A MANAGEABLE CONTROL SYSTEM FOR ANKA*

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Abstract

The control system of the synchrotron radiation source ANKA at Forschungszentrum Karlsruhe was segmented into several autonomous parts. The storage ring is controlled by the ACS control system, the infrastructure facilities by the supervisory control and data acquisition system (SCADA) named IGSS, and several autonomous PLC based interlock systems for the accelerators and beamlines. Each system requires special knowledge for maintenance and failure diagnostics. In order to improve the manageability and to reduce cost, the SCADA system PVSS II has been chosen as a supervisory control system, integrating each of the individual parts. As the interface is open and easy to handle the integration was straightforward. The majority of the existing control systems have been integrated with limited man power during a one year period. The new system which provides a standard user interface was quickly accepted by technicians and operators.

THE DEVELOPMENT

The 2.5 GeV synchrotron radiation source ANKA [1] delivered its first beam time for the international scientific community via peer review in 2003. In the initial phase of ANKA each company supplied and installed a separate and autonomous control system (fig.1)

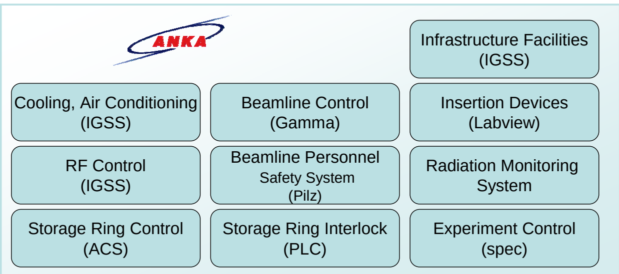

Figure 1: Originally autonomous control systems in the start-up phase of ANKA

As a result of the definition of specific tasks, each control system was first optimised self contained. Main parts of the ANKA infrastructure were controlled by the Windows based SCADA system IGSS. The original control system – based on windows- for the ANKA accelerator storage ring was designed and produced by KGB (Kontroll Gruppe für Beschleuniger) group at Josef Stefan Institute in Ljubljana, Slovenia. The same group of people also successfully upgraded part of the control system to ACS in 2002 [2]. The control system for the first beamlines was based on Gamma, a real time control system running under OS/9 [4], whereas the majority of the experiments are controlled by the command line based experiment control software spec [4]. The Beamline Personnel Safety System (BPSS) is based on a fail safe PLC solution of the company Pilz [5].

The main constraints of these autonomous solutions were that they require expert- knowledge and tools for maintenance and failure diagnostics of data generated by the ANKA facilities. Their application therefore was a time consuming task. In order to improve the manageability of facility control a supervisory system was necessary, integrating each of the individual control system parts. The requirements for such a system are

- an available commercial support,
- the scalability of hard- and software,
- a sufficiently open architecture which allows to integrate all existing and future hard- and software components.
- An object-oriented development approach – since the different systems have a large number of similar devices, it is essential to be able to develop a classdefinition for each type of device as a template then to instantiate it easily whenever it is needed.
- The support of distributed development and maintenance procedures – several programmers and technicians would work at different parts at the same time and when the system is online.
- Availability under different versions of Windows and Linux operating systems,
- a box of comprehensive diagnostic tools,
- the existence of easy to handle archiving and alarming features.

An evaluation of the existing SCADA systems used for accelerators soon showed that PVSS II (Prozess-visualisierungs- und Steuerungssystem) from the Austrian company ETM (now part of the Siemens group) was fulfilling these requirements. This system is used at CERN with comparable needs for the LHC experiments [6] and for the Synchrotron Radiation Source ELSA in Bonn, Germany. Due to this positive evaluation it was decided to use PVSS II as the overall SCADA system for ANKA.

FEATURES OF PVSS II

The SCADA system PVSS II is running under Windows and Linux. It is completely event driven with a central event-manager. It allows connecting most industrial devices with interfaces like OPC, SNMP and field busses. All managers and drivers are talking via TCP/IP with the central event manager so the system can be distributed over as much systems as needed. The open C++ application interface (API) allows to add own managers and drivers. PVSS allows an “unlimited” number of variables. The whole internal database consisting of “data points” can be stored into an ASCII-file, easily be modified and re-imported. All control structures and data points can be updated on-line without stopping the system, a powerful ANSI-C like scripting language is available which can also be used to configure PVSS II.

INTEGRATION OF PVSS II AT ANKA

Up to now three quarters of the control systems of ANKA are integrated into PVSS II (Fig. 2).

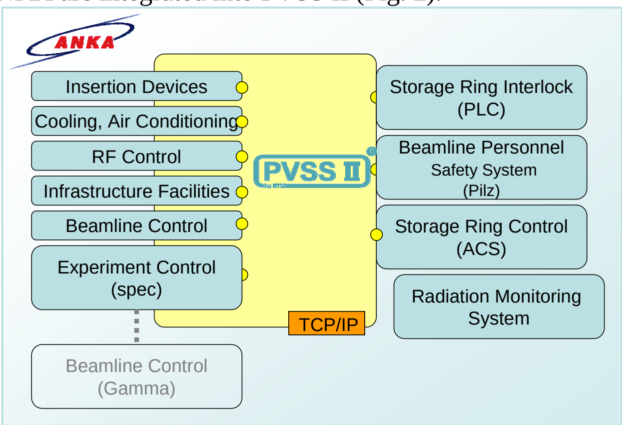

Figure 2: Integration status of the control systems into PVSS II at ANKA. The systems on the left are fully integrated, systems on the right have gateways to PVSS-II. The radiation monitoring system has to stay separately.

The integration started in 2006 and took roughly one year of manpower in total. As a standard API to PVSS II for Windows based systems OPC was established. Siemens PLCs could be directly connected with the native S7 driver of PVSS II. For other systems API managers were written, acting as gateways. The effort to write each manager was around 2 man weeks, including testing and optimising. Figure 3 gives an overview how the different systems involved in experimental tasks were integrated into the PVSS II.

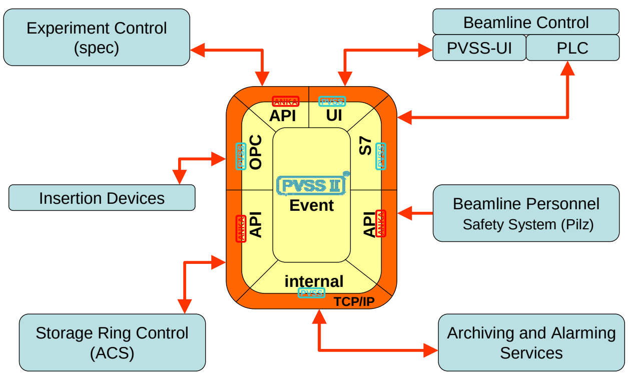

Figure 3: The ANKA PVSS-layer structure

For the ANKA infrastructure like cooling systems the decision was made to replace IGSS and to connect directly to the existing Siemens Profibus OPC server, but also some other smaller, local SCADA systems were connected via OPC. Fig. 4 shows the example of klystron control, the logic itself is running on a Siemens S7 PLC. The PVSS II tracks all changes for analysis in an archive with a SQL like interface. The most recent alarms are shown on each panel, depending on the priority. Alarms/warnings are simply displayed or have to be acknowledged. High priority alarms can be also sent via email or SMS to on call duty personnel.

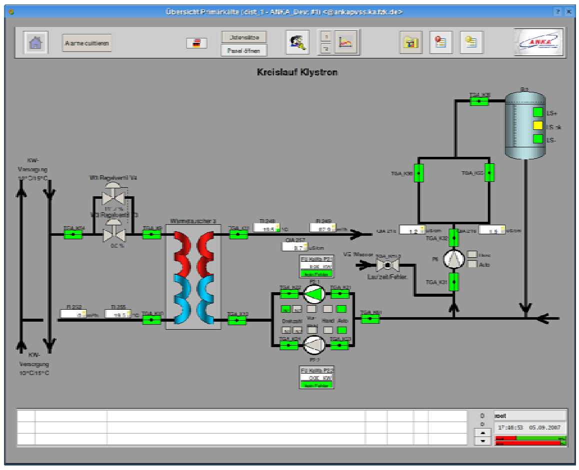

Figure 4: PVSS panel for the klystron control

For the beamline control the decision was made to introduce PVSS II and to replace cost effective the out-dated OS/9 based Gamma system during beamline upgrades. The distributed driver structure of PVSS II allows placing the native PVSS S7 driver on a beamline PC, which connects to the PLC via a private beamline measurement LAN [figure 5].

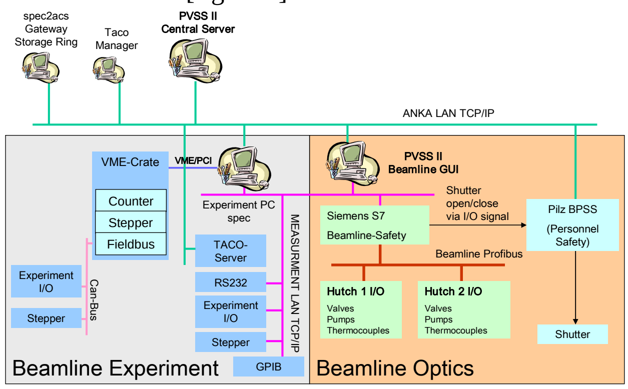

Figure 5: Bus systems of a beamline control system

As a result only changing values are sent to the central server and so the processor load for the event server is only around 0.5% by each beamline.

For the experiment control a specific situation occurred: regarding SPEC, PVSS II acts as a device like a stepper motor or a scaler. In addition a response time of less than 4 ms is required for scans as for all other local devices on the private measurement network of the beamline. This demand was fulfilled by an own API-manager -spec2pvss-, installed locally on the same linux machine like SPEC. Spec2pvss makes a “slow” cached connection to the PVSS event server and allows access to each PVSS data point in the script functions by its name, e.g. the beam safety shutter status. The cached values are updated typically once per second. Fig 6 shows a representative PVSS beamline panel.

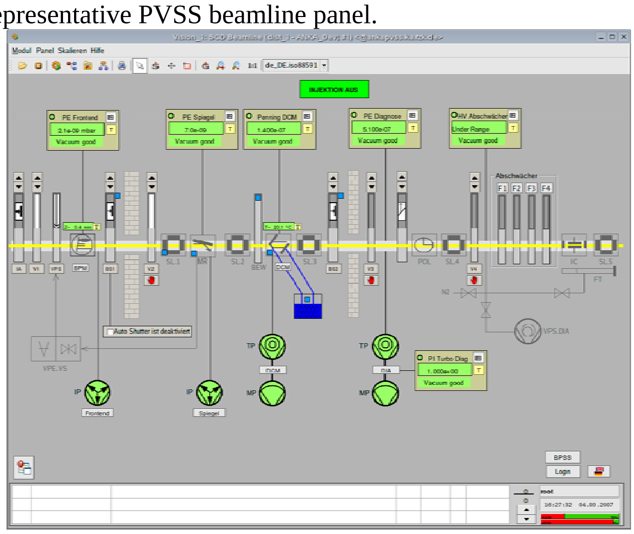

Figure 6: PVSS beamline control panel

As a gateway-client between the CORBA based ACS written in Java and PVSS II spec2acs was developed. This gateway client has a simple socket-interface, which allows reading and writing CORBA properties in ASCII via a get/set command. The gateway - event oriented - sends all requested properties to a C++ PVSS-API manager.

For the fail safe beamline personnel safety system, every beamline has its own PLC. For safety reasons these systems works totally autonomous, for a comprehensive view of the beamline status a 128 bit data word can be evaluated. This information is now collected via serial to ethernet converters from each beamline by use of an own API manager and stored - time resolved - into the PVSS database. In case of interlock events a PVSS alarm is launched via email or SMS.

OPEN ISSUES

The number of upgrades of beamlines to PVSS II is limited by four two week shutdown periods of ANKA per year, so it will take around two years to upgrade all beamline control systems to the PVSS II standard.

A preventive maintenance facility for infrastructure, based on the very improved possibilities of PVSS II - regarding warning, alarming and diagnostic features for analysing of side effects - will be implemented.

The next goal is the optimisation of the alarm handling routines, the sheer number of useful alarms and warnings forces the ongoing processes of the grouping and prioritisation of data.

CONCLUSION

PVSS II is a useful tool to develop a manageable SCADA system for accelerators. The open structure of PVSS II allowed a straightforward integration of the different autonomous systems at ANKA. The new alarming and warning features admit preventive maintenance measures and so grant the future growth of capabilities of the ANKA synchrotron facility. Providing a standard user interface, the new system is in high acceptance by the ANKA operational staff.

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