with special controlling system gives a possibility to stabilize the gas cell temperature in the range 8 K - 30 K on the level ± 0.05 K. The gas supply tube connected to the central part of the gas cell. The flow of the hydrogen (deuterium) is introduced to the central part of the cell after thermalization on the cell surface. We used fine valve to arrange of the gas flow ($10^{16} - 10^{18}$ molecules/s). The fine valve is calibrated by the constant volumes method.

The cell and the heat exchanger volume are placed inside the helium tank. Such construction allows to use the helium tank for the cell cooling and for pumping of the gas outside the cell. Two cryopumping blocks are placed at the sides of the helium tank. Special elements form the gas flow and approximately 75% of the gas from the cell goes to the space between the liquid helium tank and the "nitrogen" radiation screen. After that gas is pumped by the cryopanels on the helium tank surface.

Controlling system:

- measures the temperature of the cell;
- stabilizes the cell temperature;
- changes the pressure in the heat exchanger volume and optimizes the liquid helium outlay.

The main advantages of the internal gas target are:

- It does not necessary to use the additional pumps for the target operation. The gas from the cell is pumped in to the same volume at the maximum density by internal cryopumps.
- The temperature of the gas is stabilized in wide region without changing the helium outlay. The helium density is changed in the heat exchanger volume and it is possible to decrease the electric power at the heaters to the level 0.3–0.4 W.

The main parameters of the internal gas target are:

- The average gas flow is $2 \cdot 10^{17}$ molecules/s.
- The hydrogen density on the way of the beam 10^{14} molecules/cm^2 (average flow, cell temperature 15 K).
- Vacuum in the target with the gas flow $2 \cdot 10^{17}$ molecules/s is 10^{-5} mbar.
- Working time without liquid helium refilling is 30 h.
- Working time without regeneration of cryopanels is about 2–3 weeks (for hydrogen).

KNOWLEDGE BASED CONTROL: METHOD AND APPLICATION

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The paper presents the results of last several years in the field of developing and implementation of software for real time control systems of sophisticated installations such as nuclear reactor, accelerator, large detector, etc. All of those installations are characterized with a huge number of parameters and complex control rules that, practically, can not be represented in a complete form. The approach presented combines the knowledge based technique (procedural knowledge representation [1]) with object oriented technology and

implements facilities needed for real time applications.

The executable description language PROSC (Procedural Reasoning Object System for Control) developed for defining the structure of an installation and their control methods is described in [2–4]. The knowledge description is based on software entities called "goal procedures" for real time control in an object oriented manner. The knowledge interpreter is driven by events coming from the installation and is capable of procedure graph traversal and forward chaining to find an appropriate way of operating if an event has arisen or a control goal has been established by the user. The interpreter searches a way of passing the procedure graphs depending on the current conditions (object' facts) and taking into account the asynchronous events arising during the inference.

The structure of the knowledge interpreter The structure of the PROSC and its place in the general control system means is illustrated with Fig. 1. The protected statements block at the figure represents the part of knowledge to provide the synchronization of control actions by means of establishing conditions that should not be violated.

The complete implementation of the method and tools was made [2,5] in the frame of the control system reconstruction for the accelerator complex of CERN PS division [6] to provide the automated set-up, i.e., cold start and recovery, of accelerator control equipment. Figure 2 shows the general layout of that control system implemented as a cooperation of local area networks with different types of nodes.

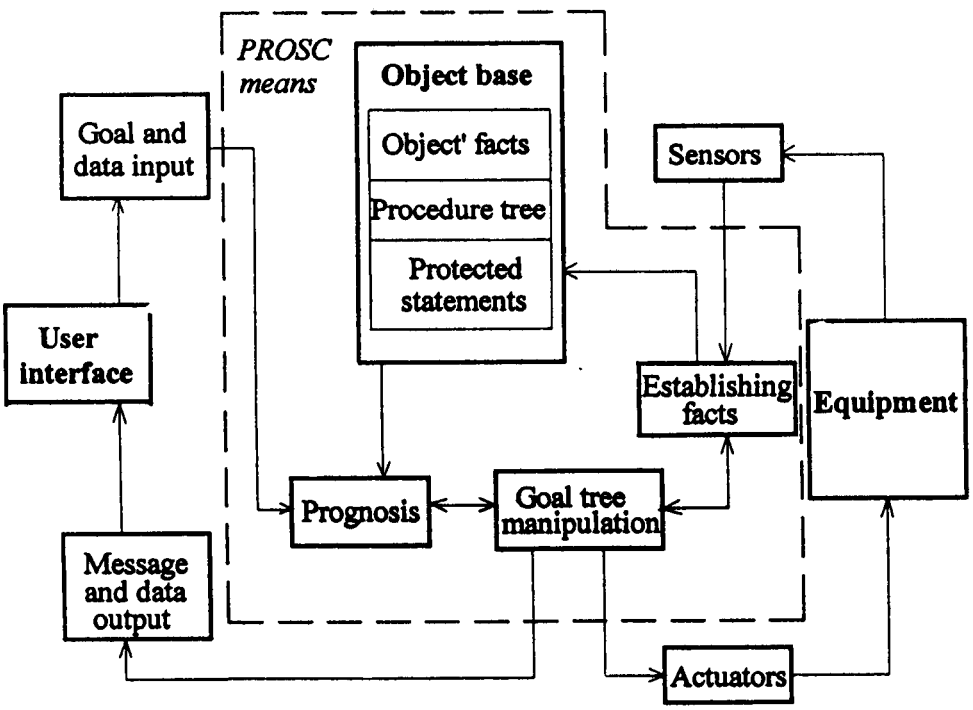

Fig.1. Structure of the knowledge interpreter

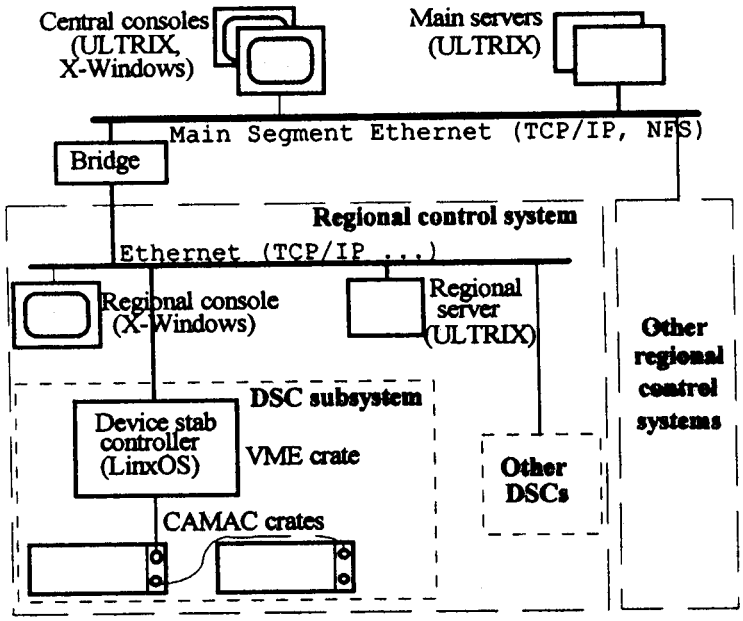

Fig.2. Layout of CERN/PS control system

The set-up facility should be capable to perform the following functions for any system element:

- Initialization of hardware and setting up the initial characteristic values, then testing equipment;
- Non-destructive testing at any moment of operation;
- Informing the user during an action execution what is the current state of the object under control;
- Diagnosis of faults if an action has not been successful;
- Collection of the set-up protocol (list of elementary actions and tests, diagnostic messages, etc.), which could be printed with the user command.

The object model has been developed comprising the classes for the system elements: accelerator, DSC functional subsystem, VME and CAMAC crates and modules and control equipment types as defined in [7]. The definition of those objects' instantiations being presented for the moment at the system implementation can be generated in accordance of the system configuration database. Communications of the PROSC knowledge interpreter to and from user, the control system means and any software application are provided with series of dedicated interface facilities. General structure of the SETUP product with its environment is shown at Fig.3.

All of the SETUP software except *User interface* facility run on one of the system servers while last can be integrated (via program interface) to any application running on a workstation or via X-terminal capable to communicate with the control system.

The software environment:

- Operating system: ULTRIX.

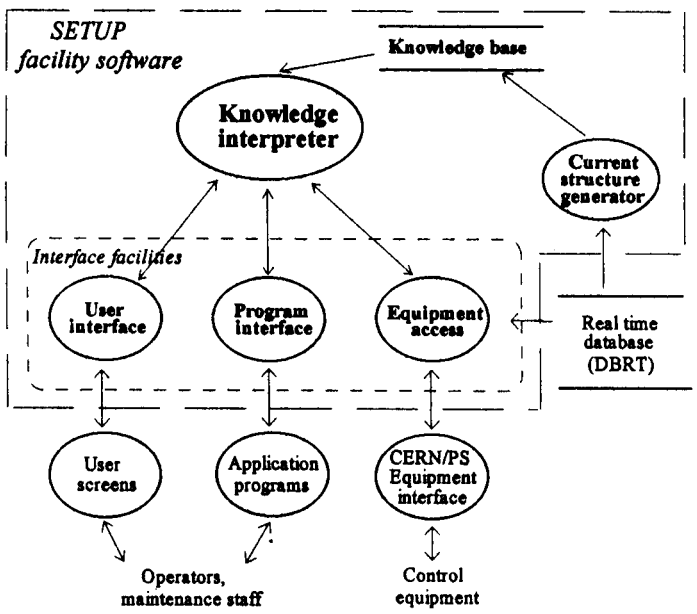

Fig.3. SETUP facility software structure

- Programming languages: C, PROSC.
- Networking: TCP/IP.
- Graphic user interface: X-Windows / OSF Motif.

The first operational version of the SETUP facility was installed at CERN/PS on February 1994 for one accelerator. One of the most popular generic applications called ALARM panel [8] was selected as the first platform for the SETUP utilization. The second version for three machines is running from October 1994 [9]. Since March 1995 the list of objects under control includes 5 accelerator complexes, about 50 VME crates (DSC subsystems) with more than 150 modules, about 40 loops of serial CAMAC including more than 130 crates with more than 700 modules. About 3000 units of control equipment are based on the hardware mentioned. The current knowledge base contains definitions of about 100 object classes and about 200 control procedures. Two more (except the ALARM system) applications are using now the SETUP facility.

The experience of the SETUP facility in operation during about two years showed its efficiency in two important aspects:

- It became a popular tool for accelerator operators, used several times per day (much more during the startup after a shutdown).
- The facility allows for the specialist of a domain to modify and reinforce knowledge easily as it was demonstrated during the extension of the knowledge base with the new equipment class definitions.

To the authors opinion the knowledge based system can be a good solution for a wide field of real time control systems.

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MS WINDOWS BASED TOOLS FOR P-CAD DESIGNERS

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The paper presents the results of joint work with CERN CN/CE group in the field of developing and implementation of software for Printed Circuit Board (PCB) designers who use the P-CAD suite of programs for board layout. The set of tools on the base of the friendly multi-documented Windows graphic user interface was developed. These tools are the useful extension of standard P-CAD utilities.

Now the people during a work with P-CAD have an access to many libraries of the standard components created by the different companies, laboratories and designers. There are a lot of recommendations for P-CAD component design, but many designers do not follow these rules in their work. As a result the part of P-CAD libraries and components have non-standard representation. In order to avoid this situation the special rule-based program for graphic normalization (**PC-NORM**) was developed. The main goal of it is to give the simple and quick way for the viewing and the correction P-CAD components graphic representation in accordance with pre-defined customized rules.

The PC-NORM works with compacted libraries of P-CAD components and alone components. It browses the contents of P-CAD component, marks all wrong (from rules point of view) elements of component, presents them and allows to edit these elements. It can change automatically the following attributes in P-CAD component files:

- line width;
- text size, justification, rotation and placement;