Active Measurement of the AS Path Prepending Method

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1 Introduction

It is widely believed that the popular AS path prepending (ASPP) method is very effective in controlling the inbound traffic for multi-homed AS. The ASPP method artificially increases the length of the AS path advertised in BGP routes with the hope of discouraging the upstream AS from using the prepended routes. But the result of this method is usually unpredictable, i.e. the amount of traffic shifted across the inbound links after prepending cannot be predicted accurately. As a result, this method was often performed in a trial-and-error basis which could increase the convergence time and even introduce congestion in the unprepended links. Moreover, very few measurement studies were reported for the ASPP method. The main objective of this work is to evaluate the effectiveness of the ASPP method from the perspective of a stub, multi-homed AS.

Previous studies of the ASPP method were mainly based on the passive measurement available from the RouteViews server from which a large number of prepended routes was observed. However, if the ASPP method were effective, the corresponding prepended routes would not be preferred. As a result, we should not see such a large percentage of prepended routes from the RouteViews data. That is, we cannot draw any sound conclusions about the effectiveness of the ASPP method based on passive measurement alone. On the other hand, an automated procedure `AutoPrepend` was proposed in [4] to determine the best prepending length before effecting the change. The procedure includes an active measurement component which, however, treats the Internet as a black box.

Unlike [4], we employ an active measurement approach to look into the route changes due to the ASPP method. Through the active measurement, we can observe and analyze the route changes under different prepending length and strategies. The results help us understand why the ASPP method is effective and to further improve `AutoPrepend`. Moreover, the active measurement approach has enabled us to observe an `unbalanced phenomenon` which has not been reported before. Although the measurement has been so far conducted from only a single AS, we believe that some of the observed phenomena could occur to other ASes. Furthermore, this set of experiments can be easily replicated in other sites if they were so allowed.

2 The Active Measurement Setup

Figure 1 depicts the components of the active measurement setup. The experiments were performed from a dual-homed, stub AS, which we simply call *HOME*.[1] *HOME* announced routes for a *beacon prefix* to *AS*9304 (a tier-1 ISP) and *AS*4528 (a regional ISP) through **BR1** and **BR2**, respectively. The beacon prefix is a set of IP addresses that were not in use in *HOME* with prefix length of /21 in order to ensure that they would not be filtered by the upstream routers. As there would not be any normal traffic destined to the beacon prefix in our active measurement, it did not disrupt the normal traffic of *HOME* and the Internet.

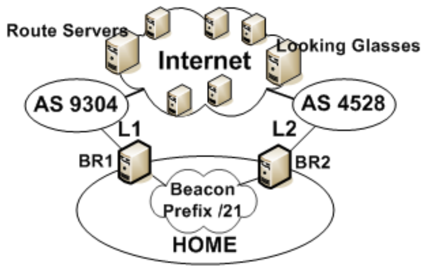

Figure 1: The active measurement setup.

Both *AS*9304 and *AS*4528 were providers of *HOME* and none of them was a backup provider. They applied the “prefer customer route” policy and were connected to different upstream ISPs. Since most of the normal traffic came in from *AS*9304, we only performed prepending on **L1**. We used 16 route servers, 43 looking glasses [1, 2], and the RouteViews server as the set of (virtual) traffic sources. After announcing the route with a new prepending length value, we then looked for route changes caused by the prepending from the BGP routing tables of the route servers and the RouteViews server [3]. We also performed reverse `traceroute` from the looking glasses and derived the AS path from the `traceroute` results. We mapped the IP addresses obtained from the `traceroute` results to the AS numbers from the RouteViews routing tables. We have discovered that some AS paths obtained from the IP-AS mapping contained AS-level routing loops. This could possibly be due to the presence of Internet exchanges on the path [5]. Since the ASes involved were not responsible for the change in the AS path due to

[1] Considering the privacy issue we cannot disclose *HOME*'s AS number.

	The AS path	% of routes
Not enough prepending length (via **L1**)	(3491 9304 *HOME*)	54%
	(3549 9304 *HOME*)	27%
	(15412 9304 *HOME*)	18%
Enough prepending length (via **L2**)	(4637 3662 3662 4528 *HOME*)	100%

Table 1: The common AS path for the routes obtained from the set of route servers.

Prepending length	No. of routes using **L1**	AS path length (all routes received)	No. of routes using **L2**
0	6	3	0
1	6	4	0
2	6 (↑) | 3(↓)	5	0 (↑) | 3(↓)
3	0	5	6

Table 2: The number of routes received by RS_A in the cases of incremental (↑) and decremental (↓) prepending strategies.

prepending, we did not include in the AS path those ASes that only showed up when there were AS-level routing loops.

3 Measurement Results

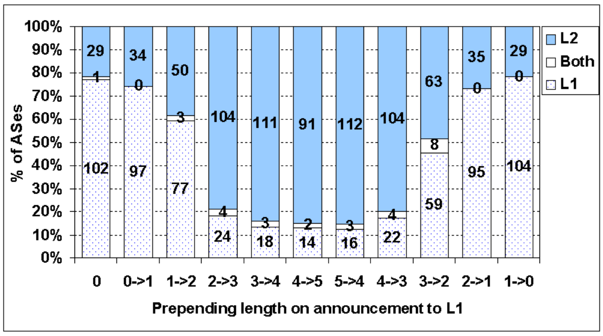

Figure 2: The distribution of ASes using link **L1** and **L2** for different prepending lengths.

We have performed *incremental prepending* from 0 to 5 and *decremental prepending* from 5 to 0 on **L1**. Figure 2 shows the link usage under different prepending lengths. Besides the percentages of ASes, we also show the actual number of ASes that used the two links to reach the beacon prefix. For example, when there was no prepending (prepending length = 0), 102 ASes, including $AS9304$, used **L1** while only 29 of them used **L2**. Moreover, 1 AS used both **L1** and **L2**. The percentage of ASes that used **L1** is almost 80%.

When the prepending length was increased, more ASes switched from **L1** to **L2**. Initially, the change was rather gradual. However, when the prepending length was changed from 2 to 3, nearly 40% of the ASes switched to **L2**. To probe into the issue further, we summarize the routes obtained from the route servers in Table 1. The first row shows the common AS path shared by the routes. The routes using **L1** reached *HOME* via either AS3491, AS3549, or AS15412. Thus, the length of the common AS path is 3. After the route change took place as a result of prepending on **L1**, all the new routes shared the common AS path (4637, 3662, 3662, 4528, *Home*). Note that the upstream AS 3662 also prepended on this route. Thus, the prepending length had to be at least 2 in order to cause a route change. Furthermore, a prepending length of 3 would cause a greatest number of route changes.

Figure 2 also shows an interesting phenomenon which we referred to as *unbalanced phenomenon*. For example, we consider one of the route servers, denoted by RS_A, and we summarize the routes received by RS_A in Table 2 for incremental prepending and decremental prepending. Note that the received routes for prepending length changed from 1 to 2 (↑) on **L1** are different from that for 3 to 2 (↓). In the former, RS_A received 6 routes, all of which were via **L1** and with an AS path length of 5. Therefore, RS_A accepted one of them and kept on using **L1**. However, in the latter, RS_A was presented with 3 routes with **L1** and 3 routes with **L2**, all of which had the same AS path length of 5. Thus, RS_A selected the best route by its tie-breaking rules. Apparently, RS_A decided to continue to use a route via **L2**. When the prepending length was reduced to 1, RS_A only received routes using **L1**. Thus, it switched back to **L1**.

4 Conclusions and Outlook

We have presented in this paper an active measurement approach to evaluating the widely practised ASPP method. As far as we know, this is the first time of using an active method to measuring the impact of the ASPP method on the Internet routes. Based on the experiments performed on a stub AS, we have observed how the upstream ASes responded to various prepending lengths. Overall, our measurement results have confirmed that the ASPP method is quite effective in influencing the inbound routes. Moreover, when equipped with the active measurement results, a network operator could predict the route changes due to prepending. Although the measurement was taken from a single stub AS, we believe that many observations described here are also applicable to other stub ASes. We are concurrently planning to replicate the experiments at an ISP network, and study the impact on other ISPs' routes.

Acknowledgements

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References

[1] BGP4.net Traceroute Wiki. http://www.bgp4.net/.

[2] traceroute.org. http://www.traceroute.org/.

[3] Advanced Network Technology Center. University of Oregon Route Views Project. http://www.routeviews.org.

[4] R. Chang and M. Lo. Inbound traffic engineering for multihomed AS's using AS path prepending. *IEEE Network*, pages 18–25, 2005.

[5] Z. Mao, J. Rexford, J. Wang and R. Katz. Towards an accurate AS-level traceroute tool. In *Proc. ACM SIGCOMM*, 2003.