ENHANCING CUSTOMER SATISFACTION AND OPERATIONAL EXCELLENCE BY DEPLOYING AN INTEGRATED DISTRIBUTION MANAGEMENT SYSTEM (IDMS) AT STEDIN

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ABSTRACT

Electric distribution utilities are continuously investigating opportunities and solutions to enhance customer satisfaction, and reduce operational costs whilst supplying electricity reliably and securely. To accomplish this, distribution utilities have been investing in making their distribution grids smarter with new hardware technology and software platforms, while also re-engineering core operational business processes for improved efficiency. This paper will address distribution operational challenges and technology solutions being deployed at Stedin in the Netherlands. The paper will also describe some of the organizational challenges and potential solutions in deploying smart grid technologies.

INTRODUCTION

Innovations in technology and regulatory incentives including fostering public-private partnerships have led to significant growth in Smart Grid pilots and deployments globally over the last few years.

A primary Smart Grid driver is utility costs savings in distribution operations for the detection and isolation of faults, for faster customer service restoration. Fault information from distribution automation and field devices provide information to better locate faults and to automatically restore healthy portions of the distribution grid. Recent deployments of smart metering provide an alternative data source to detect unplanned outages. For the distribution grid sections that do require manual intervention, the information above can help guide field crews to the fault location, instead of having them locate faults manually. This reduces fuel costs and carbon emissions from crew trucks, and also reduces customer outage times, thus improving grid reliability and potentially avoiding regulatory penalties.

Another key Smart Grid driver is improving utilization of the existing distribution networks for serving peak load growth and thus deferring additional capital expenditure on distribution grid upgrades or generation capacity additions. This is being accomplished by advanced asset optimization (including on-line condition monitoring), optimizing feeder voltages for enhanced network performance and through feeder switching and reconfiguration.

The Smart Grid is also redefining the way energy is generated and consumed in distribution grids. The deployment of Distributed Energy Resources (DER) including distributed generation (solar photo-voltaic, etc.), energy storage (batteries), electric vehicle charging infrastructure and demand response introduces new levels of complexity in distribution grid operations [1].

To meet these challenges, Stedin has develop a strategic plan around Smart Distribution with five key themes focused on their customers; (1) higher customer satisfaction through better service and very fast predictable information, (2) improved efficiency, network safety and reliability, (3) outsourcing, (4) innovation, and (5) transition towards sustainability as mandated by the EU 20/20/20 targets through the implementation of Smart Grids [2]. Stedin manages the distribution grid for 2.1 million customers including the Rotterdam Harbour, with 45,171 km of electricity cables. Stedin has approximately 650 medium voltage interruptions annually and a SAIDI of 24.7 minutes.

Figure 1. Stedin Coverage Area in the Netherlands

Stedin has begun a holistic plan to invest in new distribution automation technologies including the deployment of an Integrated Distribution Management System (IDMS). The IDMS provides a software platform with advanced grid optimization and self-healing applications for improving customer satisfaction, and enhanced situational awareness for Stedin’s distribution control rooms. The following sections will describe Stedin’s IDMS business case, strategy, plans and lessons learnt.

STEDIN BUSINESS CASE

Stedin's business case for the IDMS implementation is focused on enhancing network safety and improving the quality of operating the medium voltage network. The IDMS also provides an important step for Stedin to continue to improve customer satisfaction. Stedin's efforts in improving transparency (information sharing) with their customers and fostering an open organization are at the core of their efforts to improve grid reliability and reduce Customer Minutes Lost (CML). Stedin's goal is to continue to reduce CML, which is currently 110 minutes in their medium-voltage network. Figure 2 provides the average CML per year in the HV, MV and LV network. The MV network (in red) has the largest contribution to CML, hence Stedin's focus on this for now.

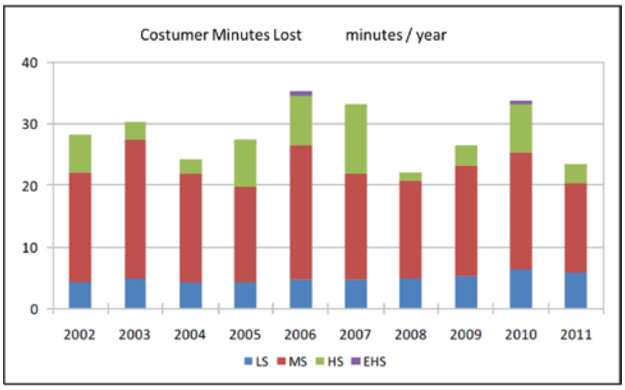

Figure 2. Stedin Average Customer Minutes Lost

A key business process in distribution grid operations is grid switching. As shown in Figure 2, Stedin performs approximately 6000 switching plans annually for maintenance and outage management. Each switching plan takes approximately 90 minutes to be processed, due to the manual nature of the process. With the IDMS, Stedin is targeting a reduction to 30 minutes per switching plan, thus saving over 1 hour per switching plan or approximately 6000 hours per year (750 man-days).

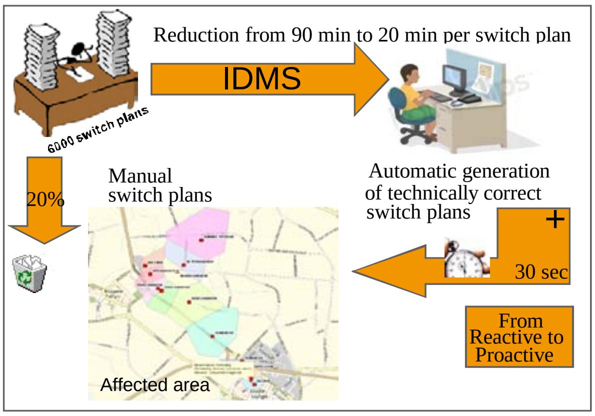

Figure 3. Stedin IDMS Business Case

In the area of network and crew Safety, the IDMS will reduce the possibility of faults in daily switching operations by enabling a more detailed analysis of switching plans (based on electrical characteristics of the network) from the control centre, and enhanced support for the field crew. In the area of Quality, the IDMS provides Stedin dispatchers with a valid set of switching plans that does not violate voltage and flow limits, and protection (relay) settings based on the real-time electrical characteristics and topology of the network.

In the area of Control, the IDMS provides real-time visibility on the status of the network, moving from traditional static distribution schematics to more dynamic schematics. This will also change operations from being reactive to a more proactive approach, and focus Stedin's dispatchers on preventing outages. In the case of an outage, the IDMS will help locate the outage, isolate and resolve it (automatically when possible). Switching plans will be automatically generated, and fault location will be presented on geographic map based displays that are shared with all Stedin's stakeholders.

In summary the main benefits of Stedin's IDMS business case is in the reduction of customer outage times, improved grid reliability, control room efficiency improvement, and reduction in compensation payment for customer outages. The benefits from the IDMS project are complementary with Stedin's smart grid objectives, contributing to customer satisfaction and enhanced safety.

INTEGRATED DMS (IDMS)

Stedin's selection of the IDMS platform was based on the most efficient option to enhance their existing systems with advanced grid optimization applications to accomplish their business objectives, and to be smart grid ready for their roll-out of smart grid devices.

The IDMS platform includes SCADA, distribution network analysis and optimization, and outage management, all sharing a single dynamic network connectivity model and a single comprehensive dispatcher user interface, i.e. a single integrated platform. The IDMS is designed to improve the performance of the distribution dispatchers, enhance their capabilities and allow them to manage the network more effectively, particularly under storm conditions with significant unplanned outages. The IDMS provides a high-performance storm-ready platform, as it is very important that these systems are able to continue operations under severe storm conditions, and not just blue sky conditions.

Figure 4 provides a high-level overview of the key components within the IDMS platform and also key enterprise systems for data integration, which will be described in the following sections.

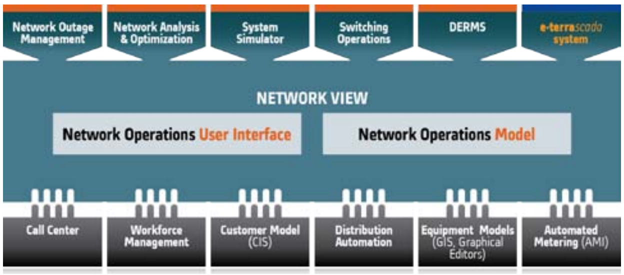

Figure 4. IDMS Modular Components

The Network View module consists of a Network Operations Model combined with a powerful Network Operations user interface, providing the dispatcher with all the key capabilities for viewing and managing the distribution network. The user interface is able to display the Network Operations Model in a range of modes from geographic to schematic or variations.

The Network Analysis module is based on a robust and high performance distribution power flow that allows dispatchers and planning engineers to study the current state of the network, or the expected state in the future. The core analysis engine is the distribution network power flow which supports a fully unbalanced model and is capable of solving for both radial and meshed networks. Network Analysis includes the following analysis functions: Distribution Power Flow, Distribution State Estimation, Power Quality Analysis, Loss Analysis, Short Circuit Analysis and Load Modelling and Forecasting.

The Network Optimizer module provides an enhanced level of analysis that allows the dispatcher to optimize the network configuration and achieve desired goals such as load balancing across feeders and improved feeder voltage profiles. Network Optimizer includes the following analysis functions: Load and Volt/Var Management, Fault Location, Isolation and Service Restoration, Planned Outage Study and Automated Feeder Reconfiguration.

The Switching Operations module supports the process of switching the network and interfaces directly to the Network Operations Model. Switching Orders can be created manually or generated automatically by the Network Optimization functions. Key functionality includes creation, validation and execution of Switching Orders, and Safety Documents.

The Network Outage Management module is a combined Trouble Call and Outage Management System. It allows dispatchers to manage unscheduled and planned network outages from within a unified and integrated environment. From the initial notification of a fault, through prediction, crew assignment, and restoration switching to return-to-normal, the dispatcher is able to work from a single set of user interfaces.

The Network Simulator module utilizes the same software components, interfaces and user interface as the real-time IDMS. The simulator includes simulation for smart meters and customer calls. Dispatchers can be trained in both routine and emergency procedures in an environment that accurately represents the behaviour and response of the real system. In addition, the simulator can be used to validate new network models, business processes such as storm restoration programs, and also includes a replay mode for detailed analysis and training purposes.

The IDMS platform includes standards based web-services for integration with other enterprise IT software using a Service Oriented Architecture (SOA) approach.

PROJECT IMPLEMENTATION

The IDMS project being the first of its kind in Europe, Stedin used a project strategy that was based on an iterative development and prototyping approach to mitigate project uncertainty and risks. The project execution involved primarily Stedin personnel and this ensured that relevant knowledge was acquired within the Stedin enterprise and retained for future support of the system. Stedin kept the scope and complexity on a level that was controllable by the project team through the use of industry standard project management methodologies.

The initial project scope included a subset of the Stedin network operating areas. Once in production the next phase of the project would be to implement all network operating areas within Stedin. This will enable Stedin to flush-out and implement necessary change management processes required within their organization, as the IDMS required changes in distribution operations to accomplish their business objectives.

Stedin implemented a separate Development, Test, Acceptance and Production (DTAP) environment for the project to fully test the IDMS functionality and integration. Within the Stedin enterprise, the IDMS system is integrated with several external systems both in the Information Technology (IT) and Operational technology (OT) domains. The system architecture required considerable IT/OT integration and included comprehensive requirements around IT security. All static asset information for the IDMS is stored and managed in the Geographic Information System (GIS) within the IT domain. This data includes geographic data, schematic data and substation internals. Some of this data was not initially available in the GIS and Stedin implemented procedures and functions to ensure that the GIS was the only source for all static data (single source of truth). Additional interfaces from external systems were developed to the GIS for storing this data within the GIS. The only exception to this was background layer data which is sourced separately.

Figure 5 shows the data extraction process from the GIS and the creation of both schematics and geographic layers. The extractions process includes multiple levels of model validation and error checking to ensure that the network model is suitable for the IDMS advanced applications. All dynamic data is delivered from the SCADA systems to the IDMS. There is only one interface from IDMS outwards to an external system which is for the workflow application used by both Stedin and service provider personnel.

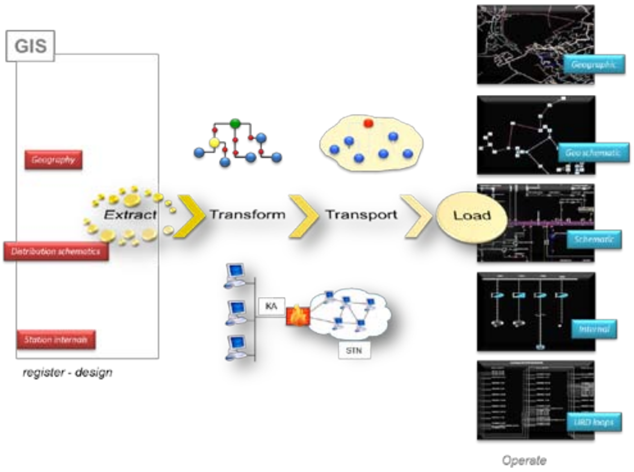

Figure 5. GIS to IDMS Model Management

Since the IDMS project is not only an IT project, the impact on processes, data quality, and IT/OT integration required strong focus from the beginning. The role of business management was crucial to ensure that business process changes were implemented within the project timeline. Testing is a critical part of the project, not just the IDMS but also all other enterprise systems. Stedin choose to have a dedicated test manager on the project team from the very beginning to ensure that testing was structured and coordinated with all stakeholders.

The main business process required for this project was to improve the process of updating the GIS system. Prior to the project, the GIS system was updated by personnel from the service provider after they had completed work on the network, e.g. after adding a new MV substation. To enable the IDMS to be used effectively for creating switching plans, the process was modified such that a future modification on the network had to be designed in the GIS at least 10 working days before it was moved into production. This modification was then visible and distinguishable in the IDMS graphical user interface as a future planned addition.

Stedin is also utilizing the Distribution Operations Training Simulator (DOTS), which is embedded within the IDMS platform to train operators on live usage, system acceptance and study off-line power flows. The simulator provides the capability for modifying scenarios, not just reviewing pre-recorded events, thus shortening system acceptance time and overall delivery schedule.

SOCIAL MEDIA

Stedin is very active in using social media to communicate with all their stakeholders (including government agencies and regulators) and also with their customers. One of the key benefits of deploying the IDMS is the ability to automatically transfer relevant network and outage information in real-time through social media to communicate with customers.

Stedin's experience to date has been that during an outage, customer satisfaction tends to improve when customers are informed about the cause of the outage and critically the expected restoration time. When Stedin is predictable in communicating the correct restoration time, customer satisfaction has improved significantly [3]. Stedin is also planning on sharing a real-time read-only version of their IDMS with the local safety regions for improved coordination during major storms and other natural disasters. This will enable real-time outages and customer counts to be shared transparently to improve emergency response.

SUMMARY

To continue to meet the challenges of improving customer satisfaction, grid reliability and business efficiency, Stedin has begun to invest in Smart Grid technologies including implementing a comprehensive control room solution using the IDMS platform. A team from different parts of the organization including business operations, IT and OT were chartered and given the tools and support to succeed. The project required a detailed impact analysis of existing processes, systems, data and organization, leading to some re-engineering in existing operational business processes. Stedin is on track to finalize project implementation and process changes, with the aim of going into production in Q2-2013.

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