SCADA AND ENERGY MANAGEMENT

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ABSTRACT: With the appearance of modern SCADA software packages and with the development of VLSI technology, PC computer systems are becoming increasingly used as a workstation. The capacity of such station is determined according to the complexity of a local power system. The main problem is the selection of the suitable hardware and software for efficient supervision and control of the local power system. In this article the criteria for the selection of configurations of suitable hardware and directions of further development in this field are presented.

SCADA IN ENERGETSKO VODENJE IN NADZOR

POVZETEK: Z pojavom modernih SCADA programskih paketov in z razvojem VLSI tehnologije, se PC računalniški sistemi vse bolj pojavljajo kot delovne postaje. Zmogljivost takšne postaje se določi glede na zapletenost internega energetskega sistema. Glavni problem pri tem je pravilna izbira strojne in programske opreme za učinkovito vodenje in nadzor internih energetskih sistemov. V tem članku so predstavljeni kriteriji za izbiro strojne opreme in nakazane smeri nadaljnjega razvoja na tem področju.

1. INTRODUCTION

Traditional SCADA (Supervisory Control And Data Acquisition) systems have for a long time resembled the monolithic direct digital control systems, but as distributed process control matured, both the concept and components began to look inviting. With software developments of both process control and management systems the SCADA systems have infiltrated in the utilities industries where there are distant units of operation, often unattended, that require supervision from a control facility [BLI85].

With further development SCADA systems became more distributed. Most SCADA systems were evolved into networks of computers with functions distributed among numerous machines: man/machine workstations, remote terminal units, application processors, etc [BLI88].

The growing familiarity of SCADA system with the ever present personal computer transformed the PC into an integrated workstation for real-time process control. In addition, development of multitasking operating systems (Unix, OS/2, NT), the key to system integrity and high speed response, was an important factor in the acceptance of the PC.

Although SCADA system has traditionally utilized the operator to 'close the control loop' via supervisory control, the constant development of the SCADA system software has opened the door for the SCADA master to be more than just a monitoring device [BLI89].

With all features of the powerful, low-cost automation and control software, the SCADA system became a perfect tool for energy management.

The purpose of this paper is to obtain the basic information of suitable hardware and software in order to facilitate the choice to the user.

2. ENERGY MANAGEMENT AIM

In Slovenia consist calculated costs for electricity consist of item for power (consumed power in kWh) and item for peak load (maximum 15-minute average peak in month). The purpose of process control is to keep consumption smooth and steady over various periods of a day i.e. to keep peak load as low as possible.

Energy management offers three main methods to apply control strategies:

- Load scheduling,
- Load shedding,
- The use of additional power units (co-generating units, diesel aggregate).

Proper scheduling of production processes introduces time-driven loads and represents backbone or rough tuning in Predicted Demand Control PDC.

Load reduction for a longer period of time, i. e. load shedding, occurs when predicted power (projection to the end of demand interval) is higher then optimum power (target). Thus, it represents fine tuning of load management system.

With the use of additional power units it is possible to minimize load shedding and achieve optimised energy usage. Among those units a co-generating unit usually represents the best choice wherever the process requires industrial steam. it is very often a case that such a turbogenerator-set is already installed in the factory though originally not for the purpose of load management.

Figure 1 depicts the heat and power production and consumption in a local power system.

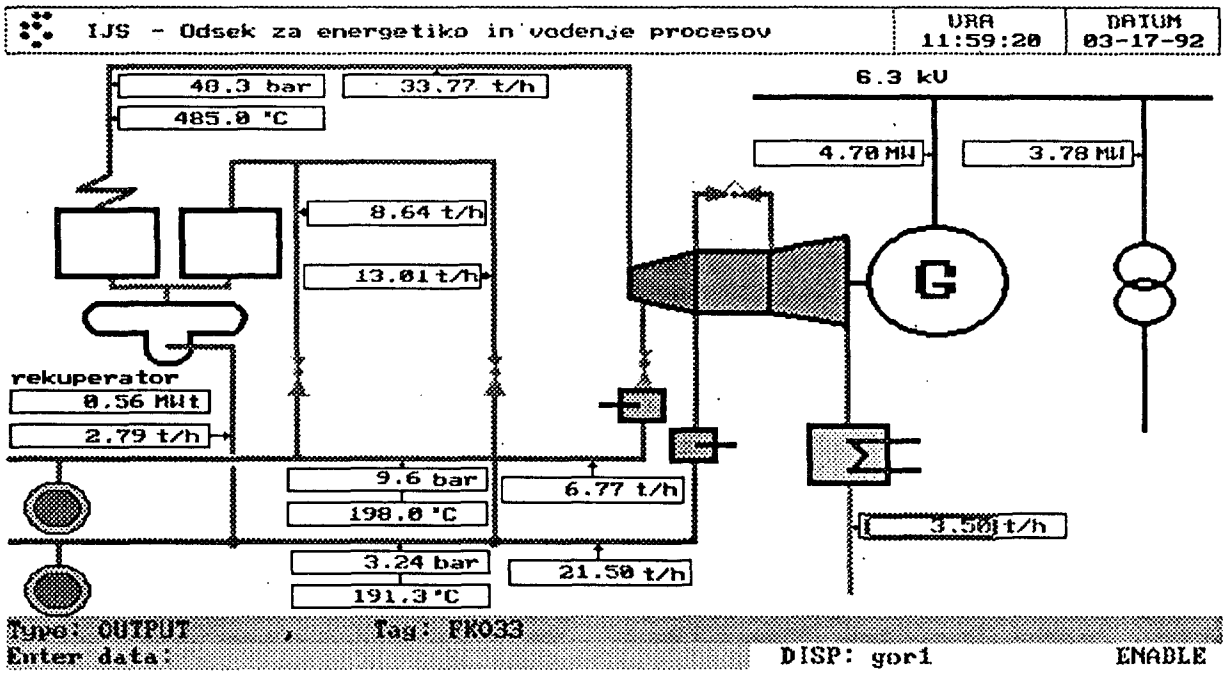

Figure 1: The heat and power production and consumption

By using the SCADA system for energy management implemented through monitoring and supervisory control of a local power system, significant savings can be achieved.

3. CRITERIA FOR PROPER CONFIGURATIONS

The proper selection of suitable software and hardware is of the crucial meaning for efficient supervision and control of local power systems. A priority task is therefore to elaborate the criteria for the right choice of [MRD90]:

- I/O intelligent devices, that operate as slave devices to a host computer,
- PC industrial computer, built to withstand the harsh physical conditions frequently found on the plant floor,

- SCADA software package for load management

3.1. I/O INTELLIGENT DEVICES

For intelligent analog and digital I/O devices, the next criteria has been made [MRD91B]:

- The possibility of locating the control point at each heating or conditioning unit in an energy management application. Thus, considerable installation savings and improved performance can be realised.
- The communication with the host computer over an RS422/485 communication link or LAN (i.e. ARCnet). The RS422/485 link offers excellent noise immunity, long cable lengths and reduces wiring costs. With LAN the increased operating efficiency is achieved.
- The possibility to outline the functions of the application software, thus offload host computer processing time and reduce data link activity (moving control to PLCs).
- The numerous combinations of analog and digital I/O module types.
- Photo-isolated analog or digital power I/O modules.
- The support of different baud rates, simply selectable.
- The possibility of additional programming on the PC with the appropriate development tool (for example: CYRANO visual language).

3.2. PC INDUSTRIAL COMPUTER

Industrial computer can be used as a workstation or a gateway to in-plant communications networks. Engineered specifically for the unique requirements of plant floor environments, the computer has to include following features:

- Passive backplane,
- Dual-fan cooling with removable filter,
- Security door,
- Vibration proof hold-down clamp.

It has to perform reliably under environmental conditions such as:

- Extended temperature,
- Extended vibration and shock,
- Extended voltage transients,
- Extended particulates.

For extremes the computer based on FTSA (Fault Tolerant System Architecture) is required. It protects data integrity and ensures immediate data and system recovery from catastrophic failure. The FTSA PC addresses the primary sources of PC failure - inconsistent power, damaged or destroyed data, user errors and component breakdown - by combining selective redundancy with elaborate diagnostic, regulatory and recovery systems into a synergistic unit, tied together by an enhanced, DOS-compatible BIOS.

3.3. SCADA SOFTWARE PACKAGE

We have made appropriate criteria for the selection of SCADA for supervisory control of a local power system [MRD91A].

- Possibility of the use of programmable blocks which enable the programmer to work with a suitable interpreter. To make the SCADA applicable to supervision and control, it must have besides standard input, output and calculation blocks also trend blocks, PID blocks, on-off control blocks and program blocks.
- Possibility to archive data. Observation of the history enables us to make reports and statistics later.
- Use of standard DOS functions or their presence in the main SCADA menu.
- Use of MMS standard (Manufacturing Message Standard) for the communication with the network. It assures compatibility with the MAP protocol.
- Possibility of the own algorithm development in a higher program language. Supervision and control of local power systems requires the use of optimisation algorithms for the needs of cogeneration units.
- With advantages of DLL (Dynamic Link Library), DDE (Dynamic Data Exchange),

OLE (Object Linking and Embedding), and GUI (Graphic User Interface), the feasibility to operate on the Windows platform is becoming more and more important.

4. CONFIGURATIONS

On the basis of the criteria we decided to use the following equipment [MRD92].

For intelligent I/O devices OPTOMUX units (OPTO22) has been chosen. OPTOMUX units can be configured to operate in multidrop or repeat mode via jumpers located on each unit.

For industrial computers IBM 7541 286/10, IBM 7561 386/25 and TEXAS MICRO 386 (486)/25 have been applied. Features such as a hardened case, filtered air cooling and full function industrial keyboard are included.

On the basis of the criteria we decided to use FIX-DMACS, modern PC-based distributed process control and supervisory control and data acquisition (SCADA) software package, with completely open architecture and on-line configuration.

With this SCADA software package eight applications have been realised in Slovene and two are still in progress.

Computers IBM 7541 were used for smaller applications, while for large and complex applications IBM 7561 and later TEXAS MICRO 386 (486)/25 were used, according to the requirements of specific applications. For process control applications FIX release 3.01 is accepted as a standard, while for distributed process control DMACS release 2.1 and the local area network Token Ring 16 Mbits/sec or DECnet speed 10Mbits/sec are applied.

INTELlution software (FIX and DMACS) was used for process animation, data archiving and collection, automatic elaboration of reports and implementation of our own programs in C language (a program package for load management that has been developed in our department).

A problem that we always faced was the DOS barrier of the first 640 KB. It was overcome by QEMM 386 driver on 386/486 computers, which runs itself, progress database and all background programs in expanded memory. On 286 computers an INTEL ABOVE card/2 MB of LIM 4.0 standard was used.

5. DESCRIPTION OF INSTALLED (APPLIED) SYSTEM IN THE PULP AND PAPER MILL "GORIČANE"

In the factory local heat and power system a microcomputer system is installed. The functions that are provided with this system are:

- monitoring of natural gas purchasing and transforming from main pipeline,
- monitoring of electric energy purchasing from public grid,
- monitoring and controlling of combined heat and power production system,
- monitoring of local heat and power distribution and individual consumer consumption.

Operating of condensing extracting steam turbine is based on heat following method. In order to achieve the cheapest substitution of power from public grid the control system for steam turbine condensing part is set. This system controls operating of steam turbine according to the built in tariff system.

There are two possibilities for steam turbine controlling:

- automatically, control system directly drives the turbine without operator confirmation or
- manually, operator is informed for optimal operating by control system but the final decision is left to him.

At the same time the programs for data continuous monitoring and archiving are upgrade. They include several tasks that were found as useful for factory energy management:

- monitoring of fuel and power consumption and peak load achieved
- elaboration of daily and monthly reports for power purchasing, production and energy supplying to local consumers including the evaluation of energy transformation efficiency.

Historical database was found very useful for factory and energy management. It is

especially used by quality control (estimation of specific energy consumption) and maintenance department, as well.

The described application, besides the improvement of overall energy efficiency on the factory level, has also showed its value in comparison with state of energy monitoring and controlling equipment in paper mills of neighbouring countries in West Europe.

6. CONCLUSION

In this article we have proposed some basic configurations in order to facilitate the selection of the equipment, required for efficient energy management of smaller local power system, to the user. However, the fast changing world of control made SCADA systems less expensive while functionality is increasing. Therefore the world trend in this field is tending to more distributed process control. In addition, with advanced technologies and adding intelligence, the control is moving to lower levels, even down to sensors.

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