DISTRIBUTION MANAGEMENT SYSTEM INTO A ELECTRICITY DISTRIBUTION BRANCH

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INTRODUCTION

As we know, an Distribution Management System (DMS) includes automation and monitoring of power networks operation, substations and transformer points in order to supply electricity to customers more safety and having higher level of Power Quality.

The improvement of the performance is the main objective of the electricity distribution company. Using DMS, this objective is realised through: *reducing the number and duration of the network incidents*, in fact improving of the power quality and *reducing of the operation expenditures,* in fact increasing of the efficiency of the company activities.

In the same time, solution for neutral treatment of the 20 kV networks can improve the performance of the distribution system related to the reducing of the number and duration of the network incidents in the case of the faults.

There are well known the main advantages of the implementation of DMS/SCADA System:

- Increasing of the reliability of the system;
- Increasing of the operation safety of the system;
- Reducing of the losses due the undelivered energy;
- Reducing of the expenditure with human resource;
- Operating control based on economic indices;
- Reducing for going in the place where disconnector is montained;
- Reducing the time for insulating of the fault place.

DMS PILOT PROJECT

The Electricity Distribution and Supply Branch of Targoviste, part of ELECTRICA Company, is electricity distributor for customers from Dambovita County.

It is known that the DMS has five main components such as followings: *Automation and management of the Medium Voltage (MV) network, Automation and control of the transformer points, SCADA of the substations, Data Transmission System and Central Point (hardware and software) – Electrica (1).*

In this branch *the first step* of the DMS Pilot Project is implementing. This system will lead to the increasing of quality of the electricity distribution service to customers and increasing of the efficiency of the branch.

In order to optimise the investment costs for increasing of the availability degree of the Electricity Distribution Network (EDN) and of the continuity degree in electricity supply, first step of this project include the remote control of the reclosers and disconnectors in Medium Voltage network and acquisition of hardware and software for Central Control Point (CCP).

This first step of the project include three of all components of a DMS from above: *Automation and management of the Medium Voltage network, SCADA of the substations (two of all), Data Transmission System (partial) and Central Point (hardware and software).*

The architecture of the DMS is according the reference Electrica (2) and is presented in Figure 1 and 2.

SCADA System in substations

The components of the architecture have the following role:

- SCADA server, which has data base and main functions for operating, according the requirements of SCADA System;
- Communication server (front-end) and watchdog, which is responsible for real time communication channels;
- Workstation, which allows connecting of user to the system and has a very well graphic interface.

The main components of this architecture are following:

1. *The central equipment- RTU at the substation level.* The communication of the equipment with low level is realized by the optical fibre, and the communication with the high level is realized with interface RS 232/RS 485. In the same time this equipment allows to record periodical of the measured parameters into a non-volatile internal memory.
2. *Digital protections at the cell level* operate independent and autonomy when one component of the system is broken and other of them has a normal operation. Protection relays have self-testing function, self-diagnosis, programming functions and communication interface with control system at the central level of the substation.
3. M*easurements at the cell level* are done by RTUs, which are direct connected to the current and voltage transformers.
4. *Local automations (for example Automated Connection of Reserve - ACR).* Programmable Automation is used.
5. *Communication way* in the substation is realised by optical fibre and RS 232/RS 485 interfaces, creating a star type network with a known disadvantage: non existence of the redundancy of the communication way.

Management of the Medium Voltage Network

The following information can be processed, which is got from each equipment through the interfaces:

- The telecontrol of the network
- The telecontrol of the substation
- The network operator.

This first step of the project includes the achievement of Central Point, automation and management of the part of 20 kV power network and the integration of the SCADA system for two 110/20 kV substations. The 20 kV network area includes 20 auto-reclosers and 18 remote sectionalizers/disconnectors (60% from these are in operation at present).

The existing applications of the substations are integrated in the application of the Central Point. The control of the power networks is achieved by the Central Point, using the received information, from the process (through the communication channels): alarms, signalisation of the equipment state (switch on/ off), measured quantities, signals of the protections and so on.

The second step of the project will mainly include extension of the number of the SCADA systems in substations and extension of the 20 kV network area, which is led from the Central Point.

The second step (eventually third step) of the implementation **of the SCADA/DMS** package includes a configurable set of power analysis modules (DMS functions), which are specifically developed for application on electrical distribution networks. These modules include:

- Short Circuit analysis
- Contingence analysis
- Coordination of the intervention teams
- Phone recorder in dispatching department

- Simulator for training of the operational personal

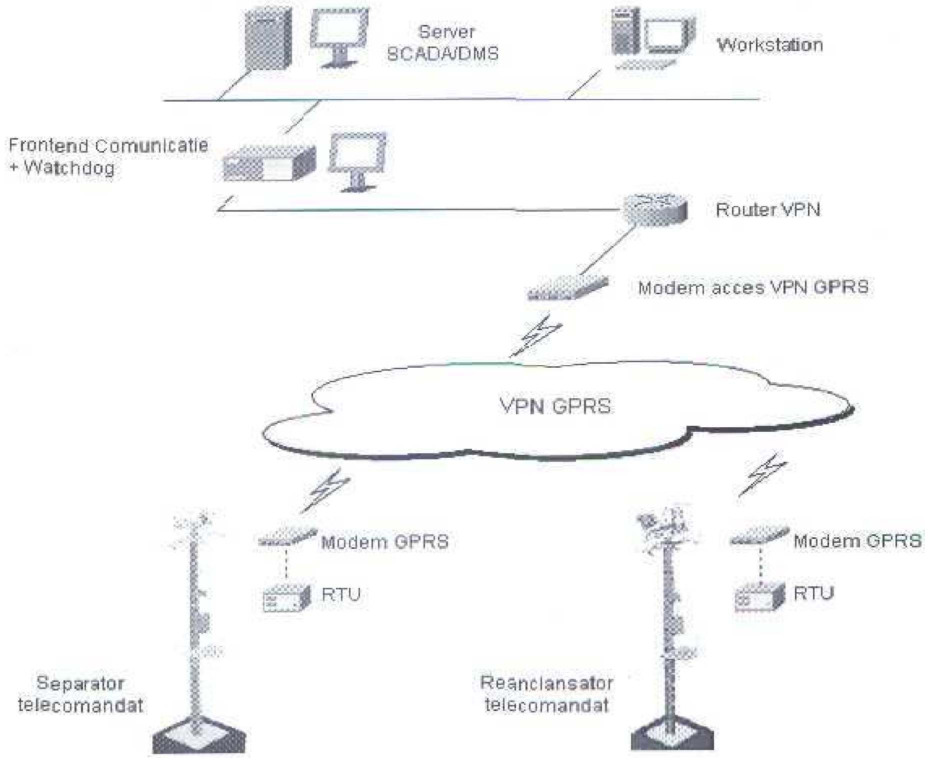


Figure 1. Architecture of the DMS related to the Medium Voltage Network

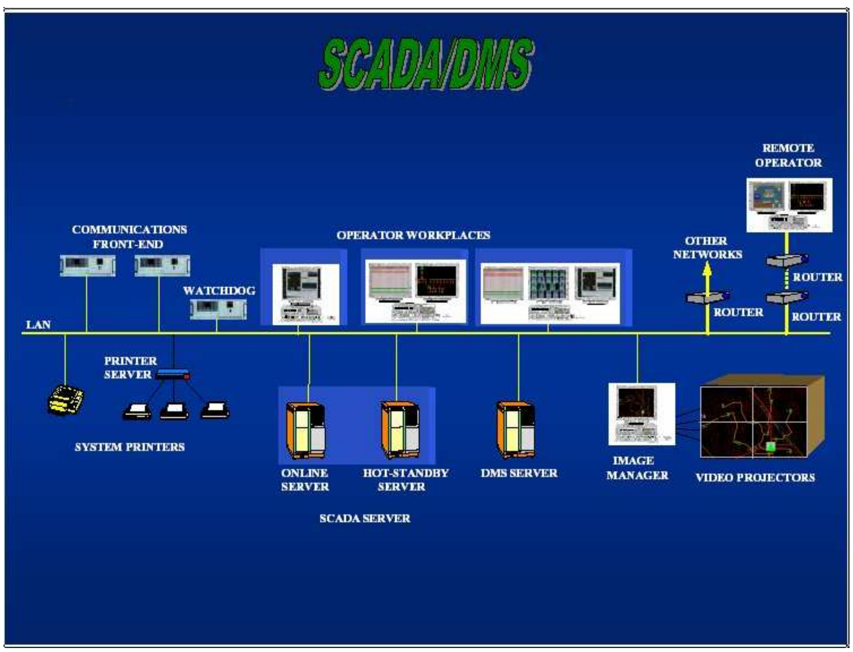


Figure 2. General Diagram of the *SCADA/DMS* Control Centre

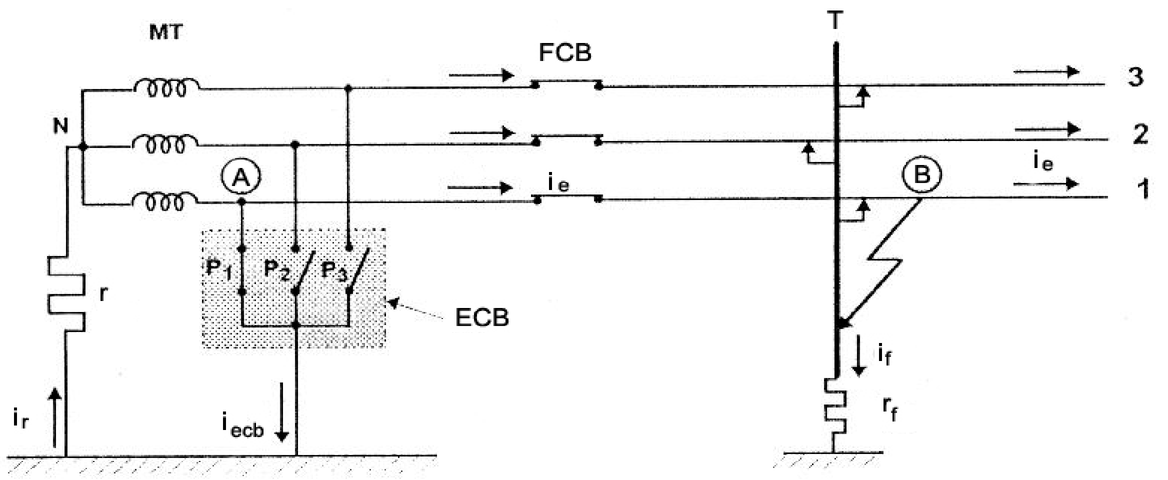
A SOLUTION FOR NEUTRAL TREATMENT OF THE 20 kV NETWORK

Usually, the neutral of the 20 kV network is treated by connection through resistor or inductance. Solution using neutral connection through resistor offers many benefits, but most of single-phase faults can determine the interruptions of electricity (switching off of the circuit breakers) – Goia (3).

The principle of the adopted solution means the by pass connection single-phase fault appeared in the network, switching on of the affected place, without delay time, of the “earth circuit breaker” (operating on the Medium Voltage bus bars) – Vatra (4).

Based on the adopted solution the current through the fault place is reduced to zero and the electric arc will be put out, without any interruption of the feeder.

Figure 3 presents the overview diagram of the Medium Voltage network, connected to the HV/MV transformer, having the neutral connection through resistor.



Where,	ECB	Earth circuit breaker	i_e	load current
	FCB	feeder circuit breaker	i_r	current of the neutral point
	R	resistance of the neutral point	T	overhead line tower
	r_f	fault resistance	A	connection of the earth circuit breaker
	i_{ecb}	earth circuit breaker current	B	fault point
	i_f	fault current		

Figure 3. Operation diagram for earth circuit breaker

Each phase of this MV network can be connected to earth through in circuit breaker having independent action for each phase (earth circuit breaker – ECB).

We suppose a non-permanent fault with earth affects phase 1 of the network in point B of the overhead line (for example to the tower T). The technical solution for elimination of the non-permanent fault consist in self turn off fault arc from the point B, buy-passing through switching on (without delay time) of the pole P1 of the earth circuit breaker ECB for a Δt time, followed by switching off of the pole P1, after the Δt time delay. In this case, the potential between point B and earth is reduced to lower value of the voltage for arc back and thus the non-permanent fault is eliminated.

In the case in which the fault has been non-permanent, the operation of the network returns to the normal state, after the switching off of the P1. If the fault is not eliminated in Δt time, this is a permanent fault, which will be isolated through switching of the protections of the overhead line. In this case, the repeating of the action of the earth circuit breaker is blocked. It is expected a successful indices of 80-90% from all of single-phase faults.

RESULTS OF THE IMPLEMENTATION

DMS Pilot Project

From this project in first step was got the following benefits:

- *The reduction of the cost for maintenance of the circuit breakers*, which operate
- Through using of the reclosers, *electricity sold to customers positioned between the substation and the point in which recloser is operating* is an important benefit;
- *Reduction of period of time for isolation of the fault*, that determines an increasing of the electricity sold and quality of service offered to customers;
- Using SCADA in substations, *the salary of the operator is saved* (2 substation*5operator per substation*800 euro per operator and month*12 months = **about 100000 euro per year**).

Solution for neutral treatment of the 20 kV network

There are presented some outcomes of the implementation of a solution for neutral treatment of the 20 kV network – mix solution (resistor + shunt circuit-breaker), solution in which the number of interruptions and number of customers, affected by faults in the supply networks, are considerable reduced.

Regarding to the short interruptions, we present results before and after applying the new solution. Thus, one year before applying the technical solution of shunt switch in a 110/20 kV substation, 2102 trippings of MV lines were recorded (faults), followed by successful resetting. All of these were short interruptions of the customers (one second).

During a similar period, after the application of this solution, the following was recorded:

- 1496 operations of the shunt switch from 1829 trippings of medium voltage lines were recorded (faults), followed by successful resetting. In this case only 252 trripings was short interruptions. That means the number of the short interruptions was decreased by the improvement of the performance in the distribution system. The success factor by using of this solution was 81% (1496/1829 *100) - Appendix.

CONCLUTIONS

Some conclusions of this project can be underlined.

DMS Pilot Project

By implementation of the SCADA/DMS System are got important reduction of the annual total costs of about 150000 euro, and return of investment is returned in 5 years.

Solution for neutral treatment of the 20 kV network

This solution *„Earth circuit breaker"* performs the same functionalities as the solution using „the Petersen Coil plus resistance" (elimination of the non-permanent faults without interruption of the electricity supply, rapid and safety selection and switching off of the single phase faults), having the following main advantages:

- It is cheaper both as initial investment and maintaining and operation expenditure;
- It is much simple both for primary circuits and for auxiliary circuits, including the point of view of protections and automations;
- It have kept the advantages of neutral treatment using resistance, showing only few:
  - Low level of the over voltages
  - Rapid selection and elimination of permanent faults and the reduction of the duration of exposure of isolation of equipment;
  - Reduction of the step and touch voltage;

We can conclude the high value of the success factor relating to the reduction of the number of short interruptions (81%) and increasing of the quality of services offered to customers.

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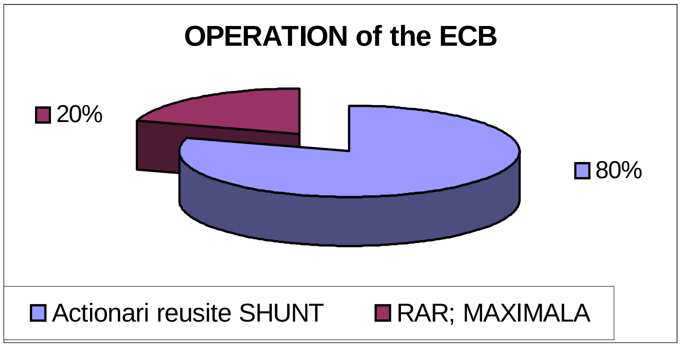
APPENDIX

The Solution of "Earth Circuit Breaker - ECB" in Gaesti - 110/20 kV Substation

Pilot Project

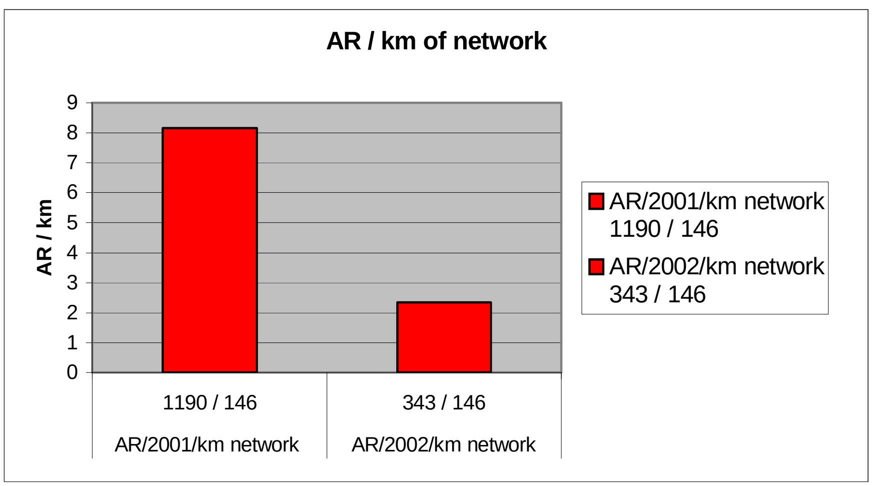
Successful Action of ECB	1496
AR; Overcurrent	354
TOTAL actions of ECB	1829

AR=Auto Recloser



AR/2001/km network	1190 / 146	8.15
AR/2002/km network	343 / 146	2.34
AR/2003/km network	50/146	0.34

Total km of network 20kV = **146 km**



Statistics of AR on overheadline 20 kV 2001 - 2002

	AR/2001	AR/month	AR/2002	AR/month	AR/2003	AR 6luni
PETRESTI	369	30.75	122	10.16	21	3.5
AVICOLA	316	26.33	47	3.91	7	1.16
GAESTI 1	254	21.16	105	8.75	16	2.66
FUSEA	120	10	27	2.25	4	0.66
MOGOSANI	131	10.9	42	3.5	2	0.33