

A Method for Network Distance Prediction

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Abstract

Network coordinates provide a practical and efficient way to estimate network distances among computers in the network. In this paper, we study the problem of designing and implementing a Network Coordinate System (NCS). To combine advantages from both Vivaldi and GNP algorithms, we propose our Network Coordinate System. We implement such a system on PlanetLab. This system can predict network distances quickly and accurately. We believe that our system can provide a network service of network distance prediction, which is very useful for other Internet applications..

1. Introduction

A class of large-scale network services and applications such as overlay network multicast, peer-to-peer file sharing, distributed content services has been implemented all over the world. Path selection and neighbor node selection should be very important and flexible for these systems. These systems can benefit from intelligent path selection and neighbor selection. Network performance characteristics such as latency and bandwidth are the most relevant to the applications and should be measured in the network. Unfortunately, measurement is impractical because the large number of end-to-end measurement is too time-consuming and too costly, and may bring high overhead.

To resolve this problem, we can predict network distance instead of measuring in the real network. Therefore network distance is used as a metric to greatly reduce the need for network measurements. Round-trip-time is used as network distance in this paper.

Some methods for predicting network distance have already been proposed. Among these methods, network coordinate methods are proved to be simple and useful. Network coordinates can represent the positions of the hosts in the network, and in some sense can represent the topology of the network as a result. These network coordinate algorithms can predict network distance with appropriate information.

Network coordinate methods have performed well in simulation. But there are not enough experiments on Internet. In this paper, we will design a Network Coordinate System (NCS) which combines advantages from Vivaldi and GNP algorithms. We implement our NCS on PlanetLab. The experimental results on PlanetLab show that our Network Coordinate System can predict network distances quickly and accurately.

2. Network Coordinate System Design and Implementation

Our algorithm for computing network coordinates used in our Network Coordinate System (NCS) is inspired by both Vivaldi and GNP. Our algorithm combines the advantages from the two algorithms. We explain our algorithm below.

Usually there are only a few nodes at the beginning of NCS. These nodes compute coordinates by using the Vivaldi algorithm. As soon as there are enough nodes in the system, the GNP algorithm are used by the following nodes. The following nodes view previous nodes as landmarks and compute coordinates by using GNP. To resolve the minimization problems in computing GNP coordinates, we use the Simplex Downhill method. The only difference between the two types of nodes is which algorithm is used for computing network coordinates.

The advantage of our system is that some nodes are used as landmarks or reference points by other nodes. These nodes' coordinates are computed in a decentralized way. The overhead of this system will be less than the pure Vivaldi algorithm, because GNP brings less overhead than Vivaldi. And our algorithm will compute coordinates more easily than Vivaldi because most nodes do not exchange information with one another. And positions of most following nodes are consistent to the first nodes that are used as landmarks. The positions of nodes will not change rapidly in our NCS.

We can predict network distances based on our Network Coordinate System. Since all nodes in the system have coordinates, distances in the geometric space are used for predicting the distances in the real network. When a node wants to predict the distance between any other node and itself, it firstly obtains the coordinate of remote node and then computes the distance. As we can see, this method of predicting network distance is very simple, and should be implemented on Internet.

3. Conclusion and Future Work

In this paper, we have studied some solutions to the network distance prediction and network coordinate computation. We design a Network Coordinate System which combines advantages from the Vivaldi and GNP algorithms. We implement our Network Coordinate System on PlanetLab. We propose to apply this system to predict network distances. According to the experimental results, we conclude that our Network Coordinate System can predict network distances quickly and accurately.

The operational experience will guide our future work of network distance prediction. We will continue to develop the system and our goal is to provide a network distance prediction to other Internet services and applications.