MMI Object Analysis and the Distributed Components for a New Console in the KEK e^-/e^+ Linac

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Abstract

The J portion of the electron-positron accelerator (e^+/e^- Linac) is now under construction (1994-1998). Its completion will greatly improve and reinforce the console system. The operators' console consists of PCs and a method to enhance cost efficiency, software development productivity and flexibility. The system, which consists of middle layers that include the PC-based console and a Windows NT server database, has reached the stage of practical use.

It has been reported that system construction based on PCs, Windows NT, and its hardware and software have produced successful results at several research institutes, and is reaching the phase of maturity.

Consequently, the rapid emergence of a new trend in software development has made it necessary to review the man-machine interface (MMI) in the operation and display systems of the console. This paper discusses the fact that a reanalysis of MMI and the abstraction of the lower layers at databases have become increasingly important research subjects.

1 Preconditions for MMI analysis

We have set up a project[1] for review of man-machine interface (MMI) at the operation console, and reanalysis has been carried out looking for an common objects which is sharable among different institute. Device classes and operation classes are reported in a paper[2]. This paper analyzes MMI objects in the following sections:

(1) MMI components;
(2) Operation phases, patterns, and procedures;
(3) Operation tools.

In the future, added to the above, the production of MMI objects should be studied and designed while maintaining a balance with the middle-layer objects expected of databases.

2 Items dealt with in MMI

If the accelerator is viewed from the standpoint of human interface (HI/F) layers, all device layers are abstracted by middle-layer databases. In particular, the spread of Java and other software is making this tendency increasingly clear, which demands revising the notion that databases are solely for the purpose of storing and providing information. In conjunction with Web servers, databases abstract lower-layer objects and show them to upper MMI strata. The following are some of the data items required for the operation of an accelerator when operated in HI/F layers:

(1) Various fixed parameters, system data and its operation;
(2) Real-time processing of information concerning changes in various systems and other data;
(3) Storage and control of wave signal information, image data and system photographs;
(4) Recording of commands sent from the operation console;
(5) Accelerator operation record and Maintenance log.

Items (2), (3) and (4) must be accomplished in real time.

3 Operation phases

From the viewpoint of operation, the foregoing items are changed to the phases shown below. Essentially, it is desirable that the accelerator has data structures and operation procedures that suit the operation phases. It should have common MMI components at each of the phase:

(1) Start-up phase;
(2) Partial test run;
(3) Trial- operation phase (beam commissioning);
(4) Regular operation;
(5) Diagnosis and support;
(6) Shut-down;
(7) Maintenance phase;
(8) DTP and provision of data to Web and others

4 Operation patterns

This Linac has various devices or components, such as a gun, a vacuum system, RF, a monitor, beam transport, and safety interlock and control systems. In each device, operation patterns can be divided into the following categories:

(1) Direct operation;
(2) Linked operation between devices;
(3) Operation via log (relative) trend analysis and support;
(4) Diagnosis support using the alarm system.

Basically, it is desirable that data and methods related to these devices be abstracted in middle layers and handled as objects reducing clients load. It is also necessary to not only abstract devices through databases, but also make them virtual in order to provide them to the console system.

5 MMI components

The operators can handle the accelerator in a specific and unified manner by operating it in HI/F layers using actual

MMI windows visual components. The more successfully middle layer objects are formed, the more easily the accelerator is operated. The following are tools that can be operated in the console system:

1) Creation of displays using language;
2) Creation of displays at an exclusive tool level;
3) Construction through such commercially available general-purpose software as Excel;
4) Software for operating networks, such as Web and Java;
5) Construction via combining parts and components (VBX, OCX, VB-forms).

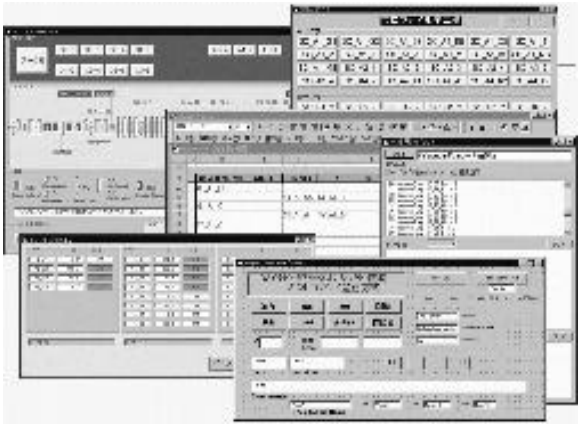

Fig. 1 Example of VB-form Objects

We have used Visual Basic Enterprise 4.0 until now (it is changing with 5.0J) , linking IE, Netscape and MS-Office product. Common objects are being make by OCX or VB-form sharable objects shown in Fig.1. These items must be checked as to whether they work on:

1) Single-station operation;
2) That which enables multiple-station operation;
3) Multiple-vendor operation.

However, actually, not every component works on a multi-CPU, OS, or platform. At this moment, operators' console is running on Windows NT, and about half of the components are made by VB. The VB components are very portable and easy to add to other objects. These are communicated to only by messages. All others are made by Java and other commercial packages.

6 Database system

6.1 Overall configuration

All data from the device layers are provided to MS-SQL DB through VME, PLC or UNIX, as well as a PC device manager at a regular basis, or when the data change. MS-SQL 6.5J and Windows NT4.0 were upgraded in June 1997. A new command format between the MMI components has been installed. Same format command is available between server and clients.

6.2 Link with gateway (G/W)

Historically, the operation and display systems of the KEK PF Linac have used the client/server system, which continues to be used in that way. G/W and DB are placed in one machine (distributed operation also possible) and serve as middle layer; abstracting layers between lower and upper device strata. In other words, all data from the device layers go through these strata and are controlled, while links to databases are controlled by G/W.

In the remodeling at the outset of constructing the PF Linac device, a commercially available database having an engine was not installed. A server for client control was installed as a console system along with the trial operation of a database engine, conducted because Windows NT was used. A database engine was introduced since it could be introduced at a relatively low cost, and worked well with other applications. Since then, improvements have been made, including upgraded speed and response to real-time data.

6.3 This DB offers the features listed below by standardizing:

(a) the trigger functions;
(b) cashing mechanism;
(c) sdf object commands.

6.3.1 This database conditions data using SQL's trigger functions, and by bringing about triggering under such conditions and starting other tasks (possible to start tasks at stations beyond networks); it conducts database-driven operation to enable object distribution.

6.3.2 In the past, it was hard for DB to follow dynamic data, much less the impossibility of its following dynamic data on personal-computer systems. Recently, however, it has become possible to change the situation by adding a cashing mechanism to the G/W on a Pentium CPU.

6.3.3 It has become possible to exchange with DB in client-based communication systems even without issuing SQL commands to DB. As shown below, the format is based on the one which has become familiar through the operation of VB and others.

Object name. method/property. Option <= value>

It can also be set. If data are conditioned in a more complex way by issuing SQL commands, and exchanges are conducted with DB through the program, operation through VB using the ODBC connection and other means also occurs.

7 DB operation MMI

DB has been considered as abstraction layers for MMI, and our present system is described in the previous chapter. To operate databases, the following three methods are available. (The figure below shows a recent method of operation using a WWW browser):

(1) Operation using applications (possible only at the console) ;
(2) Operation using browsers (possible from anywhere);
(3) Operation using tools (used for development, maintenance and other occasions).

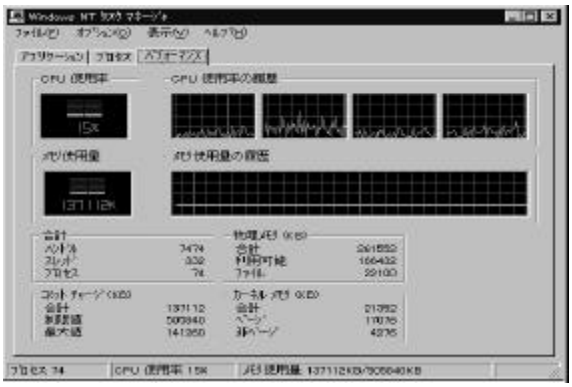

Fig. 2 CPU load factor on NT4.0 server

8 DB performance helps MMI operation

The load factor on the CPUs when using the database appears in Fig 2. The figure shows how information concerning changes in various devices emerges from device layers, and collectively goes down from cash to DB, as clients access DB. In the past, when Windows NT3.51 (Pentium 133MHz) was used, the load factor on G/W reached 15%; however, when multi CPU (X4) Windows NT4.0 (Pentium 200MHz) was bought for the J-linac, the load factor decreased to less than 5-6%. If the clock rate is raised, the processing speed improves remarkably, which indicates the possibility of loading more distributed objects.

9 Future improvement measures

(1) In the future, consoles using Web browsers and other methods where the learning cost is very low will increasingly spread. It is already obvious that there is a possibility that more displays based on multi-platform specifications will develop than exclusive displays.

(2) Because the clients described above tend to grow numerically, the volume of processing at the DB level will expand if the load on clients is reduced. More and more pre-processing of functions that users need together with Web servers tend to be conducted at the DB layer, which will make object distribution a major subject of research.

(3) In June 1997, load and other tests were conducted using the existing Linac; it was confirmed that several problems had been resolved, and that it is possible to operate DB for the J-Linac at the PC level. In October, 1997, partial operation of the J-Linac started, and, with this, the main system also began actual operation.

10 Conclusion

System construction based on PCs and Windows NT has produced successful results[3].

To enhance the cost efficiency, a software development productivity and flexibility, MMI reanalysis resulted in important and good efforts. Common MMI objects being developed are becoming shareable software on Windows and others.

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