Role of Information Technology in Electrical Distribution System Management

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Abstract:
The GIS industry will feel the impact of these activities since each new entrant in the energy business, in the form of a broker, aggregator or marketer, increases the need and utilization of GIS tools, data and products by viewing customers and infrastructure data in new ways. The restructuring is not just about deregulation and competition. It is about the creation of a new vision, new opportunities and new ways to think about a business that is over a century old.

Introducing Geographic information System (GIS) into a business will not cause change to occur if it is viewed merely as a replacement for manually drawn circuit maps. Nearly every wires business process involves some spatial element, whether that is a new retailer, customer, pole, wire, underground switch or communication device. Under industry restructuring, there will be an increasing need to leverage information to reduce costs and to provide better customer service. Regulated utilities, transmission providers and unregulated retailers will be looking at GIS to meet their changing business needs.

Keywords: *CCC, Feeder Manager, GIS, HT Network, LT Network, SCADA, T & D Losses*

1. Introduction

1.1 Problems in Distribution Systems

The main issue in **distribution systems** or rather more appropriately the issue confronting the power sector as a whole, is the reduction of transmission & distribution (T&D) losses to acceptable minimum levels. The all-India T & D losses, which were about 15% till 1966-67, increased gradually and are not at 24.79% (1997-98). During the last few years some of utilities variously estimated the losses in the range over 30% to 50% much higher than the preceding years. T & D losses in developed countries are around 7-8% only. Taking into consideration the Indian conditions such as far-flung rural areas, nature of loads, system configuration etc. the reasonable permissible (technical) energy losses should be 10%-15% in different states.

While the losses in Extra High Voltage (EHV) network are about 4%-5%, bulks of the losses occur in ST & D system. It is well known that these losses in distribution systems include non-technical or commercial losses and that of power by various users with or without connivance of utility staff. These constitute a large component of overall losses. There are also losses on account of defective(slow) meters, stuck up/burnt meters etc. further on account of estimation involved in agriculture sector consumption (30% of total), absence of adequate metering at the system level, deficiencies in consumer metering the validity of figure of T & D losses being reported become a questionable.

General conclusions losses (theft), actual figures are higher, technical losses are also high and bulk of losses occur in sub-transmission and distribution systems. Inefficiency, frequent interruptions, flickers and poor voltage also characterize distribution systems. In addition the billing and revenue collections

are very poor leading to combined state utility financial losses of Rs. 26,000 crores every year. If the current trend continues, in another three years, state utility financial losses will reach Rs. 45,000 crores a year. It is, therefore, necessary to bring about improvements in planning implementation and operation of ST & D systems in a scientific and efficient manner. The present traditional reactive and ad-hoc approach to network development should be replaced by an approach based on technical and reliability requirements, economic considerations of costs of energy loss and expansion of system to meet the growth of prospective demand with least cost.

2. Status of Data Documentation in Power Utilities

Reliable and sufficiently detailed data is required to facilitate decision making in all activities of distribution system management. Controlling costs improve efficiency and reducing down time has become essential for a utility in order to successful in the highly competitive environment of today where private utilities/ distribution companies are coming into distribution. With huge connected networks, number of spur lines and alternative feeds from different sources the creation, updation and management of distribution data is a herculean task. Many studies conducted in the utilities of the country have indicated that the data documentation in most of the utilities is very poor. The data of distribution system is maintained through hand-drawn maps with facilities data printed in text form on them and available with the JE/linesman in charge of the feeder. These maps are rarely updated.

3. Data Requirement

The data requirements for management of distribution systems are voluminous and varied. Some of them are indicated below:-

1. Consumer data

Category wise number of consumer and connected load including the bulk consumers details such as

- Contract demand
- Maximum demand
- Energy Consumption
- Supply Voltage

2. Demand data:

- Peak demand MW/MVAR-simultaneous and non-simultaneous
- Annual Energy consumption data

3. Network data

- Geographical map (to scale of the area depicting Transmission and Sub-transmission system)
- Source of power supply/Grid substation supplying power to the area
- Existing substation
- Existing Lines

4. Sub-Transmission System:

- Existing 66-33/11 KV sub-stations & Existing 66-33 KV Lines.
- Under Construction Sub-station
- Under construction 66/33/11 lines

5. Distribution System:

- 11 KV lines
- Distribution transformers
- LT lines

6. Operational Parameters:

- Substation equipment status
- 66/33 KV feeder breakdowns
- Failure of distribution transformers
- Tripping on 11 KV feeders/lines
- Consumer outages

7. Electrical network details:

- Electrical network details- single line diagrams with conductor sizes, lengths, transformer locations, capacitors, consumer location and load etc.
- Parameters of equipments, devices and conductors.
- Load data-peak load, diversity factor, power factor etc.

8. LV Network

- Section length
- Conductor size of each section
- Connected load for each group of consumer
- Number of consumers in each group
- Total connected load on the transformer

Further data on billing, revenue collection, pending applications investment, material & manpower requirements etc are some of the other data required. As can be seen, the data requirement is very voluminous. These records have to be stored, retrieved and used by many different, people at different locations. If manual records are used, then there is every likely hood of these records getting displaced or destroyed. The use of advanced information technology tools for maintaining a coherent database becomes very essential.

4. Role of Information Technology in Distribution System Management

Initially, computers handled data only in alphanumeric form. GIS is an important tool in this area. Geographic Information Systems is a system of mapping of complete electrical network including low voltage system and customer supply points with latitude and longitudes overload on satellite imaging and survey of India maps. Layers of information are contained in these map representations. The first layer corresponds to the distribution network coverage. The second layer corresponds to the land background containing roads, landmarks, buildings, rivers, railways crossings etc. The next layer could contain information on the equipment viz poles, conductors transformers etc. most of the electrical network/ equipment have a geographical location and the full benefit of any network improvement can be had only if the work is carried out in the geographical context. Business processes such as network planning, repair operations and maintenance connection and reconnection has also to be based around the network model. Even while doing something as relatively simple as adding a new service connection; it is vital to know that users of the system are not affected by this addition. GIS in conjunction with system analysis tools helps to do just this.

For efficient and reliable operation of a distribution system, a reliable and well knit communication network is required to facilitate project coordination of the maintenance and fault activities of the distribution system. GIS when integrated with real time SCADA can help in sending the right signals to the communication network. Outages can be isolated faster than even before and maintenance crews dispatched with critical information including location of the fault.

5. GIS can be used in distribution system management for..

- Handling customer inquires
- Fault Management
- Routine maintenance can be planned
- Network extension and optimization
- What is analysis
- Network reconfiguration
- Improved revenue management
- SCADA can be integrated with GIS
- Rights of way and compensation

GIS environment hosts a wealth of presentation techniques that enable fast and accurate interpretation of results from power flow results to short circuit analysis.

6. Benefits of using GIS in Utilities

Digital tools such as GIS, CAD, and AM/FM (Automated mapping and Facility mapping) software are quickly becoming an essential part of the utility industry's day to day business. The major benefits come from sharing data at all levels of an enterprise. GIS helps utilities better organize, manage, and display data, and in turn help them better meet customer needs. GIS can help predict where potential growth and development may occur and where an expansion of utility services may be warranted.

Another objective is to reduce the amount of windshield time required by repair crews. Routing programs can provide accurate street level details, turn-by-turn directions to a specific location, and even dynamic information on traffic jams and construction zones that increase the time needed for a service call. The use of GPS units in service vehicles and accurate GIS maps helps lower maintenance and fuel costs by providing routing information and precise locations of utility features.

6.1 GIS in power: Information Retrieval

The maps created by using AM facilities can be made as intelligent as one can imagine. For example, if an engineer needs to know the date of installation of a given transformer, all that he has to do is to click onto that transformer symbol. The attributes attached to this transformer will appear in which one of the attributes will show him the installation date. Consider that the same engineer now wants to know more complex information. He only wants to see on the map, which are the 100 KVA transformers in a given area that were installed prior to a given date. The query facilities of the software will quickly process this requirement of his, and show on the map only those transformers that qualify his requirement, hiding all other transformers that do not qualify it. Let us assume that an engineer wants to know how many transformers are installed in a given locality. The software will quickly process his information need by taking the feeder network data processing it within the a buffer zone showing the locality of the engineers interest and given him the results. At another time if he wants to assess the requirement of a cable to be laid along a certain road, the GIS will return him the results of processing considering even all the bends and turns the road may have. The cable length so shown by the GIS will be precise and will therefore help him procure the exact required quantify of the cable.

6.2 GIS in power: Maintenance & monitoring

Let us assume that the engineer has to send a cable jointer in the field who has to access a certain underground cable joint. The engineer can take the digitized map file of the area, mark a small portion of that area in the neighbourhood of the joint, and print that small part on a piece of paper. This printed map of that small area will show, to the jointer, the location of the joint with proper distance and bearing references to the nearby identifiable objects. With these references so readily available with the jointer, his work will be easy and quick. There will be no need for him to have any guesswork or to constantly contact the office for knowing the joint location.

6.3 GIS in power: Site identification

The remote sensing technology is being used for the identification of suitable sites for locating new hydropower projects. The conventional method could not be directly adopted in the inaccessible areas like Himalayas where the water resource potential is high by means of glaciers and intensive rainfall. Similarly the geological, structural configuration is essential to study to understand the strength and weakness of the area so that the project will be implemented in the suitable terrain (ex. aseismic). For geologic mapping, reflectance information of the rocks in the SWIR and emissivity of the rock information in the TIR are very important. Again, remote sensing data available in the near infrared region provides clearly the contrast between land and water features can easily be discernable. Satellite imagery may be used for the identification of catchment boundary, drainage network; perennial streams, land use and vegetation cover for these projects. Digitizing the elevation contours

and spot heights from topographic maps and using capabilities of various GIS software's may generate Digital Elevation Model (DEM) of these catchments. The catchment boundary, drainage network and location of major habitation may be overlaid on these DEM for further analysis.

6.4 GIS in power: Information Processing

Information processing is a key to improve productivity and cutting costs of excess work. Converting information to a computerized format in GIS is more useful and timely for electric utility. For example: - GIS will allow to search and retrieve information stored on a server simply by pointing and clicking through user-friendly menus or typing requests in a windows environment. GIS has a way of making work processes simpler through more productive use of time and information.

6.5 GIS in power: Importance of Data

Accurate and current information is vital to maintaining and improving customer service. With GIS, the electric companies will have the ability to improve customer service by better gathering and processing customer's information. Through a computerized environment, a GIS can keep information on customers, accurate and current. Improving record-keeping and making data accessible to more users in more useful forms is vital to improving customer service. Evidently, improving ways of record keeping and data access is possible with GIS; therefore, it can be a key to improving customer service.

7. Distribution systems have suffered mainly from the following things

- Unbalanced load flow
- Poor voltage regulation
- High level of technical (Peak power / Energy losses)
- Conductor Heating / Equipment Damages
- Very high unaccounted energy losses

8. GIS plays a Role in industry Restructuring

With the radical changes that the electric utility industry is facing, customer choice has become the buzzword for the entire country. Nearly every state is either implementing limited choice program. Choice pilots or at least debating choice.

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Regulated utility-AM/FM V/S GIS electric utilities use the term automated mapping/facilities management (AM/FM) to describe what essentially GIS is. Yet there is a subtle difference. The term AM/FM is limiting, since it infers only two functions relating to hard copy maps of circuits and traditional infrastructure maintenance and construction. In these respects, AM/FM lives in the traditional engineering departments of regulated utilities. GIS is much more than this since it uses spatial data to create information for running and re-inventing the business.

In the near future, GIS will be a management asset tool to enable the utility to make wise investment decisions about its infrastructure. It will serve as one of the important building blocks for operational and customer service excellence, which will be critical in the world of performance-based rates.

The retailer's view and GIS the game for retailers will be to capture market share, creating portfolios of customers to diversify and minimize market risk and to sell other services that might include internet service or appliance maintenance contracts. Since retailers are unregulated, they are not constrained by a traditional utility's franchised service territory, which means that there likely will be hundreds of retailers doing business in that service territory.

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