GIS In Electrical Distribution Network System

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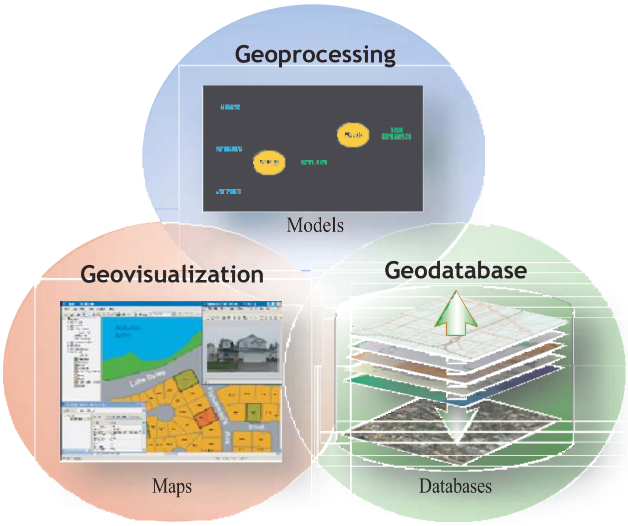
Abstract: Geographical Information System (GIS) is designed to support analysis, management, manipulation, and mapping of spatial data. It is used with a customized dataset to develop a map which can show the spatial relationship between assets and their customers in the field of utility engineering. The project area consists of two modules - Editor Module and Tracer Module. Editor Module consist of features like Add, Update, Merge, Copy, Split, and Delete. Tracer Module consists of upstream and downstream tracing. Longitudinal and latitudinal parameters will be used to map the assets like customers, transformers, and distribution lines.

***IndexTerms* – GIS, Electric Network, Spatial Data, Assets, Map, Tracing, Editing**

I. INTRODUCTION

A system designed for managing, analyzing, and visualizing spatial or geographic data is called as a geographic information system (GIS). Geographic information is represented by a series of geographic data sets that model geography using simple, generic data structures. For working with the geographic data, it includes a set of comprehensive tools.
A geographic information system up ports several views for working with geographic information. These three GIS views are represented in Arc GIS by the catalog (a GIS is a collection of geographic datasets), the map (a GIS is an intelligent map view), and the toolbox. Together, all three are critical parts of a complete GIS and use varying levels of data in all GIS applications.



Geo Database View: A GIS is a spatial database containing datasets that represent geographic information in terms of a generic GIS data model (features, raster images, topologies, networks). A GIS is a unique kind of database of the world—a geographic database (Geo database). It is an "information system for geography." Fundamentally, a GIS is based on a structured database that describes the geographic terms. GIS uses a collection of vector-based features such as a set of points, lines, and polygons to provide a geographic representation of some aspect of the world. A network describes a graph of connected GIS objects that can be traversed. This is useful in transportation for modeling pathways and navigational routes.

Geo Visualization View: A GIS is a set of intelligent maps and other views, that's how features and feature relationships on the earth's surface are mapped. From the underlying geographic information, various map views can be constructed to support queries, analysis, and editing of the information. When it comes to Geo visualization we are working with maps, 3D scenes, summary charts and tables, time-based views and schematic views of network relationships. For operating on geographic datasets, a GIS provides interactive maps and other views. Maps provide a powerful meta definition and standardize how people use and interact with geographic information.

Geo Processing View: A GIS is a set of information transformation tools that derive new geographic datasets from existing datasets. A geo processing function takes information from the existing datasets and applies analytic functions, and write results into new derived datasets. The collection of geographic data sets and the operators or tools used on those datasets provide another view of a GIS. Geographic data sets can represent raw measurements such as satellite imagery, information interpreted and compiled by analysts (for example, roads, buildings, and soil types), or information derived from other data sources using analysis and modeling algorithms. For generating the derived datasets, the tools and processes used refer to Geo processing. A GIS provides its users with a rich set of tools to work with and process geographic information.

II.NEED OF SYSTEM

I. **Data Management**: In worldwide Utility engineering use GIS to manage, manipulate and map the location of millions of miles of overhead and underground circuits. In GIS, utility's assets can be linked directly to the customer information system, allowing us to proactively monitor work orders, vegetation management, and outages.

II. **Planning and Analysis**: GIS useful in the distribution utilities to identify the vulnerabilities that cause outages, to weigh asset investments and also to understand customer satisfaction. With a rich set of easy-to-use spatial analysis tools, GIS helps us to determine the right location for new facilities and new technology like smart grid sensors and smart meters.

III. **Workforce Automation**: This system allows us to more efficiently schedule and dispatch utility service staff. The productivity will be even greater with a workforce automation system when it's built with GIS technology. GIS shows us where the crews are working and give you the status of their work. In addition, street-level routing allows us to reduce fleet costs and gain additional scheduling time, it gives us the ability to handle more service calls.

IV. **Situational Awareness**: On the basis of GIS tool graphics outputs and web-based reports, we can quickly determine and demonstrate how the organization can meet its compliance requirements, how to responds to the large outages, or to see where organization spending their money wisely. when we use GIS to communicate with regulators and the public, then meeting regulatory requirements and keeping the public informed becomes less time consuming and easier to accomplish.

III.MOTIVATION

The main motivation behind the system is to overcome the problem of human efficiency and brings a digital view to the areas. This helps to trace the path easily at the time of power-cuts and avoids the interruptions caused during industrial, commercial and private constructions.

IV.REVIEW OF LITERATURE

1. Yusuke Kakumoto et al. [1] has mentioned a new application of Geographic Information System (GIS) in the field of electric power engineering. Recently, photovoltaic (PV) generation is being introduced in power systems day by day for the needs of clean energy. If installed in large quantities, it may cause voltage variation and result in worsening the quality of electric power. In this context, the concept of introducing PV in required quantities in the power system should be grasped correctly. This research focuses on distribution system with large amounts of PV. It is required to evaluate the PV generation and analyse the distribution system's state to grasp the limit of introducing PV in the distribution system. Although PV generation is proportional to solar radiation, solar radiation is affected by the shadows of buildings, the angle, and the direction. Therefore, it is difficult to calculate PV generation and accurately grasp solar radiation falling on the PV panels. GIS can solve the problem. It can analyse the amount of solar radiation by modelling an actual townscape. The amount of solar radiation can be evaluated by performing an analysis on solar radiation at any specific location in the modelled townscape. Using the result of the analysis, PV generation installed at any place in town can be estimated and a more accurate distribution system analysis can be performed as opposed to a conventional one.

2. Sedigheh Veisi et al. [2] has mentioned a targeted and innovative strategy based on GIS (Geographic Information System) and location-based analysis such as IDW, Density, etc. are used to identify network vulnerabilities and centres of gravity of the load and then the final composition of the stations including number, location and the scope of service are determined, so, while meeting customers' needs all construction requirements will be regarded. With regard to the economic issues and the need for quick realization of the goal, reduction of losses in Tavanir Company, this study aimed to locate single trans sub-transmission substations. The application of the proposed method is illustrated on Kermanshah Distribution Network.

3. Field Visit: Upon visiting a couple of MSEB offices (MSEB, Ali Somji St, Ambedkar Nagar, Kondhwa, and MSEB Vadgaon Sheri, Pune, Maharashtra) we concurred that they still rely on handwritten notes, physical area maps, and log books to store and act upon the information in case of any disruptions that may cause hindrance to the electrical network. They highly reply on human resources so as to recover from these disastrous situations. To resolve consumer complaints, they call the corresponding substation technicians to visit the failure node, however to locate the substation there is no digitized system, it is done manually.

V. PROJECT SPECIFICATION

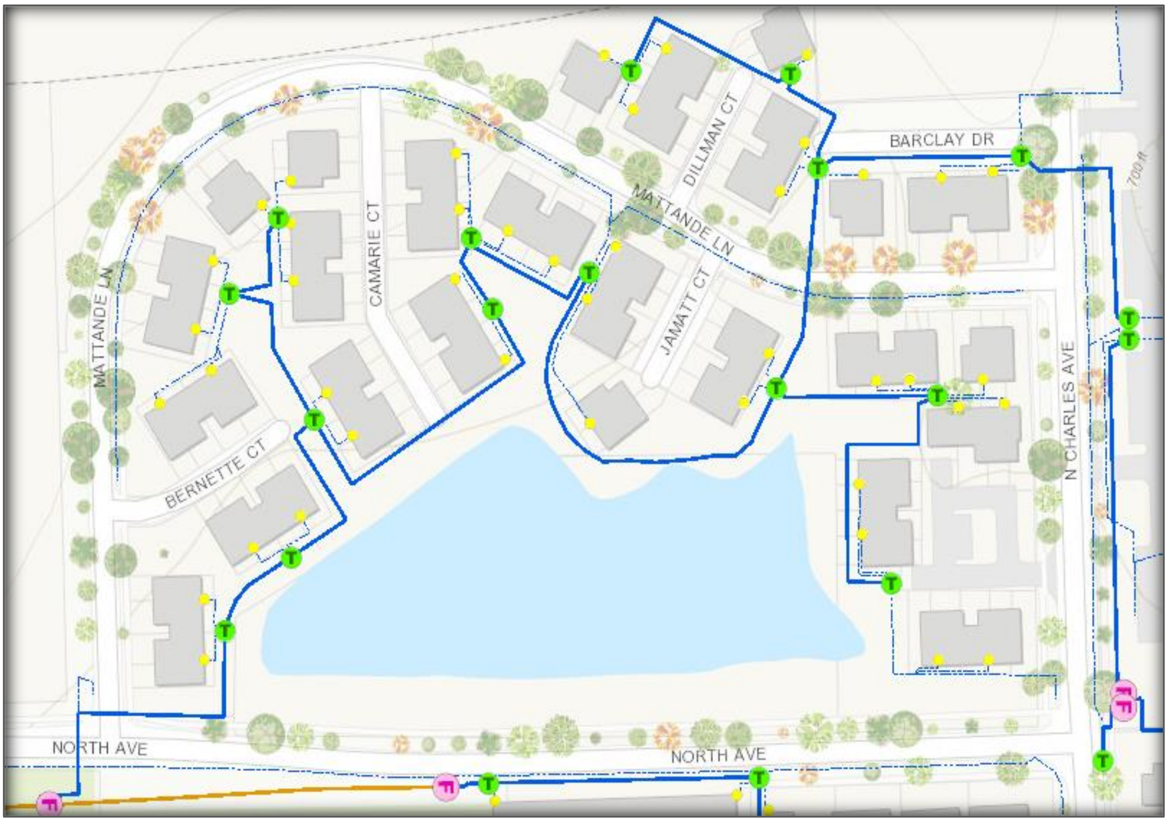


Fig.1 View of the data on the map

Using Geographical Information System (GIS) Platform for viewing, accessing and manipulating electrical network asset data. The proposed system, an electric distribution utility uses a network of physical facilities to provide electric power and energy to customers connected to those facilities throughout a geographical area. Each component of the distribution system (i.e. an asset) has a physical location and associated data, so does each customer.

It is well known that the distribution network is the connection of the power supply enterprise and the users. It plays a very important role in the entire power supply system. Meanwhile, about "ten-fifteen" deepened electric power organizational reform implementation opinions had also pointed out at the right moment to develop the experiment site for transmission and distribution of electricity reform. Along with the technical unceasing progress and the reform continuation advancement, power distribution dispatching will take up an increasingly important role in power supply production.

The main responsibility of power distribution dispatching is to organize, command, instruct and coordinate the distribution network. Facing complicated structure, various lines and frequent renewal electrical network, power distribution dispatching cannot leave the Distribution Network Management System (DMS). It mainly includes following several sub-systems: Distribution network SCADA system, Distribution network geographic information system (GIS). Distribution network high-level application software, for example, power distribution (power flow Status estimation. Power distribution dispatching also must consider the connection of production management information system (MIS). Except the distribution network SCADA system which have the basic surveillance and the control function, GIS takes important role in DMS, which directly impacts the quality and efficiency of power distribution dispatching.

The processing object quantity of the distribution electric network is so large that the traditional computer database system has not been able to satisfy the request. Whereas, GIS provided the powerful method to process the graph and the non-graph information, in order to match the power distribution dispatching to provide the intellectualized decision-making and control. This article mainly analyzes the important application in power distribution dispatching and the main technical issues of the application.

VI. SYSTEM ARCHITECTURE

System Architecture contains 4 main layers:

1. Data Tier
2. Business Tier
3. Service Tier
4. Presentation Tier

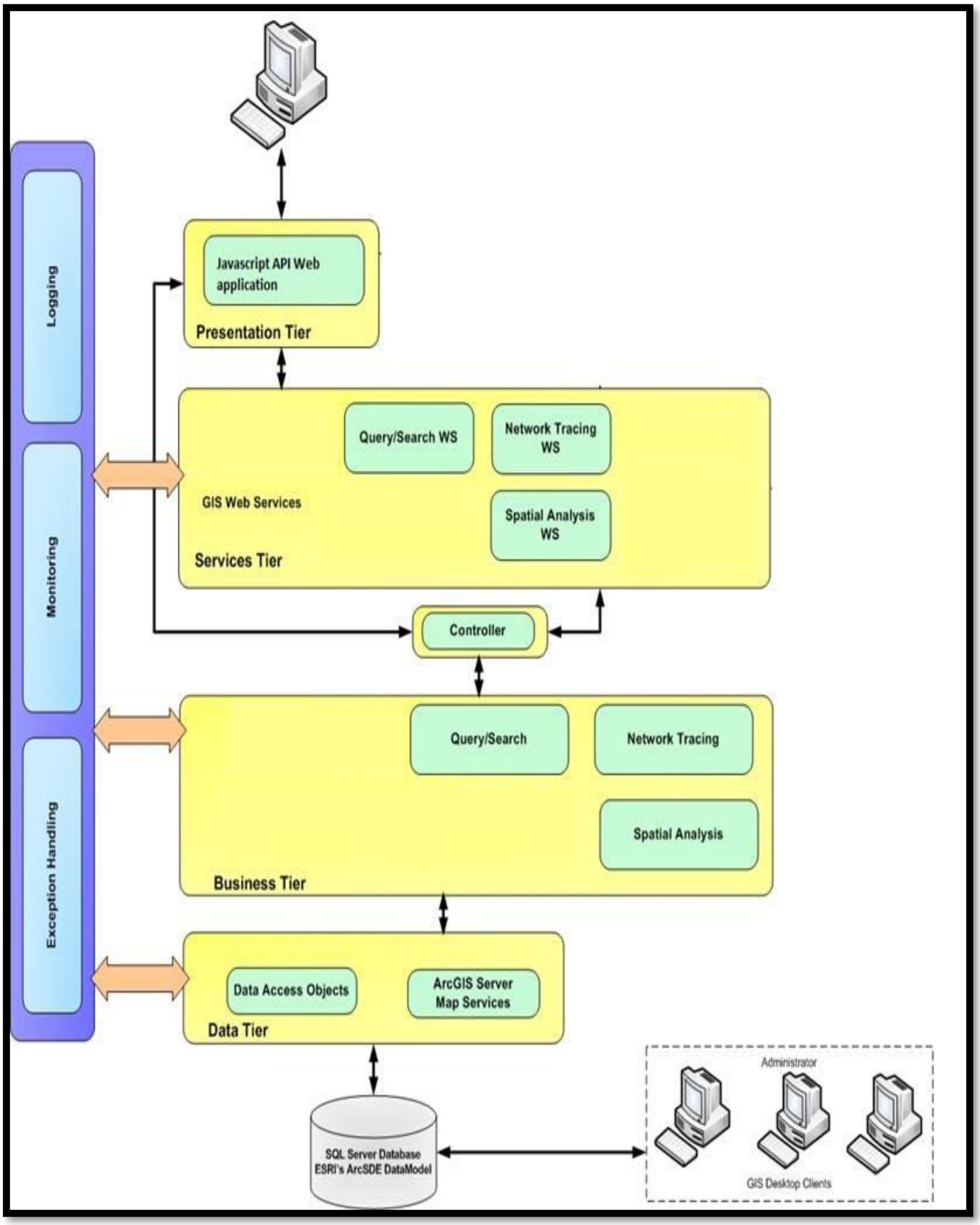


Fig.2 System Architecture

1. **Data Tier**:

It is the bottom-most layer of the system architecture which mainly contains:

a) Data Access object
b) ArcGIS Server and Map Service

Data tier layer is used to access the data object from ESRI's database. And it also provides map services. The Data layer consists of a database management system that provides data storage abstraction and the query language. The first commercial approaches to providing geographic data types and operators were implemented as a software layer on top of the DBMS. This has proven inefficient, and it is now accepted that the geographic data types and operators must be provided by the DBMS in order to achieve efficient data storage and algorithm implementations.

It provides data management functionality independently from the software technology. Information retrieval and manipulation requests for the data tier are expressed using a query language. Queries are evaluated within the data tier and the result is a set of geographic features that are represented using an information exchange language that is suitable for the conceptual model.

2. **Business Tier**:

Business tier performs query searching, network tracing and spatial analysis of the data. The Application Logic layer implements the functionality of the system. Particularly, it receives the requests of the user from the Presentation Layer and translates them to the appropriate queries for the Data Layer. Then, it translates the geographic objects returned by the Data Layer into the cartographic objects that are displayed by the Presentation Layer.

Given a network defined by the user using the geographic information in the application schema, this service can be used to find routes from locations on the network, or to compute all the elements of a type that are reachable from a location.

3. **Services Tier**:

This layer does the same job as the Business Tier by only using GIS web services.

It implements problem-solving and application specific functionality of the system. The top-most interface of this tier consists of a collection of operations for data processing tasks. These operations represent high-level abstractions of problem-solving techniques (e.g., find a route between two nodes in a network) instead of the primitive operations from the data tier query language (e.g., find whether there is a direct edge between those two nodes).

4. **Presentation Tier**:

JavaScript API web application is present in this layer in which user can access and manipulate the data by using customize ArcGIS application. The maps computed by the Application Logic Layer are displayed by the Presentation Layer.

This layer also displays the graphical controls that receive the interaction from the user, and converts these interactions to requests for the Application Logic Layer. The task of displaying the map is carried out by a map display component, which receives a set of cartographic objects and displays them on the screen. The component also displays buttons and other controls to manipulate the graphical representation of the map.

It implements the user interface of the system, which enables data visualization, data manipulation and data entry. The Presentation Tier receives the user interaction in the form of mouse gestures, keyboard inputs or inputs from other devices. These inputs are evaluated and the appropriate operations in the application logic tier are invoked.

VII. ALGORITHMS

1. Dijkstra's algorithm

Dijkstra's algorithm is used to find a shortest-path problem on a weighted graph. It is a single source-based algorithm. To find the shortest path from a starting location s to a destination location d, Dijkstra's algorithm maintains a set of junctions, S, whose final shortest path from s has already been computed. This algorithm repeats the steps to find a junction in the set of junctions which has the minimum shortest-path, and adds it to the set of junctions S, at last it updates the shortest-path estimates of all neighbors of this junction that are not in S. Until destination junction is not added to the S the algorithm continuously execute itself.

Dijkstra’s algorithm is used in the electricity Distribution network system for upstream and downstream tracing purpose. It is used to find nearest electricity assets from source to destination. Assets includes transformers, fuse and cables connects to each asset.

For example, let’s consider the graph shown in the figure below. The starting vertex is a (i.e. 1) and the destination is vertex b (i.e. 5). First, we find an unvisited vertex with the smallest weight from vertex which in our case is vertex 2, we update the weight for vertex 2 by adding its weight to the weight of vertex a. Similarly, we calculate the path from the next vertex until we reach our destination node i.e. vertex b. Hence, the shortest path from vertex a to b is: 1 -> 2 -> 3 -> 6 -> 5 and the weight is 20.

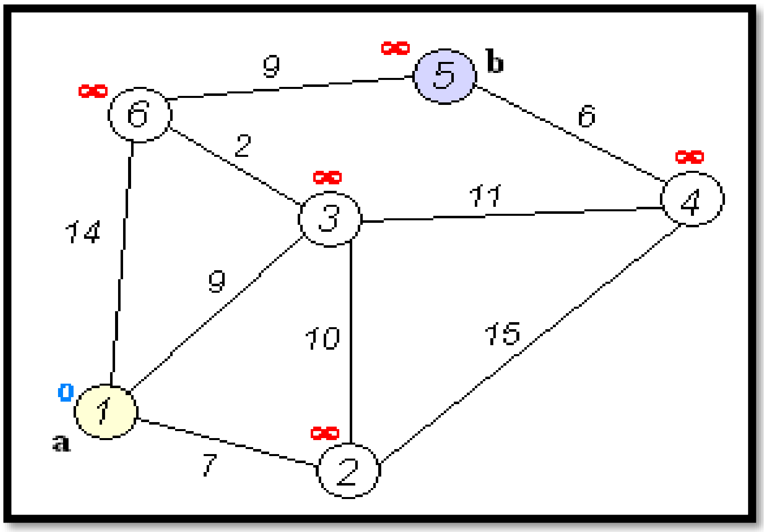


Fig.3 Dijkstra's algorithm

2. The traveling salesman problem option for Route Solver

The Route solver is a basic property of TSP which has the option to generate the optimal sequence of visiting the stop locations. This is the traveling salesman problem or TSP. It is a combinatorial problem. It means that there is no straightforward way to find the best sequence. To find good solutions to these types of problems in a short amount of time, Heuristics are used. The TSP implementation within Network Analyst also handles time windows on the stops; that is, it finds the optimal sequence to visit the stops with a minimum amount of lateness.

Travelling salesman problem is used in the electricity network to complete the upstream or downstream tracing in less amount of time. It finds the optimal sequence of visits in less lateness.

For example, let's consider the graph shown in the figure below. A TSP tour in the graph is 1-2-4-3-1. We find the cost of the tour is 10+25+30+15 which is 80.

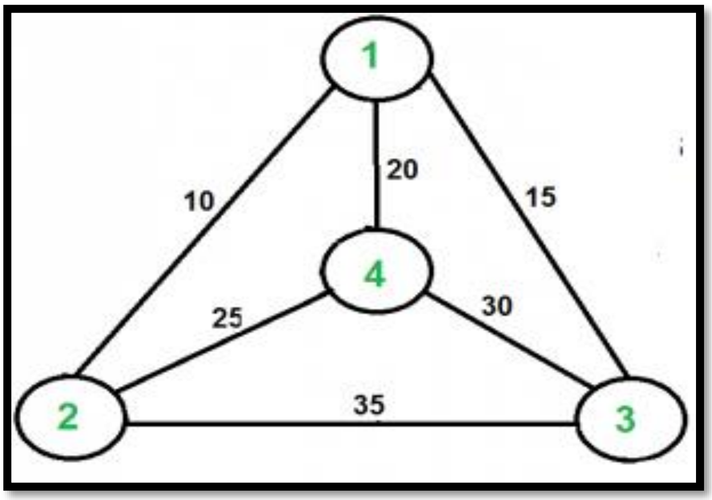


Fig. 3 Travelling Salesman Problem

3. Route Solver

Network Analyst can find the best way to get from one location to another or to visit several locations. The locations can be specified by entering an address, placing points on the screen, or using points in an existing feature class or feature layer. If you have more than two stops to visit, the best route can be determined for the order of locations as specified by the user. In other ways, Network Analyst can determine the best sequence to visit the locations, which is known as solving the TSP problem.

VIII.APPLICATIONS

1. Power Production Management Information System:

The application of GIS in the MIS selects the vivid direct-viewing method and unifies each kind of geography information organization, the analysis and demonstrates the data of power distribution network. The application may realize geographical distribution network information and visualize performance data, promote the power distribution network in a scientific style.

2. Processing urgent accent load time:

The most important job of distribution network is accident processes. When there is system accident, the dispatcher isolates the breakdown region fast, takes the breakdown feed line's load(partly) through the switch to shift to other feed lines and will restore the non-breakdown region promptly to a normal power supply. Every so often, the distribution dispatcher is requested to carry on the load shift, which is usually called "Contingency Load Transfer". Speaking of the predetermined plan overhaul, dispatcher also needs to carry on the load shift between the feed line to guarantee user uninterrupted power supply.

3. Improved engineering and operations efficiency:

The opportunities for improving the efficiency of designing and operating a utility network range from better maintenance and corrosion protection to improved subdivision service design. Cost savings for this category are normally measured in terms of more efficient scheduling, or reduced costs in plant through better design and maintenance.

IX.CONCLUSION

From this case study undertaken, it can be concluded that GIS applications have not reached the optimal investigation and there is still room for further study and improvements in the area as far as utility service delivery (like in the case of electricity distribution) is concerned. It can help to maintain the electrical assets, provide better consumer services, reduce technical losses, energy audit and accounting, real time operation of distribution network, better revenue protection, long term distribution planning, etc.

With this study, future proposed location of DTRs has been easily identified so that, with the expansion of the town and development of the area, as consumer demands for electricity increase, those new DTRs will help to meet the demands of consumers and new consumers will not face electricity problems. Furthermore, GIS based consumer indexing helps to decrease electricity theft and reduce electrical losses. By executing electric asset mapping and consumer indexing, it is easy to get the asset data regarding electric poles, DTRs & consumers in the database, and this database can be used for electrical planning and development by electricity department.

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