SFS-KNOPPIX WHICH BOOTS FROM INTERNET

Kuniyasu Suzaki, Kengo Iijima, Toshiki Yagi
National Institute of Advanced Industrial Science and Technology,
Tsukuba Central 2, Umezono 1-1-1, Tsukuba, Ibaraki 305-8568, Japan

Hideyuki Tan
Alphasystems Inc., 6-6-1 Kami-kodanaka, Nakahara-ku, Kawasaki 211-0053, Japan

Kazuhiro Goto
Oita Industrial Research Institute, 1-4361-10 Takaenishi,Oita, Oita 870-1117, Japan

Keywords: Internet boot, KNOPPIX, Self-certifying File System(SFS)

Abstract: KNOPPIX is a bootable CD with a collection of GNU/Linux software. KNOPPIX is very convenient but it requires downloading 700MB iso image and burning a CD-ROM when it is renewed. In order to solve this problem we make SFS-KNOPPIX which boots from Internet with SFS (Self-certifying File System). SFS-KNOPPIX requires 20MB boot-loader with Linux-kernel and miniroot. Root file system is obtained from Internet with SFS at boot time. It enables to change root file system and makes easy to try new version of KNOPPIX. In this paper we describe the detail of SFS-KNOPPIX and its performance.

1 INTRODUCTION

In early 1990's diskless machines were popular because hard-disk and CD-ROM drive were expensive. They could boot from network with help of a server. A client broadcasts a message of BOOTP protocol with MAC address on the LAN and the BOOTP server sends back IP address. The kernel image is transferred by TFTP protocol form the server. The client boots with the kernel and mounts NFS as a root file system. It offers easy maintenance environment, because whole software and configuration files are stored on the server. Even if an application or configuration has a security hole, it is easy to change for each client. Unfortunately it is not easy to extend to Internet, because the boot procedure depends on a broadcast protocol and personal information of client machine has to send on the network, for example MAC address.

On the other hand 1CD bootable OS becomes popular recently. For example, KNOPPIX[Knopper 2000], DemoLinux, Mepis, Adios, etc. They can boot OS on any IBM PCs, because boot sequence finds devices and setup drivers automatically. Unfortunately they require downloading 700MB iso image and burning a CD-ROM, when it is renewed.

We propose SFS-KNOPPIX to mix the easy maintenance environment of LAN boot and anonymous boot ability of 1CD OS. In this paper we describe the detail of SFS-KNOPPIX and its performance. The rest of the paper is organized as follows. We introduce 1CD Linux "KNOPPIX" in section 2 and secure Internet file system "Self-certifying File System (SFS)"[Mazières 2000, Fu 2002] in section 3. In section 4 the detail of SFS-KNOPPIX is presented. In section 5 we report the performance. We discuss some future works in section 6 and conclude in section 7.

2 KNOPPIX

KNOPPIX is a bootable CD with a collection of GNU/Linux software (Knopper, 2000). It is not necessary to install anything on a hard disk and enables to run GNU/Linux on IBM PCs. KNOPPIX can be used as a normal desktop Linux because it includes powerful graphical desktop environment (KDE), office software (OpenOffice.org), Web browser (Konqueror, and Mozilla), image manipulation software (GIMP), many games, etc.

Suzaki K., Iijima K., Yagi T., Tan H. and Goto K. (2005).
SFS-KNOPPIX WHICH BOOTS FROM INTERNET.
In *Proceedings of the First International Conference on Web Information Systems and Technologies*, pages 214-218
DOI: 10.5220/0001233102140218

CD bootable Linux isn't an exclusive feature of KNOPPIX. There are many distributions; DemoLinux, Mepis, Slax, Adios, etc. Among them, KNOPPIX is first popular CD bootable Linux, because automatic hardware detection/configuration (Autoconfig) and compressed loop back device (cloop) are excellent.

Autoconfig function of KNOPPIX detects individual devices and load suitable device drivers. Autoconfig is achieved by "/etc/init.d/knoppix-autoconfig" script. The script is consisted of hardware detection part and driver setup part. Hardware detection is done by the "hwsetup" binary which is based on "kudzu"; Red Hat Linux hardware probing library. After hardware detection, driver is setup by setup-scripts like "xmk86config". If network card is detected and DHCP is available, IP address is automatically set up.

Cloop is a compressed loop-back device. Loop back device enables us to mount a file as block device. It reduces the space needed on the CD to about 50% down to 25% of the original file system. KNOPPIX stores root file system to a cloop file and mounts it at boot time. 700MB volume of CD-ROM is almost occupied by cloop file "/KNOPPIX/KNOPPIX". The rest of the volume is files for boot. Figure 1 shows the image of KNOPPIX CD-ROM. A cloop file is loopback-mounted and read a file on-the-fly decompression.

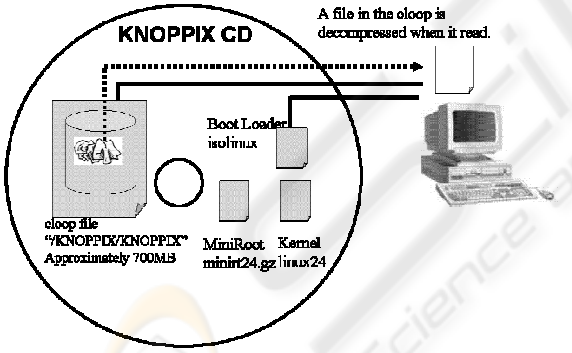

Figure 1: The contents of KNOPPIX CD

3 SFS

Self-certifying File System(SFS) is a secure network file system for Internet [Mazières 2000, Fu 2002]. SFS provides a suitable and more secure alternative to the widely deployed NFS file system.

SFS cryptographically secures all client-server network communications with encryption and a message authentication code. To prevent rogue servers from impersonating valid ones, each SFS server has a public key which is generated by SHA-1 hash. A server's files all reside under a so-called self-certifying pathname derived from its public key. Self-certifying pathnames contain enough information for an SFS client to connect to a server and establish a cryptographically secure channel.

SFS consists of two programs run at boot time. SFS clients must run the SFS client daemon (sfscd), which creates "/sfs" directory and implements the auto-mounting of remote SFS servers. SFS servers must run the SFS server daemon (sfssd), which makes local file systems available to SFS clients on TCP port 4. "sfscd" is responsible for automatically mounting new remote file systems. On the server machine, "sfssd" accepts incoming SFS connections and de-multiplexes these requests to the appropriate SFS server daemons. The client and server file system daemons communicate with the kernel using NFS loopback.

4 SFS-KNOPPIX

FS-KNOPPIX is a combination of KNOPPIX and SFS, which enables to boot KNOPPIX form Internet. Unfortunately SFS-KNOPPIX is not perfect Internet boot, because nobody could get IP address and kernel image form Internet. LAN boot depend on BOOTP and TFTP server to allocate IP address and get a kernel image.

SFS-KNOPPIX is a customized KNOPPIX, which is got rid of cloop file in the CD (Figure 2). A cloop file is obtained form Internet using SFS at boot time. The original KNOPPIX requires downloading 700MB iso image but SFS-KNOPPIX requires 20MB iso image, which is just a boot loader of KNOPPIX. SFS-KNOPPIX doesn't need to download a whole cloop file, because SFS is a file system which allows random access to cloop file. It means that only necessity block of data is transferred when application requires. It can reduce network traffic. The performance is shown in Section 5.

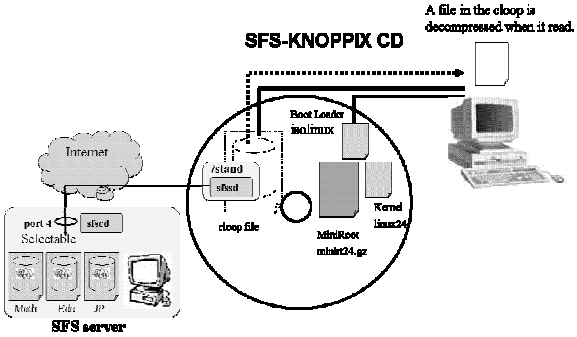

Figure 2: The contents of SFS-KNOPPIX CD

Another merit of SFS-KNOPPIX is to be selectable of a cloop file when it boots. Figure 2 shows the image of selection of a cloop file. In original KNOPPIX a cloop file is build in the CD-ROM. This merit means that we don't need to make a CD-ROM even if new KNOPPIX is released. We can try new KNOPPIX via SFS server with low network traffic.

The boot seqeunce of SFS-KNOPPIX is three stages, as is normal KNOPPIX. Figure 3 shows the role of each stage. The first and third stage are alomost similar but the second stage grews comlex.

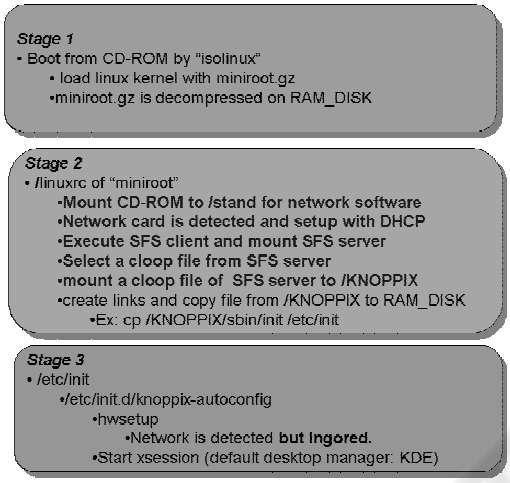

Figure 3: Boot procedure of SFS-KNOPPIX

The kernel of SFS-KNOPPIX includes drivers of Network Interface card(NIC), because network has to setup up in the second stage. The kernel of normal KNOPPIX doesn't include drivers of NIC, because a driver module of NIC is dymamically added at Autoconfig in the third stage.

In the second stage of SFS-KNOPPIX, "linuxrc" mount CD-ROM file system(iso9660) to "/stand" at first. The action is different from normal-KNOPPIX. The reason is that miniroot is small to include SFS client binary. CD-ROM file system includes static linked binary of SFS client. This technique comes from BSD "stand" boot. Using "/stand" software, IP address is set by DHCP. SFS client daemon "sfscd" is launched and connects to a SFS server. SFS server is selectable form a list.

Cloop file is also selectable from SFS server. The selection message is displayed at the boot sequence. After the selection, cloop file is loopback mounted to "/KNOPPIX" from the SFS server. After that, infrastructure of RAM-DISK root file system is setup in the same manner of normal KNOPPIX.

In the third stage, "init" is executed in the same manner of normal KNOPPIX, because SFS-KNOPPIX uses a same cloop file of normal KNOPPIX. The different point is network setup. A NIC is detected in the Autoconfig procedure, but it has already linked. The setup of NIC is ignored.

5 PERFORMANCE

We evaluated performance of SFS-KNOPPIX. We measured the boot time and network traffic. SFS-KNOPPIX booted with the same cloop file on the SFS server. The specification of server and client machine is the following.

[SFS server]
Pentium4 2.66Ghz, 512MB memory, 1Gbps NIC

[SFS client]
PentiumM 1.0Ghz, 512MB memory, 100Mbps NIC, 24X CD-ROM Drive

The target cloop file on SFS server is the one which is extracted form knoppix_v3.4_20040510-20040520.iso.

5.1 Boot Time

We measured the boot time. The boot time is defined as the time when default desktop manager "KDE" is finished. The boot time sometimes changed longer by machine condition. We picked up the typical boot time. Table 1 shows the boot time of SFS-KNOPPIX and CD-KNOPPIX.

Table 1: Boot Time

	SFS	CD-ROM
boot time	80sec	180sec

SFS-KNOPPIX is faster than normal CD-ROM KNOPPIX. It is caused that the network bandwidth is wider than CD-ROM.

A part of boot time depends on Autoconfig. It isn't constant because sequence of Autoconfig depends on the equipped devices. It works different on each machine. The result of 80 second on SFS-KNOPPIX means only one example.

5.2 Network Traffic

We measured the network traffic on SFS server. The traffic is used to read cloop file as the root file system. It is measured from the time of loopback-mount to the finish time of KDE. To measure the network traffic we used "tcpdump" on SFS server.

Figure 4 shows the transferred data. The amount of transferred data is 80MB. The half of transferred data is used for X-Window and KDE. KDE is a rich window manager and requires much

data. If we use a light window manager it will be faster.

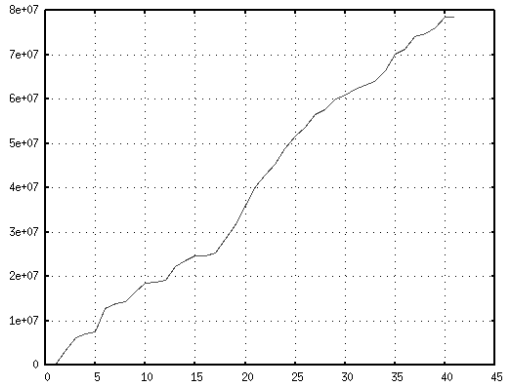

Figure 4: Transferred data of SFS-KNOPPIX.
X axis is time (second) and Y axis is transferred data (byte)

Figure 5 shows the throughput of network traffic. The maximum of throughput is 40Mbps. The average time of throughput is 2.0 Mbps. From the result we confirm SFS-KNOPPIX doesn't use up the network bandwidth(100Mbps) and SFS server can allow multiple connections of clients.

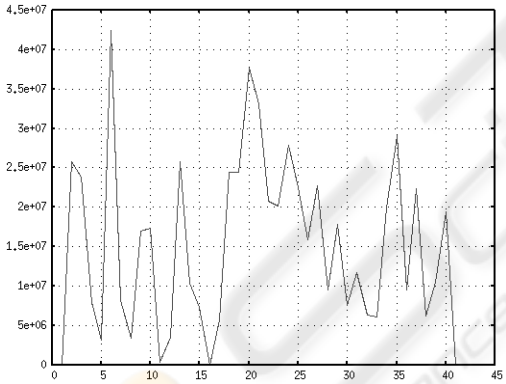

Figure 5: Throughput of network traffic
X axis is time (second) and Y axis is throughput (bps).

6 DISCUSSIONS

6.1 BOOT Device

SFS-KNOPPIX uses CD-ROM as a boot device, because there is no method to obtain a kernel image from Internet. Most Network-Interface-Cards have PXE (Pre-boot Execution Environment) function but they support BOOTP and TFTP protocol for LAN boot. As another method, we were hoping for iSCSI(Internet SCSI) but the situation isn't changed. We are still looking for a method to boot from Internet without the support of software.

6.2 From C/S to P2P

SFS-KNOPPIX is still Client and Server model. Scalability is limited by the ability of SFS server. The role of SFS is a read-only file system. We can replace SFS with read-only P2P file system. We have plan to try P2P file system " Co-operative File System" [Dabek 2001] which is based on SFS in near future.

7 CONCLUSIONS

We proposed SFS-KNOPPIX which mounted SFS at boot time and loopback-mounted a cloop file on the SFS as the root file system. SFS-KNOPPIX allows us to change root file system by selection of cloop file. The Autoconfig function of KNOPPIX allows us to boot on any IBM PCs. The mixture of SFS and KNOPPIX makes easy to try new OS and applications from Internet.

The performance of SFS-KNOPPIX is faster than normal CD-ROM KNOPPIX but the evaluation environment is ideal and the analysis isn't sufficient. We will extend the evaluation to Internet and analyze the detail of performance. It will make clear the advantage of SFS-KNOPPIX.

REFERENCES

Klaus Knopper, "Building a self-contained auto-configuring Linux system on an iso9660 file system", 4th Annual Linux Showcase&Conference Atlanta,2000.
http://www.knopper.net/knoppix-info/knoppix-als2000-folien.pdf

David Mazières, Self-certifying file system, PhD thesis, MIT, May 2000.
ftp://cag.lcs.mit.edu/pub/dm/papers/mazieres:thesis.ps.gz

Kevin Fu, Michael Kaminsky, and David Mazières, "Using SFS for a Secure Network File System",USENIX ;login: magazine, December 2002.
http://www.usenix.org/publications/login/2002-12/pdfs/Fu.pdf

Frank Dabek, M. Frans Kaashoek, David Karger, Robert Morris, and Ion Stoica, "Wide-area cooperative storage with CFS", In Proceedings of the 18th ACM Symposium on Operating Systems Principles (SOSP '01), 2001.
http://www.pdos.lcs.mit.edu/papers/cfs:sosp01/cfs_sosp.pdf