IP2DC: Making Sense of Replica Selection Tools

Anish Bharata, Mike P. Wittie, Qing Yang
Department of Computer Science
Montana State University
{anishbabu.bharata, mwittie, qing.yang}@cs.montana.edu

1. INTRODUCTION

Cloud-based applications being developed for consumer electronics market (tablets, smart TVs) struggle to deliver the same level of responsiveness as standalone software, leading to user frustration and slow adoption. Often the network that separates user end-hosts from server back-end is to blame. To limit the impact of poor network performance on message delay, or *lag*, back-end logic and application data are deployed across geographically distributed servers and user requests are directed to the closest one [14]. Such nearby servers deliver content more quickly thanks to a faster expansion of TCP congestion window and more rapid retransmissions over low round-trip time (RTT) paths.

The challenge to realising these benefits is the accurate selection of a server closest to a user, or a group of communicating users. Direct latency probing, for example using `ping`, is accurate, but time consuming and does not scale [3]. Tools, such as CloudGPS, can reduce the number of user measurements, but require cooperation between ISPs and cloud providers [6]. Content distribution networks (CDNs) rely on DNS redirection, though when a user's DNS server is not nearby, for example in the case of public DNS infrastructure, the likelihood of selecting a nearby server is low [13].

Instead the research community has proposed a number of predictive *matchmaking* tools to identify the closest replica server to a client IP based on geographic proximity [1, 2, 9, 15], or network distance [3, 5, 7, 10, 12]. However, these tools suffer from incomplete coverage of the IP space and can make predictions based on stale network measurements. It remains unclear, which of these tools makes the most accurate prediction in most cases.

To provide guidance to application developers in choosing a predictive tool for server selection, we have undertaken a comparative evaluation of matchmaking tools. Specifically we are interested in their coverage of the IP space and their accuracy in determining the closest public cloud datacenter to a given IP, relative to direct probing. Our early results, presented in this poster, show a high level of discrepancy between the available tools and motivate further measurement as well as the need to develop techniques for more accurate server replica selection.

2. BACKGROUND

To aid in interpretation of our measurements, we briefly describe existing matchmaking tools and their specific sources of error.

IP geolocation databases maintain physical location entries obtained from `whois` and DNS records, or by mining websites that ask for user addresses [1, 2]. Sources of inaccuracy include errors in the source databases and staleness of data.

Traceroute-based tools estimate the physical location of an IP address from locations of nearby routers identified by `traceroute` to that IP [15]. However, `traceroute` may not return information for all hops and accurate location estimates require traceroutes from multiple vantage points [4].

Network coordinate systems (NCSs) use network measurements to build a graph of Internet topology and predict end-to-end network performance based on paths along graph edges [7, 11, 12]. Instead of using physical proximity, the closest datacenter to a given IP can be chosen based on predicted path latency. Improved prediction accuracy can be achieved by embedding nodes in a multidimensional space [5, 10]. However, such embeddings are sensitive to initial node placement and do not reflect Internet triangle equality violations [3]. Regardless of the underlying data structure, predictions require that a large number of path measurements be kept up to date. Systems based on the Meridian P2P measurement system reduce problem size by maintaining measurements only between application servers and can identify the closest among them to a given IP [8, 16, 17].

Table 1: IP space coverage and DC selection accuracy.

	IP geoloc. DBs		Traceroute tool	NCS
	[1]	[2]	[15]	[12]
Coverage (%)	93.20	1.30	63.36	39.27
Accuracy (%)	26.80	3.10	22.04	9.60

3. EVALUATION

Our goal is to compare the IP space coverage and accuracy of existing techniques for IP assignment. We entered 100,000 random IP addresses to representative matchmaking tools from each category to predict the closest of seven public cloud datacenters in the continental US operated by different providers. Table 1 shows *coverage*, as the percentage of IP addresses for which each tool produced a prediction, and *accuracy* (for the addresses inside the coverage), as the percentage of time each tool selected the same datacenter as direct measurements latency using `ping`. Our results show low accuracy across the tool categories and a high variation in coverage of IP space. Taken together these results motivate further work on replica selection mechanisms that combine high accuracy and broad coverage.

4. REFERENCES

[1] Neustar IP service. `http://developer.quova.com/`, January 2012.

[2] IP fingerprints. `http://www.ipfingerprints.com/`, 2013.

[3] S. Agarwal and J. R. Lorch. Matchmaking for online games and other latency-sensitive P2P systems. In *ACM SIG-COMM*, August 2009.

[4] G. Connolly, A. Sachenko, and G. Markowsky. Distributed traceroute approach to geographically locating IP devices. In *IEEE Workshop onIntelligent Data Acquisition and Advanced Computing Systems*, September 2003.

[5] F. Dabek, R. Cox, F. Kaashoek, and R. Morris. Vivaldi: a decentralized network coordinate system. In *ACM SIG-COMM*, August 2004.

[6] C. Ding, Y. Chen, T. Xu, and X. Fu. CloudGPS: a scalable and ISP-friendly server selection scheme in cloud computing environments. In *Workshop on Quality of Service (IWQoS)*, June 2012.

[7] P. Francis, S. Jamin, C. Jin, Y. Jin, D. Raz, Y. Shavitt, and L. Zhang. IDMaps: a global internet host distance estimation service. *IEEE/ACM Transactions on Networking*, 9(5):525–540, October 2001.

[8] M. J. Freedman, K. Lakshminarayanan, and D. Mazières. OASIS: anycast for any service. In *USENIX NSDI*, May 2006.

[9] GeoBytes. IP traceroute locator tool. `http://www.geobytes.com/traceroutelocator.htm`, August 2006.

[10] J. Ledlie, P. Gardner, and M. Seltzer. Network coordinates in the wild. In *USENIX NSDI*, May 2007.

[11] D. K. Lee, K. Jang, C. Lee, G. Iannaccone, and S. Moon. Path stitching: Internet-wide path and delay estimation from existing measurements. In *IEEE Infocom*, March 2010.

[12] H. V. Madhyastha, T. Isdal, M. Piatek, C. Dixon, T. Anderson, A. Krishnamurthy, and A. Venkataramani. iPlane: an information plane for distributed services. In *Symposium on Operating Systems Design and Implementation (OSDI)*, November 2006.

[13] J. S. Otto, M. A. Sánchez, J. P. Rula, and F. E. Bustamante. Content delivery and the natural evolution of DNS: remote dns trends, performance issues and alternative solutions. In *ACM IMC*, November 2012.

[14] P. Wendell, J. W. Jiang, M. J. Freedman, and J. Rexford. DONAR: decentralized server selection for cloud services. In *ACM SIGCOMM*, August 2010.

[15] whatismyipaddress.com. Traceroute-tool. `http://whatismyipaddress.com/traceroute-tool`, 2013.

[16] B. Wong and E. G. Sirer. ClosestNode.com: an open access, scalable, shared geocast service for distributed systems. *SIGOPS Operating Systems Review*, 40(1):62–64, January 2006.

[17] B. Wong, A. Slivkins, and E. G. Sirer. Meridian: a lightweight network location service without virtual coordinates. In *ACM SIGCOMM*, August 2005.