HOW TO ZIP A MULTI M€ GIS PROJECT INTO A FEW DOZEN K€?

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ABSTRACT

This paper shows how EDP implemented a Geographical Information project that would cost several million euros with just a few dozen thousand euros. The Low Voltage (LV) and Public Lighting (PL) grids had very poor geographic information detail and it became clear that the company needed better geographic and more detailed information about these grids. However, to make a global project to acquire that information would be too expensive. So, it was necessary to find alternative methods to achieve the company needs. The solution was supported in technology, information and procedure efforts.

INTRODUCTION

The detailed knowledge of the grid and its assets is essential to a Utility company but it could be very expensive to acquire and represent on GIS. However, it is essential to improve activity performance and operations optimization.

To a company like EDP Distribuição, as the Portuguese DSO managing the continental Portuguese territory Electric Distribution Grid, from the High Voltage (HV) and Medium Voltage (MV) to the Low Voltage (LV) and Public Lighting (PL), to acquire and represent all the grid elements requires saving on a Data Base (DB) several millions of points, spread geographically from all over the country. Also the knowledge and resources needed to do it would be very specialized and costly. Considering that, several years ago EDP made a very detailed representation of the HV and MV entire grid and equipment that was very expensive even for a very inferior scale compared to LV and PL grid, it was necessary to find some alternative method. We didn´t start from scratch. Some years ago we migrated the LV information from the former outage management information platform (SGI). This migration gave us the topologic LV grid representation, with the distribution cabinets and the client supply circuit information. This was the basis of the LV and PL project.

METHODOLOGY APPROACH

In order to improve the LV and PL grid geographic information, EDP searched for some simpler and cheapest solution that could still answer the business needs. We've designed a strategy to limit the acquisition information to the essential, supported by a final user survey, and adopted some algorithm based techniques to represent the best approach of the electrical grid.

The LV project strategy was to geo-locate the main elements: LV distribution cabinets and Customer Delivery Points (DP). We splitted the project in two parts, one to get the correct geographic information of the LV distribution cabinets and the other to get the geographical information of the DPs. For the DPs we tried to automate the most of the process with firstly a Geocoding process and a second step to acquire the remaining DP geographic information.

For acquiring the PL information several techniques were explored but a simple and quick android application was proved to be the best solution.

LV GRID CABINETS GEOLOCATION

To geo-locate the cabinets we've done a one year massive field campaign where maintenance crews with portable devices identified the exact location of the cabinets on a digital map, assisted by GPS and vector maps. This was made with our GIS (Geographic Information System) mobile tool on a simple way, ignoring the path representation of the grid associated to the cabinets. Why? Because updating the path would be very laborious and time consuming and could compromise the entire campaign. The update process was made by a special tool developed on the corporate GIS that imported the file from mobile devices and moved the LV cabinet to the new location, assuring all the electric and logical connections. This step just updated connections with straight lines between cabinets. The improvement path representation of the connections will be made at the end of the project by an algorithm, when LV DP are imported with the geographic information updated. However, there are constantly grid extension field works being done and some maintenance that requires GIS representation updates. In these particular cases, users update manually the entire information of that particular intervention zone and it will be preserved later on the automated process.

DELIVERY POINTS (DP) GEOLOCATION

There are a few regions where almost the entire LV grid is already represented correctly in GIS. There are also some recent DP with accurate geographic information in GIS. As previously referred, some field works had recently updated all the grid geographic information of a narrow

zone. The existence of these very distinct situations create some difficulty to the process automation, because the algorithms to be used have to be instructed to preserve grid manually updated and update only the wrong information, which is mixed geographically with the accurate information.

Geocoding

If addresses are available, the quickest and cheapest way to have geographic information is to use a Geocoding tool. We used the customer's address from our technical information database. To simplify the process we ran a Geocoding tool to all our customer database, regardless if we had or not already the correct position of customers DPs. The project was very well succeeded, despite we had some Quality of Information problems, with lack of house numbering and some old street names. Also the Geocoding database didn't have information of some rural areas. For all of these aspects we've been well succeeded on half of the overall DPs that is very positive because now we just need the information from the other half of the DPs!

Remaining DPs

The DPs to which was not possible to convert the address to coordinates using Geocoding have to be collected during field operations. We have periodic field operation to acquire metering information of almost all the customers. We will use these operations to automatically acquire the mobile device GPS coordinates, although the main process focus are not to acquire geographic information but the metering itself. We'll abdicate on the coordinate accuracy because the necessary time to do it and the user profile of the metering process are incompatible with an acquisition process of accurate coordinates. Instead, we'll use the four coordinates automatically acquired yearly by the GPS for each customer location with some inaccuracy and treat it with an intelligent algorithm that will calculate an average coordinate that represents the best location for the DP.

On another front we have the maintenance and commercial operations that can acquire accurate coordinates on the hundreds of thousand operations done yearly. In each one, user will check and eventually update the PL coordinates, making this a permanent Quality Information improvement program.

This strategy allows us to cover on a short time basis the overall DPs and use the regular maintenance and commercial operations to verify and improve the coordinates of each DP with a more accurate position.

When we have a satisfactory picture of the overall DPs we will use an algorithm that reroute the path representation between the DP and the LV cabinet or MV substation, as described on data integration section.

GEOACT PLATFORM

This project needed a platform that would allow the acquisition of specific spatial data to be easily, quickly and intuitively done on the field. Additionally, that could be made by non-expert users and that could be cheap, also with cheap and very portable devices. To fulfil these requirements, a platform was developed to acquire the DPs and Public Lighting information on a campaign basis. This platform is supported by a server available on the Internet and portable Android devices, costing less 200€.

The platform was designed to be very easy to use and to give to the user just what he needs on each moment. A simple workflow was implemented to minimize user errors.

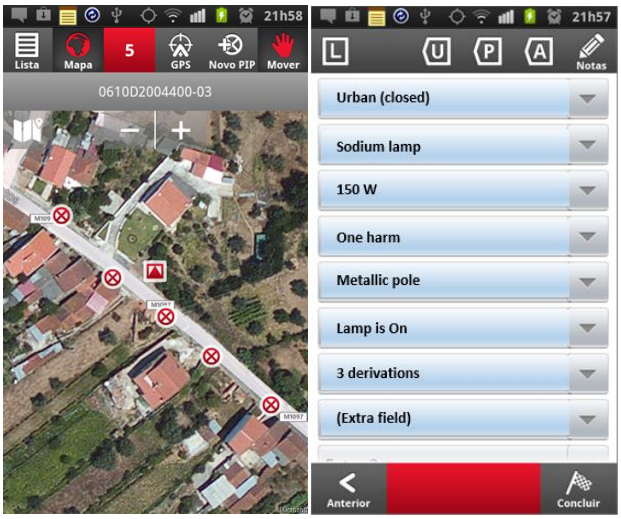

Fig. 1: Android app workflow view of each PL point acquisition. First step - geographic PL point location; Second step - PL point characteristics.

As said before, a work group determined essential information to be acquired, have made a simplification work of the data model to minimize doubts about equipment characteristic and studied the process that users do, to minimize the number of clicks for each point. Having several million points, it was essential that operations were as quick as possible.

Using the Public Lighting app version, users can fully mark a PL point in less than 3 seconds, and no longer than 30 seconds. This was achieved because of the similitude between collateral PL characteristics. By default when creating a new PL it is represented on the actual GPS coordinates but the user can improve that position sliding the new dot on the detailed satellite map image of that zone, using reference shapes visible on the map (e.g. houses, trees, streets, etc.). After position acquisition, the user goes to the next step where the equipment technical simplified characteristic are selected from existent lists. Most of the PL on a street have the same characteristic or are very similar. Taking that, the Android app copies all the characteristic from previous PL point and allows users to change one or more of the seven fields of the Data Model. Additionally, there are three memories with the last three different PL characteristics that user can call directly

by pressing an app button. These functionalities allows users to save much time on PL acquisition.
What user does on the first step is to select the MV substation where PL points belongs. After this he creates a circuit for each individual command (light sensor, telecontrolled or automatic astronomic clock) where PL points are associated. This father-son hierarchy allows us to know the PL point groups that are connected together, what is crucial to maintenance and energy efficiency purposes.

PUBLIC LIGHTING CAMPAIGN

For the particular case of the Public Lighting, EDP Distribuição have made a 20 months campaign, made by the maintenance technicians equipped with an Android smartphone and a proprietary application (GeoAct) to collect the PL asset characteristics and geographical location. This application was designed by EDP Distribution to be extremely time efficient and user friendly, allowing to users acquire up to 1000 entire PL asset information by day. The PL Data Model pragmatic design and the optimization of the application's interaction were decisive to the success of the campaign.
This work involved about 200 people, from field technicians and management team, with a special focus on team efficiency and quality data.
A very detailed planned was made and it was essential to achieve the target project date. Monthly periodic reports were made and used by team managers to compare the plan with rollout results.

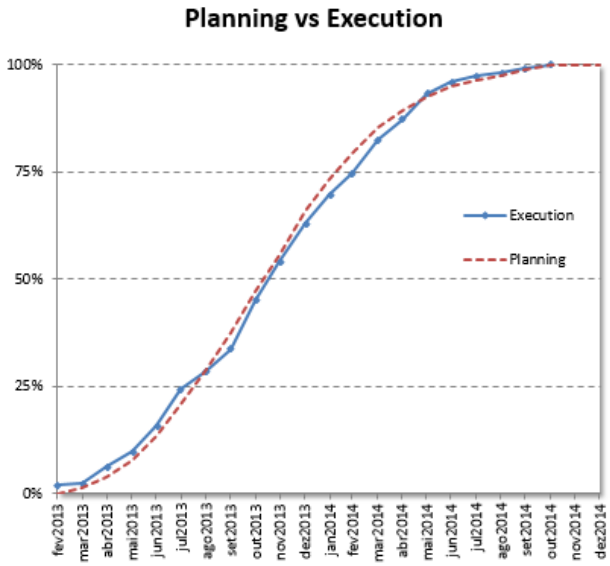

Fig 2: Public Lighting campaign planning versus execution. The detailed planning and periodic reporting was essential to fulfil the project target date.

A regular data analysis was one of the key words to the project success, aligning the quality information results with the target and minimizing the out of line data.

The final phase of the campaign is a field audit work, recurring again to the field technicians, to do an audit cross process that allows us to confirm the results on the field and to act when faced with less quality information data.

DATA INTEGRATION ON CORPORATE SYSTEMS

On EDP all the business processes are supported by corporate systems and the GIS (Geographical Information System) is the master repository of EDP's Technical Information.
As it was said before, it's just misses the LV and PL information to complete all asset information of GIS. To simplify the entire project, it was decided to develop all of these sub-projects on a separate database on systems disconnected from our GIS. Now it is time to integrate all of these information on GIS. The first information to be integrated will be the Geocoding result database. To integrate this and the remaining DP information it was developed an algorithm to compare geographic position of each DP and to automatically decide if it should be moved or if it maintains the current position, to assure that recent manual update information are not overlapped.
The algorithm starts at the MV substation and considers all outputs already connected, DP points and existing LV network. To take the decision if the DP moves or not, it compares three geographic positions: current GIS coordinates, GeoAct coordinates (field survey) if it exists, and the Geocoding coordinates. The main decision to move the DP is based on the comparison of the distance between present GIS Coordinate and GeoAct or Geocoding coordinates. If it's bigger than 20m then the DP is marked to move to Geocoding or GeoAct coordinate. We have considered that GeoAct coordinates are more accurate then Geocoding, so when it exists it's used instead of Geocoding.
Also the LV network is used on the decision process. We consider the network characteristics: its origin, if it is aerial or underground, the distance to the substation, etc. Based on that, algorithm takes the final decision if DP will be moved or not.
The algorithm has also the possibility to reroute path between DP and substation. The path can be drawn following the Public Lighting position acquired by the GeoAct or can be coincident with the vector street line. The network will be repositioned following the shortest path between the source point and the end point following the existing maps. All the electrical connection representation between DPs and the Substation will be preserved.
The data information collected by the Public Lighting campaign will be incorporated in the existent GIS data model prior to LV path rerouting because LV and PL grid are coincident in most of the situations. To match the simplified data model used on field acquisition with the GIS data model, a conversion table will be used.
In the meantime, updates made on a daily basis in GIS will

continue to exist and need to be updated on the database.
The LV and PL integration rollout planning will have an important impact on system performance and on the regular work of GIS updating. It will depend on the amount of information to be processed, the geographical area and network density.
The number of areas will be defined to process the volume of data and the timing thereof. The smallest geographical unit to consider will be a substation and respective circuits. It is also at this stage that the business units will define the customization allowed by the algorithm to be used on its geographical area, the exceptions, for example substations to be excluded from the process, etc. This allows that a unique algorithm can be used by all business units, having different field realities. The regulated integration will be fundamental because the large volume of information could jeopardize the performance of interconnected systems (Project, Maintenance, Dispatch and Control Center).
At the end, the GIS will have all the information updated and the field operations will be used to check its consistency, revise eventual errors and update grid changes.

Fig. 3: GIS screenshots of a neighbourhood LV grid representation on its original situation (LV and PL grid without correct geographic information) and after conclusion of this project (demonstration pilot screenshots).

NEXT STEPS

After the finish of this giant project EDP Distribuição will have a huge and important database of almost all its assets. However, the simplified Public Lighting data model assumption made on the beginning of this project and that allowed its existence and conclusion must be complemented. So, there will be a permanent work to be done to improve information with more details that has to be done on a continuous basis. This will be done while regular work occurs, being it maintenance, grid expansion or renovation. The best moment to fill accurate and detailed asset information is on the buying moment. On that moment we have all the technical characteristic of the product, given by the manufacturer. So we'll have to tie our systems with our processes to track materials since the buying moment, through all the storage way till its application on an installation or location on the field. On that crucial moment we'll just need a barcode scanner that reads the material code and associates it with the location or installation. Systems must do the remaining work of pointing all the technical characteristic to the catalogue provided by the manufacturer. Although the idea is very simple, its implementation on existent systems is not trivial neither easy and will be a big challenge that we must win.
The information enrichment brought by this project will allow an interaction between EDP Distribuição, customers, citizens and other stakeholders on an innovative way. Smartphone applications and sites can be available to communicate with customers and citizens, to make solicitations, to allow failure communications, to search foreseen work or known malfunctions on their areas, etc. Additionally, the present main channel with customers – the call center – can have online information about grid situation on a geographic basis, allowing an interaction with public geographic databases or social networks information given by customers or citizens. Twitter and Facebook are being used for these purposes on a lot of projects, where police, companies and other entities use online social network information to correlate with its own information on a real time basis. It will be very useful, for example, to detect or confirm outages faster than just with company own information, even if we are talking about Smartgrids.

Fig. 4: Public Lighting implantation satellite image that can be used to improve communication with the stakeholder community.

Other necessity is communicating with all stakeholders. Municipalities and other entities ask every more for

information, has information to give us and we need to create fluent information channels with all of them. EDP Distribuição is already working on an online platform to interact with stakeholders that will allow a controlled and direct access to the technical and geographical asset information, as well as to put maintenance, grid changes requests and new PL infrastructures necessities directly into EDP systems. This process represents an efficiency improvement to both, EDP Distribuição and stakeholders, and a paperless solution implementation.

CONCLUSION

This project is essential to EDP efficiency because it will allow quicker answers, to reduce time to repair, by knowing equipment and its feeder location, to communicate better with stakeholders, to better manage assets, etc. Also it will make possible Energy Efficiency studies and apply efficient measures.

Another conclusion is that even giant projects are possible to be done with much less budget when made on an innovative way and addressing the tools and the right available technologies.

The key is to do only the essential, eliminating all the “nice to have” and divide the way on very steps of different difficulty and maturity levels, implementing a continuous information improvement program.

On a project like this, evolving a huge amount of locations, spread geographically, the main cost is Human Resources, so it is fundamental to reduce field operations and time the most and use algorithms whenever possible.