EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH
ORGANISATION EUROPÉENNE POUR LA RECHERCHE NUCLÉAIRE

CERN - ST Division

CERN-ST-2001-018
30 January 2001

ELECTRICAL NETWORK SUPERVISOR STATUS REPORT

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Abstract

During year 2000 CERN has installed the Electrical Network Supervisor (ENS) for the monitoring and control of the equipment of the electrical distribution network located in about 100 substations throughout the different sites. In the first phase the system has been installed in parallel with the original CERN-developed system and databases and mimic diagrams have been prepared to cover parts of the distribution network. The system has been integrated with the general ST supervision systems for alarms monitoring and measurement logging, and the data from the ENS are gradually being integrated. In the second phase an extension of the system has been tested to include a direct industrial interface with the electrical equipment without the need for the existing CERN equipment interfaces. During the 2000-2001 shutdown the supervision will be renovated in a number of zones to operate a complete industrial system covering all aspects of the supervision from equipment interfaces to end-user applications.

Presented at the 4th ST Workshop
Chamonix, France, 30 January - 2 February 2001

1 INTRODUCTION

During the first half of year 2000 CERN installed a new SCADA system which will serve for the supervision of the electrical distribution network. The new system was installed via a software interface to the existing data acquisition system and did not require any hardware installations. This system interfaces with several types of controllers and PLC types such as the MICENE system and SEPAM protection devices.

It was not originally foreseen to renovate the data acquisition system, which is evolving anyway as a consequence of the electrical substation renovation programme. However, after the project was started it became clear that a more complete system was needed which would also cover the data acquisition system itself and could provide a replacement of the MICENE controller, which cannot be maintained any longer.

2 SCADA SYSTEM

2.1 Data acquisition

The new SCADA system was first installed with a software interface to the existing CERN supervision system. The interface was designed by the supplier and implemented in a close co-operation between CERN and the supplier to provide a homogenous communication interface with 19 types of controllers using five different serial protocols. The communication interface chosen is based on an existing standardised communication protocol over TCP/IP. The interface is only responsible for the event-driven data communication and the original CERN supervision system is still responsible for specific controller management such as clock synchronisation, start-up configuration initialisation etc.

2.2 Database configuration

The SCADA system is configured via an operational SCADA database defining the components of the supervision system (e.g. PLC-type controllers) as well as the properties of the signals being supervised. This database is very general and can be applied to other domains of control than electrical networks. In the future it will also describe the electrical devices in terms of electrical properties and be loosely integrated with the electrical installation and maintenance databases.

An off-line “controls database” has been designed to assist with the definition of the SCADA database and contains the description of the different electrical devices and their related controllers; each electrical devices is associated with its states, measurements, parameters and controls. A special aspect of the database is the management of the interface to the MICENE controller with a description of the wiring and card configuration. When new equipment is connected for supervision it is first inserted into this database and the data is checked for correctness to facilitate the update of the operational database. The update of the operational database is performed using an import tool when the data is completely defined. This procedure is illustrated in **Figure 1**.

For each controller type (e.g. UPS system) it is decided which of the entities made available by the controller are required for the supervision via the SCADA system. For most controllers the complete set of data is considered and the data attributes are defined once per type of equipment or per type of utilisation. Most controllers have a very specific function and only one type of utilisation.

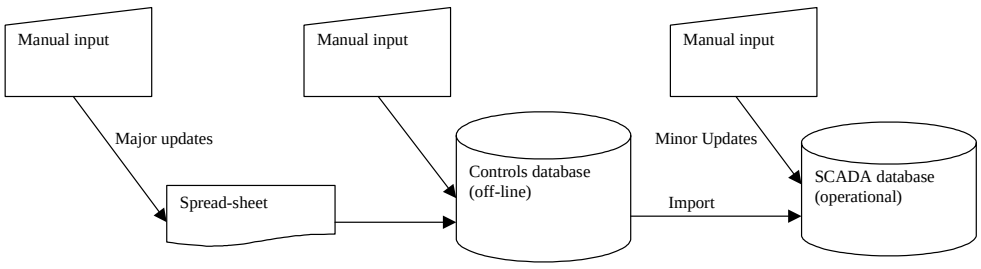

Figure 1 – Database configuration

3 COMMUNICATION FRONT END

The new SCADA system has a distributed interface to the different controllers offering communication capabilities. This is the communication Front End (FE). The FE is needed because the controllers installed today can only be interfaced via a serial communication link limited to a distance of a few hundred meters without special equipment. It is estimated that about 20 of such FE*s* are required to cover all electrical substations.

The SCADA system was originally integrated with the existing CERN FE*s* but a new FE has been developed within the project to deal with all the different controllers in use at CERN (except the MICENE system). This FE will be based on standard hardware adapted to the potentially harsh environment in the electrical substations. The software is designed specifically to support the existing controllers but new controllers can easily be interfaced if they use the same protocols and therefore it is important to standardise these. There will be a cost of integrating new controllers which use (currently) unsupported protocols and this cost should be taken into account in the overall cost analysis when purchasing new equipment.

The complete set of FE driver software developed for CERN is currently undergoing Site Acceptance Tests and only a reduced system is already installed for operational purposes in the first renovated substations. Later during the 2000-2001 shutdown it is planned to install up to 10 new FE computers. Ultimately this FE can be installed everywhere where there is no MICENE controller since this system will not be supported by the new FE. As a specific feature the FE can interface to several supervision systems and in a number of vital zones – such as the BE complex under renovation – a local supervision display will be installed for operation in parallel with the remote SCADA system installed in the TCR. This is illustrated in **Figure 2**.

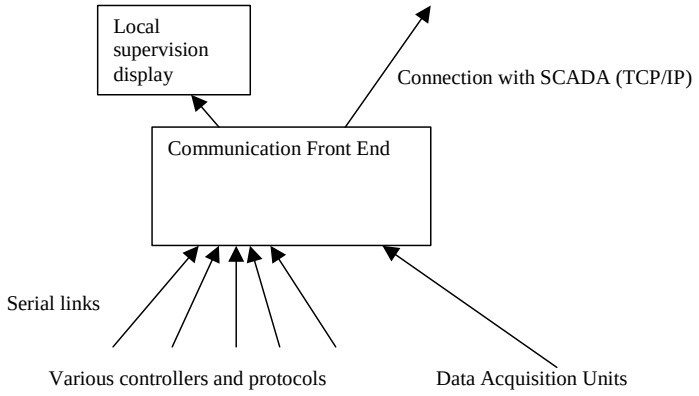

Figure 2 - Front End

4 CONTROLLERS

At CERN the most important electrical general-purpose controller is the MICENE. There are up to 120 MICENE*s* installed and operational at the moment, which interface some 50000 digital signals and measurements. The system was developed in-house for the LEP project when there was no industrial data acquisition interface available to provide local and remote supervision of the electrical equipment. After a long period of operation there is a now a need to replace the system with modern equipment which is reliable, secure and precise.

The eradication of the system will happen in two directions: Together with the substation renovation programme the electrical devices will be equipped with communicating “intelligent” controllers and specialised PLC*s* thus reducing the need for the MICENE*s*. In some cases there will still be a need for an interface to digital and analogue signals and an industrial system – Data Acquisition Unit (DAU) - will be installed for this purpose. We will standardise on a few common signal types which means that special direct AC power measurements will not be supported in the future; instead industrial measurement devices will be used. Automation and regulation functions

which today are performed by the MICENE, will be performed by standard PLCs of the types accepted and operated at CERN. To reduce the cost and work required to perform these new installations the data quantity will be reduced significantly compared to the current situation to only include the minimum needed for operational purposes. In particular will less detailed information be acquired for non-essential low-voltage and low-consumption systems.

The principles of this type of installation have been tested via a pilot project implemented in the 1999-2000 shutdown and during the last months of LEP operation an 18KV substation was operated with this new fully industrial system. The next major installation of the system will happen together with the renovation of the BE complex. This installation illustrates the principles described above:

- The reactive power compensators will be controlled by a system of several PLCs. Ref. [1]
- The high-voltage switch-gear will be installed with modern protection devices with integrated communication capabilities. Approximately 70 devices will be installed
- The power measurements which are not made available by the protection devices will be acquired by a number of specialised energy metering devices
- The remaining equipment which is not completely renovated, will be equipped with DAUs for integration with the SCADA system

5 INTEGRATION WITH THE TCR SUPERVISION INFRASTRUCTURE

The SCADA system has been integrated with the ST supervision systems via the TDS middleware system based on the commercial Talarian SmartSockets® protocol. A specific software interface - the Equipment Controller (EC) - has been developed based on the infrastructure and programming facilities provided by the TDS project and is in operation since June, 2000. During the operation some project specific changes have been introduced to the original SCADA system to better suit the operational environment of the TCR and more modifications are being discussed and foreseen.

A limited set of CAS alarms for the electrical network have been defined in co-operation with the TCR. With the TCR it was decided to make just two alarms per electrical system per LHC Point, which makes less than 100 alarms per point. These alarms are groupings of equipment alarms as illustrated in **Figure 3**. This figure shows the SCADA alarms from "System X" (composed of four pieces of equipment each having at least one warning) and the corresponding CAS alarm.. It has been decided not to transmit the detailed equipment specific information to the TDS to avoid overloading the TCR with information. To provide the detailed information the SCADA system is available for consultation on a dedicated console.

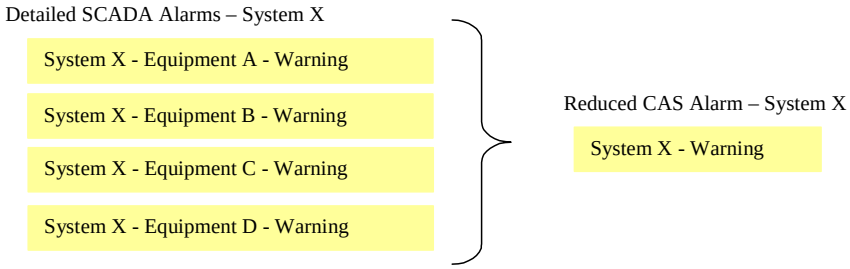

Figure 3 - Reduced CAS alarms

A few measurements – primarily related to the energy consumption - which are needed outside the ENS are also transmitted via the TDS interface to the new TCR Event Logging System. The philosophy is to limit the data logging outside the ENS to the real needs of specific clients.

The software installed for the TCR integration will also provide an interface from external clients outside the ST division to the SCADA system. This may be needed when the future LHC experiments will require limited monitoring and control of the electrical for which they are responsible for the operation.

6 SCHEDULE

6.1 Shut-down 2000-2001 activities

During the shutdown of 2000-2001 the supervision system will be completely renovated in the LHC Point 5 and BE areas in parallel with the electrical installation work. In the LHC Point 1, SM18 and Meyrin areas, where the electrical renovation has been performed in the previous years, the new FE will be installed together with a number of DAUs to control equipment without specific communication capabilities. The configuration of databases and mimic diagrams for the remaining zones where no hardware installations are upgraded will continue to cover the major CERN sites and substations by the end of this shutdown.

6.2 Long-term planning

The controllers of the LHC installation will be gradually renovated during the period 2001-2004. Up to a third of these will be removed together with the LEP dismantling and the rest will be renovated together with the electrical installation of the respective LHC Points. A thorough renovation of the SPS network is also being planned to take place during this period and the controls will be upgraded in the BA substations in parallel.

7 MAINTENANCE AND HUMAN RESOURCES

The ENS project is implemented by an external supplier but CERN personnel has been involved in the development related to the integration of the SCADA system with the existing data acquisition devices. CERN staff and contractor personnel also perform the hardware maintenance of the existing MICENE system. The SCADA system still relies on some support from the IT and SL divisions related to the original CERN-developed FEs and operator terminals but this support will become less needed as CERN equipment is replaced with industrial equipment.

In the future the supplier will perform corrective maintenance on all components of the new system but some limited non-corrective maintenance functions are to be performed regularly by on-site personnel. These functions include adaptive maintenance such as database updates required by the operation and preventive maintenance primarily needed for hardware modules of the DAUs. Some of these interventions will be performed under the newly established contract for software support for industrial controls. Ref. [2].

8 CONCLUSION AND FUTURE

The supervision system for the electrical control is being upgraded in parallel with the electrical renovation activities. An industrial SCADA system is the core of the ENS, which minimises the development effort, but some customisation of the standard system will always be required and can normally be delivered with minor cost impact. In this way the system will be able to evolve and fit the requirements of the evolving electrical environment. To minimise the need for potentially expensive and time consuming developments there will be an emphasis on standardisation of the interfaces to the system; however current industrial trends in substation communication technology will at some point in time dictate important changes in the way new controllers are integrated.

The operational environment within CERN and the TCR is developing as well and an effort must be made to evolve the ENS in parallel. Some decisions must be taken regarding the distribution of supervision functionality between the specialised SCADA systems used by different equipment groups and the centralised TCR supervision services. The integration of different systems and architectures into a suitable supervision environment will be critical to the effective operation performed by the TCR and the equipment specialists.

9 REFERENCES

[1] Reactive Power Regulation with PLC, G. Burdet, 4th ST Workshop, Chamonix, 2001

[2] Software Support for Industrial Controls, E. Sanchez-Corral, 4th ST Workshop, Chamonix, 2001