CHAPTER I

INTRODUCTION

1.1 Background

Integration of Supervisory Control and Data Acquisition (SCADA), Geographical Information System (GIS), CALL CENTER and Automatic Meter Reading (AMR) is most useful in electric power systems to monitor, coordinate and operate distribution components. On-line information, remote control and efficient management systems are required for power distribution utilities. Considering the extensive size of the network, these tasks can be effectively achieved through the intervention of information technology utilizing the available high-speed computer and communication technology. These systems are to monitor and control the electric power distribution networks, they are also called "Distribution Automation (DA)" system. The distribution automation system is based on an integrated technology, which involves collecting data and analyzing information to make control decisions (Steven 2007). Thus different IT systems are implemented to manage utility business & operations and using real time data in relation with critical data to meet the requirements of utility managers and executives who are looking for new ways to - optimize their operations, increase workforce efficiency and the business processes. In that respect, the new software and modern control systems can provide new possibilities for improving present control strategies and performance. The present state of the electric software tools and methods for analyzing combined power systems are isolated and the data is not shared. An integrated electric grid is a complete enterprise-wide information architecture and infrastructure system. It provides the knowledge flow, power flow, information flow and business flow, to achieve efficient operation and scheduling in an electric grid. The safe operation of the dispatching automation systems depends on information system and the basis of DA systems includes database management, graphic management, network management and systems management. Database management systems include the two parts of databases. the real-time database management and commercial database management. Thus Information Technology (IT) has already been introduced in the power distribution management system to provide useful solutions in the power distribution sector utilizing the available Internet / Intranet technology.

Integration of Call Center with SCADA, GIS and AMR, is expected to reduce technical and commercial losses, improved cash flow, lower electric service restoration time, reduction in equipment damage, better availability of system information, improved operational planning, remote load control and shedding, and enhanced power quality and reliability (Jack & Frank, 2003).Using Geographical Information System (GIS) and the advent of high-powered computer graphics has accelerated the progress in this field.

The GIS application for Distribution Utility is multi-modular like new connection management, meter data management (MDM), billing and collections, customer care, network analysis and energy audit. For better manageability, the GIS software selected for developing Utility applications should be capable of centrally managing geo data, providing best security and integrity of the vast utility database of distribution network assets and electrical consumers. It should provide large volumes of data resources, while reducing storage costs and data processing overheads. It should extend the GIS capability for workforce management, increasing the accuracy and value of field data collection and asset monitoring. The GIS software should be scalable and robust, designed to meet the Utility's requirements (Jayant, 2011).

The other functions include outage analysis and system restoration. In the event of an outage, the calls from customers are displayed on the system maps. Then, from the outage pattern possible causes of outage are determined. The maps are then used to direct the crew to perform switching operations or to operate switches remotely.

1.2 Problem Statement

The basic problem of this thesis is to create a model that can integrate real time and transactions databases to the SCADA system designed to operate in the harsh environment of real-time systems, with strict requirements for resource utilization. These systems were to be ready to provide the performance and reliability required by real-life applications. As memory is the core part of a real-time database. SCADA functions cover the database data model, data operation, real-time resource management and network communication, limitedly the traditional disk database operation is based on disk I/O. Which this leads to time delays and sometimes is fatal to the real-time task. The Web services and ESB (Enterprise Service

Bus) are woefully inadequate for integrating real-time systems. They have no concept of timing control, also it will not be possible to estimate the state of the distribution system with enough accuracy to form the basis for planning or operations and build real-time analysis database. There are problems in the integration strategy such as repetitive functions and non-uniform data description as well as more than one interface for the same object.

1.3 Research Objectives

The main objectives of this thesis are to

1- Designing and developing an integrated business intelligence and data warehouse solution to handle and enable access to large and complex amounts of real time collected data.
2- Designing and developing an architecture which makes historical data accessible and easily combined with real time data to enable new functionalities and more efficient asset management.
3- Implementing SCADA environment to evolve with the smart grid, from a central static system to create a flexible system to enable the combination of real time distribution automation information with transactional and geospatial information.
4- Improving communication among departments e.g. Network Analysis can have access to the network data in GIS along with real time data from SCADA/GIS & AMR.
5- The model would lead to the reduction of maintenance costs and perform more efficient database management, determining what would be the optimal solution and allowance to be made for the uncertainties in the prediction of the future scenario of customer demand.

1.4 Methodology

The methodology of this thesis is to build a real time integration model including real time database and transaction database.

The work can be summarized as follows:

- Understanding the practicalities of bringing together two different cultures to support the effective integration of these separate departments.

- Ensuring the required information is accessible in the SCADA environment and examining, how the SCADA environment is evolving with the smart grid, from a central static system.
- Specify basic and overall requirements and characteristics of the electrical power distribution company and customer locations.
- Study the characteristics and utilization possibilities of distribution control strategies for outage management.
- Design the geographical information model for the overall system equipments.
- Design single line diagram in GIS to be similar as in the SCADA system.
- Design model based on parameter and link parameters to send the unique feature code like (lines, cables...) to SCADA.
- Design databases in GIS to request all parameters from SCADA.
- Designing AMR database depends on the locations of the electrical features and customers meters.

1.5 Contributions

The main contributions is to integrate real time databases with transaction databases to obtain real-time information from the server of SCADA, such as telemetry data and power flow etc and showing them on the GIS based feeder map. Moreover online GIS systems . store the circuit topology information in a standard format to detect the Outage and Fault Isolation and change the status of the customer in call center database from on to off.

1.6 Thesis Structure

After the introduction the thesis is structured as follows:

Chapter 2 presents a theoretical background for the typical system structure of integration real time systems. In addition, a review for some related works of integration of the geo-database with real-time database.

Chapter 3 describes the electric utilities GENERATION, TRANSMISSION and DISTRIBUTION of the power system from generation to consumers, and explains the SEDC as the study area as well as describing the situation of the existing systems.

Chapter 4 This chapter explores the process for designing the integration model of Geographical Information System (GIS) with Supervisory Control and Data Acquisition (SCADA) to send real-time data to the call center.

Chapter 5 presents the experiment results and discussion about these results.

Chapter 6 introduces the conclusion and the future work based on the experiment results.

1.7 Publications

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Integration of SCADA, GIS, and Call Center Systems for Electrical Power Distribution Management and Planning

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CHAPTER II

LITERATURE REVIEW

2.1 Introduction

This chapter goes through the theoretical background and briefly summarizes the previous literature which is most relevant to the research, so there are many studies of the Geographic Information System (GIS) integration and its application in electric utilities. chapter summarize the work done previously on Supervisory Control and Data Acquisition(SCADA) systems to monitor and control plants or equipment in electric industries and it's also focuses on Real-time systems that are designed to operate in a timely manner, that is, performing certain actions within specific timing constraints . Added to all this chapter covers enterprise integration as the task of making various applications work together to produce a unified set of functionality such as custom developed applications in house or purchased from third-party vendors. Also this chapter includes the

- GIS.

- GIS integration.

- SCADA integration.

- GIS integration with SCADA.

- CALLCENTER.

-GIS and CALLCENTER.

-GIS, CALLCENTER and SCADA.

2.2 Geographic Information Systems (GIS)

Geographic Information Systems' technology, defined as an arrangement of computer hardware, Software and geographic data that people interact with to integrate, analyze, and visualize data, identify relationships, patterns, trends, and find solutions to problems. GIS system is designed to capture, store, and update, manipulate, analyze, and display the geographic information (ESRI 1996). GIS is typically used to represent maps as data layers that can be studied and used to perform analyses.GIS has been applied in Power Distribution Dispatching widely to improve distribution management. The application and development of GIS in Power Distribution management not only improve the work efficiency and save the workforce strength of workers, but also bring the important meaningful instructions to the main productivity and competition (Abdurrahman 2013).

GIS used for

- Load Flow and Load Growth studies.
- Data presentation over a raster map.
- Location based data analysis.
- Asset Management System
- Easy planning.
- Improved data quality.
- Unique identifications of features.
- Flexible database for adding more and more information of a geo-feature.

2.2.1 GIS System Integration

The utilization of Geographic Information Systems and its technologies in conjunction with the ability to integrate within various applications, systems and hardware throughout an organization; which allows the management of assets and infrastructure and provides decision makers with spatial awareness of risks and exposures associated with an incident as well as the incident's scale and magnitude. This new knowledge affords decision makers with a better opportunity to deploy resources more effectively to mitigate further incident escalation. GIS systems store information about utilities' electrical assets, asset types, and their geographical locations and layout. This information is used by other information systems to build various models that used in electrical distribution system, GIS has ability to create datasets including graphical display of distribution system layouts and locations on geographical mapping platforms such as Google Maps (Abakchi 2007).The GIS and

Enterprise resource planning (ERP) in industry lead to identify a number of integration options and methods. The options and methods are derived based on the system functions objects. Partnership between Environmental Systems Research Institute (ESRI) and Systems, Applications & Products (SAP) the industry leaders of GIS and ERP systems respectively, has resulted in identification of five main technical interfaces available for integration. The integration technical interfaces include, SAP connectors, third-party connectors, and SAP generic GIS connector, and third-party Enterprise Application Integrators (EAI), SAP EAI and vendors partner solutions (Arfaj 2008) . The integration of SAP and GIS immensely helps staff identify work order locations and find related faults, thereby reducing the resolution time and increasing customer satisfaction. Decision makers rely on the GIS for a visual representation of the network, facility search options, and work order management (Lanjewar & JOGE 2012).

2.2.2 GIS and Utilities

In Electricity Distribution Utility, it is a fundamental requirement to have a proper energy accounting and auditing system, by distribution network analysis on GIS platform. Energy Audit and Network Analysis modules can be seamless integrated with meter data management, billing and collections, asset management, indexed consumer database and electrical network mapping on a middleware enterprise service bus. Standard plug-ins, business APIs and inter integration process Sang & Hytichul 1989).GIS has been used by electrical utilities, it focuses on automated mapping, facilities management, and geographical information systems (AM/FM/GIS). Critical utility applications include map editing, creation of map products, facility query and display, design/work order processing, network modeling, and executive information systems. The costs and benefits of implementing AM/FM/GIS in utilities are briefly examined. AM/FM technology incorporates two sets of technology automated mapping (AM) and facilities management (FM). The AM is used for producing maps, whereas the FM provides digital inventories of the facilities. The AM/FM technology is widely used for managing municipal utility information that requires a high level of data accuracy. The AM/FM technology has capability to manipulate both graphic data and descriptive data. But the AM/FM lacks the capability to perform spatial analysis and modeling (Zhao 2002).The design of the improved application program, based on AM/FM/GIS pilot system, with intranet database system provides detailed information of facilities, but also offers loading behavior analysis of the transformers. This program helps distribution engineers to manage and design the distribution system more efficiently and conveniently. The transformers will overload and fault in the summer season, the program can forecast the peak load of transformers and send an alarm before an overload or light-load event happens. In addition, the improved program adds several new sub functions and modifies others to enhance its performance and operation efficiency. This application program has been running, operated by distribution engineers. Especially, it provided quick and correct inquiry information to increase repair efficiency and reduce outage time for maintenance engineers(Chao 2010).Using GIS in power system has greatly enhanced the efficiency in energy sector(Jeff & KRSTIĆ 2011). Proximity to the furthest customer and high cost to invest capital, are the reasons that make the distribution system as an important part of electrical utility, which to improve the reliability of general power system Problems of planning in distribution system can be solved by using new methods and specific techniques. Complexity of electrical distribution system and necessity of accurate up-to-date information of the network assets is a reasonable intention for introducing new method of information technology. GIS software breakthrough technology which help utilities discover new things about their investments and risks, reduce the cost of manual maintenance of the maps, and allows the simultaneous assessment of technical, financial, and environmental factors. GIS have been proven to be a workable system to connect database information such as billing, material account, distribution analysis and outage reporting in power utility. Geographic Information Systems (GISs) are now being used widely for the mapping and modeling of utility network systems. Utilities use network models to monitor and analyze their distribution systems. Network analysis conclude network tracing which selects a particular path through the network based on user's criteria, network routing which determines the optimal path that has the shortest and the fastest distance and minimum cost and network allocation which deals with the designation of portions of the network. The most important usages of GIS in distribution system are optimizing electric line routing, suitable sites for locating new feeders, optimal design and choice of substation location and capacity, load distribution and load forecasting(Collier 2009).The power of GIS helps utilities understand the relationship of its assets to each other. Since the smart grid is composed of two networks electric and communications utilities must understand physical and spatial relationships among all network components. These relationships will form the basis for some of the advanced decision making the smart grid makes. A smart grid must have a solid understanding of the connectivity of both networks. GIS provides the tools and workflows for network modeling and advanced tracing.(Abakchi 2007) (ESRI 2009).GIS was developed for the utility departments to improve the efficiency and manage the utility data has allowed more flexibility over the previous CAD system when analyzing data. The management of the utility data has become much more efficient compared to previous management with CAD also the ability to read the meters from the GIS instead of having to read them in the field and measuring distances for proposed lines in the office instead of in the field has saved the department a lot of time(Davie 2012).Many utilities have the opportunity to use base map data produced by a local, regional, or national government agency, or in rare cases, by another utility serving the same area. To run distribution system efficiently for providing reliable service, it is required to manage geographic information, which can help engineers to operate the system as per the requirement. Schematic diagrams of the network are prepared which are used for overall understanding of the network. Electrical features described in schematics with dimensions are also captured. These electrical features include cables, poles, conductors, transformers, etc (Vader & Head 2011).

2.3 SCADA

SCADA is an acronym for Supervisory Control and Data Acquisition. SCADA systems are used to monitor and control a plant or equipment in industries such as telecommunications, water and waste control, energy, oil and gas refining and transportation. These systems encompass the transfer of data between a SCADA central host computer and a number of Remote Terminal Units (RTUs) and/or Programmable Logic Controllers (PLCs), and the central host and the operator terminals. A SCADA system gathers information (such as where a leak on a pipeline has occurred), transfers the information back to a central site, then alerts the home station that a leak has occurred, carrying out necessary analysis and control, such as determining if the leak is Critical, and displaying the information in a logical and organized fashion. These systems can be relatively simple, such as one that monitors environmental conditions of a small office building, or very complex, such as a system that monitors all the activity in a nuclear power plant or the activity of a municipal water system. Traditionally, SCADA systems have made use of the Public Switched Network (PSN) for monitoring purposes. Today many systems are monitored using the infrastructure of the corporate Local Area Network (LAN)/Wide Area Network (WAN). Wireless technologies are now being widely deployed for purposes of monitoring.SCADA information and command processing was distributed across multiple stations which were connected through a LAN. Information was shared in near real time. Each station was responsible for a particular task thus making the size of the information very big some problems that appear during the practical application. The problems involve the difficulty of interoperation and sharing resources resulting from the lack of a unified data model grid and Graphics standards (Qiang 2009) (DALE & PETER 2004).

2.4 Real Time Database

Real-time systems can be defined as those computing systems that are designed to operate in a timely manner. That is, performing certain actions within specific timing constraints; e.g., producing results while meeting predefined deadlines. Hence, the notion of correctness of a real-time system is contingent upon the logical correctness of the produced results as well as the timing at which such results are produced. Typical real-time systems consist of a controlled system (the underlying application) and a controlling system (a computer monitoring the state of the environment, as well as supplying it with the appropriate driving signals). The controlling system interacts with its environment based on the data available about the environment. Therefore, it is important that the state of the environment, as perceived by the controlling system, be consistent with the actual state of the environment. Otherwise, the effects of the controlling system activities may be inappropriate. The need of maintaining consistency between the actual state of the environment and the state as reflected or perceived by the system leads to the notion of temporal-consistency. Therefore, the specification of real-time systems includes timing constraints, which must be met in addition to the desired computations. Such timing constraints are usually defined in the form of deadlines associated with the various operations of the computing system. In addition, such timing constraints introduce a notion of periodicity, where certain tasks must be initiated at specific instants and must be executed within specific time intervals. The need to handle explicit deadlines and periodicity that are associated with activities requires employing time-cognizant protocols. Such time-driven management policies should be applied on a system-wide basis; e.g., processor, memory, I/O, and communications resources (data and channels). Thus, for a set of tasks to meet their prescribed deadlines, precedence constraints must be established, satisfied, and resources must be available in time for each task. Abrupt delays at any stage of the process can disrupt the system's behavior and objectives; i.e., delayed production of results Scheduling decisions are guided by various metrics that depend on the application domain. The variety of metrics suggested for real-time systems indicates the different types of real-time systems that exist in the real world, as well as the type of requirements imposed on them. Different execution requirements of firm deadlines and soft deadlines lead to different system objectives, and hence, different performance metrics in comparative studies. The fundamentals of real-time systems and to address the real-time issues that is most relevant to the construction of Real-Time Database (RTDB) systems. Real-time applications can be modeled as a set of tasks, where each task can be classified according to its timing requirements as hard, firm, or soft. A hard real-time task is the one whose timely and logically correct execution is considered to be critical for the operation of the entire system. The deadline associated with a hard real-time task is conventionally termed a hard-deadline. Missing a hard-deadline can result in catastrophic consequences – such systems are known as safety-critical. Thus, the design of a hard real-time system requires that a number of performance and reliability trade-off issues to be carefully evaluated. Real-time databases needs to be able to handle time-sensitive queries, return only temporally valid data, and support priority scheduling. Real-time database systems are emerging as a structured and systematic approach to manage data, avoiding application-dependent designs. This approach combines techniques from the database systems community with the existing methods for real-time computing. At least part of the database must be placed in main memory, in order to avoid the non-determinism of disks. However, a fast database executing in main memory is not necessarily a real- time database. For some applications completing each transaction within its deadline is more important than the average transaction rate. This requires a specialized design which ensures that transactions meet their deadlines(Barbosa and Engineering; Garcia-Molina2).The approach of the real time database is aiming to reduce delays by having main memory resident database also to achieve high performance to replace bottleneck devices (disks...) (Science, Virginia et al.). Many real-time applications need a database environment. But classical databases cannot satisfy all requirements of these applications. Real-time databases have all requirements of traditional databases, such as the management of accesses to structured, shared and consistent data, but they also require management of time-constrained data and time-constrained transaction(Jim See). Each real-time attribute value is characterized by a timestamp, which indicates the time at which it was last updated. So, for each real-time attribute value corresponds a timestamp, which distinguishes it from other attribute's values(Nizar & Aldarmi 1998).Real time database operates on data that is extracted from operational data sources with zero latency, and provides means to propagate actions back into business processes in real-time. Specifically, Real time database could comprise: real-time information delivery, real-time data modeling, real-time data analysis, real-time action based on insights(B Azvine; Son, Dept. of Computer Science et al.).Real-time database management system (DBMS) is the one of core of the dispatching automation system; it plays an important role for the safe operation of the smart grid. (ZHANG 2012)

2.5 Integration

Enterprise integration is the task of making various applications work together to produce a unified set of functionality. These applications can be custom developed in house or purchased from third-party vendors. They likely run on multiple computers, which may represent multiple platforms, and may be geographically dispersed. Some of the applications may be run outside of the enterprise by business partners or customers. Other applications might not have been designed with integration in mind and are difficult to change. These issues and others like them make application integration complicated. Data integration systems offer uniform access to a set of autonomous and heterogeneous data sources. Sources can range from database systems and legacy systems to forms on the Web, web services and flat files.

Styles of Integration

There is no one integration approach that addresses all criteria equally well. Therefore, multiple approaches for integrating applications have evolved over time. The various approaches can be summed up in four main integration styles.

File Transfer Figure 2.1 Have each application produce files of shared data for others to consume and consume files that others have produced.

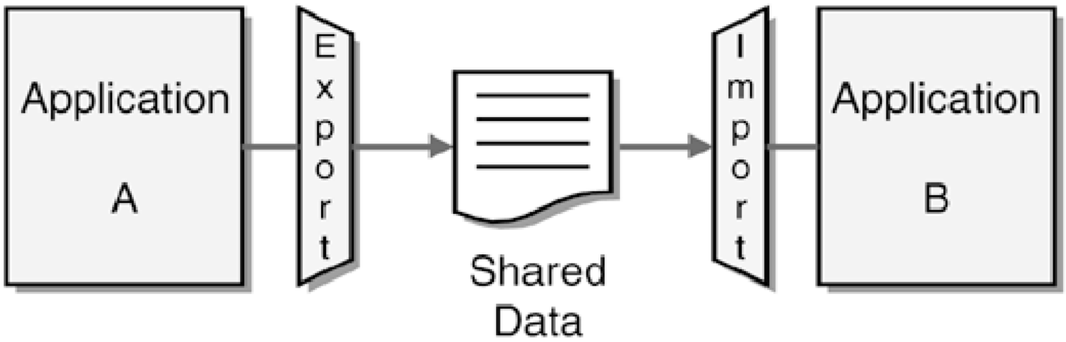


Figure 2.1 Shared data Style Integration

Shared Database— Figure 2.2 Have the applications store the data they wish to share in a common database.

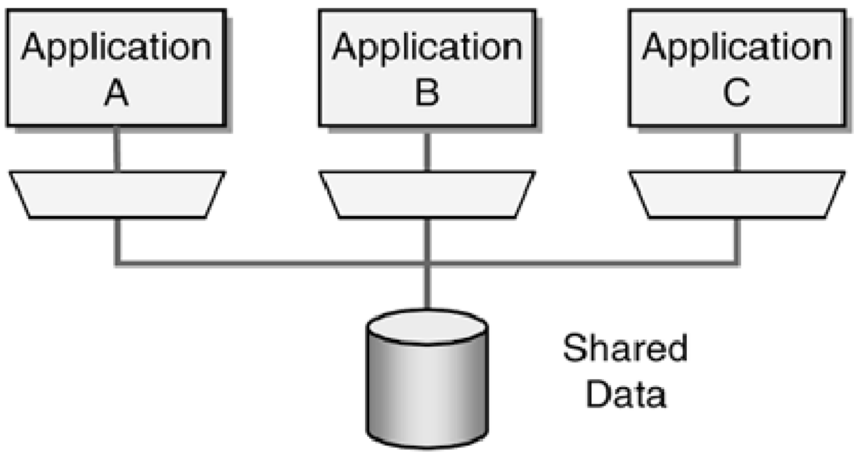


Figure 2.2 Common databases Style Integration

Remote Procedure Invocation— Figure 2.3 **Have** each application expose some of its procedures so that they can be invoked remotely, and have applications invoke those to initiate behavior and exchange data.

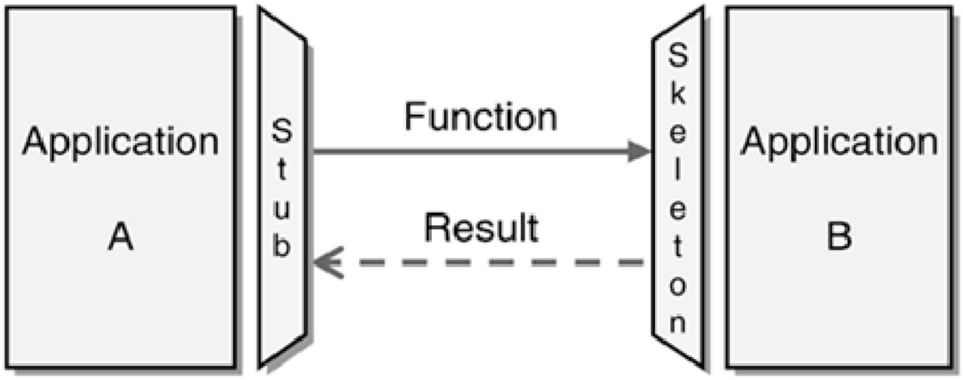


Figure 2.3 Application behavior Style Integration

Messaging— Figure 2.4 Have each application connect to a common messaging system, and exchange data and invoke behavior using messages.

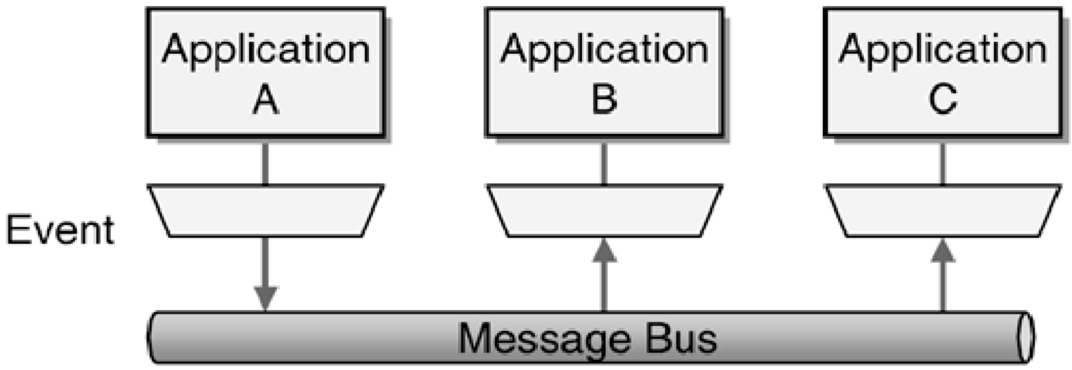


Figure 2.4 Common messages Style Integration

The four patterns share the same problem statement—the need to integrate applications—and very similar contexts. What differentiate them are the forces searching for a more elegant solution. Each pattern builds on the last, looking for a more sophisticated approach to address the shortcomings of its predecessors. Thus, the pattern order reflects an increasing order of sophistication, but also increasing complexity. The trick is not to choose one style to use every time but to choose the best style for a particular integration opportunity. Each style has its advantages and disadvantages. Applications may integrate using multiple styles so that each point of integration takes advantage of the style that suits it best. Likewise, an application may use different styles to integrate with different applications, choosing the style that works best for the other application. As a result, many integration approaches can best be viewed as a hybrid of multiple integration styles (Gregor & Bobby 2003).

The data in the sources need not be completely structured as in relational databases.

Three of the major trends in information technology today are the Web, enterprise software packages, and application integration. The reality is that there are still many aspects around integration that present significant challenges such as the amount of time it takes to integrate systems, complexity of integration solutions, reliance on expensive specialist skill sets and cost of providing "anytime/anywhere" integration technology across the enterprise. In most cases it is challenges such as these that prevent organizations from realizing the true potential of an investment in integration software. Integration between applications concerns not just the transfer of data, but also the business logic that controls the sequencing and ensures the integrity of the business transactions. Each step may have to complete before the next can commence(Beaton 2008). Data entered by people and systems communicating with the business process have to fulfill correctness criteria, usually expressed through (business) rules. In object-oriented analysis and design, e.g. UML, rules are often during the definition of use cases Moreover, customers should be able themselves to specify which service combination they want. This calls for the ability to augment the service definition with guard conditions that hinder the use of services that customers are not authorized to use or that are not possible to combine with other services selected(Johannesson & Wangler & Jayaweera 2000).The movement to real-time data integration requires an understanding that the use of data is going to be a bit different than with traditional approaches. In the past, we accepted that data could flow occasionally from system to system, data store to data store, and as long as the data was replicated at some point, all was well. However, the movement to real-time data integration takes a different mindset. We need to interact with existing business transactional systems that drive the enterprise. This means that we no longer wait for data to find its way to a back-end data store, but need to capture it directly from the core transactional systems as the data is gathered. Moreover, the data must be transmitted and processed at the time of collection, and presented along with historical information within the BI tools or business applications. Service-oriented architectures (SOA), though widely accepted in a variety of industries, must be enhanced to support real-time activities in order to gain even greater adoption. The architecture for real-time SOA support predictability in business processes. Based on a user-specified process and deadline, the architecture, containing global resource management and business process composition components, can reserve resources in advance for each service in the process to ensure it meets its end-to-end deadline(Mark 2009).

2.6 Integrated GIS and SCADA

Over time, increases the importance of using GIS in the management and operation of electric networks, increasing the possibility of integration with all other data as AutoCAD drawings and hydraulic modeling systems results. The selection of geo-spatial information systems as a tool to work allows users to easily handle both of the location data and any other data on scheduled work, ongoing activities, recurring maintenance problems, and historical information. The topological properties of a GIS database can support network tracing and can use it to analyze how stoppages, main breaks, drainage defects, and so forth, may impact specific properties or services. GIS supports many other operations and maintenance tasks including work order and warehouse inventory management and supervisory control and data acquisition (SCADA). GIS can be integrated with SCADA, so the data can be collected from the site using SCADA and analyzed spatially by GIS allowing control of all operations connected to the electric distribution system and doing analysis required to obtain the results which need to develop solutions for the problems as they happen. GIS can also use the results of integration with the computer modeling and simulation of the operational processes in the network for widespread surveillance in urban areas for electric distribution systems in a variety of GIS applications ranging from improving and controlling the work of the substations and managing of transformers to detect the location and size of load in the network, such a system can also be used for the implementation of systems to protect the electric by predicting the performance during emergency events.

The GIS in a utility is a major source of important information in the company, and often is, or should be, the master repository of the utility's facilities and equipment. The SCADA control room requires a particular view of the facilities, and therefore needs access to the GIS data. It is expensive to manually re-create the graphics and equipment definitions in the SCADA system, especially in a system subject to continual expansion, upgrades, and changes. Rather, a mechanism to easily and periodically move the information into the SCADA system and convert it to a suitable form, or in some other way make the GIS data available to the SCADA system, is needed(Clarke 2001).The main aspects of the design of an integrated Information System for implementing a Distribution Automation System (DAS) consisting of Supervisory Control Data Acquisition System and Distribution Management System (SCADA-DMS). Outage Management System and Crew Management System (OMS, CMS) Trouble Call System (TCS). The DAS can also include other computer-based systems to be integrated, for example: Geographic Information System (GIS) Customer Information System (CIS) Work Management System (WMS) Asset Management System (AMS) PCs and workstations on the Corporate WAN. The article addresses System Integration using an Enterprise Application Integration (EIA) methodology, which gives utilities a simpler, faster, and less costly method of integrating legacy and new systems.(Inc 2004) .The current distribution SCADA is mainly integrated with distribution GIS in production management area through interfaces. There are problems in the integration strategy such as repetitive functions and non-uniform data description as well as interface for the same object. Moreover the distribution GIS adopts commercial GIS which is provided with complicated features and functions with expensive cost, with limitation of the runtime platform. However the functions of GIS in SCADA are simple, but the cross-platform feature is necessary(Lili & Michael & Moore 2011).At present, GIS has been widely used in energy management system (EMS), providing visualization platform to electrical distribution system analysis, design and operation. The system platform is called AM/FM/GIS. The platform provides powerful capability to manipulate both graphic and non-graphic information. It is an integrated distribution information system with automated mapping and facility management based on GIS platform. It integrates graphic representation of information with spatial relationship and information management for distribution system facilities(Lee 2002) .In distribution systems many calculations and analyses, such as power flow analysis, network planning, line loss analysis, are conducted to deal with the information regarding the distribution network topology. Therefore, both geographic maps and feeder one-line diagrams are important graphic data in power system(Xianqi 2008). The Power Supply has implemented the integration of distribution SCADA and GIS using emerging integration technology. This avoids data duplication and data redundancy in various

systems. Thus the overall maintenance and support cost would be considerably reduced. The distribution SCADA system provides the real-time data for the power distribution GIS system, and enhances the capabilities of GIS(Technology 2010) (Michael S. Moore and (ISIS)).The integration and synchronizing the operation of SCADA and Smart Meters linked by Advanced Metering Infrastructure (AMI) and GIS system open new horizons for new advanced applications for control and optimize the distribution network operation. SCADA serves as watchdog over the distribution network and continuously monitor the integrity of the distribution network together with the remote synchronic-sensors to generate detailed information about the state of the network. The synchronization of SCADA monitoring operation with the remote Smart Meters data gathering provides an accurate picture of how the actions of the end devices at the remote sites affect the operation of the energy delivery system. The wealth of information generated becomes a source and the basis for new and advanced control functions designs that improves the customer satisfaction and the reliability energy delivery system. (Michael & Mak 2011).Electrical utilities & various Business Systems
In the present days are facing problems due to high energy losses, reduced quality & reliability of supply, billing issues, theft of energy, no proper strategic revenue collection methods, etc. This results in inefficient operation, consumer dissatisfaction & loss of market value of the utility in public. These problems are mainly associated with the Sub-transmission & distribution networks in the Power system. The present traditional 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, there are several integration techniques / strategies, which can be used for SCADA/DMS & GIS integration. The integration technology discussed in this is based on the ABB's SCADA/DMS (Network Manager) & ESRI's GIS technology (ArcGIS 9.0) being implemented at Reliance Energy Ltd. The primary aim is to access the data from Network Manager's real time database. An emerging technology is Message- Oriented Middleware (MOM) where communication is based on publish – subscribe paradigm. This method enables easy extensions of additional receivers (subscribers) of the data as the sender (Publisher) does not need to be configured (Kale 2006.).

2.7 Integrated GIS and AMR

Automatic Meter Reading (AMR) is the term given to a system that provides Meter readings automatically. There are two methods of providing data via a one or two-way communications route:

• The Data Collector's system 'polls' the Meter for its data routinely.

• The Meter 'sends' its readings automatically to the Data Collector or a Central location for processing.

The primary benefit of this technology is more accurate and precise measurement of electricity consumption. Consumers will be billed the amount that exactly corresponds to what they have consumed. On the other hand, utility companies will have more efficient operations. Less manpower and resources are needed in meter reading and data gathering; they only need to access the main database to get the information that they need for billing and analysis. The AMR used to automatically collecting consumption, diagnostic, and status data from energy metering devices (electric). Transferring data to a central database for billing, troubleshooting, and analyzing. This technology mainly saves utility providers the expense of periodic trips to each physical location to read a meter. Another advantage is that billing can be based on near real-time consumption rather than on estimates based on past or predicted consumption. This timely information coupled with analysis can help both utility providers and customers' better control the use and production of electric energy usage or consumption.

GIS converts the AMR data at electronic plants, into trends, patterns and maps that can be used for further analysis. Operations like automated performance of analytical functions, notification and calculation of cost and saving, help it extend its scope to managers, engineers, analysts and other business departments. A GIS normally provides asset and customer location data; AMR provides timely customer usage data. One potential synergy in combining information from these two systems is that the load on distribution components can be analyzed for reliability and maintenance purposes, and a field inspection/maintenance program can be built around that same information along with asset location data. Enterprise integration is an evolving field composed of several major elements, including enterprise application integration

(EAI), business process integration (BPI) and enterprise information integration (EII). When utilities think of enterprise integration, they typically look at an EAI suite or framework to enable business process optimization. EAI usually uses middleware to integrate the application programs, databases and legacy systems involved in a utility's critical business processes. The correct assessment of commercial & technical loss parts need correct metering data from AMR. This information can be provided to Network analysis tool along with network model from GIS. Then finding the feeders, transformers, distribution areas having high energy losses from network analysis & displaying this output in GIS would help lot for doing spatial analysis(Kale, Ltd et al.).

2.8 Integrated SCADA and AMR

Currently, there are many technologies available to automate public utilities services (water, gas and electricity). AMR, Automated Meter Reading, and SCADA, Supervisory Control and Data Acquisition, are the main functions that these technologies must support Public utilities' management has many different aspects closely interrelated that must be coordinated within a corporative network: (e.g. Meter reading from customer meters, Distribution management, Economic dispatch. . .) These applications are often distributed throughout many computers.(Francisco Javier Molina). The main purpose of SCADA and AMR system is introduction of Global and integrated system comprising functionalities of SCADA and AMR systems on the basis of well-developed hardware, transmission and database infrastructures of SCADA. Minimization of repeated visits by meter readers at customer's doorstep improves property and both sides persons security, supports client's privacy. In the integrated structure the new definition of data point in the system is introduced. Its interpretation for Remote Terminal Units (RTU's), flow computers, transmission protocol and applications is wider than traditionally applied(Elzbieta 2003).

2.9 Integrated GIS, SCADA and AMR

Automatic Meter Reading (AMR) smart grid system is determining the needs of all the vital aspects e.g. daily workflow, workforce management, asset management, call center philosophy, billing systematic etc. AMR system could cover variety of installation techniques meeting customer requirements. The concepts presented include installation of standalone automated metering system which only enable monitoring of load on transformers, automated reading with full controlling features using SCADA system where as metering management system operating separately. Moreover, it also includes automated meter reading with limited controlling and enhanced function of SCADA system. More advanced features of an integrated AMR, enhanced distribution management system with full controlling, monitoring and Geographic Information System (GIS) are also addressed. AMR smart grid system provides fundamental benefits including efficient power system control and monitoring, Timely operational decisions to minimize outages and losses and acquiring meter readings of several energy interchange points and many 11 KV incoming and outgoing feeders(Mahmood 2008). GIS plays a significant role in establishing a communication between automation systems like SCADA, DMS, AMR and customer care and billing systems. This, in turn, is helping the company in its smart grid journey making the management smart. GIS is indeed a transformational technology. Finally, GIS is a wonderful tool to help in the deployment of the smart grid itself. Utilities can monitor construction progress, route crews in the most efficient way, and help with analysis for locating the best location for repeaters (Nidhi Nielsen 2008).

2.10 Integrated GIS and Call Center

Call Center is an application that handles incoming calls as efficiently and economically as possible. Call Center answers calls, and then routes the calls to agents in most closely meet the needs of the caller. The call center application developed to use GIS provides an interactive map within interface to plot service calls. This application will allow staff members to better manage their daily work flow by quickly displaying where existing calls have been recorded as new ones are being entered. This will greatly assist the staff in grouping calls so repeat tickets are not generated for the same problem. This implementation will also give the County a vastly improved method to target its existing resources and cut down on redundancy. The using of integrated approach of GIS and call center improve the accuracy and reduce the time needed to set an appointment location(Hilton 2005) .

CHAPTER III

THE SEDC SYSTEMS DESIGN

3.1 Power System

Electric power systems are real-time energy delivery systems. Real time means that power is generated, transported, and supplied the moment you turn on the light switch. Electric power systems are not storage systems like water systems and gas systems. Instead, generators produce the energy as the demand calls for it.

Figure 3.1 (According to encyclopedia) shows the basic building blocks of an electric power system. The system starts with generation, by which electrical energy is produced in the power plant and then transformed in the power station to high-voltage electrical energy that is more suitable for efficient long-distance transportation. The power plants transform other sources of energy in the process of producing electrical energy. For example, heat, mechanical, hydraulic, chemical, solar, wind, geothermal, nuclear, and other energy sources are used in the production of electrical energy. High-voltage (HV) power lines in the transmission portion of the electric power system efficiently transport electrical energy over long distances to the consumption locations. Finally, substations transform this HV electrical energy into lower-voltage energy that is transmitted over distribution power lines that are more suitable for the distribution of electrical energy to its destination, where it is again transformed for residential, commercial, and industrial consumption. A full-scale actual interconnected electric power system is much more complex than that shown in Figure 3.1; however the basic principles, concepts, theories, and terminologies are all the same.

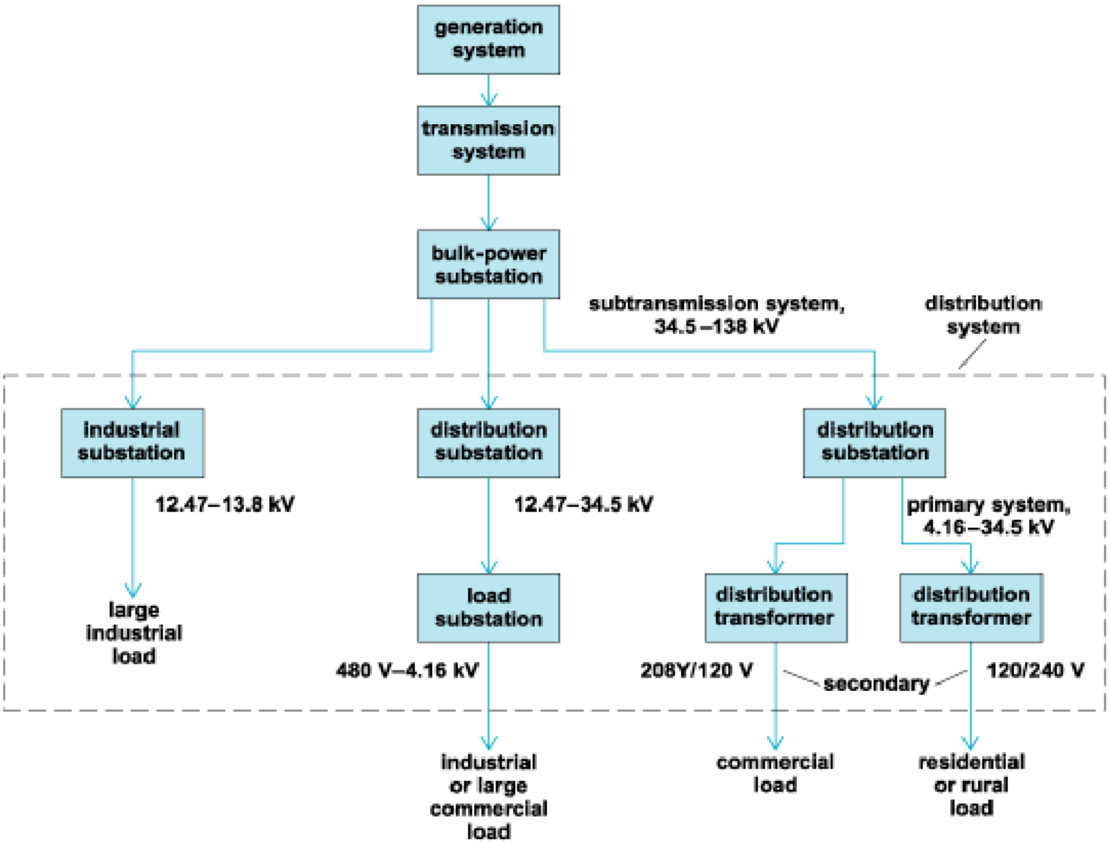


Figure 3.1: power system from generation to consumer's.

3.1.1GENARATION

Power plants produce electrical energy on a real-time basis. Electric power systems do not store energy such as most gas or water systems do. For example, when a toaster is switched on and drawing electrical energy from the system, the associated generating plants immediately see this as new load and slightly slow down. As more and more load (i.e., toasters, lights, motors, etc.) are switched on, generation output and prime mover rotational shaft energy must be increased to balance the load demand on the system (Steven 2007). Electrical generation always produces electricity on an "as needed" basis. Note: some generation units can be taken off-line during light load conditions, but there must always be enough generation online to maintain frequency during light and heavy load conditions. There are electrical energy storage systems such as batteries, but electricity found in interconnected ac power systems is in a real-time energy supply system, not an energy storage system.

3.1.2TRANSMISSION

The transmission network provides the vital link between power plants that produce electricity and the distribution system that delivers electricity to the demand centers – homes, businesses, and industries – that use it. It is a highly complex and integrated network that works well because it has been carefully designed and constructed according to strict operating standards. The vast majority of the network is owned and operated by the shareholder-owned segment of the electric utility industry.

When electricity leaves a power plant (1) Figure3.2 (According to earthlyissues), its voltage is increased at a "step-up" substation (2). Next, the energy travels along a transmission line to the area where the power is needed (3). Once there, the voltage is decreased, or "stepped-down," at another substation (4) and a distribution power line (5) carries the electricity until it reaches a home or business (6).

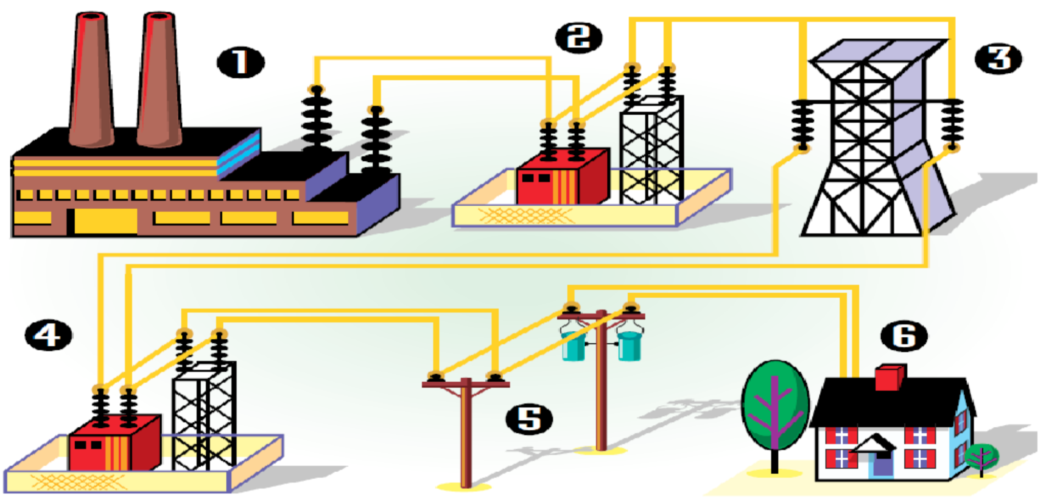


Figure 3.2 Transmission Grid Work flow

3.1.3 DISTRIBUTION

Electricity distribution is the final stage in the delivery of electricity to end users. A distribution system's network carries electricity from the transmission system and delivers it to consumers. Typically, the network would include medium-voltage (less than 50 kV) power lines, electrical substations and pole-mounted transformers, low-voltage (less than 1 kV) distribution wiring and sometimes meters. Also Electric power distribution defines as the portion of the power delivery infrastructure that takes the electricity from the highly meshed, high-voltage transmission circuits and delivers it to customers. Primary distribution lines are "medium-voltage" circuits, normally thought of as 600 V to 35 kV. At a distribution substation, a substation transformer takes the incoming transmission-level voltage (35 to 230 kV) and steps it down to several distribution primary circuits, which fan out from the substation. Close to each end user, a distribution transformer takes the primary-distribution voltage and steps it down to a low-voltage secondary circuit (commonly 120/240 V; other utilization voltages are used as well). From the distribution transformer, the secondary distribution circuits connect to the end user where the connection is made at the service entrance. Functionally, distribution circuits are those that feed customers, regardless of voltage or configuration. Some also think of distribution as anything that is radial or anything that is below 35 kV.

The distribution infrastructure is extensive; after all, electricity has to be delivered to customers concentrated in cities, customers in the suburbs, and customers in very remote regions; few places in the industrialized world do not have electricity from a distribution system readily available. Distribution circuits are found along most secondary roads and streets. Urban construction is mainly underground; rural construction is mainly overhead. Suburban structures are a mix, with a good deal of new construction going underground.

A mainly urban utility may have less than 50 ft of distribution circuit for each customer. A rural utility can have over 300 ft of primary circuit per customer. Several entities may own distribution systems: governments, state agencies, federal agencies, rural cooperatives, or investor-owned utilities. In addition, large industrial facilities often need their own distribution systems. While there are some differences in approaches by each of these types of entities, the engineering issues are similar for all. Because of the extensive infrastructure, distribution systems are capital-intensive businesses. Low cost, simplification, and standardization are all important design characteristics of distribution systems. Few components and/or installations are individually engineered on a distribution circuit. Standardized equipment and standardized designs are used wherever possible.

Distribution planning is the study of future power delivery needs. Planning goals are to provide service at low cost and high reliability. Planning requires a mix of geographic, engineering and economic analysis skills. New circuits (or other solutions) must be integrated into the existing distribution system within a variety of economic, political, environmental, electrical, and geographic constraints. The planner needs estimates of load growth, knowledge of when and where development is occurring, and local development regulations and procedures.

3.2 Distribution Systems Planning

System planning is essential to assure that the growing demand for electricity can be satisfied by distribution system additions which can both technically adequate and reasonably economical. In the past a considerable work has been done for planning of generation and transmission, but unfortunately been somewhat neglected.

3.3 SEDC Systems Architecture

Sudanese Electricity Distribution Company (SEDC) is the electrical power distributor in Sudan. SEDC covers the majority of Sudan area SEDC has 120 maintenance offices for making the necessary switching operations, detecting the faulty cables or lines and restoring supply again. Each office is located in the centre of load area under its control. The nature of occupied areas, traffic jam or long distances from maintenance centers too many faulty locations, causes delay of supply restoration under manual operation system.

3.4 SCADA System Architecture in SEDC

SEDC installed SCADA system in 1999 by MICROSOL Company. Applying SCADA system on all substations is required but the cost is so high. To get better results with lower cost, SCADA system was applied only on 14 substations **Figure 3.3** as a pilot project. The system runs on windows using hp servers with Oracle backend. After that SCADA applied on all substations in Khartoum states and it consists of three Distribution Control Centers (DCCs) and Supervisory Control Centre (SCC). Each DCC controls separate geographical areas with no overlapping for decision responsibility. Each centre is equipped with its automation equipment in the master station (main building of DCC). Motor operated load break switches were provided in some selected substation points. Additionally, a Supervisory Control Centre (SCC), located at the main branch of the company, is responsible for overall monitoring of the entire SEDC electrical distribution network. It has access to real-time data and display for all of the three DCCs areas. It also provides capabilities that merge data from all DCCs for reporting.

3.4.1 SCADA Data

The system provides Equipment Parameter Data as the Schematic diagram for Sub-Stations, Distribution Points and transformers, Power transformer rating, Impedance etc. Bus bar scheme, Circuit breakers and Switches types & ratings, CTs and PTs, MV Cables locations and specifications. Also the SCADA systems applied the Operational parameters like ECS configuration Control (Close/Open Status of substations' equipment, breakers, switches etc.), Data Acquisition from RTUs: online Analog values of MV voltage, current, PF, Active & Reactive Power, Indication of Location/zone in case of Line fault, Network configuration, Failure of distribution transformers, Historical accounts and events, Power system snapshots and studies, Alarm and Event Logging.

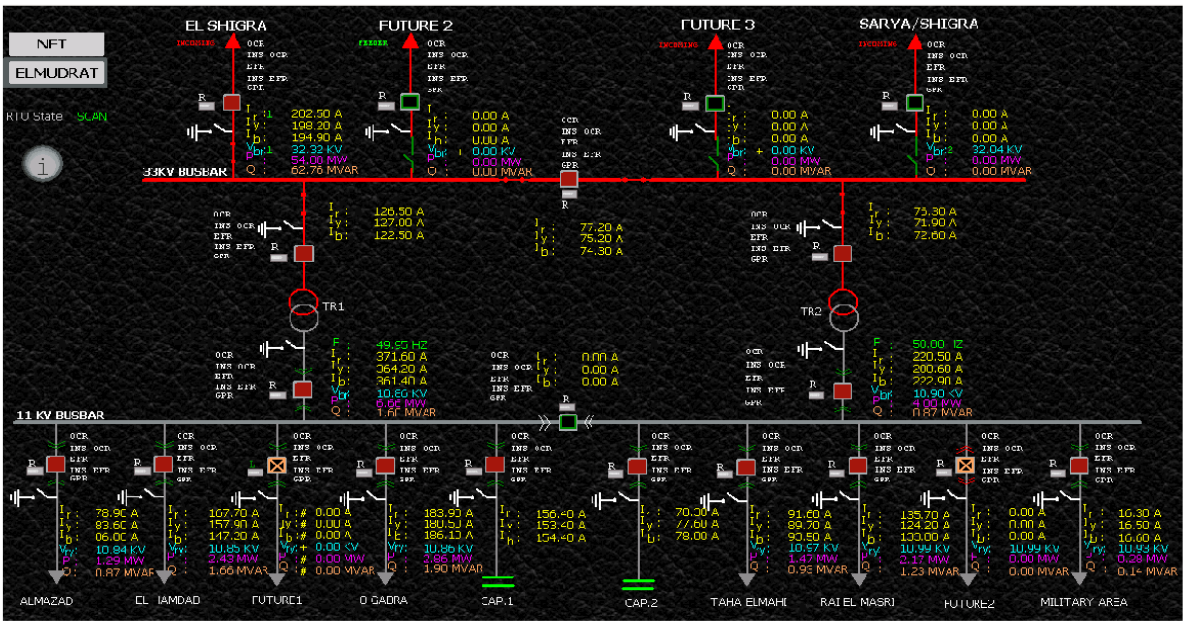


Figure 3.3 SEDC Single Line Diagram

3.5 GIS Architecture IN SEDC

SEDC installed ESRI's GIS software to manage its electric power facility in 2011. The main advantage of mapping in ArcGIS is to develop different layers to retrieve the network information quickly and easily. ESRI's ArcGIS server is running on Windows platform and is connected to Sqlserver database **figure 3.4**.

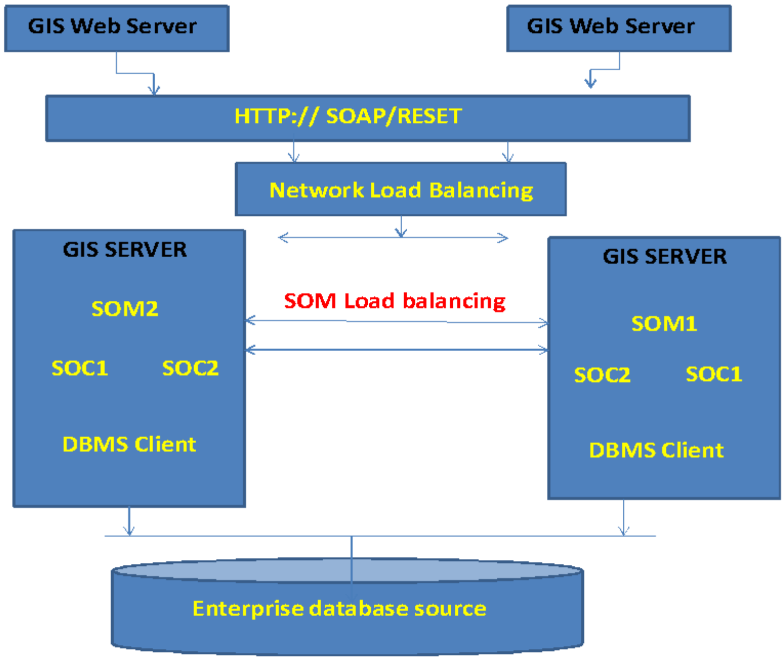


Figure 3.4 SEDC GIS Configuration

3.6 SEDC GIS data

3.6.1 Topological (Network) data

Geographical maps consisting of MV network Distribution System & Consumer area including spatial & attribute information of the following: MT Cables, Distribution transformers, RTUs, Cable / Conductor Route, Cross Section details, Underground system, Service Points, Feeding Point details etc.

3.6.2 Land Base Data

Building, Roads, Landmarks, and Railway Lines etc **figure 3.3**.

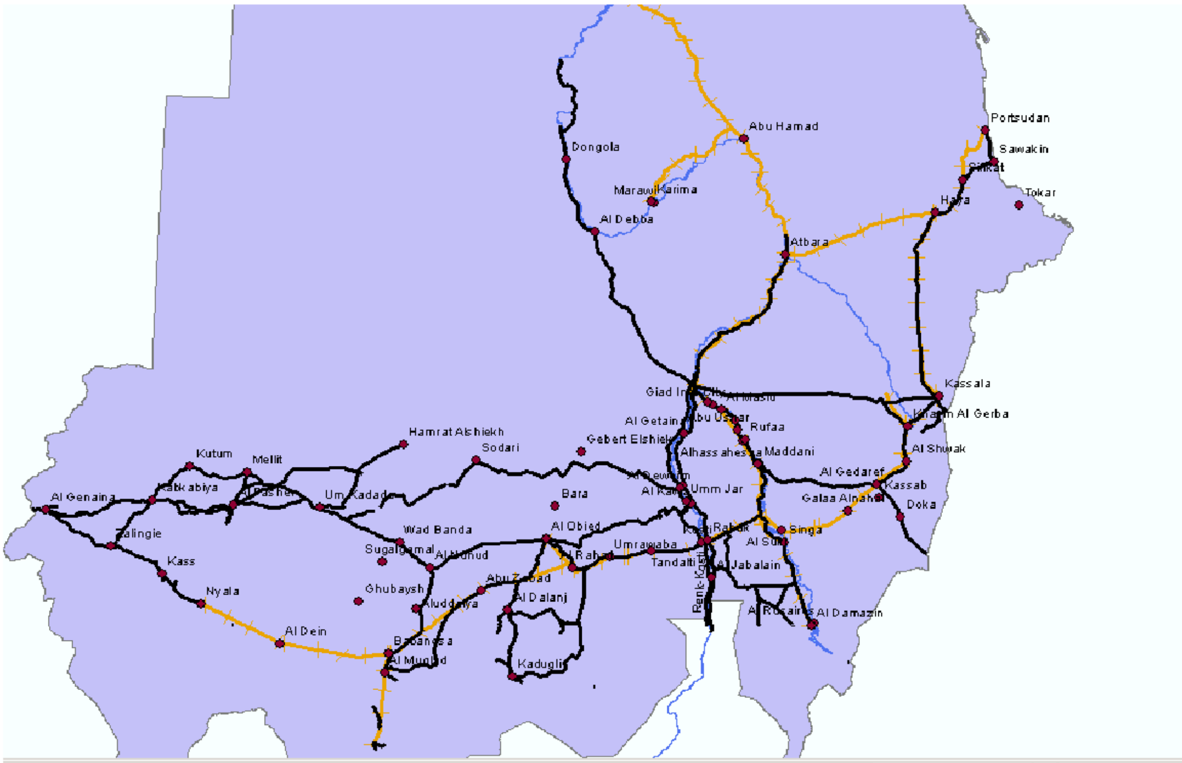


Figure 3.5 SEDC Land Map

3.6.3 Building Geodatabase

A geodatabase is a virtual "container" for various types of information relevant to a GIS. It provides an organizational structure for a variety of data sources and provides a level of intelligence to help manage this information. In addition to assisting data management, a geodatabase also extends GIS functionality. The SEDC geodatabase covering the network equipments **Figure 3. 4** the geodatabase presents the spatial information of the MV and LV network efficiently**. Figure 3.4** displays the exact structure of the geodatabase utilized in SEDC. The data for Distributions were stored as dbase files within this structure ("cable_kV", "line_", "poles_kV", and "substation").

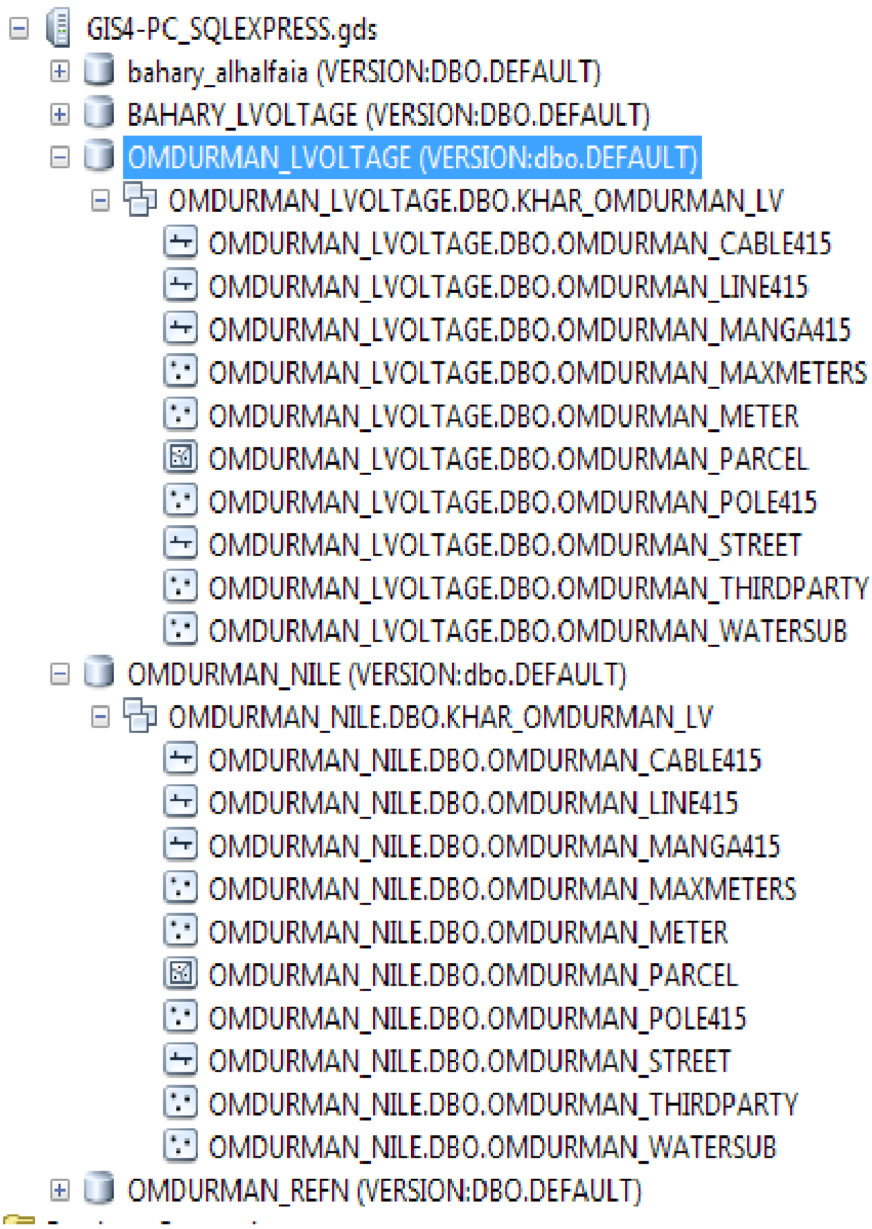


Figure 3.6 SEDC Geodatabase

Building a geodatabase for SEDC required some data conversion and minimal formatting.

GIS is layers can be likened to the shape file for the geodatabase structure **Figure 3.7**. Once the basic layers resided in the geodatabase, feature datasets were created. The feature dataset is another level of SEDC structure that allows the added functionality of network building and strictly enforces the precision of grouped, spatial datasets.

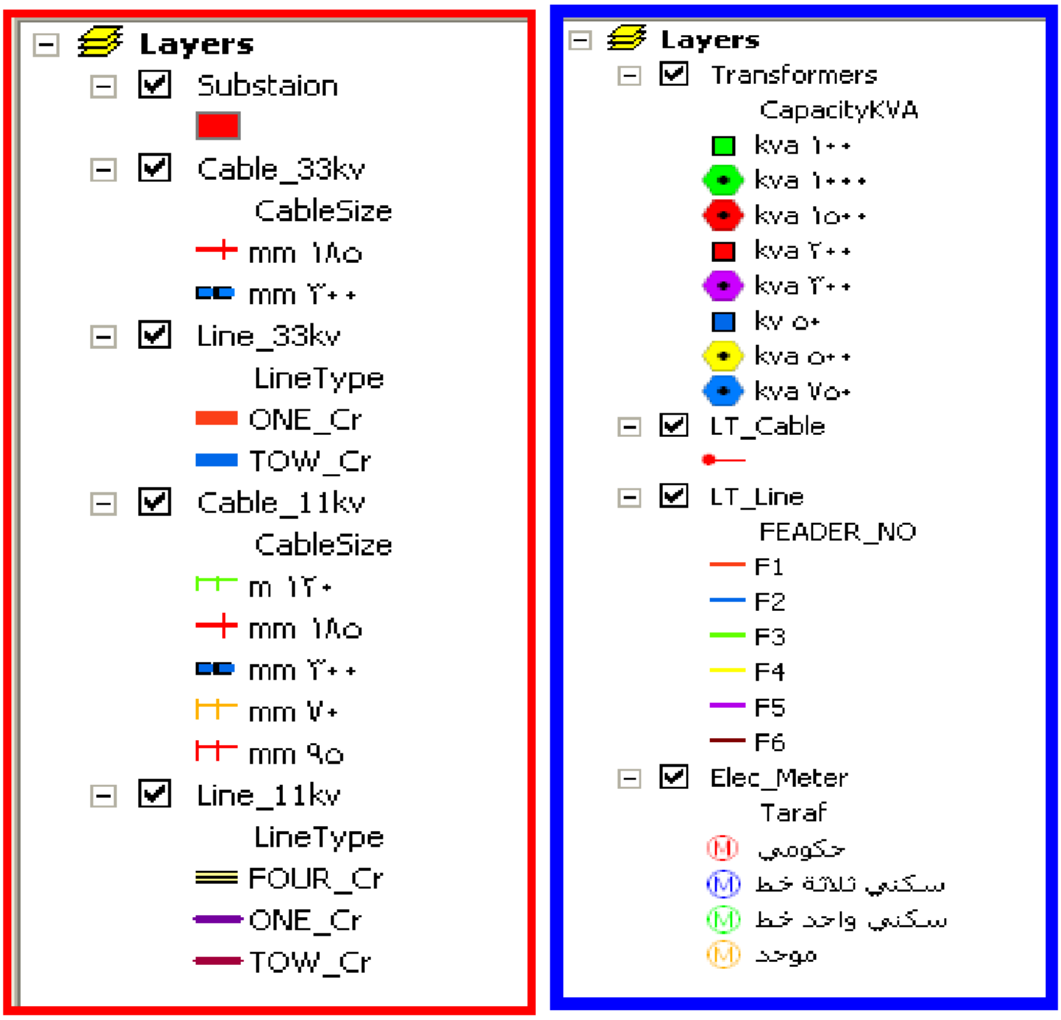
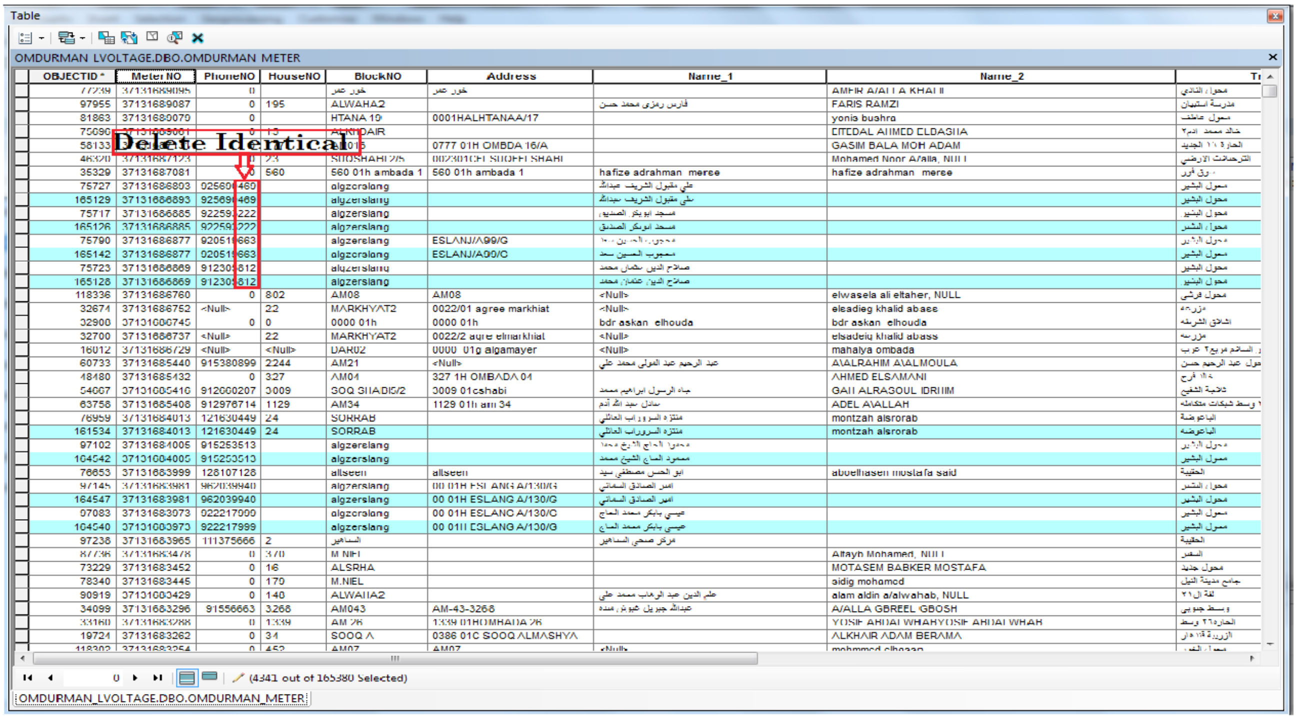


Figure 3.7 SEDC Equipments layers

3.6.4 The geodatabase Tables

The tabular attribution is used in SEDC GIS to display information as reports and spreadsheets **Table 3.1**. The attribute information was exported from .xls to dBASE format to allow exchange data in the GIS software. Once the dBASE files were imported into the GIS, they were joined based on unique identifiers.



OBJECTID *	Meter NO	PhoneNO	HouseNO	BlockNO	Address	Name_1	Name_2	Tr
77239	37131689095	0		خور عمر	خور عمر		AMFIR A/ALLA KHALIL	محول النادي
97955	37131689087	0	195	ALWAHA2		فارس رمزي محمد حسن	FARIS RAMZI	مدرسة استيهان
81863	37131680079	0		HTANA 19	0001HALHTANAA/17		yonis bushra	محول عاطف
75090	[illegible]	0	13	ALKHDAIR			EITEDAL AHMED ELDASHA	خالد محمد ادم٢
58133	[illegible]	[illegible]	[illegible]	[illegible]016	0777 01H OMBDA 16/A		GASIM BALA MOH ADAM	الحارة ١٦ الجديد
46320	37131687123	0	23	SHOSHAHI 2/5	002301CH SHOHFI SHAHI		Mohamed Noor A/alla, NULL	الترحيلات الارضي
35329	37131687081	0	560	560 01h ambada 1	560 01h ambada 1	hafize adrahman meree	hafize adrahman meree	سوق فور
75727	37131686803	025600460		algzeralang		علي مقبول الشريف عبدالله		محول البشير
165129	37131686893	925690469		algzerslang		علي مقبول الشريف عبدالله		محول البشير
75717	37131686885	922591222		algzerslang		مسجد ابوبكر الصديق		محول البشير
165126	37131686885	922591222		algzerslang		مسجد ابوبكر الصديق		محول البشير
75790	37131686877	920519663		algzerelang	ESLANJ/A99/G	محجوب الحسين سعد		محول البشير
165142	37131686877	920519663		algzeralang	ESLANJ/A99/C	محجوب الحسين سعد		محول البشير
75723	37131686869	912305812		algzerslang		صلاح الدين عثمان محمد		محول البشير
165128	37131686869	912305812		algzerslang		صلاح الدين عثمان محمد		محول البشير
118336	37131686760	0	802	AM08	AM08	<Null>	elwasela ali eltaher, NULL	محول قرشي
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32900	37131686745	0	0	0000 01h	0000 01h	bdr askan elhouda	bdr askan elhouda	اشلاق الشرطة
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60733	37131685440	915380899	2244	AM21	<Null>	عبد الرحيم عبد المولى محمد علي	A\ALRAHIM A\ALMOULA	محول عبد الرحيم حسن
48480	37131685432	0	327	AM04	327 1H OMBADA 04		AHMED ELSAMANI	خالد فرح
54007	37131685416	912000207	3009	SOQ SHADI5/2	3009 01cshabi	جاد الرسول ابراهيم محمد	GAH ALRAGOUL IDRHIM	شاخبة الشفيع
63758	37131685408	912976714	1129	AM34	1129 01h am 34	عادل عبد الله آدم	ADEL A\ALLAH	وسط شبكات متكاملة
76959	37131684013	121630449	24	SORRAB		منتزه السروراب العائلي	montzah alsrorab	الباعوضة
161534	37131684013	121630449	24	SORRAB		منتزه السروراب العائلي	montzah alsrorab	الباعوضة
97102	37131684005	915253513		algzerelang		محمود الحاج الشيخ محمد		محول البشير
164542	37131684005	915253513		algzerslang		محمود الحاج الشيخ محمد		محول البشير
76653	37131683999	128107128		allseen	allseen	ابو الحسن مصطفى سيد	abuelhasen mostafa said	الحقيبة
97145	37131683981	962039940		algzerslang	00 01H ESLANG A/130/G	امير الصادق السماني		محول البشير
164547	37131683981	962039940		algzerslang	00 01H ESLANG A/130/G	امير الصادق السماني		محول البشير
97083	37131683973	922217999		algzeralang	00 01H ESLANG A/130/G	عيسى بابكر محمد الحاج		محول البشير
164540	37131683973	922217999		algzerslang	00 01H ESLANG A/130/G	عيسى بابكر محمد الحاج		محول البشير
97238	37131683965	111375666	2	السباهير		مركز صحي السباهير		الحقيبة
87736	37131683478	0	370	M.NIEL			Altayb Mohamed, NULL	السفر
73229	37131683452	0	16	ALSRHA			MOTASEM BABKER MOSTAFA	محول جديد
78340	37131683445	0	170	M.NIEL			sidig mohamed	جامع مدينة النيل
90919	37131683429	0	140	ALWAHA2		علم الدين عبد الوهاب محمد علي	alam aldin a/alwahab, NULL	لفة ال٢١
34099	37131683296	91556663	3268	AM043	AM-43-3268	عبدالله جبريل غبوش مدة	A/ALLA GBREEL GBOSH	وسط جنوبي
33160	37131683288	0	1339	AM 26	1339 01HOMBADA 26		YOSIF AHDALWHAHYOSIF AHDALWHAH	الحارة ٢٦ وسط
19724	37131683262	0	34	SOOQ A	0386 01C SOOQ ALMASHYA		ALKHAIR ADAM BERAMA	الزريبة قاعدار
118302	37131683254	0	452	AM07	AM07	<Null>	mohmmed elhasan	[illegible]

Table 3.8 SEDC attribute table

3.7 Call center and GIS

Customer Information System (CIS) a computerized system used in SEDC to track customer information, generate bills, issue service requests, and “manage” customer relationships by providing the information about each customer’s needs and preferences and Interactive Voice Response System (IVR) Interactive computer system which can answer telephone calls, route information, compile data, return calls, and call back customers as programmed. It can be linked to record customers' locations and link these with locations in the GIS distribution system.

CHAPTER IV

DESIGNING INTEGRATION MODEL

4.1 Introduction

This chapter explores the process for designing the integration model of Geographical Information System (GIS) with Supervisory Control and Data Acquisition (SCADA) to send real-time data to call center. To realize the complete design integration of GIS and SCADA, model proposed to develop distribution SCADA applications based on GIS. Once GIS integrate with SCADA, the real time operational data obtained, the Single-line diagrams could represent electrical distribution system dynamic topological relationship. The model Design to integrate and simulate workflow of SEDC using information systems technology. The characteristic policies are used business process method, and SEDC workflow-based architecture. The business process consists only of direct interactions between the original SEDC customer needs and the original performer of the target problem.

4.2 MODEL APPROACH DESCRIPTION

The proposed model depends on major sub-systems, GIS, SCADA, Call and Center. These systems can be summarized as follows:

Geographic Information System (GIS)

GIS system designed to support the capture, management, manipulation, analysis and modeling of spatially referenced data. GIS has been extensively used in SEDC to management systems and provides a visualized platform for electrical distribution system analysis, design and operation.GIS is used to display the complete electrical network assets from generation to service point on top of the land base data

SCADA system

SCADA is the RTDB an In-Memory database stores and manipulates data in main-memory (RAM).

CALL CENTER

Call Center roles in SEDC are to handles incoming calls as efficiently and economically as possible. Call Center answers calls, and then routes the calls to agents in most closely meet the needs of the caller.

The model **Figure 4.1** depend upon computer systems for managing maps using Geographic Information Systems (GIS),and Supervisory Control and Data Acquisition (SCADA) systems for remotely managing sub-stations and main switches ,and Interactive Voice Recognition Systems (IVR) which automatically logs the calls of customers reporting outages in the call center database.

The model shows that SCADA and GIS are two distinctly different applications. To maximum advantage of the GIS functionalities for SCADA processes involve many manual processes and redundancy. The model explain easily the flow between RTDB and Geodatabase , where both systems can be kept in sync with each other, where an end-user can access, analyze and update information from both systems from a single platform. When benefits can be easily visualize, challenges to achieve such an integration need to be given due consideration.

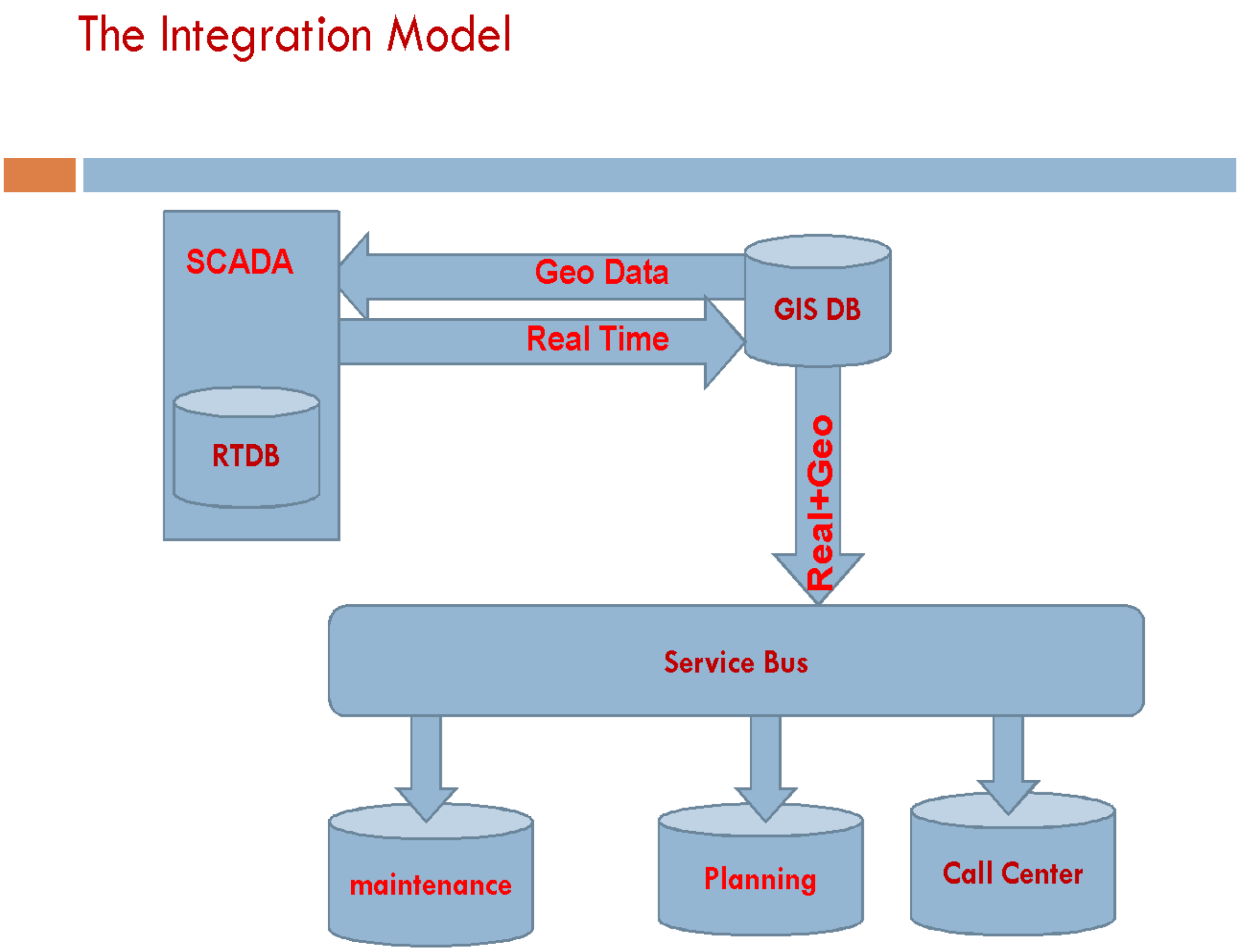


Figure 4.1 The integration Model

4.3 Model Development

The model development consists of two phases: the business design, and methodology. The designing activities are categorized into the process related and the data related ones. In each phase the business process modeling method and the workflow based on SEDC architecture are applied.

4.3.1 The Business Model Design

The model based on the SEDC business design and the needs of data to provide information about the network configuration, and customers. The information can be thought of as instrumentation of the grid. For example, a SCADA system will provide remote monitoring of currents, voltages, and switch positions of various remote circuit components (direct measurements). An Interactive Voice Response (IVR) or trouble calls system will respond to customer phone calls and log service outages (observations of customers). A Customer Information System (CIS) database contains address and contact information of customers, service location, and billing information (additional information about the network and customers) that can be used in matching meter numbers of trouble calls to locations in the network. A Geographic Information System (GIS) contains a model of the grid topology, i.e. where components are? How they are inter-connected? , includes some service or customer information. The overall integration framework is designed to work with GIS systems which store the grid topology information in a standard format, such as a commercially available database.

4.3.2 Model Methodology

The model architecture is built upon various interfaces, the deployment of SEDC Grid and the systems that operate it. However, the data to be collected, coded, transformed, and managed.

Coding Equipments

Coding facilitates the SEDC to retrieval, and interpretation of data and leads to conclusions on the basis of that interpretation. A unique code number has been created for each category, the need to give names to any features to define is important for analyze and share with others. Once it's defined. Codes important to find the similarities feature and group them into categories based on their common properties. Also consider dimensions of the codes that represent the location of the property along a continuum or range. The unique code for any features like (Substations, Lines, and Transformers etc) is important for the equipment in the SEDC grid Table 4.1.

no	Equipment Description	Equipment Code
1	Mudarata Substation	MDR
2	Manshia Substation	MAN

3	Mudarata Power transformer	MDRT01
4	Manshia Power transformer	MANT01
5	Mudarata Busbar	MDRB01
6	Mudarata Isolator	MDRIS01
7	Mudarata Circuit Breaker	MDRCB01
8	Mudarata Earth Switch	MDRES01
9	Mudarata Voltage transformer	MDRVT01

Table 4.1 SEDC Grid Equipment Code

Building Geodatabases Schema

The spatial data in SEDC Geodatabase stores all elements of a physical network such as stations, substations, transformers, lines, poles, meters etc and groups them together in a feature dataset Figure 4.2

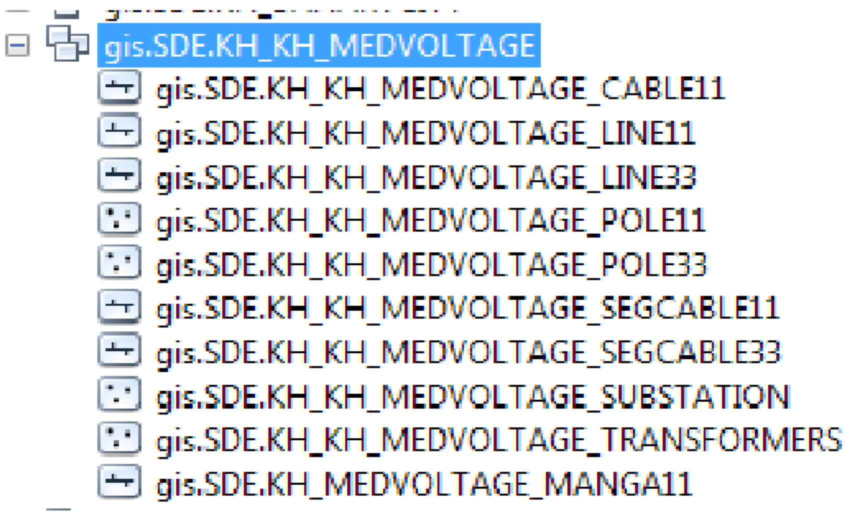


Figure 4.2 SEDC Grid Dataset

A logical network (geometric network) having rule-based connectivity between all network elements resides in the same feature dataset. The geometric network helps in tracing the network as it maintains connectivity. The geodatabase Figure 4.3 enable to store and maintain customer information as a table or feature class with point geometry in their Geodatabase.

sde.GD_CABLE_11KV
sde.GD_CABLE_11KV_H
sde.GD_CABLE_33KV
sde.GD_CABLE_33KV_H
sde.GD_Cable_415
sde.GD_CABLE_415_H
sde.GD_LINE_11
sde.GD_LINE_11_H
sde.GD_LINE_33
sde.GD_LINE_33_H
sde.GD_LINE_415
sde.GD_LINE_415_H
sde.GD_Manga
sde.GD_MANGA_H
sde.GD_MAXMETER
sde.GD_MAXMETER_H
sde.GD_METER
sde.GD_METER_H
sde.GD_METREES
sde.GD_Open_Point
sde.GD_OPEN_POINT_H
sde.GD_POLE_11
sde.GD_POLE_11_H
sde.GD_Pole_33kv
sde.GD_POLE_33KV_H
sde.GD_POLE_415
sde.GD_POLE_415_H
sde.GD_STATE
sde.GD_STATE_H
sde.GD_STREET
sde.GD_STREET_H
sde.GD_SUBSTATION
sde.GD_SUBSTATION_H
sde.GD_THIRD_PART
sde.GD_THIRD_PART_H
sde.GD_TRANSFORMER
sde.GD_TRANSFORMER_H

Figure 4.3 SEDC Feature Class Structures

Attribute Tables

The SEDC Geographic Information System (GIS) combines a map with a database, relating a geographic feature with a record in a data table containing the feature's attributes Table4.3.

gis.SDE.KH_KH_MEDVOLTAGE_SUBSTATION

CODE	CAB	LINE11	LINE33	CAB_TRANS	Made_in	Operation_Date	State	City	volt
21AZH	3	4	3	2*20MVA	ايطاليا	<Null>	khartoum	khartoum	3
	0		3	2*100MVA	المانيا	<Null>	khartoum	khartoum	0
21RYD	3	8		2*20MVA	اسبانيا	<Null>	KHARTOUM	KHARTOUM	3
21MAN	1	5	2	2*10	shnader	<Null>	KHARTOUM	KHARTOUM	1
21NBR	2	5	2	2*15	shnader	<Null>	KHARTOUM	KHARTOUM	2
21KHE	1	9	8	2*100	ABB	<Null>	KHARTOUM	KHARTOUM	1
21BUR	2	5	2	2*10	shnader	<Null>	KHARTOUM	KHARTOUM	2
	0	8	4	2*20 MVA	EGYPT	11/7/2010	KHARTOUM	KHARTOUM	0
21FAR	0	8	4	2*20 MVA	CHINA	11/1/2002	KHARTOUM	KHARTOUM	0
	10	4	2	2*5MVA	SHNAIDER/EGYPT	1/1/2012	KHARTOUM	KHARTOUM	10
	10	4	2	2*5MVA	ABB	1/1/2009	KHARTOUM	KHARTOUM	10
21JAS	1	1	1	2*150MVA	المانيا	1/1/2008	KHARTOUM	KHARTOUM	1
21AML	3	5	1	2*20MVA	اسبانيا	1/1/2008	KHARTOUM	KHARTOUM	3
21ALF	3	4	1	2*10MVA	ألمانيا	1/1/1990	KHARTOUM	KHARTOUM	3
21SAR	3	5		2*10MVA	المانيا	1/2/1900	KHARTOUM	KHRTOUM	3
21AMT	3	8	3	2*15MVA	تركيا/فرنسا	1/1/2006	KHARTOUM	KHARTOUMM	3
21MCR	3	1	1	1*5MVA	بولندا	1/1/1978	KHARTOUM	KHARTOUMM	3
21PPR	3	1	1	2*5MVA	ايطاليا	1/1/1995	KHARTOUM	KHARTOUMM	3
21MLK	20	6	2	10*2	ABB	<Null>	khartoum	KHARTOUM	20
	40	6	2	20*2	اشنايدر	<Null>	khartoum	KHARTOUM	40
21JUD	40	7	2	20*2	اشنايدر	<Null>	khartoum	KHARTOUM	40
21MUG	200	11	9		ABB	<Null>	khartoum	KHARTOUM	200
21SIF	30	7	4	15*2	اشنايدر	<Null>	khartoum	KHARTOUM	30
21GID	40	6	3	20*2	اشنايدر	<Null>	khartoum	KHARTOUM	40
21NEC	30	7	4	15*2	اشنايدر	<Null>	khartoum	KHARTOUM	30
	40	4	2	20*2	اشنايدر	<Null>	khartoum	KHARTOUM	40
21KHG	40	7	2	20*2	اشنايدر	<Null>	khartoum	KHARTOUM	40
21GAS	3	1	1	2*10	روماني	<Null>	KHARTOUM	khartoum	3
21DUB	3	1	1	1*4.5	روماني	<Null>	KHARTOUM	khartoum	3
21ALN	3	8	3	2*20MVA	ايطاليا	1/1/2008	KHARTOUM	khartoum	3

Table 4.3 Attribute table of the Substations

SEDC use geodatabase to map their Substations and other buried assets, to manage these assets by associating maintenance data with them, and to model the behavior of Electric flow through the networks. geodatabase data was stored in files or a combination of files and databases. As implied by its name, a geodatabase is a geographic database. A geodatabase uses database tables to store not just the geodatabase attributes, but also the geometry. A geodatabase allows imposing constraints on both the geometry and the attributes, limiting the data that is added to the geodatabase to intended values. Geometric constraints allow the SEDC to control how features relate to each other geographically. Attribute constraints allow controlling what type of data can be entered into a field. Through attribute domains, can limit data to a range of acceptable values or to a list of predefined values. Implementing SEDC schema of the geodatabase involves a significant investment of resources in software. This investment can yield substantial benefits when the reasons for adopting the geodatabase are clearly defined, and the design process is carefully planned. These benefits include improved data quality and integrity, enhanced feature editing, better performance, the ability to use "smart" features, and the use of SEDC standard relational databases. The implementing a geodatabase because it stores both geometry and attributes for SEDC distribution and SEDC collection systems, the geodatabase as an excellent option, since it provides to improve data storage, retrieval, and security. The geodatabase of distribution network is composed of spatial information tables, asset information tables, topology information tables, and operation information table. Spatial information is the properties of figures which are stored when symbols of equipments are drawn. It consists of graph ID, equipment ID, affiliated substation, center coordinates of terminal, connectivity node ID and other information. Asset table is used to store the electrical properties and maintenance information of equipments Table 4.4; it provides information for advanced applications, such as power flow analysis and state estimation. The object information of equipment, terminal, and connectivity are stored in the topology tables that will be used for distribution topology analysis.

Feature	Representation	Notes
Line	Line	usually contain information about electric lines (33kv,11kv and 415kv)
Substation	Point	Is the electric distribution substations
Transformers	point	Distribution transformers
Cables	Line	usually contain information about electric cables (33kv,11kv and 415kv)
Poles	point	usually contain information about electric poles (33kv,11kv and 415kv)
equipment ID	int	The different types of electric equipment
Maintenance date	date	The day time of maintenance
Maintenance locations	point	Contains information about the maintenance locations

Table 4.4 Asset Information

Build Single Line Diagram

SEDC has electrical networks of energy composed of many complicated elements which can malfunction in an instant. In many facilities, loads are continually added or removed in small increments. The grid effect is not always seen until some part of the system becomes overloaded or exhibits other problems. The single-line diagram is the first step to understanding and correcting the problem Figure 4.5.

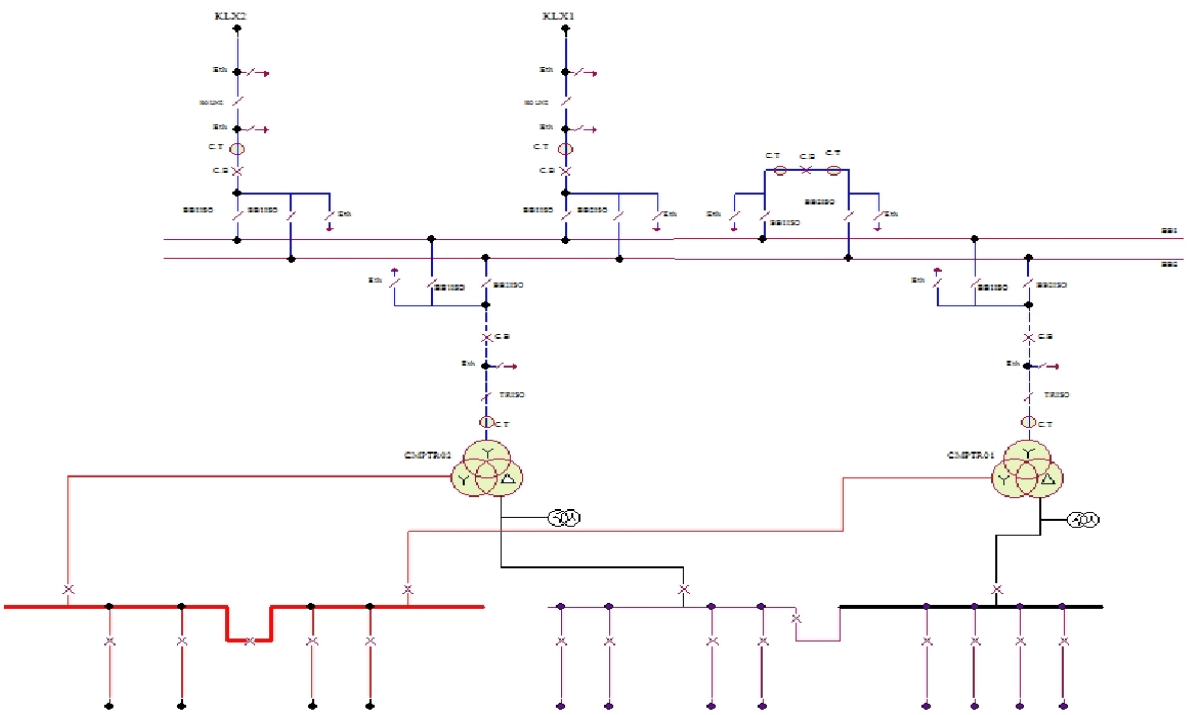
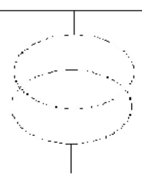


Figure 4.5 Single Line Diagram of The Substation

Electric power is produced at the power generating stations, which are generally located far away from the load centers. High voltage transmission lines are used to transmit the electric power from the generating stations to the load centers. Between the power generating station and consumers a number of transformations and switching stations are required. These are generally known as substations. Substations are important part of power system and form a link between generating stations, transmission systems and distribution systems. It is an assembly of electrical components such as bus-bars, switchgear apparatus, power transformers etc. Their main functions are to receive power transmitted at high voltage from the generating stations and reduce the voltage to a value suitable for distribution. Some substations provide facilities for switching operations of transmission lines, others are converting stations. Substations are provided with safety devices to disconnect equipment or circuit at the time of faults. Any complex power system even though they are three phase circuits, can be represented by a single line diagram, showing various electrical components of power system and their interconnection. In single line representation of substation the electrical components such as power transformers, incoming and outgoing lines, bus-bars, switching and protecting equipments, are represented by standard symbols and their interconnections between them are shown by lines Table 4.4. Single line diagrams are useful in planning a substation layout. Some of the standard symbols used to represent substation components are given in Table below.

no	**Electrical components**	**Symbols**
1	AC Generator	
2	Bus Bar	
3	Power transformer – Two winding	
4	Three winding transformer	

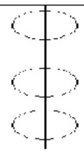
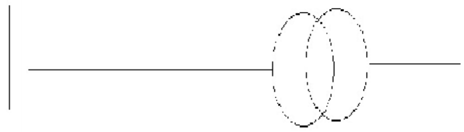
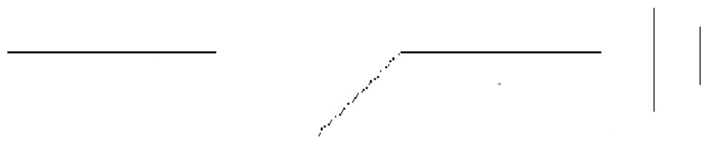
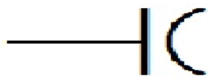
5	Current Transformer (CT)	
6	Voltage transformer or Potential transformer (PT)	
7	Circuit Breaker (CB)	
8	Earth Switch (ES)	
9	Wave or Line trap	
10	Coupling Capacitor (CC)	

Table 4.4 Symbols of The Substations Elements

Substations Elements

(1) Transformer substations: Majority of the substations in the power system are in the type. They are used to transform power from one voltage level to another voltage level. Transformer is the main component in such substations. Transformer substations are further classified into Step-up substations, Primary grid substations, Secondary substations and Distribution substations.

(a) Step-up substations: These substations are usually located at the generating stations. Generating voltage of the order of 11kV needs to be stepped up to a primary transmission voltage level of the order of 220kV or 400kV.

(b) Primary grid substations: These substations are located at the end of primary transmission lines and the primary voltage is stepped down to suitable secondary voltages of the order of 66kV or 33kV.

(c) Secondary substations: The voltage is further stepped down to 11kV. Large consumers are supplied power at 11kV.

(d) Distribution substations: These substations are located near the consumer localities to supply power at 400V, three phase or 230V, single phase to the consumers.

(2) Switching substations: These substations are meant for switching operations of power lines without transforming the voltage. Different connections are made between the various transmission lines.

(3) Converting substation: Such substations are meant for either converting AC to DC or vice versa. Some are used to change the frequency from higher to lower or vice versa for industry utilizations. According to constructional features substations are classified into Indoor substations, Outdoor substations, Underground substations and Pole mounted substations.

(1) Indoor substations: All equipments of the substation are installed within the station buildings.

(2) Outdoor substations: All equipments such as transformers, circuit breakers, isolators, etc., are installed outdoors.

(3) Underground substations: In thickly populated areas where the space is the major constraint, and cost of land is higher, under such situation the substations are laid underground.

(4) Pole mounted substations: This is an outdoor substation with equipments installed overhead on a H pole or 4 pole structure.

Power transformers: Power transformers are used generation and transmission network for stepping-up the voltage at generating station and stepping-down the voltage for distribution. Auxiliary transformers supply power to auxiliary equipments at the substations.

Current transformers (CT): The lines in substations carry currents in the order of thousands of amperes. The measuring instruments are designed for low value of currents. Current transformers are connected in lines to supply measuring instruments and protective relays. For example a 100/1A CT is connected in a line carrying 100A, and then the secondary current of CT is 1A.

Potential transformers (PT): The lines in substations operate at high voltages. The measuring instruments are designed for low value of voltages. Potential transformers are connected in lines to supply measuring instruments and protective relays. These transformers make the low voltage instruments suitable for measurement of high voltages. For example a 11kV/110V PT is connected to a power line and the line voltage is 11kV then the secondary voltage will be 110V.

Circuit breaker (CB): Circuit breakers are used for opening or closing a circuit under normal as well as abnormal (faulty) conditions. Different types of CBs which are generally used are oil circuit breaker, air-blast circuit breaker, and vacuum circuit breaker and SF6 circuit breaker.

Isolators or Isolating switches: Isolators are employed in substations to isolate a part of the system for general maintenance. Isolator switches are operated only under no load condition. They are provided on each side of every circuit breaker.

Lightning arresters (LA): Lightning arresters are the protective devices used for protection of equipment from lightning strokes. They are located at the starting of the substation and also provided near the transformer terminals.

Earth switch: It is a switch normally kept open and connected between earth and conductor. If the switch is closed it discharges the electric charge to ground, available on the uncharged line.

Wave trap: This equipment is installed in the substation for trapping the high frequency communication signals sent on the line from remote substation and diverting them to the telecom panel in the substation control room.

Coupling capacitor: A coupling capacitor is used in substations where communication is done by AC power line. It offers very low impedance to high frequency carrier signal and allows them to enter the line matching unit and blocks the low frequency signal.

Bus-bar: When number of lines operating at the same voltage levels needs to be connected electrically, bus-bars are used. Bus-bars are conductors made of copper or aluminum, with very low impedance and high current carrying capacity. Different types of bus-bar arrangements are single bus bar arrangements, single bus-bar with sectionalisation, double bus-bar arrangements, section alised double bus-bar arrangement,

double main and auxiliary bus-bar arrangement, breaker and a half scheme/1.5 Breaker scheme, and ring bus-bar scheme.

Single bus-bar arrangement: It consists of single bus-bar. Both incoming and outgoing lines are connected to the single bus-bar. The advantages of this arrangement are low maintenance, low initial cost and simple operation. The drawback of this arrangement is if any repair work is to be done on bus-bar, complete system get interrupted. Figure below shows that three incoming and three outgoing line are connected to the single bus arrangement.

4.4 Implementations

The diagram show that the model integrate different system from different vendors in one framework ,the model represents all major objects normally used within an SEDC and is maintained by attributes and relations to others Included objects bundled in packages cover equipment, topology, load data, coding, SLD . The amount of data exchanged in SCADA real time database can become very large, Processing this data is time-critical, this makes processing via geodatabase more difficult so the status of the equipments will be send to the geodatabase that represent as master database for the integrated model to perform all operations related to the spatial analysis of data on the distribution network. After that the service send status change to the CALL CENTER database. the process for transferring data based on parameter and link parameters with query to send the unique feature code like (lines, cables...) to SCADA real time database this query access the data that is currently in-memory and return the status of the equipments in SCADA to the geo database .

on the other side the SEDC data is dynamic and it will change daily from side to side so to achieve high availability the GIS server side send the updated data to the SCADA server by using background service that send the change from geodatabase side to the real time side by using the code bellow

```
import arceditor
```

import arcpy

from arcpy import env

KH_Line11=r'C:\Python27\Min\Connection to SCADSERV\GIS.DBO.GIS_Transfer_Data\GIS.DBO.KH_Line11'KH_Line11=r'D:\Scada\Scada.gdb\KH_Line11'KH_Line33=r'C:\Python27\Min\Connection to SCADSERV\GIS.DBO.GIS_Transfer_Data\GIS.DBO.KH_Line33'KH_meter =r'C:\Python27\Min\ConnectiontoSCADSERV\GIS.DBO.GIS_Transfer_Data\GIS.DBO.KH_Meter'NewLine=arcpy.CreateFeatureclass_management("in_memory","New_KH_Line11","POLYLINE",KH_Line11,"SAME_AS_TEMPLATE","SAME_AS_TEMPLATE",arcpy.Describe(KH_Line11).spatialReference,"","","","")arcpy.env.workspace= r'C:\Python27\Min\ConnectiontoGSERVER'KhKhLine11=arcpy.ListFeatureClasses("USER.KH_KH_Line11","Line","USER.DB1")[0]KhKhLine33=arcpy.ListFeatureClasses("USER.KH_KH_Line33","Line","USER.DB1")[0]KhKhmeter=arcpy.ListFeatureClasses("USER.KH_KH_Meters","Point","USER.DB2").

Also SCADA RTDB sends the status to the specific GeoDB by matching the SCADA key code by the GIS feature Code by using this code (example code for one unit)

STATUS,00209700,GIS.KH_Line11,status,LineCode,T21K3,GIS.KH_Line11,TLQ,LineCode,T21K3

ANALOG,11603210,GIS.KH_Line11,Analoge,LineCode,T21K3,GIS.DBO.KH_Line11,TLQ,LineCode,T21K3

STATUS,00209700,GISKH_Line11,status,LineCode,T21K4,GIS.KH_Line11,TLQ,LineCode,T21K4

ANALOG,11604210,GIS.KH_Line11,Analoge,LineCode,T21K4,GIS.KH_Line11,TLQ,LineCode,T21K4

And the entire data store in the geo database, the geo data and real time status will be send to call center database by using service created in middle server that use the real data ,this service using joson format to send the parameters to the callcenter IVR in callcenter applications ex


```
{
 "currentVersion": 10.31,
 "id": 1,
 "name": "GIS.DBO.KH_Line11",
 "type": "Feature Layer",
 "description": "",
 "geometryType": "esriGeometryPolyline",
 "copyrightText": "",
 "parentLayer": null,
 "subLayers": [],
 "minScale": 0,
 "maxScale": 0,
 "drawingInfo": {
  "renderer": {
   "type": "uniqueValue",
   "field1": "Name",
   "field2": null,
   "field3": null,
   "fieldDelimiter": ", ",
   "defaultSymbol": {
    "type": "esriSLS",
    "style": "esriSLSSolid",
    "color": [
```

```
    133,
    0,
    11,
    255
   ],
   "width": 1
  },
  "defaultLabel": "<all other values>",
  "uniqueValueInfos": [
   {
    "symbol": {
     "type": "esriSLS",
     "style": "esriSLSSolid",
     "color": [
      158,
      120,
      36,
      255
     ],
     "width": 1
    },
    "value": " المنطقة الصناعية شرق",
    "label": " المنطقة الصناعية شرق",
    "description": ""
   },
```

Chapter V

RESULTS

5.1 Introduction

Integration of GIS with SCADA and Call center Solutions focuses on the increasing the SEDC capability to achieve the customer satisfactions reducing the cost and outage time, the traditional methods is not effective to response to the customer that call to the call center and give feedback in real time so the process to integrate real time status will be important because it decrease the waiting time for the real outage especially in medium voltage line outage because the number of customer is large. This increases operator efficiency and eliminates the need to go to multiple systems with potentially different data. The integration SCADA, GIS and call center systems make adequate preparation for using mixture of data that has various natures to achieve one goal. Also on the side of planning the SEDC engineers can use geographical data for the purpose of studying and analyzing the current situation of any geographical. Also the geodatabase in GIS provides solutions in the power field by setting up network and load management to customer information, assets management, and customer services .However, the interfaces between GIS and other utility software applications should open new side to analysis and planning for network problem.

5.2 Results

The integration process displays an accurate customer location in electrical grid to provide accurate outage locations. The following figures are representative of the SCADA data results displayed on the GIS environment. This capability does not exist with traditional distribution systems, also the following results show that integrating information into one real time database provides an SEDC with an opportunity to monitor not only usage data but also quality and reliability of supply by decreasing waiting time in call center system for the customer complaining because the IVR answer all outage call that related to the medium voltage lines.

1- The following scenarios demonstrate a geographic view of integration real time data with static data, this integration will change geo database to be online **Figure 5.1 & Table 5.1** present that GIS reflect the electric ampere from the SEDC SCADA SLD of the substations feeders and update the table automatically from the real time database. Also this will enable to design and develop an integrated business intelligence and data warehouse solution to handle and enable access to large and complex amounts of real time collected data and spatial data.

Ampere	status/1 or 0	LINE
78.44	1	ALNK2
0	0	ALNK6
0	1	SARK7
23.33	1	SARK8
204.48	1	SENK3
175.2	1	STSK4
72.4	1	AMLK4
0	0	ALFK4
186.4	1	ADMK2
188.6	1	ADMK5
0	0	MAMK3
176	1	NBRK1
229.6	1	ADMK3
144.17	1	ALFK2
256.4	1	ALDK2

Table 5.1 Online GIS

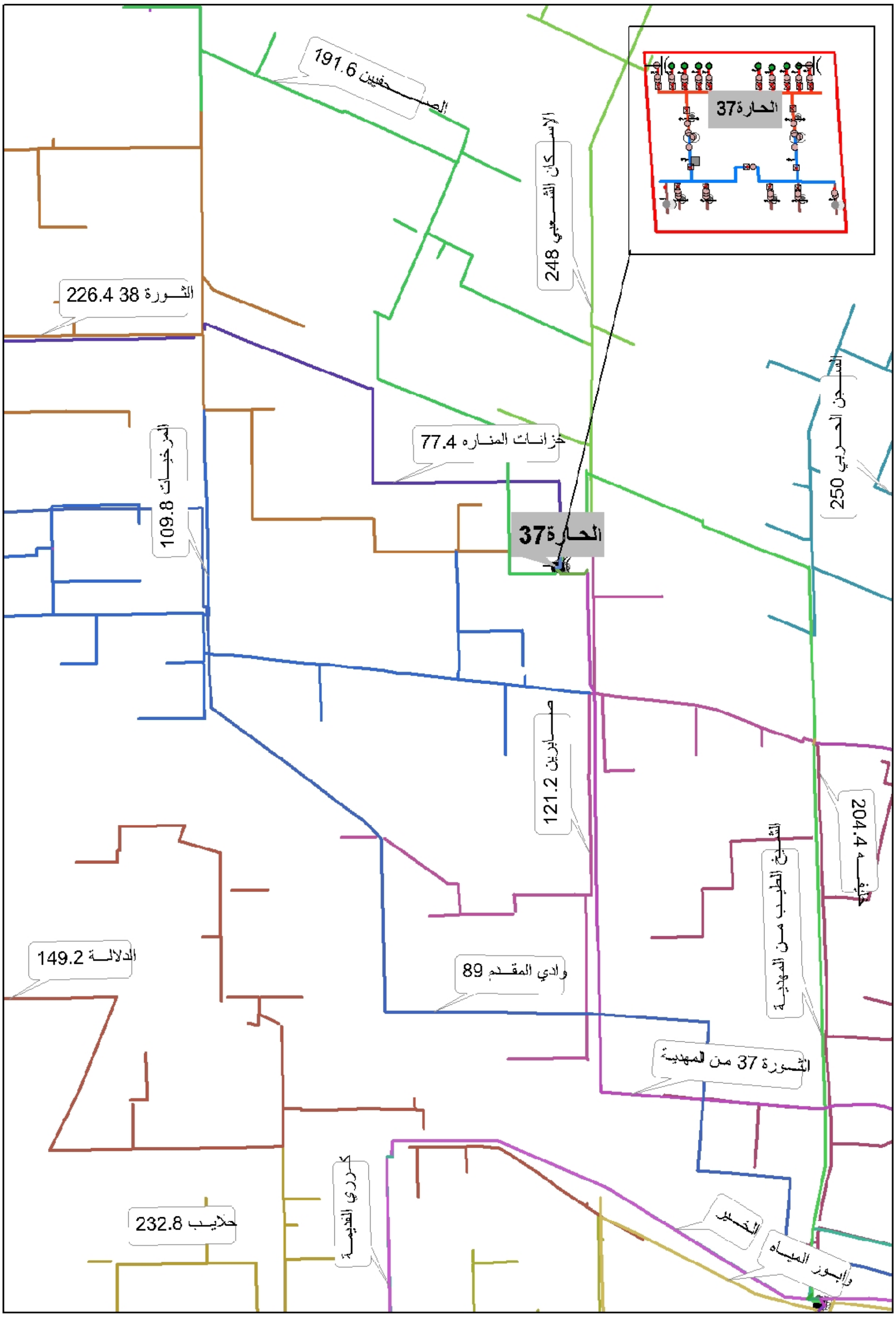


Figure 5.1 Online GIS

2- Determines the Outage location in distribution network by selecting coordination of the features and the area which suffers a power outage Figure 5.2. That to minimize the effort of searching a fault location on the network.

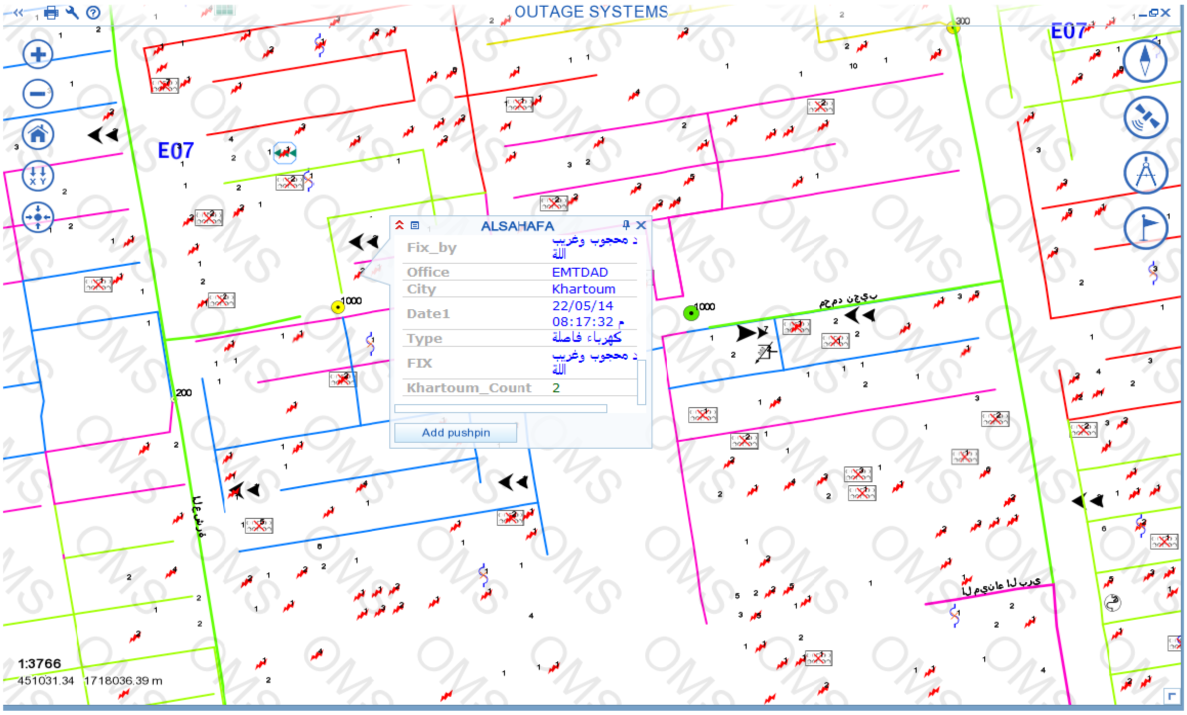


Figure 5.2 Real Outage Type Locations

Figure 5.3 Real Outage Customer Locations

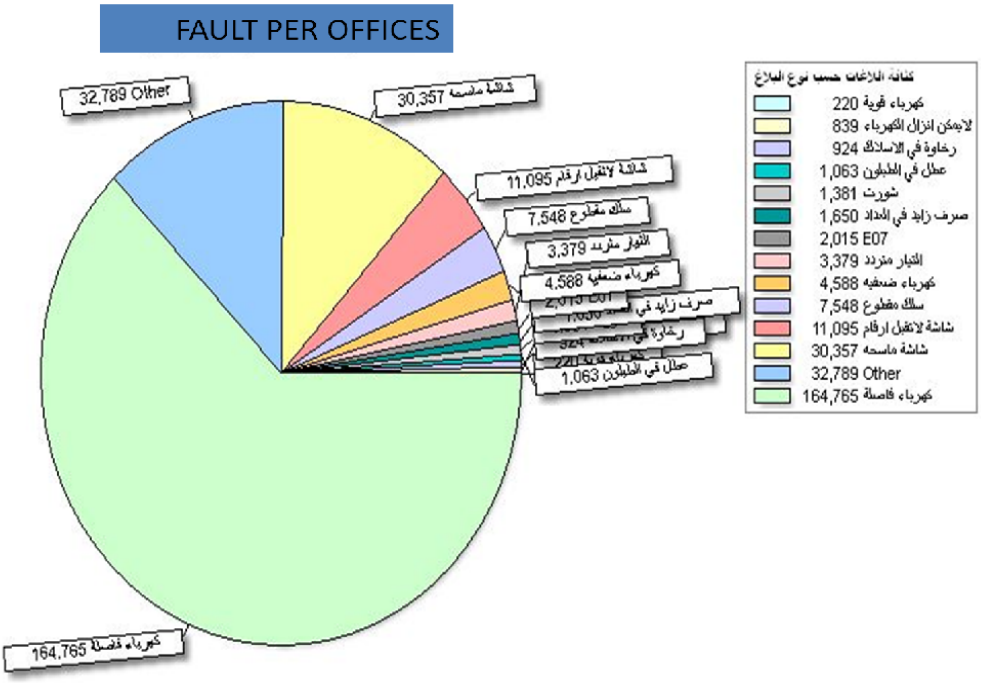


Figure 5.4 The Outage Customer Per Office

3- Get real-time information from the server of SCADA like SCADA status information and join it with Customer Information and Geographic location to show them on the GIS service and send request to the customer by Interactive Voice Response. **Table 5.2.**

Meter no	**4168765198**
Name1	**BABKER ELHASSAN AELRHMAN**
NAME	**الازهري 21**
LINE_CODE	**SENK3**
status	**1**
Analoge	**191.64**

Table 5.2. Online status and Customer information

4- The integration developments in web based GIS and database technologies provide interface that show the status of the substations at the real time and reflect all the status on the dashboard that will enable the different engineers to monitor their network grid flow Table 5.3.to report outages, measuring responses, analyzing trends, and other information about the electric grid, this increase efficiency and productivity, reliability, safety, and customer satisfaction. also the web service can improve communication among departments e.g. Network Analysis can have access to the network data in GIS along with real time data from SCADA/GIS interface.

Name: ساريا 2 **LineCode:** SARK7 **status:** 1 **Analoge:** 45.669998	**Name:** خط الفردوس **LineCode:** ARKK2 **status:** 1 **Analoge:** 0
Name: ميقـــــــــــــــا **LineCode:** SHAK4 **status:** 1 **Analoge:** 117.119995	**Name:** خط جامعة افريقيا **LineCode:** MAMK1 **status:** 1 **Analoge:** 132.23999
Name: السلمة **LineCode:** AZHK4 **status:** 1 **Analoge:** 169.919998	**Name:** خط السوق المحلى من اركويت **LineCode:** ARKK5 **status:** 1 **Analoge:** 0
Name: الازهري 26 **LineCode:** LOMK4 **status:** 1 **Analoge:** 141	**Name:** خط مدارس هولم **LineCode:** MAMK2 **status:** 1 **Analoge:** 140.399994
Name: خط اركويت شمال **LineCode:** ARKK6 **status:** 1 **Analoge:** 0	**Name:** خط حي الصفا **LineCode:** NBRK5 **status:** 1

Table 5.3 Line Status in the Substation at Real Time

5- The integration Data supports the activities of the plan review section, SEDC planning section, and customer service division, and uses it in Performance indicators that increase the electric grid performance Table 5.4. The model would lead to the reduction of minimize maintenance costs and perform more efficient database management determining what would be the optimal solution and allowance has also to be made for the uncertainties in the prediction of the future scenario of customer demand. The integration can achieve accurate information that move SEDC to measure system performance by using performance indicators concept to calculate SAIDI, CAIDI, and SAIFI.

CAIDI	**SAIFI**	**SAIDI**	**Outage Customer**	**Total Number of Customer**	
3:16:14	**0.86**	**1:50:35**	**168061**	**298242**	**khartoum**
٥:٠٣:٣٠	**0.92**	**2:39:00**	**154916**	**295709**	**omdurman**
3:57:58	**1.42**	**3:09:53**	**١٧٨٥٢٨**	**٢٢٣٧٤٣**	**Khartoum north**
3:48:46	**0.96**	**2:18:10**	**501505**	**817694**	**total**

Table 5.4 Calculate Reliability Indices

- System Average Interruption Duration Index (SAIDI):

$$\mathrm{SAIDI} = \frac{\sum U_i N_i}{\sum N_i}$$

Where N_i is the number of customers and U_i is the annual outage time for location i. In other words,

$$\mathrm{SAIDI} = \frac{\text{sum of all customer interruption durations}}{\text{total number of customers served}}$$

SAIDI is measured in units of time, often minutes or hours. It is usually measured over the course of a year.

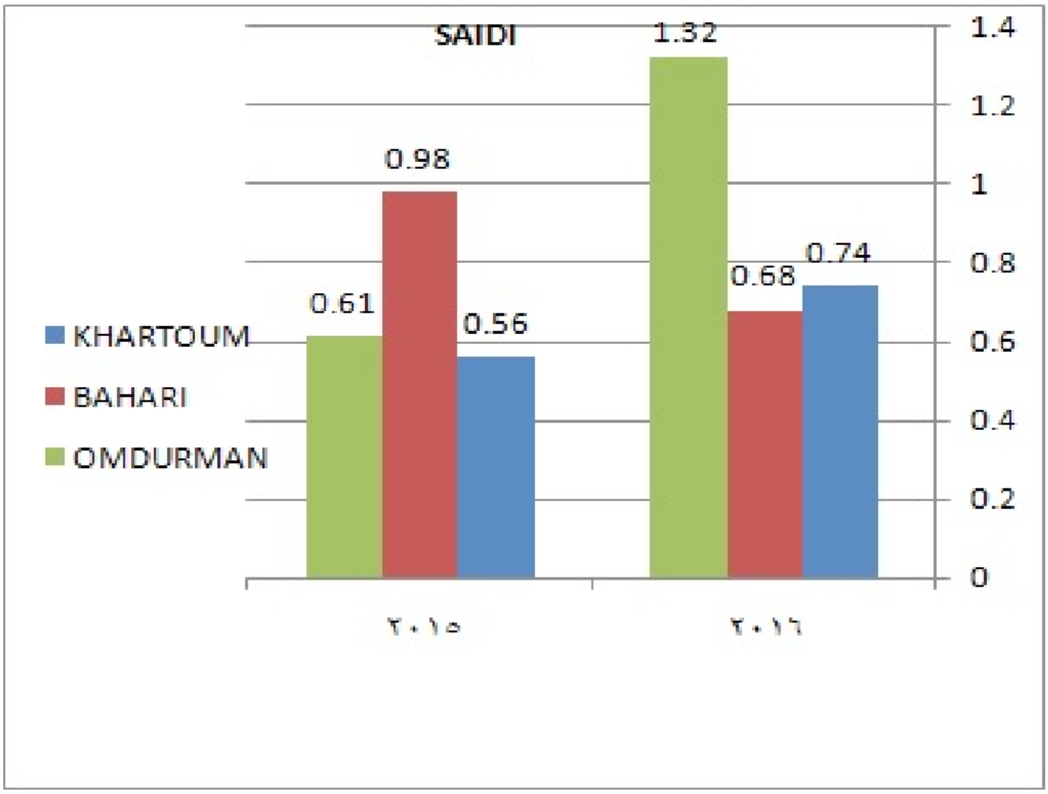


Figure 5.5 Calculate SAIDI Indices

- System Average Interruption Frequency Index (SAIFI):

$$\mathrm{SAIFI} = \frac{\sum \lambda_i N_i}{\sum N_i}$$

Where λ_i is the failure is rate and N_i is the number of customers for location i. In other words,

$$\mathrm{SAIFI} = \frac{\text{total number of customer interruptions}}{\text{total number of customers served}}$$

SAIFI is measured in units of interruptions per customer. It is usually measured over the course of a year.

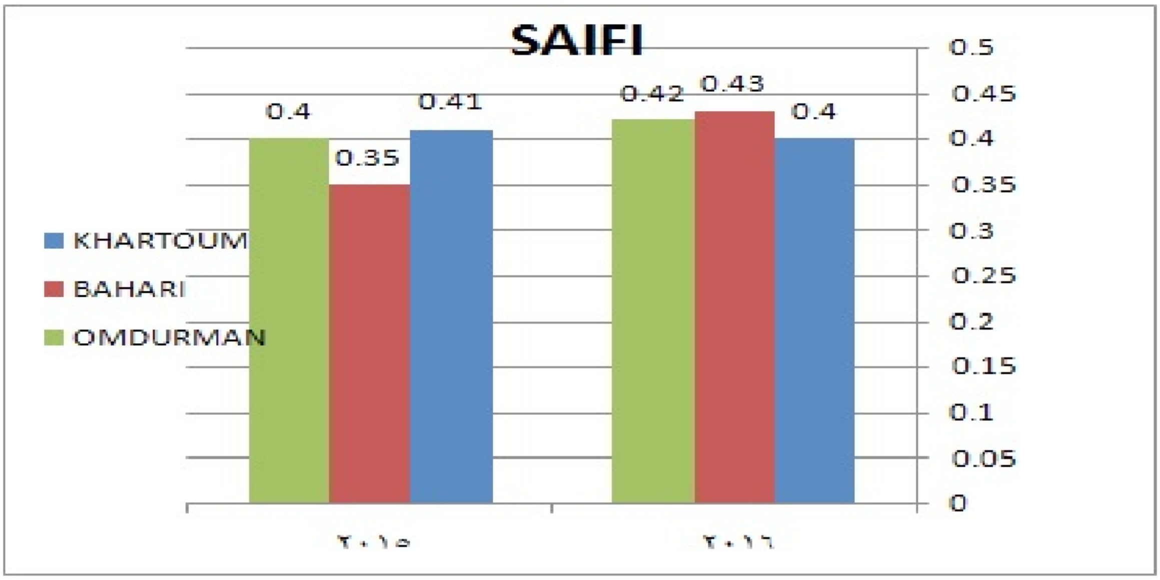


Figure 5.6 Calculate SAIFI Indices

6- The impact of integration in call center is very clear on the losses calling .The number of losses calling decrease the Table 5.3, Table 5.4 show the comparison between month before integration and after integration.

total of outage	presentage of not answered	The calls			department
		not answered	answered	Incoming	
47319					khartoum
33523	22%	83798	304693	388491	bahari
47920					omdurman
128762		83798	304693	388491	الإجمالي

Table 5.5 Number of calling before Integration

total of outage	presentage of not answered	The calls			department
		not answered	answered	Incoming	
53334	7%	26091	366896	392987	khartoum
40662					bahari
51212					omdurman
145208		26091	366896	392987	total

Table 5.6 Number of calling after Integration

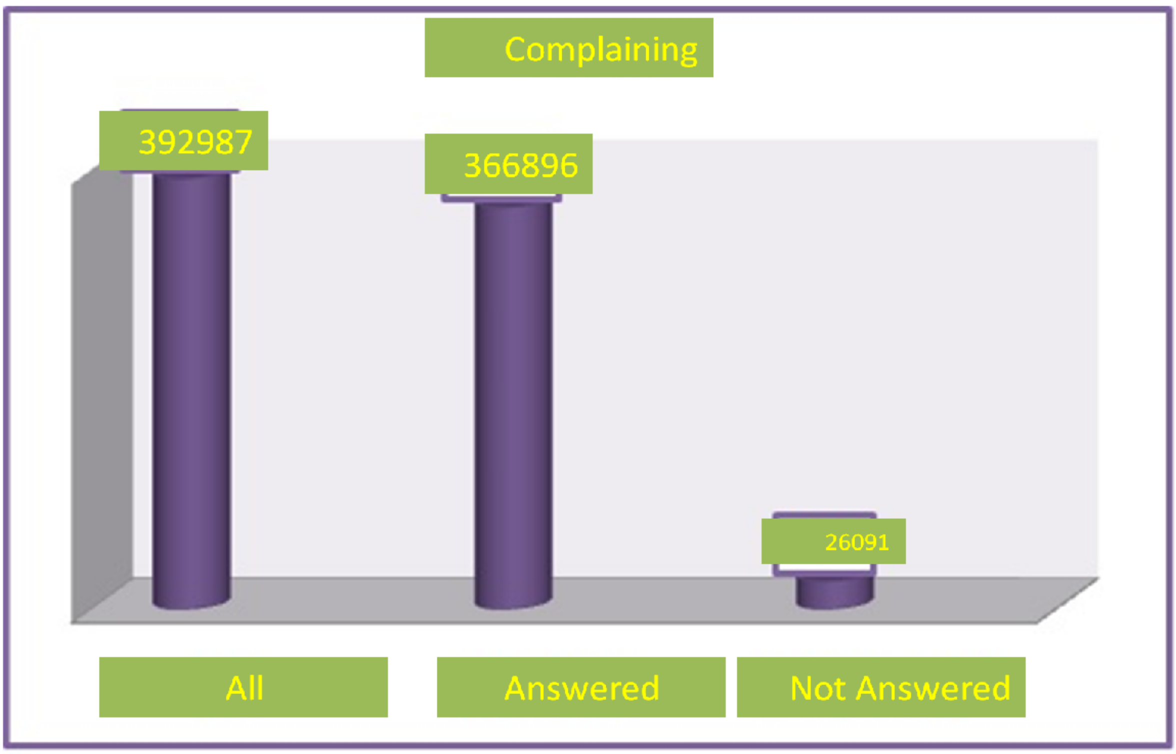


Figure 5.7 Number of calling after Integration

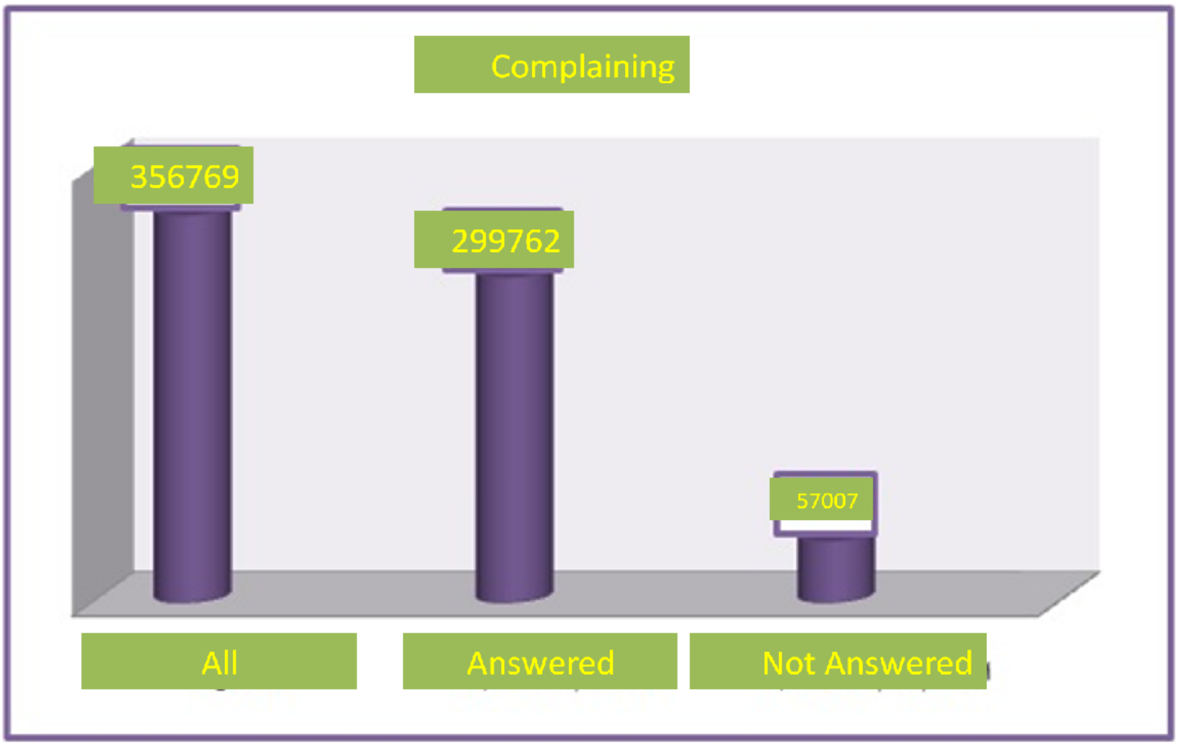


Figure 5.8 Number of calling before Integration

This impact reflect on call center agent to response to the customer without waiting in the queue also a big effect in time of recovering outage because the outage office received only real customer outage or individual complaint so the maintenance Technician go to real customer and real problem.

CHAPTER VI

CONCULTION

6.1 Introduction

The Data Base Management System becomes the source of information for Customer Services and the Maintenance and Repair Services of the electric distribution at the real time of the fault.The integration of the systems in on logical data base is also structured to provide easy and fast access to various user information. The integration of these three systems would support decision-making by providing the right information at the right place at the right time. The integration of the real time database of the SCADA and static database in GIS with CALL CENTER database open new side for new applications in electric distribution management to optimize the distribution network fault. SCADA serves as control and monitor over the distribution network and continuously monitors the integrity of the distribution network together with the remote synchronic-sensors to generate detailed information about the state of the network. The synchronization of the SCADA monitoring operation with the spatial data in GIS provides an accurate picture of how the actions of the outage happened. The wealth of information generated becomes a source and basis for new and advanced control functions designs that improve the customer satisfaction and the reliability of the energy delivery system.

6.2 Recommendation

To develop the solution concept combine geo information with smart meter electric data in one system that open new concept lead to use the Real-time database and defined as computing systems that are designed to operate in a timely manner to increase the opportunity to convert electric grid to be smart .

Also use GIS with electrical grid in one geodatabase and drawing substations, lines and transformers with their customers in one database to improve power management this increase management and improve the work efficiency to calculate the electric losses. On other side, the SCADA and smart meter handles the electric delivery network; this gives the grid flexibility to share real time data to the different applications that needed to use it in analysis and reporting. the nature of Smart meters design permit electric network to monitor the status of all features of the network in database related to the time of the event that support the process to manage and plan the electric grid data at fixed intervals in close style by the smart meters supply moreover insight about the attitude of the grid with time.

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APPENDIXES

Appendix A

A.1 GIS to SCADA

The SCADA network is very secure and it is isolated from other network in SEDC, so the following code send update data from GIS server to middle server in SCADA network.

```
import arceditor

import arcpy

from arcpy import env

if arcpy.GetLogHistory:()

   arcpy.SetLogHistory(False(


KH_Line11=r'C:\Python27\Min\SERV1\GIS.DBO.GIS_Transfer_Data\GIS.DBO.KH_Line
11'

KH_Line11=r'D:\Scada\Scada.gdb\KH_Line11'

KH_Line33=r'C:\Python27\Min\SERV1\GIS.DBO.GIS_Transfer_Data\GIS.DBO.KH_Line
33'KH_meter
=r'C:\Python27\Min\SERV1\GIS.DBO.GIS_Transfer_Data\GIS.DBO.KH_Meter'

NewLine =
arcpy.CreateFeatureclass_management("in_memory","New_KH_Line11","POLYLINE"
,KH_Line11,"SAME_AS_TEMPLATE","SAME_AS_TEMPLATE",arcpy.Descrie

)KH_Line11).spatialReference("","","","",arcpy.env.workspace=
r'C:\Python27\Min\GIS_S'KhKhLine11=arcpy.ListFeatureClasses("GIS_SEDC.DBOWNE
R.KH_KH_Line11","Line","GIS_SEDC.KH_MV")[0[KhKhLine33 =
```

```
arcpy.ListFeatureClasses("GIS_SEDC.DBOWNER.KH_KH_Line33","Line","GIS_SEDC.KH
_MV")[0[KhKhmeter=arcpy.ListFeatureClasses("GIS_SEDC.DBOWNER.KH_KH_Meters
","Point","KH_LV")[0[mklyrkh11 =
arcpy.MakeFeatureLayer_management(KhKhLine11,'featurekh('','','','

mklyrkh33 = arcpy.MakeFeatureLayer_management(KhKhLine33,'featurekh33('','','','

mklyrkhmeter = arcpy.MakeFeatureLayer_management(KhKhmeter,'meterkh('','','','

KHchvline11=arcpy.ChangeVersion_management(mklyrkh11,"TRANSACTIONAL",u'D
BOWNER.KH_KHARTOUM_MV('KHchvline33 =
arcpy.ChangeVersion_management(mklyrkh33,"TRANSACTIONAL",u'DBOWNER.KH_
KHARTOUM_MV('KHchvmeter =
arcpy.ChangeVersion_management(mklyrkhmeter,"TRANSACTIONAL",u'DBOWNER.
KH_LVOLTAGE('KhomLine11=arcpy.ListFeatureClasses("GIS_SEDC.DBOWNER.KH_OM
_Line11","Line","OM_MV")[0[KhomLine33 =
arcpy.ListFeatureClasses("GIS_SEDC.DBOWNER.KH_OM_Line33","Line","OM_MV")[0
[Khommeter=arcpy.ListFeatureClasses("GIS_SEDC.DBOWNER.KH_OM_Meters","Poin
t","OM_LV")[0[

#

mklyrom11 = arcpy.MakeFeatureLayer_management(KhomLine11,'featureom('','','','

mklyrom33=arcpy.MakeFeatureLayer_management(KhomLine33,'featureom33
('','','','mklyrommeter=arcpy.MakeFeatureLayer_management(Khommeter,'metero
m('','','','

#

OMchvline11=arcpy.ChangeVersion_management(mklyrom11,"TRANSACTIONAL",u'
DBOWNER.KH_OMDURMAN_MV('

OMchvline33=arcpy.ChangeVersion_management(mklyrom33,"TRANSACTIONAL",u'
DBOWNER.KH_OMDURMAN_MV('
```

```
#OMchvmeter=arcpy.ChangeVersion_management(mklyrommeter,"TRANSACTIONA
L",u'DBOWNER.KH_OMDURMANLV('

######################

KhbhLine11=arcpy.ListFeatureClasses("GIS_SEDC.DBOWNER.KH_BA_Line11","Line","
BA_MV")[0[

mklyrbh11 = arcpy.MakeFeatureLayer_management(KhbhLine11,'featurebh(",",",'

KhbhLine33 =
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mklyrbh33 = arcpy.MakeFeatureLayer_management(KhbhLine33,'featurebh33(",",",'

Khbhmeter =
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mklyrbhmeter = arcpy.MakeFeatureLayer_management(Khbhmeter,'meterbh(",",",'

BHchvline11 =
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BAHARY_MV('

BHchvline33 =
arcpy.ChangeVersion_management(mklyrbh33,"TRANSACTIONAL",u'DBOWNER.KH_
BAHARY_MV('

BHchvmeter =
arcpy.ChangeVersion_management(mklyrbhmeter,"TRANSACTIONAL",u'DBOWNER.
baharylvolt('

######################################## #

arcpy.TruncateTable_management(KH_Line11(

arcpy.Append_management("'Database
Connections/GIS_S/GIS_SEDC.KH_MV/GIS_SEDC.DBOWNER.KH_KH_Line11';'Databas
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e Connections/GIS_S/OM_MV/GIS_SEDC.DBOWNER.KH_OM_Line11';'Database Connections/GIS_S/BA_MV/GIS_SEDC.DBOWNER.KH_BA_Line11'", target="Database

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Connections/GIS_S/BA_MV/GIS_SEDC.DBOWNER.KH_BA_Line11,LineCode,-1,-1;SubstaionName "Substaion" true false false 30 Text 0 0 ,First,#,Database Connections/GIS_S/GIS_SEDC.KH_MV/GIS_SEDC.DBOWNER.KH_KH_Line11,SubstaionName,-1,-1,Database Connections/GIS_S/OM_MV/GIS_SEDC.DBOWNER.KH_OM_Line11,SubstaionName,-1-,
,1Database
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,First,#,Database
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Connections/GIS_S/OM_MV/GIS_SEDC.DBOWNER.KH_OM_Line11,TransNO,-1,-

1,Database

Connections/GIS_S/BA_MV/GIS_SEDC.DBOWNER.KH_BA_Line11,TransNO-,

;1-,1PoleNO "Pole_No" true false false 2 Short 0 5 ,First,#,Database

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Connections/GIS_S/OM_MV/GIS_SEDC.DBOWNER.KH_OM_Line11,PoleNO,-1,-

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Connections/GIS_S/BA_MV/GIS_SEDC.DBOWNER.KH_BA_Line11,PoleNO,-1-,

;1ConductorSize "Conductor_Size" true false false 8 Double 8 38 ,First,#,Database

Connections/GIS_S/GIS_SEDC.KH_MV/GIS_SEDC.DBOWNER.KH_KH_Line11,Conduct

orSize,-1-,

,1Database

Connections/GIS_S/OM_MV/GIS_SEDC.DBOWNER.KH_OM_Line11,ConductorSize,-

1,-1,Database

Connections/GIS_S/BA_MV/GIS_SEDC.DBOWNER.KH_BA_Line11,ConductorSize,-1,-

1;City "CIty" true false false 30 Text 0 0 ,First,#,Database

Connections/GIS_S/GIS_SEDC.KH_MV/GIS_SEDC.DBOWNER.KH_KH_Line11,City,-1,-

1,Database Connections/GIS_S/OM_MV/GIS_SEDC.DBOWNER.KH_OM_Line11,City,-

1,-1,Database

Connections/GIS_S/BA_MV/GIS_SEDC.DBOWNER.KH_BA_Line11,City,-1,-1;State

"State" true false false 30 Text 0 0 ,First,#,Database

Connections/GIS_S/GIS_SEDC.KH_MV/GIS_SEDC.DBOWNER.KH_KH_Line11,State,-1,-

1,Database

Connections/GIS_S/OM_MV/GIS_SEDC.DBOWNER.KH_OM_Line11,State,-1,-

1,Database

Connections/GIS_S/BA_MV/GIS_SEDC.DBOWNER.KH_BA_Line11,State,-1,-1;GlobalID

"GlobalID" false false false 38 GlobalID 0 0 ,First,#,Database

Connections/GIS_S/GIS_SEDC.KH_MV/GIS_SEDC.DBOWNER.KH_KH_Line11,GlobalID,

-1,-1,Database

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1,Database

Connections/GIS_S/BA_MV/GIS_SEDC.DBOWNER.KH_BA_Line11,GlobalID,-1,-1;DATE "DATES" true false false 36 Date 0 0 ,First,#,Database Connections/GIS_S/GIS_SEDC.KH_MV/GIS_SEDC.DBOWNER.KH_KH_Line11,DATE,-1,-1,Database Connections/GIS_S/OM_MV/GIS_SEDC.DBOWNER.KH_OM_Line11,DATE,-1,-1,Database Connections/GIS_S/BA_MV/GIS_SEDC.DBOWNER.KH_BA_Line11,DATE,-1,-1;OfficeName "OfficeName" true false false 30 Text 0 0 ,First,#,Database Connections/GIS_S/GIS_SEDC.KH_MV/GIS_SEDC.DBOWNER.KH_KH_Line11,OfficeName,-1,-1,Database Connections/GIS_S/OM_MV/GIS_SEDC.DBOWNER.KH_OM_Line11,OfficeName,-1-,,1Database Connections/GIS_S/BA_MV/GIS_SEDC.DBOWNER.KH_BA_Line11,OfficeName,-1,-1;Department "Department" true true false 30 Text 0 0

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1;SHAPE.len "SHAPE.len" false false true 0 Double 0 0 ,First ,"""#,
subtype(""=kh11=arcpy.MakeFeatureLayer_management(NewLine(

arcpy.Append_management([KHchvline11,OMchvline11,BHchvline11], kh11,
"NO_TEST","""Name "NAME" true false false 30 Text 0 0 ,First,#,Database
Connections/GIS_S/GIS_SEDC.KH_MV/GIS_SEDC.DBOWNER.KH_KH_Line11,Name,-
1,-1,Database
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Connections/GIS_S/GIS_SEDC.KH_MV/GIS_SEDC.DBOWNER.KH_KH_Line11,LineCode
,-1,-1,Database
Connections/GIS_S/OM_MV/GIS_SEDC.DBOWNER.KH_OM_Line11,LineCode,-1,-
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1;SubstaionName "Substaion" true false false 30 Text 0 0 ,First,#,Database
Connections/GIS_S/GIS_SEDC.KH_MV/GIS_SEDC.DBOWNER.KH_KH_Line11,Substaio
nName,-1,-1,Database
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Connections/GIS_S/BA_MV/GIS_SEDC.DBOWNER.KH_BA_Line11,SubstaionName,-1,-
1;TransNO "TR_NO" true false false 2 Short 0 5

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Connections/GIS_S/OM_MV/GIS_SEDC.DBOWNER.KH_OM_Line11,TransNO,-1,-
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Connections/GIS_S/BA_MV/GIS_SEDC.DBOWNER.KH_BA_Line11,TransNO-,
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;1-,1PoleNO "Pole_No" true false false 2 Short 0 5 ,First,#,Database
Connections/GIS_S/GIS_SEDC.KH_MV/GIS_SEDC.DBOWNER.KH_KH_Line11,PoleNO,-1,-1,Database
Connections/GIS_S/OM_MV/GIS_SEDC.DBOWNER.KH_OM_Line11,PoleNO,-1,-1,Database
Connections/GIS_S/BA_MV/GIS_SEDC.DBOWNER.KH_BA_Line11,PoleNO,-1-,

;1ConductorSize "Conductor_Size" true false false 8 Double 8 38 ,First,#,Database
Connections/GIS_S/GIS_SEDC.KH_MV/GIS_SEDC.DBOWNER.KH_KH_Line11,ConductorSize,-1-,

,1Database
Connections/GIS_S/OM_MV/GIS_SEDC.DBOWNER.KH_OM_Line11,ConductorSize,-1,-1,Database

Connections/GIS_S/BA_MV/GIS_SEDC.DBOWNER.KH_BA_Line11,ConductorSize,-1,-1;City "CIty" true false false 30 Text 0 0 ,First,#,Database
Connections/GIS_S/GIS_SEDC.KH_MV/GIS_SEDC.DBOWNER.KH_KH_Line11,City,-1,-1,Database Connections/GIS_S/OM_MV/GIS_SEDC.DBOWNER.KH_OM_Line11,City,-1,-1,Database
Connections/GIS_S/BA_MV/GIS_SEDC.DBOWNER.KH_BA_Line11,City,-1,-1;State "State" true false false 30 Text 0 0 ,First,#,Database
Connections/GIS_S/GIS_SEDC.KH_MV/GIS_SEDC.DBOWNER.KH_KH_Line11,State,-1,-1,Database
Connections/GIS_S/OM_MV/GIS_SEDC.DBOWNER.KH_OM_Line11,State,-1,-1,Database
Connections/GIS_S/BA_MV/GIS_SEDC.DBOWNER.KH_BA_Line11,State,-1,-1;GlobalID "GlobalID" false false false 38 GlobalID 0 0 ,First,#,Database
Connections/GIS_S/GIS_SEDC.KH_MV/GIS_SEDC.DBOWNER.KH_KH_Line11,GlobalID,-1,-1,Database
Connections/GIS_S/OM_MV/GIS_SEDC.DBOWNER.KH_OM_Line11,GlobalID,-1,-1,Database
Connections/GIS_S/BA_MV/GIS_SEDC.DBOWNER.KH_BA_Line11,GlobalID,-1,-

1;DATE "DATES" true false false 36 Date 0 0 ,First,#,Database
Connections/GIS_S/GIS_SEDC.KH_MV/GIS_SEDC.DBOWNER.KH_KH_Line11,DATE,-1,-1,Database
Connections/GIS_S/OM_MV/GIS_SEDC.DBOWNER.KH_OM_Line11,DATE,-1,-1,Database
Connections/GIS_S/BA_MV/GIS_SEDC.DBOWNER.KH_BA_Line11,DATE,-1,-1;OfficeName "OfficeName" true false false 30 Text 0 0 ,First,#,Database
Connections/GIS_S/GIS_SEDC.KH_MV/GIS_SEDC.DBOWNER.KH_KH_Line11,OfficeName,-1,-1,Database
Connections/GIS_S/OM_MV/GIS_SEDC.DBOWNER.KH_OM_Line11,OfficeName,-1-,
,1DatabaseConnections/GIS_S/BA_MV/GIS_SEDC.DBOWNER.KH_BA_Line11,OfficeName,-1,-1;Department "Department" true true false 30 Text 0 0

,First,#,Database
Connections/GIS_S/GIS_SEDC.KH_MV/GIS_SEDC.DBOWNER.KH_KH_Line11,Department,-1,-1,Database

Connections/GIS_S/OM_MV/GIS_SEDC.DBOWNER.KH_OM_Line11,Department,-1,-1,Database

Connections/GIS_S/BA_MV/GIS_SEDC.DBOWNER.KH_BA_Line11,Department,-1,-1;status "status" true true false 2 Text 0 0 ,First,#,Database
Connections/GIS_S/GIS_SEDC.KH_MV/GIS_SEDC.DBOWNER.KH_KH_Line11,status,-1,-1,Database
Connections/GIS_S/OM_MV/GIS_SEDC.DBOWNER.KH_OM_Line11,status,-1,-1,Database
Connections/GIS_S/BA_MV/GIS_SEDC.DBOWNER.KH_BA_Line11,status,-1,-1;Analoge "Analoge" true true false 8 Double 8 38 ,First,#,Database

Connections/GIS_S/GIS_SEDC.KH_MV/GIS_SEDC.DBOWNER.KH_KH_Line11,Analoge,-1,-1,Database
Connections/GIS_S/OM_MV/GIS_SEDC.DBOWNER.KH_OM_Line11,Analoge,-1,-1,Database
Connections/GIS_S/BA_MV/GIS_SEDC.DBOWNER.KH_BA_Line11,Analoge,-1,-

```
1;SHAPE.len "SHAPE.len" false false true 0 Double 0 0 ,First ,"""#,
subtype(""=

#

CoCodeCal = arcpy.CalculateField_management(kh11,"CoCode","[Name] &
[LineCode] & [SHAPE_Length]", "VB("" ,"

 #Replace a layer/table view name with a path to a dataset (which can be a layer file)
or create the layer/table view within the script

 #The following inputs are layers or table views: "gg", "KH_Line11"

Join_kh11= arcpy.AddJoin_management(in_layer_or_view=kh11 ,
in_field="CoCode", join_table=KH_Line11 , join_field="CoCode",
join_type="KEEP_ALL("

print Join_kh11

Select_Join_kh11 =
arcpy.SelectLayerByAttribute_management(in_layer_or_view=Join_kh11,
selection_type="NEW_SELECTION", where_clause="KH_Line11.CoCode IS NULL("

for f in arcpy.ListFields(Select_Join_kh11: (

   print f.name

khLine=arcpy.MakeFeatureLayer_management(KH_Line11(

arcpy.Append_management(inputs=Select_Join_kh11, target=KH_Line11,
schema_type="NO_TEST", field_mapping="""Name "NAME" true false false 30 Text
0 0

,First,#,Select_Join_kh11,New_KH_Line11.Name,-1,-1;LineCode "LINE_CODE" true
false false 20 Text 0 0 ,First,#,Select_Join_kh11,New_KH_Line113.LineCode,-1-,

;1SubstaionName "Substaion" true false false 30 Text 0 0
,First,#,Select_Join_kh11,New_KH_Line11.SubstaionName,-1,-1;TransNO "TR_NO"
true false false 2 Short 0 0
```

,First,#,Select_Join_kh11,New_KH_Line11.TransNO,-1,-1;PoleNO "Pole_No" true false false 2 Short 0 0 ,First,#,Select_Join_kh11,New_KH_Line11.PoleNO,-1,-1;ConductorSize
"Conductor_Size" true false false 8 Double 0 0
,First,#,Select_Join_kh11,New_KH_Line11.ConductorSize,-1,-1;City "CIty" true false false 30 Text 0 0
,First,#,Select_Join_kh11,New_KH_Line11.City,-1,-1;State "State" true false false 30 Text 0 0 ,First,#,Select_Join_kh11,New_KH_Line11.State,-1,-1;GlobalID "GlobalID "

false false false 38 GlobalID 0 0 ,First,#,Select_Join_kh11,New_KH_Line11.Glob_alID,-1,-1;

DATE "DATES" true false false 8 Date 0 0
,First,#,Select_Join_kh11,New_KH_Line11.DATE,-1,-1;OfficeName "OfficeName" true false false 30 Text 0 0
,First,#,Select_Join_kh11,New_KH_Line11.OfficeName,-1,-1;Department
"Department" true true false 30 Text 0 0
,First,#,Select_Join_kh11,New_KH_Line11.Department,-1-,

;1status "status" true true false 2 Text 0 0
,First,#,Select_Join_kh11,New_KH_Line11.status,-1,-1;Analoge "Analoge" true true false 8 Double 0 0

,First,#,Select_Join_kh11,New_KH_Line11.Analoge,-1,-1;SHAPE_Length
"SHAPE_Length" false true true 8 Double 0 0
,First,#,Select_Join_kh11,SHAPE_Length,-1,-1;CoCode
"CoCode" true true false 75 Text 0 0
,First,#,Select_Join_kh11,New_KH_Line11.CoCode,-1,-1""", subtype(""=

khLine=arcpy.MakeFeatureLayer_management(KH_Line11(

arcpy.CopyFeatures_management(Select_Join_kh11,r'D:\Scada\Scada.gdb\Select_Join_kh11('

arcpy.Append_management([kh11],khLine,"NO_TEST("

arcpy.Append_management([kh11], khLine, "NO_TEST","""Name "NAME" true false false 30 Text 0 0 ,First,#,Database

Connections/GIS_S/GIS_SEDC.KH_MV/GIS_SEDC.DBOWNER.KH_KH_Line11,Name,-1,-1,Database Connections/GIS_S/OM_MV/GIS_SEDC.DBOWNER.KH_OM_Line11,Name,-1,-1,Database Connections/GIS_S/BA_MV/GIS_SEDC.DBOWNER.KH_BA_Line11,Name,-1,-1;LineCode "LINE_CODE" true false false 20 Text 0 0 ,First,#,Database Connections/GIS_S/GIS_SEDC.KH_MV/GIS_SEDC.DBOWNER.KH_KH_Line11,LineCode,-1,-1,Database Connections/GIS_S/OM_MV/GIS_SEDC.DBOWNER.KH_OM_Line11,LineCode,-1,-1,Database

Connections/GIS_S/BA_MV/GIS_SEDC.DBOWNER.KH_BA_Line11,LineCode,-1,-1;SubstaionName "Substaion" true false false 30 Text 0 0 ,First,#,Database

Connections/GIS_S/GIS_SEDC.KH_MV/GIS_SEDC.DBOWNER.KH_KH_Line11,SubstaionName,-1,-1,Database Connections/GIS_S/OM_MV/GIS_SEDC.DBOWNER.KH_OM_Line11,SubstaionName,-1-,
,1Database
Connections/GIS_S/BA_MV/GIS_SEDC.DBOWNER.KH_BA_Line11,SubstaionName,-1,-1;TransNO "TR_NO" true false false 2 Short 0 5
,First,#,Database
Connections/GIS_S/GIS_SEDC.KH_MV/GIS_SEDC.DBOWNER.KH_KH_Line11,TransNO,-1,-1,Database

Connections/GIS_S/OM_MV/GIS_SEDC.DBOWNER.KH_OM_Line11,TransNO,-1,-1,Database
Connections/GIS_S/BA_MV/GIS_SEDC.DBOWNER.KH_BA_Line11,TransNO-,
;1-,1PoleNO "Pole_No" true false false 2 Short 0 5 ,First,#,Database
Connections/GIS_S/GIS_SEDC.KH_MV/GIS_SEDC.DBOWNER.KH_KH_Line11,PoleNO,-1,-1,Database

Connections/GIS_S/OM_MV/GIS_SEDC.DBOWNER.KH_OM_Line11,PoleNO,-1,-

1,Database

Connections/GIS_S/BA_MV/GIS_SEDC.DBOWNER.KH_BA_Line11,PoleNO,-1-,

;1ConductorSize "Conductor_Size" true false false 8 Double 8 38 ,First,#,Database Connections/GIS_S/GIS_SEDC.KH_MV/GIS_SEDC.DBOWNER.KH_KH_Line11,ConductorSize,-1-,
,1Database
Connections/GIS_S/OM_MV/GIS_SEDC.DBOWNER.KH_OM_Line11,ConductorSize,-1,-1,Database

Connections/GIS_S/BA_MV/GIS_SEDC.DBOWNER.KH_BA_Line11,ConductorSize,-1,-1;City "CIty" true false false 30 Text 0 0 ,First,#,Database Connections/GIS_S/GIS_SEDC.KH_MV/GIS_SEDC.DBOWNER.KH_KH_Line11,City,-1,-1,Database Connections/GIS_S/OM_MV/GIS_SEDC.DBOWNER.KH_OM_Line11,City,-1,-1,Database

Connections/GIS_S/BA_MV/GIS_SEDC.DBOWNER.KH_BA_Line11,City,-1,-1;State

"State" true false false 30 Text 0 0 ,First,#,Database

Connections/GIS_S/GIS_SEDC.KH_MV/GIS_SEDC.DBOWNER.KH_KH_Line11,State,-1,-

1,Database

Connections/GIS_S/OM_MV/GIS_SEDC.DBOWNER.KH_OM_Line11,State,-1,-

1,Database

Connections/GIS_S/BA_MV/GIS_SEDC.DBOWNER.KH_BA_Line11,State,-1,-1;GlobalID

"GlobalID" false false false 38 GlobalID 0 0 ,First,#,Database

Connections/GIS_S/GIS_SEDC.KH_MV/GIS_SEDC.DBOWNER.KH_KH_Line11,GlobalID,

-1,-1,Database

Connections/GIS_S/OM_MV/GIS_SEDC.DBOWNER.KH_OM_Line11,GlobalID,-1,-

1,Database

Connections/GIS_S/BA_MV/GIS_SEDC.DBOWNER.KH_BA_Line11,GlobalID,-1,-

1;DATE "DATES" true false false 36 Date 0 0 ,First,#,Database

Connections/GIS_S/GIS_SEDC.KH_MV/GIS_SEDC.DBOWNER.KH_KH_Line11,DATE,-1,-

1,Database

Connections/GIS_S/OM_MV/GIS_SEDC.DBOWNER.KH_OM_Line11,DATE,-1,-

1,Database

Connections/GIS_S/BA_MV/GIS_SEDC.DBOWNER.KH_BA_Line11,DATE,-1,-

1;OfficeName "OfficeName" true false false 30 Text 0 0 ,First,#,Database

```
Connections/GIS_S/GIS_SEDC.KH_MV/GIS_SEDC.DBOWNER.KH_KH_Line11,OfficeNa
me,-1,-1,Database
Connections/GIS_S/OM_MV/GIS_SEDC.DBOWNER.KH_OM_Line11,OfficeName,-1-,
,1Database
Connections/GIS_S/BA_MV/GIS_SEDC.DBOWNER.KH_BA_Line11,OfficeName,-1,-
1;Department "Department" true true false 30 Text 0 0
,First,#,Database
Connections/GIS_S/GIS_SEDC.KH_MV/GIS_SEDC.DBOWNER.KH_KH_Line11,Departm
ent,-1,-1,Database
Connections/GIS_S/OM_MV/GIS_SEDC.DBOWNER.KH_OM_Line11,Department,-1,-
1,Database

Connections/GIS_S/BA_MV/GIS_SEDC.DBOWNER.KH_BA_Line11,Department,-1,-
1;status "status" true true false 2 Text 0 0 ,First,#,Database
Connections/GIS_S/GIS_SEDC.KH_MV/GIS_SEDC.DBOWNER.KH_KH_Line11,status,-
1,-1,Database
Connections/GIS_S/OM_MV/GIS_SEDC.DBOWNER.KH_OM_Line11,status,-1,-
1,Database

Connections/GIS_S/BA_MV/GIS_SEDC.DBOWNER.KH_BA_Line11,status,-1,-
1;Analoge "Analoge" true true false 8 Double 8 38 ,First,#,Database

Connections/GIS_S/GIS_SEDC.KH_MV/GIS_SEDC.DBOWNER.KH_KH_Line11,Analoge,
-1,-1,Database
Connections/GIS_S/OM_MV/GIS_SEDC.DBOWNER.KH_OM_Line11,Analoge,-1,-
1,Database
Connections/GIS_S/BA_MV/GIS_SEDC.DBOWNER.KH_BA_Line11,Analoge,-1,-
1;SHAPE.len "SHAPE.len" false false true 0 Double 0 0 ,First ,"""#,
subtype(""=

#

arcpy.TruncateTable_management(KH_Line33(

##
```

kh33=arcpy.MakeFeatureLayer_management(KH_Line33(

##

arcpy.Append_management([KHchvline33,OMchvline33,BHchvline33], kh11,
"NO_TEST","""Name "NAME" true false false 30 Text 0 0 ,First,#,Database
Connections/GIS_S/GIS_SEDC.KH_MV/GIS_SEDC.DBOWNER.KH_KH_Line11,Name,-
1,-1,Database
Connections/GIS_S/OM_MV/GIS_SEDC.DBOWNER.KH_OM_Line11,Name,-1,-
1,Database
Connections/GIS_S/BA_MV/GIS_SEDC.DBOWNER.KH_BA_Line11,Name,-1,-
1;LineCode "LINE_CODE" true false false 20 Text 0 0 ,First,#,Database
Connections/GIS_S/GIS_SEDC.KH_MV/GIS_SEDC.DBOWNER.KH_KH_Line11,LineCode
,-1,-1,Database
Connections/GIS_S/OM_MV/GIS_SEDC.DBOWNER.KH_OM_Line11,LineCode,-1,-
1,Database
Connections/GIS_S/BA_MV/GIS_SEDC.DBOWNER.KH_BA_Line11,LineCode,-1,-
1;SubstaionName "Substaion" true false false 30 Text 0 0 ,First,#,Database

Connections/GIS_S/GIS_SEDC.KH_MV/GIS_SEDC.DBOWNER.KH_KH_Line11,Substaio
nName,-1,-1,Database
Connections/GIS_S/OM_MV/GIS_SEDC.DBOWNER.KH_OM_Line11,SubstaionName,-
1-,

,1Database
Connections/GIS_S/BA_MV/GIS_SEDC.DBOWNER.KH_BA_Line11,SubstaionName,-1,-
1;TransNO "TR_NO" true false false 2 Short 0 5

,First,#,Database
Connections/GIS_S/GIS_SEDC.KH_MV/GIS_SEDC.DBOWNER.KH_KH_Line11,TransNO,
-1,-1,Database

Connections/GIS_S/OM_MV/GIS_SEDC.DBOWNER.KH_OM_Line11,TransNO,-1,-1,Database

Connections/GIS_S/BA_MV/GIS_SEDC.DBOWNER.KH_BA_Line11,TransNO-,

;1-,1PoleNO "Pole_No" true false false 2 Short 0 5 ,First,#,Database

Connections/GIS_S/GIS_SEDC.KH_MV/GIS_SEDC.DBOWNER.KH_KH_Line11,PoleNO,-1,-1,Database

Connections/GIS_S/OM_MV/GIS_SEDC.DBOWNER.KH_OM_Line11,PoleNO,-1,-1,Database

Connections/GIS_S/BA_MV/GIS_SEDC.DBOWNER.KH_BA_Line11,PoleNO,-1-,

;1ConductorSize "Conductor_Size" true false false 8 Double 8 38 ,First,#,Database

Connections/GIS_S/GIS_SEDC.KH_MV/GIS_SEDC.DBOWNER.KH_KH_Line11,ConductorSize,-1-,

,1Database

Connections/GIS_S/OM_MV/GIS_SEDC.DBOWNER.KH_OM_Line11,ConductorSize,-1,-1,Database

Connections/GIS_S/BA_MV/GIS_SEDC.DBOWNER.KH_BA_Line11,ConductorSize,-1,-1;City "CIty" true false false 30 Text 0 0 ,First,#,Database

Connections/GIS_S/GIS_SEDC.KH_MV/GIS_SEDC.DBOWNER.KH_KH_Line11,City,-1,-1,Database Connections/GIS_S/OM_MV/GIS_SEDC.DBOWNER.KH_OM_Line11,City,-1,-1,Database

Connections/GIS_S/BA_MV/GIS_SEDC.DBOWNER.KH_BA_Line11,City,-1,-1;State "State" true false false 30 Text 0 0 ,First,#,Database

Connections/GIS_S/GIS_SEDC.KH_MV/GIS_SEDC.DBOWNER.KH_KH_Line11,State,-1,-1,Database

Connections/GIS_S/OM_MV/GIS_SEDC.DBOWNER.KH_OM_Line11,State,-1,-1,Database

Connections/GIS_S/BA_MV/GIS_SEDC.DBOWNER.KH_BA_Line11,State,-1,-1;GlobalID "GlobalID" false false false 38 GlobalID 0 0 ,First,#,Database

Connections/GIS_S/GIS_SEDC.KH_MV/GIS_SEDC.DBOWNER.KH_KH_Line11,GlobalID,-1,-1,Database

Connections/GIS_S/OM_MV/GIS_SEDC.DBOWNER.KH_OM_Line11,GlobalID,-1,-
1,Database
Connections/GIS_S/BA_MV/GIS_SEDC.DBOWNER.KH_BA_Line11,GlobalID,-1,-
1;DATE "DATES" true false false 36 Date 0 0 ,First,#,Database

Connections/GIS_S/GIS_SEDC.KH_MV/GIS_SEDC.DBOWNER.KH_KH_Line11,DATE,-1,-
1,Database
Connections/GIS_S/OM_MV/GIS_SEDC.DBOWNER.KH_OM_Line11,DATE,-1,-
1,Database

Connections/GIS_S/BA_MV/GIS_SEDC.DBOWNER.KH_BA_Line11,DATE,-1,-
1;OfficeName "OfficeName" true false false 30 Text 0 0 ,First,#,Database
Connections/GIS_S/GIS_SEDC.KH_MV/GIS_SEDC.DBOWNER.KH_KH_Line11,OfficeNa
me,-1,-1,Database
Connections/GIS_S/OM_MV/GIS_SEDC.DBOWNER.KH_OM_Line11,OfficeName,-1-,
,1Database
Connections/GIS_S/BA_MV/GIS_SEDC.DBOWNER.KH_BA_Line11,OfficeName,-1,-
1;Department "Department" true true false 30 Text 0 0
,First,#,Database
Connections/GIS_S/GIS_SEDC.KH_MV/GIS_SEDC.DBOWNER.KH_KH_Line11,Departm
ent,-1,-1,Database
Connections/GIS_S/OM_MV/GIS_SEDC.DBOWNER.KH_OM_Line11,Department,-1,-
1,Database
Connections/GIS_S/BA_MV/GIS_SEDC.DBOWNER.KH_BA_Line11,Department,-1,-
1;status "status" true true false 2 Text 0 0 ,First,#,Database

Connections/GIS_S/GIS_SEDC.KH_MV/GIS_SEDC.DBOWNER.KH_KH_Line11,status,-
1,-1,Database
Connections/GIS_S/OM_MV/GIS_SEDC.DBOWNER.KH_OM_Line11,status,-1,-
1,Database
Connections/GIS_S/BA_MV/GIS_SEDC.DBOWNER.KH_BA_Line11,status,-1,-
1;Analoge "Analoge" true true false 8 Double 8 38 ,First,#,Database
Connections/GIS_S/GIS_SEDC.KH_MV/GIS_SEDC.DBOWNER.KH_KH_Line11,Analoge,

```
-1,-1,Database
Connections/GIS_S/OM_MV/GIS_SEDC.DBOWNER.KH_OM_Line11,Analoge,-1,-
1,Database
Connections/GIS_S/BA_MV/GIS_SEDC.DBOWNER.KH_BA_Line11,Analoge,-1,-
1;SHAPE.len "SHAPE.len" false false true 0 Double 0 0 ,First ,"""#,

subtype(""=

#

arcpy.TruncateTable_management(KH_meter(

fields =["MeterNo","TransName","Line11","LineCode","SubstationName","City["

##

with arcpy.da.SearchCursor(KHchvmeter,fields) as cursor:

   with arcpy.da.InsertCursor(KH_meter, fields) as icur:

      for row in cursor:

         icur.insertRow(row(

         del row

   del icur

del cursor

with arcpy.da.SearchCursor(OMchvmeter,fields) as cursor:

   with arcpy.da.InsertCursor(KH_meter, fields) as icur:

      for row in cursor:

         icur.insertRow(row(

         del row

   del icur
```

```
##
del cursor
##
with arcpy.da.SearchCursor(BHchvmeter,fields) as cursor:
    with arcpy.da.InsertCursor(KH_meter, fields) as icur:
        for row in cursor:
            icur.insertRow(row(
            del row
    del icur
del cursor
    r1= row[0[
    r2= row[1[
    r3= row[2[
    r4= row[3[
    r5= row[4[
    r6= row[5[
##
    iCursor = arcpy.da.InsertCursor(KH_meter(
    row = iCursor.newRow()
    row.setValue("MeterNo",r1(
    row.setValue("TransName",r2(
    row.setValue("Line11",r3(
```

```
    row.setValue("LineCode",r4(

    row.setValue("SubstationName",r5(

    row.setValue("City",r6(

    iCursor.insertRow(row(

    del iCursor

    del row

Temp = tempfile.gettempdir()

khr1,khr2,khr3,khr4,khr5,khr6 =
{row[0],row[1],row[2],row[3],row[4],row[5]}.formate

arcpy.env.workspace= r'Database Connections\SERV1'

r'Database Connections\SERV1\GIS.DBO.GIS_Transfer_Data\GIS.DBO.KH_Line11'
```

Appendix B

B.1 SCADA TO GIS

This code link SCADA key with GIS features to send real status to the geodatabase.

######MUDRAT########

STATUS,03013700,line,status,LineCode,MODK5,line,LineCode,MODK5

ANALOG,03013210,line,Analoge,LineCode,MODK5,line,LineCode,MODK5

STATUS,03012700,line,status,LineCode,MODK3,line,LineCode,MODK3

ANALOG,03012210,line,Analoge,LineCode,MODK3,line,LineCode,MODK3

STATUS,03010700,line,status,LineCode,MODK4,line,LineCode,MODK4

ANALOG,03010210,line,Analoge,LineCode,MODK4,line,LineCode,MODK4

STATUS,03004700,line,status,LineCode,MODK1,line,LineCode,MODK1

ANALOG,03004210,line,Analoge,LineCode,MODK1,line,LineCode,MODK1

STATUS,03003700,line,status,LineCode,MODK6,line,LineCode,MODK6

ANALOG,03003210,line,Analoge,LineCode,MODK6,line,LineCode,MODK6

STATUS,03001700,line,status,LineCode,MODK2,line,LineCode,MODK2

ANALOG,03001210,line,Analoge,LineCode,MODK2,line,LineCode,MODK2

######STS########

STATUS,01002700,line,status,LineCode,STSK1,line,LineCode,STSK1

ANALOG,01002210,line,Analoge,LineCode,STSK1,line,LineCode,STSK1

STATUS,01001700,line,status,LineCode,STSK2,line,LineCode,STSK2

ANALOG,01001210,line,Analoge,LineCode,STSK2,line,LineCode,STSK2

STATUS,01003700,line,status,LineCode,STSK3,line,LineCode,STSK3

ANALOG,01003210,line,Analoge,LineCode,STSK3,line,LineCode,STSK3

STATUS,01005700,line,status,LineCode,STSK4,line,LineCode,STSK4

ANALOG,01005210,line,Analoge,LineCode,STSK4,line,LineCode,STSK4

######ARK########

STATUS,00508700,line,status,LineCode,ARKK1,line,LineCode,ARKK1

ANALOG,00508210,line,Analoge,LineCode,ARKK1,line,LineCode,ARKK1

STATUS,00506700,line,status,LineCode,ARKK2,line,LineCode,ARKK2

ANALOG,00506210,line,Analoge,LineCode,ARKK2,line,LineCode,ARKK2

STATUS,00502700,line,status,LineCode,ARKK3,line,LineCode,ARKK3

ANALOG,00502210,line,Analoge,LineCode,ARKK3,line,LineCode,ARKK3

STATUS,00505700,line,status,LineCode,ARKK5,line,LineCode,ARKK5

ANALOG,00505210,line,Analoge,LineCode,ARKK5,line,LineCode,ARKK5

STATUS,00507700,line,status,LineCode,ARKK6,line,LineCode,ARKK6

ANALOG,00507210,line,Analoge,LineCode,ARKK6,line,LineCode,ARKK6

######AZH########

STATUS,02009700,line,status,LineCode,AZHK1,line,LineCode,AZHK1

ANALOG,02009210,line,Analoge,LineCode,AZHK1,line,LineCode,AZHK1

STATUS,02006700,line,status,LineCode,AZHK2,line,LineCode,AZHK2

ANALOG,02006210,line,Analoge,LineCode,AZHK2,line,LineCode,AZHK2

STATUS,02003700,line,status,LineCode,AZHK4,line,LineCode,AZHK4

ANALOG,02003210,line,Analoge,LineCode,AZHK4,line,LineCode,AZHK4

STATUS,02002700,line,status,LineCode,AZHK5,line,LineCode,AZHK5

ANALOG,02002210,line,Analoge,LineCode,AZHK5,line,LineCode,AZHK5

STATUS,02011700,line,status,LineCode,AZHK6,line,LineCode,AZHK6

ANALOG,02011210,line,Analoge,LineCode,AZHK6,line,LineCode,AZHK6

######AMT########

STATUS,01113700,line,status,LineCode,AMTK1,line,LineCode,AMTK1

ANALOG,01113210,line,Analoge,LineCode,AMTK1,line,LineCode,AMTK1

STATUS,01105700,line,status,LineCode,AMTK2,line,LineCode,AMTK2

ANALOG,01105210,line,Analoge,LineCode,AMTK2,line,LineCode,AMTK2

STATUS,01110700,line,status,LineCode,AMTK3,line,LineCode,AMTK3

ANALOG,01110210,line,Analoge,LineCode,AMTK3,line,LineCode,AMTK3

STATUS,01104700,line,status,LineCode,AMTK4,line,LineCode,AMTK4

ANALOG,01104210,line,Analoge,LineCode,AMTK4,line,LineCode,AMTK4

STATUS,01103700,line,status,LineCode,AMTK6,line,LineCode,AMTK6

ANALOG,01103210,line,Analoge,LineCode,AMTK6,line,LineCode,AMTK6

######AML########

STATUS,02803700,line,status,LineCode,AMLK1,line,LineCode,AMLK1

ANALOG,02803210,line,Analoge,LineCode,AMLK1,line,LineCode,AMLK1

STATUS,02804700,line,status,LineCode,AMLK2,line,LineCode,AMLK2

ANALOG,02804210,line,Analoge,LineCode,AMLK2,line,LineCode,AMLK2

STATUS,02811700,line,status,LineCode,AMLK3,line,LineCode,AMLK3

ANALOG,02811210,line,Analoge,LineCode,AMLK3,line,LineCode,AMLK3

STATUS,02808700,line,status,LineCode,AMLK4,line,LineCode,AMLK4

ANALOG,02808210,line,Analoge,LineCode,AMLK4,line,LineCode,AMLK4

STATUS,02809700,line,status,LineCode,AMLK5,line,LineCode,AMLK5

ANALOG,02809210,line,Analoge,LineCode,AMLK5,line,LineCode,AMLK5

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######GRF########
STATUS,01903700,line,status,LineCode,GRFK1,line,LineCode,GRFK1
ANALOG,01903210,line,Analoge,LineCode,GRFK1,line,LineCode,GRFK1
STATUS,01905700,line,status,LineCode,GRFK2,line,LineCode,GRFK2
ANALOG,01905210,line,Analoge,LineCode,GRFK2,line,LineCode,GRFK2
STATUS,01909700,line,status,LineCode,GRFK3,line,LineCode,GRFK3
ANALOG,01909210,line,Analoge,LineCode,GRFK3,line,LineCode,GRFK3
STATUS,01902700,line,status,LineCode,GRFK4,line,LineCode,GRFK4
ANALOG,01902210,line,Analoge,LineCode,GRFK4,line,LineCode,GRFK4
STATUS,01908700,line,status,LineCode,GRFK5,line,LineCode,GRFK5
ANALOG,01908210,line,Analoge,LineCode,GRFK5,line,LineCode,GRFK5
STATUS,01911700,line,status,LineCode,GRFK6,line,LineCode,GRFK6
ANALOG,01911210,line,Analoge,LineCode,GRFK6,line,LineCode,GRFK6
######KHE########
STATUS,03910700,line,status,LineCode,KHEK7,line,LineCode,KHEK7
ANALOG,03910210,line,Analoge,LineCode,KHEK7,line,LineCode,KHEK7
STATUS,03912700,line,status,LineCode,KHEK8,line,LineCode,KHEK8
ANALOG,03912210,line,Analoge,LineCode,KHEK8,line,LineCode,KHEK8
######ALD########
STATUS,02403700,line,status,LineCode,ALDK1,line,LineCode,ALDK1
ANALOG,02403210,line,Analoge,LineCode,ALDK1,line,LineCode,ALDK1
STATUS,02411700,line,status,LineCode,ALDK2,line,LineCode,ALDK2
ANALOG,02411210,line,Analoge,LineCode,ALDK2,line,LineCode,ALDK2
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STATUS,02406700,line,status,LineCode,ALDK3,line,LineCode,ALDK3

ANALOG,02406210,line,Analoge,LineCode,ALDK3,line,LineCode,ALDK3

STATUS,02408700,line,status,LineCode,ALDK4,line,LineCode,ALDK4

ANALOG,02408210,line,Analoge,LineCode,ALDK4,line,LineCode,ALDK4

STATUS,02410700,line,status,LineCode,ALDK5,line,LineCode,ALDK5

ANALOG,02410210,line,Analoge,LineCode,ALDK5,line,LineCode,ALDK5

STATUS,02404700,line,status,LineCode,ALDK6,line,LineCode,ALDK6

ANALOG,02404210,line,Analoge,LineCode,ALDK6,line,LineCode,ALDK6

######RYD########

STATUS,01309700,line,status,LineCode,RYDK2,line,LineCode,RYDK2

ANALOG,01309210,line,Analoge,LineCode,RYDK2,line,LineCode,RYDK2

STATUS,01311700,line,status,LineCode,RYDK3,line,LineCode,RYDK3

ANALOG,01311210,line,Analoge,LineCode,RYDK3,line,LineCode,RYDK3

STATUS,01308700,line,status,LineCode,RYDK4,line,LineCode,RYDK4

ANALOG,01308210,line,Analoge,LineCode,RYDK4,line,LineCode,RYDK4

STATUS,01306700,line,status,LineCode,RYDK5,line,LineCode,RYDK5

ANALOG,01306210,line,Analoge,LineCode,RYDK5,line,LineCode,RYDK5

STATUS,01303700,line,status,LineCode,RYDK8,line,LineCode,RYDK8

ANALOG,01303210,line,Analoge,LineCode,RYDK8,line,LineCode,RYDK8

######SAH########

STATUS,03713700,line,status,LineCode,SAHK1,line,LineCode,SAHK1

ANALOG,03713210,line,Analoge,LineCode,SAHK1,line,LineCode,SAHK1

STATUS,03711700,line,status,LineCode,SAHK2,line,LineCode,SAHK2

ANALOG,03711210,line,Analoge,LineCode,SAHK2,line,LineCode,SAHK2

STATUS,03705700,line,status,LineCode,SAHK3,line,LineCode,SAHK3

ANALOG,03705210,line,Analoge,LineCode,SAHK3,line,LineCode,SAHK3

STATUS,03704700,line,status,LineCode,SAHK4,line,LineCode,SAHK4

ANALOG,03704210,line,Analoge,LineCode,SAHK4,line,LineCode,SAHK4

STATUS,03706700,line,status,LineCode,SAHK6,line,LineCode,SAHK6

ANALOG,03706210,line,Analoge,LineCode,SAHK6,line,LineCode,SAHK6

STATUS,03710700,line,status,LineCode,SAHK7,line,LineCode,SAHK7

ANALOG,03710210,line,Analoge,LineCode,SAHK7,line,LineCode,SAHK7

STATUS,03714700,line,status,LineCode,SAHK8,line,LineCode,SAHK8

ANALOG,03714210,line,Analoge,LineCode,SAHK8,line,LineCode,SAHK8

######LOM########

STATUS,04013700,line,status,LineCode,LOMK1,line,LineCode,LOMK1

ANALOG,04013210,line,Analoge,LineCode,LOMK1,line,LineCode,LOMK1

STATUS,04009700,line,status,LineCode,LOMK2,line,LineCode,LOMK2

ANALOG,04009210,line,Analoge,LineCode,LOMK2,line,LineCode,LOMK2

STATUS,04002700,line,status,LineCode,LOMK3,line,LineCode,LOMK3

ANALOG,04002210,line,Analoge,LineCode,LOMK3,line,LineCode,LOMK3

STATUS,04005700,line,status,LineCode,LOMK4,line,LineCode,LOMK4

ANALOG,04005210,line,Analoge,LineCode,LOMK4,line,LineCode,LOMK4

######SHA########

STATUS,02212700,line,status,LineCode,SHAK1,line,LineCode,SHAK1

ANALOG,02212210,line,Analoge,LineCode,SHAK1,line,LineCode,SHAK1

STATUS,02203700,line,status,LineCode,SHAK2,line,LineCode,SHAK2

ANALOG,02203210,line,Analoge,LineCode,SHAK2,line,LineCode,SHAK2

STATUS,02209700,line,status,LineCode,SHAK3,line,LineCode,SHAK3

ANALOG,02209210,line,Analoge,LineCode,SHAK3,line,LineCode,SHAK3

STATUS,02202700,line,status,LineCode,SHAK4,line,LineCode,SHAK4

ANALOG,02208210,line,Analoge,LineCode,SHAK4,line,LineCode,SHAK4

STATUS,02208700,line,status,LineCode,SHAK5,line,LineCode,SHAK5

ANALOG,03706210,line,Analoge,LineCode,SHAK5,line,LineCode,SHAK5

STATUS,02206700,line,status,LineCode,SHAK6,line,LineCode,SHAK6

ANALOG,02206210,line,Analoge,LineCode,SHAK6,line,LineCode,SHAK6

STATUS,02205700,line,status,LineCode,SHAK7,line,LineCode,SHAK7

ANALOG,02205210,line,Analoge,LineCode,SHAK7,line,LineCode,SHAK7

######ALF########

STATUS,00605700,line,status,LineCode,ALFK1,line,LineCode,ALFK1

ANALOG,00605210,line,Analoge,LineCode,ALFK1,line,LineCode,ALFK1

STATUS,00608700,line,status,LineCode,ALFK2,line,LineCode,ALFK2

ANALOG,00608210,line,Analoge,LineCode,ALFK2,line,LineCode,ALFK2

STATUS,00607700,line,status,LineCode,ALFK3,line,LineCode,ALFK3

ANALOG,00607210,line,Analoge,LineCode,ALFK3,line,LineCode,ALFK3

STATUS,00606700,line,status,LineCode,ALFK4,line,LineCode,ALFK4

ANALOG,00606210,line,Analoge,LineCode,ALFK4,line,LineCode,ALFK4

######FRD########

STATUS,02312700,line,status,LineCode,FRDK1,line,LineCode,FRDK1

ANALOG,02312210,line,Analoge,LineCode,FRDK1,line,LineCode,FRDK1

STATUS,02311700,line,status,LineCode,FRDK2,line,LineCode,FRDK2

ANALOG,02311210,line,Analoge,LineCode,FRDK2,line,LineCode,FRDK2

STATUS,02309700,line,status,LineCode,FRDK3,line,LineCode,FRDK3

ANALOG,02309210,line,Analoge,LineCode,FRDK3,line,LineCode,FRDK3

STATUS,02306700,line,status,LineCode,FRDK4,line,LineCode,FRDK4

ANALOG,02306210,line,Analoge,LineCode,FRDK4,line,LineCode,FRDK4

STATUS,02305700,line,status,LineCode,FRDK5,line,LineCode,FRDK5

ANALOG,02305210,line,Analoge,LineCode,FRDK5,line,LineCode,FRDK5

######MAM########

STATUS,02612700,line,status,LineCode,MAMK1,line,LineCode,MAMK1

ANALOG,02612210,line,Analoge,LineCode,MAMK1,line,LineCode,MAMK1

STATUS,02609700,line,status,LineCode,MAMK2,line,LineCode,MAMK2

ANALOG,02609210,line,Analoge,LineCode,MAMK2,line,LineCode,MAMK2

STATUS,02606700,line,status,LineCode,MAMK3,line,LineCode,MAMK3

ANALOG,02606210,line,Analoge,LineCode,MAMK3,line,LineCode,MAMK3

STATUS,02602700,line,status,LineCode,MAMK4,line,LineCode,MAMK4

ANALOG,02602210,line,Analoge,LineCode,MAMK4,line,LineCode,MAMK4