Supporting Windows NT as Physics Workstations and Servers

David Foster, Alberto Pace

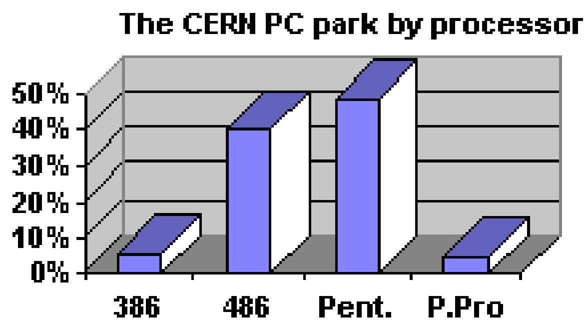
CERN Information Technology Division,
CH-1211 Geneva 23, Switzerland

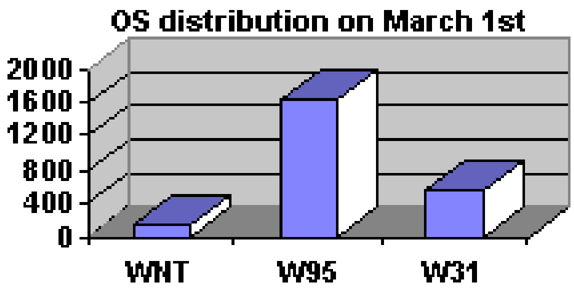
Since 1992 CERN has had a support infrastructure for PC based desktop systems. This has evolved with the generations of the Windows operating system from Windows 3.1, through Windows 95 and now NT 4. With each evolution we have maintained a consistent architecture to provide integrated network services maximising the transfer and sharing of information. The architecture is aligned with the organisational needs of high levels of support to the increasing numbers of CERN users together with keeping the costs under control. Managing change is a fundamental concept in the architecture and asset management techniques allow the effects of introducing and changing software packages to be predicted. This paper will deal with the techniques used to support Windows NT as an integrated element within the architecture. Concepts of delegation of responsibility and control will be discussed which allow Physics experiments to gain benefit from the general infrastructure whilst being able to add value. Paper presented at CHEP97, International Conference on Computing in High Energy Physics, April 7-11 1997, Berlin, Germany.

INTRODUCTION

CERN has more than 2200 Personal Computers (PC) connected to its internal Local Area Network (LAN) that where purchased in the last 5-6 years. The park is composed by less than 6 % PCs based on the Intel 386 processor, 40 % on 486 (mainly 33 and 66 MHz), 49 % on Pentium (mainly 90 and 133 MHz) and 5 % on Pentium Pro. With few exceptions, all the PCs have at least 16 MB of memory.

All PCs are being migrated from Microsoft Windows 3.1 to either Windows 95 or Windows NT 4. On March 1^{st} 1997, 69 % of the PCs were running Windows





95, 7 % were running Windows NT while the remaining 24 or MS-DOS. Every month, more than one hundred PCs are migrated from Windows 3.1 and it is planned by this summer, to reduce the support for Windows 3.1 and to encourage all windows computers to use Windows 95 or Windows NT.

The site wide support for Windows NT is just starting, which is why we have only 7 % of the NICE computers running NT. It is also planned to open an official support for Windows NT desktop PCs within the next few months and as soon as this becomes available, the number of PCs running Windows NT is expected to increase dramatically.

All the PCs at CERN are connected to central servers or to local workgroup servers from which provide the network services. There are 15 central servers [1] running Novell Netware offering more than 180 GB of disk space distributed on 75 volumes which is used to store software, home directories and data. All PCs have pre-installed the necessary software components to run any of the more than 100 packages available from the software servers.

REDUCING OWNERSHIP COSTS

The costs of ownership increase dramatically as the diversity of both hardware and software increases. This problem, associated with the lack of remote management tools, often results in maintenance and support costs increasing to thousands of US dollars per node per year. To manage the tendency to diversify, the PC hardware and software configurations have been standardised wherever possible keeping the needs and wants of the user community the foremost consideration. The minimum hardware configuration [2] 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 or Pentium-Pro based computer with 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. Policy decisions aim to ensure that the evolution of the hardware and software investment is maintained, to continue to satisfy user requirements, whilst keeping the support costs manageable. All PCs are centrally purchased through a unique service called the PC-SHOP [3]. This ensures 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 advice on recommended and supported configurations is available.

The software configuration [4] of all PCs is standardised and centrally maintained. The hardware configuration of every PC is known and is kept in an asset management inventory which is dynamically updated. All users and all PCs are equally managed [5]. This implies that the same application software available to all users and all software is available to all PCs, always loaded from the network. The service is managed to satisfy user software availability and stability requirements and to reduce the requirement for end-users from installing software locally on their hard disk.
The only digression from the standard configuration is possible within the boundaries of well-known and managed workgroups. Inside a workgroup, the local administrator can decide to support non-standard hardware or additional software when this is necessary [6]. To ensure 24 hours/day service, the workgroup administrator can also replicate all necessary support files to his local workgroup server.

WINDOWS AT CERN

Windows at CERN is supported within the NICE (Network Integrated Computing Environment) project that has the vision to create a desktop environment capable of accessing all the information systems and to provide a single entry point into all information resources at CERN.
Two client configurations have been defined: The first one is NICE95, based

on Windows 95 and recommended for low end PCs, for portable computers, and for users requiring excellent application compatibility with 16-bit software originally designed for MS-DOS or Windows 3.1. The second configuration is NICENT, based on Windows NT, and recommended for high end computers and for users needing to run mainly 32bit applications.
Both Windows 95 and Windows NT configurations [7] can run 32bit applications (Win32 applications). In addition, computers running NICE95 keep the maximum possible compatibility with all the existing applications running previously on the Windows 3.1 network. This has facilitated the decision to stop support of the Windows 3.1 environment on the site.
Without any additional hardware investment, most Windows 3.1 computers have been upgraded to Windows 95. 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, performance 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 performance has increased, especially because the network driver has proven to have a very efficient cache of network files.
Computers moving to Windows NT 4.0 have proven to be extremely stable and to provide excellent performance when running 32 bit code. This environment has proven to be significantly more reliable than the corresponding environment under Windows 95. For all computers, Windows is installed on the local disk. A consistent set of Windows "system" files (mainly dynamic link libraries and OLE controls) on 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. To preserve the installation of local application that may require newer versions of system files, the internal "Fileversion" resource is checked before copying any file from the server to the local disk.

SERVICES FOR USERS

The end-user just uses the computer he has on his desk and he does not need to 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 on his desktop, despite the fact that these may have been 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 specific data not linked to a particular person but related to an activity (databases, archives, drawings, logbooks, ...) can be saved.
All data saved in home directories and in divisional volumes are backed up daily and the information is easily shareable with other users on multiple platforms (DOS, Win31, Win95, WinNT, Macintosh, the World Wide Web, and UNIX via NFS). These facilities provide compelling reasons to use the network disk instead of the local hard disk, which is generally not backed. In addition, the local disk is generally not available from the network, because peer-to-peer networking is generally discouraged, given the large number of nodes that would be advertised as servers without providing the necessary backup and availability levels.

Program disks

The variety of application software available to the Windows desktop on NICE is very large in order to be able to satisfy all users requirements. However, for each user requirement only a few solutions (often only one) are provided to encourage all users with similar requirements to use the same software tools. This is to facilitate the exchange of compatible information in the laboratory and to encourage user-to-user support thereby gaining some economies of scale with 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, Java, Nodal, 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 on the server, and it is therefore the same on all PCs within the same workgroup. Application software can come either from the central servers or from the local workgroup server or even from a third party workgroup server. Well defined processes are in place

to make software available CERN-wide by installing it on the central servers or in the local workgroup server [8].
The user accesses all the standard applications software using the Windows "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 content which is centrally maintained on all PCs. The user can install software on his local disk, under his own responsibility, without any central support.

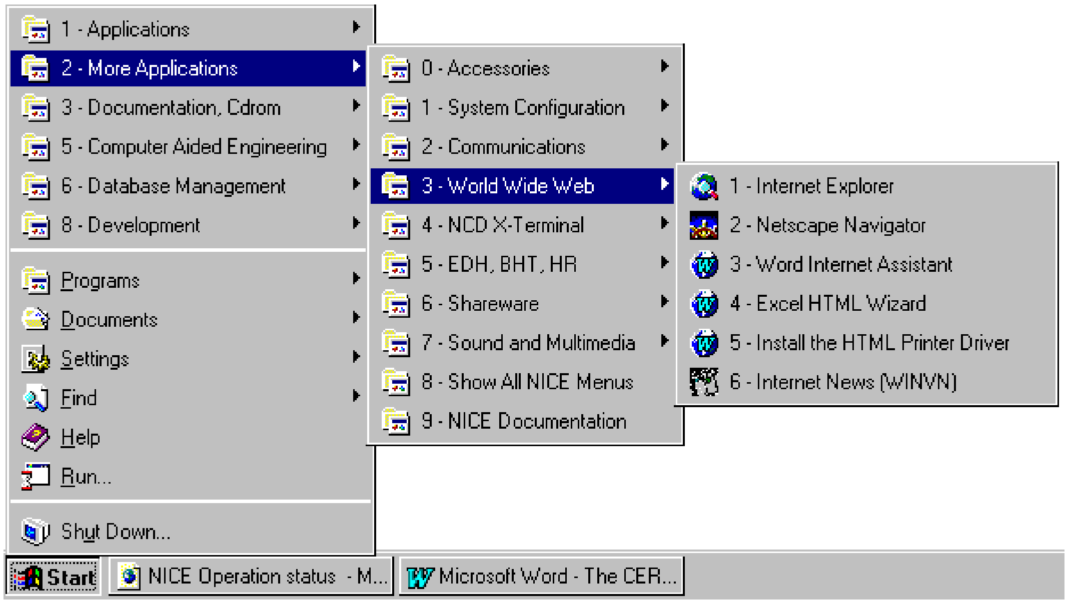


Fig. 1. The NICE Start Menu, as it appears on all PCs

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 which ensures that all copies are identical.

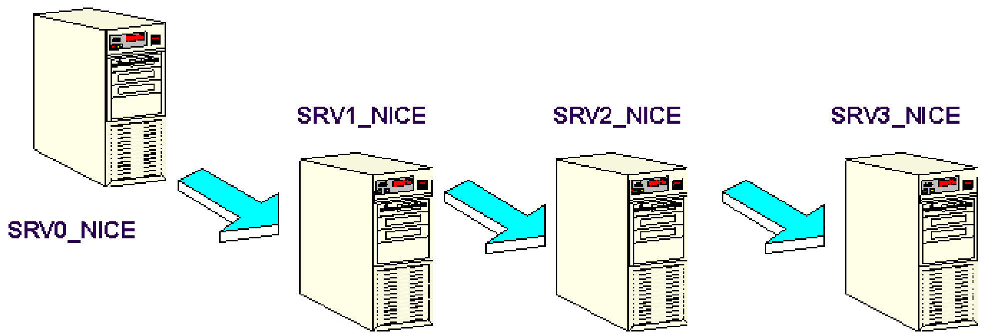


Fig. 2. The reference program disk is replicated on other servers

The reference program disk is replicated on other servers The reference "program disk" can also be replicated to a "workgroup server disk". The replication process can be automatic or manual under the supervision of the local

workgroup administrator. An automatic replication can be used when the workgroup administrator wants to ensure that all software services are local and independent from the network availability (typically for an experiment running 24 hours/day, 7 days/week). A manual replication can be used when the workgroup administrator wants to control all software upgrades that are taking place on the desktops he manages, to freeze the environment for an experimental run for example.
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 disk" on the network even when one server is down or powered off. A simple algorithm is used to load-balance the connections to the central servers.

Print Services

Every computer has access to all the printers on the site [9] (more than 600). The access is database driven and allow the user to search for a particular printer by location, building or by capability (postscript / laserjet, colour / black & white, printer/plotters, A0 / A1 / A2 / A3 / A4, ...) Print services are available from W95 platforms while access from WNT is currently being implemented.

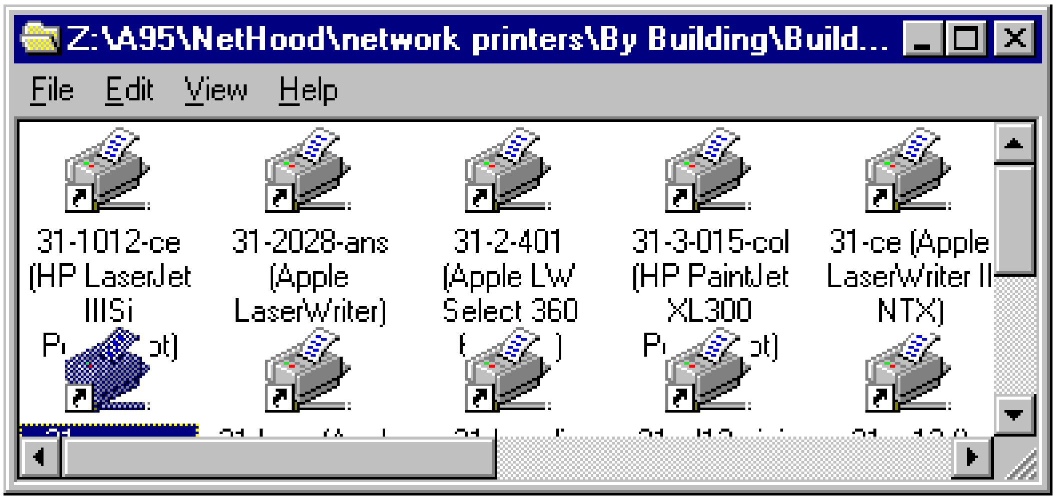


Fig. 3. Printers in building 31 seen from the network neighborood

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 provides 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 leaves 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 [10]
Access to the CERN network is also possible using telephone lines, GSM and 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 [11].

Documentation

A few set of document is available to the user. The general documentation [12] is made available in French and English, while the technical documents [7,11] 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 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 fast changing 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 connected to NICE 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 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.

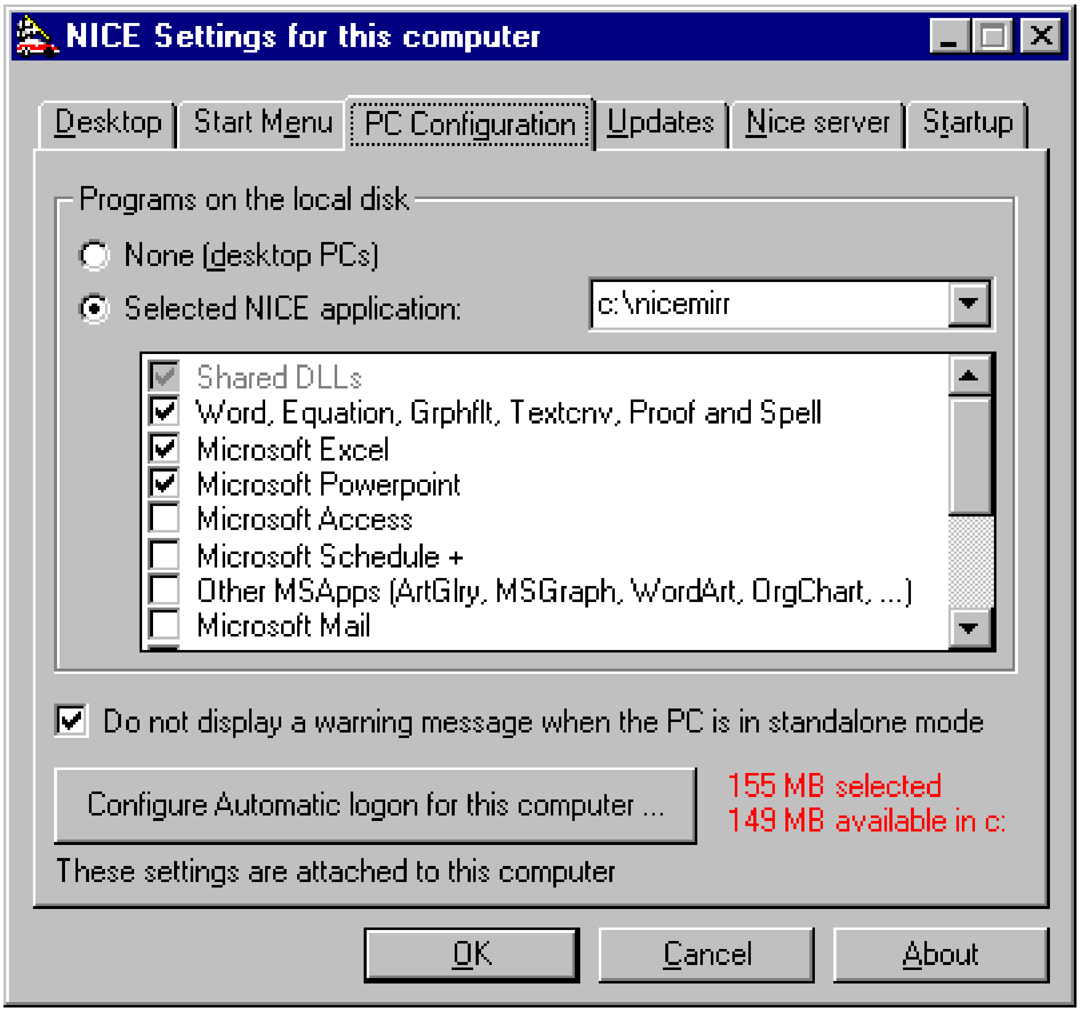


Fig. 4. Mirroring the programs disk locally

With this model, mobile computers are supported [13] 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. This facility has been made available to all desktops which require the critical availability of some applications even in the event of network failure.
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 on the program disks are automatically propagated to the local disks once a month if the computer connects again to the CERN LAN.
The official support for portable computers currently exists for Windows 95 only. There are plans to extend this support to Windows NT in the next few months.

WHAT THE USER SEES

The Windows desktop

All NICE computers have the standard Windows desktop [14] 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 "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 from NICE.

The user can start applications from the start menu, that is common to all computers within the same workgroup 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 for Windows 95 users and in a dedicated profile server for Windows NT users. This guarantees that 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 a portable PC is disconnected from the CERN LAN.

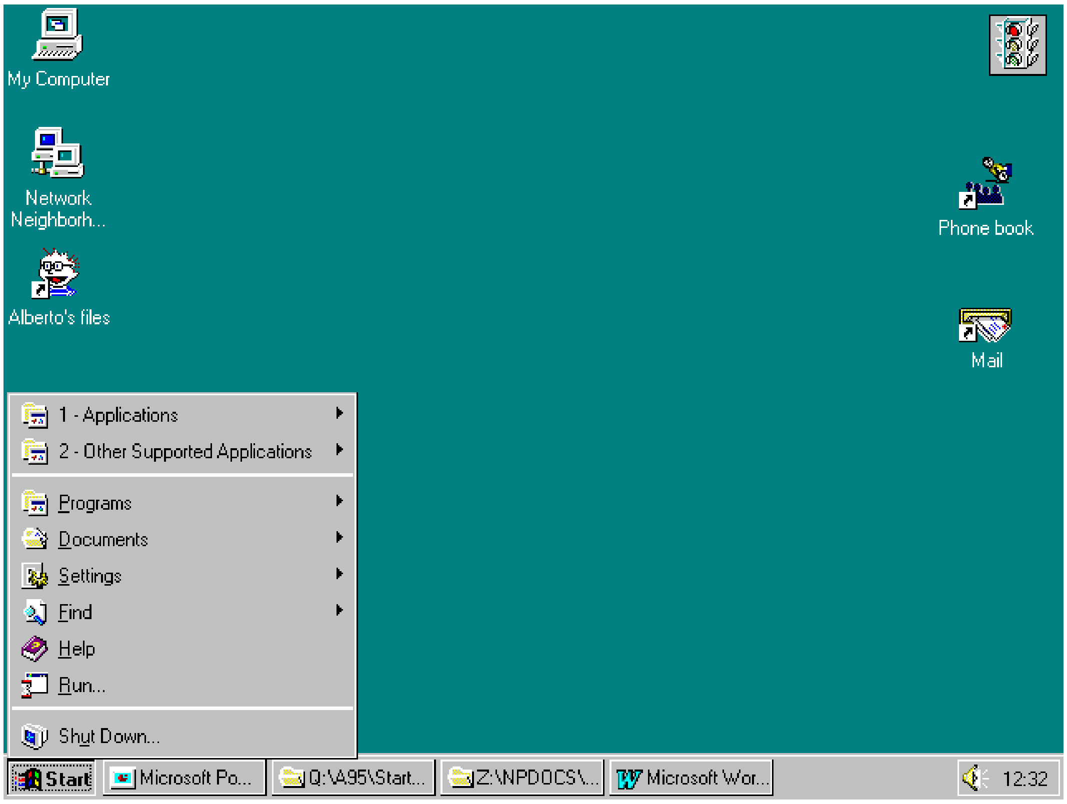


Fig. 5. The NICE standard desktop

The Network Neighborhood

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. For W95 users this means authenticating in the Netware NDS, while for WNT users, this means authenticating in the CERN NT domain and in the Netware NDS.

The aim is to have the "Network Neighborhood" the same on every PC and network resources such as printers, home directories and 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 around the physical network without breaking the access to them.

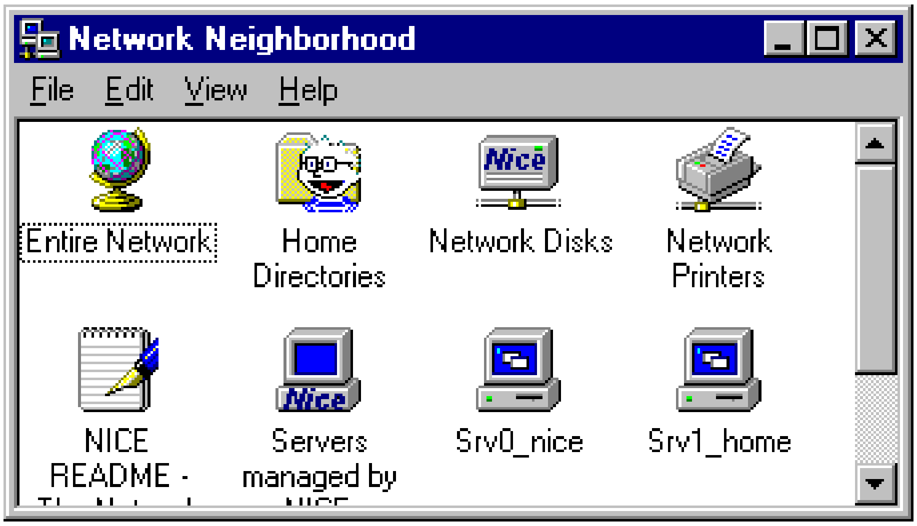


Fig. 6. The Network Neighborhood as seen from a NICE95 PC

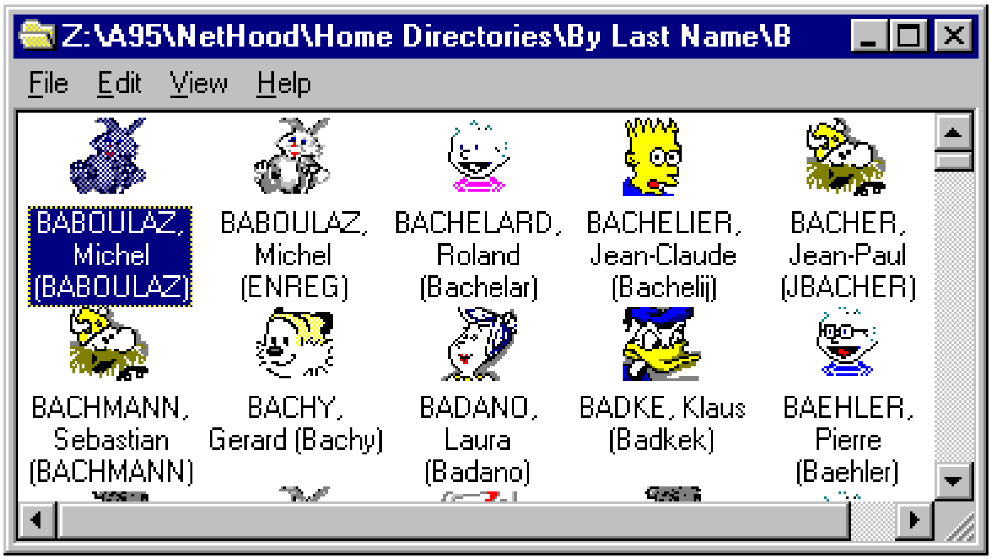


Fig. 7. Access to home directories from the Network Neighborhood

THE NICE ARCHITECTURE

The Desktop Computer

The standard PC installation of every NICE95 PC is obtained by booting the PC with the "NICE95 & NT Installation diskette" inserted. The installation is done automatically in 30 (W95) to 60 (WNT) minutes and the user must supply only the Ethernet card type, the IP address of the computer he is installing and the operating systems he wants installed (Windows 95, Windows

NT workstation, Windows NT server) [7].

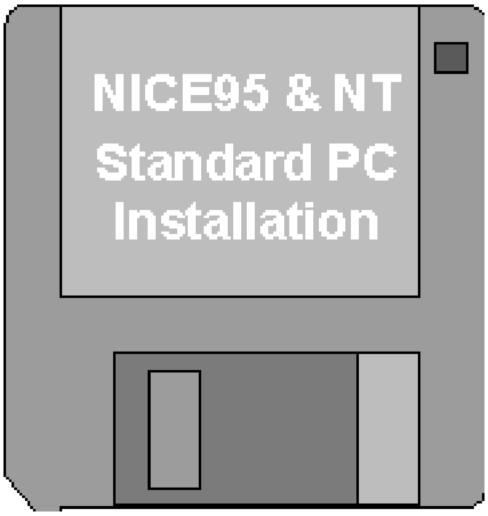


Fig. 8. Only one floppy is necessary to install Windows from the network

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 Windows.

The NICE Services

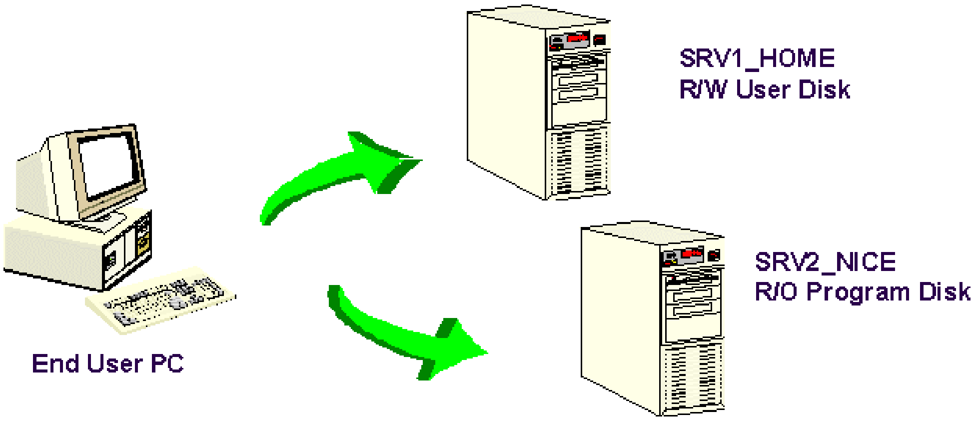


Fig. 9. Every PC attaches at least two servers

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 (note: PCs belonging to a managed workgroup may instead attach a workgroup server containing a controlled replica of the central NICE servers). The "Program Disk" server is a mirror copy of the reference that is the principal place from where all services to the desktop are distributed. Several groups [15] of people are working independently on the reference server to provide desktop services in the laboratory.

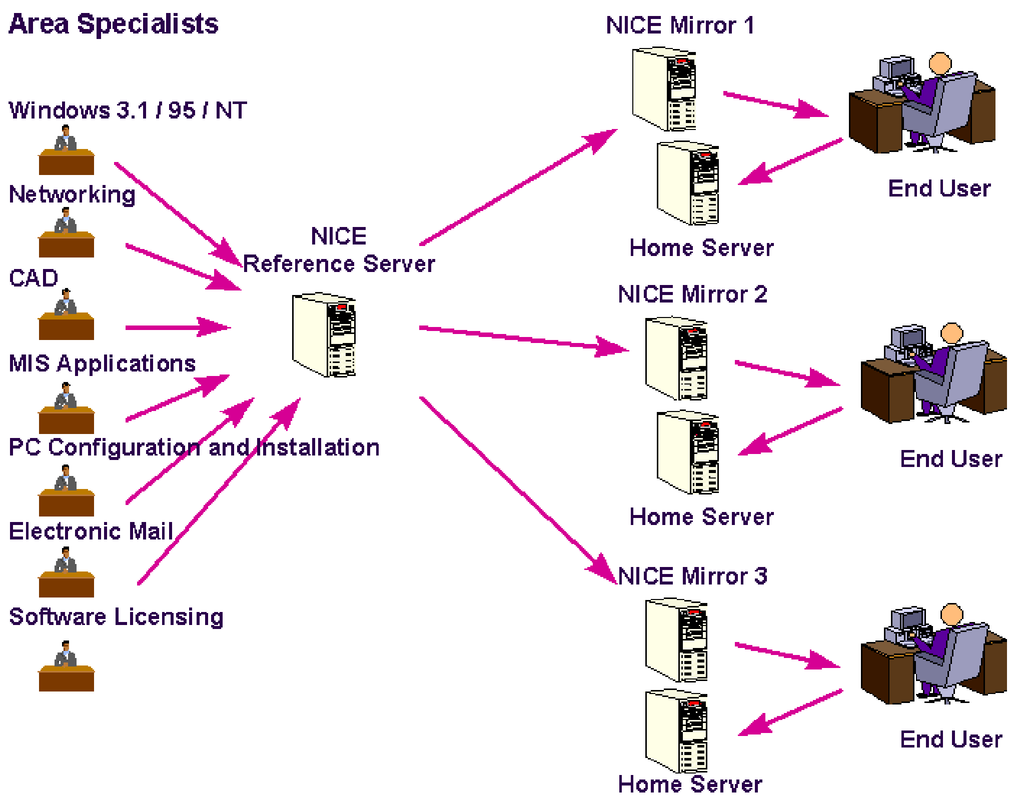


Fig. 10. Organisation of all software services for the desktop

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.

Accounting and licensing

All CERN PC users are centrally registered and all the CERN PCs hardware configuration are logged in detail into the PC Asset Management database. An extension to the Windows shortcut file has been made to have the possibility of accounting the software usage and the global Start Menu contains only these extended shortcuts. In addition, every PC has a low-priority process that runs permanently and logs the application usage of every node. This gives the possibility of accounting the simultaneous software usage on the site [16].
With this scheme, everything is known: by computer, by software, by user, by time. The PC inventory allows planning upgrades of both hardware and software, while the software usage statistics allow negotiation of licenses based on

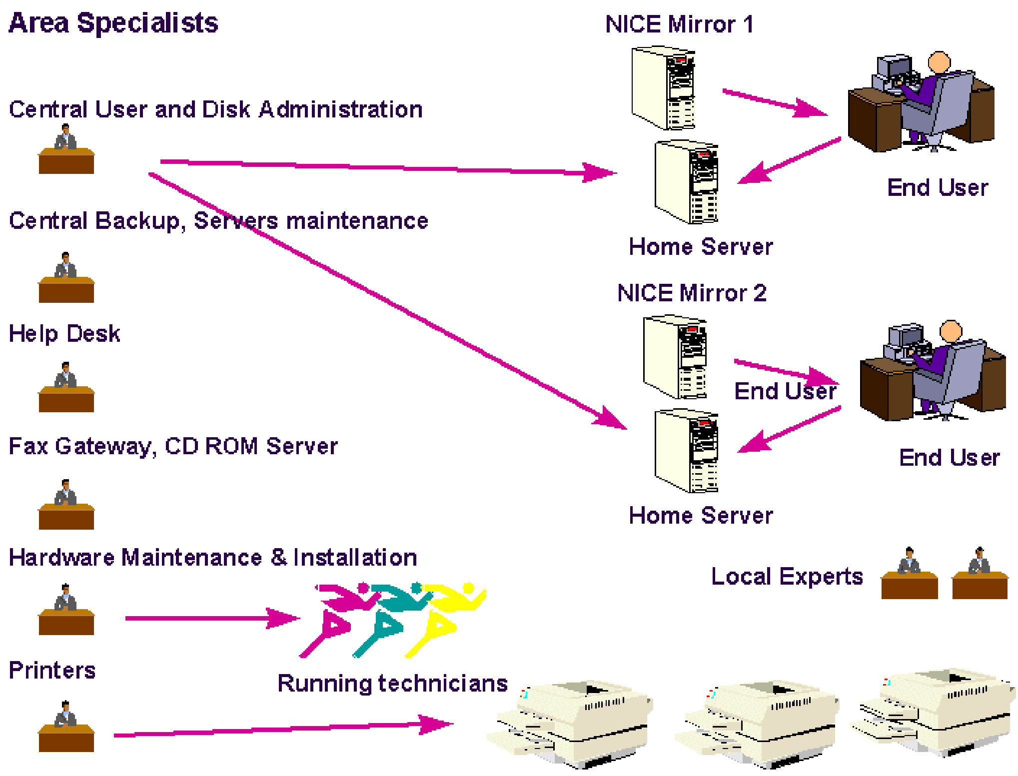


Fig. 11. Organisation of the NICE core services

simultaneous usage as well as the possibility of redistribution of licensing cost to end-users (or to divisions). Preferably, licensing is based on simultaneous users, that are monitored to reduce administrative costs.

WINDOWS NT FOR PHYSICS

Windows 95 has been a strategic direction to allow Windows 3.1 users to use 32 bit software.
Windows NT appears to be extremely appealing as a physics platform that can benefit directly from the availability of commodity software and development tools. Within the few past months experience that has been accumulated at CERN has shown it is possible to have the major physics simulation packages ported to NT and to integrate them easily in the plug and play environment provided by NICE.
Within the next few months, it is planned to have installed on the NICE servers all the basic compilers and UNIX-like tools necessary for large project software management (this includes UNIX shells, basic UNIX commands, all GNU utilities, PERL, Telnet deamons, etc). In addition, a careful study is being done to offer to NT workstation access to existing large UNIX file systems, either using AFS, NFS, or SAMBA.

CONCLUSIONS

NICE has improved dramatically the quality of services for PC users. It gives the user all the advantages of the PC Windows platform (great availability of commercial software and high quality development tools) while reducing to the minimum the system management costs and the cost of ownership that distributed computing inevitably generates.
A common culture is being generated in the laboratory, where everyone uses the same application set and has the same way of working, which provides scalability in terms of central user support and user to user support. The end user productivity has increased with the introduction of the long awaited 32bit applications for which important requirements existed. Proliferation of self-installed PC clusters and servers in the lab has been avoided.

References

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

[2] See http://nicewww.cern.ch/doc/install/in95reqe/ in95reqe.htm and http://nicewww.cern.ch/doc/install/ inntreqe/inntreqe.htm for the list of the hardware requirements at CERN

[3] See http://asdcwww.cern.ch for a description of the PC-SHOP services

[4] See http://nicewww.cern.ch/doc/admguide/addescre/ addescre.htm for a description of the standard CERN PC desktop configuration

[5] See http://nicewww.cern.ch/doc/admguide/adproce/ adproce.htm for a description of the standard PC system management procedures

[6] See http://nicewww.cern.ch/doc/admguide/adntsrve/ adntsrve.htm for a description of the administration facilities available to Workgroup Resource server administrators

[7] P. Hagen, A. Pace, "Installing Windows 95 or NT at CERN", CERN-UCO/97/196, February 1997, http://nicewww. cern.ch/doc/install/install.htm and P. Hagen, A. Pace, "The Windows 95/NT administration guide at CERN", CERN-UCO/97/194, February 1997, http://nicewww.cern.ch/doc/admguide/admguide.htm

[8] See http://nicewww.cern.ch/doc/admguide/adswinse/ adswinse.htm for information on the software installation procedures at CERN

[9] See http://wwwcio.cern.ch/Others/printerspage.html for a description of the printer support service

[10] See http://nicewww.cern.ch/doc/usere/uswwwe/ uswwwe.htm for a description of the WWW gateway service

[11] P. Hagen, A. Pace, "Home Access to the CERN Network from Windows", CERN UCO/96/192, January 1997, http://nicewww.cern.ch/win95/acb/ acb.htm

[12] A. Pace, "Using Windows 95 or Windows NT at CERN", CERN-UCO/97/195, February 1997, http://nicewww.cern.ch/doc/usere/users.htm and A.Pace, "Utilisation de Windows 95 ou Windows NT au CERN", CERN UCO/97/197, February 1997, http://nicewww.cern.ch/doc/userf/userf. htm

[13] See http://nicewww.cern.ch/doc/usere/usportae/ usportae.htm for a description of how applications are mirrored to "Portables" and see http://nicewww.cern.ch/doc/install/in95inse/ in95inse.htm for a description of the portable computer automated installation procedures

[14] See http://nicewww.cern.ch/doc/usere/usdeske/ usdeske.htm for a description of the standard Windows Desktop at CERN

[15] 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", http://nicewww.cern.ch/ psdata/psco/doc/index.htm

[16] See the chapter "Accounting Software usage" on http://nicewww.cern.ch/doc/admguide/adswinse/ adswinse.htm for a description of the CERN accounting strategy.