Using the CERN generic Windows infrastructure in a specific control environment

Ivan Deloose, David Foster, Alberto Pace

CERN, CH-1211 Geneva 23, Switzerland

Abstract

CERN has a large Windows 95/NT infrastructure with more than 3500 PCs connected that is used as one of the main information services for the laboratory. This infrastructure is used for a wide set of services, including Office Automation, Computing Aided Engineering, Calculations, Software Development, and ... controls. This paper will describe the CERN generic infrastructure for Windows 95 and Windows NT and then give several examples of PC control applications and future directions. The implementation of an object oriented device server based on Windows NT and ActiveX in the CERN ISOLDE-REX experiment will be reported.

Invited paper presented at PCaPAC 1999, the second workshop on PCs and Particle Accelerator Control, 12 - 15 January, 1999, KEK, Tsukuba, Japan.

Introduction

CERN has more than 3500 Personal Computers (PC) connected to its internal Local Area Network (LAN) that where purchased in the last 5-6 years. The park is composed mainly of Pentium and Pentium II computers and they have a memory size ranging between 16 MB and 128 MB of memory.

All Windows PCs are running any of the two supported operating systems: either Windows 95 (75 %) or Windows NT 4 (25 %). PCs running Linux are in addition. All computers are connected to central servers or to local workgroup servers which provide the network services. There are more than 25 central servers[1] running Novell Netware offering more than 400 GB of disk space distributed across more than 100 volumes which are 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.

The software configuration[2] 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 *centrally managed*[3]. 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 to instal 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[4]. To ensure 24 hours/day service, the workgroup administrator can also replicate all necessary support files to his local workgroup server. It is within this frame that the control system of the CERN ISOLDE-REX experiment described later in this paper has been developed and implemented.

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 32-bit applications.

Both Windows 95 and Windows NT configurations[5] can run Windows 32-bit applications on which all the CERN major services are based.

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 applications 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.

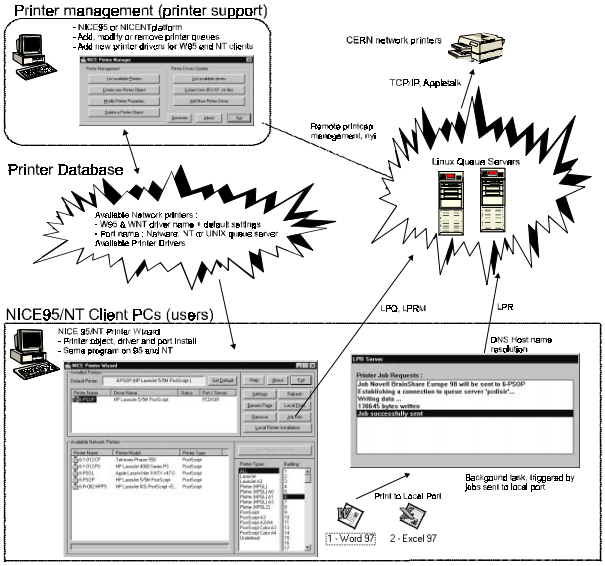
Every user has a *Home Directory* that he can use to store his documents. The home directory is by default read-protected for other users but has a public readable subdirectory where public information can be stored. The user can change the access rights to his home directory as he wishes. All security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

Data saved in home directories is *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 up.

A large set of application software is available to all Windows desktops in order to be able to satisfy all users requirements. 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 either *pre-installed* on the server or *installed-on-demand* in the local disk, and it is therefore the *same* on all PCs within the same workgroup. 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[6]. Central software usage accounting is done in order to monitor the simultaneous usage of all commercial software packages which are accessed by the user accesses using the Windows *"Start Menu"* which is the *same* on all computers.

Every computer has access to all the printers on the site[7,8] (more than 1000). Print services are available from both 95 and NT platforms using a CERN designed LPR client on TCP/IP.



The CERN Printing Architecture

All PCs are directly connected on the Internet: they have access to the World Wide Web, to electronic mail, can run X-applications and can *telnet* or *ftp* to any host world wide.

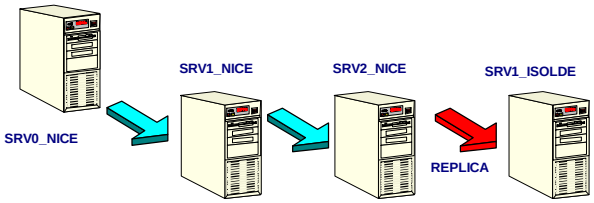
All home directories and divisional volume files are accessible from the Internet remotely using FTP or WWW. The host name http://nicewww.cern.ch is a gateway that provides transparent access to all data files without the necessity to hard-code in the URL the physical server name or volume name or directory 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[9]

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[10].

A set of document is available to end users. The general documentation[11] is made available in French and English, while the technical documents[5,10] are normally available in English only.

The ISOLDE-REX control system as an extension in the NICE architecture

The standard software is always installed on a reference "program disk" saved on the reference server. To ensure a correct scalability of the system (able to support more than 4000 simultaneous PCs connected) this *"program disk"* is replicated several times with a consistent replication process which ensures that all copies are identical.



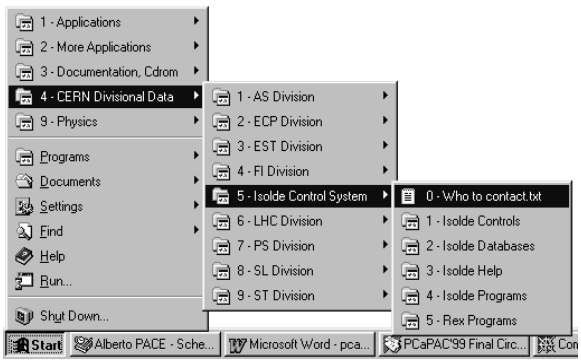
The reference program disk is replicated on other servers

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.

The ISOLDE-REX control system is implemented in this way. A server SRV1_ISOLDE contains a controlled replica of the standard reference server and it has, in addition, an entire volume containing specific control software used to run the experiment.

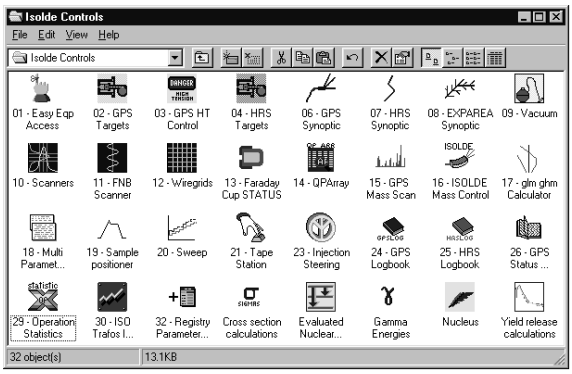
How the software is distributed

As the start menu is centrally managed on every computer, an entry for the ISOLDE-REX control system is made available to every computer on the CERN site. The shortcuts of the ISOLDE-REX specific software point in the specific ISOLDE server which is attached on-demand. The advantage of this approach is that all CERN personal computers have access (provided they have enough privileges) to any application of the control system.



Access to the ISOLDE-REX control system through the start menu

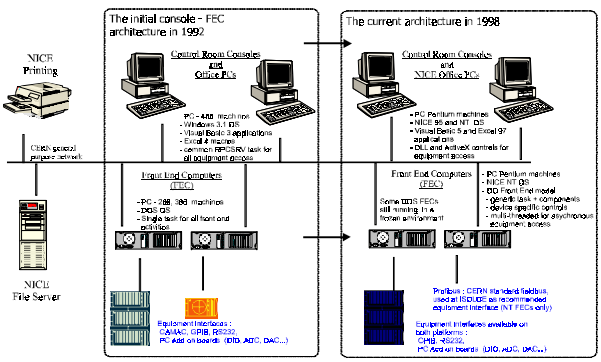
The access to the control system is not limited to few specially configured computers in the control room or in the specialist offices: virtually any PC on the CERN network can run any application from the control system.



Some control applications available to all CERN PCs

The ISOLDE-REX control system architecture

The ISOLDE control system is designed as a two level system: Consoles and Front-End-Computers (FEC) physically connected to the equipment. As consoles, standard desktop PCs are used with no special configuration. This is why any normal office PCs at CERN can be seen as a potential console to the ISOLDE console system. In the computer connected to the equipment (FEC) a network listener is running and executes control requests coming from the consoles. For slow types of controls, like power supplies, these computers are running MS-DOS, while for all fast or sophisticated types of access, like instrumentation, the FEC computers are running Windows NT4.



The ISOLDE control system architecture evolution

All computers are connected to the local Ethernet where the TCP/IP protocol is used for the equipment control access. The FECs are all connected to the equipment using the *standard* PC data acquisition cards on the local ISA bus. The cards used contains ADC, DAC, Digital I/O, Timers, Counter, RS232, CAMAC and GPIB IEEE-488 chips.

For FEC computers requiring large number of cards, one or two bus extension chassis have been added in order to accommodate up to 25 control/acquisition cards per PC. The CAMAC bus has been used in order to recuperate the large amount of second-hand

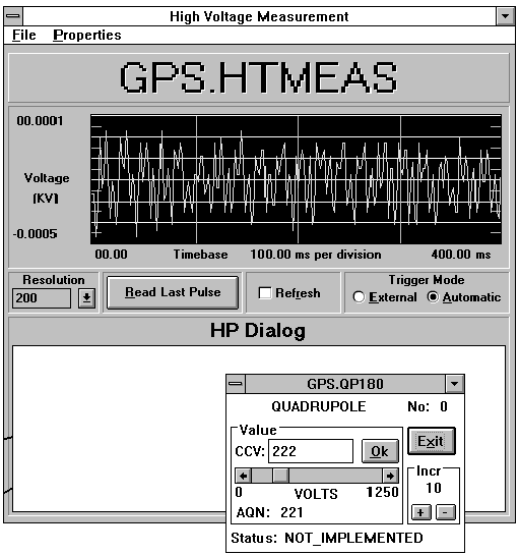
CAMAC interfaces that are used to control one fourth of the existing equipment. The RS232 and GPIB bus has been used to support directly new instruments that were purchased and integrated in the system.

To quantify the dimension of the project, the control system counts roughly 600 devices (elements) and more than 2000 analogue or digital wires (control channels) coming into the control system on four buses (CAMAC, GPIB, ISA and RS232).

The Software

The ISOLDE model is object oriented and every object has his own name: every equipment, also known as a physical device (e.g. power supply, RF amplifier), has a unique ASCII name and is registered in the control system database. Each equipment is member of an equipment type family, called class. A class describes all parameters that can be controlled for this type. Every parameter is identified by an ASCII name, called property. The implementation of a class and its properties is carried out in an equipment module, residing in the Front End Computer.

The original client-server model designed in the early 90s only included synchronous communication calls. But with the years, several additional features like data subscriptions, timing synchronisation, asynchronous calls have been added to the system.



One application of the ISOLDE control system

In the early days, the single tasking limitations of MS-DOS forced the developer to statically link into one single executable all subroutines providing all services of the FEC. This program consists of a generic software (repeated in every FEC) linked with the equipment specific procedures (equipment modules). In a DOS FEC environment, such a module is a C function implying a switch to distinguish the property names.

The RPC server module, initially running on the ISOLDE FECs, has been ported to other front end environments like Windows 3.1 (PC), OS/9 (VME crate) and UNIX (IBM RS/6000 workstation). This multi-platform extension of the server module has been initiated in the PS division with the introduction of a gateway providing controlled access from the PC world to the controls of the PS accelerators.[12]

With the introduction of Windows NT 4 at CERN, it became very attractive for ISOLDE to benefit from this new CERN supported environment on both console and FEC sides. Combining the powerful object oriented development environment of Visual C++ and Visual Basic, the FEC model was dramatically improved from a single statically linked executable to a set of OLE objects dynamically interacting at run time. This evolution provided a great simplification with the ability of reusing existing software and modifying existing configurations without relinking executables.[13]

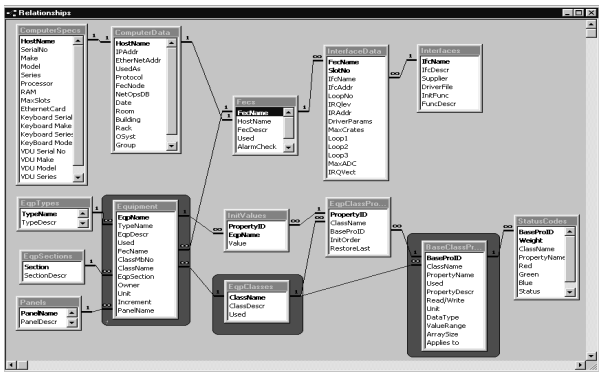
When Windows NT FECs were introduced, the entire development environment became much more stable. The latest version of the development products, for example the native code compiling capabilities of Visual Basic, made the PC a very efficient rapid development platform, especially for prototyping.

Another advantage of this modular evolution was that the NT computer can simultaneously work as a FEC and a client (console), which is very useful for local testing and to implement FEC-to-FEC communication which is necessary when implementing sophisticated measurements requiring data coming from different computers.

The Database

In the initial design phase of the ISOLDE control system, all data required by the Consoles and FECs to access the equipment was stored in a set of independent Comma Separated Values (.CSV) files. With the addition of the REX-ISOLDE equipment, maintenance of this flat-database structure would become increasingly difficult. A new relational database was therefore developed to accommodate the existing ISOLDE data as well as data required by the REX extension. The new database allows the organisation of multiple data tables joined in defined relationships within one single file.

Microsoft Access was chosen as the new database application due to availability as well as simplicity with respect to system configurations, maintenance and portability of the existing Excel data.

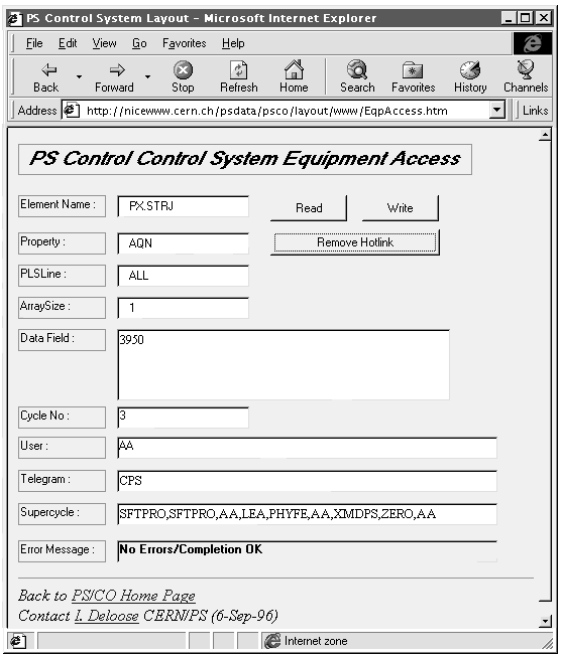


ISOLDE control system database relationships

In order to simplify data entry, a Graphical User Interface (GUI) has been developed. The database editor is written in Visual Basic and can be run from any PC compatible platform

The modular approach

The object oriented modular approach had an important side benefit also at the console level: the reusability of the code was directly possible in a huge number of commercial applications. Applications developed for the ISOLDE-REX control system could be embedded in any other application (Word, Access, Excel), making it very easy for the users of these applications to get (and process) data coming from the control system. The reverse was also possible: Control system applications could directly use any generic functionality of commercial applications to implement specific functionality (example: the database engine of Access, the report capabilities of Word, calculations of Mathematica, etc…).[14]



ISOLDE control system application available from the internet

One direct consequence of this approach has been the possibility to export to the world wide web any control applications making them available on demand not only to all Windows PCs inside CERN but to virtually any PC world wide connected to the internet.

Conclusions

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. In the case of the ISOLDE-REX control system, a direct leveraging of services from the generic infrastructure have been in

- standard installation of every of Win 95 or NT [5]. Operating system support
- network cabling, routing and troubleshooting[15]
- server infrastructure[1], maintenance[2] and backup
- generic application installation[6], support and licensing[16]
- computer inventory, printing support[7,8]

As a result, the ISOLDE-REX control system has been completely integrated in the generic infrastructure. In addition to the very low maintenance cost, the benefit of this approach has been that the control specialists could focus their efforts in solving control-related issues and leveraging from the existing support infrastructure for all the generic PC and Windows related issues.

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/admguide/addescre/addescre.htm* for a description of the standard CERN PC desktop configuration

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

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

[5] 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*

[6] See *http://nicewww.cern.ch/doc/admguide/adswinse/adswinse.htm* for information on the software

installation procedures at CERN

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

[8] I. Reguero, D. Foster and I.Deloose, "Printing at CERN", CERN-IT, LISA Conf., Dec. 98, Boston, USA

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

[10] 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*

[11] 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*

[12] I. Deloose, "Integrating the New Generation of ISOLDE Controls into a Multi Platform Environment", CERN-PS 96-44, PCAPAC96, Oct. 96, DESY, Hamburg, Germany, *http://nicewww.cern.ch/ps/psco/report96-44.pdf*

[13] I. Deloose, "Windows NT as Device Server for the ISOLDE-REX Project", CERN-PSCO Note 97-27, *http://nicewww.cern.ch/ps/psco/note97-27.pdf*

[14] I. Deloose, "Simultaneous access to the Controls of the PS & SL machines from the Windows 95 and NT Platforms via PS & SL passerelles", CERN-PSCO Note 98-33, *http://nicewww.cern.ch/ps/psco/note98-33.pdf*

[15] See *http://network.cern.ch/*

[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.