FROM TRADITIONAL TO DIGITAL ASSET MANAGEMENT OF NETWORK COMPONENTS

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Abstract

This paper has, as a main objective, to go deep in the applications needed, at an ecosystem level, to have a proper inventory of traditional and digital assets taking inspiration from IEC TC57 as a reference architecture. In addition, the paper will also define the data exchange and services needed between the new electronic devices and the application installed in DSO premises to control and manage easily hundreds of deployed devices, mainly in secondary substations. This should be considered as the initial key step towards a digital twin of the electrical network. The final aim is having a holistic approach to the management of all the assets involved in the operation of the distribution network.

1 Introduction

The main goal of the Smart Grid paradigm is to transform the distribution networks, to operate it in a more secure and stable way. This transformation requires an improvement in its flexibility, reliability, and efficiency. These last goals can be achieved by new hardware and software solutions combined with a digital transformation strategy.

One of the key business operations of a DSO, as the operator of its electrical network and the thousands of components inside it is related to a proper strategy and control of their main assets.

The digitalisation process that is undergoing in the distribution network, is allowing to conventional electrical equipment to evolve and increase their functionalities thanks to electronic devices. These new components allow the operator to manage the network, have access to the status of the electric components and gain observability of the measurements of the installations and customers.

Year by year, more and more devices are being installed, therefore new needs show up when big quantities of installations want to be managed. Indeed, the current scenario, because of COVID-19, might present restricted access to facilities, pushing the operators towards a complete remote management of the digital assets.

This paper has, as a main objective, to go deep in the applications needed, at an ecosystem level, to have a proper inventory of traditional and digital assets taking inspiration from IEC TC57 as a reference architecture [1]. TC57 is one of the technical committees of IEC that is in charge of the development of standards and harmonized documents for the exchange of information in power systems including EMS, SCADA and distribution automation and teleprotection. In addition, the paper will also define the data exchange and services needed between the new electronic devices and the application installed in DSO premises to control and manage easily hundreds of deployed devices, mainly in secondary substations. This should be considered as the initial key step towards a digital twin [2] of the electrical network.

2. Methodology

This paper performs an introduction to the capabilities a Utility must put in place to manage an increased number of network automation devices in an efficient and effective manner. For this purpose, many advanced digital services will be exchanged between devices and the system, using remote access management not only during commissioning but also during operation and maintenance, covering the complete life-cycle of the devices.

Initially, Secondary Substation asset management is analysed from a device perspective, explaining the evolution this type of electrical installations are undergoing, where no digital assets were present some years ago. Today all the traditional electrical components such as switchgears, transformers or low voltage boards are now being treated as digital electrical components.

Secondly, the focus will go to the system level.

2.1 Asset Management from a Secondary Substation device perspective

Before the SmartGrid concept started to become familiar, Secondary Substations were not particularly digitized. Medium Voltage switchgears were mainly manual, and the Low Voltage side of the installations were very far away from any automation concept. One of the first approaches towards the improvement of the quality of service of the end-customers, was to motorize the Medium Voltage switchgears and therefore be able to reconfigure the grid after a fault. This motorization process comes together with the introduction of electronics and communication devices in the Secondary Substation [3-6]. These initial steps were performed with serial communications and protocols, which many times were even proprietary protocols until IEC standards started to become familiar. At this stage, operation of the asset was the main target, being still very far away from a potential complete management.

Leaving smart metering aside, (where in some countries helped a lot the digitization process of the Secondary Substations), the main inception point during the digitization process of the Secondary Substation was the standardization of IEC 60870-5-104 [7] protocol for switchgear automation, a change that came together with the introduction of an Ethernet port in the main electronic device, the Remote Terminal Unit.

The introduction of Ethernet protocols in the Secondary Substation opened the opportunity to start using IT standards (which were not at all common in the electrical installations to the moment), such as NTP, FTP, HTTP, Telnet, DHCP, … (not to speak here about the secure versions of this protocols) leaving aside the restrictions of proprietary protocols.

Thereby, this allowed a big increase in terms of the amount of information that could be exchanged from the Secondary Substation, allowing many more Use Cases to be tackled. Getting to the point where you could have the same or even more information remotely than locally. This fact also allowed to increase the number of stakeholders interested in the information supplied during the installation, where nowadays not only operation departments are interested but also maintenance or big data analytic departments.

The increase of small electronic and embedded devices, with an easy access to the information, ends up digitizing all the traditional electrical components of the Secondary Substation. From Medium Voltage switchgear to the Low Voltage Board and the transformer, elements included in thousands of installations. There is no need to say that electronic devices are “alive” and therefore they need an active management strategy through their live time. The following section will cover the main services required to these electronic devices for successful deployments.

2.2. Main services

Among others, the main functions needed from the point of view of the new devices are:

- Device first configuration.
- Check device status.
- Read and write device settings.
- Update data point list of RTU/IEDs.
- Software update of RTU/IEDs.
- Real-time notification of alarms/events.

Recovery of report files (events, alarms, faults, oscillography, protocol traces, measurement statistics, etc.).

Asset management provides analytics for the maintenance and equipment´s health monitoring [8]. Thus, provides key KPIs to operate devices, to schedule upgrades, to plan replacement or repairs, and to support maintenance tasks. Advanced reports are necessary to determinate all devices inventory, their data regarding events and faults (real-time and historical), device status, integration data, etc.

Exist multiple asset management strategies, but all of them aims to achieve efficiency, reduce costs and prevent threats and risks. For this reason, devices management is required. From planning to maintenance of electrical grid. Figure 1 summarizes strategy considering planning, operation and maintenance.

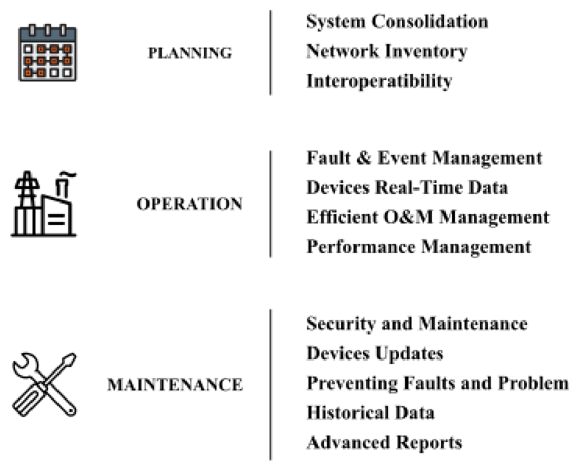

Figure 1 General strategy.

Device life-cycle management is a big challenge. As a time passes, the network evolves and incorporates new equipment and new systems. Frequently, businesses manage an installed legacy equipment that could have been installed more than 20 years ago with a new systems and devices. To achieve seamless management, communication, operation and maintenance capabilities are required. To connect old and new devices, to operate and configure equipment, to detect early-stage repairs and execute an accurate maintenance provides a long-term seamless management.

A proper device management avoids significant revenue losses, high repair costs, lower employee productivity, reputation damages and data leaks among others. For example, if the teleprotection system is not running properly, it is probable to suffer damages to power equipment with the consequent high repairing costs and perhaps long outage times.

Asset Management highlighted tools:

- Inventory and autodiscovery of all the devices.
- Device Viewer component where you can visualise the equipment, check its connections, historical alarms and events, additional information, etc.
- Multi-NE firmware activation & distribution.
- History Backups management.
- Settings comparison.
- Devices autodiscovery.
- Map Viewer with hierarchical layers and graphic representation of the entire infrastructure. Visualise and monitor your devices and links between them, drilling deeper devices such as: firewalls, HMI, IEDs, etc.
- Faults management and monitoring.
- Alarms and Events monitoring.

Assets inventory advanced reports:

- Equipment by site
- Equipment by family and area
- Equipment counter by family
- Units list
- Unit counter (by model & area)
- Units counter (by model & family)
- Units equipment

When talking about IEC TC57 standard, asset management comes into play. It is a critical aspect to properly plan, operate and maintain not only the substation even an entire electrical grid.

An accurate grid asset management allows mission-critical organisations to manage and control their resources. This combined with asset performance management (APM) turns into a powerful tool against faults, downtimes, outages, decreasing equipment´s life cycles and security threats, among others.

Asset performance gives you general information about what is happening on the power line and stores performance data for the analysis. If this is mixed with a proper asset management, it makes it easier to obtain clean and clear information according to each user profile. This way, delivering specific information of interest to each business area. Asset management helps to categorise the data obtained from the electrical line.

Utilities are facing different challenges and their concerns are focused on ensuring their supply delivery, protecting their infrastructure, reducing costs, increasing long-term efficiency, as well.

Here a key concern:

- Maintaining continuity in the critical service delivery.
- Minimising damages impacts and costs.
- Reducing outage time and avoiding downtimes.
- Improving response times.

Asset management complements APM and impacts directly on all areas of the grid management such as operation, control, and maintenance of all elements in place.

To keep running the infrastructure at its best, assets such as switches, transformers, breakers, teleprotection equipment and systems and others require to be properly operated, controlled and maintained.

Often outdated equipment provides a huge problem, this is why we need to carry out network inventory and plan regularly upgrades. Furthermore, hackers often attempt to attack through outdated systems. Hence, it is essential to keep in mind that your systems need to be updated.

Nowadays, numerous threats exist. For this reason, it is critical to be able to detect anomalies in data traffic, determine increased resource consumption and avoid unauthorised accesses. Likewise, access to high frequency graphs of disturbances is outmost importance.

In case the power failure occurs, you need to assure your backup systems supply enough energy to keep running your infrastructure. Even if you have off-grid generation capacity you should prevent a fuel lack or a low batteries charge. Again, device management is required.

To avoid human risks, it is essential to define a proper planning, to automate complex tasks, to monitor the activities and to elaborate procedures.

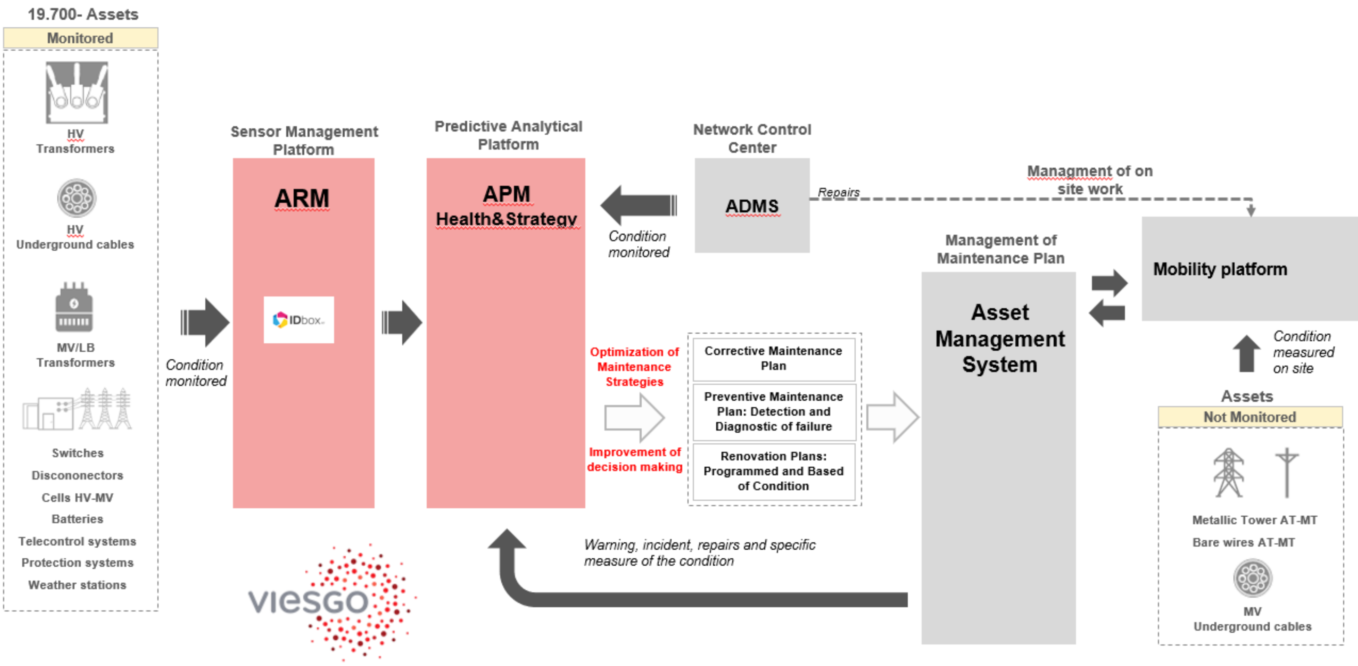

Figure 3. Predictive maintenance implementation model in Viesgo.

Currently a TC57 reference architecture is a crucial start point and guide for project designing and strategies implementation for any power grid. To assure the information exchange through all levels, the interoperability comes into play. It is essential to be able to guarantee the communication between different elements. Moreover, when these elements are from different vendors, network management becomes very difficult to handle without a proper asset management tool. Figure 2 shows the conceptual approach of the proposed architecture.

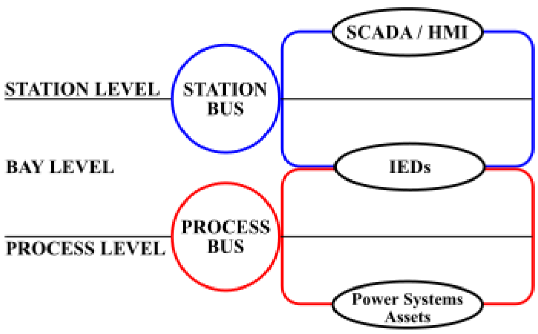

Figure 2. Architecture levels.

The entire world is moving forward to TC57, in order to unify their communications by means of interoperability, avoiding proprietary protocols and being able to integrate and manage equipment from several manufacturers, bettering set up and maintenance processes.

In an accurate architecture it is necessary to contemplate the computing edge, as well, allowing you very fast response times and optimisation of the bandwidth.

In addition, from the point of view of the integrated management of these devices, it is essential to support:

- Multicomponent, connector may be on the edge.
- Connect the services on the devices on the edge to the operational systems.
- Other tasks like device management.
- Proactive life-cycle management of devices and technologies:
  - Covering new standards.
  - Supporting legacy equipment.
- Support part of the operational functionality.
- Special care with the security, segmentation of different layers. Other cybersecurity issues.
- Flexible architecture.
- Support for high availability.

3 Results

All the proposed ideas are being tested in the Spanish DSO VIESGO. It is important to underline that VIESGO generates 1,400 MW of energy in the Iberian Peninsula, being 487,4 MW coming from renewable sources. Additionally, VIESGO counts with 31,300 km of electrical grid in the North of Spain. VIESGO provides services to more than 695,000 consumers and counts with smart meters at house level for fraud control and consumption monitoring. The contribution of renewables is RES: 39% MV (5.2%

Hydro, 94.8% wind) MV; fossil: 61% coal-fire thermal plants.

Figure 3 summarizes how this integral approach is being applied in Viesgo for predictive maintenance.

4 Conclusion

The results and conclusions of this paper will show the effort that VIESGO is performing to achieve a digital twin of all the electrical components.

It has been shown how all started from the main substations and principal electrical components of the network and it is continuing over the secondary substation IEDs. Thanks to several innovative initiatives and the partnership between VIESGO and state of the art developers like CIC and ORMAZABAL and the scientific contribution of the University of Cantabria it is possible to define a holistic approach to the digitalization of all the assets involved in the management of the distribution network. The FLEXIGRID project [9] is one of the most significant research projects that is being carried out by a European consortium under the H2020 initiative.

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6 Acronyms

APM. Asset performance management
DSO. Distributor System Operator
EMS. Energy Management Systems
HMI. Human Machine Interface
IED. Intelligent End Device
KPI. Key Performance Indicator
O&M. Operation and Maintenance
RTU. Remote Terminal Unit
SCADA. Supervisory Control And Data Acquisition

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