

# In Search for Path Diversity in ISP Networks

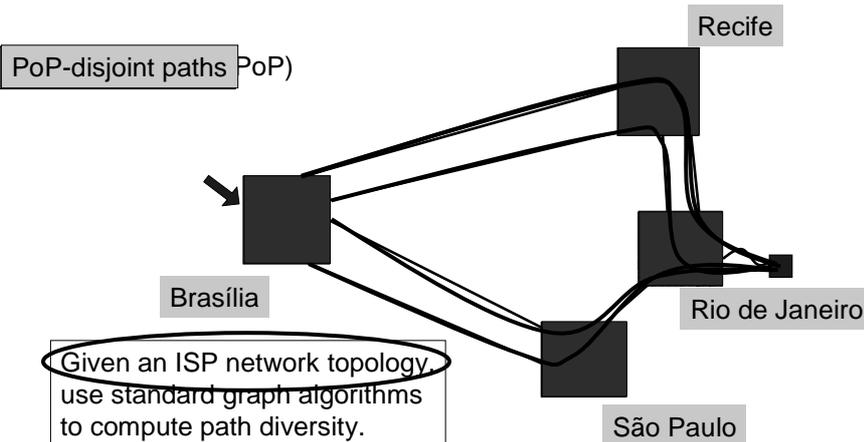
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*UC San Diego*

*Internet Measurement Conference  
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## Path Diversity

- ◆ Number of paths for a packet to transit between two points
  - Inside an autonomous system network (ISP)
  - Fully link and PoP (Point of Presence) disjoint paths
  - Observed at IP level
- ◆ Applications
  - Robustness, resilience to failures
  - Traffic engineering
- ◆ How much path diversity is there in real networks?

## Path Diversity inside an AS



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## Topologies Studied

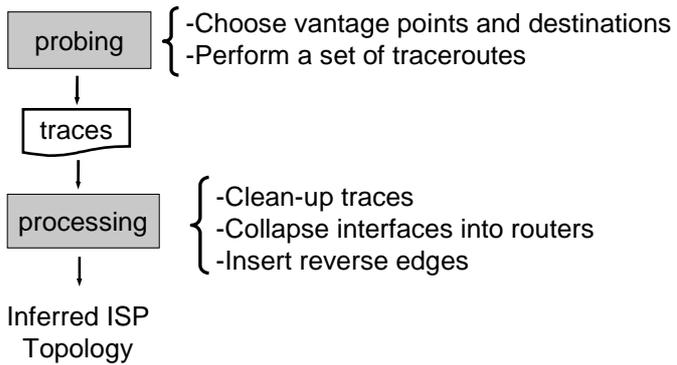
- ◆ Inferred topologies (Rocketfuel)
  - Nine router-level ISP topologies (incl. Sprint)
  - Reconstruct PoP-level topology
- ◆ Exact Sprint network topology
  - PoP-level topology of the continental US backbone network

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# Inferring ISP Topology

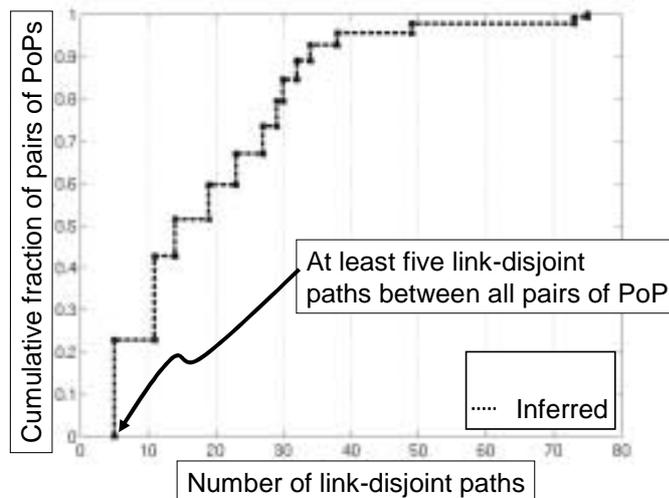
ISP Network



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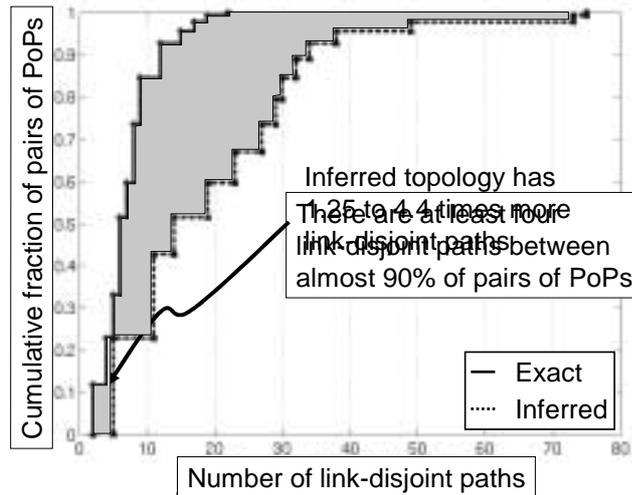
# Path Diversity in Inferred Sprint Topology



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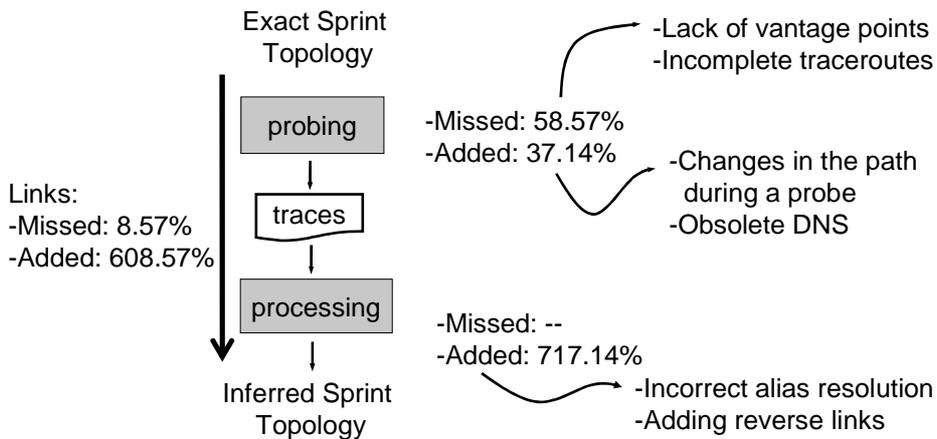
## Inferred vs. Exact Path Diversity



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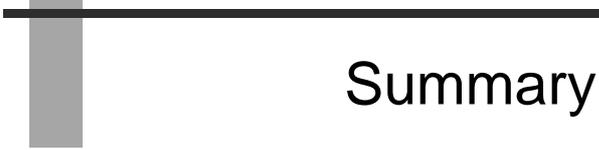
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## Accuracy of Inferred Sprint Topology



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## Summary

- ◆ Large diversity in path diversity!
  - Depends on network design
- ◆ High level of path diversity in Sprint network
  - 90% of PoP-pairs have at least 4 link-disjoint paths
- ◆ Extracting path diversity is challenging
  - Inferred topologies are not representative of path diversity
  - Getting real data is unrealistic



## Warning

Inferred topologies should be used carefully!

- Need to understand limitations of the data
- Impact on relevant topological properties