The Adaptation of Control System Software According to Experimental Characteristic Features at the Pulsed Thermonuclear Installation ANGARA-5.

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Abstract.

High pulsed power installations such as Angara-5 are used for different kinds of experiments, e.g. nuclear fusion, high current Z-pinch and X-ray generation. These various experiments have differences including timing, measurement circuits, sensor types and other parameters of the measurement and control system (MCS). Software of such a system must be flexible enough to be quickly tuned for all kinds of experiments, and special software satisfying this requirement has been developed.

All the MCS parameters are stored in appropriate database files (DBF). A special utility similar to usual database management programs provides presentation and editing of these parameters. The interaction between DBF and local system software is performed by means of a special dispatcher program. Such a set of tools allows one to reconfigure the system immediately before the experiment. Both MCS parameters and data obtained are stored in the main DBF and can be used during data processing. The present paper describes the software structure and configuration tools.

1. Introduction.

The features of the Angara-5 measuring and control systems were discussed at ICALEPCS'91 [1]. The program of the installation includes different types of experiments. Each type usually consists of a few tens of real cycles (shots), of which the installation construction allows several per day. In the course of each experiment, and especially when a new experiment is being prepared there is a need to correct the measuring environment. Examples are to change the set of detectors and MCS equipment modifications. In connection with any hardware change it is necessary to correct MCS software as well, and it is desirable to produce this correction without a delay in the experimental program.

The Angara-5 MCS software structure and special tools that allow fast and easy modification of the measurement environment according to the experimental requirements are presented in this paper.

2. MCS information structure.

Information streams in the MCS structure are shown in Fig. 1. Signals from sensors and detectors are transmitted in analog form by coaxial cables to local systems where analog-to-digital conversion is performed. There are several local systems, each dealing with a certain set of signals. Data are sent by means of a computer network to a supervisor computer for later processing, presentation and storage in a database. The main database is accessible for several applications, chiefly ones doing mathematical and statistical analysis and process modeling. A computer network gives one the possibility of reading data on his personal workstation. There is also a reverse information stream from the supervisor to control the local systems and the installation as a whole.

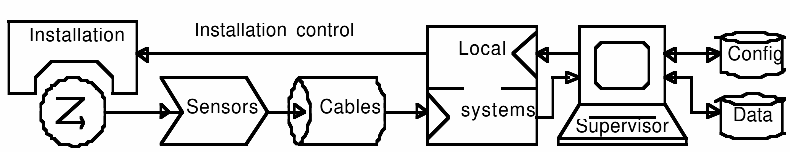

Fig. 1. Information streams

There are three general stages determining the information characteristics - detectors, cables and local systems. There are a few hundred distinct detectors in the Angara-5 installation. Each is described by its own purpose, sensitivity and frequency band. Signals from detectors are transmitted by coaxial cables to data acquisition systems which are located in a special shielded enclosure. The cable length may be up to 80m, and because a general process of the installation has typical time 10^{-8} seconds it is necessary to take account of time delay and high frequency signal damping during cable passage. For this purpose each cable line has two parameters - time/length and bandpass. These parameters are sufficient for reconstruction of signals [2].

MCS measurement equipment includes a digital waveform recorder, time and amplitude measurement devices etc. Each type of device is described by means of a parameter set, i.e. sensitivity, time and amplitude coefficients, digitizer least count etc. Angara-5 MCS uses about 200 gauges of different types, each one having a specific parameter set.

The full description of the measurement equipment used in a particular experiment, combined with data from the installation, is stored in the main database for use in data processing. However it is a difficult job to make up such a description for each experiment type. Moreover there are often changes in experiments and no time to carefully correct this description. For this purpose a special tool, the measuring environment description program (DSR) was designed. DSR combines all gauge characteristics in a special database and allows one to check and correct the parameters just before the shot.

3. MCS description database management.

Fig. 2 illustrates schematically the structure of the measurement environment database and its usage during an experiment. All parameters of detectors, cables and gauges are contained in corresponding sections of the database. Also stored are typical signal parameters - amplitude, waveform, etc., for the information of the operators.

The DSR program is a database manager which performs the following:

- enter and to edit the MCS component parameters;
- create the description file (experiment scheme) of a certain experiment's measurement environment;
- output the experiment scheme as a document.

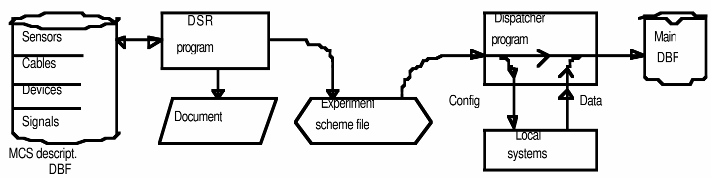

Fig. 2. MCS overview

The component parameters are entered by means of the special tables and sorted in accordance with their functions and locations inside the system. A program can indicate a signal name for reference if the component is used in the current configuration; thus it is possible to view signal parameters at once. Such tables were prepared for each component type and are in spreadsheet form.

The experiment scheme composition is a most interesting and critical part of DSR. Fig. 3 illustrates the process, where the main point is to bind the signal to measurements and MCS components in the chain. The concept is realized made by means of a four column table, as indicated in the figure, which contains names and codes of signals used in the current experimental session. The DSR automatically takes all component parameters from the database and saves them in a special file, called the 'experiment scheme.' This file contains a full description of the measurement environment and is used in the main control program (dispatcher) at experiment time. There are several advantages to such a procedure:

- all the MCS component parameters are located in the same record which one can easily edit if required;
- an experiment scheme has no surplus information;
- MCS preparation for a new experiment type does not require much time; moreover some changes can be made just before a shot;
- the main database record contains the minimum of information, including only experimental data and the description of gauges used.

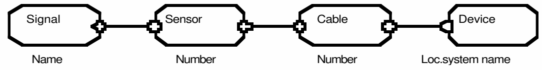

Fig. 3 Experiment scheme composition

The DSR program creates the experiment scheme document which reflects the current MCS state. The parameters of all detectors, cables and devices are contained in additional forms also provided by DSR.

The main control program on the supervisor computer uses the computer network Ethernet (Decnet-2.01 software) for distributed system control according to the appropriate experiment scheme. The user protocol is designed for interaction between the supervisor and local systems. Its main functions are:

- to control the communication channel (open, close and obtain status);
- to send the experiment scheme to the local systems;
- to send the current shot number and prepare all systems;
- to acquire data from local systems.

The local system programs receive the experiment scheme and set devices to their required states. After a shot one performs data acquisition, storage and transfer to the supervisor, where the data are stored in the main database with the measurement environment description (experiment scheme file).

4. Conclusion.

The experience gained from DSR usage has shown the following:

- the time of MCS preparation for an experiment is reduced considerably;
- there were no errors caused by operator mistakes in parameter entry;
- the DSR software, together with utilizing adjustable configurations of local systems [3], provides flexibility and convenience during the control of an experimental session.

The software structure presented here allows one to include additional local measurement systems into Angara-5 MCS with minimum effort.

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References.

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