INTEGRATED GIS AND SCADA SYSTEM MODEL FOR ALEXANDRIA ELECTRICITY DISTRIBUTION COMPANY

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ABSTRACT

Alexandria Electricity Distribution Company (AEDC) is the electrical power distributor in Alexandria governorate in *Egypt. The nominal medium operating voltage is 11KV.Seeking efficient methods for managing MV network assets, AEDC installed SCADA/DMS system in 1998.The system runs on UNIX using DEC Alpha servers with Sybase SQL backend. It is implemented to the key sections of distribution network. Additionally, AEDC installed Esri's ArcGIS in 2002 separately, running on Windows platform and connected to Oracle database. The geodatabase presents the spatial information of the MV networks efficiently. Both systems are isolated from each other. Data is maintained and accessible to only those who use these systems, leading to data redundancy and systems out of synchronization.*

It is crucial for SCADA staff to operate on the MV network with a geographical context for better explaining events, predicting outcomes and planning strategies, meanwhile GIS staff needs to operate while knowing the current status of the network in real-time. This situation has raised the need of integrating both systems.

The data mapping from SCADA to GIS was a challenging job, facing several technical and non-technical issues. Several approaches were held for integrating both systems before implementing the most efficient and economical one. The integrated system allows users to easily manage both spatial and non-spatial data and interact with multiple databases.

This paper explains the need, the approaches made with the evaluation and analysis of the implemented system and its benefits. It shows how the integrated GIS/SCADA/DMS system serves as a low-cost effective asset management system that improves the MV network efficiency, helps to reduce operational costs and down time, and increases the value of the information resources and decision processes.

INTRODUCTION

Alexandria Electricity Distribution Company (AEDC) is the electrical power distributor in Alexandria governorate. Alexandria lies on the North West Coast of Egypt. Alexandria covers an area of 2819 Km^2

AEDC has 8 maintenance centres for making the necessary switching operations, detecting the faulty cables or lines and restoring supply again. Each centre is located in the centre of load area under its control. The nature of occupied areas, traffic jam or long distances from maintenance centres to many faulty locations, causes delay of supply restoration under manual operation system.

SCADA SYSTEM IN AEDC

AEDC installed SCADA/DMS system in 1998. Applying SCADA system on all kiosks is required but the cost is so high. To get better results with lower cost, SCADA system was applied only on 200 kiosks as a pilot project. The system runs on UNIX using DEC Alpha servers with Sybase SQL backend. It consists of three Distribution Control Centres (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 transformer points. Remote Tele-metering Unit (RTU) are placed for each S/S (24 S/Ss), DP (104 DPs) and Pole mounted RTU (PRTU) for each kiosk from the selected group (200 Kiosks).

Additionally, a Supervisory Control Centre (SCC), located at the main branch of the company, is responsible for overall monitoring of the entire Alexandria 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.

Fig.1 Network Representation in SCADA

The system provides the following data:

- **Equipment Parameter Data**
  - The Schematic diagram for Sub-stations, Distribution Points and kiosks.
  - Power transformer rating, Impedance etc.
  - Bus bar scheme.
  - Circuit breakers and Switches types & ratings.
  - CTs and PTs.
  - MV Cables locations and specifications.

- **Operational parameters**
  - 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.

GIS SYSTEM IN AEDC

AEDC installed ESRI's GIS software to manage its electric power facility in 2002. 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 Oracle database. The geodatabase presents the spatial information of the MV network efficiently.
The GIS system is totally isolated from SCADA.

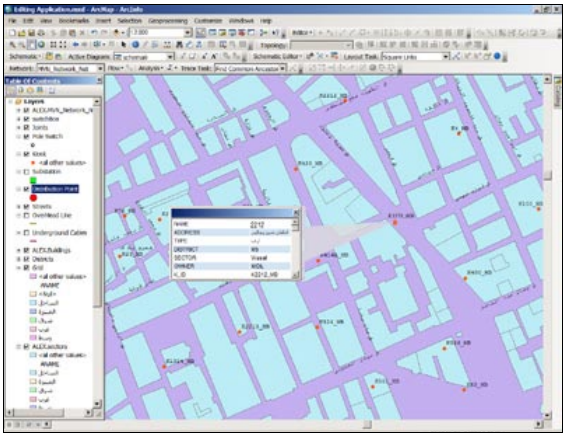

Fig.2 Network Representation in GIS

The data available from ArcGIS:

- **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.
- **Land Base Data**:
  Building, Roads, Landmarks, Railway Lines etc.

GIS mapping proved to be a very useful tool in decision making.

- Reduced the need of site surveys for preparation of new network connections.
- Power Distribution Network interpreted spatially.
- Easy and speedy retrieval of information.
- Improved management of the network assets.
- Better Preventive maintenance.

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Feature	SCADA	GIS
Live System Availability	**yes**	**no**
Real Time Data Management	**yes**	**no**
Spatial Data Representation	**no**	**yes**

Table 1 SCADA and GIS Features Comparison

Seeking for a solution, we were having three options for integrating SCADA and GIS

- Building an integrated system within the SCADA system.
  We found that this solution may affect the SCADA system integrity and security, also the current hardware and the software versions will not handle the huge spatial data propagation.
- Building middleware software to integrate both applications.
  This solution raised several issues related to authorization and authentication.
- Building an integrated system within the GIS System.
  This solution is manageable since the current GIS server can handle the SCADA data and we don't compromise SCADA integrity and security.

SCADA/DMS AND GIS INTEGRATION

The integration process of SCADA and GIS was a challenging job, due to several technical and non-technical issues.

Some of the major obstacles and its remedies in the integration process were:

1- The SCADA system network is completely isolated from the internal network of the GIS department.
   The implementation process started with connecting a windows PC located at SCC with two local area networks (LAN A and LAN B), where LAN A represents SCADA network and LAN B represents the GIS network. The PC serves as a center point that can easily access both the SCADA database server and the Esri's ArcGIS server.
   SCADA staff at SCC can simply log into the ArcGIS system through the connected PC that is running windows where ArcView is installed and can easily access ArcGIS maps and schematics of the MV network.
2- The current Sybase version used by SCADA system cannot interact directly to ArcGIS server, thus we developed a process, using cron jobs, to replicate data from the SCADA alarms and events database to a file database internally in XML format, where Esri's ArcGIS server can access as an additional resource, a geodatabase file, defined in ArcCatalog. This also guarantees that the GIS/SCADA integration will not affect the SCADA operations.
3- There is a lag between the real time SCADA and viewing that information in the GIS system, so we reduced the propagated data to high priority alarms and major network components status.
4- There were conflicts between the naming conventions of MV network components like Cables, kiosks. This issue is eliminated by unifying the tagging of the network components.

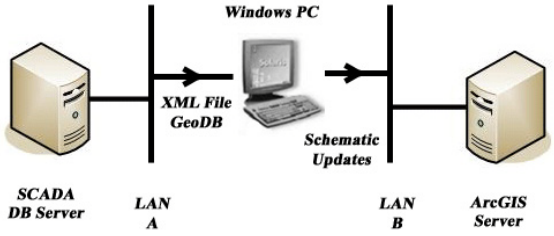

Fig.3 SCADA/DMS & GIS integration System Configuration

The implementation process takes advantage of Esri's ArcGIS Schematics software extension that can digest the XML geodatabase and update its diagrams accordingly. By using ArcGIS schematics, we are able to obtain logical views of MV network layout (Single line diagrams). GIS staff can create easy-to-read multilevel representations (geographic, geoschematic, and schematic) of MV network. Since Arc Schematics can integrate data from geodatabases and other databases within a single session, we configured the ArcGIS Schematics to get the necessary updates periodically from the resulting SCADA XML files.
Schematic diagrams can be generated from XML files/streams that follow the XML Schema definition for the MV network schematic diagrams. We have also used query-based diagrams. These diagrams are based on data that does not participate in a geometric network but identify the connectivity between network components and provide views for inside substations, distribution points and kiosks. Partial updates to schematics can be done easily in situations where full synchronization is unnecessary and time consuming.

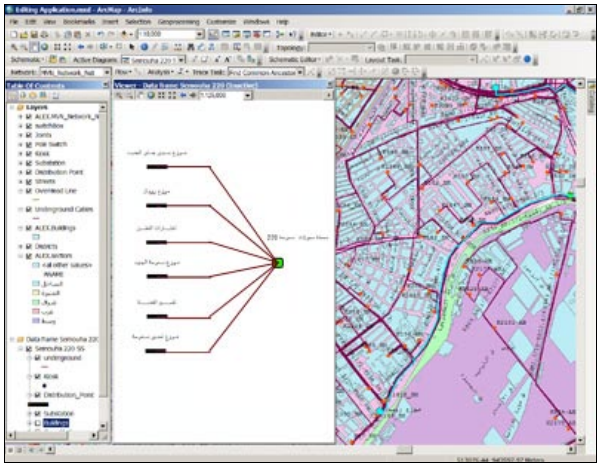

Fig.4 Arc Schematics representation of Semoha220 SS

RESULTS AND FUTURE WORK

GIS integration with SCADA/DMS system required a considerable investment in software development and faced many challenges. The data integration of both systems provides a low-cost effective asset management tool.

In case of outages, operation engineers and field technicians consumed a lot of time performing maintenance activities at multiple locations. Accessing GIS, it helps them to optimize the switching order plan to a more efficient route to the designated locations, thus reducing maintenance time, supply restoration time and increasing the efficiency of the available work force.

The improvement in reliability of supply through much quicker faults' identification, isolation and restoration helps in better customers' relation.

Additional business improvements are revealed with the real time SCADA data available along with critical data maintained by GIS. Since many departments of the company are working separately and seeking specific information from each other, time and money is saved. Thus the overall maintenance and support cost would be considerably reduced.

Integrating both systems has also eliminated the MV network data conflicts and redundancy in both systems that occurred when acting separately. It helps in dividing the responsibility of ownership of data, maintaining the accuracy and integrity of the information between these systems.

Managers and Decision makers can now quickly access to the most real time, latest & accurate data. The integration helps in providing intelligent reports to them and helps providing speedy feedback to customers when problems arise.

Future work includes the potential of being extended and integrated with the company's various power distribution software systems as Trouble Call, Customer Information and Billing Departments.

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