EXPERIENCES WITH PVSS II AS AN OVERALL SCADA SYSTEM FOR ANKA

W. Mexner, K.-H. Cerff, T. Spangenberg, M. Hagelstein, FZ-Karlsruhe, Karlsruhe, Germany

Abstract

The control system of the synchrotron radiation source ANKA at Forschungszentrum Karlsruhe was segmented into several autonomous parts. The storage ring have been 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 beam lines. Each system required 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 followed by a continuous optimization process. The new system with a common look and feel for beam lines and machine was quickly accepted by beam line scientists, technicians and operators.

INTRODUCTION

The 2.5 GeV synchrotron radiation source ANKA [1] provided 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).

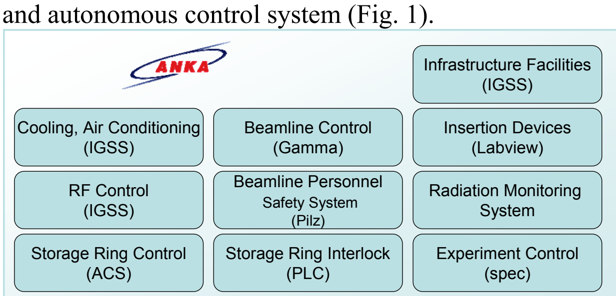

Figure 1: Originally autonomous control systems in the startup phase of ANKA.

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 accelerator control system is based on ACS since 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 Pilz company [5].

The main constraints of these autonomous solutions were that each of them require expert knowledge and tools for maintenance and failure diagnostics. 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 for ANKA 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 class definition 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 to connect 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 reimported. All control structures and data points can be updated on-line without stopping the system, a powerfull 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).

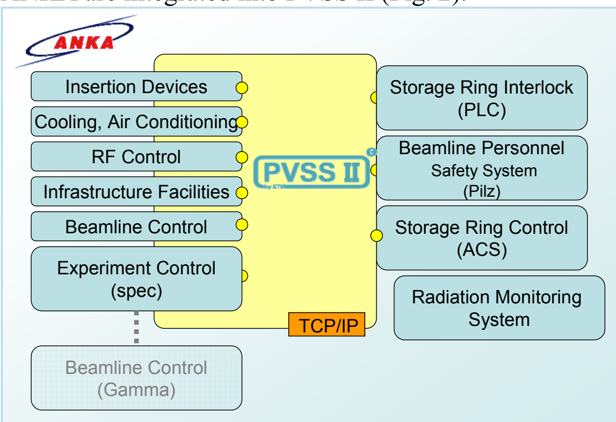

Figure 2: Integration status of the control systems into PVSS II at ANKA. The systems on the left are fully integrated or have gateways to PVSS II. The systems on the right side are only monitored by PVSS II. The radiation monitoring system has to stay separately.

Since 2006 the integration took roughly two years 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.

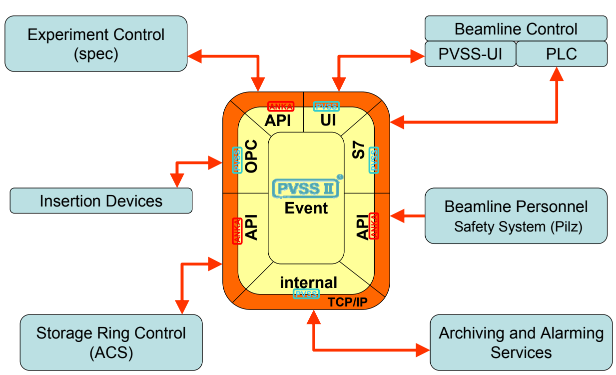

Figure 3: The ANKA PVSS-layer structure

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 the RF 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 operators.

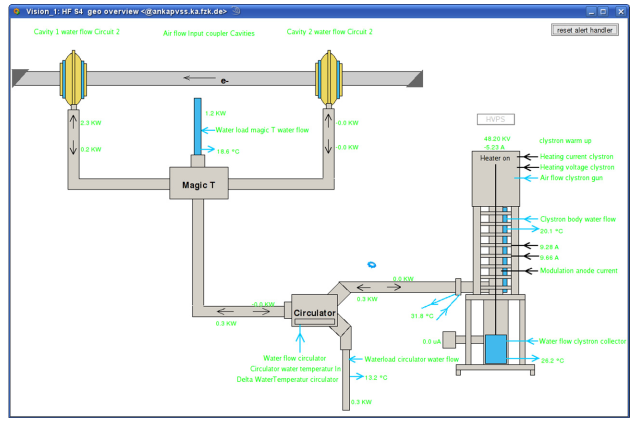

Figure 4: PVSS panel for the RF control of ANKA

For the beamline control the decision was made to introduce PVSS II and to replace cost effective the outdated OS/9 based Gamma system during beamline upgrades. The distributed driver structure of PVSS II allows to place the native PVSS S7 driver on a beamline PC, which connects to the PLC via a private beamline measurement LAN (Fig. 5).

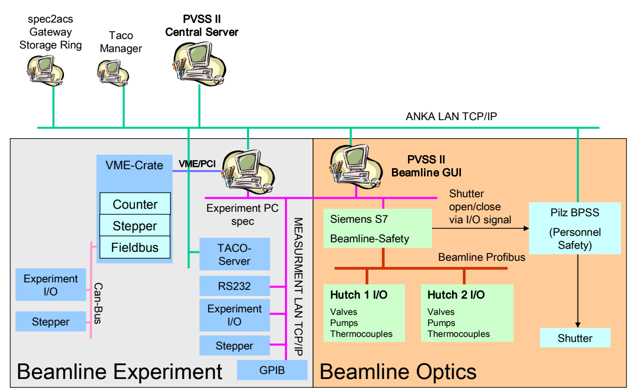

Figure 5: Bus-Systems of a beamline control system

As a result only changing values are send to the central server and so the processor load for the event server is only around 0.5% by each beamline. The total processor load for the overall SCADA system is less than 10% for a standard dual core opteron 2 GHz processor.

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 requested 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. Figure 6 shows as an example the PVSS main panel of the SUL beamline. The total effort for such a beamline were around 2 man months including a commissioning time of around 1 week.

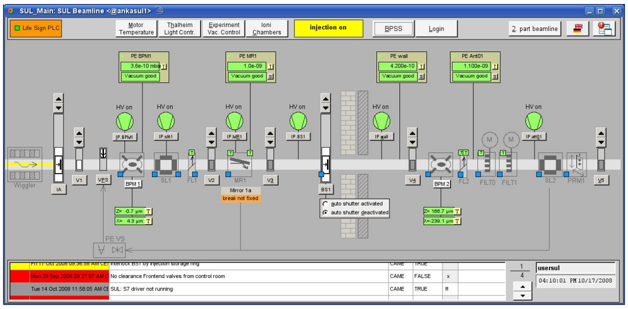

Figure 6: Part I of the SUL beamline control panel

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.

PVSS II CONSTRAINTS

The flexibility and modularity of PVSS II is an advantage and a disadvantage at the same time. As for every complex project, the maintainability of a PVSS II project depends on a well designed and documented control system concept. Because a TCP/IP based driver can be started on each computer you like, a good server concept is mandatory. Therefore just from the beginning a wiki was introduced for documentation purposes.

Despite the technical possibility to distribute drivers and managers as favoured, bad designed scripts could produce easily a lot of network traffic and slow down the total system, if database and script are running on different systems. PVSS II offers a set of diagnostic tools to identify such a trouble.

As a big advantage, the same PVSS II panel can be used for Windows and Linux with the same look and feel due to the cross platform graphics library QT. But nevertheless a check of the panels on both platforms is mandatory due to small differences in fonts or colours. Also the usage of windows specific features, which are offered in the windows version of the development system, have to be avoided.

The base system of PVSS II shows a high stability. An uptime of the central event manager process of several weeks or months is normal. Nevertheless it is possible to crash a driver due to wrong parameterisations, but such problems usually do not affect the overall system and mainly happens during setups of new modules. Crashed drivers – if they are not hanging – can be automatically restarted by PVSS II and are not detected by the "normal" user. Therefore a regular check of the PVSS II logfiles is advisable.

OPEN ISSUES

The number of upgrades of beamlines to PVSS II is limited by four two week shutdown periods of ANKA per year, so the upgrade of all beamlines is planned to be finished in 2010.

Despite the high acceptance of the new system due to standardisation, the operators are using only a few percent of the possibilities. The next goal after system setup is a training concept for the operators.

A continuous process is the optimisation of the alarm handling routines, as the sheer number of useful alarms and warnings forces an ongoing process of grouping and prioritisation of data.

CONCLUSION

PVSS II is a useful tool to develop a manageable SCADA system for accelerator and beamline control. 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.

.

REFERENCES

[1] http://www.fzk.de/anka/

[2] I. Kriznar, G. Pajor, M. Plesko, M. Sekoranja, G. Tkacik, D. Vitas,, K. Cerff, W. Mexner, "THE UPGRADE OF THE ANKA CONTROL SYSTEM TO ACS (ADVANCED CONTROL SYSTEM)", Proceedings of ICALEPCS2003, Gyeongju, Korea, p. 45

[3] W. Mexner, K.-H. Cerff, R. Butzbach, "THE STANDARDISED MODULAR BEAMLINE CONTROL SYSTEM OF ANKA", Proceedings of PCAPAC 2002 , Frascati, Italy

[4] http://www.certif.com

[5] Karl-Heinz Cerff, Wolfgang Mexner, Ralph Steininger, „BPSS, the Beamline Personnel SafetySystem of ANKA", Proceedings of PCAPAC 2002 , Frascati, Italy

[6] David Myers and Wayne Salter, "Industrial solutions find a place at CERN", CERN Courier, Jun 7, 2005, Geneve, Switzerland