Investigating the preparedness for Adaptive SCADA for efficiencies in energy utility companies

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ABSTRACT

Current level of systems monitoring & strategic data mining in distribution of electrical power can be reorganized & restructured with a new understanding of ICT. The short comings of the current level of practicing using SCADA system encounter many of bottlenecks which need to be resolved with newer innovations. This paper is essentially investigating the current level of inefficiencies in practicing SCADA system for strategizing power distribution and creating a conceptual model for futuristic ICT integrated adaptive / self learning system. New power system   or stability has risen for system operators all around the world. So t strategies in SCADA.

Keywords : Adaptive SCADA, DMS, AMR, GIS

1 INTRODUCTION

Electrical utility companies are using three steps Generation, Transmission and Distribution, where Generation and Transmission are fully automated but Distribution requires special attention as it has many bottlenecks like: Last mile reliability, Huge no. of elements, Feed complexity, Theft, Revenue collection.

Public/private sectors like MSEB, Reliance energy etc. are using SCADA technology to automate the distribution process.

SCADA a Supervisory Control and Data Acquisition System is a widely used application in various industries including electric utility industry. SCADA

control center performs centralized monitoring and control for field sites over long-distance communications networks, including monitoring alarms and processing status data. Based on information received from remote stations, automated or operator-driven supervisory commands can be pushed to remote station control devices, these Field devices control local operations such as opening and closing valves and breakers, collecting data from sensor systems, and monitoring the local environment for alarm conditions. Although it is a widely used application, SCADA requirements within the electric utility industry for remote control of substations and generation facilities have probably been the driving force for modern SCADA systems.

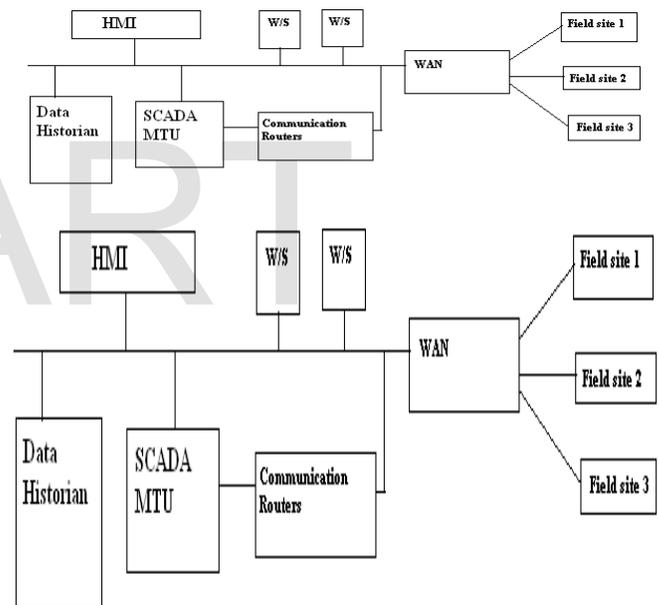Fig. 1 shows the components and general configuration of a SCADA system[1].

Fig 1: SCADA Architecture

The control center contains the SCADA Server (MTU), the communications routers, the human machine interface (HMI), engineering workstations, and the data historian, which are all connected by a LAN. The Control center collects and logs information gathered by the field sites. Field sites are often equipped with a remote access capability to allow field operators to perform remote diagnostics and repairs usually over a separate dial up modem or WAN connection which performs local control of actuators and monitors sensors. This information will be passed to the HMI, and actions based upon detected events are generated. The control center is also responsible for centralized alarming, trend analyses, and reporting. Standard and proprietary communication protocols running over serial communications are used to transport information between the control center and field sites using telemetry techniques such as telephone line, cable, fiber, and radio

frequency such as broadcast, microwave and satellite [4].

SCADA Hardware

SCADA Systems usually have Distributed Control System components. RTUs or PLCs are also commonly used; they are capable of autonomously executing simple logic processes without a master computer controlling it.

SCADA Software

SCADA software can be divided into proprietary type or open type. Proprietary software are developed and designed for the specific hardware and are usually sold together. Open software systems are designed to communicate and control different types of hardware. It is popular because of the interoperability they bring to the system.

This paper is summarized as follows: in section 2 we have analyzed certain bottlenecks in current SCADA systems, further in section 3 we have discussed about current innovations in the technology, in section 4 we have discussed about how SCADA can be integrated with GIS,AMR and DMS. In section 5 we have suggested an adaptive SCADA model with ICT like data mining and neural network. Finally we have concluded the paper in section 6.

2 BOTTLENECKS IN CURRENT SCADA:

- The main problem with the proprietary software of the SCADA systems is the overwhelming reliance on the supplier of the system.
- The data model of SCADA is designed keeping in mind the power system's operation in real time basis. Every signal (alarm, status, analog value) is modeled as an object in SCADA. Updating all these data structures is a big challenge.
- SCADA follows the naming convention system which is generally based on the position of the object in Network configuration. So integration with other systems would be an issue as the mapping of objects to newer technologies would be a serious issue.
- Data maintenance, a vital part of any distribution company operation, requires keeping the data model updated always. With the huge & complex electrical distribution network consisting of many sources, feeders, alternate feeding points; updating and management of network data is a Herculean task.
- The data model of SCADA/DMS is designed keeping in mind the power system's operation in real time basis. With network expansion, maintenance and equipment upgrades, this becomes a challenging task. Incremental update in SCADA network should reflect in each of its components.
- The Electrical utility companies in India are facing problems due to high energy losses in distribution and transmission, 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. So there is a need for better technical and reliable development tools which has to be integrated with SCADA.
- It should serve as both a historical database showing the entire distribution pattern of an energy system and a forward-looking scenario-based tool that can create forecasts of how a system might distribute or "backcasts" that examine how a society might try to meet its distribution goals in the energy sector.
- We need structured distributing energy system. Emphasis should be on creating data structures and scenarios and entering all of the data describing both historical years and forward-looking scenarios. The data structure should support standard operations that simplify the construction and maintenance of data in an energy analysis. These data structures should be designed in such a way that it could afford a great deal of flexibility in modeling a system.
- We may also need for a system that supports multi-regional analyses in which different data structures can be created for each region. For example, some countries might be described in more detail where data are available or where important issues need to be addressed.
- SCADA users often need ready access to comprehensive and up-to-date data describing energy technologies. Such data are spread across a range of sources, which are not easily accessible. To address this problem, a system which includes a Technology and Environmental Database (TED) that describes the technical characteristics, costs and environmental impacts of a range of energy technologies including existing technologies, current best practices and next generation devices is needed. This database includes data on hundreds of technologies, referencing reports by dozens of institutions including the different Energy Providers, Indian Meteorological Department (IMD), and the International Energy Agency. In addition to its quantitative data, TED[5] also includes qualitative information pages that review the availability, appropriateness, cost-effectiveness and key environmental issues for a wide range of energy technologies. TED's own core database of distribution factors can be edited or supplemented by a user's own data.
- SCADA supports operational improvements by using online network by providing planned switching orders and load flow analysis, only to a small extent. So SCADA need a real time basis system, to monitor, control, and optimize the performance of the distribution system.
- Each electrical network has a geographical reference, which has to be mapped in a unique way to enable fast, accurate & unique presentation of network data. This increases operational efficiency, improvement in policy design, decision making, communication, and dissemination of information. Integrated GIS system with the help of its unique prediction engine can identify the most probable part in electrical network along with the location of problem immediately.
- SCADA needs better utility to access the latest and

accurate information from the metering devices which provides savings in time, manpower, and helps efficiency and energy management

3 INNOVATIONS

Currently electricity utility companies like MSEB are using new innovative technologies for efficient functioning. It also takes care of meter tampering issues, decisions regarding power leasing, and consumer satisfaction.

Prepaid meters is a technology in which consumer can take the coupon of the desired amount for the electricity usage in advance. This leads to various advantages like[7]:

- Elimination of cost involved in connection and disconnection.
- cash flow improved as Electricity paid for before use.
- Consumer can budget and manage the electricity more effectively.
- Convenience of electricity purchases
- No billing estimates
- Payment for used power only

It also has some disadvantages like

- Prepaid meters require more maintenance
- Regular inspections have to be carried out on metering installations

AMR (Automatic Meter reading) is a technology in which meter with modem and GSM technology is installed at consumer's premise and meter data mgmt software captures data from meter over the network.
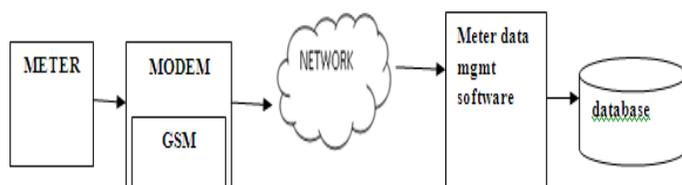

Fig 2: AMR

AMR as shown in fig. 2 gives various benefits like[8]

- Ability to detect tamper events and outage occurrences.
- Remotely Connect/ Disconnect power supply through meter.
- Calculate transformer loading and sizing from interval data
- 15 minute interval data gives accurate load information for supply scheduling, switching operations, planning etc
- Monitor voltage at each premise to know conditions when to operate capacitor switches or regulators
- Consistent and granular data for improved accuracy

4 INTEGRATION OF SCADA WITH DMS, AMR AND GIS

DMS when integrated with SCADA gathers real time information, such as status of switching devices, information of fault occurred in an electrical distribution system. It transfers information from home station to a control center & vice versa and carries out necessary analysis and control & displaying the information. It introduce a certain measure of automation in to the distribution system.

- Complete automation of distribution network is not possible as it requires implementation of SCADA/DMS[2] at every section of distribution system, which is quite expensive. Hence getting real time data from SCADA/DMS for all parts of distribution network is not possible. This problem can be overcome by the integration of GIS with AMR as explained earlier.
- Normally the Metering data from AMR is available to Billing personal. This data is not available to other employees directly. Once integrated AMR with GIS, every employee can have access to AMR data through GIS application.
- AMR data is helpful to detect leaks in distribution system, with the help of GIS the same can be viewed with the land base, analyzed & can be used to plan & take necessary measure.
- Data requirement for various users could be - Real time data from SCADA/DMS, energy consumption data from AMR, Consumer data from ISU-CCS, complete network data from GIS. As can be seen, the data requirement is very voluminous. This data has to be stored, retrieved and used by many different people at different locations for various purposes. If data has to be handled manually, then it is very likely that the data may get displaced or destroyed. No system can use as substitute for another system. Hence integration strategy/techniques are required to exchange data from different systems. Though SCADA, DMS are used in business operations on real time basis, GIS as asset management, the organization should think in the direction of using all these systems as integrated one to manifold their advantages.
- Integrated GIS may be easier and less costly to support. There is no such requirement of having proprietary hardware, software platform, and special skills for GIS implementation. By virtue of openness of GIS, interoperability is easily possible with other systems[3].

5 ADAPTIVE SCADA

The challenging issues for SCADA systems and projects today are not the same as they were a few years ago. Today, there is much more importance placed on integration, use of new communication and network technologies, access to information by more users, and other purposes. So the SCADA

systems has to be adaptive in responding to changing business needs, and should act as an aid for strategic advancements towards interactive, self healing smart grids of the future.So adaptive SCADA should have prediction and optimization to adapt to the recent changes in the business needs as shown in fig 3.
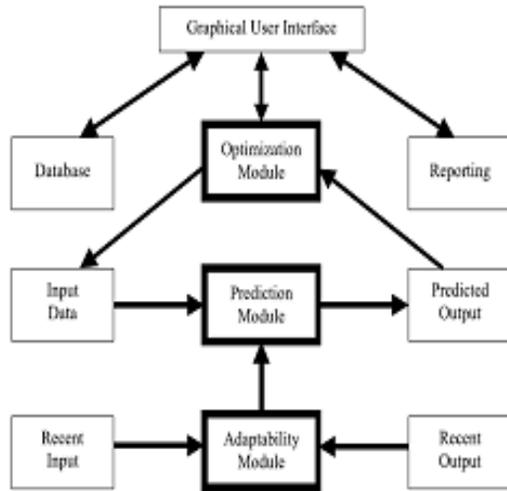

Fig 3: Adaptive SCADA

The figure 4 shows the architecture of Adaptive SCADA Distribution System. **Master terminal unit (MTU)** acts as a client system that gathers data locally and transmits it to the **Remote Terminal Unit(RTU),** which is the central component that brings adaptiveness to the entire distribution system.RTU has Adaptive Intelligence system that includes data mining, predictive modeling and forecasting using artificial neural networks, scheduling and optimization to solve real-world problems that have: complex constraints, Time-changing environments, several (possibly conflicting) objectives, the large number of possible solutions to enumerate. The output from RTU is passed to **Field control systems** which have a direct interface to field data elements such as sensors, pumps, and switches.
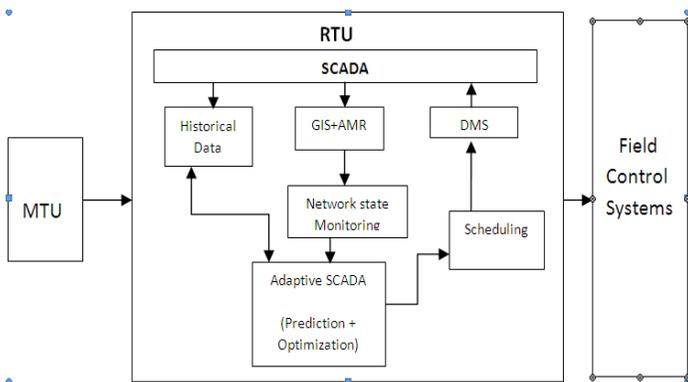

Fig 4: Adaptive SCADA Architecture

An adaptive SCADA[6] system can be a strategic investment which is needed for utilities of all sizes facing the challenges of the competitive market and increased levels of real time data exchange that comes with it.

In this paper we suggest an adaptive SCADA system to achieve new levels in electric grid reliability, Proactive problem detection and resolution, Meeting the mandated power quality requirements, and Real time strategic decision making. The adaptiveness can be added by using Neural Network as shown in fig 5.
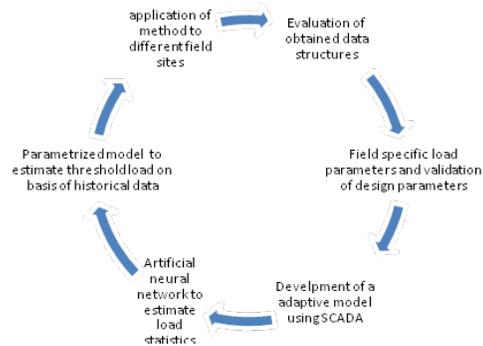

Fig 5: Adaptive SCADA using neural network

The process of updating the adaptive module should repeat at regular intervals. Field specific load parameters should be encoded into data structure of the individual solutions and should undergo variation(mutation and cross over).The better values of these encoded parameters lead to better solutions, which inurn are more likely to survive and produce offspring solutions. By automating this process, new data can be fed in quite frequently (i.e. the end of each business day).If a new pattern emerges; an updated model can capture it immediately.

6 CONCLUSION

The given economic, social and quality-of-life aspects and the interdependencies among infrastructures call for a modern power grid with an upgraded SCADA system.

The usage of adaptive SCADA/DMS is one of the most powerful tools for wide-area distribution and control since it uses current system conditions to predict potential problems ahead of time. SCADA/DMS when integrated with AMR and GIS will bring IT revolution into power distribution business[9].

7 FUTURE SCOPE

In future SCADA can be integrated with 3D GIS to create three-dimensional maps for analysis of future paths. This ex-

tension can be an excellent tool for analyzing SCADA in electricity distribution paths.

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