data from ~70 different ASs.

Observations:
- The connectivity of tier-1 ASs is more easily observed than that of non tier-1 ASs.
- The connectivity of an AS is more easily observed by it customer than by its peer.

Augmenting AS topology data: IRR

- Internet Routing Registry: coordinate/facilitate inter-AS policy routing.
- Obtaining AS peering relationship info from IRR:
  - Data sanity check: identify (1) void, (2) obsolete, and (3) incomplete records.

Validating Our Topology

- Do the newly found edges reflect physical inter-AS connectivity?
- Methodology: Identify those ASs that are physically co-located at existing public exchange points (EPs).

More Representative AS graph?

- A more complete “our topology” is much more dense than Oregon topology.

AS graph statistics

<table>
<thead>
<tr>
<th>Source</th>
<th># of node (%inc)</th>
<th># of edges (%inc)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oregon route-views</td>
<td>11,174</td>
<td>23,469</td>
</tr>
<tr>
<td>+ RSs</td>
<td>11,268 (0.84%)</td>
<td>26,224 (12.5%)</td>
</tr>
<tr>
<td>+ RSs + LG</td>
<td>11,320 (1.3%)</td>
<td>27,999 (19.2%)</td>
</tr>
<tr>
<td>+ RSs + LG + RIPE</td>
<td>11,456 (2.5%)</td>
<td>32,758 (60.0%)</td>
</tr>
</tbody>
</table>

“A our topology”

- The degree distribution of “our topology” is still heavy-tailed or highly-variable, but deviates significantly from strict power-law.

Conclusion

- The completeness issue of BGP-inferred AS Internet topologies.
- Important lesson for network-related measurement studies in general.