You can't handle the lie: Catching lying actors in the BGP protocol

Clay Thomas, Gavriel Hirsch
claytont@princeton.edu, gbhirsch@cs.princeton.edu

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Abstract

In many BGP networks, nodes can get their preferred path by advertising a certain path, but forwarding traffic along another. However, in many of the example networks from the literature, other nodes can collectively detect these lies by comparing the route that is advertised (known by the node the manipulator lies to) to the route actually taken (known by the node the manipulator actually forwards traffic to). We want to study the conditions under which nodes can lie without being detected, as well as the economic incentives of other nodes to collaboratively check each other (such as providers helping customers detect liars).

1 In the [LSZ08] model, you can always catch a liar

Conjecture 1. *Suppose No Dispute Wheel holds, but route verification does not, and assume that the network is connected. Suppose that (assuming other nodes play truthfully) a node m can achieve a better path to d by announcing a route that does not exist to a node v. Let m's next hop in the manipulated routing tree be denoted r. Then there exists a path in the network, not containing m, between v and r.*

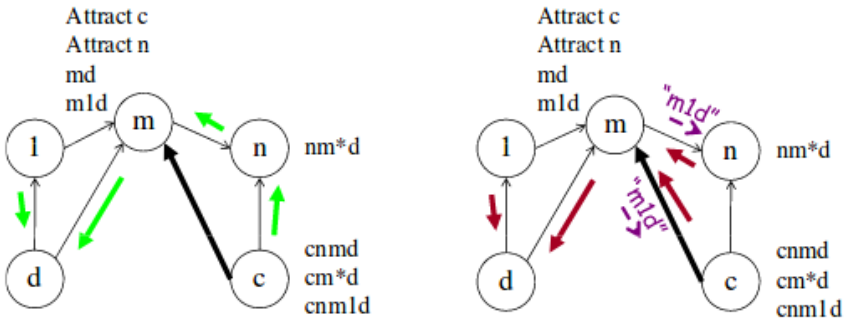
This means that, if all nodes other than m are fully collaborative and honest, the nodes will be able to detect m's lie by communicating along the links that already exist in the network.

(a) In the [GHJ+08] model, you can't

Consider Bowtie (figure 1), an example taken directly from [GHJ+08]. In this case, node m needs to lie to nodes c and n, but actually forward traffic to node d. The only nodes between d and c (or n) pass through node m. Thus, the honest nodes cannot catch m in its lie solely using the communication channels provided by the network itself.

One objection may be that real-life networks are much more highly connected than the small counterexamples presented in these papers. However, we believe that very small sets of nodes surrounding the adversary m can reasonably model the set of nodes that actually

Figure 1: Bowtie

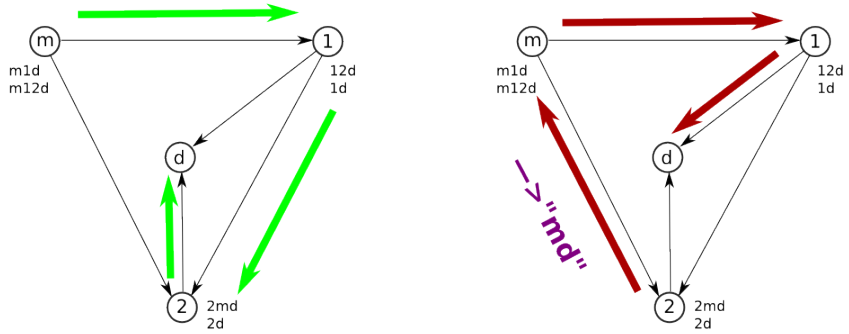


care enough to try and catch m lying. Thus, it makes sense to ask if small subnetworks can catch m communicating only along links among themselves.

2 But will you?

Figure 2 shows an example network (taken directly from [LSZ08] but rendered in the style of [GHJ+08]) where m has an incentive to advertise a path that does not exist. We regard this network as the canonical example of Conjecture 1. Indeed, node 1 can inform node 2 that it is receiving traffic from m, so 2 will know that m is lying about its path.

Figure 2: Nonexistent



This example is a Gao-Rexford network, where customer-provider relationships are denoted by arrows pointing from customers to providers. Note that node 2 must be a provider of node 1 for this example (otherwise, 2 would not export its route to d to 1). In general, customers do not provide services for their providers, so it may not make sense for node 1 to help node 2 catch m's lie. Thus, it is not reasonable to assume that 1 will want to help 2 detect the lies of m, because 1 does not perform services for its provider 2. On the other hand, if 1 does inform 2 of the lie, and 2 resumes using its old route, 1 actually gets a path that it prefers.

Thus, we regard the competing incentives of getting good paths (especially in the presence of uncertainty about what routing actually occurs) with the economic obligations of customer-provider relationships to be an interesting avenue of research. That last sentence is a trainwreck, but it has the core idea lol.

And in fact it may be that 1 has strict incentives to not perform routing services. [1]

3 Project Components

We plan to first analyze which situations can result in a node having an incentive to lie and other nodes having incentives to not expose that lie to each other. In addition we will design a new protocol and consider corresponding business relationships in which nodes can both send messages about their paths, and separately share other information that can be used to expose others' lies. We will also analyze situations under this new protocol and see how the analysis differs.

We will also program virtual nodes and run simulations of networks using this new protocol, and confirm that the protocol works as we expect it to. [2]

References

[GHJ+08] Sharon Goldberg, Shai Halevi, Aaron D. Jaggard, Vijay Ramachandran, and Rebecca N. Wright. Rationality and traffic attraction: Incentives for honest path announcements in bgp. In *Proceedings of the ACM SIGCOMM 2008 Conference on Data Communication*, SIGCOMM '08, pages 267–278, New York, NY, USA, 2008. ACM.

[LSZ08] Hagay Levin, Michael Schapira, and Aviv Zohar. Interdomain routing and games. In *Proceedings of the Fortieth Annual ACM Symposium on Theory of Computing*, STOC '08, pages 57–66, New York, NY, USA, 2008. ACM.

[1] hmmm no I don't quite follow this

[2] The above seems fine, but I guess we don't need it now