THE STANDARDISED MODULAR BEAMLINE CONTROL SYSTEM OF ANKA

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Abstract

For the synchrotron radiation source ANKA, Karlsruhe/Germany 9 beamlines have been constructed simultaneously. This resulted in the unique possibility to design a standardised beamline control system for all 9 beamlines. Due to the standardisation, all beamlines have the same look and feel. The integration of new beamlines is easily and effectively done by reusing beamline standard components.

The solution is based on a VME crate with the real time operating system OS/9 running on a Power PC or 68K system as a server. The I/O signals and the stepper motors are controlled by the VME crate via CAN-Field bus. The different beamline components like slits, DCM, mirrors, vacuum controller etc. were developed as independent standardised nodes for the OS/9 system using the PC based integrated process control development system "Gamma" from RST, Munich/Germany. For the automatic experiment control as well as for the GUI for manual control, all functions can be called over the LAN via DLL from multiple PC´s simultaneously.

1 THE ANKA FACILITY

The synchrotron radiation facility ANKA is embedded in the Forschungszentrum Karlsruhe, Germany [1].

Based on a 2.5 GeV electron storage ring, photons are delivered essentially from the hard X-ray, XUV to the infrared range out of dipole sources. The inclusion of wiggler and undulator devices will provide a cost effective $2^{nd}+$ generation facility of high brilliance for research and industry to the middle of 2003.

2 HARDWARE LAYOUT

The demand for the control system was to provide a reliable installation which should be capable to operate more than 10 years. The maintenance costs should be as low as possible. Because the lifetime of a normal PC is approximately 5 years, it was decided to use a server/client concept. The servers, which controls the beamline parts, should be based on components, for which also in 10 years spare parts are available. Therefore for the beamline control servers VME-crates with the real time operating system OS/9 running with a Power PC or 68K processor board were chosen. On the other hand, the clients should be independent from a specific hardware. Thus any commercial PC with a Ethernet connection can be used as a client.

The VME crate is located at the beamline in the control rack together with other electronics. The beamline control server is the central supervising component of the beamline. The beamline status is continuously monitored and written to history logfiles by this server. Security sensitive parts are separately controlled by PLC´s. The beamline safety PLC acts as an interlock system which prohibits opening a valve to a evacuated beamline section or overheating a valve by synchrotron light. Personnel safety issues (hutches and shutters) are handled by a second separated PLC, the Beamline Personnel Safety System, which had been approved by legal authority. The interfacing to the synchrotron machine control system is done via a special server, which distributes machine and beamline specific information in both directions. The experiment control is done by Windows or Linux PC-clients. For practical reasons, these clients are also controlling hardware, for which no OS/9 (or OS/9000) driver is available.
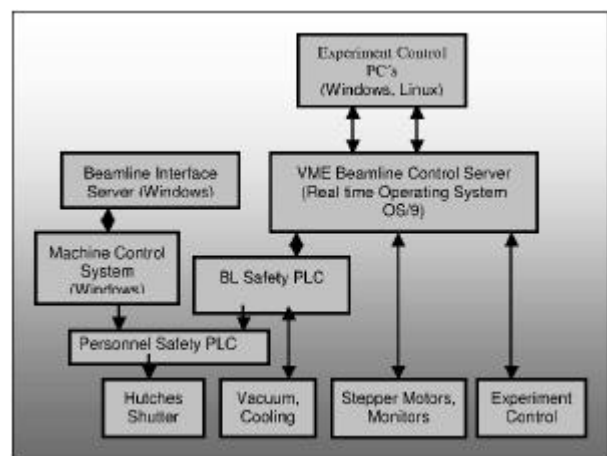

Figure 1: Hardware Layout Beamline Control System

2 SERVER/CLIENT SOFTWARE STRUCTURE

The beamline control server software is developed with the PC based CASE tool GAMMA (RST industrial automation, Munich [2]), which allows to develop a multi-tasking and multi processing application. The server has its own GUI, which can be mirrored to a Java based PC client (see figure 3). Also a low level debugging of the complete system is possible via an terminal based tool via LAN or serial line.
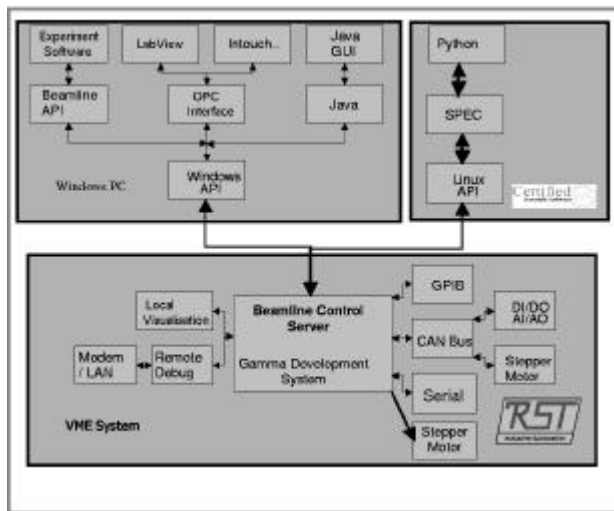
Figure 2: Server Client Software Structure

The connection to the clients is done with a proprietary TCP/IP based network protocol developed by RST. An application interface (API) allows the access of all variables and functions of the server simultaneously by multiple clients. Experiment control on a PC is possible via a beamline application DLL, or via an OPC interface. Based on this DLL and the OPC interface, every process control software for the PC can be used to write experimental applications. At ANKA, the clients are based on the Borland's C++ Builder and Research Systems' IDL. Under Linux, Certified Scientific Software's experiment control system spec [3] can access the beamline control server via its own built-in Gamma interface. Spec allows a very quick application development due to its easy to learn C-like macro language. Graphical interfaces can be easily adapted to spec due to spec's large bunch of interfaces.
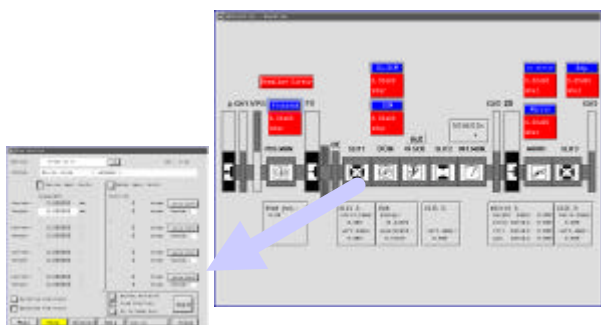

Figure 3: GUI for manual beamline control

Performance measurements show for the Windows-DLL an average completion time for read or write operations of about 195 ms, nearly independent of the amount of data which is transported. The same network protocol for Linux and OS/9 systems shows a much better performance of 20 to 25 ms for the same operations. Detailed investigations indicate that this astonishing long transport time for the windows client is caused by the

reentrant interface for the data transport which is using Windows messages for signals. Future releases based on libraries without the reentrant interfaces are expected to speed up the communication by a factor of two. Nevertheless the total time for an experiment often depends essentially only on the measuring time itself, e.g. the total time for a typical EXAFS measurement with a windows client (figure 4) takes at ANKA about 45-60 min, which is comparable to other installations.

Figure 4: Windows Client for EXAFS

3. STANDARDISED BEAMLINE COMPONENTS

The smallest stand alone working unit of the gamma system is a node. Each standard beamline component like slits, intensity monitor, double crystal monochromator, *etc* is represented by such a node (figure 5).
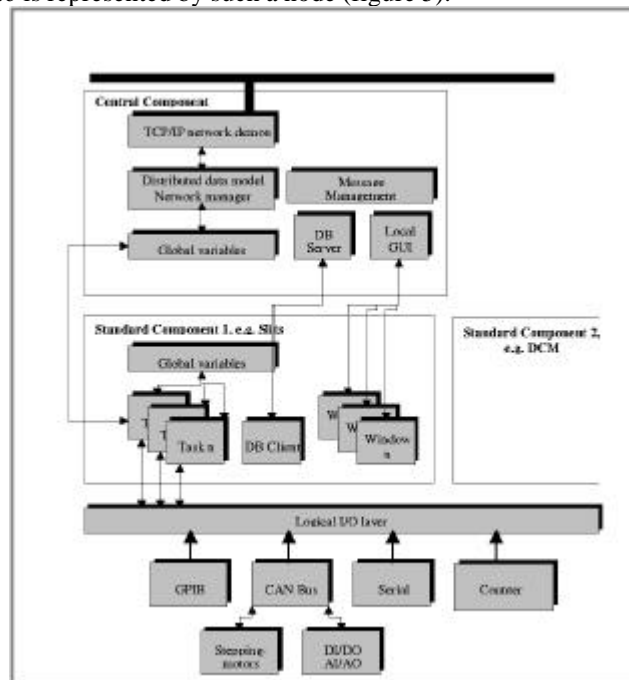

Figure 5: Gamma data model with standardised beamline components

New beamlines can be assembled by selecting the required nodes from the library. The configuration of a single node is done via a database. All nodes have a

common I/O abstraction layer and a common central node. Message management, window-handling and calling of the other nodes are done from this central module. Most of the I/O and the motors are handled with the CanOpen Field bus [4]. For the I/O connection Beckhoff Bus Terminals [5] are used, for the motors McLennan stepper motor controllers [6]. The global data of a node is accessed via a data abstraction layer. Therefore it is invisible to a node, where its data are stored and it is no difference, whether a variable is accessed which is stored on the local system or on a remote system. Thus if the processor load is too high, all nodes can be redistributed to several processor boards without the need to change the gamma code.

4 CONCLUSION

Nine beamline control systems were setup and commissioned simultaneously in less than 2 years. This was possible only because of standardised beamline components and software. The OS/9 beamline control servers operated several months without failure. The server/client concept works well, although further optimization of the windows network driver is required.

5 REFERENCES

[1] http://www.fzk.de/anka
[2] http://www.rst-automation.com/
[3] http://www.certif.com
[4] http://www.can-cia.de/
[5] http://www.beckhoff.com/
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