EVOLUTIONS IN THE ENEL SCADA SYSTEM

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ABSTRACT

This paper presents how the Electrical Distribution Division of ENEL is performing the transition from its stand alone SCADA to an enhanced Distribution Management System, capable of optimizing and integrating all the concurrent processes and able to meet new regulatory and operational requirements.
ENEL has put in place a multi-year Program based on an innovative engineering and governance approach, with the result that 28 Control Centres can now manage an extremely complex network system, carrying out both traditional network operations and also extended activities.

INTRODUCTION

ENEL DISTRIBUZIONE has to manage a very complex reality: 28 control Centres (STUX and STM Systems), about 2200 Primary Substations (HV/MV) and more than 100.000 remote controlled Secondary Substations (MV/LV).

Nowadays a modern Control Centre, apart from the traditional network operation, has in charge several activities that cannot be defined "subsidiaries" anymore.
These activities, such as Quality of Service certification, management of crews in the field, network and equipment predictive maintenance, cooperation with the national Grid Operators in order to prevent blackouts and face emergency situations, produce new needs and new challenges.
ENEL reacted to this new scenario launching a significant activity of redesign, integration and HW/SW upgrade of its SCADA system, in order to build up an enhanced Distribution Management System, capable to optimize and integrate all the concurrent processes and to replay to all the new requirements.
This big leap in the evolution of the SCADA System toward an enhanced Distribution Management System, has been reached by means of a strategic multi-year Program, that has requested an huge endeavour to plan and to coordinate the tasks assigned to the different stakeholders involved.
This Program has been executed using a specific engineering approach with the supervision of a PMO Team, supported by a methodology specifically developed for the governance of big project initiatives with a strong technological background.

ACTIVITIES PROCEEDINGS

Until few years ago each SCADA system was completely independent on the others.
System LANs were isolated and not connected to WANs.
Data import/export was quite limited and operated by floppy disks, cassettes or serial point-to-point connections; network data base was very poor and limited only to SCADA function needs.
There were a few auxiliary functions and reports that could not be defined as "Distribution Management Functions".
In the open market, ruled by European directives and local regulator rules, new activities are in charge of network operators and systems: these activities come out from the following needs:

- to be compliant with the regulator rules: such as the certification of the continuity of service;
- to avoid penalties or to gain bonuses by the ruler (Italian Authority): such as all the actions undertaken for the reduction of interruption durations;
- to be competitive in the electricity market: such as the reduction of costs, the improvement of efficiency, optimization of operative processes, etc.

Renewal and functional upgrade of SCADAs and DMS systems are continuous activities that must be planned on time to obtain real advantages in the Distribution process management. Therefore it is important to anticipate future needs and to sign flexible contracts with HW/SW external providers to face activities not foreseen.
During the year 2005, an ENEL working group examined the existing functionalities supported by the actual telecontrol system, characterized the needing and defined not only the short terms actions but also the guidelines for the long term evolution of the entire System.
These evolution regards technological upgrades - both in central system architecture and in RTUs - and new functions implementation.

Actually in the meantime ENEL lunched the "TPT-2000 Project": this is the massive substitution of the old RTUs installed in HV/MV substations with a new intelligent device, called TPT2000.
TPT-2000 is a new generation of RTU developed specifically for ENEL substations: the renewal regards

- *Technology:*
  standard PC platform, optical Ethernet interface, standard TCP-IP protocol;
- *Functions:*
  local intelligence and time tagging for a precise event diagnosis, local automation functions, event logging to avoid loss of information in case of communication interruptions;
- *Capacity:*
  1000 signals versus 240 (old RTU size);
  200 commands versus 100;
  72 measures versus 50.

New functions implementation

Continuity of service calculations and certification
This packet is used by the operators for fault management and then transmitted to a corporate system for continuity of service calculations and certification.
For each outage the Central system produces packet of data containing the following information:

- the list of the operations carried out automatically or by the operators from the beginning to the end of the outage;
- the connection status of MV relevant network at the beginning and at the end of the outage;
- the number of customers involved in each phase of the outage and relative interruption times.

Planned works in the network
The electronic management of work plans on MV network has been integrated in the system and allows the work plan definition and documentation, according to the internal safety rules and organization.
A web access to network data and diagrams. is now allowed at all operative levels. Collision checks with other work plans are automatically executed.

A Simulation system will be developed to help the planners to define the operation sequences, to manage configuration simulations and introduction of future elements in the network diagrams, to verify and virtual execute all the operations, with the support of electrical calculations.

Off-line and real time electrical calculations
An electric calculation packet is being integrated in the System to provide high speed Real Time calculations with continuous display of the results on existing network diagrams (i.e. load flow, voltage, etc).
The on line electric evaluations help the operators in resupplying procedure, large area restoration or fault detection.
The off line procedures are available for optimal network configuration, state estimation, load flow on modified portion of network.
Topographic views of the networks.
By means of a second video display, the operator can ask the system for a topographic view of the network in the area of his interest.
Links between topological and topographic representations are suitable so as to focus both views on the same elements of network.

This feature is possible by means of electronic managements of satellite photos or graphical maps of the territory under control.
Tools for optimal Fault management
The operator can follow each outage, optimizing interventions, crew deployment and number of clients out of supply thanks to special dashboard that monitor the evolution status of each interruption.
Special procedures propose operative actions to the operator, to optimize and speed up fault isolation and supply restoration.
Functions and tools to improve System availability
When the number of events at the Central System input become very close to the system capacity to process each event correctly, there is a switch to a very special status named *"Critical context"* where event processing is simplified in order to avoid excessive delay or system crash.
Also the acquisition of alarms and events by the operators is simplified and limited only to a significant subset of information: in these condition a operator must pay attention only to the more critical events under control.
System Load simulation
It is an HW/SW to generate sequences of events at the system input, to measure its capacity to manage situations of very high event flow (outages in large areas).
By means of this tool it is possible to set the right level to switch the System into the "Critical context status" and to

verify the effects of the actions that should improve the System availability.

Connection with ENEL intranet and corporate systems

A lot of new data exchanges are now available:

- Data exchange between SCADA and corporate network Data Base,
- Data transfer towards Trouble Call Management System;
- Data Transfer towards the System for continuity of Service calculation and certification;
- Data Transfer towards National grid control Centres.

Technological upgrades

Each ENEL remote Control System has being provided by a Data Archives Server, to collect and to store all relevant data for years. Each System has now an Web interface, to facilitate the access to the data and to the network diagrams.

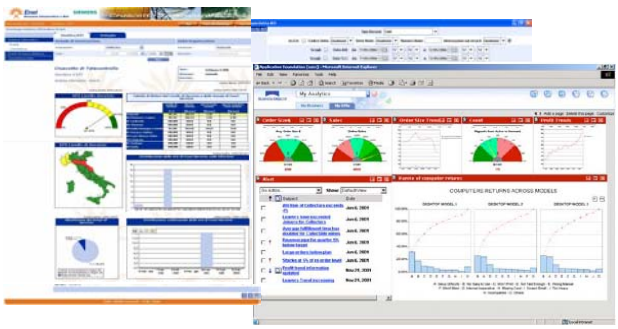
All the systems have been connected each other via IP Network: this new communication architecture brought ENEL to define and to realize a security layer to prevent intentional damages.

The connection within all systems has allowed ENEL to face the emergencies in a more effective way, thanks to the introduction of remote operative stations, capable to provide mutual assistance between the different Operative Centres.

The new hardware architecture allows to distribute several information to a wide set of new applications, available not only in the Control room but also in ENEL peripheral sites: for example, the definition and the execution of Work Plan is now fully supported and usable by people everywhere in the country thanks to web interface, the Fault Management has been improved and linked with other company procedures and tools.

All these architectural and functional developments are changing ENEL's approach to the Network Operations and Supervision.

The large amount of data led up to develop synthetic dashboards with either local and global point of view, useful to measure the performances of all the systems and to identify possible operational enhancement.



Modern Electric Distribution is based on several systems, networks and procedures that are connected each other and must be always available and well performing.

In this context it is important to monitor constantly the functional status of equipments, procedures and performance of each component of the puzzle, in order to maintain the global performances of the Utility in the market.

From these need the idea of a "National surveillance center" was born, that coordinates and supervises all 28 Operative Centres.

This National Centre is connected with all ENEL SCADA Systems and allows to have a real time view over the entire Distribution Network. The operators of this new National "Control Room" can have:

- System performance reports;
- Network and System Management of STUX and STM Systems all over the Country
- Network operation performance report;
- Real time monitoring of the service continuity all over the territory (Italy);
- Electrical Network "Event log" (both National level)

The National Control Room has in charge the management of the situation in case of outage in large areas of the country and is the unique interface towards National Grid operator, press agencies and governmental organization.

THE ENGINEERING AND GOVERNANCE APPROACH

The evolution of SCADA System toward an enhanced Distribution Management System is related to a multi-year Program with a lot of complexity elements:

- First of all, it is necessary to assure the full System availability during the transition.
- The customization level requested can become potentially high, raising integration issues with the enterprise information system.
- During the program execution can emerge changes in the scope of work or new functional/not-functional requirements, resulting in important changes in the operation processes, with a significant impact to the final user.

The key questions are: which software engineering model best fit the evolution of the system and which is the best approach for the governance of the project, with the above constraints?

Regarding the software engineering model, a mixed approach has been chosen, putting together a structured model with an agile one:

- The structured model is based on a incremental and iterative software development process, characterized by

an high level of traceability and written documentation of each management entity (i.e. User Requirements or Change Request), structured communication and different level of evaluation and test for each functional implementation.
- The agile model is based on real-time communication, preferably face-to-face, producing very little written documentation relative to the structured model; software is developed in short time boxes, which typically last one to four weeks.

The structured model is the backbone of the software engineering model, representing the "standard" way of work. Instead, the agile model is generally used during the final refining and tuning of each function implemented or exceptionally to develop prototypes or to cope with emergencies.

Both methods are based on strong collaboration between the customer (ENEL) and the software provider (Siemens), that share planning, risks and issues.

The software provider takes part to the initial requirement definition, in order to understand the real ENEL needs and the related business processes; for this reason it has set-up a Demand Management Team, that collects and analyzes user requirements in order to write the functional specifications, finally approved by ENEL.

Subsequently, when the software modules are ready, tests are carried-out on the customer site in an environment very similar to the final one; final users, analysts and developers are directly involved during tests, that normally are followed by a bug fixing and tuning session.

In order to guarantee the program success ENEL has adopted a new paradigm for the governance of Project Initiatives, that is able to mitigate the risks and to address the following critical success factors:
- Purpose alignment between Business and IT.
- Governance awareness about Scope of Work.
- Structured involvement and communication between stakeholders.
- Integrated supporting tools, in order to assure information availability and consistency.

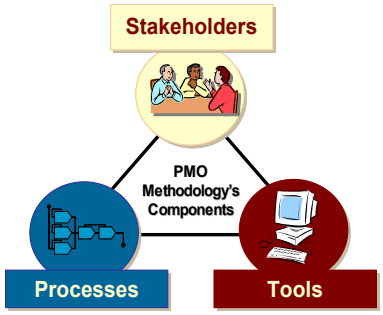
ENEL has introduced a permanent PMO Team, playing the role of a Communication Hub between Business and IT people, that typically have different objectives and point of view.

The PMO Team is not a bureaucratic structure but it is actively involved in the daily life of project initiatives, knowing in deep the scope of work, the issues and the dependencies between the different components.

PMO is supported by a methodology specifically developed for the governance of big project initiatives with a strong technological background.

The methodology adopted is composed by 3 main elements, that are the Stakeholders involved, the Processes that regulated the Project life cycle and the supporting tools:
- Stakeholders: To allow an effective Project governance, it is necessary to set-up a proper OBS (Organizational Breakdown Structure) with clear roles and responsibilities, and characterized by an high level of collaboration between the customer and the sw provider.
- Tools: Supporting tools play a key role by assuring coherence and consistence of project information, make them available to all authorized stakeholders.
- Processes: Processes could be viewed as Project Laws that regulate Project Life Cycle, because they represent the correct way that allow stakeholders to execute management tasks using proper supporting tools.

A lot of benefits can be related to the use of such methodology, for example supporting tools allow to distribute in a structured and timely way the critical information needed by stakeholders, assuring an adequate support for helping make decision.



The Project scope of work is clearly identified, defined and tracked in a structured and controlled way thanks to the implementation of proper workflows, that in practice also implement the communication plan. Every System release is clearly defined in terms of functionalities and software components, the PMO Team has the responsibility to manage the consistency and the dependency of different releases. This kind of awareness makes the PMO Team able to actively take part in daily project life, supporting the Project Manager and Team Leaders to manage issues, staffing problems and workload planning.

The engineering and governance approach used has allowed to set a "win-win" relationship between ENEL and software provider, where the first is mainly focused in time and quality issues in order to reach business objectives, whereas the second is focused in technical and economical sustainability of the software development projects. Following the main benefits related to the software provider:
- Final reworking derived by tests are traced by means of Change Requests, that are managed using ad-hoc contracts, thus avoiding scope creep.
- Early participation in requirement definition results in more accurate estimations, that are quickly approved by ENEL.
- Software Releases are jointly defined in terms of date and contents, assuring sustainable development for the Software Provider together with ENEL Priorities.
- Issues, risks and delays are discussed during monthly meeting, where key stakeholders assure a quick response.

Obviously, the introduction of this new approach wasn't painless for stakeholders (both for individual and the whole company) and without obstacles, but today ENEL can rely on strong engineering and governance methodologies that together make it possible to achieve highly challenging business objectives.