



**SUDAN UNIVERSITY OF SCIENCE AND  
TECHNOLOGY**



**COLLEGE OF GRADUATE STUDIES**

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

تكامـل نظم الاشراف والمراقبة ونظم المعلومات الجغرافية وخدمات  
الزبائن لتخطيط وادارة توزيع الطاقة الكهربائية

A thesis submitted for the degree of Doctor of Philosophy in Computer  
Science

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## DEDICATION

*This thesis is dedicated to my Parents,  
Brothers,  
Sisters*

*To my Wife, daughters*

*For their endless love, support and encouragement*

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# ABSTRACT

In electrical power distribution systems the traditional methods cannot detect the customer fault location in real time and respond to customer complaints at the same time of the outage of the electric power, because the required information is scattered among isolated databases.

In this thesis, the combination of Supervisory Control and Data Acquisition (SCADA) and Geographical Information System (GIS) with the CALL CENTER solve the problem, in particular using SCADA parameters and GIS features that using Single Line Diagram (SLD) has been shown to solve this problem.

The model suggested in this thesis reduced the response time of the customer waiting when the customers called the agent in the CALL CENTER. The model enables the integration of real time data in SCADA system real time database and static data in the GIS database, hence GIS data is made available online and is sent to the CALL CENTER instantaneously. The prototype of the model describes the flow of the data between various systems and integrates all in one logical database that contains all data about the customers. The model depends on three major sub-systems: GIS, SCADA, and Call Center systems. The GIS is the base of the model so it has been designed to accommodate the changes and the update of the integrated systems. It provides different features like maps, real coordinates and tables. The model contains three different databases, GIS as geodatabase, SCADA as the real time database and Call center as customer information database. All databases will be integrated in one logical global database that contains spatial information tables, asset information tables, topology information tables, and operation information tables. This method has been shown to significantly improve the accuracy and efficiency of fault detection in distribution networks and to decrease the response time in call centers.

## المستخلص

الاعتماد علي الطرق التقليدية في أنظمة توزيع الطاقة الكهربائية لا يمكن من الكشف عن موقع الاعطال الخاصة بالزبائن في الوقت المناسب، والاستجابة لشكاوى العملاء في نفس الوقت من انقطاع الطاقة الكهربائية وذلك بسبب عدم توفر المعلومات في لحظة العطل في مكان واحد. هذا البحث يوضح ان عملية ربط أنظمة التحكم والمراقبة بنظام المعلومات الجغرافية يساهم في حل هذه المشكلة . وايضا نجد ان عملية ربط النظامين مع نظام مركز خدمات الزبائن يعمل علي تقليل زمن الانتظار والرد بصورة اسرع للزبون. في هذه الرسالة تم بناء نموذج لتكامل البيانات في الوقت الحقيقي بين بيانات تعتمد فعليا علي الزمن مع بيانات ثابتة في نظم المعلومات الجغرافية للتمكن من تحديد الموقع حقيقي للزبون في الزمن المناسب للزبون المتصل ب الرد الالي في مركز خدمات الزبائن . يصف النموذج المقدم تدفق البيانات بين الأنظمة الثلاثة نظام التحكم ونظام المعلومات الجغرافي ونظام معلومات الزبائن ودمجها منطقيا في قاعدة بيانات متكاملة. نظام GIS هو قاعدة النموذج الاساسية لذا تم تصميم قاعدة البيانات الجغرافية بصورة مرنة تستوعب كل التغيرات في النظام من تغيير وتحديث الجغرافية . ويقدم النموذج قاعدة بيانات متكاملة تشتمل علي بيانات من انواع متعددة مثل الخرائط والإحداثيات الحقيقية من نظام المعلومات الجغرافي وبيانات الاشارات لحدوث الاعطال من المحطات في الزمن الحقيقي من نظام التحكم والاشراف. وقد تبين أن هذه الطريقة إلى حد كبير تساعد في تحسين دقة وكفاءة الكشف عن خطأ في شبكات التوزيع وتقليل زمن الاستجابة للزبائن في مركز خدمات الزبائن.

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## **LIST OF ABBREVIATIONS**

SCADA	<b>Supervisory Control and Data Acquisition</b>
GIS	<b>Geographical Information System</b>
AMR	<b>Automatic Meter Reading.</b>
DA	<b>Distribution Automation.</b>
IT	<b>Information Technology.</b>
MDM	<b>Meter Data Management.</b>
ESB	<b>Enterprise Service Bus.</b>
ERP	<b>Enterprise Resource Planning</b>
ESRI	<b>Environmental Systems Research Institute</b>
SAP	<b>Systems, Applications &amp; Products.</b>
EAI	<b>Enterprise Application Integrators.</b>
AM/FM	<b>Automated Mapping, Facilities Management.</b>
PLC	<b>Programmable Logic Controllers.</b>
RTU	<b>Remote Terminal Units.</b>
PSN	<b>Public Switched Network.</b>
LAN	<b>Local Area Network.</b>
RTDB	<b>Real-Time DataBase</b>
OMS	<b>Outage Management System</b>
DMS	<b>Distribution Management System</b>

TCS	<b>Trouble Call System.</b>
CIS	<b>Customer Information System</b>
AMS	<b>Asset Management System</b>
EMS	<b>Energy Management System</b>
AMI	<b>Advanced Metering Infrastructure</b>
BPI	<b>Business Process Integration</b>
EII	<b>Enterprise Information Integration</b>
DCC	<b>Distribution Control Centers</b>
SEDC	<b>Sudanese Electrical Distribution Company</b>
SLD	<b>Single Line Diagram</b>