bdrmap-IT: Mapping AS Borders in the Internet

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Problem

• How do we infer router operators and interdomain links from a traceroute dataset?

• Why?
  • Public policy – interdomain link congestion
  • DDoS – analyze potential attacks against interdomain links
Previous Work

• bdrmap [Luckie et al. IMC ’16]
  • Highly accurate
  • Limited to the border of the traceroute vantage point network

• MAP-IT [Marder & Smith IMC ’16]
  • Identifies inter-AS links at Internet-scale
  • Precise, but lower recall
Goals: For All Routers and Links in Traceroute Dataset

• Synthesize bdrmap and MAP-IT

• Infer AS operators of routers

• Identify interdomain links

• Work with existing traceroute data
  • For all ASes seen in the dataset
Algorithm: 3 Main Components

1. Create hybrid router-interface graph from traceroutes

2. Identify last-hop router operators

3. Graph refinement loop:
   A. Determine router operators
   B. Infer inter-AS links
Graph Construction: Priority Edges

• 3 edge labels (in priority order):
  - adjacent TTL Expired hops or same AS
  - echo replies
  - separated by unresponsive hops

• Edges from router to interface

• Only highest priority edges used for each router

<table>
<thead>
<tr>
<th>Hops</th>
<th>IP</th>
<th>AS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>a</td>
<td>AS_A</td>
</tr>
<tr>
<td>1</td>
<td>b</td>
<td>AS_B</td>
</tr>
<tr>
<td>2</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>c1</td>
<td>AS_C</td>
</tr>
<tr>
<td>7</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>c2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>d</td>
<td>AS_D</td>
</tr>
</tbody>
</table>

Edges:
- \( \overset{N}{a} \rightarrow \overset{E}{b} \rightarrow \overset{M}{c_1} \rightarrow \overset{N}{c_2} \rightarrow \overset{E}{a} \)
- \( \overset{N}{\text{Echo Reply}} \rightarrow \overset{E}{?} \rightarrow \overset{E}{H_8} \)
Identify AS Operators of Last Hop Routers

• Only routers which only appear last in their traceroutes

• Use traceroute destinations to determine AS operator

• 95% accurate
Graph Refinement Loop: Router Operators

• Lots of heuristics: IXP addresses, unannounced addresses, third parties, hidden ASes, etc.

• All highest priority edges get a vote

• Highest vote AS operates router
Graph Refinement Loop: Inter-AS Links

- Interface origin AS different from router operator

- Select most frequent AS from connected router operators
Results: Precision and Recall

• Ground truth with 3 networks – tier 1, large access, and R&E

• **Precision:** fraction of inter-AS link inferences which were correct

• **Recall:** fraction of inter-AS links in the dataset correctly identified
Results: bdrmap-IT Identifies Far More Inter-AS Links Than MAP-IT
Results: `bdrmap-IT` Performs Slightly Better Than `bdrmap` Restricted to the Vantage Point AS Border
Reducing the Number of Traceroute Vantage Points Doesn’t Decrease Accuracy
Conclusions

• Maps the borders of ASes
• High accuracy for correctly identifying inter-AS links
  • At least as accurate as its component techniques
• Using on ITDK and RIPE Atlas traceroutes

• What we want:
  • People to use it, soon
  • Ground truth from networks