Rationality and Traffic Attraction: Incentives for Honest Path Announcements in BGP

Sharon Goldberg[1] Shai Halevi[2] **Aaron D. Jaggard**[3]
Vijay Ramachandran[4] Rebecca N. Wright[3]

[1]Princeton [2]IBM Research [3]Rutgers [4]Colgate

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Interdomain Routing

- Physical connections between Autonomous Systems (ASes)
- Fix a destination AS *d* to which other ASes want to send traffic
- Routes to *d* are propagated through the network using the Border Gateway Protocol (BGP)
- Nodes iteratively:
  1. Receive BGP updates (with route information)
  2. Apply local policies (and update routing table if necessary)
  3. Send BGP updates to neighbors
- *If an AS advertises a path, it should be the path in the AS's forwarding table*
- Preferences and filtering determined by local policies

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Interdomain Routing as a Game

Lots of interest in:

- Economics in BGP analysis, *e.g.*, Gao–Rexford, Griffin–Shepherd–Wilfong, Sobrinho, . . .
- Interdomain routing as a game, *e.g.*,
  Feigenbaum–Papadimitriou–Sami–Shenker,
  Feigenbaum–Karger–Mirrokni–Sami,
  Feigenbaum–Ramachandran–Schapira,
  Feigenbaum–Schapira–Shenker,
  Feigenbaum–Sami–Shenker,
  Hall–Nikolova–Papadimitriou,
  Nisan–Ronen,
  Levin–Schapira–Zohar,
  Shneidman–Parkes,
  . . .

Model and Question

- Start with the Interdomain Routing Game of Levin–Schapira–Zohar:
  1. AS selected in round *i* processes updates,
  2. decides on an outgoing link (if any) to use for forwarding,
  3. and decides on paths (if any) to announce to its neighbors.
- Add more realistic utility functions
  - Utility of *v* depends on forwarding path from *v* to *d and on forwarding paths from other ASes through v*
  - Eavesdropping, commercial considerations, . . .
- In this model, when does an AS have no incentive to lie about its forwarding choice (assuming no other AS lies)?

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Results

- Consider different types of traffic attraction
- Lots of negative results!
- Some positive results, *e.g.*,

Theorem (Sample)

Given a "dispute-wheel free" AS graph with "next-hop" valuations in which all ASes but v use "BGP-compliant" strategies ($\Rightarrow$ truthful announcements) and obey "all-or-nothing" export, and Secure BGP is used globally, there is a BGP-compliant strategy for v that uses all-or-nothing export and obtains the best possible (in terms of v's utility) stable outcome.

[Set-Nash Equilibrium of Lavi–Nisan]

Dropping any condition here gives *v* an incentive to lie!

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Summary

- More realistic utilities for the Interdomain Routing Game
  - Various ways to gain from carrying traffic (in addition to gain from route used)
- Focus on whether nodes have incentive to lie about routes used
- Combinations of strong conditions guarantee no incentive to lie
  - Dropping any of them gives incentive to lie, *e.g.*, SBGP and next-hop routing alone are not enough!

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