# A ROMANIAN UTILITY COMPANY'S APPROACH IN THE NEW SCADA SYSTEMS DEVELOPMENT

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## SUMMARY

The Romanian national power system interconnection with the UCPTE led to a qualitative leap materialized in new investments for modernizations and retrofit of the power system nodes. Consequently, the IEDs number from different manufacturers grew rapidly, while the communication systems, inside and outside of the substations, need to handle a greater data volume.
The numerical technologies in distribution network control are an essential component for an efficient management; therefore, each utility company should have its own goals and strategy in this field. While numerical protections, SCADA and DA applications and a better control and monitoring level are required by the present business environment, the investments limitations are still an important issue. The paper offers a utility company's point of view in SCADA development and its achievements in the field. Integrated solutions towards hybrid and local solutions were analyzed based upon the company's experience. It became possible to emphasis on a sum of conclusions about the cost-effectiveness, reliability, expandability and open structure to further developments of the systems we have up until this moment. Local systems, even if effective for the first period of implementation, prove not always reliable in medium and long term.
In the last two years, the fund limitations seems to become less restrictive, the business environment becomes dynamic, and this trend will, hopefully, continue even stronger after Romania's EU integration. A more daring approach in the investments for modern SCADA systems was considered to be the right way for this moment. Based on our previous experience of less-reliable control systems, the company adjusted its policy in the field, from simple and mostly local systems and integrators, towards standard integrated systems. The integration of different devices in an interoperable system structure with, preferably, the latest protocols, IEC 61850 and 870-5 series, is an essential requirement of our utility company. The paper presents the most significant actions and achievements of the "Electrica Distributie Muntenia Nord" company in the field of SCADA/DMS and DA systems development, the prospective options and projects. The system configuration is presented, as well as integration problems of the old applications, likewise local SCADA solutions, into company's SCADA system.

**Key words**: SCADA, IED, local vs. standard solution, system' configuration

# 1. INTRODUCTION

The power production, transmission and distribution field are experiencing a highly dynamic development due to new economical realities and trends, in the globalization process. Therefore, as a local company, having a "classical" power distribution network, even if compliant, in terms of reliability of the main primary components with similar power networks from abroad, this might be new longer a guarantee for an adequate integration in the margins of the performance standard imposed by the National Regulatory Authority (ANRE).
It becomes clearer on the importance of an interconnected information network for supervising and control, possibly integrated in a future "Energy Web". Standard protocols implementation and new software tools in this field are increasingly, together with the IEDs number. By raising the information transmission speed and enhancing the data processing it will be possible to reach at a real time efficiency level.

## Overview of Electrica Muntenia Nord Power Distribution

"Electrica Distribution Muntenia Nord" provides the electricity distribution in the centre and east of Romania (Figure 1).


**Figure 1. The Company's area of activity and the 110 kV power network**

Geographically, the company covers 29,765 square kilometres, for approximately 1,300,000 distribution customers, from a total number of 3,300,000 inhabitants in the area. The 110 kV power distribution network consist in 2300 km overhead lines and 121 substations of 110/MV. The company's power networks are spread across 6 Romanian counties with relatively important towns and various industrial activities, agriculture and tourism. There are two dispatchers for the high voltage network and substations, seven local dispatchers for the medium voltage network and MV/LV substations and one dispatcher coordination office. Some of the most important industrial consumers also have their own 40 of 110 kV/MV substations, coordinated by Muntenia Nord's dispatchers. Likewise, there is a number of 84 Medium Voltage substations (most of them being 20/6 kV) and 9500 Medium Voltage/Low Voltage substations or MV connection points.
We are still facing an important moral and physical ageing of the power installations, occurred especially in the eighties' and nineties'. Consequently, a very important range of issues in the investments field is represented by the power substation retrofit and modernization, numerical protections, SCADA and DA projects and applications. The documents of the ANRE (the independent Romanian system authority), like The Power Network Technical Code, and the present business environment require a better control and monitoring level, simultaneously with the improvement of the power quality parameters.

## LOCAL SCADA FOR HIGH AND MEDIUM VOLTAGE

Because modernizing actions for a large number of substations were, in the past years, impossible to sustain, due to fund shortages, this lead to the decision of achieving simple SCADA systems, with local partners or with our own specialists. Firstly, this was feasible for the substations with old remote control panels. The software application uses the Visual Basic language and the Windows XP operating system and allows managing a large amount of information, user-friendly graphical interface and the remote control of the substation.

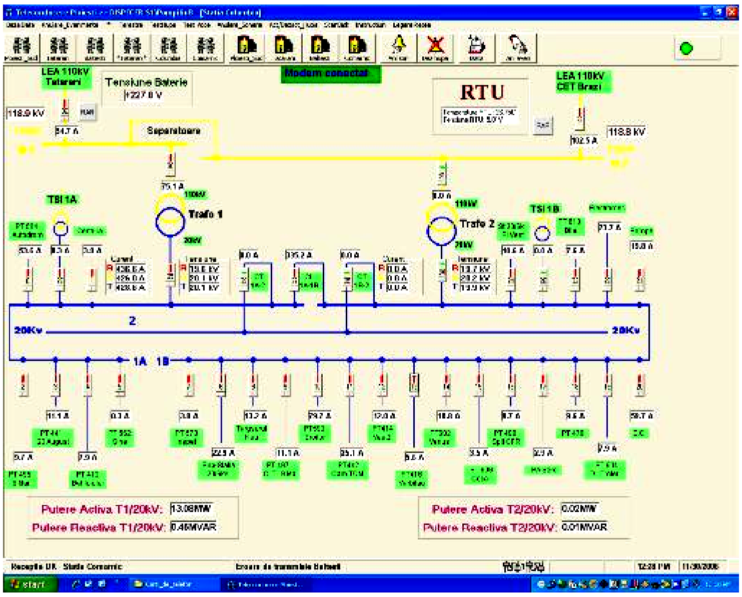



**Figure 2. Main process-image for a 110 kV substation (local solution)**

This approach offered the possibility to implement SCADA functions in several substations. With limited funds, this achievement offered initially good return in terms of results, as reliability, availability and operation cost. The main process-image of this software application is presented in Figure 2. The main image has the role of a container for the other secondary windows, including the buttons and menu bars of the program, the state and signalling bar.

There is also the possibility to display the information referring to the data transmission mode and reception quality in other windows of the program. The application enables the event recording and processing. In case that it is useful to watch the parameters variation for a time interval, the active power, voltage and current variations can be visualized for the chosen period, under the form of a graph or a table. If the computer screen is busy with one substation, and an event occurs in another substation, this will automatically become foreground. If several events occur simultaneously, they range in a waiting queue to be approached in the order of importance. The switching devices are controlled with a “select before operate” method. Each of the operator’s actions is registered in the database, chronologically, together with the events caused by the reception cycle.

In the MV network (20 kV) a number of remote controlled reclosers and sectionalizers were placed in the most important overhead lines in the last years. The remote control package and software is provided by a local firm, on a Windows Xp platform, but remains the problem of integrating the application in a SCADA concept.

### The local solutions’ limitations

As the new technical trends reached to us, we realized that the achievement of an almost hand-made SCADA system cannot represent our goal and this action has its own limitations. After implementation we experienced a number of failures, the troubleshooting rate for a single substation with proprietary solutions reaching, as an average, a Mean Time Before Failure, MTBF ≤ 500 hours. In this number we implied only the hardware components and the software problems, not the communications lines. The MTTR (mean time to repair) can be considered 4 hours, thus, the operational availability results:

$$A = MTBF/(MTBF + MTTR) \times 100 = 99.21\ \%$$

According to this availability level, the failures time reach to an average of 70.1 h/year for a single installation (substation). By multiplying the time with 16, the number of 110 kV/MV substations driven in different variant of proprietary solutions, the failure time is about 1122 hours per year. The total down-time becomes more relevant after the evaluation of the expenses involved (70 000 €/year for maintenance and repair). The substations are not in the same area; therefore three different teams for repairs and maintenance are necessary, with 5-6 substations for each team. Even if the repairs cost was not extremely high, it has a growing trend. Resuming for our local system, we offer a simple "for"/"against" analysis. As arguments, we count:

- It was achieved and developed mainly by our own staff (hardware and software), with minimal costs;
- For a period, offered important savings in operation and maintenance and allowed a better control of the substations;
- It was directly adapted to the dispatchers procedures and specifications;
- Offered the possibility for training and to distinguish the system requirements limitations, both from the user as from a designer perspective.

But, we found important limitations for the local systems, such as:

1. The fact they don't use a standard protocol;
2. A local system has limited development as SCADA and no DMS functions;
3. Reliability and scalability of the software applications are bellow of the modern systems;
4. The IED's and RTU results from an unreliable manufacturing process and the failures of the components have a growing trend;
5. Finally, any of these systems creates dependence upon components, developing and service staff, and soon the maintenance and repairs become difficult and unreliable.

Whatever promising results this approach has given, especially in short-time savings in operation and maintenance, it rapidly turned, in few years, in a so-called "legacy system" [2] that must be adapted to an integrated concept, using standard protocols, such as DNP, IEC 870-5 series, or the latest IEC 61850. We are continuing to use local systems in substations of less importance, but we plan to integrate the HV/MV substations in a company's DMS/SCADA concept using adequate protocols.

The different IEDs origin in substations, and also, the different SCADA solutions provided by manufacturers or local integrators, used to create difficult integration problems at the company level. A step forward in this direction was made with the requirement that new equipments shall use the IEC 61850 communication standard, accepted now by most of the manufacturers and providers [5].

## TOWARDS MODERN DISTRIBUTION CONTROL SYSTEMS

The requirements of the SCADA/DMS system results from strategic goals of the company, such as:

✓ The improvement of the ANRE performance indicators for power distribution - subsequently, the improvement of the client's satisfaction by lower number of failures and unsupplied duration.
✓ Improving the financial revenue and operation efficiency of the company;
✓ A better safety in operation, due to real time information from the field.

In this context, the role of the Operative Control Centre becomes even more important, as a "first line" of defending company's good operation and business. The Operative Control Centre's responsibilities know a new level, by the involvement in the supply contractual clauses accomplishment, as well as real time efficient operation for the power network. The new Control Centre will insure, practically, on-line and real time optimal operation for the company, both technically and economically, for the supplier and customers. As result, two types of functions must be fulfilled:

- Technical functions;
- Economical functions.

Subsequently to the power market and stock exchange operation, and to different power acquisition prices for different points and suppliers, appears the importance of a permanent evaluation and amelioration of costs for the transited (purchased and sell) energy. Therefore, we estimate that in the close future, the role of the Dispatcher Control Centre will be one of high complexity. It will be directly involved in the power acquisition policy of the company, both on 110 kV and MV level. The power acquisition and transit policy will be established on consumption prognosis on short term, market prices, on power losses in our own network and transit losses.

Having these objectives on short and medium term the company strives to implement a performance, flexible, scalable, open SCADA system, up-gradable with DMS functions under course. Fortunately, numerical relays and HMI tools cover now a much wider application range than their analogue counterparts, involving both enhancement in performance and functional integration. The new company's integrated system must be planned and developed coherently from the bay and IED level to the company's Control Centre.

As technical functions, the Control Centre has to fulfil the network operation, including supervisory control and data acquisition (SCADA) and functions like predictive maintenance planning, contingencies calculations, trouble call management, crew management, etc. included usually in the DMS components.

The company plans now to reach towards new state-of-the-art control systems, and the projects shall be briefly presented further-on. The system configuration will be structured in four distinct levels:

L1. The substation and distribution level – the use of the IEC 61850 protocol in a FO-ring LAN, like in Figure 3, we consider it optimal for redundancy and reliability [1]. In the Ploiesti area, there is now one 110/20/6 kV substations with a ring configuration under commissioning. Other existing solutions are still implying old protocols to be integrated via protocol conversions (Figure 2 – HMI in a LON protocol SCADA substation).

L2. The branch level – 4 branches connected via an Ethernet network as shown bellow (figure 4). The same network is used for the substations' connexions and other SCADA or DA solutions in medium voltage. The communication network is mainly achieved on Optical Fibre, but with GPRS access points where the FO is not yet available. Each Local Control Centre (Dispatcher) is provided with a video-wall, as well as the area dispatcher (Figure 6).

L3. At the company's level the designed system as shown in Figure 5. The domain of each user, his rights and limitations, will be stated in the software architecture;

L4. A fourth level can be named the company's connection with the National Power System Control Centre (National Dispatcher), The Energy Market (power stock exchange) and other WAN connections.

The main standard protocols used for data transmission within the system and with power grid and market operators will be:

- IEC 60870-6-TASE 2 (ICCP) between company's Control Centre and National Power System Control Centre;
- XML – https between company's Control Centre and the Commercial Operator (power stock exchange);
- IEC 60870-5-104 with substations' RTU and RTU concentrators over substation's level;
- IEC 61850 at the substation level (or local protocols where these ones will remain in use).

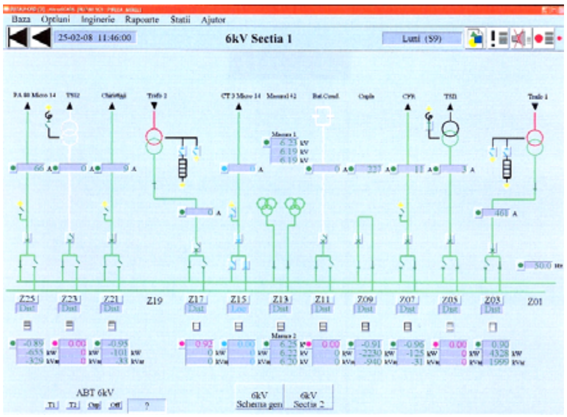



**Fig. 2. Process image on substation HMI**

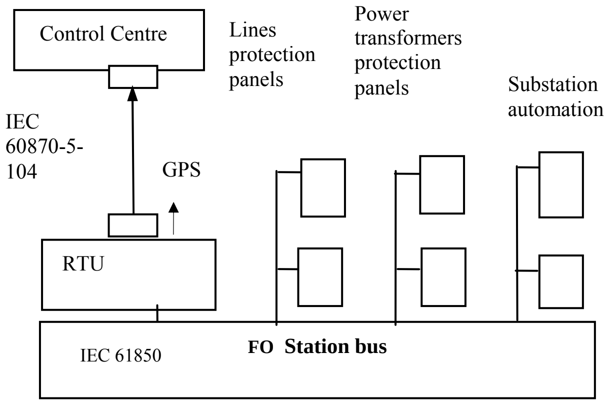
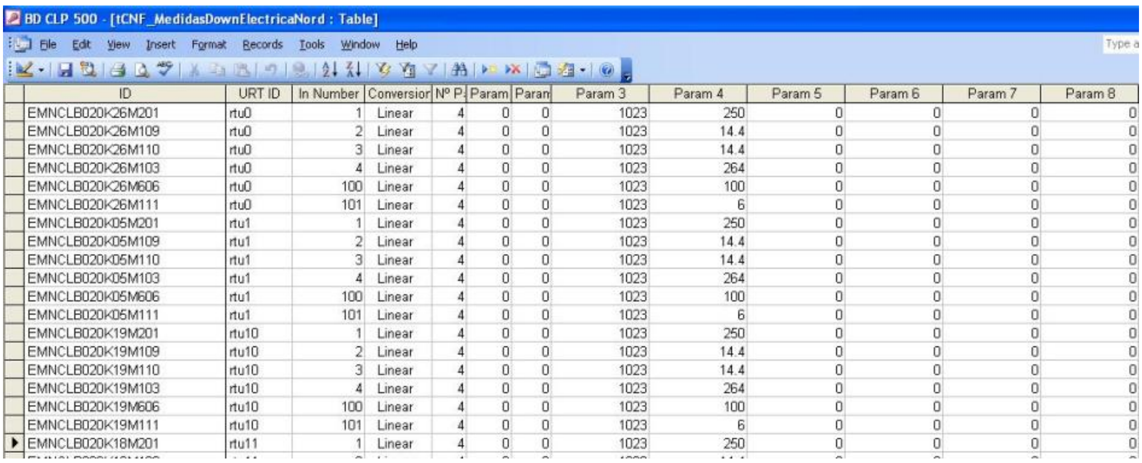



**Fig. 3. Usual 110 kV/MV substation' configuration**

The use of the data support must provide reliable operation and a good performance/cost ratio. The new systems will have a modular and distributed architecture, to allow up-grades and adaptations to future needs.

Now, both the technical solutions offered by manufacturers representing brand-names in the industry, as well as local solutions are put in work. This proved to be difficult for the system integrated operation. The integration of different manufacturers' devices in an interoperable system structure with the IEC standard protocols is an essential requirement, and our short history in the field offered enough evidence to sustain the importance of a strong supplier for adaptable state-of-the-art systems.



BD CLP 500 - [tCNF_MedidasDownElectricaNord : Table]

| ID | URT ID | In Number | Conversior | Nº P | Param | Param | Param 3 | Param 4 | Param 5 | Param 6 | Param 7 | Param 8 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| EMNCLB020K26M201 | rtu0 | 1 | Linear | 4 | 0 | 0 | 1023 | 250 | 0 | 0 | 0 | 0 |
| EMNCLB020K26M109 | rtu0 | 2 | Linear | 4 | 0 | 0 | 1023 | 14.4 | 0 | 0 | 0 | 0 |
| EMNCLB020K26M110 | rtu0 | 3 | Linear | 4 | 0 | 0 | 1023 | 14.4 | 0 | 0 | 0 | 0 |
| EMNCLB020K26M103 | rtu0 | 4 | Linear | 4 | 0 | 0 | 1023 | 264 | 0 | 0 | 0 | 0 |
| EMNCLB020K26M606 | rtu0 | 100 | Linear | 4 | 0 | 0 | 1023 | 100 | 0 | 0 | 0 | 0 |
| EMNCLB020K26M111 | rtu0 | 101 | Linear | 4 | 0 | 0 | 1023 | 6 | 0 | 0 | 0 | 0 |
| EMNCLB020K05M201 | rtu1 | 1 | Linear | 4 | 0 | 0 | 1023 | 250 | 0 | 0 | 0 | 0 |
| EMNCLB020K05M109 | rtu1 | 2 | Linear | 4 | 0 | 0 | 1023 | 14.4 | 0 | 0 | 0 | 0 |
| EMNCLB020K05M110 | rtu1 | 3 | Linear | 4 | 0 | 0 | 1023 | 14.4 | 0 | 0 | 0 | 0 |
| EMNCLB020K05M103 | rtu1 | 4 | Linear | 4 | 0 | 0 | 1023 | 264 | 0 | 0 | 0 | 0 |
| EMNCLB020K05M606 | rtu1 | 100 | Linear | 4 | 0 | 0 | 1023 | 100 | 0 | 0 | 0 | 0 |
| EMNCLB020K05M111 | rtu1 | 101 | Linear | 4 | 0 | 0 | 1023 | 6 | 0 | 0 | 0 | 0 |
| EMNCLB020K19M201 | rtu10 | 1 | Linear | 4 | 0 | 0 | 1023 | 250 | 0 | 0 | 0 | 0 |
| EMNCLB020K19M109 | rtu10 | 2 | Linear | 4 | 0 | 0 | 1023 | 14.4 | 0 | 0 | 0 | 0 |
| EMNCLB020K19M110 | rtu10 | 3 | Linear | 4 | 0 | 0 | 1023 | 14.4 | 0 | 0 | 0 | 0 |
| EMNCLB020K19M103 | rtu10 | 4 | Linear | 4 | 0 | 0 | 1023 | 264 | 0 | 0 | 0 | 0 |
| EMNCLB020K19M606 | rtu10 | 100 | Linear | 4 | 0 | 0 | 1023 | 100 | 0 | 0 | 0 | 0 |
| EMNCLB020K19M111 | rtu10 | 101 | Linear | 4 | 0 | 0 | 1023 | 6 | 0 | 0 | 0 | 0 |
| EMNCLB020K18M201 | rtu11 | 1 | Linear | 4 | 0 | 0 | 1023 | 250 | 0 | 0 | 0 | 0 |

**Figure 4. Analogue measurements' conversion table, from a local protocol to standard protocol in the RTU**

The local protocol conversion to standard protocol is achieved in the new substation RTU, by taking over and processing the ID from the old RTU (ex. Figure 4).

The new hardware configuration will allow to distribute information to a wide set of applications and users. The presented connection with Call Centre system, SAP, remote metering systems, on one hand, and National Dispatcher and Energy Market, on the other hand, will strongly enhance the company's operation efficiency.

## Using the Internet technology

The Internet use was foreseen to be achieved via GPRS communication package, with the VPN (Virtual Private Network) technology [6]. The GPRS network is provided by a well-known mobile phone operator and is seen as a backup way of communication, not yet effective, the main way being through company's FO network and radio trunking. The VPN technology builds a secure communication tunnel for each substation, through the public Internet. Each side of this virtual "tunnel" is protected by a firewall and, also, data encryption and authentication will be employed.

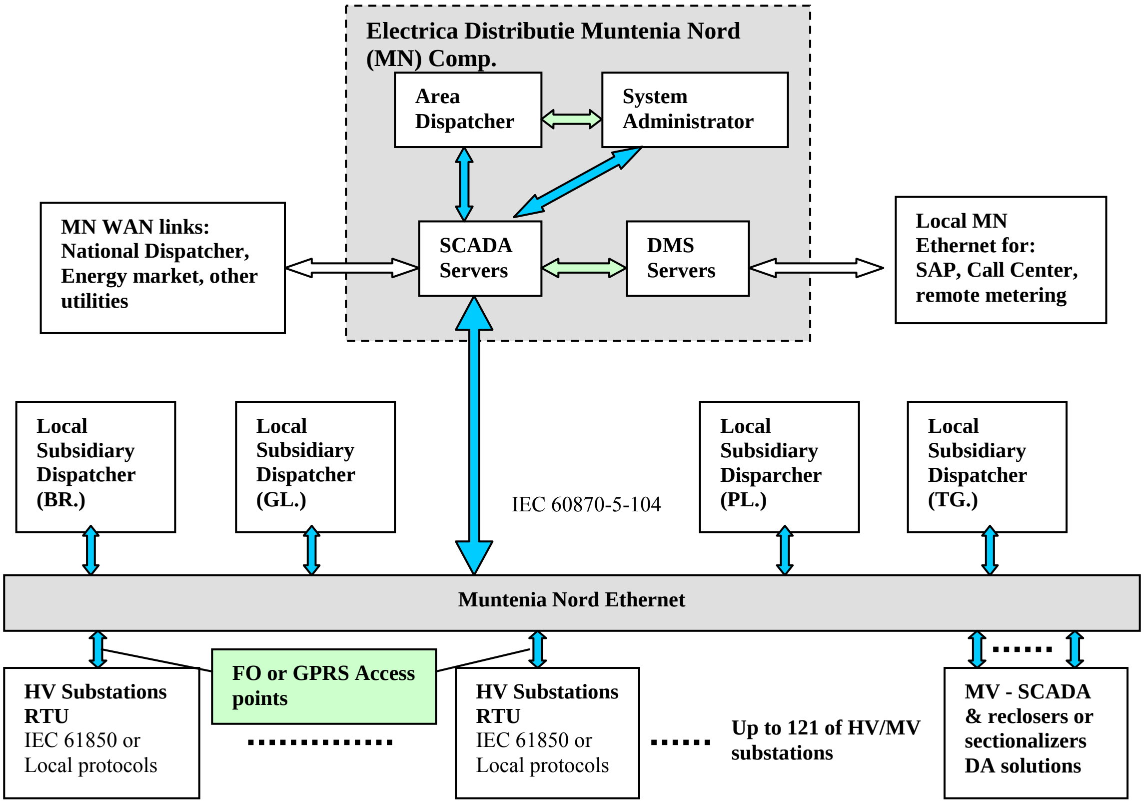



**Figure 5. Control system' configuration at the company level**

## CONCLUSIONS

As in many other fields of activity, in the control systems implementation and evolution, at the company's level, the first steps might be sometimes innovative, but not always in complete accordance with the main technical trends. It was particularly our case, because the first solutions were achieved by own company's staff, starting from local conditions. This happened some 10 years ago, with the first SCADA applications.
For an efficient management and strategy in the company's control systems, the time for local solutions is now away. In the last two years, the fund limitations seems to become less restrictive, the business environment becomes dynamic, and we hope this trend will continue

even stronger after the recent Romania's EU integration. A more daring approach in the investments for modern SCADA/DMS systems might be the right way for this moment. Based on our previous experience of less-reliable control systems, the company gradually adjusted its policy in the field, from simple and mostly local systems and integrators, towards future state-of-the-art integrated standard systems.

The trend for the future SCADA achievements is the integration of the overall system from the bay level to the company's control centre with fast data handling and reliable operations. The integration of different devices in an interoperable system structure with, preferably, the latest standard protocol, IEC 61850 and 870-5 series will be an essential requirement of our utility company. The systems architecture is modular, redundant and scalable to allow upgrades and replacements of some functional blocks without affecting the basic operation.

On long term, all these developments will change profoundly the company's operations, know-how, and even culture. Therefore the high responsibility implied in today's actions. The new hardware configuration will allow to distribute information to a wide set of applications and users.

**Figure 6. Local dispatcher post and video-wall**

LIST OF REFERENCES

1. C. Hoga, G. Wong, 2005, "Communication according to IEC 61850 – Reliability at high speed", CIRED, Turin, Session 3 Technical Reports, 47/1-4.

2. D. Ossenblock, R. Derkinderen, 2005, "How to integrate new technologies and legacy systems", CIRED, Turin, Session 3 Technical Reports, 50/1-4.

3. A. Illo, M. Reischbőck, F. Jaklin, W. Kirschner, 2005, "DMS impact on the technical and economical performance of the distribution systems", CIRED, Turin, Session 3 Technical Reports, 41/1-5.

4. C D'Adamo, F Tramonti, G. Mauri, M Sforna - Contribution of Distribution Network to the Security of The Italian Power Systems: Present Strategies and Future Innovations, CIRED, 2005, Turin, Session 3 Technical Reports, 1/1-5.

5. G. Koch, G. Reichenbach – Smart HMI tools for numerical relays-more than just a setting assistant, CIRED, Turin, Session 3 Technical Reports, 78/1-4.

6. W. Eichelburg – Using GPRS to connect outlying distribution substations, CIRED, Turin, Session 3 Technical Reports, 54/1-4.

7. L. Consiglio, G. D'Amelio, F. Corti – Evolution in the ENEL SCADA system, CIRED, 2007, Vienna, Session 3, paper 032.