CERN-CN-96-014

CN/96/14

The CERN Personal Computer Network

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Abstract

This paper contains the description of the strategies taken to manage all the Personal Computers connected to the CERN network. The current status and all major evolution strategies are herein described.

Paper presented at the "International Workshop on PCs and Particle Accelerator Controls" (PCAPAC '96), October 7-9 1996, Hamburg, Germany.

INTRODUCTION

CERN has more than 2200 Personal Computers (PC) connected to its internal Local Area Network (LAN) that where purchased in the last 6-7 years. The park is composed by less than 10 % PCs based on the Intel 386 processor, 50 % on 486 (mainly 33 and 66 MHz) and 40 % on Pentium (mainly 90 and 133 MHz). With few exceptions, all the PCs have at least 16 MB of memory.

All these PCs are being migrated from Microsoft Windows 3.1 to Windows 95. On September 1st 1996, more than one half of the PCs (1136) were running Windows 95 while the other half (1083) was running Windows 3.1 or DOS. Every month, few hundred PCs are migrated from Win31 to Win95 and it is planned, by the end of this year, to stop the support for Windows 3.1 and to force all computers to use at least Windows 95. By that date, it is also planned to open an official support for Windows NT desktop PCs.

The CERN PC park by processor

OS distribution on September 1st
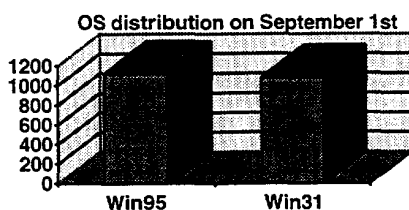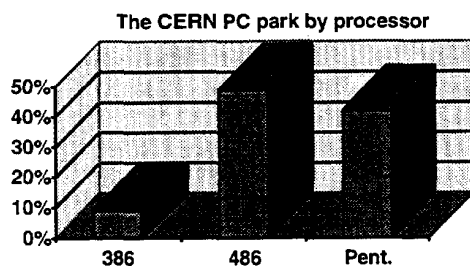
All the CERN PCs are connected to the central servers from which they get all services. There are 15 central servers[1] running Novell Netware offering more than 160 GB of disk space distributed on 75 volumes used to store software, home directories or data. All PCs have pre-installed the necessary software components to run any of the more than 100 packages available from the software servers.

THE BASIC PRINCIPLES

The *minimum* hardware configuration supported is a 486 computer with 16 megabytes (MB) of RAM and 100 MB hard disk. 386 computers or computers with less than 16 MB RAM can be connected to the network but not all the standard applications are guaranteed to run. The recommended hardware configuration is a Pentium-based computer with 16 or 32 MB of RAM and 1.2 GB or more hard disk. It is also recommended to equip every PC with an audio card if the user wishes to run multimedia applications (mainly computer-based-training) from the network.

The hardware park is kept as standard as it is possible. All PCs are centrally purchased through a unique service called PC-SHOP. This ensure that all the hardware coming into the lab is tested and guaranteed to work before it is delivered to the user. There are a few holes in this scheme due to computers owned by non-CERN staff coming in the laboratory as visitors, but this is kept as limited as possible.

The software configuration of all PCs is *standardised* and *centrally maintained*. The configuration of every PC is known from an accurate inventory, dynamically updated.

All users and all PCs are *equally managed*. The same application software available to all users and all software is available to all PCs, always loaded from the network. The service is kept as much as possible attractive and reliable to discourage end-users from installing the software locally in their hard disk.

WINDOWS 95 AT CERN

The Microsoft Windows 95 environment on the CERN network is called NICE95.

On NICE95[2], all computers can run 32bit applications developed for Windows 95 and for Windows NT (Win32 applications) while keeping the maximum possible compatibility with all the existing

applications running previously on the Windows 3.1 network (Win16 applications and DOS applications). This has allowed the introduction of a set of strategic 32 bit applications on the network and to start planning the stop of the Windows 3.1 support on the site.

The upgrade from Windows 3.1 to Windows 95 is being done without any additional hardware investment, keeping the existing hardware base. The hardware requirement have not been changed (except for the hard disk size that has been raised from 40 MB to 100 MB) and the final result, as seen by the user has been that on the same hardware, *performances* and system *reliability* on Windows 95 *are significantly higher* than on Windows 3.1. This result has been achieved by moving the Windows "system" files from the network to the local disk in order to have the operating system immune from network errors and glitches. The 32bit network driver and the 32bit disk driver were also one of the major reason why performances have increased, especially because the network driver has proven to have a very efficient cache of network files.

The ease of the system management has been kept as simple as it was with Windows 3.1, where the local disk was only used for the swap file. A consistent set of the Windows "system" files (mainly dynamic link libraries and OLE controls) in the local disk is a *mirror* copy of an image on the reference server. With this model, the local disk is considered a *cache* of the network disk that provides the *stability* of the local installation and the *manageability* of the diskless installation.

THE SERVICES FOR THE USERS

The end-user just uses the computer he has on his desk and he does not often understand what a *service* is. However, the fact that he can start a wide variety of different tasks using his computer, means that there are services tightly integrated in his desktop, despite that these may be provided by different groups or divisions in the laboratory.

Home Directories and Divisional Volumes

Every user has a *Home Directory* that he can use to store his documents. The home directory is by default public readable but has a read-protected subdirectory where confidential information can be stored. The user can change the access rights to his home directory as he wishes. All security features are available to the user and rights can be granted up to every single file (who, from where, when, what).

Every activity (division, workgroup, project) can have a network volume where all sorts of data not linked to a particular person but in relation with that activity

(databases, archives, drawings, logbooks, ...) are saved.

All data saved in the home directory and in the divisional volumes is *backed up daily* and all information is easily shareable with other users also on *multiple platforms* (DOS, Win31, Win95, WinNT, Macintosh, the World Wide Web, and partially UNIX). These facilities push the users to use the network disk instead of the local hard disk which is generally not backed up and is available only from the local computer.
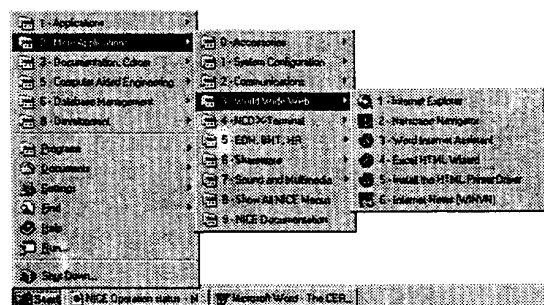
Program disks

The offer of application software to the NICE95 desktop is very large in order to be able to satisfy all users requirements. However, for each user requirement *only one solution* is provided to encourage all users with similar requirements to use the same software tools, this to facilitate the exchange of compatible information in the laboratory and to encourage *user-to-user* support.

Solutions are available to all the users in the following fields: Word Processing and Desktop Publishing, Drawing and Drafting (with clipart image libraries), Spreadsheet, Management, Presentation Graphics, Computer Aided Design (Mechanical, Electrical and Electronic), Computer Aided Engineering, Symbolic and Numerical Analysis, Controls, Tests, Instrumentation, Programming (in C, C++, Basic, Nodal, Pascal, and FORTRAN), Database access (remote and local), Communication and Internet access (Telnet, FTP, Mail, X terminal, WWW clients, ...).

The application software is always *pre-installed*, and it is the *same* on all PCs. This has the advantage that all problems are shared among all users, and gives the best warranty to have them fixed.

The user access all the standard applications software using the Windows 95 *"Start Menu"* which is the *same* on all computers. The user can hide parts of the menu he does not use, but he cannot modify its contents which is centrally maintained on all PCs. The user can install software in his local disk, under his own responsibility, without any central support.

The NICE95 Start Menu, as it appears on all PCs

The standard software is always installed on a reference *"program disk"*. To ensure a correct scalability of the system (able to support more than 3000 simultaneous PCs connected) this *"program disk"* is replicated several times with a consistent replication process ensures that all copies are equal.
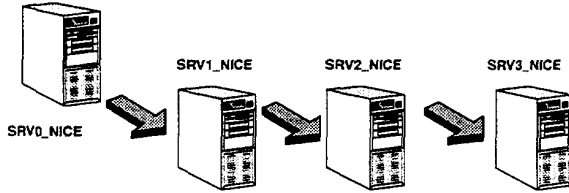

The reference program disk is replicated on other servers

This is how the software is distributed to all PCs. Every PC at CERN attaches to a copy of the *"program disk"* which contains all the software the PC needs. The redundant availability of these copies ensures that every PC is always able to locate at least one *"program disks"* on the network even when one server is down or powered off.

Print Services

Every computer has access to all the printers on the site (more than 600). The access is database driven and allow the user to search for a particular printer by location, building or by capabilities (postscript / laserjet, colour / black & white, printer/plotters, A0 / A1 / A2 / A3 / A4, ...)

All print services are available from all platforms (DOS, Win31, Win95, WinNT, Macintosh, and partially UNIX) using a large number of gateways.
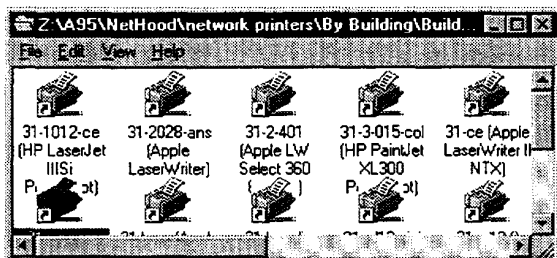
Printers in building 31 seen from the network neighborood

Communication services

All PCs are directly connected on the Internet: they have access to the World Wide Web and can *telnet* or *ftp* to any host world wide. Every user can send and receive electronic mail and can fax documents from the e-mail client.

All home directories and divisional volumes files are accessible from the Internet remotely using FTP or WWW. The host name `http://nicewww.cern.ch` is a gateway that provide transparent access to all data files without the necessity to hard-code in the URL the physical server name or volume name or directory name, and leave the complete freedom to the server

administrators to move/copy/rename/split volumes without breaking URLs hard-coded in the HTML documents. Using this facility, every user can easily have his home page on the Web

Access to the CERN network is also possible using telephone lines, GSM and (soon) ISDN. Portable computers can dial into CERN and access remotely all documents located at CERN and get access to the Internet using a dial-up connection[3].

Documentation

A few set of document is available to the user. The general documentation[4] is made available in French and English, while the technical documents[2,3] are normally available in English only.

CD ROM server service

All PCs can access a set of CD-ROM titles from two types of servers: servers that have CD-ROM readers directly connected to them and fast servers, connected to the FDDI backbone, with large hard disks where the CD-ROM disks are copied.

The first solution is practical for CD-ROM titles that have few simultaneous users and do not require fast network access (example: ASCII-based databases). The solution of the CD-ROM copied to a fast disk server is used when fast network access is demanded by several users simultaneously to the same title (example: multimedia computer based training applications).

The CERN CD-ROM service offers 28 CD-ROM readers (slow access) and 12 GB of fast disks, making the total offer around 40 CD-ROM titles.

Portable and mobile computers

The standard *"desktop"* computer has only the operating system installed locally and it accesses all software from the *"program disk"*, mapped to the *z:* drive. All software is configured to use the *z:* drive letter as an *alias* to access the program disk, which is typically a volume on a network server.

All PCs configured with NICE95 have the possibility to *mirror* part of the *"program disk"* to the local disk (this goes typically to the *c:\nicemirr* directory). During the boot process, if a NICE95 PC cannot locate on the network a *"program disk"* volume, it will map the *z:* drive to the local *c:\nicemirr* directory and all the applications that have been mirrored locally will be available.
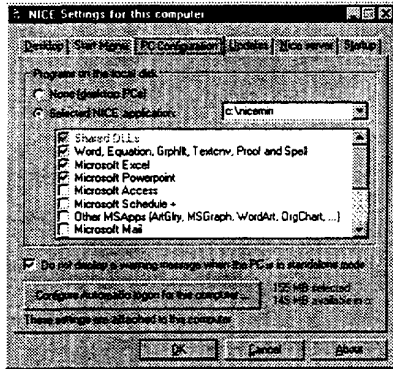
Mirroring the programs disk locally

With this model, mobile computers are supported exactly as desktop computers, with the same configuration.

The possibility of mirroring part of the program disk to the local disk, is not restricted to portable computers: it is more and more frequent to see desktop computers configured with local applications that are available even during a network breakdown.

The price the user has to pay for this service is on the disk size requirement that grows to a minimum of 256 MB (512 MB recommended). More than 200 MB of files in the local disk are a mirror copy of the network disk that is centrally maintained and updated. Modifications done in the program disks are automatically propagated to the local disks once a month, if the computer connects again to the CERN LAN.

WHAT THE USER SEES

The NICE95 desktop

All NICE95 computers have the standard Windows 95 desktop with at least the following icons:

- *"My Computer"* gives the user access to the local disks of the PC and to any local resource.
- "Network Neighborhood" gives the user access to all network resources, including a logical view of the CERN Network, centrally maintained (see below).
- An icon with a face and the name of the user which opens the user's home directory.
- An icon for the CERN *"Phone book"* which lets the user send mail or view the home directory of any other CERN user.
- A *"mail"* icon will appear for users using electronic mail on NICE95.
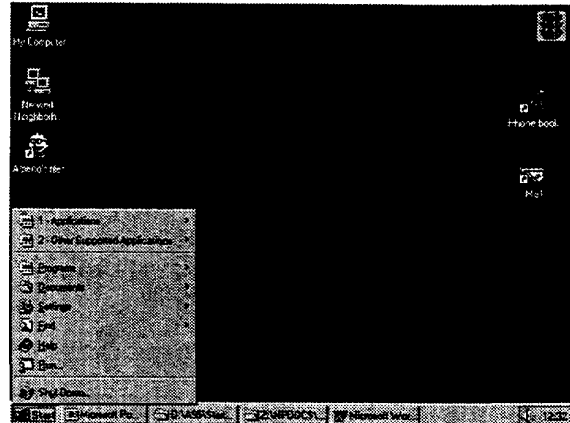
The NICE95 desktop

The user can start applications from the start menu, that is common to all computers and cannot be modified. The user can place icons or shortcuts to his favourite programs or documents on his desktop as he wishes, but he cannot delete the mandatory ones.

All the user's settings (including the desktop colors, wallpapers, shortcuts, application settings, etc.) follow the user when he moves from one computer to another. The user settings are stored in the home directory and the user always finds his own working environment. The user settings are mirrored to the local disk in order to have them available even when the network is down or when the portable PC is disconnected from the CERN LAN.
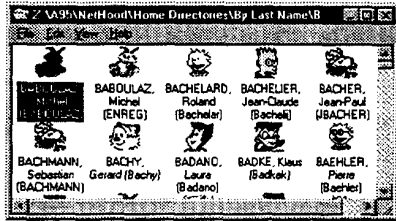
The NICE95 Network

The user logs on the network with one, unique and global login than give him access to all services. The user is authenticated on network servers only when necessary and without any user intervention.
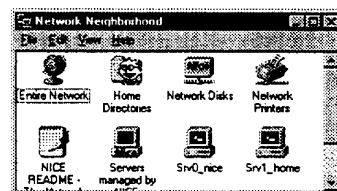
The Network Neighborhood as seen from a NICE95 PC

The *"Network Neighborhood"* is the same on every PC and network resources as printers, home directories, activity volumes are organised logically by building, by users, by division. The user does not need to know where the resource is located, and in addition, resources can be easily moved in the physical network without breaking the access to it.

Access to home directories from the Network Neighborhood

THE NICE95 ARCHITECTURE

The Desktop Computer

The standard PC installation of every NICE95 PC is obtained by booting the PC with the "*NICE95 Installation diskette*" inserted. The installation is done automatically in approximately 30 minutes and the user must supply only the Ethernet card type and the IP address of the computer he is installing.

*Only one floppy is necessary to install NICE59 from the network*

This *automatic installation* allows support technicians to solve ALL hardware and software related problems in the local computer by always being able to bring it into a *known working state* by reinstalling NICE95.
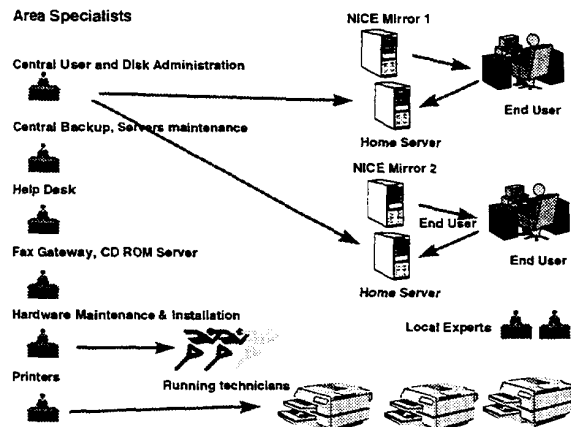
The NICE Services
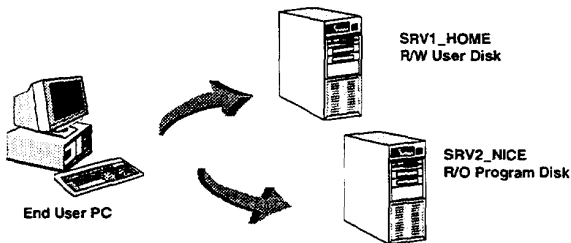
Every PC attaches at least two servers

The PC always attaches at least 2 servers: the *Home Directory server* of the current logged on user and the nearest "*Program Disk*" server (NICE Server) from where the programs are loaded. The "*Program Disk*" server is a mirror copy of the *reference* that is the key place from where all services to the desktop are distributed. Several groups[5] of people are working independently on the reference server to provide desktop services in the laboratory.
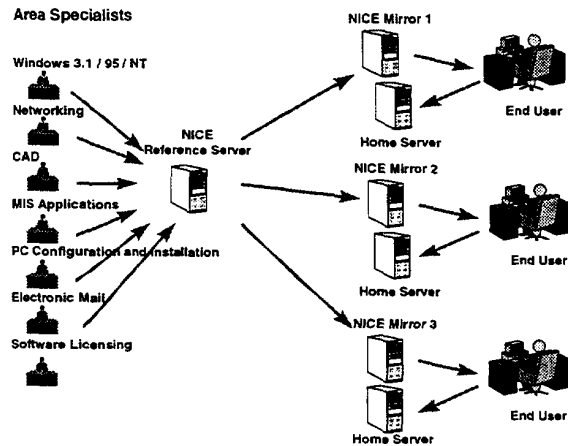
Organisation of all software services for the desktop

In addition to that, there are core services that are not provided using the reference server and its automatic replication mechanism. These are shown in the following picture.

Organisation of the NICE core services

Accounting and licensing

All the CERN PCs hardware configuration are logged in detail into the PC Inventory database. In addition, an extension to the Windows 95 shortcut file has been made to have the possibility of accounting the software usage. The *Start Menu* of every PC contains only of these extended shortcuts that give the possibility of accounting the software usage on the network.

With this scheme, everything is known: by computer, by software, by user, by time. The PC inventory allows planning hardware upgrades while the software usage statistics allow negotiation of "cheap" licenses based on simultaneous usage as well as the redistribution of licensing cost to end-users (or to divisions). Licensing is preferably based on simultaneous users, that are monitored.

CPU	W31	W95
80386	180	3
80486	611	369
Pentium	190	572

IS WINDOWS NT THE NEXT STEP ?

The choice of Windows 95 was related to the good compatibility with Windows 3.1 that would let all applications previously available on the CERN PCs to be also available on Windows 95. On the *average* machine (a 486 with 16 MB of memory), the highest performances between 3.1, 95 and NT was clearly on Windows 95. In addition, the migration to Windows 95 is being done without heavy hardware (mainly RAM memory) investments and is including portable and laptop computers.

In the last year, there have been several discussions whether the PCs running Windows 3.1 should be upgraded directly to Windows NT, given that NT could have been a good opportunity to *skip* one generation of software.

However, NT could have been perceived by the user as not the best operating system for their current task given the reduced performances compared to Win95 and the necessary hardware upgrade. The lack of support for portable computers and the unavailability of few Win16-based application under NT would have required to continue the Windows 3.1 support in the medium term.

The conclusion has been that *both* 95 and NT were *necessary* in the organisation in the medium term. In the short term, Win95 has been set as the *preferred* platform to which the *current* Win 3.1 PCs are migrated in order to stop the Windows 3.1 support, while the NT support will be set up in order to be able to accommodate all the new requirements of users migrating from UNIX and VMS to Windows.

The major worry was that CERN would end in supporting 3 PC operating systems (Win 3.1, 95 and NT) in the long term. These will be limited to 2 (3.1 and 95 this year, 95 and NT in the next years) and this will delay in several years all hardware upgrades necessary to migrate all the PCs to NT without sharp increases in the financial investments.

CONCLUSIONS

Windows 95 has improved dramatically both performances and stability of all PC desktop services compared to what was available using Windows 3.1. A common culture has been generated in the laboratory, where everyone uses the same application set, reducing the need of central support that is mainly done in a *"user to user"* way. The end user productivity seems to have increased especially after

the introduction of new 32bit applications for which a requirement existed. Proliferation of self-installed PC clusters and servers in the lab has been avoided.

There is hope that this will also be possible using Windows NT.

REFERENCES

[1] See http://nicewww.cern.ch/operations/status.htm for the list of the online servers and volumes.

[2] A. Pace, "The Windows 95 Installation at CERN", CERN UCO/96/191, March 1996, http:// nicewww. cern.ch/ win95/ detail/ nice01.htm

[3] D. Heagerty, A. Pace, "Home Access to the CERN Network from Windows 95", CERN UCO/96/192, June 1996, http:// nicewww.cern.ch/ win95/ acb/ acb.htm

[4] A. Pace, "Using Windows 95 at CERN", CERN UCO/96/189, May 1996, http://nicewww.cern.ch/ win95/ introe/index.htm: and A.Pace, "Utilisation de Windows 95 au CERN", CERN UCO/96/190, May 1996, http:// nicewww.cern.ch/ win95/ introf/ index. htm

[5] As an example of an additional service that is available to all CERN PCs, see I.Deloose, "Integrating the New Generation of ISOLDE Controls into a Multi Platform Environment", these proceedings, http:// nicewww.cern.ch/ psdata/ psco/ doc/ index.htm