A Performance Improvement System (College-Net) for Energy Saving in Campus Networks towards Green Computing

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Abstract— In corporate networks, idle desktop machines hardly ever sleep, mainly for the reason that turning off the hosts will affect the internet connection. There are number of systems have been proposed, few of them have mutually considered energy consumption and performance. In this article, we consider the case of file downloading, which is one of the most common internet applications. A system called College-Net is proposed for saving energy while improving performance by exploiting task migration and redundancy reduction. With this College-Net system, file downloading will not be interrupted even when a PC switches to sleep. In particular, it allows a PC to sleep while continuing to run large file downloads. Moreover, by caching the downloaded files in the server, College-Net suppresses the reduplicate downloading effort and reduces the network traffic. The strategy of redundancy reduction used in College-Net improves the average speed while avoids the energy waste caused by repeated transmissions of downloaded files. The proposed College-Net does not require any hardware additions to end hosts, and can be realized purely by additional software.

Keywords-Green Computing; College-Net; Energy Saving; Performance

I. INTRODUCTION

The energy consumed by the computing infrastructure has recently drawn important notice by researchers in green computing. Many researchers have been focusing on energy conservation in data centers which can be found in [1, 2, 3]. Current interest has also been directed to saving the energy consumed by desktop computers in homes and enterprises discussed in [4, 5]. Recently, energy wastage in PC mainly lies in that it is common to let machines enter a low-power sleep state, but they do not – even when the user leaves. Previous literature studies have shown that users often leave their computer powered on, even when they are largely idle [7].

A study in [8] shows that in offices, 67% of desktop PCs remain powered on outside work hours, and only 4% use sleep mode. The reasons have been undiscovered in [4], which shows that 57% did so for applications running in the background, of which 40% are for file downloading. Turning the idle PC off is likely to cause broken connections especially when the PC is downloading file. Thus, the user might then choose to disable the energy savings mechanism altogether.

Conversely, the downloading of redundant file is also another source of energy waste. There are large numbers of redundant files caused by repeated downloading especially in Local Area Networks (LANs) where the users may have common interest. The redundant files also lead to unnecessary energy wastage on the Internet while make the PC energy-consuming fiend.

There are many research works concentrating on reducing user disruption while still allowing machines to sleep. The advance researches of creating the image via virtual machine or proxy for each computer are proposed in [9, 10]. Though, these works are very difficult to be deployed due to the prerequisite of installing complex software for each computer. Moreover, these approaches do not consider the redundancy of downloaded files.

II. COLLEGE NET

First, In this paper the College-Net system is proposed which is focused to save desktop energy by employing an empirical approach to minimizing user disruption and avoiding the complexity of installing software at the client side. The basic idea is to transform the process of file downloading from each computer or the client to a predefined server, such as the gateway node. And the client computer will receive the finished files from the server only if it is active. This server could co-exist with the WEB, E-Mail server in the same machine.

Based on this strategy deployment, the client computer will be provided additional sleeping opportunity and thus can go to sleep once the user steps away even when there are files being downloaded. At the same time, a simple and efficient file management mechanism is used at the server side to reduce the retransmission of big files from the outside networks. Thus, the proposed system reduces an amount of unnecessary network traffic which also results in energy conservation in Internet. At last, using the efficient file management, some later file requirement can be met immediately by feed the buffered file which might have been downloaded previously. By using this system, the performance of file download is also improved.

An energy saving approach for the PCs in LAN environment is proposed. One of the vital advantages of this approach is that it can increase the energy saving opportunity without interrupting the internet connection of file downloads. Together, this approach improves the average downloading speed while reduces the network traffic, especially for the hot files.

The College-Net system focuses on two objectives:

First, when the host changes to idle status or the user leave for a period of time, the system should be able to make the host sleep and if there are file being downloaded, the connection should not be disconnected so that the file can be able to be downloaded when the host is sleeping.

Second, the attempt to download an existing file, which might have been downloaded by others in the same LAN, should be cancelled in order to reduce the redundant network traffic.

With the above mentioned objectives in mind, the College-Net system architecture is designed. In a LAN environment, one server (which can act as a router for the LAN) can be added in addition to the host computers. This server could be co-used as the WEB, E-Mail server for the enterprise network or the research group. A SerPxy proxy application runs on the server and each host has a ClntPxy application.

The ClntPxy is light-weight software. It is only responsible for sensing the user downloading behaviours and host status. Along with, it communicates with the SrvPxy for information transmission. Once when it senses the status change of a host, it will intimate the SrvPxy the change.

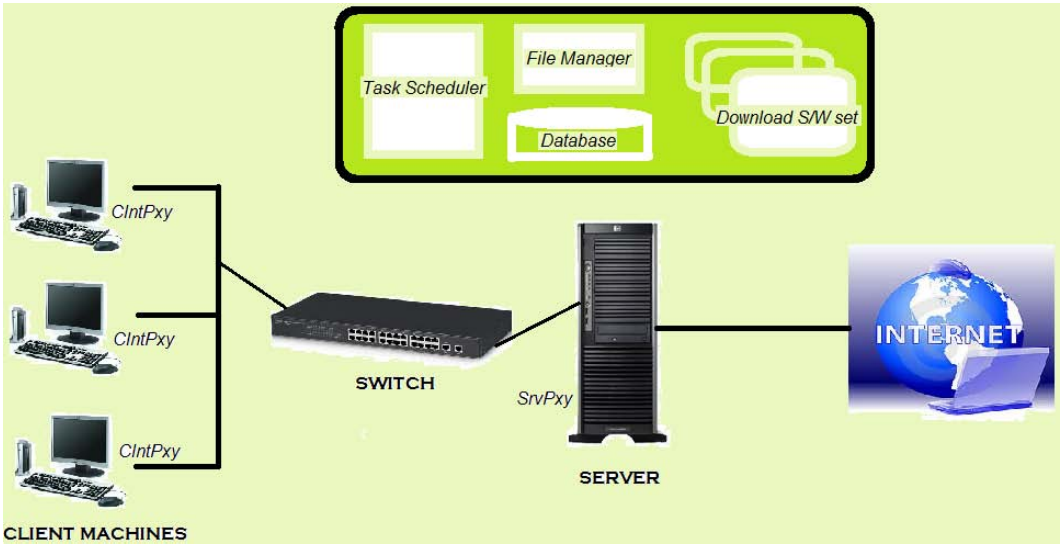

Fig.1 College-Net Architecture

The SrvPxy is used as the agent for all hosts in the same sub network which have the requirement of downloading files. All the downloading operation will be processed by the SrvPxy. This means that the download task required by the hosts will be migrated to the server and finished by SrvPxy. Besides, the SrvPxy is responsible for file management such as file storage, file query, file Stat. and deletion of old files.

There are three key components in SrvPxy: the task scheduler, the file manager and the download software. The task scheduler is responsible for receiving the task requirements from the hosts, and then demultiplexing the requirements to the corresponsive download software. In addition, it also needs detect the status of the requiring host and transmit the finished file back to it if the host is active. The file manager is essentially a tiny Database which is responsible for recording and storing the previously downloaded files. If required, it will delete some older and infrequently-visited files. The task scheduler can query the file information in this database to

determine whether a file has been downloaded already before and to initiate a new download. The download software includes the download software for common file type.

III. WORKING OF COLLEGE-NET

Before Each host using College-Net for energy-conservation need install proxy software ClntPxy in a plug-in style. Also, a light-weight software SrvPxy is installed at the server side. Downloading software [e.g. Download Manager] is also required to be installed at the server and wait for being called by the SrvPxy.

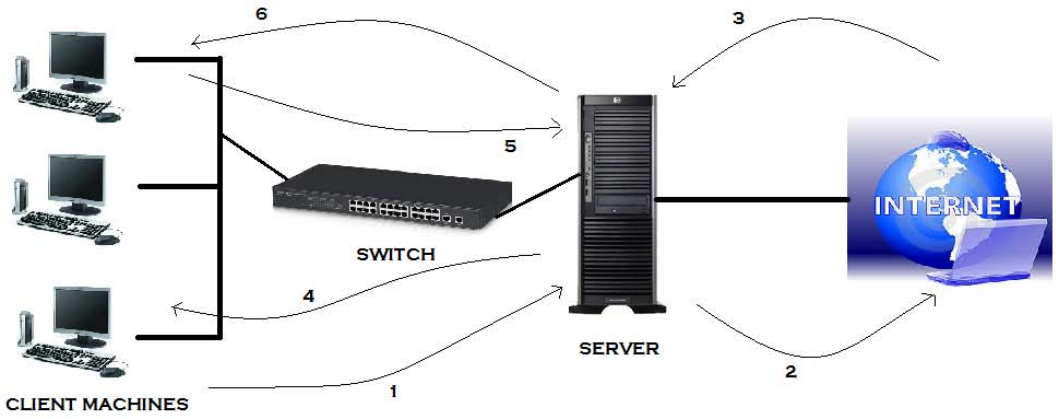

Fig.2 Working of College-Net

When a particular host is enabled for use with the College-Net system, the ClntPxy connects with the SrvPxy machine in its network subnet. Then it specifies its network parameters such as IP address and its firewall configurations. The SrvPxy records this information in its local database.

Step (1): When the user triggers an action of file download, the web link of required file will be fetched by the ClntPxy. And then the corresponsive requirement information will be sent to the SrvPxy in the same subnet. After that, the host can go to sleep when the user leave it beyond a period of time.

Step (2): When the SrvPxy receives a requirement from any host, it first parses the parameters in the web link and extracts the filename. Based on the filename and link, SrvPxy queries the database and determine whether the required file has been cached before. If not, SrvPxy will call the corresponsive download software to download the file on the behalf of the host.

Step (3): When the file is finished, SrvPxy will store it and send the file back to the requiring host if the host is active.

Step (4): Otherwise, the SrvPxy will send the file only when it receives the notification of status change from the host.

Step (5): When another host wants to download the same file accidently, the requirement information is also sent to SrvPxy.

Step (6): In this case, SrvPxy will find that the file has been downloaded before initiated by others. Thus, the new effort to download the file from Internet can be cancelled and the file can be sent back immediately.

From the description of downloading process, the energy saving opportunity lies in the following aspects: when the user leaves the host, the machine can go to sleep even if there are files being downloaded; when a required file has been cached in SrvPxy, subsequent requests will not trigger additional network traffic to the Internet.

A. Working Mechanism of ClntPxy

In the whole system, the ClntPxy, in a plug-in style, works in the host side. The design of the ClntPxy should be very simple so that it will affect the common behavior of user as less as possible. In an ideal way, the users should not be aware of the cPorxy's existing. In this meaning, it can be designed as a right-clicked menu, as many tools do. In our current implementation, the ClntPxy is implemented as a dialog frame.

When a user wants to download a file from the Web, the ClntPxy running in the background traps this behavior and sends the download requirement to SrvPxy. On the other hand, when the host transitions out of a low power mode (e.g when the user leaves the PC) for a period of time, the ClntPxy traps this event and sends a message to the SrvPxy notifying it of the transition. After that, the ClntPxy makes the PC into sleeping state for saving energy.

After a period of time, the user comes back and the ClntPxy will run again. The changes will be sent by the ClntPxy to the SrvPxy. If the required file has been downloaded, the ClntPxy will receive the finished file.

B. Working Mechanism of SrvPxy

The SrvPxy on the server is responsible for downloading the files on behalf of the hosts especially when they are asleep. In principle, it should implement all download function for common user. The SrvPxy is always on waiting for the requirements from any host. On receipt of the requirement from ClntPxy, it first gets the file name from the link sent by the ClntPxy and then query in the local database to determine whether the sever has cached the required file. If yes, the file will be sent back the requiring host immediately. If the file is firstly required, the SrvPxy need trigger a new download process. The SrvPxy is also designed to maintain all the downloaded files and their information, such as finished time, file size, file type and visited times. These information is used to guarantee for making a better redundancy reduction. All downloaded files will be cached in the server and some older files with a few visited times will eventually be removed from the server.

IV. CONCLUSION AND FUTURE WORKS

In this paper, a system College-Net for energy saving has been proposed for networked desktops such as in enterprise LAN. We presented the system architecture and design detail. A prototype system has also been implemented and deployed in many research groups. Some experiment results are also provided to evaluate the performance of the proposed system. Compared with the existing systems and solutions, the proposed system jointly considers the performance and energy consumption. The experimental results and analysis show that College-Net improves the download speed while keeps the merit of energy saving for hosts in LAN. In the future, we will study the pattern of downloading in LAN using the proposed system and make much more extensive experiments.

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