Discovering Routers in Load-balanced Paths

Jean-François Grailet, Benoît Donnet
Université de Liège – Montefiore Institute
Belgium
firstname.lastname@ulg.ac.be

ABSTRACT

Usually, a set of traceroute measurements collected for a large amount of target addresses contain one or several route hops at which the IP interfaces vary from one measurement to another. These variations occur even if several measurements share the same length and the same last hops. This is likely a consequence of load balancing, a traffic engineering policy which aims at sharing the load between multiple paths to ensure quality of service. In this paper, we consider the problem of conducting alias resolution on IP interfaces discovered via traceroute and that are involved in load balancing. By conducting alias resolution in such a context, we want to verify if the IP interfaces involved in load balancing belong to unique routers, and more broadly, how relevant is alias resolution in this context. To do so, we use a slightly edited version of TreeNET, a topology discovery tool which relies on a tree-like structure based on traceroute measurements to map a target domain. The upgraded TreeNET along our measurements are both freely available online.

CCS CONCEPTS

- Networks → Network measurement; Topology analysis and generation;

KEYWORDS

TreeNET, subnet topology, alias resolution, traceroute

1 TRACEROUTE AND TREE NET

traceroute [10] is one of the earliest and most used topology discovery tools. It consists in sending probe packets towards a target with an increasing time-to-live (TTL) value until the target replies to the probe. By collecting the time-exceeded replies for each TTL value and checking their source address, one can collect one IP interface of each router crossed by the packets sent towards the initial target. Since then, variants of traceroute have been proposed to extend its capabilities. Paris traceroute [1] can keep a consistent route when tracing through per-flow load balancers towards a specific target and can enumerate all paths [2]. Other applications of traceroute includes subnet inference [9] as well as analytical alias resolution [5, 7].

traceroute also finds application in TreeNET [4], a tool which maps a target network on the basis of its subnets. The key idea of TreeNET is to collect (Paris) traceroute measurements towards each inferred subnet to group subnets according to the last hop in their respective route. Doing so, TreeNET can obtain a subnet-level map of the target network, which can also be used to conduct alias resolution [3]. In practice, TreeNET obtains the subnet map by building a network tree, a structure where leaves model subnets while internal nodes model each route hop. Each internal node is labelled with an IP interface appearing in the routes towards each subnet. With this construction, all subnets sharing the same last hop in their respective route ends up under the same internal node.

However, a set of traceroute measurements consists most of the time in a directed acyclic graph, even with Paris traceroute. Indeed, Paris traceroute ensures a route is consistent for a single target, but tracing towards multiple targets will still result in having multiple paths. To still be able to build a tree, TreeNET allows internal nodes to bear more than one label (i.e., an IP interface) [4]. These multi-label nodes therefore model a collection of interfaces involved in load balancing, and ensures each IP interface observed with traceroute appears only once at a given depth in the tree.

Fig. 1(a) shows a simplified topology, while fig. 1(b) shows how it is modeled by TreeNET using the network tree construction.
2 DISCOVERING ALIASES IN LOAD-BALANCED PATHS

The tree structure of \texttt{TreeNET} naturally reveals the parts of a set of routes that are affected by load balancing. Moreover, \texttt{TreeNET} already implements an alias resolution methodology involving IP fingerprinting and several state-of-the-art alias resolution techniques [3], such as \texttt{ifffinder} [6] and \texttt{Ally} [8]. Our methodology therefore simply consists in applying the alias resolution methodology of \texttt{TreeNET} on the labels (i.e., IP interfaces) of multi-label nodes appearing in the network tree. However, we restrict the obtained aliases to those inferred with \texttt{ifffinder} and IP-ID based methods (like \texttt{Ally}), as these methods are very accurate on small sets of addresses. Indeed, other approaches implemented in \texttt{TreeNET} might result in overly optimistic results. The upgraded \texttt{TreeNET} is freely available online.\footnote{https://github.com/JeGrailet/treeet/v3/}

3 RESULTS

We deployed our upgraded \texttt{TreeNET} on PlanetLab to probe 12 ASes, listed in Table 1, in order to evaluate the relevancy of alias resolution on interfaces discovered in load-balanced paths. In the next figure, we denote each AS by the index provided in Table 1. We collected our dataset on August 27\textsuperscript{th}, 2017 and made it freely available.\footnote{https://github.com/JeGrailet/treeet/v3/Measurements/}

The main results of our measurements are shown in Fig. 2. For each AS, we provide three ratios: (i) the proportion of multi-label nodes for which some aliases were obtained (white), (ii) the proportion of multi-label nodes for which only one alias gathering all labels was inferred (grey), and, (iii), the proportion of aliased IP addresses with respect to the total of IP interfaces that could be aliased (black). We also provide the script for generating such a figure.\footnote{https://github.com/JeGrailet/treeet/v3/Measurements/PreAliasing/}

The figures shows, via the white bars, that finding aliases in multi-label nodes is not systematic, even if we have a large amount of aliasable IPs (cf. black bars). However, for almost all ASes, we have one or several multi-label nodes where all labels were aliased together. By looking in depth into the data, we discovered that these cases often corresponded to multi-label nodes with few labels (less than 10) that were themselves children of other multi-label nodes. This suggests small multi-label nodes correspond to routers located at the end of load-balanced paths, causing them to respond depending on the path taken in the load balancer. For (much) larger multi-label nodes, few aliases were obtained.

4 CONCLUSION

In this paper, we took a look at alias resolution on IP interfaces found in \texttt{traceroute} measurements influenced by load balancing. We proposed a simple addition to \texttt{TreeNET} to do so, and deployed it on PlanetLab. Our first observations show that, while alias resolution in such a context does not give a lot of results, it could be used as a way to spot the convergence point of multiple paths in a load balancer and refine subsequent analysis.
REFERENCES


