Impact of Alias Resolution on *Traceroute*-Based Sample Network Topologies

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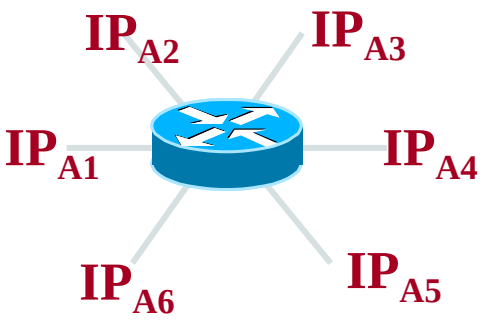
Overview

- Context:
  - Alias resolution problem in Internet measurement studies.
- Study:
  - Impact of alias resolution on *traceroute*-based sample network topologies.
- Results:
  - The accuracy/completeness of the alias resolution process has a significant impact on topological characteristics of the sampled network.

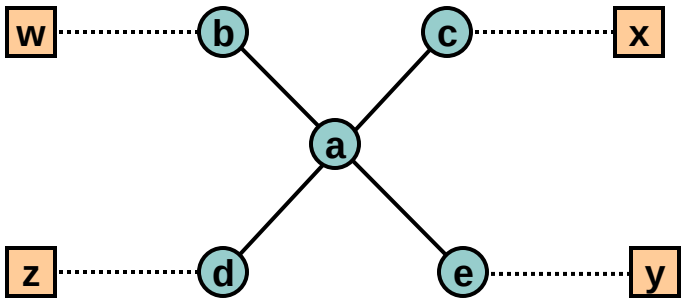
Internet Mapping:
Alias Resolution Problem

- Internet mapping projects utilize *traceroute* like tools for topology collection.
- Each interface of router has an IP address (possibly unique).
- A router may respond with different IP addresses to different queries.



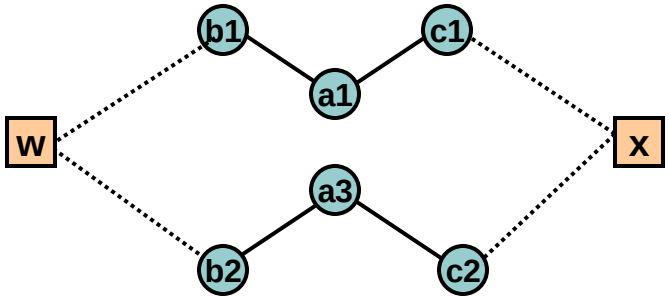
- *Alias Resolution* is the process of grouping the interface IP addresses of each router into a single node.
- Inaccuracies in alias resolution may result in a network map that
  - includes artificial links/nodes
  - misses existing links/nodes

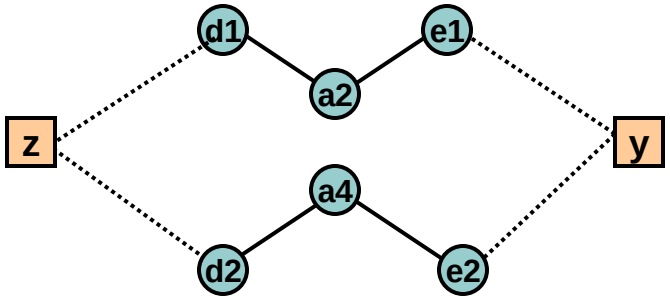
Alias Resolution:
Problem



a sub-graph

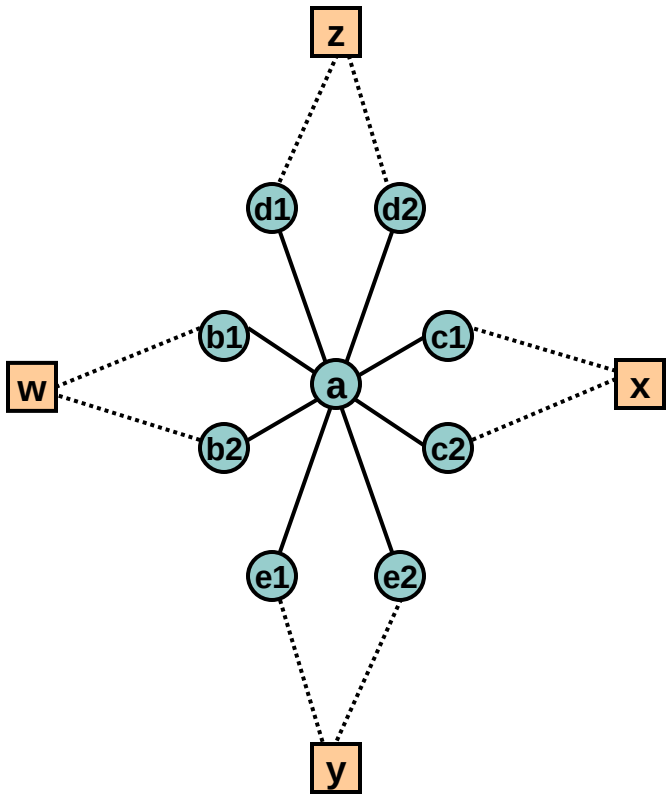
- Traces
  - w, …,b1, a1, c1, …, x
  - z, …,d1, a2, e1, …, y
  - x, …,c2, a3, b2, …, w
  - y, …,e2, a4, d2, …, z



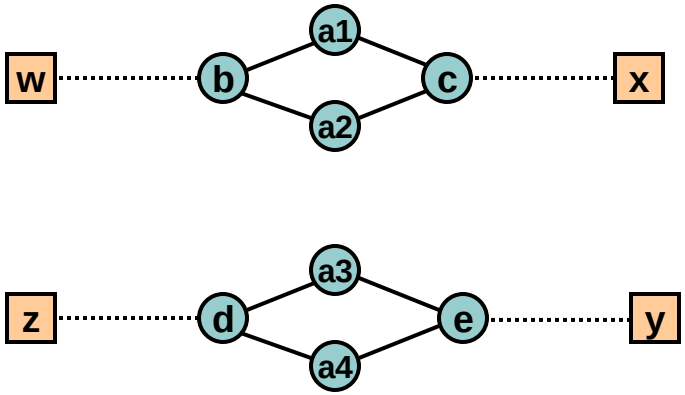


no alias resolution

Alias Resolution:
Problem



partial alias resolution
(only router **a** is resolved)



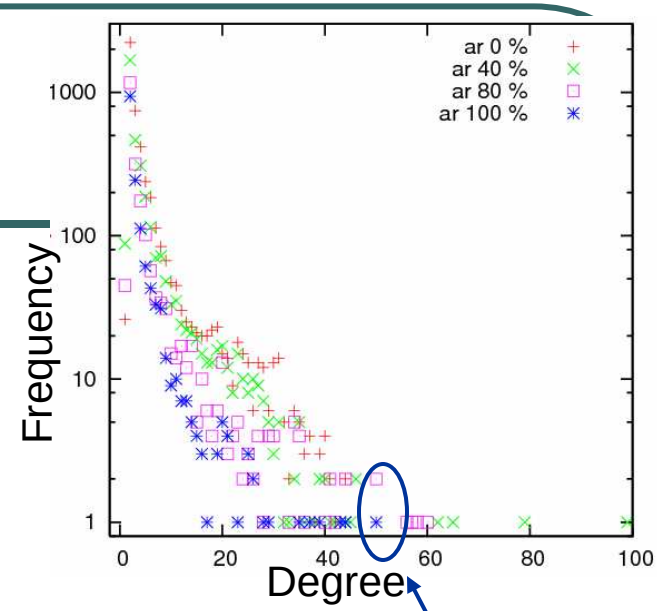
partial alias resolution
(only router **a** is *not* resolved)

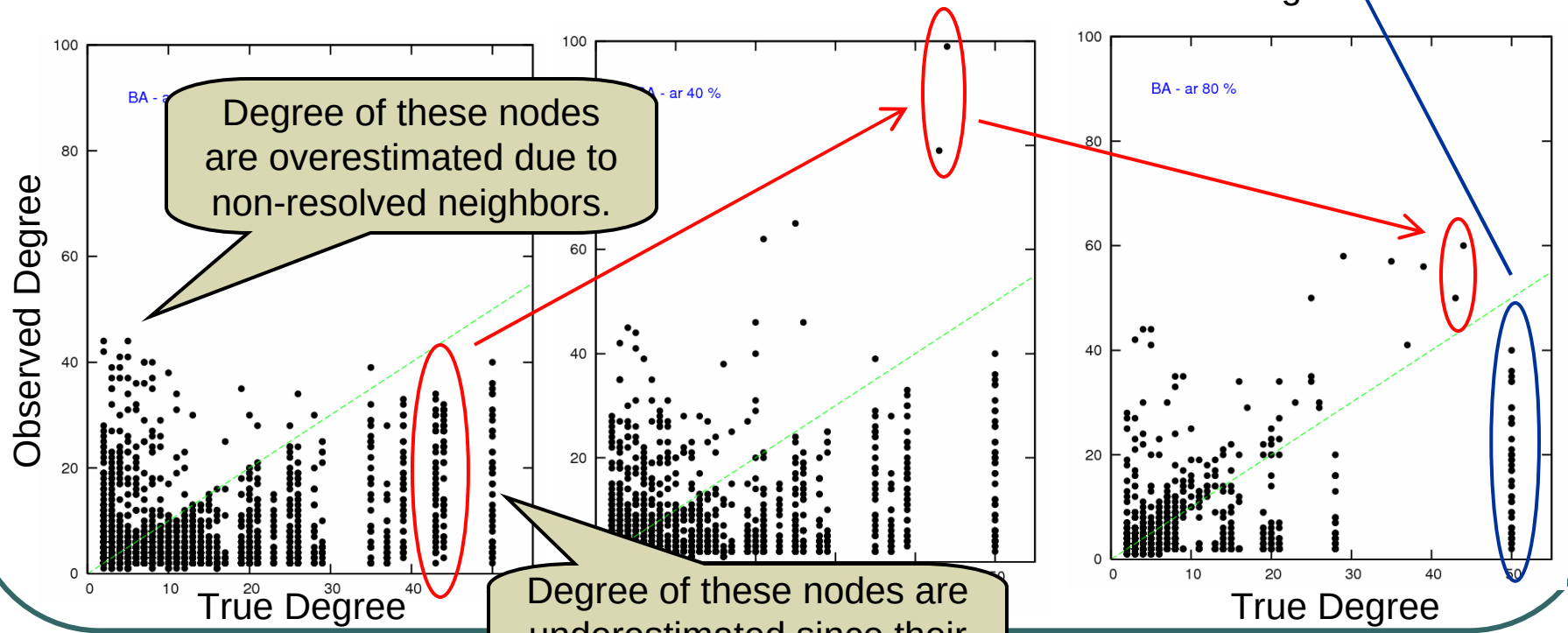
Alias Resolution:
Problem Magnitude

- We quantify the impact of alias resolution on *traceroute*-based sample network topologies.
- We utilize *Barabasi-Albert* (BA), *Waxman* (WA) and *Transit-Stub* (TS) network models.
- We observe significant variations in the following graph characteristics with varying degree of alias resolution.
  - Topology Size,
  - Node Degree,
  - Degree Distribution,
  - Characteristic Path Length,
  - Betweenness,
  - Clustering.

Alias Resolution:
Effect on Node Degree

- Observed degree vs. true degree
  - Overestimation and
  - Underestimation exist.





Alias Resolution:
Effects on Topological Characteristics

- Topology Size
  - Number of nodes and edges reduces by 57% and 62%, on average, as alias resolution improves from 0% to 100%.
  - The impact of imperfect alias resolution increases as the size of the sample topology increases.
- Node Degree
  - Alias resolution problem at neighboring nodes causes overestimation.
  - Alias resolution problem at the node causes underestimation.
- Degree Distribution
  - Changes with the success rate of the alias resolution process.
  - Imperfect alias resolution
    - distorts the power-law characteristic of *BA-based samples,*
    - impacts especially low degree ranges of *TS-based samples,*
    - impacts especially high degree ranges of *WA-based samples.*

Alias Resolution:
Effects on Topological Characteristics

- Characteristic Path Length
  - Reduces with the increasing alias resolution success rate.
  - The average reduction for BA and WA-based sample topologies is about 30%.
- Betweenness
  - The average betweenness reduces with an improvement in alias resolution success rate.
  - The normalized betweenness increases as the alias resolution success rate increases.
- Clustering
  - All samples yield a clustering coefficient of 0 with 0% alias resolution success rate.
  - It increases with the increasing alias resolution success rate.

Conclusion

- The accuracy of the alias resolution process has a significant impact on almost all topological characteristics that we consider in this study.
- Internet measurement studies should employ all the means possible to increase the accuracy/ completeness of the alias resolution process.
- Our confidence in the results of measurement studies is limited by the lack of a mechanism to verify the accuracy/completeness of the alias resolution process.