STUDY OF THE PROJECT MANAGEMENT PHASES AND THE ARCHITECTURE OF A SCADA SYSTEM

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Abstract: The aim of this paper is to present firstly the concepts of the supervisory control and data acquisition system SCADA, and secondly to present the project management phases of SCADA projects. A review on SCADA in power systems has been presented. Then, we present the different project management phases of SCADA projects and an example of the architecture of a SCADA system in a thermal power plant. Finally, we present the different steps of the programming and the configuration of the tabular in a SCADA environment.

Keywords: SCADA architecture, Project Management Phases, Power systems.

1. Introduction

In recent years, our modern developed life has deeply depended on different electricity services such as air-conditioner, refrigerator, TV, computer system, etc. These services are possible with the availability of a sustained, reliable and good quality of the electric power supply. Nevertheless the electric power distribution networks are susceptible to interruptions caused by a variety of reasons such as adverse weather conditions, equipment failure, accidents, etc. The Electricity Distribution Companies (EDC) normally identify the faulty section of the network and restore the power supply using their own resources which are mostly based on classical methods. Today the rapid growth of Information Technology (IT) tools has promoted many EDC to modernize their fault diagnosis as well as troubleshooting systems.

Supervisory control and data acquisition systems (SCADA) are widely used in industry for supervisory control and data acquisition of industrial processes. The process can be industrial, infrastructure or facility [1].

The SCADA system usually consists of the following subsystems [2]:

- A Man-Machine Interface (MMI) is the apparatus which presents process data to a human operator, and through this, the human operator, monitors and controls the process.
- A supervisory system, acquiring data on the process and sending commands to the process.
- Remote Terminal Units (RTU) connecting to sensors in the process, converting sensor signals to digital data and sending digital data to the supervisory system.
- Communication infrastructure connecting the supervisory system to the RTU.

In fact, most control actions are performed automatically by RTU or by programmable logic controllers (PLC). Host control functions are usually restricted to basic overriding or supervisory level intervention. For example, a PLC may control the flow of cooling water through part of an industrial process, but the SCADA system may allow operators to change the set points for the flow, and enable alarm conditions, such as loss of flow and high temperature, to be displayed and recorded [3-5]. The feedback control loop passes through the RTU or PLC, while the SCADA system monitors the overall performance of the loop.

The objective of this paper is to show interests of the use of SCADA systems in power systems. The next section briefly presents the different project management phases (identification of need; initiation; definition; design; acquisition and project closeout) of SCADA projects. Finally, we present and discus a case study of the architecture of a SCADA system in a thermal power plant.

2. Review on SCADA in power systems

We present in this part, types of SCADA systems reviewed that include those for electric power generation, electric power transmission, electric power distribution, and process control.

Researcher, Kumar P. & al. [6], have explained that the control centre in a SCADA set up is the place from where the operator or the system engineer monitors the health of the power system and issues essential control information. The operator or the system engineer at the control centre undergoes a diversity of muscular stresses while working for long durations, which degrades the quality of work. So, the authors have given importance on the different aspects of the ergonomics in designing the control room and housing rooms in the control centre for the power system.

Researcher, Lezhnuk & al. [7], have presented the simulation using similarity of best states that develop the efficiency of optimal load flow control of electric power systems. Integration of the simulation model into the system of optimal control provide the means of verification of control software in course of operation and perform testing of automated control of regulating devices aiming at comprehensive evaluation of possible all-system result.

Researcher, Missouri R. [8], has said that security of supply has been always an essential factor in the improvement of the electric industry. Adequacy, quality of supply, stability, reliability and voltage collapse along with costs have been always carefully considered when planning the future of the electric power system. The increasing development of SCADA/EMS systems, the growing number of market participants, and the development of more complex market schemes have been more and more relying on Information Technologies, making the physical system more vulnerable to cyber security risks.

Researchers, Arghira N. & al. [9], have presented SCADA concepts used essentially in power systems, as a critical infrastructure in all life sectors. New power system requires regarding energy quality and efficiency, power system load or stability has risen for system operators all around the world. The new control and monitoring strategies include improved SCADA systems and new measurement systems. The SCADA concepts discussed were used at the national power system dispatcher and also, at the power plant level.

Reasearchers, Jeong L.S & al. [10], have presented SCADA of KEPCO (Korea Electric Power Corporation), that consists of tree structure and there is a RTU in lowest layer for the unmanned supervision. At this time in using RTU and communication protocol, there is a limit to operate the electric power equipment for obtaining the high reliability. The authors have developed distributed network protocol RTU in order to realize a manpower reduction and a cost reduction of commotion materials.

Reasearchers, Duan X. & al. [11], have suggested an approach to transmit electric power system dynamics in the SCADA. They propose to compress dynamics data with curve fitting in the RTUs and reconstruct the dynamics in the SCADA server for reducing communication demand. Dispatchers in the control center can thus get system dynamics with a delay of several seconds. Simulation result shows that for a power system under disturbance with short-circuit that once occurred and was cleared, the SCADA can approximate the original dynamics with satisfying precision using limited degree polynomial fitting. The approach is highly scalable and adaptable, and can be implemented on existing communication infrastructure with a few software modifications.

Researchers, Cepisca C. & al. [12] have proposed a computerized measuring system, based on up-to-date method, for surveying and monitoring of hydroelectric power stations (HPS). The SCADA system for hydro power plants is a two level hierarchical system. Its components are the dispatcher level and the hydro power plant level.

Researcher, Agrawal V.K. & al. [13] have presented SCADA measurements that have been providing information on bus voltages, line, generator and transformer flows (MW, MVAR and Amperes), transformer taps and breaker status as well as other system parameters. However, for monitoring and control of such large grid only steady state information may not be sufficient. Synchrophasor Measurement technology provides dynamic view of the grid along with information like load angle between different locations of the grid. Since Phasor Measurement Unit is a new technology which is still evolving; a pilot project has been implemented in Northern Region (NR) in India by Power grid Corporation of India Ltd in order to gain firsthand experience in use of this technology for monitoring and control of large power grids.

Researchers, Patel M. & al. [14], have presented a SCADA system that allows communication with, and controlling the output of, various I/O devices in the renewable energy systems and components test facility RESLab. This SCADA system differs from traditional SCADA systems in that it supports a continuously changing operating environment depending on the test to be performed. The SCADA System is based on the concept of having one Master I/O Server and multiple client computer systems.

3. Project management phases of a SCADA

In this part, we present the different project management phases of SCADA projects [15-18]. These different phases include: identification of need; initiation; definition; design; acquisition and project closeout.

1st Phase: Identification

The first phase consists on the identification of need. The scope of the project is essentially defined at this point. In fact, the SCADA project will be required for some of the following reasons: to reduce power costs; to reduce staffing; to improve level of service; to avoid environmental incidents; to comply with regulators requirements; to replace an existing aging system, etc.

2sd Phase: Initiation

This phase consists on the validation of the project need; the establishment of concepts and scope; the establishment of the summary Work Breakdown Structure (WBS).

At this stage some small amount of funding has been approved to undertake the preliminary investigations, and prepare a preliminary project management plan. It will be necessary to firm up on the scope, identify the main technologies to be used, and gain agreement and approval of the potential users of the system. If the system is being introduced to improve productivity, then it is important that user management understand how they can use the SCADA system to change work practices. Although the work should be concentrating on the functional requirements, it is necessary to keep an eye on the technical capabilities offered by suppliers.

3rd Phase: Definition

The third phase consists on the definition of the project. The work at this stage should still be concentrating on the functional requirements. At this stage the project is starting to get serious. A project team is in place, and organizational and reporting processes are established. The scope is being finalized (sites, functions, etc.). It is important to firmly identify the benefits of the system, to develop benefit realization plans and develop plans to manage risks.

4th Phase: Design

This phase normally involves preparing the specification, and developing tender evaluation plans. It is probable that a prequalification phase could proceed at this time to overlap the tender preparation, and the prequalification phases.

The modern approach is to use design and construct contracts, and pay for performance.

5th Phase: Acquisition

In this phase the SCADA project will go through a number of steps: design configuration of SCADA master software; development of custom software; assembly of RTU's in factory, and testing; field installation of instrumentation, communications, and RTU's; commissioning; site acceptance testing; customer training. Subsequent to this, the system normally has a defects liability period, and beyond that maintenance must be contracted for.

6th Phase: Project closeout

This phase consists on the establishment of the project final report; the closeout of any outstanding defects and nonconformities; the final completion and the post implementation review (PIR) as required.

4. Example of the architecture of a SCADA system in a thermal power plant

One of the effective tools in power network automation is the SCADA system [19-23]. In fact, the different equipments, including SCADA system, have been installed in many companies over the world to modernize their power system distribution networks [24-28].

In this part we present an example of the architecture of a SCADA system in a thermal power plant in Tunisia. So, we present on the one hand, the different steps of programming in a SCADA environment and on the other hand, the configuration of the tabular of the control-command application.

In fact, the architecture of the SCADA system of a thermal power plant is constituted of following elements (Figure 1):

- A plate of bornier;
- FBM (Field Bus Module);
- FCM (Field Bus Communication Module);
- CP60 (Control process);
- DNBT (Dual Node Bus base_T interface);
- AW (Work Station Processor);
- WP (Application Work Station).

Figure 2 presents the details of the architecture presented for connecting the different elements of the SCADA system.

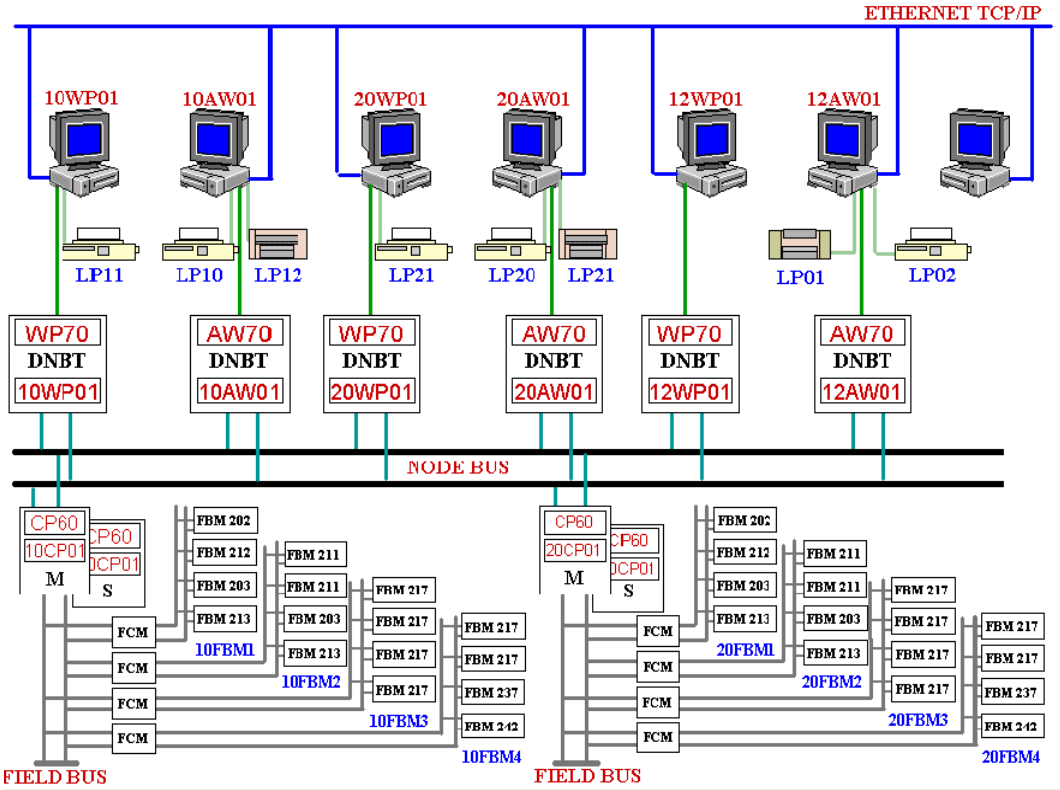

Fig. 1. Architecture of the SCADA system of a TPP.

Among software of the SCADA system, we mention:

- SYS MON: System monitor that supervises the good working of all the facilities of the system.
- FOXVIEW: Interfacing operator to visualize the tabular with a slim rod to activate the main functions of the SCADA system.
- FOX DRAW: creator of tabular.
- FOX SELECT: Software permitting to reach the various elements of the hierarchy of the data base of the CP60.
- ICC (Integrated Control Configuration): Software permitting to create and to configure programs residing in the CP60.
- AIM HISTORIAN: Software permits to collect, to organize and to protect data for storage, it also permits to configure features of points to archive, as messages partners to events.

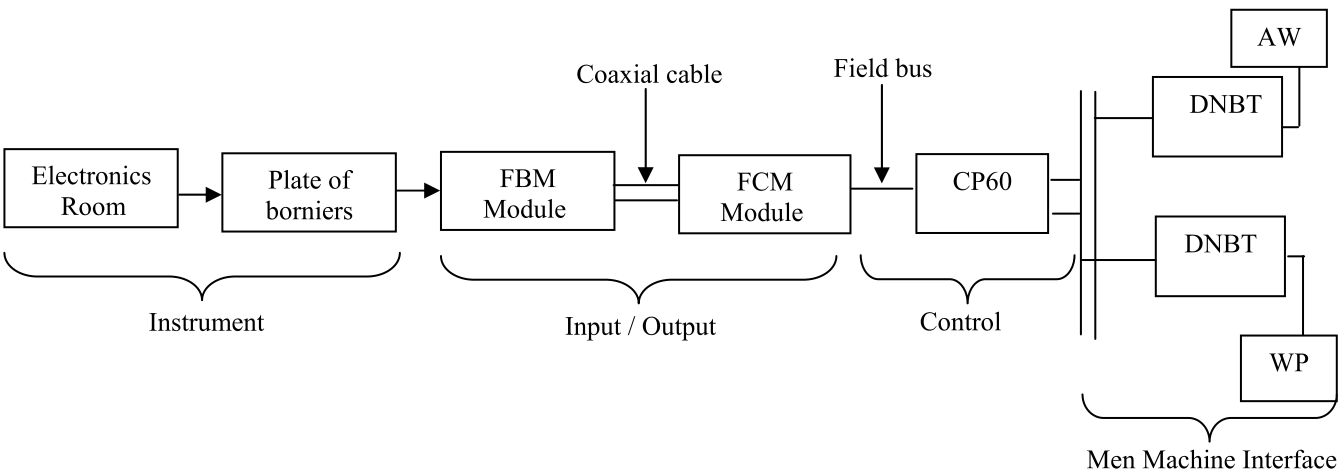

Fig. 2. Connexion of the different elements of the architecture SCADA.

In the following, we present some blocks used by the Foxboro software. These blocks include AIN, CALC, ACCUM, COUT and MATH.

The AIN block does the reading of the raw value (0 to 65535 points) a way of entrance of a module FBM217 achieves then on a read data of conditioning functions (characterization, stake to the ladder, limitation), of filtering and alarm (Figure 3).

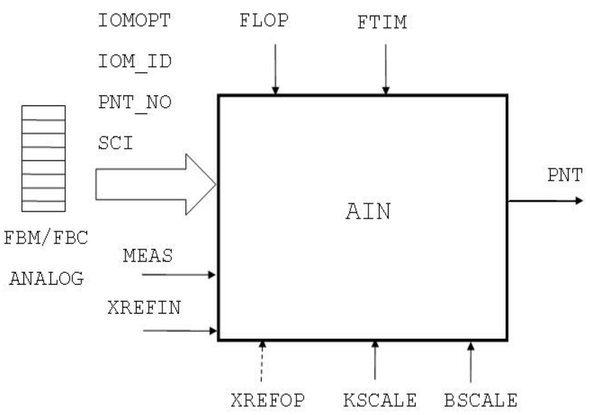

Fig. 3. AIN block.

The CALC block permits to achieve some logical and arithmetic operations in chain (reversed Polish notation) to the manner of a programmable calculate (Figure 4).

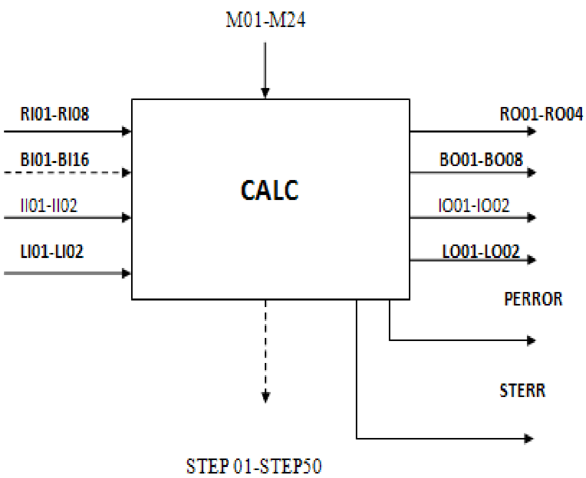

Fig. 4. CALC block.

The ACCUM block achieve the integration of the input and deliver to the output a quantity (Figure 5).

The COUT block permits to pilot one of exits all or nothing of a module of FBM E/S in bistable or pulsionnel (Figure 6).

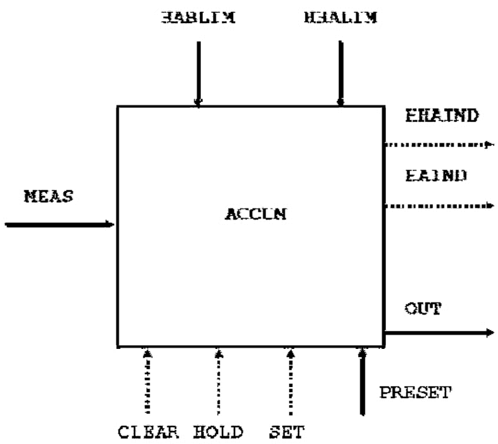

Fig. 5. ACCUM block.

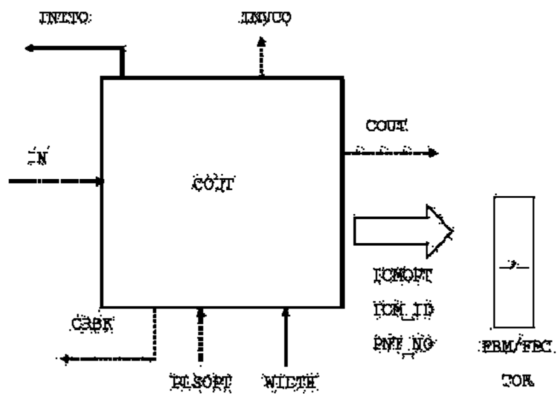

Fig. 6. COUT block.

The MATH block permits to achieve some arithmetic operations in definite chain in a program (Figure 7).

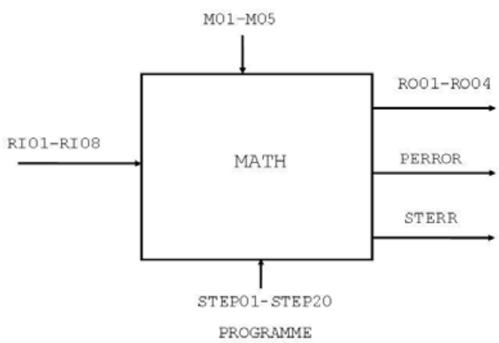

Fig. 7. MATH block.

For the stage of conception of the tabular, we present the Fox Draw software that permits the conception and the graphic view modification (Figure 8) .

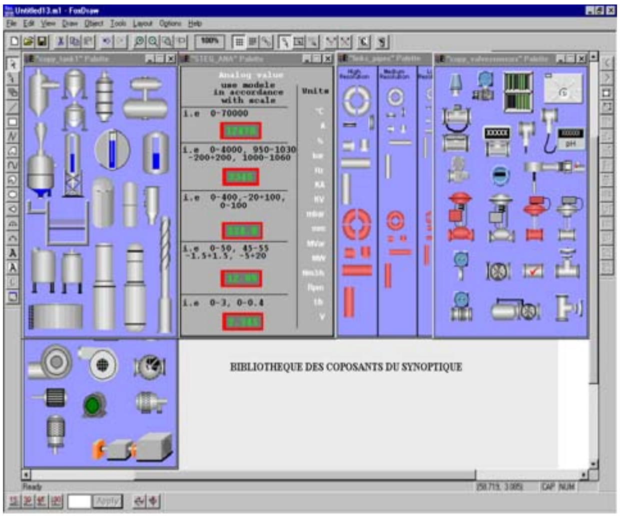

Fig. 8. Library of components of the tabular.

5. Conclusion

In this paper, we presented on the one hand, the project management phases of SCADA projects and on the other hand, a proposed architecture of a SCADA system of a thermal power plant.

It is very important to use software of the SCADA system for the programming of the different blocks and the configuration of the tabular in a SCADA environment.

Staring from this case study of the architecture of a SCADA system discussed in this paper, work is in progress to develop a functional analysis and real time for the various applications of control-command in a thermal power plant.

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