IMPROVING POWER QUALITY BY DATABASES CROSSING

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ABSTRACT

Crossing measured data with collected ones allows to enrich the PQ database of the French DNO in order to improve its working processes and to manage more efficiently measured customers PQ reports (i.e. about 25% of all MV customers today).

INTRODUCTION

In the context of the deregulation of the French electricity system, The French Distribution Network Operator (DNO) is responsible for the power quality towards both regulator and network users.
However, he also must check the contractual commitments with the French Transmission Network Operator (TNO) in all the substation delivery points. In order to produce automatically PQ reports at these points, the measurements coming from the PQ devices must be completed by the device topology location and the fault cause.

This article presents the French DNO PQ devices installation policy in substations, and the methodology used to complete automatically technical information coming from the PQ devices in the new PQ national measurement database "MAGIQ".

FRENCH DNO PQ OBJECTIVES AND PERSPECTIVES

The French DNO must produce periodically PQ reports for its MV customers who have subscribed specific contractual commitments on interruptions and/or voltage dips. He also must answer to the customers' complaints linked with the EN50160 standard levels. Moreover he decided to follow the MV network PQ quality level and the TNO's commitments at the border sites.
For these reasons, since 2002 and until 2012, the French DNO planned the PQ devices installation in all its HV/MV substations (one device per transformer). As the PQ data is centralized in a national database, it is today possible to have a PQ macroscopic view of the MV network and it is a good opportunity to follow the PQ TSO commitments at the same delivery points.
Thanks to this increasing number of PQ devices and this recent centralized PQ database, the French DNO can now improve its process. First, the PQ macroscopic view allows to take into account power quality in asset management issues.

Each network equipment like HV/MV transformers can be managed in order to anticipate an abnormal (non nominal) working condition and then to foresee their repair or their replacement. The measurement of cyclic values (10 min RMS points) on each substation can give the trend for the next years. So that the French DNO can make arrangements to limit the consequences on the downstream network.
In addition, it becomes possible to build a "black list" of HV/MV transformers and to display them on maps. With these information, the French DNO will be able to locate the main problems, in which type of area (mountain, sea, forest, urban, …) and can act on these black points in priority.
Finally, this PQ Information System allows the improvement of the current national indicators by building indicators at different geographical scales. It is an interesting detailed information for the DNO to apprehend the performance of its network but also to answer to the regulator or similar entities which want to check whether the PQ levels are compliant with the limits on specific areas.

ADDING AND USING TOPOLOGIC INFORMATION INTO THE CENTRALIZED PQ DATABASE

In the DNO PQ Information System, a PQ device and its measurement are associated by the serial number of the device and the name of its geographic location. A link with its topology network identification could allow to locate the instrument on the network and to identify whether other ones are located nearby. Besides, this information could be used to complete the recorded data of all devices concerned by a same event.
In the MV national network database, a single identifier (GDO code) is used to locate all the network components. The GDO code of a network component contains several information.

In all cases :
- the reference of the substation,
- the reference number of the feeder to which it is connected.

For a customer :
- its ZIP code (a geographical information),
- its reference number,

This GDO code can be introduced into the national PQ database. By connecting these two databases, a list of the

GDO codes could be automatically extracted. Then the PQ Information System administrator can associate a PQ device with its topologic location by choosing in the GDO code list. For the moment, this information is manually registered in the application and the potential of this topologic information only start to be used. It allows to manipulate the PQ devices by group, on a chosen perimeter. Moreover, all the devices which have recorded a same fault can be selected more easily in order to assign the same description of the event. The advantage gained is a coherent treatment between all types of PQ devices and also the recorded events by PQ meters.

TO CROSS PQ DATA AND REAL TIME NETWORK DATA (FIRST EXPERIENCE)

Today the PQ devices record events (interruptions, voltage dips and swells) but they cannot determine the fault cause, so this information must be added manually into the PQ database. A data crossing between the real time network database "SIT-R" and the "MAGIQ" PQ database has been made in order to retrieve automatically this information. The objective was to associate a "MAGIQ" measured event with a network component like a substation, a transformer or a feeder one. At this aim, correlations were made between events recorded by a device and recorded quick breakers states changes.

An important difficulty was noticed concerning the timestamp between the real time events (teleindications) and the devices events measurement.

As a matter of fact the teleindications timestamps are synchronized with an hertzian-clock. But for the PQ devices, some are synchronized with the same method when possible, and if not they are synchronized with a remote computer. So the gap between the timestamps is not always the same. The method chosen to solve this difficulty was to cross all the teleindications from a given period of time with each event recorded by a device in order to correlate them following three correlation criteria :

1. the beginning date, the end date and the duration,
2. the beginning date only,
3. the end date only.

Another important point is that each correlation must be associated to a matching probability in order to give to the user different possibilities of correlation with their respective weighting ponderation. Indeed, an automatic crossing, without asking a validation to the user, can give errors. The figure below gives an idea of correlations found for a measured event. The main window gives the different real time events correlated to the measurement which is selected to the left.

For one event (a voltage dip at 14h59min17s380ms the 18/08/2004 in the left window on the figure below), we present all the correlations results (in the right window). For each correlation founded, a correlation rate is calculated. The more probable teleindications are estimated with their maximum correlation rate (highlighted lines), and a global correlation rate is calculated.

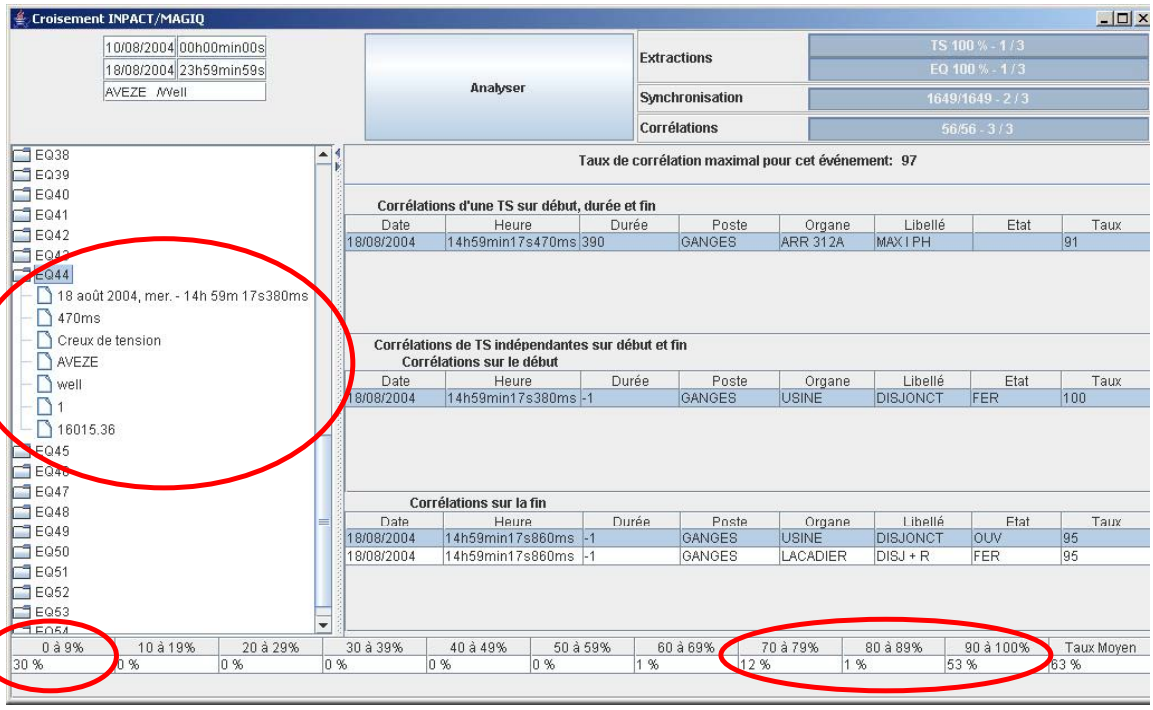

Figure 1: correlation results between measured events and teleindications

Moreover, the table at the bottom of the figure gives the repartition of the correlation probabilities for all the measured events (about one hundred). We can see that 30% of measured events are not correlated (less than 10% of correlation). But for the others, the probability to have found the right correlation is greater than 70%.
The results were encouraging, even if in some cases several teleindications might correlate with a same recorded event. However these results can't allow to characterize events automatically and don't give the fault cause that can be set in the annual customers PQ reports. Therefore, a new approach by using the supply continuity national database "CF" has been made.

TO CROSS PQ DATA AND NATIONAL CF DATABASE (NEW EXPERIENCE)

Until today, in order to produce annual customers PQ reports, the French DNO use its supply continuity national database "CF" in which all the long interruptions (more than 3 min) are collected and characterized by the origin of the fault, the cause of the fault and the type of the fault. Besides, since the end of 2006, all the French regional units are being connected to the new measured PQ database "MAGIQ", based upon PQ measurement devices and meters. The crossing between these two databases will allow to characterize automatically the events measured with the PQ devices, and to complete automatically the customers PQ reports.
The first step was to identify the tables and the useful data contained in the "CF" database, in order to enrich the "MAGIQ" one. After that, a method was elaborated to connect regularly (weekly) the two databases in order to extract the "CF" selected tables and to update the MAGIQ database.

For the time being, each "MAGIQ" interruption must be correlated with the new data. To do so, the customer GDO code is compared between the two databases, and the interruptions of a period of time with the same GDO code collected in the "CF" database are searched. Globally three criteria are used :

1. the GDO code,
2. the interruption beginning date,
3. the interruption duration.

For each correlation found, confidence indicators are elaborated on the difference between the interruption beginning dates and between the interruption durations. For the best result obtained, the characterization of the interruption located in the "CF" database is automatically written into the "MAGIQ" database and suggested to the user. After that, for a selected MAGIQ event, they have to choose in the list one of the different correlations proposed and then to validate it. However, they can always manually modify it if necessary.
There are several advantages with this characterisation method :

- the time to produce the customer quality reports is strongly reduced,
- the long interruptions characterizations in the "MAGIQ" database are more reliable,
- to obtain automatically the fault cause information
- the entered substation GDO codes located in the "MAGIQ" database are automated and then more reliable,
- and finally, the time needed to check up all the GDO codes is strongly reduced.

This method will be tested in EDF R&D in 2007, and at the end of this year, will be implemented between the national "MAGIQ" and "CF" databases.

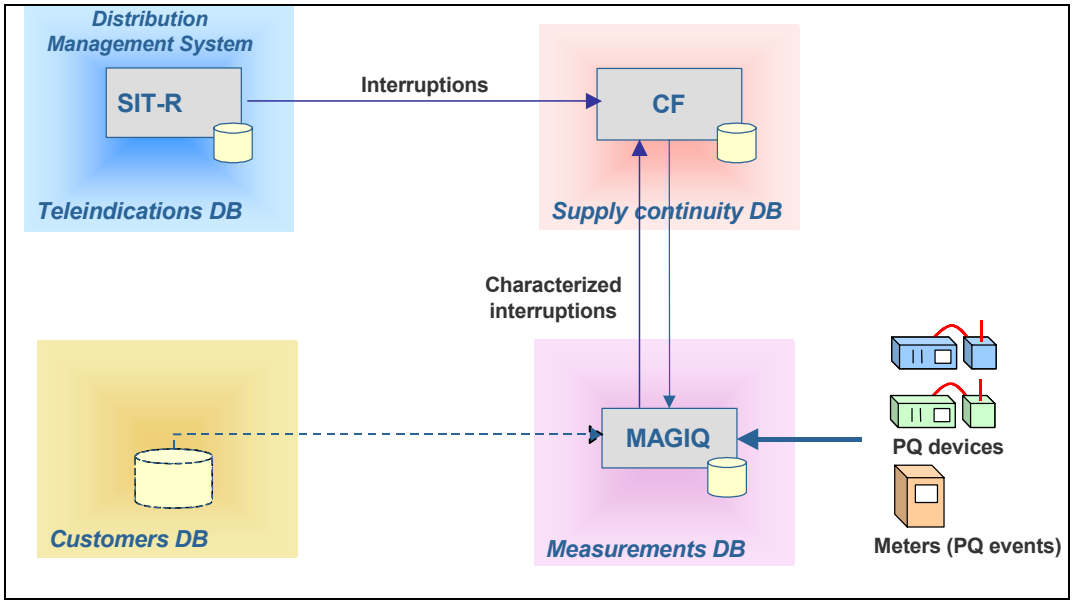

Figure 2: simplified architecture of PQ system

CONCLUSION

The PQ devices installed in the substations will give to the French DNO a macroscopic and a geographical view of its PQ MV network. They allow to optimize its asset management and can give multiples and various indicators like a transformers' "black list". They also can give the PQ trend for the future years, and thus help the French DNO to limit the consequences on its network. Besides, the fact to link the GDO code (single identifier network equipment) with the PQ devices recorded in the national PQ measurement database "MAGIQ" allows to locate them automatically on the network and to manage them with consistency.

At least, the crossing between the national measurement database "MAGIQ" and the national supply continuity database "CF" brings more complete and reliable measured PQ data. It allows the French DNO to improve and to produce more efficiently and more automatically the measured customers PQ reports.

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