Role of Information Technology in Energy Management

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Abstract:
The Information Technology (I.T.) supported Energy Management and Control System (EMACS) represent a departure from designs historically associated with energy management systems. With the help of I.T it is possible to integrate the planning, monitoring and control of the power process and management of energy sharing between surplus and deficit regions. These EMACS inherently provides a data collection system that is useful to a variety of other users not associated with operation and dispatching. To meet the needs of these users the EMACS includes an Operations Information system (OIS**)** that can support programs and displays identical to those provided to power system dispatchers. The OIS however, is intended to be used by personnel in distribution zone offices, power plant control rooms and a variety of other departments. The paper discusses the role and reasons for inclusion of the OIS for energy management as well as alternate implementations.

1. INTRODUCTION

Soaring electricity demand throughout the fast developing Asian nations has given rise to a new emphasis on independent power and energy management .In the increasingly industrlised, automated, and high technology environments of the worlds booming economies, particularly those throughout Asian countries national growth has become inextricably tied to electrical power. Energy scenario calls for reforms. The present energy scenario in India calls for fundamental reforms rather than cosmetic approach to ensure that the future requirements are met without much strain on the system. Total understanding of various problems related with the energy system, planning effective utilization and its conservation has become very important.

The capital investments in power plants, substations, and transmission and distribution networks are enormous. If it is possible to utilize this system better, with lower losses, fewer disturbances, with higher loads and over a longer lifetime, this means a significant improvement of the total economy for the power system. I.T. in itself does not give any extra mega Watt hours, but it can provide the necessary information to improve both the efficiency and quality of the power process.

Energy utilities see information technology as an important tool to enable them to improve the efficiency of transmission and distribution networks, as this technology may be used in all parts of process planning, operation and maintenance. The aim is more efficient, reliable utilization of power system, with maximum Life Cycle Economy. Powerful microprocessors have made the use of more intelligent devices possible throughout the power system. Intelligent meters with variables tariffs in houses, load control receivers to reduce peak loads, adaptive control and protection of substation, automation of processes, computer aided testing and performance analyses are some examples. Information technology can be seen as a tool to integrate all these functions and can reduce the operating cost by proper energy management and can increase the revenue.

The new EMACS incorporates state of the art SCADA, full graphics Multi Media Interface, real time database, and application program systems to allow it to extend its capability in operation of the power system. In addition to this, the EMACS includes a unique work and maintenance environment provided by directly attaching an Operations Information System **(**OIS**)** to the main processors of the EMACS. Diagrams of the EMACS are given in Appendix A. The OIS has been added in recognition of the fact that data collected by an energy management system is inherently useful to other departments. The OIS supports a copy of the real time data base and application program data files and runs programs such as:

- Power flow management
- Substation management
- Post Disturbance Analysis
- Historical Data Retention
- Generator Performance Records
- Energy Accounting
- Operations Reports
- Distribution Circuit Analysis
- Information Retrieval and Analysis
- Load Flow studies

OIS remote consoles will be installed at distribution zone offices and power plant control rooms as well as supporting consoles at other company facilities for use exclusively by engineering departments and remote terminal unit (RTU) maintenance staff. The OIS is characterized as providing information for the user organization and not direct control of the power system itself. The man-machine interface attached to the OIS supports one- line diagrams, tabular and trend displays so that support and engineering personnel can take advantage of the entire database at their disposal. By incorporating the OIS, it has demonstrated the fact that the trend in energy management systems is not only in the direction of more advanced application software, new display technologies, etc.,

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but also that the on-line information gathering and data base capabilities of the EMACS must be provided to a wide group of people who support the EMACS and maintain the power system itself.

II THE EVOLUTION OF A MODERN ENERGY MANAGEMENT SYSTEM

Energy management system (EMS) includes the constant monitoring of the fuel delivery system, generating units, and transmission and distribution systems. So it has meant that important data can be made available to departments other than the operations department. The usefulness of the data being gathered by the EMS has led to an increase in demand for more points to be monitored by the SCADA system.SCADA stands for supervisory control and data acquisition system and is an essential backbone of the energy management and automation of the power system.The control and distribution of power system data is monitored in real time through SCADA and it consists of a central host or master unit(MTU) ,remote terminal units and collection of software to monitor and control remotely located field data elements. In addition, large computer resource requirements meant that much of the long range fuel scheduling be done off-line in the corporate data processing computers rather than in the on-line system. Similarly, many of the programs that use historical data files taken from the real time system must transfer data via storage devices to data processing computers where they generate reports for use through out energy management system

The question as to whether the new EMACS would continue the practice of using off-line computer facilities led to a study of performing these functions in the real time system versus the present practice. However, once committed to including off-line functions in the real time, system was faced with another problem: how to provide near real time information to the many groups outside of the operations department without adversely affecting real time system performance. There is also the problem of how to guarantee that persons having access to the system for reasons other than real time operation will not inadvertently cause errors in the operating functions themselves. To provide adequate performance for the large off-line programs and terminals in use by people other than operations personnel, EMS opted for inclusion of the Operations Information System. The OIS consists of additional mainframe computers in the EMACS that are dedicated for use by personnel from other departments and are connected to the real time system via a direct data path. Requiring separate computers for the OIS helps to solve the problems of system performance and isolation, and also allows the OIS **to** grow and evolve at a different pace than that of the real time computers.

III. THE OPERATIONS INFORMATION SYSTEM

The real time control of the EMS system is in the hands of system operators who use the system from a variety of terminals. An intelligent electrical substation is a good example of applied Information Technology. A rough breakdown of the terminals attached to the real time system and their functions are:

1. SUPERVISION: Management of all operations functions.
2. EDC: Includes operation of the Automatic Generation Control System, the Economic Dispatch and Fuel Dispatch Systems and scheduling generation using Unit Commitment.
3. ADMINISTRATIVE RECORDS: Collecting data having to do with sales and purchases of fuel and power.
4. ENGINEERING ANALYSIS: Studies of current operations problems using Optimal Power Flow and Security Analysis programs. Maintenance and testing of real time system data.
5. SYSTEM OPERATIONS CONTROL: Switching operations.
6. PROGRAMING: Programming support.
7. SCHEDULING: Scheduling of load and contingency analysis.
8. MAINTENANCE: Maintenance of hardware and communications equipment.

The purpose of the OIS is to provide data and computer resources to departments other than dispatching. A list of other departments and their anticipated use of the OIS follows:

1. POWER PRODUCTION DEPARTMENT: Through terminals in power plant control rooms, plant operators can be made aware of anticipated movements and voltage schedules on their units. In addition the plant operators can enter miscellaneous supplementary data values directly into the OIS as well as needed energy data from the plant. The inclusion of anticipated movements on units is expected to yield better scheduling of unit auxiliaries and better scheduling of minor unit maintenance. Since the plant operators will have access to system one-line diagrams, they can bring up plant substation diagrams as well as diagrams of nearby stations. This will give them a better insight into problems existing on the system than now provided solely by voice description from system operators.

2. TRANSMISSION AND DISTRIBUTION DEPARTMENT: Through terminals located in the distribution zone offices, the OIS will promote voltage control of distribution circuits and minimize the reconnect time following a distribution outage. Remote terminal unit maintenance will be aided by allowing maintenance personnel to directly access data indicating failures of points being monitored. It should also be noted that the ability of outside people to access this data without the involvement of the system operator is of great value.

3. ENGINEERING PLANNING DIVISION: Use of the load data gathered by the real time system should provide improved modeling of loads used in load flow and load forecasting.

4. SYSTEM ENGINEERING DIVISION: The OIS provides the same set of network analysis functions (dispatcher power flow, optimal power flow, security analysis, etc.) as is available to the system operators. In addition to running these functions on a snapshot of the latest real time model they can be run using

historical data files retained on the OIS.A partial list of studies would include an examination of overload capabilities of transformers, determination of voltage levels and taps on autotransformers and the identification of over voltage and phase imbalance conditions. Through a link to an engineering load flow engineers can provide an independent verification of load flows run in the OIS and thereby improve the accuracy of real time load flow studies.

5. DISTRIBUTION ENGINEERING: Distribution engineers are expected to use the OIS to improve the power factor on individual circuits, determine peak loads on circuits for both winter and summer loading, determine the design and construction needs for new capacitor banks, reduce labour costs when searching for defective capacitor banks, reduce the number of justifiable high voltage claims and reduce overtime required for substation loading checks.

6. ENERGY PRODUCTION MANAGEMENT: This group manages the operation of all power plants and is expected to benefit from timelier reporting of plant data and to use the data in the forecasting of plant loadings and scheduling of maintenance.

As can be seen from the above list, a large number of people are expected to use the OIS and the benefits expected come from a wide variety of sources. Perhaps most importantly, EMS expects that the OIS will broaden the perception of the power system for many of these people. No longer will plant operators view the world as primarily the plant they are operating plus the voice connection to the system operators. Instead, they can access system one-line and tabular displays and "see for themselves" when problems arise. It is hoped that such use of the OIS will enlarge the plant and distribution operators' view of the system and help them to coordinate their operations with the system operators.

IV.ADVANTAGES OF OIS VERSUS A CENTRAL DATA PROCESSING SYSTEM

There are many arguments for and against the OIS approach. Most utility energy management systems have either a direct data path to the corporate data processing computers or a path via storage devices. It can be argued, therefore, that by expanding the capacity of this data path and adding the necessary software, the OIS function can be added at less cost than the present system chosen. The advantages of the direct implementation of the OIS on separate computers at the system control center come from the fact that the OIS has the same database, software and man-machine interface as the real time system. This means that people using the OIS can perform data base maintenance and testing and have the data transferred to the on-line system-by-system operations personnel. Using the same applications software as the system operators, engineering personnel can study system problems on historical data and assist operators in diagnosis of system problems.

Most importantly, operators at distribution zone offices and power plant control rooms have access to the same one-line diagrams and tabular displays as the system operators. Providing the same capability through programming in the corporate data processing computers would be far more costly and would result in two sets of displays and software to maintain. The disadvantages of the OIS route are the fact that the corporate data processing system is in place and already has terminals in offices throughout the system. Using the OIS approach necessitates some extra communications and installation of different terminals and consoles. Further, other data such as customer billing information may be useful along with the real time data from the control system and this is only available from the data processing department. Given these pros and cons, reached the conclusion that the OIS directly implemented in the system control center had great advantages. It is cost effective also as shown by the studies. The hardware configuration for the EMACS is shown in Figure 1.An overview of the OIS software functions is given in Figure 2**.**

V. CONCLUSIONS

In the past, the electrical power industry has never met such wide and important challenges as the ones that it is facing in this last decade of the century. These challenges have huge and direct impacts on the operation and control of power systems. The new technology related to microprocessors, telecommunications, computers and software engineering offers opportunities to accept this challenge.I.T as a tool allows managing and sharing information between people within the power system.

The Operations Information System represents an added dimension in the implementation of computer systems for the control of power systems. Allowing direct access of power plant and distribution system operators to real time tabular and one-line diagrams brings these operators closer to the operation of the entire system. By placing the OIS in separate computers in the control center the OIS can be isolated from the real time system as well as provide access to the real time system data for **a** wide variety of uses by many departments.

REFERENCES

[I] Trefny, F.J. and Lee, K. Y**.**, "Economic fuel dispatch", IEEE Transactions on Power Apparatus and Systems, Vol**.** 100, July 1981, pp. 3468-3477.

[2]Satya N. Prattipati, Michael O. Mensah, "Information systems variables and management productivity" Information & Management 33 (1997) 33-43

[3]Ronald W.Heron,"Benefits of computerized power management", IEEE conference proceedings 1990.

[4] Crewe A., Paddock A.G., 'Network information management system", Ferranti international plc.

[5]Williams R.I., "Hand book of SCADA system", Technofriends Ltd., 1993.

[6] Mark A. R., "Migrating an energy management system to a networked architecture", IEEE Transactions on Power Systems, Vol. 11. No. 1, February 1996

APPENDIX A

The hardware configuration for the EMACS is shown in Figure 1. A glossary of the abbreviations in Figure 1 is given below.

AGCT Automatic Generation Control Terminal (Special RTU)
CCU Channel Coupler Unit (Mainframe to main came)
CNU Communications Network Unit (Interface to Remote Terminals)
DCU Data Communication Unit (Interface to RTUs)
MCU Man-Machine Control Unit
OIS Operations Information System
PCU Process Control unit (Interface to local hardware, e. g., the mapboard and chart recorders)
RJE Remote Job Entry
RTU Remote Terminal Unit
STI Stall Timer Interface

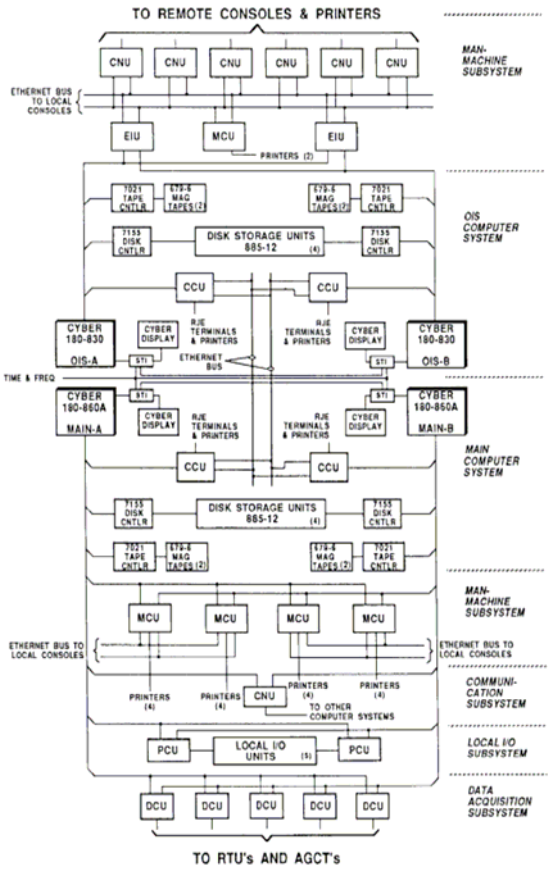

Figure 1. EMACS Hardware Configuration Overview

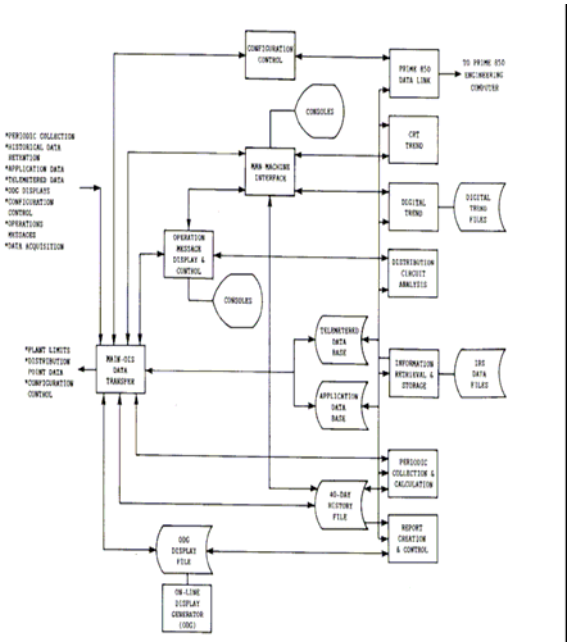

Figure 2. Operations Information System Overview