A DECENTRALIZED PROCESS-ORIENTED APPROACH FOR POWER-SYSTEM OPERATION

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ABSTRACT

It has been pointed out that the problem of "Economic Operation of Electrical Power Systems" is a problem of decision-management. To be able to reach the right decision, the right information is to be made available at the right place, and at the right time. [1J To that end, it is required that the individual tasks involved in electrical power systems, such as economic dispatch, unit commitment, hydro-thermal coordination, etc., be reengineered into decentralized coherent processes.

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INTRODUCTION

"The operation-scheduling problem is to determine which generating units should be committed r. and be available for generation, the 'units' nominal generation or dispatch and, in some cases, even the type of fuel to use. In general utilities may have several sources of power such as thermal plant (steam and gas), hydro and pumped storage plants, dispersed generation (such as wind-power or photo-voltaic), interconnection with other national or international generation companies. Also many utilities use load management-control to influence the loading factor, thus affecting the amount of generation required. The economic effect of operations scheduling is very important, when fuel is a major component of the cost.

In the present state *of* the art, load dispatch is determined through control program stored in the memory *of* the control center computers. The inputs *to* this program are in the *form of* proprietary data-files, comprising the fuel-cost characteristics *of* thermal units, total system forecast, capability *of* generation resources, etc. This program computes the unit commitment order, as well as dispatch *for* individual units, and the results derived by the center computers are dispatched over the SCADA lines *to* the operators who can then accept, modify or ignore the advice received [5].

It is a centralized decision-management system, which may be simpler to handle if the units to be controlled are small in number and the distances involved are not very large. It is important to note that *some components of the system, that are vital for better decision management are either not linked at all or are linked through slow paper links.*

In order to have an appreciation of the complexity involved, consider the unit commitment problem with following assumptions:

- There are M periods per day.
- There are N units to commit and dispatch
- Anyone of the units, as well as all the units can supply the whole load.

The number of combinations to be tried each hour would be

$$C(N,l) + C(N,2) + ...\ C(N,N) = 2^N - 1$$

Where *C(N;j)* is the combination *ofN* items taken *j* at a time

$$C(N,j) = \frac{N!}{(N-j)!j!}$$

which can become a horrid number to think about.. Considering M equal to 24 one hour intervals and a system with N equal to 20 units, this number amounts to 3.12 x 10144. [3] These very large numbers are the upper bounds for the number of enumerations required. What would happen in systems where number of units is more, than 150?

The present advances in the *Information Technology* have enough potential to provide solutions for optimal operation of electrical power systems, with the following benefits:

- Information can appear simultaneously in as many places as it is needed.
- Systems can simultaneously reap the benefits of centralization and decentralization.

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- Decision-making may become part of everyone's job.
- Plans get revised instantaneously.
- A generalist can do the work of an expert.

The overhead on the main center computers can be reduced very much, by reengineering the processes in a logical way. *As an essential enabler, the modern information-technology has an importance to the reengineering process that is difficult to overstate. To reengineer is to take a journey from the familiar into the unknown.* [9]

REENGINEERING:

Reengineering as defined by Hammer and Champy [9], is the *fundamental* rethinking and *radical* redesign of *processes,* to achieve *dramatic* improvements in critical contemporary measures of performance, such as cost, quality, service and speed.

"Processes in a company correspond to natural business activity, but they are often fragmented and obscured by the organizational structures. Processes are invisible and unnamed because people think about the individual departments, not about the processes with which all of them are involved. Processes also tend to be unmanaged, because people are put in charge of the departments or work units, but no one is given the responsibility for getting the whole job — the process —done". [9]

PROCESSES AND PROCESS-MAPS

Just like organization charts, a process map can be prepared that gives, a picture of *how workflows* through the organization. [9] Some very interesting characteristics of a process map may be outlined as follows:

- Simple: A process-map is much simpler, as compared to an organization chart of the same company. Hardly any company contains more than ten or so principal processes.
- Process Owners: A process-map includes process owners; something that is almost never displayed on a company's organization chart.
- End Users: A process-map also includes end-users in its view of processes.
- Sub Processes: A process is not seen as a monolith, but in terms of key-concepts to interact with others. This perspective indicates how a system appreciates it's owners work and how it can contribute to that work
- "Process-maps don't require months of work to construct; several weeks is the norm. But this task does induce headaches, because it requires people to think across organizational grain. It's not a picture of the organization, which is what people are used to seeing and drawing, but a depiction of the work that is being done. When it's finished, the process map should not surprise anyone. In fact, people may wonder why drawing it took as long as it did, since the finished map will be so easy to understand, even obvious. Of course, people should say, that it is just a model of what we do around here." [9]

REDESIGNING PROCESSES

Once a process has been selected and a process owner and user defined, the next step is to understand the process. The following are the key issues:

- What the process does?
- How well (or poorly) it performs?
- Critical issues that govern its performance.

Traditional process-analysis takes the process-inputs and outputs as given, and looks purely inside the process to measure and examine what goes on. In contrast to that, part of redesigning a process is, to look at it from the outside in order to find what the process's customer (the user) does with that output. Therefore, the better place to begin to understand a process is on the user-end. The following questions must be answered:

- Who is the user of this process?
- What are the user's real requirements?
- What do they (users) say they want, and what do they really need, if the two are different?
- What problems they have?
- What processes do they perform with the output?

Since the eventual goal of redesigning a process is to create one that meets user's needs better, it is crucial

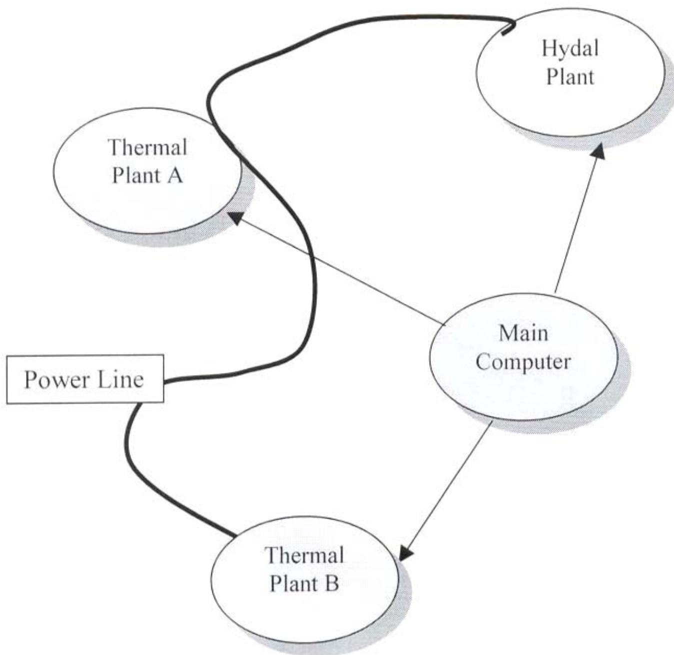

Figure - 1: Control-System Based on Centralized Management for Electrical Power Systems Operations

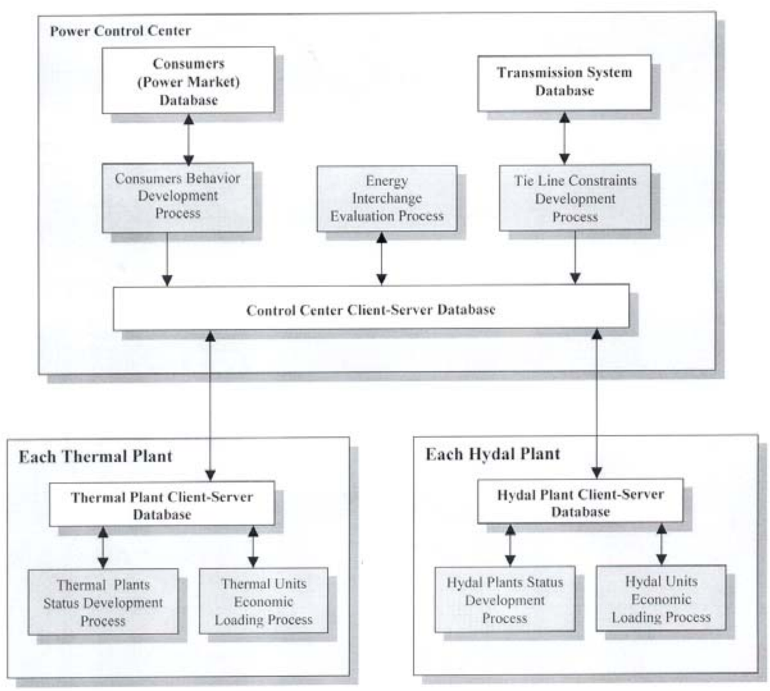

Figure - 2: A Possible Higher-Level Process-Map of an Electrical Power System that the team truly understands these needs. Understanding means considering the user's underlying goals and problems, not just the mechanics of the process that links the two organizations together.

A PROCESS-MAP FOR POWER SYSTEM OPERATION

According to Hammer and Champy [9], one way to identify processes that make up an organization is to give them names that express their *beginning* and *end* states. This implies all the work that gets done between their start and finish. Some processes involved in operation of electrical power systems, are redesigned in the following, with a view to understanding their inputs and outputs.

THERMAL PLANTS STATUS DEVELOPMENT PROCESS

This process would take in the fuel consumption data, scheduled and forced outages, startup and shut-down information, and would identify the units available and their fuel-cost characteristics, as well as minimum and maximum plant-capability, for next 24 hours. The process-owner is each thermal plant. The customer of this process is the main control center.

ENERGY-INTERCHANGE EVALUATION & PLANT-SCHEDULING PROCESS

This process uses the output of hydel status development process and thermal status development process as its input, along with load-forecast at each load-center for next 24 hours, tie-line constraints, and identifies the units to be committed and optimal share of load for each plant. The process owner is the power-control centre. The customers of this process are each power-plant. This is a shared process, which requires a few hops between plants and main control-centre, for its completion.

PLANT UNITS ECONOMIC LOADING PROCESS:

This process would utilize the output of the above process and produce optimal share of load for each of its ONLINE units. The process owner is each thermal plant. The owner of this process is also the customer of the process. This process also requires a few hops between main control center and plants for its completion. Its output would be the operation-schedule for the plant.

Keeping in view these processes, a possible higher-level process-map has been drawn as shown in fig. 2.

CONCLUSION

Older processes of *economic dispatch, unit commitment, load flow analysis, reservoir analysis,* are the individual tasks that may become a part of the larger objective, but they cannot be considered as processes. It can be clearly seen now from the *Process Map,* of an electrical power system, that the components of system-operation may be deceptralized. This would help in arriving at better decisions in a timely and more efficient manner. The presence of high-speed networks has made it possible to employ knowledge-based access of distributed databases.

It is mandatory to *Reengineer the Electrical Power System.* Only then can one take advantage of artificial intelligent techniques and build a *coupled expert system* [I] for solving the problem of "Optimal Operation of Electrical Power Systems.

FUTURE WORK

Economic operation of electrical power systems is an important issue, on which a research project is going on in the University of Engineering and Technology, Lahore, Pakistan, for developing new methodologies, utilizing decentralized artificial intelligence techniques. The present research paper is the 4th in the series. After preparation of the "Process Map", the next task would be the development of architecture of the databases required, and the communication manners in which they would interact with each other.

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