THE TECHNICAL ENDOWMENT, AT DHA LEVEL, NECESSARY FOR DISPATCHING CONTROL OF HYDROPOWER PLANTS AS PART OF A COMPLEX HYDROPOWER ESTABLISHMENT

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Abstract. This paper wants to present some aspects regarding to the technical endowment from the point of view of the needs for the dispatching control of hydropower plants as part of a complex hydropower establishment. These aspects are part of the contribution of ISPE at the MAREA research project, developed under CNMP management.

Key words: endowment, operative control, hydropower plants

1. INTRODUCTION

This paper aims to present several elements that define the necessary technical equipment for Hydro Power Establishment Dispatchers for dispatching control of the hydropower plants/ facilities within a complex hydropower cascade establishment as topic of the "Distributed Intelligent System for technological resources management of a hydropower establishment - MAREA" project, which belongs to the thematic area S / T according to Schedule/Program 4 -"Partnerships in priority areas".

2. OBJECTIVES

Recommended hardware configurations and technical facilities for the data systems for the Dispatching System for operative control of SEN should be in accordance with the principles and requirements of the "open systems" and with the requirements for the implementation of SCADA, EMS, DMS, HPMS or PPMS functions that are to be carried out by each dispatching control centre [1,2,3,4,5,6,7,8,9].

3. RECOMMENDATIONS FOR HARDWARE FEATURES OF HYDRO POWER ESTABLISHMENT DISPATCHERS (DHA)

The hardware endowment for the Hydro Power Establishment Dispatchers (DHA) is designed in a distributed, modular manner, redundant for the vital operating functions. The System should allow to be further extended and reconfigured with a minimum investment, both as a first step, and after the final stage, due to the necessity of new functions implementation or more performing technologies use.

Hardware configurations and technical facilities recommended for the final stage of data systems should be considered as maximum. At various stages of design or after the first stage of implementation, the number and destination servers and workstations will be updated depending on experience, which functions implement, and performance and hardware costs that will be presented at auction. In Fig. 1 is a schematic diagram of HPMS / SCADA Computer System from DHA's, the final stage of equipment.

Thus, in accordance with the schematic diagram, it is considering the eondowment with the following main equipment:

a) - In the Operational Area of the HPMS/SCADA Data System from DHA:

- 2 Servers for Application;
- 2 System Servers (Communication and Resources Administration in LAN)
- 2 Communication Servers/Routers for Data Acquisition and Exchange with RTUs from installations or with Data Concentrators and with the informatics systems from DEC, DET, DED;
- 1 Workstation - Supervisor Position - equipped with 2-3 color monitors, keyboard and mouse;
- 1 Workstation - Operator Position - equipped with 2-3 color monitors, keyboard and mouse;
- 1 Video Projector Sytem, with minimum 6 modules;
- 2 printers and 2 hard copies directly connected to the LAN or via terminal servers;
- a synchronization system;
- the number of Routers / Switches needed to ensure the interconnection of equipment located in the Operational Area of the HPMS/SCADA Data System from DHA and to perform data exchange with the Non-Operational Area of the HPMS/SCADA Data System from DHA.

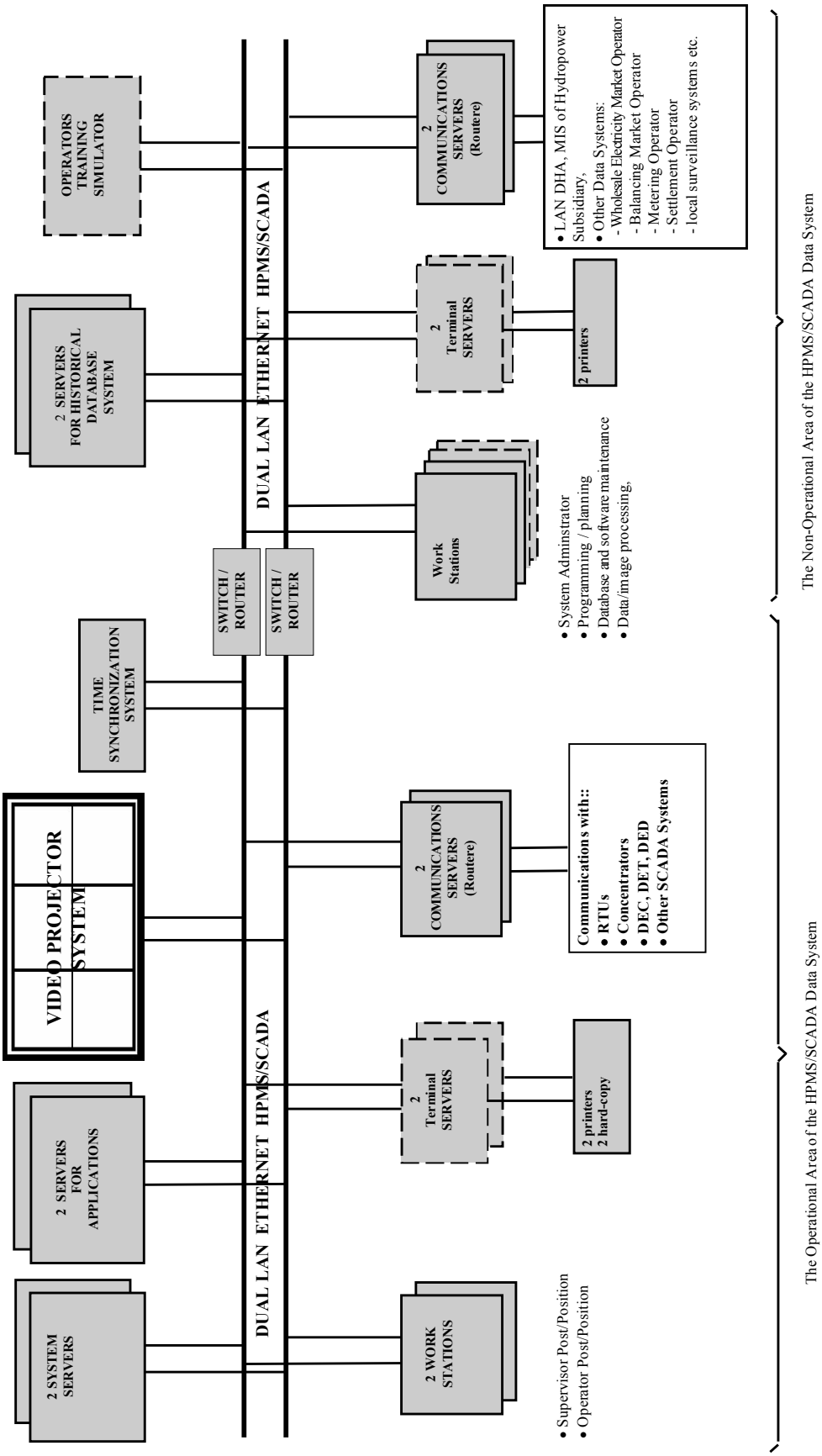

Fig. 1- Schematic diagram of HPMS / SCADA Data System at DHA level.

b) - In the Non-Operational Area of the HPMS/SCADA Data System from DHA:

- 2 Servers for Historical Database System (HIS);
- 2 Servers / Routers for Communications with MIS System of Hydropower Subsidiary and other data systems: Wholesale Electricity Market Operator, Balancing Market Operator, Metering Operators, Settlement Operator, telecounting systems in instalations, local surveillance systems (intrusion, fire, video surveillance, etc.).
- a needed number of workstations - equipped with color monitor, keyboard, mouse, eventually printer, for the following activities:
  - administration/management of HPMS / SCADA System;
  - programming / planning;
  - database and software maintenance;
  - data/image processing, etc.;
- the number of switches needed to ensure the interconnection of equipment located in Non-Operational Area of the HPMS/SCADA Data System from DHA;
- 2 printers connected to LAN, directly or through a terminal server.

The power supply of components of HPMS / SCADA Data System from DHA will be done mainly through a UPS System which should ensure the functionality of its critical equipment during temporary unavailability of electricity supply from the main power supply network.

4.- TECHNICAL REQUIREMENTS FOR HARDWARE AT DHA LEVEL

Ultimate goal of remote monitoring and management, under safe and great reliability, required by the specific activity of geographically dispersed power installations/equipment, operating in specific environmental conditions, have imposed that designers and equipment suppliers of data systems for the operative control of SEN, to know and to comply with a number of specific technical conditions.

4.1. General Technical Conditions

The General Technical Conditions for the Dispatching System for operative control of SEN are mainly the following:

- Utilization of high performance equipment supplied by experienced and well-known companies or by other companies able to supply equivalent equipment;
- High technological level including adequate availability and reliability.
- Operating at the rated parameters under temperature and humidity conditions existing in the power installations respectively under existing electromagnetic disturbance conditions - according to the specific of each location.
- Modular configuration has to allow the observance of the requirements related to the further extension of the information collected and sent.
- Control of the correctness of the data exchange through error detecting codes.
- Warning related to the damages occurs at equipment, supply sources, transmission channels.
- Make audible warning and / or visual, ie to integrate the alarm system required by the operation / installations operation, respectively by the Dispatch Center;
- Extension possibilities without important constructive changes.
- Self-testing and self-diagnosis capacity.
- Possibility to perform: rapid replacement of damaged components, repairs, revisions etc.
- Transmission maximum time (from the control starting in the central point up to the most distant reception in the electrical substation):
  - 1 s for remote control;
  - 5 s for remote adjustment;
- Maximum interval of time for update:
  - 3 - 5 s for main remote measurements;
  - 30 s for secondary remote measurements; for some secondary measurements used outside real time, the maximum period of time for renewal may exceed 30 seconds;
- Maximum interval of time needed by the operator to be informed on the remote signalings:
  - 2 - 5 s in the case of major state remote signallings (alarming, incident, circuit-breakers positions);
  - 20-30 s in the case of minor state remote signallings (positions or preventive states);
- Conversion accuracy for remote measurement: maximum error of 0.4 %;
- Time accuracy imposed to the events recording:
  - 10 ms resolution;
- System total reliability class: R3 (MTBF> 8760 h) according to IEC 60870-4;
- Total system availability shall be at least 99.95%: class A3 according to IEC 60870-4.
- Maintainability class: M4 (MTTR < 6 h) according to IEC 60870-4.

4.2. Technical Conditions related to the Data System Architecture

The design and accomplishment of the Data System for the operative control of the power installations pertaining to SEN will be in accordance with the “open and distributed architecture”, the system modular development and distributed performance of SCADA, EMS, DMS, HPMS or PPMS functions as well as of the pertaining data basis.

It will be ensured the redundancy for the data system operation vital functions performance and the possibility to accomplish the extension of the system and the changing of its configuration with minimum investment both after the first stage and after the final stage as a result

of further needs to implement new functions or improved technologies.

The System will allow the extension and gradually implementation of hardware equipment and software products as well as their modular integration. It will be considered an easier maintenance of the system components, their replacement and development with minimum impact on the other modules under operation and the utilization of modular software packages as well.

The main requirement is not to depend on a single supplier.

The above mentioned aspects impose the necessity to use standard interfaces, protocols, software packages, communication physical media, structures by abstracting levels, data basis management systems, operation systems, control applications etc.

4.3. Technical Conditions for the Data System Components

The servers, workstations and interface equipment will be connected within a local network (LAN) representing a unitary system dedicated to the operative control and supervising of the installations belonging to respective unit.

The accomplishment of this system is based on the observance of the following conditions:

- Must exist the possibility to extend easily the Data System and to communicate with the external systems, by observing the international standards.
- Distributed operation; to be ensured the possibility to process the data in parallel so that to complete the system with new components and new functions.
- Utilization of standard components.
- Easy maintenance of the Data System with least costs.
- Utilization of a worldwide used operation system.
- Utilization of software programs present on the world market.
- Redundancy dimensioned for the performance of the vital functions.
- Availability and operation reliability with minimum hardware and software endowment.

It is recommended to use servers based on the same type of computers, "open architecture" allowing an easy maintenance of the hardware equipment and software and to provide necessary redundancy for critical system functions.

It is also recommended, that for the workstations to be used a single type of computer workstation, their equipping being however dictated by their assigned functions.

Equipping and technical characteristics of servers and workstations will be set depending on the application and will be specified in design documentation, respectively, in the tender specifications/documents.

In order to record and print the events, alarms, reports, diagrams and other components established by the user the possibility to use printers, copying devices, plotters etc. have to be ensured.

The connection of these devices can be performed at any working place provided in the diagram. They will be used for the editing of measured value lists, information and alarm lists, reports, lay-out diagrams, drawings, maps etc.

There are preferred laser and color printers for the printing on A4 and A3 normal paper which can be used without imposing restrictive conditions.

No information will be lost due to the lack of paper or the damaging of any printer.

Each operation post will be equipped with the needed color monitors, keyboard and mouse. The monitors and keyboards will be of the wide worldwide used type, ergonomic, robust and adequate for compatible connections with the other equipment.

The users interface is ensured by the workstations / consoles with full graphics, with high computing capacity that would allow to the operator to interface with the entire Data System and to provide features for editing, surveillance and remote control on the equipment/installations.

User interfaces should not be redundant, since each equipment in this category is redundant to the other.

Dialogue between operator and computer system must be made online, by console operators. Consoles / workstations are equipped with one, two or three high resolution monitors, keyboard, mouse, printer, depending on destination consoles.

The interface needs an almost unlimited image surface for the representation of maps and diagrams spreaded on several screens and windows.

The graphical information will have to be represented on several levels and scales. Within different utilization levels it must be allowed the performance of images, data banks generation, system maintenance etc.

For each level it has to be ensured the possibility to automatically command the diagram displaying including a certain detail corresponding to the given moment. For instance, a diagram of an electrical network may have, at the same time, several "layers" which can be visualized simultaneously or exclusively at any zoom scale. The layers can be the distribution network represented by voltage levels, the geographical background, details of substations, equipment images etc. The representation of the electrical lines and of the bus-bars of the substation can be dynamic as well as the equipment symbols. E.g., the electrical lines under voltage or their loading degree can be represented with distinct colors and easily visible.

The graphical functions will be used besides for the representation of the electrical diagrams of the network also for presentation of different information lists such as: alarms, signallings, hours, uncancelled alarms, system errors, logbooks etc. for the displaying of the present and historical data related to the process state. The lists will be up-dated by certain rules or when events occur.

Time synchronization System refers to clock time synchronizing as part of the computer system. Depending on the existing/ available telecommunications infrastructure, it will consider, as appropriate, one of the following (there are also allowed the hybrid versions):

- GPS-based synchronization or an equivalent System: each network node has its own clock, generated by its own oscillator. The frequency drifts are maintained within acceptable limits by taking periodic information of the exact hours from the GPS system / equivalent system.
- Sync with single reference clock (master) is assumed a Clock generator information, unique across the network, accurate and very good; clock information / signal must be distributed to all other nodes through dedicated channels.
- Master-slave synchronization: is a technique derived from the previous one. In contrast, however, the information / signal generated / derived from reference clock (master) is transmitted on dedicated connections only to certain nodes, considered as high-level into the synchronization plan. These nodes retransmitte this reference to other nodes, on the same level or a lower hierarchical level in terms of timing. In such a hierarchical sync plan, one node node can receive the reference from multiple nodes (usually two). Thus, in case of lossing of designated as primary reference, it will still work based on the secondary reference,

The hubs, switches and routers for interconnections and connections will be standard ones able to ensure the operation of the System according to the descriptions made and dimensioned in compliance with the complexity of the System.

Terminal Units and IEDs are intelligent devices, acting for the data acquisition, storage, and processing and data transmission. Their family is large, conceptually different from firm to firm, with larger or smaller facilities.
They must be based on standard elements / modules, in order to ensure a quick and easy reconfiguration and expansion for the development of energetics installations or to amplify the amount of information collected.
Capacity and characteristics of these devices will be defined in the tender documents, for each installation / equipment.

5. GENERAL REQUIREMENTS FOR SOFTWARE AND DATA BASIS

5.1. General Requirements for the Software

The software is included in the technical endowment of the operative control. It will consist of the Basic Software and the Application Software.

Application Software is in reference to activities in real time and out of real time.

The Basic Software is defined as the assembly of programs for the operation of the computing equipment and of the system as a whole, for the management and control of the distributed applications execution and of programs assisting the users in preparing and controlling the applications; must be ensured by the main supplier of hardware equipment of the Data System.

Operating System software is the main component of the computer network through which all resources are managed (files, peripherals) and are provided protection services between users, communication between workstations, applications, access to shared resources etc.
Operating system must be powerful, flexible and widespread, adaptable to different needs, to provide simultaneous access to multiple users, a good ratio performance/cost, to be standardized and ensure independence from manufacturers. Usually will opt for Unix or Windows - like operating systems with real-time facilities.

Applications software for Data Systems for the operative control of the power installations pertaining to SEN must be characterized by the following attributes:

- Response time, including the time interval starting from sending of a request until it is met by the system, to be of 10 ms order in the case of state values changing;
- Utilization simultaneity: the system has to assure multi-user and multi-tasking facilities.
- System Efficiency to use under an optimum manner the available resources.
- Distribution and Security: the users may use in common the information existing in the System and to communicate between one another safely (i.e. to avoid the unauthorized access and the information alteration either on purpose or by accident).
- Availability and reliability: The damage of one or more components does not allow the break down of the entire System, maintaining the critical functions alive.
- Generality, flexibility, extensibility: new software components can be introduced without involving additional designing and programming; the system can be adapted to a specific configuration and the programs will be horizontally and vertically modular organized.
- Transparency and visibility: it allows to the users to obtain certain information necessary for a more efficient utilization.
- Favorable performance/cost ratio.

5.2. General Requirements for Data basis Organization and Management

Data basis will include the data organized by criteria related to the maximum independence of the applications towards the data. This independence is obtained through an information architecture consisting of several data basis description levels.

It will be considered the concept of Integrated System ff Data Basis Distributed and Oriented by Objectives representing a sum of collections of data which can be identified and distributed by different available processing components. This concept must be adopted for the design of the data basis system considering the large volume of data, the geographical structure, the restrictions of performance and availability as well as other factors supporting the integration of the data basis.

The Distributed Data basis Management and Organizing System shall offer each user from any processing component an integrated vision or diagram by

means of which he will have access transparently to the data placed in different computers.
The structure of the Data Basis System will be oriented towards a relational model including data storage in real time and the management of a large number of copies of the content.
The computing programs will use the original data of the data basis or any of the copies available.

The Distributed Data Basis Management System will offer facilities related to construction, utilization, maintenance and development. It will ensure:

- Continuation of operation despite damages. The users will be able to keep on the performance of up-dating operations on redundant copies even if some copies are inaccessible at that time.
- Dynamic integration of new nodes. The dynamic extension and reconfiguring will be done without system stoppage.
- Independence of physical data - the data basis manager will change the parameters which need physical distribution and the access/storage structures;
- An integrated global diagram including all the objectives of the data basis and the list of data distribution.

The Integrated Data Basis System, distributed, structured by objectives represents a "mirror" of the monitored network and includes also a large amount of information for a variety of application programs which must be implemented in the system.

The performance "in real time" of the advanced application programs (type functions of EMS, DMS, HPMS, PPMS) imposes a rapid access to the useful data and an adequate browser.

The programs for processes simulation need some parts of the "real time" situation for an analysis "further on" and for optimization.

The need of data exchange between the different data basis placed distributed is higher and it imposes the utilization of adequate standard communication procedures. The specialists have to consider the need to create Data Basis in real time, distributed, and specially designed for applications in real time. It will be taken into account a Management and Organizing System for data basis largely used worldwide able to combine the rapid access of high level with the hierarchic data structures and provide a data access standard manner.

RDBMS must be within the commonly used worldwide in information systems for dispatching operative control data systems of SEN installations/equipments.

For the performance of data basis of the installations and equipment pertaining to the dispatching operative control data systems of SEN, GIS technologies are recommended in accordance with the requirements of each management unit in hand.

6. CONCLUSIONS

The design and accomplishment of the Data System for the operative control of the power installations pertaining to SEN and by default also for DHA will be in accordance with the "open and distributed architecture", the system modular development and distributed performance of SCADA, HPMS functions as well as of the pertaining data basis.

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