CREATING VALUE FOR CLIENTS AND SHAREHOLDERS GUARANTEEING A HIGH LEVEL SERVICE QUALITY (PROJECT LAIT)

Luis MARTINS
EDP-Distribuição – Portugal
luisgoncalves.martins@edp.pt

Marcolino PINHEIRO
EDP-Distribuição – Portugal
marcolino.borgespinheiro@edp.pt

Cláudio BARROSO
EDP-Distribuição – Portugal
claudio.barroso@edp.pt

ABSTRACT

Focusing clear and quantifiable high level objectives on Interruption Time Equivalent (TIEPI) improvement, through remote control of MV network operation, is fundamental to match utilities interest with needs and expectations of clients. This tends to be critical mainly in very dense urban areas (Great Lisbon Network Area – ARGL – has more than 1,5 million inhabitants with a 566 km^2 area, in a total of 4,5 thousand km, where the underground cable distribution network is about 90% and the overhead lines distribution network, which is gradually becoming Urban, is about 10%). The project, until the end of 2006, forecasts the remote control of about 25% of MV feeders from HV/MV Substations aiming to restore service in less than 3 minutes. Topics are related with developments of network operation and control.

Important key factors for the Project are valuation criteria for remote control points (Clients with special needs as Hospitals and Optimal control points Number with respect to cost justification), the use of standard projects for installations refurbishment in order to speed up and control the program execution as well as default location function in the MV network Management System (improving operation efficiency with Workforce management tools) associated with remote control equipment installation, permitting faster localization and significant reduction of affected clients in case of default.

The project is also complemented with an experimental one, running in a few MV/LV Substations, in order to allow an evolution of the system to an Intelligent Automation one.

The Project in partnership with companies with expertise in other fields, as optic sensors, allows testing a pioneer experience that will reformulate default location in a near future.

Several options for communication, between remote control points and the Communication Centre, depending on the localization constrains, are integrated in the project to verify Communication and interoperability standards. The choice of optic fibre followed by telephone cable, according costs involved, depended also on the field conditions for communications based on GSM/GPRS or radio.

In parallel with the investment program was designed, from the very first beginning, an operation and maintenance program (on remote inspection, verification of peripherals systems) and recycling technical personnel.

The achieved goals are controlled through a detailed analysis of real network default reconfiguration and location processes.

INTRODUCTION

ARGL supplies services to more than 860 thousand clients. The typical MV distribution configuration is fed by two different HV/MV Substations with the frontier point on the half-way MV/LV Substation (10 % of the total 755 lines). So far it was possible to install at least one remote controlled MV/LV Substation in 20% MV distribution lines, a significant improvement compared with the 7 % achieved by the end of the year 2004. The liberalization of markets like MIBEL agreement means pressure from stock-holders and clients to improve efficiency and quality service as new challenge in the business activity.

Quality service analysis is related with evolution of TIEPI indicator defined as above.

$$TIEPI_{MV} = \frac{\sum_{j=1}^{k}\sum_{i=1}^{x} DI_{ij} \times PI_j}{\sum_{j=1}^{k} PI_j}$$

DI_{ij} – Interruption Time i in delivery point j [h];

PI_j – Installed power in delivery point j (delivery point considered are MV/LV Substation);

k – Total quantity of delivery points in the considered geographic area;

x – Number of interruptions in the delivery point j.

This indicator can be influenced in a short-term time period by investing in MV/LV Substations remote control providing a more efficient MV network management.
Thus, in order to control its evolution ARGL has launched LAIT project based on remote control MV network operation. The team created to follow this project makes the analyses of the incidents that occurred focusing the benefits introduced by the remote control investment (faster operations and less time in restoring affected clients) and the implementation criteria.

Since September of 2005, periodic meetings are schedule to analyse the MV network behaviour.

1 - PROJECT VALUATION CRITERIA

Main benefits with the installation of remote controlled MV/LV Substations are improvement on client quality service MV network management (switching MV lines between feeder Substations), information gathering MV/LV Substations (coupling emergency signals to the remote control, such as water flood, power transformer high temperature), service interruption time reduction (measure by TIEPI), faster physical restriction incidents area (using information transmitted by the Default Identifiers – ID), technical network manager personnel and car reductions.

The most important criteria used by ARGL to select the best point in the MV distribution line to install a remote controlled MV/LV substation are cable installed power, selectivity performance attributes, service reposition time, refurbishment works and clients with special needs as hospitals and public interest services, optimal control points number with respect to cost justification, strategic localization for the network power control, physically difficult access installations, and incidents in some critical cables.

2 - MV/LV SUBSTATION PROJECT

In the project is integrated an experimental one running in a few MV/LV Substations, based on Faraday current sensors (fig. 1) with optical fibre conductors that provides both measurements in MV and LV side as well as fault location in the MV side.

Figure 1 – Faraday current sensor

Included values for measurements (fig. 2) are MV current per phase, LV current and voltage per phase, active and reactive power, cos phi, and others.

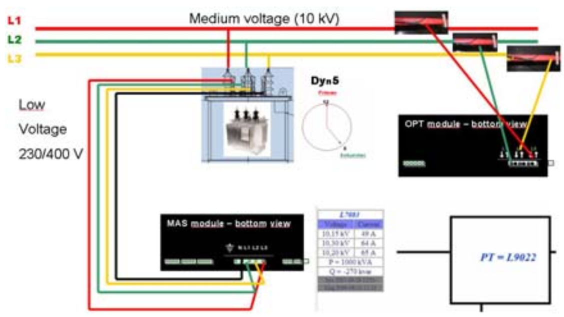

Figure 2 – MV/LV Substation 9022 experimental project

implementation

Besides, this system has binary inputs that allow controlling some additional parameters such as intruder alarm, room temperature alarm and water level alarm in underground installations.
The system is able to control and operate MV circuit breakers or switches (fig. 3) under pre-defined constraints.

Figure 3 – Remote controlled RMU

As a future development, connection between this system and the Scada Dispatching Centre will allow automatic adjustment of the network under default, avoiding in field human involvement which means not only the reduction of workers costs but also no time displacement and no traffic vehicles in use.

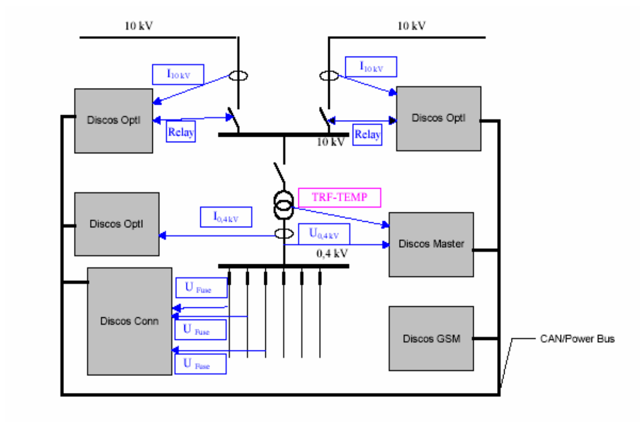

Figure 4 – Experimental project schematic diagram

3 – REMOTE CONTROL EQUIPMENT IN MV/LV SUBSTATIONS

It was identified important remote control characteristics of de equipments selected to be used in ARGL.

Remote Control Functions

The main functions integrated in remote control are described bellow in table 1

Lines	Unit	Default Identifiers ID	Commands	Signalling
Overhead	OCR	-	X	X
Underground	RTU	X	X	X

Table 1 – Remote control characteristics units

As shown there are two types of remote control equipment:

- RTU (Remote Terminal Unit) used in MV/LV substations mainly with cables network and,
- OCR (Remote Switch*)* used in MV towers in the overheads lines network.

Both equipments are able to accomplish command orders (table 2) and signalling inputs (table 3), but only the RTU in the cable network are able to identify default currents (ID) in order to inform the Dispatching Centre Operator if in case of default, from that point, it is a forward or backward one.

Commands	MV/LV Substations Underground Cables	Overhead Lines
Order to close MV switch	X	X
Order to open MV switch	X	X
Order to turn on Public Illumination	X	-
Order to turn off Public Illumination	X	-

Table 2 – Controls in remote controlled MV Lines

Signals	RTU in MV/LV Substations With underground cables	OCR in Overhead lines
On/off position of MV switch	X	X
Default passage identifier (ID)	X	-
On/off earth switch position	X	-
Open door *Signalling*	X	-
Out of order water pump *Signalling*	X	-
Local/distance panel *Signalling*	X	X

Table 3 –Remote control signals

Components:

Among the RTU equipments available options in the market, ARGL decided to use commercial remote units: the Micro RTU and the Talus 200 (fig. 5).

Figure 5 – Talus 200 - RTU

Both have similar structures that include:
A central processing unit, a command unit with a local/distance switch to choose between local operation and remote control operation from Dispatching Centre. This card includes a mimic to see the position of the MV switch/circuit breaker.
A power supply card with batteries and charger, measurement boards for currents and voltages with built-in analogue/digital converters are considered to handle the following: MV currents (3 phases), Input current to the QGBT (3 phases) and Low Voltage in the QGBT (3 phases).
Default identifier cards (ID) that are connected with toroidal current sensors (fig. 6) in each feeder to detect the presence of default currents in the corresponding cable.

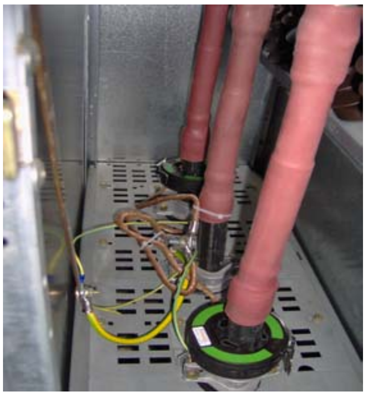

Figure 6 – Toroidal ID current sensors

Communication system:

To achieve the proposed goals it is very important to have the better communications system in order to transmit all the signals between the field stations and the Dispatching Centre. The available options are:

- Optical fibre cable from internal network;
- GPRS from the public mobile network;
- Telephone pair from internal cable network;
- Radio frequency from internal VHF network.

The optical fibre cable network owned by EDP.
The GPRS is supported by Optimus, a private mobile service provider.
The copper cable network owned by EDP.
The VHF Radio frequency network is based on 3 different antenna/switch points, covering an area of 30% of the ARGL area.
In urban areas we use mainly the optical fibre cable modems, while in the rural areas we use the VHF radio communications.

4 – MAINTENANCE PROGRAM

The maintenance program is based on a 3 level stage:

1st level – Remote Control unit level:
At this point the program includes routine commands every 6 months to control the functionality of the all system, which means: - At the Dispatching Centre, the availability of the mimic screens; - At the communications field, the working state of the interfaces, fibre optics cables, telephone lines, GPRS circuits, radio systems, etc.; - At the MV/LV Substations, the working state of the equipment installed, RTU and feeder motors and inter-locking.

2nd level - Power supply unit level:
The power supply systems are verified twice a year. In the first one a visual inspection is made, followed by cleaning procedures and voltage measurements. In the last one the same procedures apply complemented with a discharge/charge cycle to verify the battery state.

3rd level - MV cabinets, motors and command circuitry:
These circuits have a 5 year maintenance cycle to verify the micro-switches, the auxiliary contacts, the motors itself and to provide the lubrication action.

5 – PROJECT EVOLUTION

Table 4 summarizes some ARGL indicators in 2006 that were analyzed by the team in the LAIT mensal meetings. From the total amount of lines with Remote Controlled MV lines under default, 60% were operated by the Dispatching Centre and from this amount 88% with sequential manoeuvres, that lead to clients reposition in less than ten minutes.

Remote Controlled MV Lines Incidents	7%
Activated Remote Controlled MV Lines	60%
Incidents with first maneuver reposition time <= 10 min.	39%
Incidents with first maneuver reposition time <= 3 min.	8%
Incidents with sequential maneuvers reposition time <= 10 min.	88%
Incidents with sequential reposition actions <= 3 min.	46%
MV Line Incidents with selectivity anomaly	0,3%

Table 4 – MV line incidents identified in 2006

The graphics below shows the evolution between the 1st and the 2nd semesters of 2006. It is perceptible the maneuver time reduction meaning an operator familiarization with the system and a significant progress in all of the remote control manoeuvres in less than four minutes. The objective is to approximate all of the remote control maneuvers in less than three and ten minute's values and them to be close to one hundred per cent.

The presented numbers reflect the benefit of the LAIT project in the past year.

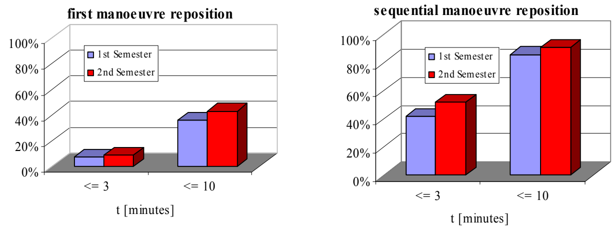

Figure 7 – Manoeuvres evolution graphics in the year 2006

The next picture and the next table show a practical example which represents an electrical default and the following sequence of manoeuvres to service reposition, identifying the power reposition in each action.

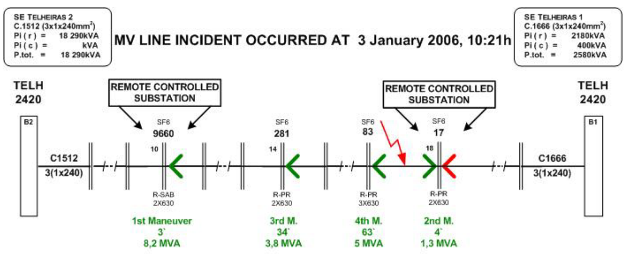

Figure 8 – Despatch Centre Schematic MV Line Incident Evolution

The MV remote control equipment (TCMT) associated to the default indicators allowed to put again by the Dispatching Centre, in the first and second manoeuvres, 60% of the affected power, being only 40% depending on local field operation.

Maneuver	Maneuver Time [minutes]	Accumulative Time [minutes]	Turned on Power [MVA]	Accumulative Turned on Power [MVA]
1.st	3	3	8,2	8,2
2.nd	1	4	1,3	9,5
3.rd	30	34	3,8	13,3
4.th	29	63	5	18,3

Table 5 – Manoeuvres sequence in the MV line incident

In the practical example herein shown, we can see a feeder cable with 2 MV/LV Substation equipped with TCMT, however some feeder have only one TCMT and others have three TCMT points (figure 9).

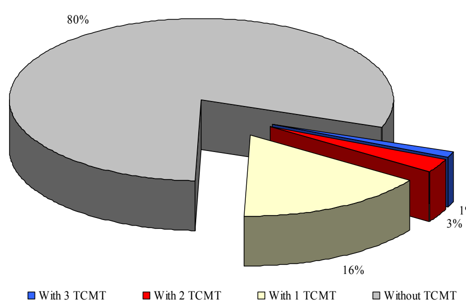

Figure 9 – Percentage of MV Lines with TCMT

6 - INVESTMENT/RETURN PROGRAM

The program herein described involves not only the installation of the remote control system in the specified installations but also the upgrade of the MV equipment, with the motorizing of existing MV-SF6 Ring Main Units (about 33%), or in some cases, the exchange of the open air MV equipment to motorized MV-SF6 Ring Main Units (about 67%), thus reducing costs of maintenance and increasing life time. The remote control equipment and its installation is about 20% of the budget for the overall project.

The expected value in minutes for the TIEPI by the end of the year means about 40% of improvement since the beginning of the project. The next graphic shows the TIEPI and the number of MV line with TCMT evolution where it can be seen that the influence in TCMT investment could reflect an increase of the service quality.

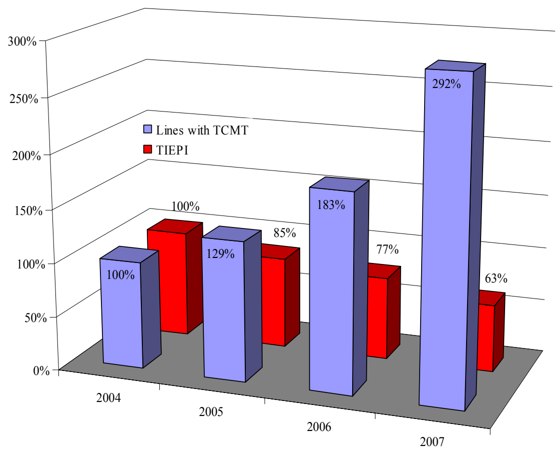

Figure 10 – TIEPI and MV Line with TCMT evolution graphics

7 – CONCLUSIONS

Since 2004, ARGL accomplished to increase almost three times the number of remote controlled MV Lines with at least one TCMT MV/LV Substations and by the end of 2007 we expect to achieve 20% of the total number of MV Lines installed.

From the MV Lines incident analysis it was possible to understand that default indicators should be installed in every feeder from the remote controlled MV/LV Substations. This practice allows obtaining the maximum benefit of the remote control installation leading to a more efficiency network dispatching. Never the less in the MV/LV Substations with only two MV Lines feeders it can be accepted to install only one default indicator because of the reduced incident probability inside the Substation.

The MV Lines optimal network dispatching cut should be situated in the mid load point between HV/MV Substations allowing the lost decrease and the increase of cables life expectation time. Therefore, this point should be considerate the first to control by remote operation allowing to switch loads together with remote controlled HV/MV Substations.

Important key factors for the Project are valuation criteria for remote control points and the use of standard projects for installations refurbishment.

An experimental project in a few MV/LV Substations, in order to allow an evolution of the system to an Intelligent Automation one will reformulate default location in a near future.

Options for communication depended on the field conditions for communications based on GSM/GPRS or radio.

In parallel with the program was designed, from the very first beginning, an operation and maintenance program (on remote inspection, verification of peripherals systems) and recycling technical personnel, controlled through a detailed analysis of real network default reconfiguration and location processes.