

INFORMATION TECHNOLOGY SOLUTION FOR POWER DISTRIBUTION SYSTEM AUTOMATION

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Abstract—The Power Industry is in the midst of a transformation process—from being Energy suppliers to becoming Energy Service Companies. Everyday the Distribution Utilities face new challenges and have to improve productivity and reduce operating costs and maintenance costs whilst providing customers with a reliable power supply and a board range of services. To achieve rapid success the effective use of Information Technology is essential. The demand-supply gap in power in any country is expected to grow by at least twenty per cent every year. The trend is expected to continue in the near future, with no significant generating capacity coming up in the country, may give rise to a power crisis.

It is thus imperative that power utilities look at increasing efficiencies in distribution networks, which have among the highest transmission and distribution losses in the world at close to and upwards of 30 per cent. In addition, the social pricing for rural and other sectors puts an increasing pressure on utilities to improve productivity as also reduce operating and maintenance costs to remain financially viable.

Our present paper gives the IT solution which will enable the business operation at the transaction level and improve the overall quality in Decision Support System. Information Technology (IT) would thus become the foundation for sustainable reforms.

Index Terms— SCADA,GIS, MIS ,Distribution Automation ,Information Technology (IT)

1. INTRODUCTION

With the advances in telecom and Information Technology(IT), the new millennium has leapfrogged into a revolution in networking and communication technologies to offer automation as a solution to improve distribution efficiencies . Distribution Management System is a tool for enterprise-wide management of an electric utility system. In other words, an ERP for an electric utility that, properly applied, provides for efficient operations, enhances operational outputs and translates into economic benefits. Some of the initiatives in distribution management include complete Distribution System Automation ,SCADA and distribution management for electric utilities.

Existing distribution systems have certain inherent inefficiencies due to their legacy. For one, most systems are monitored manually. This results in maintenance taking place only breakdowns. The present system also does not ensure reliable and complete power system and usage information that can facilitate trend forecasting or help the utility in better analysis and planning. New challenges are faced, as imposed by the deregulation of the energy markets, greater environmental concern and the proliferation of open information systems. The new energy context requires revised strategies to confirms one's position as a prime power utility. With a vision to effective operations of billing & collection, controlling of energy losses due to inefficient distribution network as well as irregularities & theft, exhaustive complaint handling besides asset & facility management, load forecasting and system planning, etc., and ultimately providing adequate services to the consumers, the power distribution company must be equipped with proper information technology, information system including GIS(Geographical

Information System) and database for collection, storage, manipulation, dissemination and online processing and analysis which will enable to enhance the efficiency and image of the utility company.

The key objective of the comprehensive IT and IS plan is to improve reliability and quality of supply, increase productivity, reduce technical and commercial losses, improve customer relations and satisfaction and a fundamental change in the work culture. It will also minimize human intervention in business processes for obvious benefit and improve the financial bottom line of the Utilities.

Under various reform program, adequate emphasis is given for using Information Technology (IT) as an enable for greater efficiency, then reduction, and collection. However, it is important to note that not all IT based solutions are equal, and poor designs can hamper long-term benefits. In this paper, an overview of some implementable technologies and process are presented after careful value-chain analysis of the utilities which may help the utilities for better accountability and efficiency and to monitor & control consumer behavior.

2. OBJECTIVE

The IT solution will enable the core business operation at the transaction level and improve the overall quality in Decision Support System. Information Technology (IT) would thus become the foundation for sustainable reforms.

There are basically two important success factors, one is improving productivity and thus making the business viable by improving cash in-flow and second is to winning customer confidence by providing quality power by minimizing black-out or brown-out situation.

So two kinds of IT solutions are required immediately, one is Utility Centric and another is Customer Centric. Both can access the same database, which can be developed by using GIS technology.

2.1 Need to Automate

Existing distribution systems have certain inherent inefficiencies due to their legacy. For one, most systems are monitored manually. This results in maintenance taking place only during breakdowns. The present system also does not ensure reliable and complete power system and usage information that can facilitate trend forecasting or help the utility in better analysis and planning. New challenges are faced, as imposed by the deregulation of the energy

markets, greater environmental concern and the proliferation systems. The new energy context requires revised strategies to confirm one's position as a *prime power utility*.

3. INFORMATION TECHNOLOGY (IT) FOR POWER DISTRIBUTION SYSTEM AUTOMATION. [1] [4]

IT is a means of generating, processing, disseminating, storing and analyzing information. In the power sector, since the information required is at consumer level, it is expensive and requires total reengineering to capture real time information for all consumers. Hence the following information system is suggested in the first phase for immediate success and achieving quick result.

A. SCADA Systems

One major tool available for power utilities is the Supervisory Control and Data Acquisition (SCADA) system. SCADA refers to a system that enables an electric utility to remotely monitor, coordinate, control and operate distribution components, equipment and devices in a real-time mode from remote locations with acquisition of data for analysis, and planning from one central location.

B. Infrastructure creation, database

generation and indexing of consumers by digital mapping.

- Complete networking covering interfaces with Intranet and Internet with Firewall and other securities
- GIS based consumer indexing and data warehousing
- GIS based material indexing

Figure 1 shows such GIS based system.

C. Information system for efficiency

enhancement and cash flow improvement

- Consumer Data Management System
- Spot Billing at consumer premises by hand held computer
- Anywhere Collection
- Integrated Metering, Billing and Collection System
- Energy Audit and Accounting
- Network Management System

D. Information system for consumer satisfaction and control [10]

- Consumer Information System
- Trouble Call Management

- Load Forecasting and Management
- Material movement, planning & control

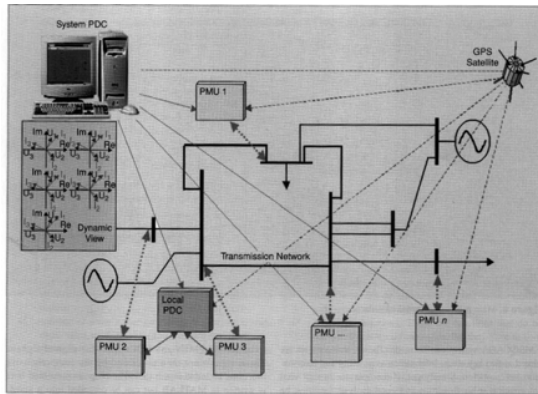


Fig. 1. GIS based system

E. Management Information System (MIS)

- Exception Reporting
- Reporting for day-to-day operations
- Reporting for management accountability and control
- Reporting for strategic planning.

Today, no utility can afford not to have a suitable SCADA system to monitor and control its distribution network. Distribution automation through SCADA systems directly leads to increased reliability of power for the consumers and lower operating costs for the utility. It results in forecasting accurate demand and supply management, faster restoration of power in case of a downturn and a quick, alternate arrangement for power for important or emergency locations. Following figure 2 and figure 3 shows Integrated Information System for first phase.[9]

4. BASIC SYSTEM ARCHITECTURE [6]

IT architectures must be conformal to information systems and data flow within and in relation to actors and beneficiaries in the proposed system.

Hardware architecture should be designed as proposed below in figure 5. There will be cluster of servers interconnected with proper security system

SERVER-1 can be the server of outsourced agency engaged in consumers billing .

SERVER-2 which will be physically located in Utility office will have GIS based consumer data (electrical address) along with name, address, sanctioned load, tariff code, meter number, assessment amount etc., which will be updated

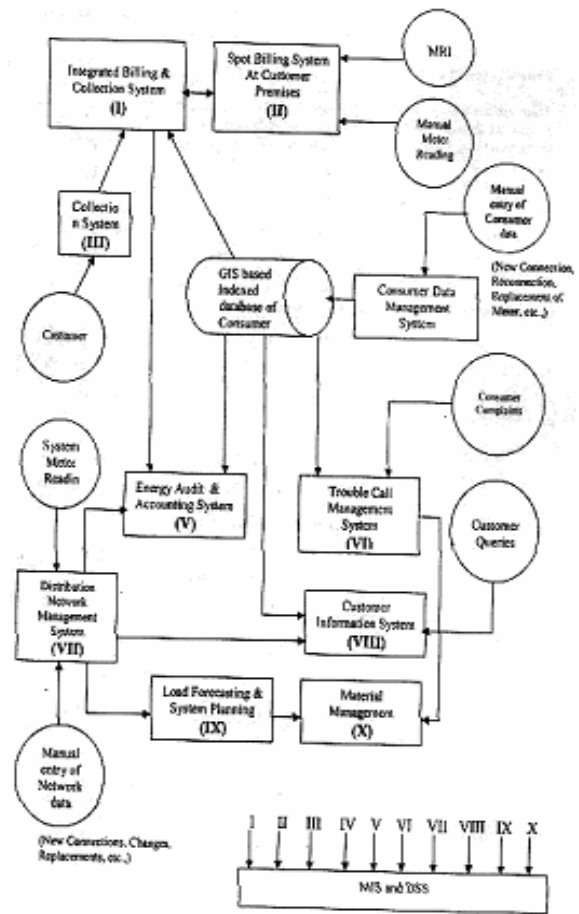


Fig.2 Integrated Information system

Management Information in second phase is shown below

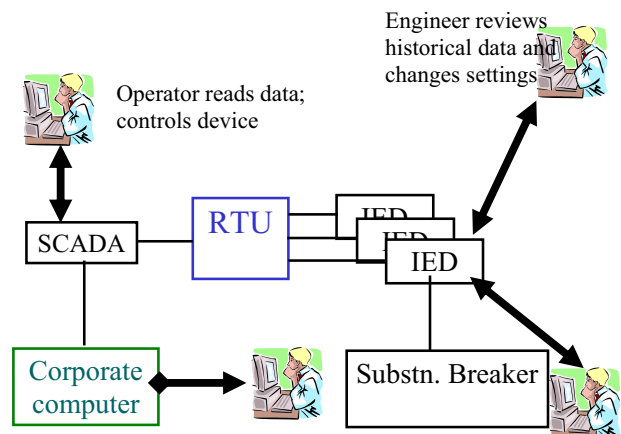


Fig.3. Management Information (Automation) system

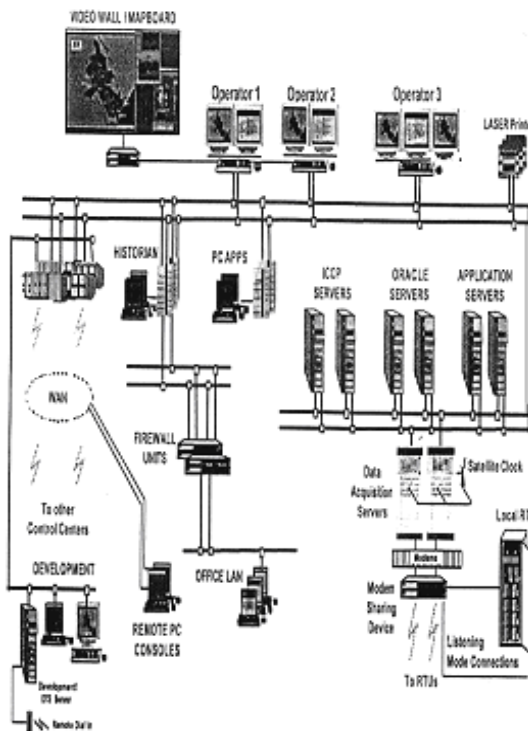


Fig.4. Basic system architecture

by Consumer Data Management System(DMS). SERVER-1 will pull consumer master data for warehousing consumer wise billing and collection. It will facilitate for downloading from and uploading into HHI. It will also maintain Accounts Receivable. SERVER-1 and SERVER-2 will be synchronized at least once a day. [3]

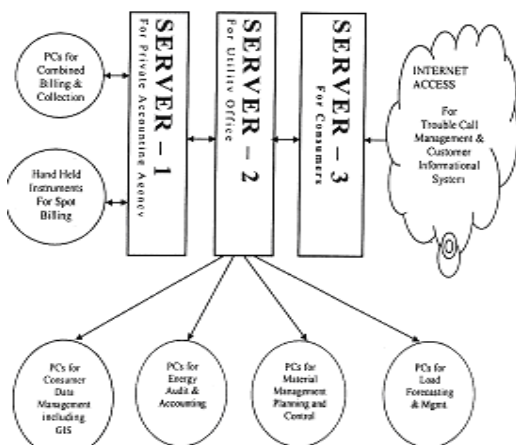


Fig.5. Hardware Architecture

SERVER-2 is mainly for collecting billing and payment status of consumer. It will generate

report of energy audit and accounting and management information. It can facilitate OLAP based information system for accessing the server anytime from anywhere. It will be firewall protected from SERVER-1 and other servers exposed to outside world. It will also be used for Distribution Network Management System.

SERVER-3 will have web server, database, business logic for TCM and CIS. This will be accessible by any consumer by valid connection ID through Internet.

The proposed architecture will have the following features

- Consistency in the structure to support collaboration, communication and interpretability
- Flexibility for retrofitting to minimize the impact on existing systems
- Network architecture based on open and vendor independent protocols to meet changing business requirements
- Authentication and authorization based access to the network, independent of location
- Robust and scalable to support large volume of transactions
- Highly granular applications that is scalable and configurable with the help of reusable components.
- N-tier architecture for easy modifications to business rules, high scalability and multiple user interface
- Platform-independent, self-contained application components for easy migration to new platforms
- Adaptive data infrastructure for vendor independence and addition of new functionality

Software Architecture [4]

A 3-tier architecture should be selected to design and develop the software utilizing the Utility Intranet for Utility centric applications and Internet for Customer Centric applications.

The 3-tier in this architecture are generally named as client-tire, application-server-tier and data-server-tier. The boundaries between tiers are logical. It is quite possible to run all three tiers on one physical machine. The system is nearly structured and that there is a well planned definition of the

software boundaries between the different tiers. This tier are described below

A. Client-tier

It is responsible for the presentation of data, receiving user events and controlling the user interface. The actual logic(e.g. energy loss calculation in energy audit and accounting) is moved to an application-server. Now-a-days Java-applets offer an alternative to traditionally written PC-applications.

B. Application –server-tier

The application objects that implement the actual internal logic of any software are available to the client-tier. This level now forms the central key to solving 2-tier problems. This tier protects the data from direct access by the clients. The object oriented analysis (OOA) aims in this tier to record and abstract, say energy audit processes in logical-objects. This way it is possible to map out the application-server-tier directly from the CASE-tools that support OOA. The term “component” describes visual components on the client-side and configurable objects which when put together forms an application process.

C-Data-Server-tier

This tier is responsible for data storage. Besides the widespread relational database systems, existing legacy systems databases are often reused here.

5. DISTRIBUTION AUTOMATION – MANAGEMENT FUNCTIONALITIES [8]

The following functionalities form core of the Distribution Management system

- Integrated Volt Var Control
- Network Geographic Information system
- Load control and balancing /scheduling
- Facilities Management
- Trouble-call management systems
- Operator Load Flow
- Fault Localization, Isolation and System Restorations.

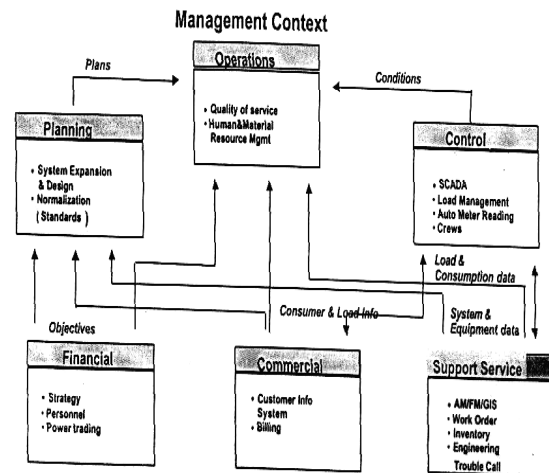


Fig 6. Integration of SCADA and DMS

6. SIMULATION RESULTS AND BENEFIT DISCUSSION

Distribution system Automation gives various benefits. Obtain regulatory incentives,(or more likely, avoid the penalties and fines), Labor savings, Squeeze more capacity out of existing equipment, Increase revenues, Provide new revenue-generating services. Defer capital expenditures, Reduce losses, Reduce O&M costs, Reduce demand. Shown in fig 7.

Labor savings

- Less overtime
- Fewer outside contractors

Increased maintenance intervals

- Labor and material savings

Increased revenues

- Get the meters running faster
- New information that customer is willing to pay for

Electrical loss reduction

- Fewer kWh to serve load (lower production or power purchase costs)
- Lower demand
- Reduction of demand charges
- Avoid new construction

Defer Capital Expenditure

- Balancing act between inflation and present worth of money
- Net savings over the life of the equipment
- Approximately \$5 savings per year for each year a \$1000 expenditure is deferred shown in fig 8.

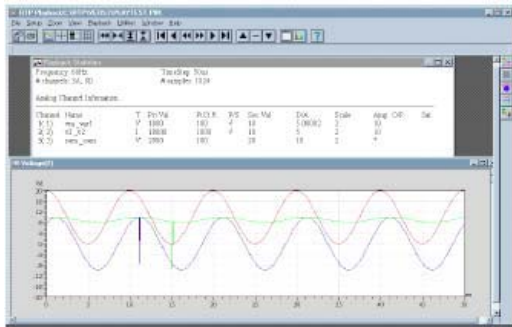


Fig 7. Simulation Results for Distribution Automation-On line Data Operation

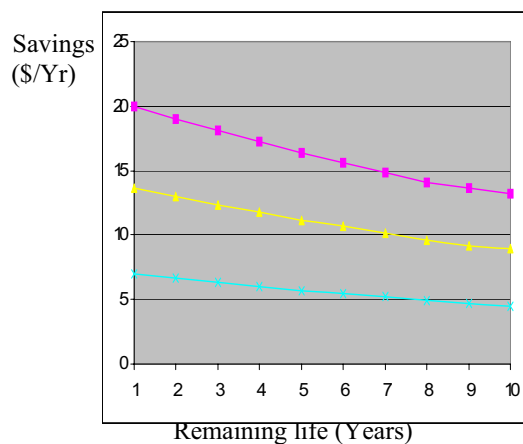


Fig 8 Simulation Results IT solution benefits

6. CONCLUSION

An IT solution for power utilities need to be considered carefully with short term or immediate goals described above along with long-term road maps for total distribution automation in which IT will be properly implemented to improve the way Utility should accomplish its business. The entire value analysis mentioned above may not give any cost benefit when interim solutions are chosen only for expensive retrofits.

Any radical change or reengineering of an age-old system is only possible if all the actors in the system are involved and the system is simple, transparent and responsive. IT there will act as technology enabler. Then only Information Technology can harnesses to its full potential.

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