Synthesis of DCS in Copper Metallurgy

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***Abstract* –Many technological processes in production plants demand transfer of information and interaction with the process from remote distances (from control centre, for example). To satisfy these requests, sometimes a complex computer network has to be generated, like a distributed control system (DCS), a type of LAN with local and remote process monitoring and control functions. This paper presents results of development a low cost and easily applied both, hardware and software solutions for process monitoring in Copper Mining and Refining Complex – Bor.**

***Keywords* – monitoring system, process control, computer network, real time**

I. INTRODUCTION

Department for Industrial informatics in Copper Institute – Bor produces industrial computer systems. As a core of the developed monitoring and control systems, the third generation of MMS (Microprocessor Measuring Station) is in use. This is a specific industrial PLC (Programmable Logic Controller), which is fully designed and developed in Copper Institute. Classical PC computer is the remote workstation, and allows the interaction between operator and process. On the PC runs the own developed, dedicated software for real time operation, with standard SCADA (Supervisory Control And Data Acquisition) functions, adapted for use in network environment.

The 'Copper production line' is a complex organizational unit of Copper Mining and Refining Complex (RTB) Bor. There are a couple of production plants. The technological equipment at all plants was very old with a poor process control systems. In most of them using the local monitoring systems are quite satisfied. Those systems are based on MMS and interactive PC, and implemented at all key production lines. On this way, technologists can follow the process outline in the plants their own. And the performance was satisfactory. But, the whole copper production process is match complex and very often needed more information's about parameters from some remote plants. This is the main reason why the integration of these partial systems into industrial Local Area Network was carried out.

That's become an industrial distributed control system (IDCS). In such way distributed system for monitoring of all key phases of technological process was formed. The design of the implemented distributed system has been dictated by practical requirements in the concrete application.

II. HARDWARE PLATFORM

To choose the hardware infrastructure to build up the network, it is useful to present basic characteristics of network nodes and the way of it's operation. The system consists of a few couples of industrial automatic measuring stations (PLC, Data Logger etc.) and a couple of PC's. The PC's are used for monitoring and interaction with the process (checking actual state of parameters and remote control). In a general case, for distributed processes a large number of PLC's are required to perform measurement of process parameters, data acquisition, control and transfer to the host computer (PC). Data about status of the process are transferred from the place of origin (PLC) to decision-making place (PC). On PC this data being processed and results presented in proper form on the screen and stored in external memory. If the system performs remote control function, depending on the status of the process, PC sends commands to PLC, which causes appropriate actions and affect the process. Apart from effects on the process, commands have their effects on PLC itself: testing its functionality, time synchronization etc. Designed and implemented network has to satisfy several basic requirements: to provide correct and efficient data transfer from PLC, to execute timely transfer of commands to PLC (while the command is active and actual), to realize supplementary transfer of data from PLC in case that there are any faults in normal transfer [1].

The core of a process control and monitoring system is MMS. It is based on Motorola 68HC11 micro controller. Main characteristics of MMS (standard configuration) are: micro controller Motorola 68HC11E, intern eight channel, 8-bit A/D converter, 64 analog inputs, 64 + 64 digital state signals (input + output) with mutual point (or independent). RS232 communication port, 48 (56) KB for data (RAM), 16 (8) KB for software (EPROM). Local display and functional keyboard gives a possibility of device control, time synchronization and start of measuring. MMS can work independent of monitoring computer (PC based system) and can control the process itself. It can also work like data logger, and memorize over 3000 data messages in local RAM, and later, when connection with the monitoring PC is established, transfer them to PC.

Because of costs, there was a reasonable demand for using the existing private telephone lines like the hardware network infrastructure, as match as possible. This practically means,

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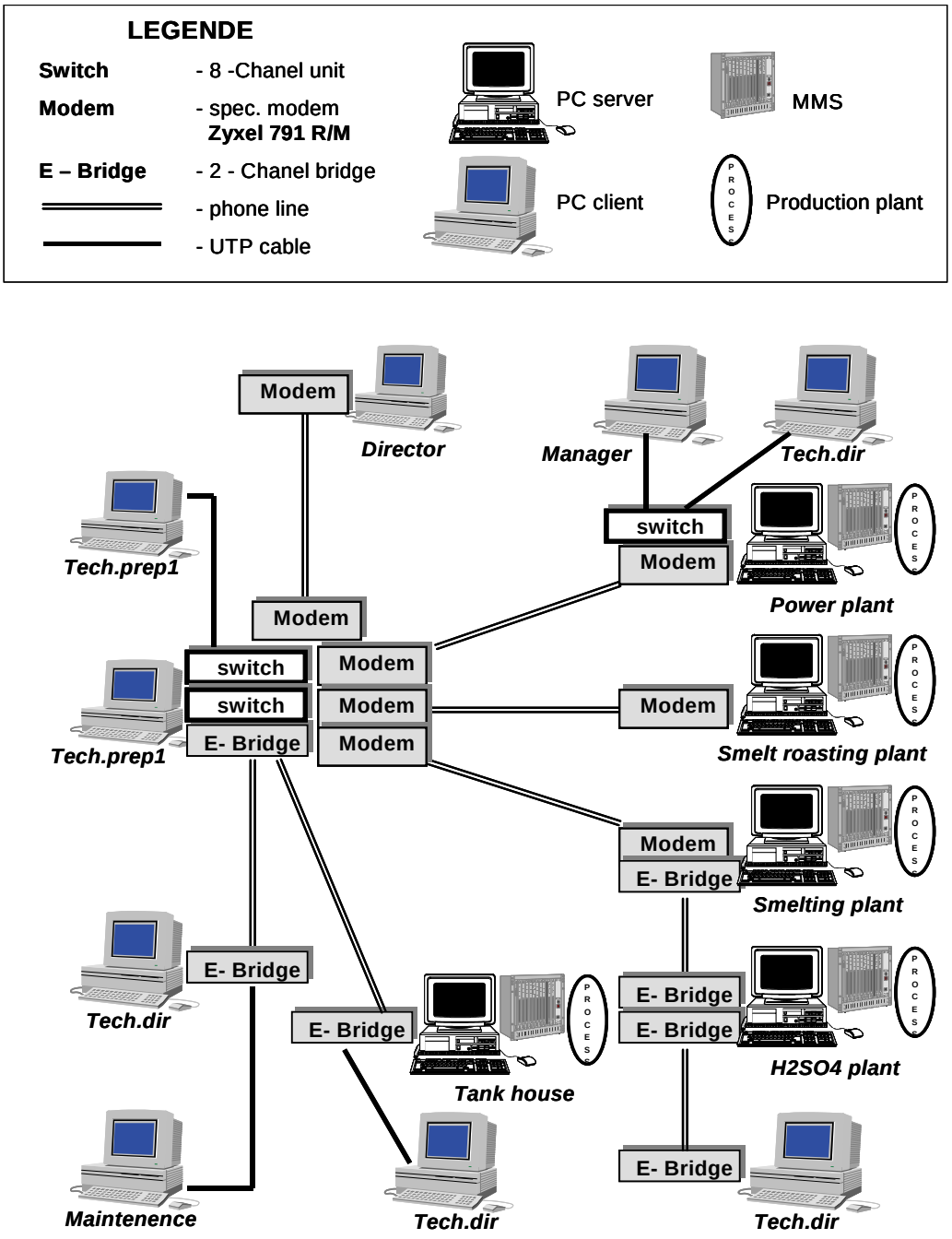

Fig. 1. Block diagram of realized DCS

that some telephone terminals become the computer network nodes. The dynamics of processes request the appropriate response time and this circumstance demands network with satisfactory performances. Building up such network needs a different kind of network equipment: modems, routers, bridges, switches (see Fig. 1.).

III. SOFTWARE ENVIRONMENTS

To control and maintain realized industrial network, the software has to cover the functions on two levels. Regarding the network structure, it is possible to differentiate software solutions at both levels: PLC and PC. EPROM of MMS holds residential software (firmware), which consists of executable versions of test, control, operational and communication software modules. Operational program module is responsible for measuring of analogue channels and checking states of digital inputs. Type of measuring, sampling rate and other parameters can be changed using local keyboard, or commanded from a monitoring PC. The message is transferred to remote PC, or memorized in local RAM (if PC is disconnected), so it can be transferred later when the

connection is established. MMS can work independently of monitoring computer, so local process control is also possible. If any parameter exceeds given limits, it causes alarm message, or even better, if any parameter shows trend of reaching limit value, it firstly can cause warning message, so the operator, or the system itself can react on time. In MMS control program (executive system) there is a complex communication module. It contains the procedures for handshaking, data transfer, transfer control and recovery, and regular disconnection. That is a kind of protocol, the own developed ASP protocol [3]. Appropriate process control application for a PC based system is developed using Microsoft Visual C++ 6.0 development kit [2], and it's main characteristics are: communication with MMS, data processing, data presentation, process control, data archiving and off-line analysis and interpretation of data.

Interactive SCADA program contains a part (unit) for communication. There are a few procedures writing in assembler and refereeing to the physical port addresses. The monitoring and control program runs very stabile under Windows 98. The client version runs on both Windows 98 and Windows XP OS.

The application communicates with MMS as a secondary network node (PC is a master) using ASP (Asynchronous Serial Protocol). The data can be displayed in real time on dynamic synoptically screens, real-time graphs or in tables. All data are saved in database in three forms, as: daily reports, monthly reports and log files. The history of the process can be displayed in a same manner as in real time. In order to get better performance, user can change process priority, comparing to other active applications on PC, from low to real-time priority. In high or real-time mode, application performances are very stable. Additional facilities are also possible, such as: on line changing of measuring range, changing alarm limits, scaling the axes at the real-time diagram etc.

IV. NETWORK DESIGN

The realized DCS is built up from a couple of sub networks. The sub network is a local plant's monitoring system which contains one, or more MMS and subordinated PC's. This PC can work as local server, workstation, or both. The industrial network is constructed from heterogeneous nodes, PC's and MMS. The PC's in the network can run in different mode: some of them are servers (local), and other is clients (remote monitoring terminals, see Fig. 1.). All of PC's run under Windows OS, and uses its network performances.

The system monitors process at five key plants of the Copper Mining and Refining Complex – Bor: Copper Smelting Plant, Converters Plant, Tank House Plant, Sulphur Acid Plant and Power Plant. The network is decentralized, and servers are sited at all of the plants, connected to corresponding MMS's. One server application can run at the time on one server PC, but all client applications can run in multitasking. This gives a possibility of monitoring processes locally and at remote plants at the same time. Also technologists can easily monitor the process flow. The client applications are restricted to monitoring only, and all control functions are disabled. As the distances between some network nodes are greater than 3 km, leased telephone lines are used as transmission lines. The second reason is that they already existed, so this solution was cost effective. The next step was integration with system for air quality control, that was carried out successfully. The simultaneous display of process parameters and concentrations of pollution substances is very significant for control of air pollution in town zone.

V. WAY OF OPERATION

The technologists, like a process engineers have to monitor their own plant using local sub networks at local server PC. But, sometimes they really need the information of process parameters from the other (remote) plant, because of interdependence between production lines. In this case on the same PC (local server), the client version of SCADA has to be activated. Now there are two independent programs (local and remote SCADA) like two windows services, running concurrently. If there is a need, it is possible to activate many client programs at every PC, but only one server, and it has to be the appropriate one. There are many differences between server and client programs. The main one is the possibility of interaction and sending commands to MMS and process. Because of decentralized network control, and chance to make some confusion in changing the system configuration and action to the process, the number of functions on client version is significantly decreased. There is shown in practice that the massive data transfer (sometimes it is necessary to take a lot of historical data from remote server) is very slow if PC works under Windows XP OS.

VI. CONCLUSION

The described monitoring system has been implemented for over a year and shown as very efficient. All of local and remote systems give timely quite sufficient useful information, and technologists make the improvements resulting in better productivity. Its significance became even bigger, by integration with air quality monitoring system. As the air pollution in town (imission) is a direct consequence of technological process, interaction between these systems is very useful.

Apart from favorable price/performance ratio, functioning of realized network has shown to be very reliable and especially resistant to poor communication conditions, thanks to solid transfer quality control.

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