An Economic Perspective on Traffic Attraction by Internet Transit Providers

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I. Introduction

Traffic attraction refers to a family of BGP (Border Gateway Protocol) techniques enabling an AS (Autonomous System) to receive traffic that would otherwise flow elsewhere [1]–[4]. The previous work examines various traffic-attraction techniques from security perspectives. There is also a body of related game-theoretic and simulation-based studies that include economic considerations but analyze traffic attraction in small-scale artificial settings.

In this paper, we focus on the economics of customer-traffic attraction by transit providers and report extensive C-BGP [5] simulations in an Internet-scale model configured with realistic data on inter-domain traffic, topology, and pricing. We consider attractors from the top 3 tiers of the transit hierarchy as well as 3 types of reactions by other ASes to the attraction: (1) filtering, i.e., discarding the BGP announcements that trigger the attraction, (2) disconnection by discontented customers, i.e., severance of their business relationships with the attractor altogether, and (3) attempts of discontented ASes to attract extra traffic to themselves. The broader scope and higher realism enable our work to offer deeper quantitative insights into traffic-attraction economics and reach reliable qualitative conclusions.

Our results demonstrate that transit providers can derive substantial financial benefits from attracting customer traffic, with tier-1 networks being in the strongest position to do so. The traffic attraction remains effective despite the countermeasures unless participation in them is broad. While the traffic attraction slightly increases router complexity, this effect is too insignificant to be a strong deterrent against the attraction.

II. Traffic attraction via prefix deaggregation

The specific BGP technique for traffic attraction in our study is prefix deaggregation. Prefix deaggregation refers to representing a prefix with multiple longer prefixes and announcing these longer prefixes to other ASes via BGP. Due to the longest-prefix match rule of IP (Internet Protocol) forwarding, the BGP announcement of a longer prefix steers traffic to the announced path. We consider the kind of prefix deaggregation where an intermediary AS learns a prefix from a customer, deaggregates the prefix, and announces all longer prefixes to each of its other customers. In particular, the traffic-attracting AS splits a learned prefix equally into 2 longer prefixes and announces both longer prefixes to the customers.

III. Model

We consider 3 different AS topologies from the CAIDA and UCLA public repositories, derive 9 traffic matrices guided by empirical Internet data, and conduct extensive simulations in C-BGP. Due to C-BGP scalability limitations, we focus on the core of each topology (roughly 6,000 ASes). The simulations determine the inter-domain link traffic rates for all these transit ASes. To compute the payment for every inter-domain link l, we use pricing function $t_l = b \cdot L^m$, where L denotes the link traffic rate in Mbps, and the $(b; m)$ values are $(45; 0.75)$ for transit links and $(20; 0.4)$ for peering links respectively. Overall traffic-delivery payment P of each transit AS is computed by subtracting its transit expenses and peering costs from its transit revenues: $P = \sum_{l \in \mathbb{V}} t_l - \sum_{l \in \mathbb{U}} t_l - \sum_{l \in \mathbb{G}} p_l$.

Our evaluation of traffic attraction and countermeasures by other ASes determines AS-level paths for all traffic and bidirectional traffic rates for every inter-domain link in the simulated topologies. Among the 6,000+ transit ASes in the topological cores, we select 30 ASes (10 each from tiers 1, 2, and 3) to act as traffic attractors. We refer to the 10-AS groups as T1, T2, and T3 respectively. To denote AS β from tier α, we use notation T$\alpha\beta$.

IV. Evaluation results

We start by examining what happens when a single AS attempts to attract traffic. We repeat this experiment for the 30 attractors with each of the 9 traffic matrices and record the median payment change for the attracting AS. Using box plots, figure 1 presents the results arranged according to the tier of the attracting AS. The plots demonstrate that transit ASes have significant financial incentives to attract traffic: the median payment change is 148%, 38%, and 21% for T1, T2, and T3 respectively. The tier-1 networks are in the strongest position to benefit from traffic attraction.

To analyze responses of other ASes to the traffic attraction, we first consider filtering, i.e., discarding the deaggregated prefixes announced by the attractor. Figure 2 presents the payment change for the attracting AS when all losing ASes do the filtering. Comparing the results in figures 1 and 2, we see that the filtering reduces but does not remove the financial benefits for the traffic attractor.

In figure 3, we examine a more severe reaction by losers where losing customers sever their business relationships with the attracting AS altogether. We consider a multi-stage response where stage 0 corresponds to the traffic attraction by
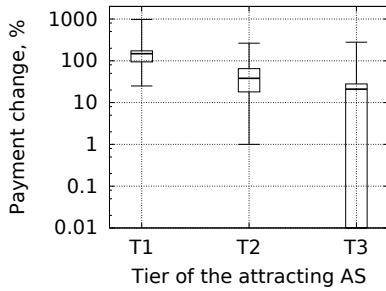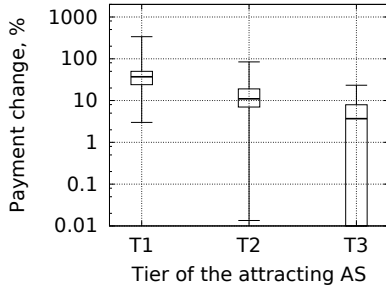
Fig. 1. Payment change for the attracting AS.

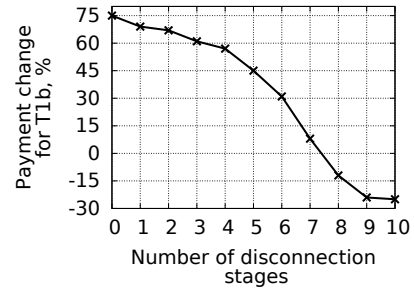Fig. 3. Payment change for attractor T1b when customers disconnect.

Fig. 2. Payment change for the attracting AS when all losers do the filtering.
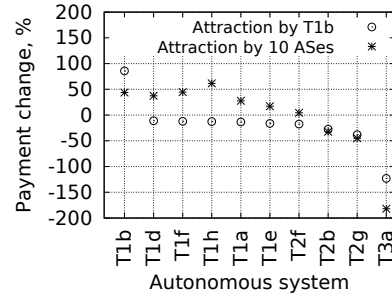

Fig. 4. Payment changes with traffic attraction by T1b only vs. all 10 ASes.

T1b without filtering (and without disconnection). On stage 1, the attractor is disconnected from the 1% of its losing stage-0 customers. On each of stages 2 through 7, the cumulative number of the disconnected customers of T1b doubles. On stage 7, the attractor is disconnected from 45% of all its original customers, the attractor still has the payment gain of 8%. On stage 10 where the attractor is disconnected from 85% of all its original customers, no new losers emerge, and the payment change of T1b stabilizes.

We also consider a different reaction where a losing AS defends its traffic-delivery payment by attracting extra traffic to itself. Specifically, we consider the scenario where T1b attracts traffic, and the 9 largest losers respond to the traffic attraction by trying to attract traffic as well. The expanded set of 10 attractors includes 6 tier-1, 3 tier-2, and 1 tier-3 ASes. Figure 4 shows the payment changes for these 10 ASes when the traffic attraction is done by T1b only vs. all 10 ASes. When all 10 ASes try to attract traffic, all 6 tier-1 ASes and T2f gain from the traffic attraction but the payment changes for T2b, T2g, and T3a are negative. The results confirm our earlier observation that tier-1 networks are in the strongest position to benefit from traffic attraction. Furthermore, figure 4 demonstrates that ASes from lower tiers are not assured to gain from traffic attraction when multiple networks attempt to attract extra traffic.

V. CONCLUSION

This paper presents an economic perspective on traffic attraction and countermeasures. The results demonstrate that tier-1, tier-2, and tier-3 networks have significant financial incentives to attract traffic. In comparison to ASes from the

lower tiers, the tier-1 networks are in a stronger position to benefit from traffic attraction with respect to: (a) the degree of the attainable gain, (b) impact on other networks, and (c) preserving their own gain when multiple ASes attract traffic. The traffic attraction remains effective despite countermeasures unless other ASes participate in the countermeasures broadly. The disconnection by losing customers is ineffective unless a large portion of them terminate their business relationships with the attractor.

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