INTELLIGENT NETWORK ASSETS SUPERVISION AND CONTROL IN ENEDIS

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ABSTRACT

Recent Years gave rise to a rapid increase of issues having an impact on ***Supervision and control Domains*** *for utilities, namely:*

a. *Automated metering (Linky Project in Enedis) provides new opportunities for deeper supervision and control of MV and LV networks; it also bursts the quantity of data managed in the control system environment,*
b. *Communication technologies are exclusively based on IP with opportunities for supervision and control but also drawbacks with the cyber security issues,*
c. *programmed abandon within the next decade of former analogue communication networks by operators and manufacturers (resp. PSTN and analogue radio still widely used by ERDF for OT systems) forces the French DSO to re-investigate Communication master plan for Supervision and Control,*
d. *Digital Control and supervision technologies in primary substations and in a lesser measure in secondary stations are heading towards digitalization with new opportunities*
e. *The present and upcoming massive connection of DER on the MV and LV networks gives rise to new control and supervision functional needs and its declination in both new IT/OT integration and new controllability and observability needs,*
f. *Smart Grids and market flexibilities leads to a wider need of exchanges between DSO, TSO, future flexibility operators and a need for the implementation of new relevant IT and OT interfaces,*
g. *The increase in the quantity of supervised equipment on the network with smart grids deployment forces utilities re-analyze subsequent assets management and maintenance issues that will be managed remotely.*
h. *The urgent need for strengthening Cyber security for OT system dedicated to electrical systems supervision and control due to energy major role in our societies.*

To efficiently address all these issues, Enedis decided to launch a global renovation project of Supervision and Control Domains. The project objectives are to re-visit all relevant issues i.e.:

- *Design of equipment, IT and OT systems including standardization needs; subsequent evolution needs definition for existing systems,*
- *Implementation methodologies,*
- *Assets management and maintenance evolutions: Unique data reference source and remote maintenance in particular*
- *Equipment and systems renovated assets management and global configuration,*
- *Equipment and systems global supervision (cyber security, telecommunication, assets maintenance)*

Project organization, priority issues, methodology (use case driven) and road map with major milestones are described in the Paper..

INTRODUCTION

Utilities are facing a rapid increase of issues having an impact on Supervision and control Domains. These latter range from innovative technological opportunities (i.e. IoT[1] and IP for telecommunications, native digitalization integrated in power equipment for supervision and control), to new threats linked to cyber security and new functional needs to cover energy Transition development (management DER on MV and LV networks, management of Electric Vehicles charging units, etc.) .

These evolutions forced Enedis to reconsider the consistency of supervision and control Domains within the utility and to launch a global renovation project

This paper describes the renovation project – so called herafter i3C as intelligent Control, Command Coordination project - in all its aspects from initial genesis to the actual status of prototypes.
It also presents main outcomes so far and further project milestones.

PROJECT GENESIS

Control Command Domain at Enedis covers Network devices control, monitoring and protection as well as all equipment, automatisms and systems addressing the related operation and maintenance needs (see fig.1 bellow).

[1] Internet of Tools

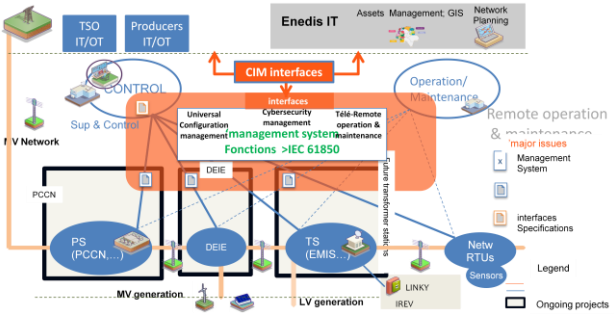

Fig.1

Enedis historically built its Monitoring and Control activities on several strong pillars:

- A centralized SCADA control system developed internally which somehow standardized design practices for monitoring and control data modelling and data lists,
- An operated telecommunication system dedicated to operation and Control (Operated IP network for Primary Substation, PSTN, private Radio and recently GPRS-xG) for remote controlled devices in the field,
- A strong *innovation culture*, backed by EDF R&D expertise, for both process interfaces with full digital substation internally designed[2] in the early 2000th and DMS function with centralized self healing deployed before 2010,
- Own Enedis operation & maintenance teams for SCADA and local process interfaces for monitoring and control (RTUs, Digital Substations supervision systems, relays, sensors, etc.),
- a strong willing to keep the data model consistency between SCADA data bases and RTUs parameters on the field.

However the design organization spilt within Enedis per expertise domain (telecom, centralised control, primary substations, secondary stations) does not allow so far to optimize synergies.
This optimization need was also enhanced by multiple other drivers which are described in the following.

The major drivers of Monitoring and Control renovation project at Enedis

Linky

Automated metering (Linky Project in Enedis) is entered in its first deployment phase. It provides new opportunities for deeper supervision and control of MV and LV networks; it also bursts the quantity of data managed in the control system environment impacting both the design of network monitoring in the future (rendering low Voltage networks operation and control accessible for utilities) while opening "supervision eyes" on the LV networks behaviour drastically increasing the quality of real time data (even on the MV networks). The Linky project was also the opportunity to design a monitoring and control project from scratch trying to make the best use of new digital technologies and innovating as well (Linky didn't rely on Enedis internal expertise for network operation & control so as to keep a wide innovation capacity). It was also confronted before any other monitoring and control projects within Enedis at a high security and cyber security challenge and prone to one of the earliest SOC[3] implementation (along with a NOC[4]). Last but not least, Linky large and short deployment schedule forced the project team to innovate in terms of deployment process (with a complete efficient and highly digitalized manufacturing-warehousing-installation-commissioning-operation chain) enhanced by remote maintenance capability (versioning management, firmware downloading for concentrators). Linky was thus from the methodological viewpoint a project similar to monitoring and control renovation except that it had no existing context to consider.

Telecommunications

Communication technologies addressing *monitoring and control needs* are today a mix of IP and conventional media. This situation will rapidly evolve due to the fact that other existing non IP or non IoT technologies are rapidly vanishing. Moreover, new technologies based on IoT will progressively expend on the electrical networks for data retrieval on smart grids on the medium term (5-10 years?). These two technological orientations –i.e. IP, IoT- that are somehow complementary for operation and control since each is adapted to different use cases, will represent opportunities (higher coverage at lower cost for IoT compared to GPRS and xG, higher resilience via easier routing capacity for IP, equipment standardisation lowering costs for IP, mutualisation of telecommunication media for IP, etc.) and drawbacks (Cyber security for IP and IoT).
Programmed abandon within the next decade of former analogue communication networks by operators and manufacturers (resp. PSTN and analogue radio still widely used by Enedis for OT systems) forces the French DSO to re-investigate Communication master plan for Supervision and Control.

Digital Control and supervision technologies

Digital Control and supervision technologies became a de-facto standard (based on IEC 61850) in primary substations, around the world, mainly for protection and related devices. They are progressively expanded to transformers, sensors, circuit breakers etc.. In Enedis, as

[2] EDF

3 SOC : Security Operation Centre
4 NOC : Network Operation Centre

said above, primary substations were digitalized around year 2000 on the basis of a proprietary standard. This latter low diffusion renders the migration to IEC 61850 quasi unavoidable. However the functional limitation of 61850 vs. Enedis needs, to cover some typical protections and services slows down the process. Such an issue should thus be addressed urgently and there is definitely room for a comprehensive analysis of the case with subsequent deep involvement in IEC Working Groups.
Regarding MV network devices monitoring and control, digitalization didn't so far, except on prototypes, concern secondary stations but the pace towards it is already launched, presenting new opportunities for monitoring and control especially for assets management and sustainability.
Moreover, several demonstrators in which Enedis is involved are experimenting 61850 digitalization for electric Vehicles charging units with a deep work on downsizing (towards low costs).
Digital technology relying on the 61850 standard is therefore a must to be globally considered throughout the design phase of primary and secondary stations as well as equipment spread on Enedis networks (LV & MV). This is thus an important driver towards a renovation of monitoring and control.

DER connected on Enedis networks
The present and upcoming massive connection of DER on the MV and LV networks (i.e. 95% of the total quantity of existing DER sites in France are connected on Enedis networks) gives rise to new control and supervision functional needs for both DSO and TSO. In particular, DER connection forces DSO to both anticipate network behaviour (with Operational Planning) and to additionally cover potential faults or defected forecasts with real time advanced functions (Volt Control and Self healing). And thus even if anticipation of DER behaviour guaranties in a "normal situation" optimizing network operation, real time advanced functions are deemed necessary.
Those latter rely on reinforced network monitoring with accurate voltage Distribution State Estimator (DSE) based on synchronised sensors (P,Q,U).
The necessary evolutions on network monitoring and control (set up values, operation scheduling) have a direct impact on standards (IEC) for which related requirements are new. These evolutions are under test in the frame of Smart Grid Vendée Demonstrator; for which preindustrial development/deployment have been made on site (sensors, new RTUs, new fully digital interfaces for DER sites -on MV networks- under a 61850 link being secured).
DER connected on DSO networks are thus a major driver towards a necessary renovation of monitoring and control policy within Enedis, in this frame the major identified use cases are:

- reinforcement of network monitoring (electric flows and voltages synchronized and smoothened via DSE) with a specific attention on DER forecasting tools and dedicated sensors deployment (i.e. soil fish eye cameras and pyranometers),
- Facilitation of DER supervision and control interface via IEC standards implementation.

Flexibility contracts and markets
Smart Grids and market /contractual flexibilities leads to a wider need of exchanges between DSO, TSO, future flexibility operators and a need for the implementation of new relevant IT and OT interfaces, which rely on underlying digitalization of the process interface. They are thus concerned by data configuration, modelling (i.e. CIM market), exchanges modelling which impact the global and detailed design of the renovation scheme of control and monitoring.

Increase in the quantity of supervised equipment
The increase in the quantity of supervised equipment on the network with smart grids deployment forces utilities re-analyze subsequent assets management and maintenance issues that should be managed remotely to master maintenance costs.

Cyber Security
The urgent need for strengthening Cyber security for OT system dedicated to electrical systems supervision and control due to energy major role in our societies definitely imposes to strengthen cyber security measures considering cyber attacks hardening on utilities in the recent months. This is definitely one of the most important drivers towards monitoring and control domain renovation needs which also impacts equipment procurement process.

After this comprehensive analysis of all factors and drivers that impact monitoring and control domain, it is obvious that the need for an internal renovation project in this frame is deemed necessary, with a high necessity to revisit existing designs, procedures and equipment.
This project launched in 2014 with the assistance of EDF R&D is being described in the following paragraphs.

MONITORING AND CONTROL RENOVATION PROJECT AT ENEDIS: PROJECT OBJECTIVES & MAJOR OUTCOMES

Project general objectives and methodology

The project objectives are to re-visit all following issues i.e.:

- Design of equipment, IT and OT systems including standardization needs; subsequent evolution needs definition for existing systems,
- Implementation methodologies,
- Assets management and maintenance evolutions: Unique data reference source and remote maintenance in particular
- Equipment and systems renovated assets management and global configuration,
- Equipment and systems global supervision (cyber security, telecommunication, assets maintenance)

To achieve these objectives the applied methodology consisted in:

a. Establishing a list of all major use cases (Business Use Cases or BUC) which are typical of monitoring and Control; in this matter, following ones have been selected:
    - Implementation and commissioning of three different subsystems i.e. Primary substation, remote controlled secondary substation, DER interfaces;
    - Maintenance of the above depicted subsytems ,

    For each of them, an analysis of relevant impacts on the control system, SOC and NOC is performed as well as the study of all interfaces with surrounding OT and IT systems either internal (GIS, Maintenance management system, Planning Tools, Linky AMR, etc.) or external (TSO IT/OT, Producers IT/ OT, Agregators IT, other DSOs, etc.).

    Moreover, a deep analysis of the impact of business use cases implementation on standards integration and necessary evolutions to cope with needs, has also been performed.
b. Deriving System Use Cases from BUCs,
c. Identifying the major impacts on existing processes and organization.

Project major outcomes

So far, the project major functional subsystem identified is the Management System (see also fig.1 above).

Cornerstone of the project, the Management System shall ensure various functions such as:

- Unique and universal data configuration for all equipment entering in the monitoring and control domain including telecommunication equipment
- equipment supervision from the maintenance perspective: analysis of faults and defects, diagnosis and remote repair, with an automatic feeding of preventive maintenance management
- equipment firmware secure remote management,
- assets management (hardware , firmware and software),

For efficiency puposes, and due to the fact that the Management System shall be able to handle a high variety of equipment types (from IEDs to RTUs, from protection relays to telecommunication equipment, etc.) and manufacturers, the Management System concept is widely based on standards introduction (IEC 61850-IEC 61968, IEC 61131, etc) and the necessary evolutions of existing standards to cover the emerging needs.

The Management System is necessarily closely interfaced with Enedis control system with a final objective of a substitution of the dedicated control system configuration tools by the Management system.

Moreover, the Management System shall be designed with standards interfaces allowing exchanges with as various IT and OT systems as internal systems participating in assets management, network planning, network engineering, network maintenance, as well as external IT and OT systems of TSO (RTE), neighbouring DSOs, flexibility Aggregators, Municipalities, etc.

These two later aspects (namely interface with Enedis control systems and multiple IT/OT interfaces) are part of the major challenges of the project.

Priority Actions on the Project

The development of a Management System prototype has been considered as a priority, as well as its declination on specific use cases linked to:

- the deployment in 2018-19 on Enedis networks of new RTUs dedicated to secondary substation observability and control and fitted with all sensors and automatisms covering smart grid needs. 61850 modelling and remote maintenance will be embedded in these new RTU generation;
- The deployment in 2018 of a new full 61850 digital interface with generation Sites. Firstly dedicated to generation plants connected on MV networks, this new interface is designed to cover all types of monitoring and control interfaces needs such as Electric Vehicles charging interfaces, LV PV panels interfaces and other various equipment potentially spread on Smart Grids networks.

  A first prototype of this digital interface (called eDEIE) is already operational on tw demonstrators.
- The deployment after 2020 of a new generation of primary substation monitoring and control systems based on 61850.

In addition the project shall also focus on the integration of existing devices management in the frame of the Management System concept.

CONCLUSION & PERSPECTIVES

Enedis Monitoring and Control Renovation project induces a real re-volution of the relevant domains with a deep impact on internal and external OT & IT systems. It fully addresses the emergence of a “Management System “ infrastructure, widely based on standards introduction (IEC 61850-61968) - while highlighting their limitations and their necessary evolutions to cover the Smart Grids emerging needs.

The Management system builds the cornerstone of future Monitoring and Control systems in Enedis while guaranteeing their evolution and perfect integration in OT and IT systems including Telecommunication infrastructure.