DISPATCH CENTER OPERATIONAL PERFORMANCE IMPROVEMENT BY CHRONOLOGICAL ANALYSIS AND SIMULATION

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ABSTRACT

The need for a chronological analysis and simulation at the HV Dispatching centers of EDP was reinforced by the new challenges facing network operation such as cost reduction and high DG penetration. Using a software application deployed in EDP for planning purposes (DPlan) proved to be the most effective solution, focusing the development in the interfaces with several databases containing measurement data, CB state data and metering data. However, some attention had to be paid to power estimation due to the existence of limited information in the SCADA system for MV feeders.

The benefits of using the chronological power flow analysis and simulation were made apparent by enabling more weekday works and thus avoiding paid over-time, in training new network operators and in checking the feasibility of contingency plans.

There are plans for future expansion to the MV Dispatching centers and have forecasts of wind power and load to aid in the short term outage planning.

INTRODUCTION

One of the main management vectors for EDP is continuous improvement due to need to continuously lower costs while improving Quality of Service. In this context several improvement opportunities were identified in the field of Network Dispatching Centers. These needed to have better information about the consequences of potential outages in the network at several times of day for planning outages and checking contingency plans.

In this paper the Dispatching center needs are presented as well as the solution found to overcome those needs. The problems found during the process presented. Finally, benefits of the solution are explained and the conclusions drawn.

DISPATCHING CENTER NEEDS

The mainland Portugal sub-transmission (HV) and MV networks are operated by EDP. There are 2 HV dispatch centers and 6 MV dispatching centers to perform real-time tasks and coordinate the field teams. This paper will focus on the HV dispatching centers.

The HV dispatching center's responsibilities are:

- Planning and execution of outages
- Field teams coordination
- Network incident classification
- Response coordination to unplanned outages
- Contingency planning
- HV network operation

After an internal assessment several improvement opportunities were identified. One of these was to have a chronological power flow that would allow:

1. Identifying overloads and over/under voltages resulting from planned outages to transformers and lines and considering DG;
2. Checking the existing contingency plans for loss of a transmission substation;
3. Training new operators to get acquainted with the usual power flows of the network and to simulate events and contingency plans;
4. Forecasting network losses and minimizing them.

The Dispatching center has functioned thus far without using power flow tools due to the difficulty of obtaining present loads from the systems. This has its limitations since it is not possible for the dispatching engineer to have clear notion of the consequences of disconnecting a line in a mesh. Therefore, in order to insure that no overloads would arise from a planned outage, a large number of works were conducted during the weekend, when the loads are lower. Thus resulting in extra expenses for EDP mainly due to paid over-time.

SOLUTIONS

The solution adopted relied upon the existing software already in use for planning at EDP (DPlan), which, has the necessary features for fulfilling the Dispatching centers needs:

1. Chronological power flow for load diagram calculation (thus allowing to select the best time frame for the planned outages);

Figure 1 – Example of a load diagram calculated by the chronological power-flow in DPlan

2. Variety of filters and data visualization that alert to over/under voltages and overloads;

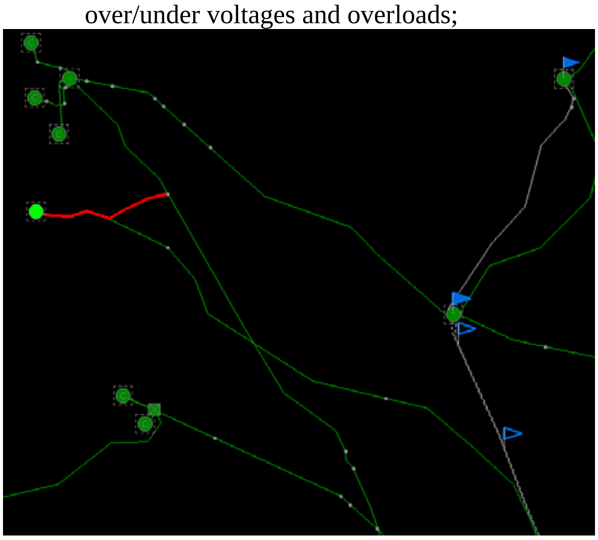

Figure 2 – Example of an overloaded line segment (in red)

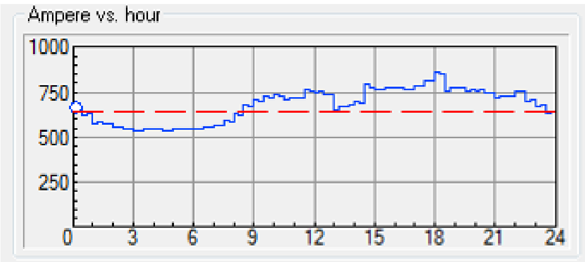

Figure 3 – Example of chronological power flow of the load diagram of line due to a planned outage in another line (notice that between 9h to 24h the line is in overload)

3. Ease of use
4. Internal know-how in EDP about the DPlan.

DPlan has the ability to perform power flows on large networks allowing to deal with the entire EDP HV network. However, network operational requirements are different from planning requirements mainly because of the shorter time horizon of the former. The main differences are:

- The withstand currents of the lines are related mainly to the protection settings and can operate in moderate overload conditions for several hours;
- The foreseeable state of the circuit breakers and other network apparatus must be estimated with the highest possible accuracy;
- Short-term load estimation must be more accurate to reduce the risk of overloads due to planned outages.

Some of the requirements implied that DPlan would have to access automatically high volumes of data. So, it was necessary to share data between DPlan and other existing IT systems.

The option of using DPlan was an economical one since the development of new features was mainly restraint to the access of information stored in several databases.

ACCESS TO INFORMATION

There are several IT systems in EDP from which information can be extracted. These are:

- *BI-SCADA* – Contains the historical data from the SCADA system including feeder currents, busbar voltages, transformer taps, etc.. The updates have a 15 minutes delay.
- *PowerOn* – Contains the state of each breaker in the network including the manual sectionalizers; The updates have less than 1 minute delay.
- *SGI* – Contains energy metering information from DG and HV clients which are not connected to the SCADA system. The delay time is one day.
- *SIT* – GIS with network topology and characteristics. The delay time is one day.

The most critical accesses are performed in through OBDC while the least time critical access (to the SGI database) is performed through FTP.

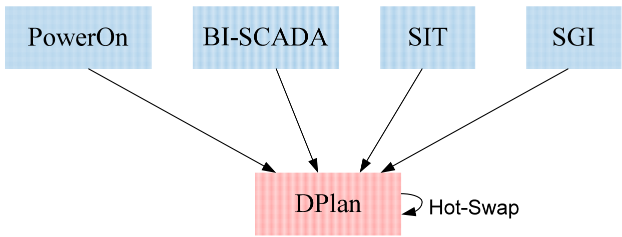

Figure 4 – DPlan data access to the IT databases of EDP

There are two DPlan servers operating in a Hot-Swap scheme (if one fails the other one takes over) to insure redundancy.

PROBLEMS FOUND

The main problems encountered during this project were:

1. The need to strictly follow the cyber-security policies for the BI-SCADA database during the project;
2. To deal with other ongoing projects related with the SCADA system, during the testing phase, which

impacted in the BI-SCADA database;
3. The need to access historical data that cannot be related or that is not coherent with other databases;

All of these problems were solved in an acceptable time frame, although that, inevitably led to delays. However, it was an alert to the fact that the internal structure of the databases may have to change and that the interfaces need to be easily configurable to adapt to those changes.
The usage of SQL queries makes it easier to adapt to changes in the database tables or naming.
Another problem was that the data from most of the feeders was comprised solely of currents. This is due to the fact that older substation's SCADA data was not selected to consider power flow applications. However, this created an added difficulty in determining:

1. Feeder reactive power;
2. Feeder active power reversal due to the presence of DG in the MV network.

This data is very important for having an accurate estimate of the real power flow in the network. However, it was not readily available in most substations therefore an estimation of these values had to be undertaken considering several redundant information:

- Current in the HV/MV transformer
- Busbar voltage
- Upstream Thévenin impedance
- Presence of DG in the feeder

The end result of this estimate was very good since the HV line actual loads were very similar to the estimations performed by DPlan. The differences were negligible.

BENEFITS OBTAINED

DPlan was installed in both Dispatching Centers in two steps. In the first step the connection to *PowerOn* was available and it was possible to access the breakers status. The connection to the measurements database (BI-SCADA) was not immediately functional therefore the option was to load DPlan with the data from the years 2011 and 2010. This allowed the operators to get acquainted with DPlan and make valuable suggestions of their own. It was also possible to start making planned outages and contingency studies because the load decreased from 2011 to 2012 in Portugal due to the effects of the economic crisis.
BI-SCADA's data was made available in December after solving all the operational problems and immediately put to use.
During the project period more than ten planned outages, that would otherwise have to be done during the weekend, were scheduled on weekdays due to the studies made using DPlan. This was translated in an immediate economical gain for EDP.
The contingency plans were also reviewed during this time using DPlan as a tool to check possible overloads and over/under voltages. This resulted in an added confidence in the contingency plans and allowed several minor changes that will enable to feed more clients in the event of a Transmission substation failure.
Several new members were added to the Dispatching centers teams during 2012. These new members were encouraged to start using DPlan which resulted in a speedier network knowledge acquisition process. They performed several planned outage studies and simulated line losses and substation losses which enabled them to understand how the network might behave in a real event. DPlan had an important part in training these new team members.

PLANS FOR THE FUTURE

Due to the success of using chronological power flow in the HV dispatching centers there are plans to extend it to the MV dispatching centers. However, the challenges in the MV side are bigger due to lack of data in the secondary substations. Despite this it should be possible to reach a good estimate for these loads.
Another area that needs to be addressed is DG production estimation, especially wind power. There are already good forecasts for wind so this task is possible.

CONCLUSIONS

Fast chronological power flow analysis has proven to have several advantages to the operation of HV Dispatching centers in Portugal: reduction of paid overtime by safely scheduling works for weekdays; new operator training; contingency plans checks.
These benefits were attained at a low cost due to the fact that most of the needed features were already present in DPlan and the main task was to interface the existing application with the existing databases.

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