

Chapter 4

Utilization of Latency Measurements for Network-Based Applications

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ABSTRACT

Distributed computing, comprised of different components of an application located on different computers connected via network, has allowed value added services to provide enhanced user experience. Offering information based on geographic location of users of a distributed system is one of the newest and most notable advancements. Internet is the biggest distributed system present today, and finding the geographical location of the user on the Internet, commonly referred to as geolocation, is one of the challenging problems currently addressed by the research community. Of the two commonly used approaches, repository-based and measurement-based, this chapter primarily focuses on geolocating Internet hosts using the measurement-based approach. A measurement-based geolocation approach is based on the latency measurements between the distributed Internet nodes. Thus, this chapter conducts a systematic analysis of latency measurements between the Internet nodes. This chapter recognizes the importance of geolocation in distributed computing. As a result, it also presents a comparative study of existing repository-based and measurement-based geolocation approaches.

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INTRODUCTION

The robust and scalable growth of the Internet has allowed different distributed services, such as email, electronic commerce and entertainment, to flourish rapidly. These applications often use latency measurements between Internet hosts in order to provide better services. Recently there have been many attempts to enhance these services in order to provide value added services to users. Providing services, using latency measurements between Internet hosts, based on users' physical location is one of the newest mechanisms. Identifying the physical location of the users on the Internet, commonly referred to as *geolocation*, is a non-trivial task. The Internet Protocol (IP) address, which is used to identify hosts on the Internet, does not have a direct association to the physical street address of the host. Moreover, the dynamic assignment of IP addresses complicates the matter as the same IP address can be found in different locations at different times.

Geolocation of Internet hosts enables a new wave of Internet applications which can be customized to serve users based on their physical location. Internet location information can be leveraged to improve user experience and determine business strategy. Some uses of such location-aware systems include load balancing and resource allocation between distributed Internet hosts, geographically targeted advertising on web sites, automatic selection of language to display web site content, web content delivery based on region, credit card fraud detection and providing emergency services for IP telephony. Whether the goal of an adopted geolocation technique is to show local advertisements on the web page or track Internet users in emergency situations, the accuracy of the localization system is vital. The accuracy requirements, however, vary from application to application.

In addition to being accurate, a geolocation technique is expected to be scalable, robust and efficient. The approaches of geolocating Internet

hosts are broadly divided into two categories. The first, *repository-based* approach finds the location information based on a lookup. And the second, *Measurement-based* approach finds the location information based on the latency measurements from some fixed hosts to the targets. Repository-based approaches have an enormous overhead associated with creating and maintaining an up-to-date repository of location information of the ever growing lists of Internet hosts. On the other hand, measurement-based approaches produce fresh results based on latency measurements to targets from some fixed hosts. Though repository-based approaches may produce quite accurate results depending on the up-to-date and rich IP-to-location mapping dataset maintained, measurement-based approaches are more scalable, robust and efficient compared to repository-based approaches.

The goal of this chapter is to study measurement-based IP geolocation techniques that are applicable to the Internet. Therefore, initially it discusses about latency to distance relationship between Internet hosts. Then it discusses this relationship of the observed latency measurements between hosts with known locations, known as *landmark*, and the node to be geolocated, known as *target*, to constrain the possible location of the target. However, the task of finding an accurate model for latency to distance relationship between Internet hosts is not a trivial tasks mainly because of the variability in latency for a given distance. Thus, this necessitates capturing the variability in the proposed relationship, which should be taken into account in the geolocation algorithm.

MOTIVATION AND SCOPE

Latency refers to the delays of any kind incurred in processing and travelling of network data between Internet hosts. A low latency network is one that generally experiences small delays in time and a high latency network generally suffers

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