ECONOMIC SOLUTIONS FOR DISTRIBUTION AND TRANSFORMATION CENTRES
AUTOMATION

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INTRODUCTION

This paper presents an economic, straightforward and very reliable solution, based on advanced digital technology, for automation and remote control of Distribution Centres (CRs) with protections and Transformation Centres (CTs) only with local command and fault detection, in a distribution network.

The characteristics inherent in these solutions lead to important cost savings. These characteristics that will be explained with more detail along this paper are: reduction in the cubicle cost, reduction of wiring, integration of RTU functionality, and as a consequence of these, commissioning time reduction.

The presented solution is a personalized, configurable and remotely controllable Automation System, adopted since 1999 by a Spanish company, which nowadays owns more than 60 CRs and 120 CTs with this solution.

PRESENTED SOLUTION

This solution is based on three main characteristics:

- Installation of a unique IED (Intelligent Electronic Device) in each bay, which performs all protection, control, measurement, data acquisition, command, signalling, automatism, etc. function.

  Each IED only incorporates the functions required by the bay. This design meeting each bay’s requirement gives rise to a feature/cost optimum configuration adapted to each substation.

- Centralization of all the electrical Centres information in a unique unit: Centre Control Unit (UCS). This unit, collects all IED’s information to send it to an external SCADA system, executes commands from SCADA, monitors and commands all IEDs and executes automatisms (load shedding, etc.).

- Communication via optical fibre with star topology between IEDs and UCS. Also, it represents the disappearance of conventional interconnection wiring between UCS and cubicles.

  This is an optimum solution in robustness versus capacity terms, due to the security the topology offers, as damage in the communication network affects partially the system.

  The solution of communication with the SCADA or with another elements present in the network, as adjoining, reclosers and sectionalizers can be via radio, telephone network, etc.

DISTRIBUTION CENTRES

A Distribution Centre is an electrical installation, inside a network (MV), normally with only one voltage level and without transformation MV/LV (Medium Voltage/Low Voltage). Their main use is steering one or more MV lines on to others of the same voltage level. It is, really, the prolongation of Bus Bar of feeding substation.

Table 1 shows the comparison between the traditional Distribution centre’s automation system and the one presented in this paper.

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<tr>
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<th>Traditional System</th>
<th>New Solution</th>
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<tbody>
<tr>
<td>Jasoning, local</td>
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<td>security subsystem</td>
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<td>Protection subsystem</td>
<td>Overcurrent relays, etc.</td>
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<td>Measurement subsystem</td>
<td>Analog inputs, measurements converters, etc.</td>
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<td>Signalling subsystem</td>
<td>Local alarm switchboard, alarm relays, etc.</td>
<td>UCS</td>
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<td>Telecontrol</td>
<td>Remote Unit with communication (RTU), telecommand cubicles, etc.</td>
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<td>subsystem</td>
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<td>Local automation</td>
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<td>subsystem</td>
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The following figure shows the application of the presented system.

![Figure 1: New system in Distribution Centres.](image)

The presented system applied to Distribution Centres leads to:

- Installation of multifunction IEDs in cubicles, with the following functions: 50/51, 50N/51N, 51NS/51NS, 67, 67N, 46, 27, 59, etc. depending on the bay requirements.
- The unit apart from the listed protection functions, collects, records and dates events and oscillograms, elaborates fault reports; measures current and voltage values and calculates powers, etc.
- These IEDs can also carry out local automatisms such as: recloser, detection of voltage presence/absence, etc. Additionally they allow breaker operation from the unit itself and monitors breaker operation as well as trip and close circuit supervision, and provide information for maintenance supervision (Nº of actuations, K12 open parameters, etc.).
- Centre Control Unit (UCS). This unit collects all IEDs information (control and protection information) and distributes it towards the SCADA systems and remote HMIs (Human Machine Interfaces).

Additionally, it distributes the commands received from SCADA to the respective IED. The unit has a graphic display which allows the visualization of the distribution centre’s alarms.

The UCS also carries out automatisms, which make easier system operation and contribute to maintain the more possible customer with power. “Feeder transfer automatism” is an example of an automatism that can be carried out in Distribution Centres.

This automatism when detecting a loss of voltage in a feeder, opens the breaker of that feeder and closes the breaker of the feeder in reserve keeping, this way, all the loads feed. This automatism can be used in single busbar schemes as well as in half busbar schemes.

The characteristics of the UCS make possible the communication between UCS and SCADA being the one required by the customer: radio, GSM modem, PLC, satellite, dedicated telephone line, etc.

- Optical fibre communication network. A star topology is proposed, with a master-slave configuration, and using optical hubs to simplify the laying. Additionally, the optical fibre offers an electrical isolation among the system elements.

### TRANSFORMATION CENTRES

A Transformation Centre is an electrical installation, which converts medium voltage into low voltage. It is the basic element, which conform general structure of MV network. It normally has a set of LV lines integrating a bit of LV Network.

Table 2 shows the comparison between the traditional Transformation centre’s automation system and the one presented in this paper.

| TABLE 2 –Comparison between traditional system and new solution in CTs |
|---------------------------------|-----------------|-----------------|
| **Traditional System** | **New Solution** |
| Monitoring, local command and security subsystem | Pushbuttons, auxiliary relays, switches, etc. |
| Detection subsystem (voltage presence and current Passover) | Voltage detection relays and Current Passover relays |
| Measurement subsystem | Analog inputs, measurements converters, etc. |
| Signalling subsystem | Local alarm switchboard, alarm relays, etc. |
| Telecontrol subsystem | Remote Unit with communication (RTU), telecommand cubicles, etc. |
| Local automation subsystem | Outside the scope |

This diagram illustrates the application of the presented system.
The presented system applied to Transformation Centres leads to:

- Installation of multifunction IEDs in cubicles, which measure and control different bays. They include the following functions: Current Passover detection, voltage presence detection, slack springs detection, records and dates events, measures voltages and currents, etc.

In this case the IED does not include protection functions.

- Centre Control Unit (UCS). In the same way as in CRs it concentrates all system data, and distributes it towards the SCADA systems and remote HMIs.

It also carries out automatisms, which can be configured in a similar way for all the Centres or, in personalized way, for adapting particular conditions. One of the automatism implemented in Transformation Centres is the “isolating switch automation function”, which is use to reduce the duration of customer power cuts and minimize the number of affected customers. In the same way as in Distribution Centres, Transformation Centres can also implement the “Feeder transfer automatism”.

The unit has a graphic display which allows the visualization of the distribution centre’s alarms. The characteristics of the UCS make possible the communication between UCS and SCADA being the one required by the customer: radio, GSM modem, PLC, satellite, dedicated telephone line, etc.

- Optical fibre communication network. A star topology is proposed, with a master-slave configuration, and using optical hubs to simplify the laying. Additionally, the optical fibre offers an electrical isolation among the system elements.

The following figure shows the application of the presented system in Transformation Centres.

**Figure 2: New system in Transformation Centres.**

**RECLOSERS AND SECTIONALIZERS**

The evolution of distribution automation tends to the installation of remotely controlled reclosers and sectionalizers in the aerial net, due to their significant contribution to power quality improvement, optimising fault location and leaving out of service the minimum possible area, reducing therefore the affected zone.

In this new automation conception, the capacity of the UCSs installed in the CTs and CRs allow the integration of recloser and sectionalizer’s information in their database. This integration strategy, apart from the direct advantages on the system operation, has some collateral advantages as the decision taking is carried out at a lower level, clearing the control centre of work and therefore optimising its functionality as control centre unit. This information integration also improves substations automatisms effectiveness as they incorporate the distributed elements.

It also provides significant advantages on communication, because allows less powerful communication links as the distributed elements have to link up with the head substation, which usually is near geographically, instead of communicate with the distribution centre.

**REMOTE COMMUNICATION**

The proposed system has another inherent feature with no extra cost, the remote access to all the information it can provide with from all the elements that integrate the system. Since it is not necessary to perform this remote access in real time, an alternative low cost communication path can be used, for example GSM modem, apart from the more powerful communication’s channel for the SCADA.

This option not only makes possible to have available all the registered data but also the access from the remote office in the System Centres, allowing the protection remote setting and even to act as a telecontrol emergency system, in case of fault or unavailability of the SCADA.

This gathered information allows the detailed event analysis, the study of the response of protections, breakers or control gear in those events, the analysis of the usual fault currents in certain lines, zones or areas, the analysis of the measurement historical reports, etc.

**ADVANTAGES**

The system proposed by Team Arteche is an economical, complete and very reliable solution for the distribution automation, which provides an important improvement of the power supply quality, with the advantage of resulting more economical than traditional solutions.
The solution proposed is valid, in the same way, with Centres of new making or with modernization of old Centres. It is probably in these cases when the solution is much more propitious.

The economy is get by means of:

- Cubicle cost reduction. The elimination of auxiliary elements in cubicles due to the IEDs functionality, which allows executing on one single unit protection, signalling, measuring, command, locking etc., functions, gives rise to cubicle cost reduction. This advantage allows defining with cubicle manufacturers, a standard cubicle, because all the installation specifications lie in the integrated control and protection unit.

- Wiring reduction, because the IED makes needless conventional interconnection. Moreover, the IED, as well as carrying out control functions, incorporates measuring and telemeasuring functions, which makes also needless measurements converters and simplifying current transformers.

- Elimination of RTUs, because the system itself carries out its function.

- Commissioning time reduction, because the system is completely tested by the manufacturer before supplying it.

Technically an integrated System is offered with more features than conventional solutions:

- Includes more information: measurements, events, the possibility of changing settings remotely, etc.

- It is able to carry out automatisms, which make easier system operation.

- Reduction of actuation time. As all the need information is available in the control centre, the actuation time when a contingency occurs is reduced due to the less time employed localizing the element that causes the contingency.

- Remote loading. It is possible to load UCSs and IEDs configuration remotely.

- Reclosers and sectionalizers integration

- Maintenance task reduction. With all the information of all the system’s elements available, their maintenance can be programmed which leads to a decrease of incidences due to elements wear.

- Power quality improvement. Which means saving to the electrical companies because of the reduction of possible fines, etc.

**FUTURE TRENDS**

The new requirements and needs, as well as the technological progresses, make the control and protection field to be a dynamic one, in constant development. A proof of this development is the increasing installation in substations of Ethernet communication networks. Ethernet is the most popular Local Area Network (LAN) technology currently used. The IEC 61850 architecture, the standard for communication networks and system in substations is a good example of this tendency.

Nowadays the implantation of this technology in CRs and CTs is expensive, but this cost is expected to be reduced at the same time as the evolution to this technology.

The next step in the distribution automation may be the interconnection with the Wide Area Networks (WAN). If we provide the CRs and CTs a secure connection with the utility private Intranet, the current technology could allow, for example, the access with a standard Internet Explorer to the local information gathered in the CRs or CTs, with Web servers embedded in the IEDs.

The present communication and IED technologies fulfil the technical requirements of this remote access through the utility Intranet. The use of the Internet and Intranet is continuously increasing therefore it seems probable that this type of accesses will be used in the distribution automation.