NC-APT: An Efficient and Scalable Download Mirror Selecting System

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***Abstract*—When large files are offered by many mirrors for clients to download, selecting the proper download mirrors is necessary in speeding up the clients' download. The existing method, which measures all the Round Trip Time (RTT) between clients and all mirrors, costs much time and Internet traffic. In this paper, we propose NC-APT, an efficient and scalable download mirror selecting system, which is capable to provide clients an efficient method to select quick download mirror. NC-APT is scalable because it only requires the mirrors to response to ICMP ping instead of keeping running an NC software program. Our experimental results show that NC-APT significantly improves the clients' download rates with slight cost of time and Internet traffic.**

I. Introduction

File downloading is one of the most important applications of the Internet. Some of these files are large and offered by many mirrors at the same time. A typical instance could be the software update service offered by Ubuntu, a well-known Linux distribution. Much time can be saved if the clients can accurately select high speed download mirrors.

The download rate is usually closely relevant to the RTT between the client and the selected mirror. Thus the problem of seeking a quicker mirror is correlated with the problem of seeking a mirror that has small RTT. Unfortunately, the existing mirror selecting method in Ubuntu requires full RTT measurements between clients and mirrors. Typically, a client need ping more than 200 mirrors, which costs much time and Internet traffic. As the number of users is still growing fast, the cost of full measurements becomes intolerable.

Network coordinate (NC) systems such as GNP [**?**], Vivaldi [**?**] and Pharos [**?**] are proved to be stable and accurate in predicting RTT between hosts. However, ordinary NC systems require every host in the system running an NC software and response to all clients' measurement. It costs the mirrors Internet traffic and CPU resource.

In this paper, we propose NC-APT, an efficient and scalable download mirror selecting system to break the limit above. Firstly, in the framework of NC-APT, a novel scheme called *inverse GNP* is introduced. It can calculate the NC of a certain host without deploying NC software on it. The download mirrors only needs to response to a few hosts' RTT measurement. Secondly, NC-APT works very fast for clients with high accuracy. It provides users a good trade-off between measurement cost and download rate. Thirdly, GNP was proved to be scalable in current Internet [**?**]. Inverse GNP costs as much as GNP does. Therefore, NC-APT is scalable.

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Our experiments on PlanetLab shows that NC-APT impressively improves clients' download rates with relatively low cost. The effect is very close to the full measurement method while only costs no more than 10% time and Internet traffic of full measurement method. On the other hand, the effect is much better than a purely random select strategy.

The rest of the paper is organized as follows. In section 2 we describe the detailed design and implementation of NC-APT. Section 3 gives performance evaluation results. Finally we conclude this paper in section 4.

II. NC-APT Design

A. System Architecture

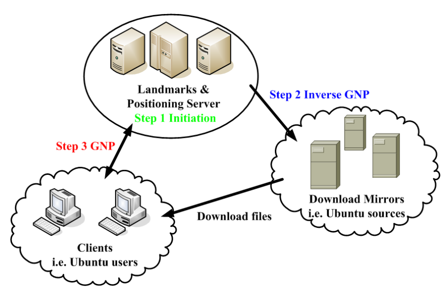

Fig. 1. System Architecture

Figure 1 shows the high level architecture of NC-APT. Different from ordinary NC systems, the download mirrors no longer need to maintain an NC software program. This fact results in that NC-APT is more scalable and flexible than ordinary NC systems. NC-APT has 3 basic components.

1) Landmarks and positioning server: The landmarks and positioning server not only embeds the landmarks into an NC space with GNP [**?**], but also calculates every download server's coordinate with inverse GNP method, which will be explained in work flow of NC-APT.

2) Download mirrors: They offer clients the same files for downloading. In NC-APT, they response to landmarks' measurement in inverse GNP.

3) Clients: Clients are the hosts which want to download files. A client runs the NC-APT client program when selecting a fast download mirror.

B. *Work flow of NC-APT*

The work flow, as Figure 1 shows, can be described in 3 major steps.

1) Initiate NC space: When the system starts, every landmark measures RTTs to all the other landmarks and sends the measurement data to the positioning server. This positioning server embeds the landmarks into a coordinate space using GNP. All landmarks repeat this process periodically in order to adapt to the change of Internet.

2) Embed mirrors by inverse GNP: Every time the NC space is initiated, the landmarks begin to make measurements to all download mirrors. The measurement data is sent to the positioning server when the measurements finish. Then the positioning server embeds the download mirrors into the same coordinate space according to gathered data. This process is also periodically since it immediately follows Step 1. We call this process inverse GNP.

3) Selecting mirrors with GNP: A client measures the RTTs to a subset of landmarks and gets the landmarks' and mirror's coordinates from positioning server. Then it embeds itself into coordinate space using GNP. With its own coordinate and the mirrors' coordinates, a client predicts all RTTs to download mirrors. Finally it chooses the mirror which has the least predict RTT. In order to eliminate the impact of inaccurate prediction, our system offers an option that allows clients to ping 5 or 10 fastest (in predict) mirrors and select the one with least measured RTT [**?**].

III. Performance Evaluation

The experiments were carried out on 500 PlanetLab hosts on Dec 7th. 250 Ubuntu official sources, which didn't run any NC software programs, served as the download mirrors in NC-APT. 15 of the 500 PlanetLab hosts were chosen to be landmarks and 1 to be positioning NC server. The rest 484 hosts played the role of clients. All hosts, including Ubuntu official sources, were embedded into an 8-dimension Euclidean space using aforementioned mechanism.

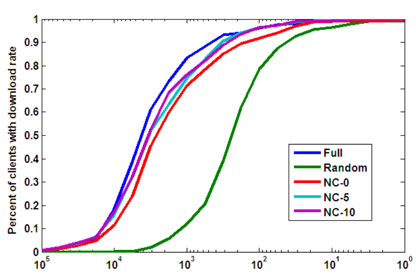

Fig. 2. Download rate CDFs

Five strategies of selecting download mirrors were compared, namely, 1) full measurement, 2) random, 3) NC-APT without any extra measurement, 4) NC-APT with 5 extra measurements and 5) NC-APT with 10 extra measurements. After a mirror was selected by one strategy, the client began to download a file (about 4MB) from the mirror and the speed was recorded. Every client tested the 5 strategies one after another in order to avoid download processes affecting each other. After all downloading finished, the recorded speed data was gathered and included in the Cumulative Distribution Function (CDF) graphs.

Figure 2 shows the CDFs of the download rates recorded by clients with 5 strategies. NC-x means making x extra pings to select the fastest download mirror from x fastest download mirrors in predict. Compared to selecting by random, the download rates are significantly improved by using closest download mirror selected by NC-APT. Even none extra measurement is made, the download rates with NC-APT are very close to the download rates with full measurement. In addition, the more extra measurements that are made before the download begins, the rates will be the closer to full measurement strategy.

Strategy	Full	Random	NC-0	NC-5	NC-10
Number of Pings	250	0	15	20	25
10% Percentile Rate(MB/S)	11.4	1.23	10.7	11.4	11.4
50% Percentile Rate(MB/S)	4.32	0.29	2.63	3.34	3.61
80% Percentile Rate(MB/S)	1.19	0.09	0.51	0.67	0.67

TABLE I
Measurements vs. Download Rate

Table 1 shows some key points in our experiment. It can be seen that NC-APT costs much less time and Internet traffic in measurements than full measurement strategy (no more than 10%). The NC-0 costs less than 1 minute on most of the hosts in PlanetLab. When using NC-APT, the download rates significantly outperform random strategy (5-12 times). In sum, NC-APT provides users a good trade-off between measurement cost and accuracy in selecting mirror.

IV. Conclusions

This paper proposes NC-APT, an efficient and scalable download mirror selecting system. It requires lighter load on the download mirrors than ordinary NC systems because of a novel scheme called inverse GNP. The experiment results on PlanetLab demonstrate that NC-APT can significantly improve the clients' download rates with little cost of time and Internet traffic. We are going to release NC-APT as an open-source Linux tool and let more users get benefit from the efficient and scalable download mirror selection.

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