You Can't Handle the Lie: Next-Hop Verification in BGP

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Abstract

The main goal of this work is to provide evidence for the following claim: corroborating facts from the data plane and control plane can improve the incentive properties of BGP.

In [LSZ08], the authors take a popular and well-studied extension of BGP, and study how it interacts with incentive properties. Their central claim of the authors is that BGP with path verification (such as S-BGP) has simple incentive properties: assuming all other nodes tell the truth, no node (or group of nodes) can lie in order to get strictly better routes. However, in [GHJ+08] it is demonstrated that in realistic models nodes have incentives to lie in order to *attract traffic*, e.g. ISP attracting traffic from customers. One idea of [GHJ+08] is to find the simplest set of criterion needed for incentive-compatibility to hold, including the simplest form of verification required. They find that in some settings, a simple form of verification known as *loop verification* suffices. Our work is motivated by the question: *What is the simplest form of verification needed to provide good incentive properties of BGP?* We call the form of verification we came up with Next-Hop verification.

1 Introduction

2 Previous Work

3 Next-Hop Verification

(a) Informal Model and Assumptions

(b) The Protocol

4 Our Implementation Sketch

5 Conclusion

References

[FSS07] Joan Feigenbaum, Michael Schapira, and Scott Shenker. *Algorithmic Game Theory, chapter Distributed Algorithmic Mechanism Design.* Cambridge University Press, 2007.

[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.

A Formal Definitions

We follow the model of [LSZ08] and [FSS07], and start with the following model.

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

Intuitively, if a node lies to get a better path, the node it lies to and the node it routs through must be connected. The following conjecture, which we hope to prove formally, makes this precise.

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. Moreover, no node along this path benefits from the manipulation performed by m.

Proof. For the sake of contradiction, assume that all paths between r and v include m. One of r or v is on the "same side of m" as the destination node d. There must be a path from r to d not containing m, because m cannot appear twice on it route to d in the manipulated tree. Thus, every path from v to d must contain m.

Let T denote the original routing tree, and for each node n let T_n denote the path n receives to the destination. Let M_n denote the advertised route that n selects in the manipulated routing tree, i.e. the route n believes it receives, while $\widetilde{M}$ is the actual manipulated routing tree and $\widetilde{M_n}$ is the actual route n's traffic follows. Note that the path M_n need not actually exist in the graph. □

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.