Gradual Workstation Migration to Linux OS Maintaining Hardware and Software Compatibility

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Abstract. *This paper describes a solution of the gradual migration to Linux OS of the MS Windows based IT infrastructure. The migration is workstation oriented while the the network and server infrastructure remain based on Microsoft technologies. The user applications and local peripherals remain unchanged and fully functional. All shared network resources can be used by the workstations and the majority of applications is installed on Intranet servers. Users and asset management is accomplished through the MS Active Directory. Three migration methods for applications are presented. Installed Linux OS is enhanced with the new program that makes virtual interfaces which enable virtualized applications to use local peripherals. Hardware and software compatibility with the previous MS Windows workstation is maintained while the stability and security of the whole infrastructure is increased.*

Keywords. Workstation, migration, open source, Linux, Microsoft, Windows, Novell, Citrix, Wine, Active Directory, peripherals, PoS, bar code reader, flatbed printer, virtual interface.

1 Introduction

Projects of contemporary IT infrastructure plan for lower costs and long-term compatibility of hardware and software components. This demands can be adequately met by using open source software and Linux OS. Studies and migrations of IT infrastructure to open source software are currently performed in many organizations in the World [1].

General principles of IT infrastructure migration are well presented in the detailed study of the German Ministry of Interior [2].

Migration usually starts with the server infrastructure where the software and procedures are well-established since the open source software currently provides the majority of the Internet services. Network, Web and Email services can readily be implemented by Linux servers. Open or commercial replacements for MS services such as Exchange and SharePoint exist (eg. OpenGroupWare, Kolab, Zimbra, etc.). Commercial database software providers (eg. Oracle, IBM) offer their products for Linux OS and many open solutions for databases exist (eg. MySQL, PostgreSQL). Considering the server-client relationship two main solutions exist: open protocols in a Unix/Linux based workgroup or MS based protocols (WINS/CIFS) for MS Windows workgroup. Both approaches can be implemented with Linux servers (eg. Samba server) where the first solution has the advantage of not being influenced by the changes in the provider policy.

Workstation i.e. client computer migration is usually the last phase of the migration. It includes the migration of the user's applications which is the combination of the following procedures [2]:

1. Application replacement with open source equivalent (for common office and network applications).
2. Application virtualization (for maximum compatibility or during the transition phase).
3. Application replacement with commercial equivalent (change of version or provider, new build).

2 Analysis of the IT infrastructure

The necessary condition for planing the migration is detailed testing of all existing user's applications in the current environment [2].

The current IT infrastructure of the company is MS Windows based and consists of Windows server farm, Citrix server farm, several specialized servers (eg. proxy, time), shared network resources (eg. folders, printers) and workstations, cf. Fig.1. For user authentification the centralized MS Active Directory (AD) service is used which is continuously expanding to management of other IT resources.

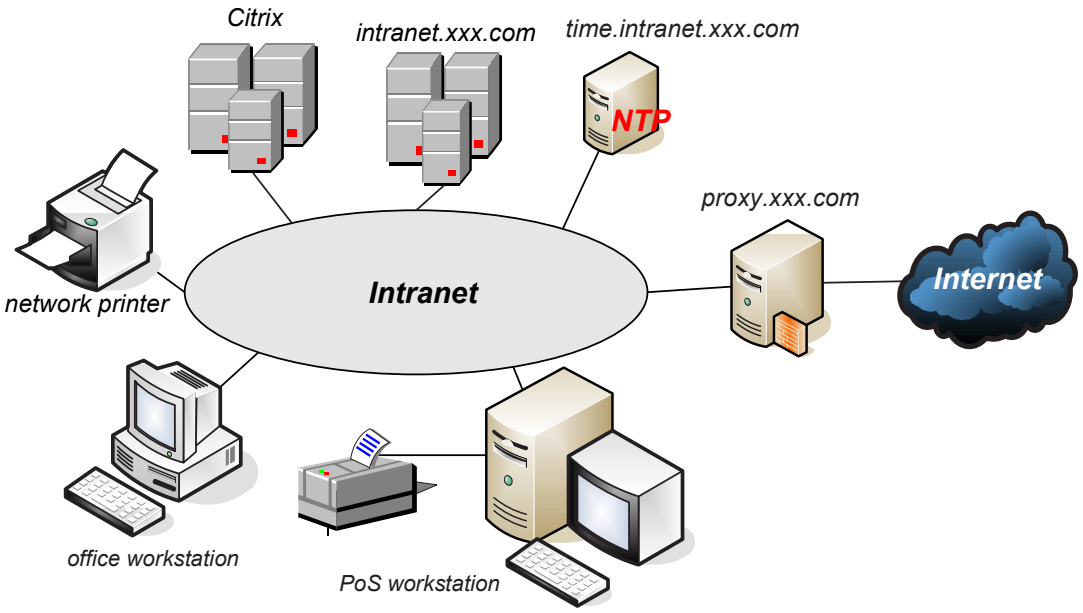

Figure 1: Current IT infrastructure.

Open software and protocols are used at some places in the IT infrastructure but only in supporting roles. There is no significant and organized pool of open source knowledge or practice in the company. The customer requirement was to migrate the workstations to Linux OS, maintaining the full hardware and software compatibility. In this way, the costs and incompatibilities caused by the migration to a new MS Windows release should be avoided.

2.1 Hardware

More than 1000 workstations used in the infrastructure can be divided in two main types: office workstation and Point of Service (PoS) workstation. Office workstation applications are mainly office and network oriented and they use shared network resources. PoS workstation additionally has some custom-made applications and local peripherals. Typical PoS workstation is shown in Fig. 2 where the specific peripherals connected to the workstation's communication ports can be seen. These peripherals usually interface with the custom-made applications. Local peripherals are of the same hardware type or highly compatible to each other but for some no Linux drivers exist. There are 7 different hardware configurations of workstations with same communication ports.

2.2 Software

MS Windows XP SP2 OS is installed on all workstations. More than 100 applications used in the infrastructure are of two types: Win32 applications and Web applications (mainly Java based). The majority of Win32 applications are configured to work with the Citrix Presentation server which simplifies the administration and upgrades but should also ease the migration to a different environment. Web applications are expected to work with Linux since all network protocols and Java programs are supported.

2.3 Migration requirements

According to the agreement with the customer, migration of workstations to Linux OS must be done under following conditions:

1. Novell SUSE Linux Desktop (SLED) should be installed and functional on all workstations.
2. Application functionality should remain unchanged either by continuing to use the same application or by replacing it with the open source equivalent.
3. Users should continue to authentificate through the MS Active Directory and use the shared network resources.
4. Continue and expand the usage of Citrix Presentation server with the Win32 applications.
5. Maintain or increase the level of antiviral protection, backup, supervision and upgrade by using a central administration system.
6. Minimize the usage of additional resources (software or hardware) and cost.

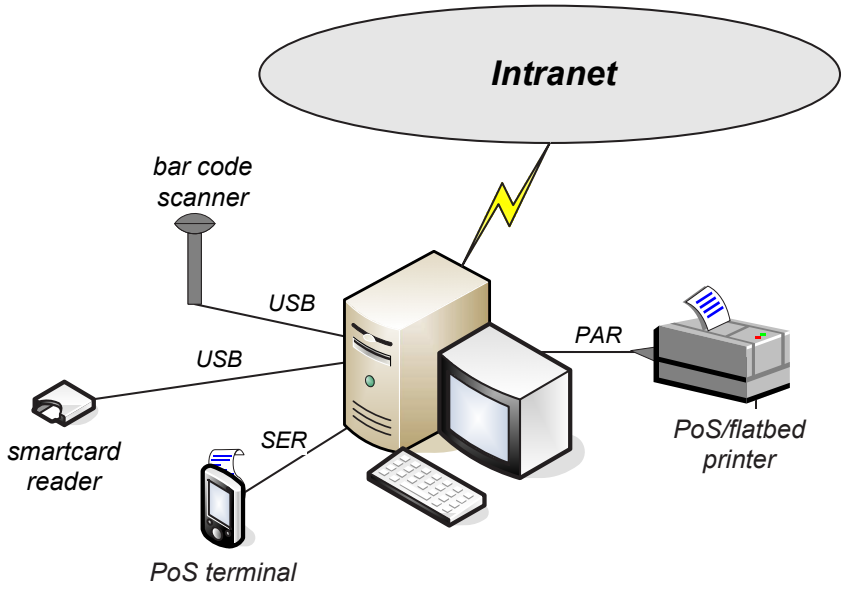

Figure 2: PoS workstation with local peripherals.

3 Migration methods

Migration of the applications which are not to be replaced with the open source equivalent is analyzed here. Considering the listed requirements, possible migration methods for the presented IT infrastructure are:

Virtual machine for Linux host can be used (eg. VMWare, VirtualBox, Xen). Guest OS MS_Windows XP is installed and configured with the Win32 applications which are not replaced. Virtual machine can be isolated from the computing environment by providing only the resources which are necessary. Image of the whole installation can be made and even shared over the network among many workstations. This migration method is very adaptable and can be used in various situations which could not be solved by other means [3]. The additional cost of hardware and software is zero if the virtual machine software is free and the additional load of applications running in the virtual machine on the workstations is acceptable.

Citrix Presentation server (ver. 4.5 is used here, from 2008. onwards the product name was changed to Xen App Server [8]) which is installed together with the Windows Terminal server in the server farm can be used for the Win32 applications which are not replaced. This solution is usually applied in the most demanding situations [2] and has the advantage of provider support that is closely connected to Microsoft. Citrix client software ICA is available for many operating systems (including Linux) and has support for local communication ports. Disadvantages are the higher licenses costs (Citrix + Microsoft licenses) and higher load on the server where the applications are running. Since the licenses were already obtained and the enterprise version of the Citrix Presentation server can stream the applications to run on the client, additional cost of this migration method should be zero.

Wine emulator can be used to run the Win32 applications which are not replaced [9]. Applications can be installed locally on a workstation or on a shared network folder. Serial and parallel local communication ports can be used. Wine is highly configurable and available in open as well as several commercial versions (eg. CrossOver, Cedega) [7]. The applications are run locally on a workstation.

By using some or combination of these methods, a gradual workstation migration to Linux OS is possible maintaining hardware and software compatibility from the user's viewpoint.

3.1 Problems and limitations

Local peripherals can pose a problem in migration to Linux OS. Their functionality should remain preserved not only with the Linux OS and applications but also with the Win32 applications which are not replaced. This means that the equivalent access to local communication ports should be ensured to the

Win32 application running on a server, in a virtual machine, or emulator. For Linux applications the driver for the peripherals should be made available.

Some Win32 applications are legacy applications which work properly only in a strictly defined environment that resembles the single user MS Windows environment for which they were developed. This may require special adjustments to run them in a shared or virtual/emulated environment. For example, legacy application M1 requires a dynamical loaded library which cannot be shared (for technical and legal reasons) and therefore must be installed locally on a workstation and run in a virtual/emulated environment. It also uses a PoS terminal connected to the serial communication port. Another legacy application B2 uses a 2D bar code scanner on a USB port in a mode which is not supported by Linux driver. This application also uses a flatbed printer on a parallel communication port. USB ports cannot be shared over the network just by using the Citrix Presentation server.

4 Solutions

All solutions were thoroughly tested with all hardware configurations and the functionality of the workstations with Linux and MS Windows was compared. The Linux workstations were finally tested in everyday operation.

4.1 Operating system and applications

According to the migration requirements, basic Linux OS version was chosen to be SLED 10.2 with kernel 2.6.16 and X server xorg 6.9. In order to test the hardware compatibility and MS AD integration some workstations were installed with the more recent versions of SUSE Linux: OpenSUSE 11.1 and SLED 11.0β which both use the kernel 2.6.27 and X server xorg 7.4. Default OS configuration options were chosen during the installation and the disk was divided in several typical partitions in order to make it ready for future modifications and upgrades. There were no significant hardware compatibility issues with any workstation type. Standard set of typical Linux applications which can replace the MS Windows applications was installed (eg. OpenOffice, Firefox, Thunderbird).

4.2 Network architecture and integration

Workstations obtain their network addresses from a DHCP server and current time from a time server (cf. Fig. 1). Exact time synchronization between server and client is necessary for MS AD authentification mechanism based on Kerberos tickets. In the IT infrastructure 4-6 MS domain servers running MS Windows Server 2003 R2 are active at any time. They all share one common domain name to provide redundancy and load balancing. Integration of Linux workstations into a MS domain is possible by using the Kerberos 5 protocol for authentification which has an open source implementation in Linux. Samba package ver. 3 then enables the authorized Linux users to access the shared domain resources. SUSE Linux distributions (rel. 10 onwards) include scripts for integrating the Linux client into a MS AD domain. Unfortunately, the scripts work reliably only in simple environments and manual configuration of services is recommended [4]. LikeWise Open software package [10] offers reliable integration of Linux clients into a MS AD domain with simpler configuration and administration [5, 6] and was used in this project. It is also included in the newer releases of SUSE Linux (rel. 11) as a standard tool.

After installing and configurating the packages the integration of the Linux workstations in the MS AD domain was tested with following operations: adding and deleting a Linux workstation in AD, user authentification and single sign-on to domain computers through Kerberos, adding and deleting a user, changing user's password, accessing shared network resources: folders and printers.

4.3 Legacy applications and peripherals

Main problem with legacy applications is the hardware and software environment for which they were developed. Two legacy applications on the PoS workstation mentioned in Sec. 3.1 were first installed and tested in a virtual machine (recent versions of VMWare workstation and VirtualBox were used) with local peripherals. After proper configuration of virtual machines, the legacy applications worked flawlessly with the peripherals. This confirms the statement that this migration method is universally applicable. For this project the method was rejected, because of additional costs for the commercial licenses of virtual machines that were the only ones to support the direct access of the guest OS to the USB system. License issues with Windows XP and the customer requirement to continue and expand the usage of the Citrix Presentation server were another reason for this decision.

Two remaining methods were used to migrate the legacy applications. The application M1 cannot be shared and is locally installed and runs in a Wine emulator (ver. 1.1.14). The application B2 is installed and run on a Citrix Presentation server (ver. 4.5). Both applications use local peripherals over virtualized interfaces as shown in Fig. 3.

Virtualized parallel and serial ports exists both in

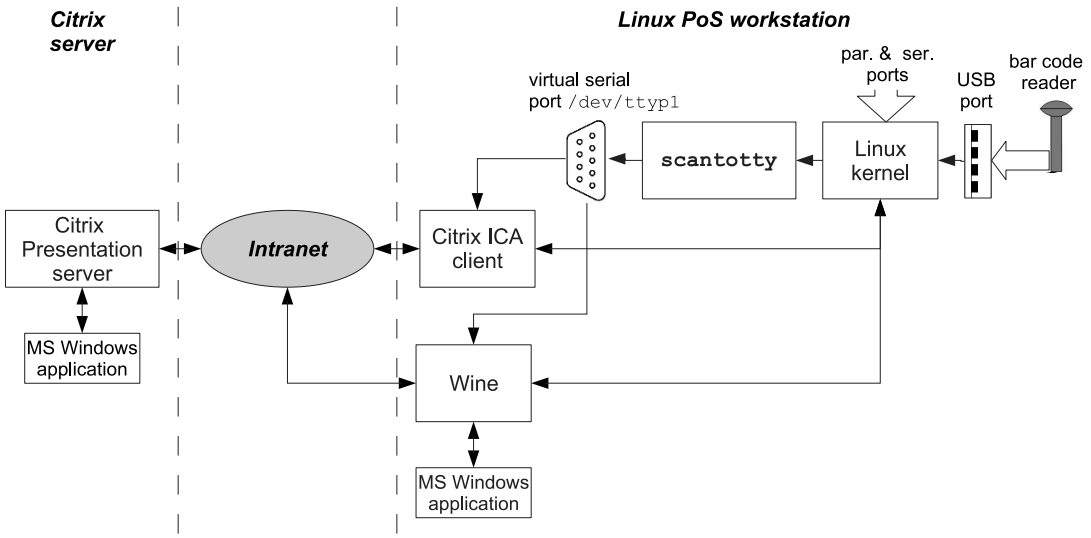

Figure 3: Realization of virtual interfaces in a Linux workstation.

Wine and Citrix and are actually forwarded Linux kernel devices. Virtualized USB ports are not available in Citrix or Wine. The driver for the 2D bar code reader was not available for the 2D bar code (binary) transfer mode which is used by the application B2. The reader cannot be connected to the serial port since it would block this port for the PoS terminal and require the replacement of the interface cable.

Since the application B2 supports the bar code reader connected to the serial port, the solution was found in forwarding the data stream from the USB port to a virtual serial port `/dev/ttyp1`. A new program `scantotty` was written for this purpose by using the `libusb/libhid` libraries for interfacing with the USB port. This approach has the advantage over writing a new Linux kernel driver because it is simpler and applicable to Linux distributions with different and older kernels where the 2D bar code reader is not recognized as an USB device (kernels older than 2.6.20 as in the used distribution SLED 10.2). Long-term solution would be to write a Linux kernel driver which provides the same functionality and the virtual serial port. The program `scantotty` runs in the user mode with some root privileges since it uses two interfaces: USB and virtual serial port. It forwards only the data from specific bar code readers (USB VendorID and ProdID which requires some `udev` configuration) and can be started as a daemon at boot time. Virtual serial port is tested and can be used by all applications installed and configured to work with Citrix and Wine (Fig 3). This solution can generally be used to migrate the legacy applications which use peripherals connected to the serial port, running in virtual/emulated environments and even on a remote server since forwarding serial ports over network can be achieved with reliable open source tools.

4.4 Maintenance, Security and Backup

Novell Zenworks is used for supervision and upgrades of the Linux OS (SLED) and its applications. Disk images of Linux installations for all workstation hardware configurations were made and can be easily restored over the network by using Zenworks or open source tools. These disk images also serve as configuration backups. User management is done on MS Windows servers in AD. All user data (home directory and profiles) is either stored on the server or locally reseted to a default state after the user logs out.

Security is increased compared with the MS Windows reference workstation because:

- Linux users do not have all administrative privileges which were sometimes necessary in MS_Windows to run the legacy Win32 applications.
- Linux OS is more resistant to computer viruses and worms which was proven to be true during the testing phase when one worm disabled many MS Windows workstations but none of the tested Linux workstations.

During the testing, Linux OS has also proven to be more stable than the Windows XP OS.

5 Conclusions

The first phase of the gradual migration to Linux OS was performed with several workstations of different hardware configurations and tested in everyday operation. Hardware and software compatibility with the reference MS Windows workstation is maintained while the stability and security of the whole IT infrastructure is increased. Two generally applicable migration methods for the Win32 legacy applications which use peripherals were presented: virtual machine and virtual interfaces.

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