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Implementation of a Vendor Agnostic Substation Automation System using the IEC 61850 Standard

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SUMMARY

The major requirement in the implementation of the Substation Automation System (SAS) for Azogues 2 Substation was the integration of equipment and devices from various manufacturers using the new IEC 61850 standard as well as traditional System Control and Data Acquisition (SCADA) protocols like DNP3 and Modbus.

Originally the strategy of the utilities in the region was to source the SAS system and devices from a single vendor to reduce the technical risk and interoperability issues. However, the strategy also exposed disadvantages such us increasing costs, slow technical support, and vendor lock-in practices.

This paper outlines the lifecycle of the project, including a description of the interoperability challenges and how they were solved during the implementation of the multivendor and multiprotocol independent SAS solution.

INTRODUCTION

One of the objectives of the IEC 61850 standard is to achieve device interoperability enabling electric power companies to avoid proprietary technology. However, device interoperability is still a challenge when devices from different vendors are integrated.

Most recently, the Azogues Electric Company had the challenge of interoperability as they sourced protection and control devices from different vendors for the substation Azogues 2. It overcame this challenge by using the standard IEC 61850 (MMS) in the majority of the devices and selecting a vendor and protocol agnostic SAS solution.

AZOGUES ELECTRIC COMPANY

The Azogues Electric Company is a power company in Ecuador that is responsible for the distribution of electrical power in the districts of Azogues, Deleg and part of the province of Chimborazo. It serves more than 30.000 customers and covers an area of over 1.700 km2.

AZOGUES 2 SUBSTATION

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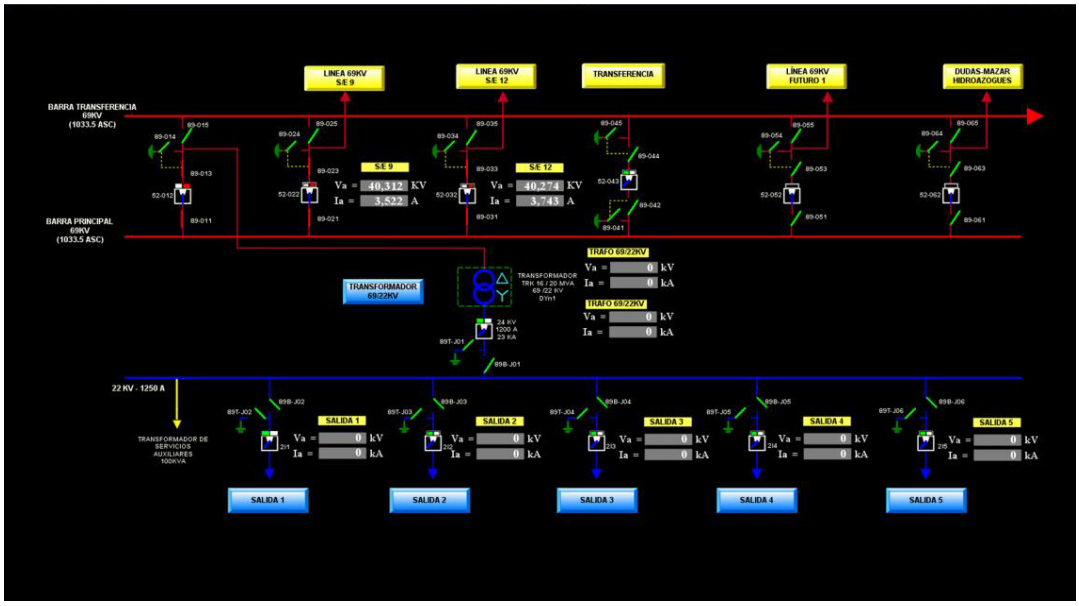

The Azogues 2 Substation is a 69/22 KV distribution substation configured with the following:

- 1 x 16/20 MVA power transformer
- 6 x 69 KV bays
- Sub-transmission systems
- Outward connection of power generated by the CELEC EP Alazán Hydro Plant Central at Dudas-Mazar

It plays a key role with the possibility to expand through other companies in Azogues. The main factor that influenced Azogues Electric Company to execute the project was to guarantee its reliability, continuity and quality of its power delivery by using new systems and technology for its operation, and, upgrade to global protocols and standards like IEC 61850 (MMS).

SAS ARCHITECTURE

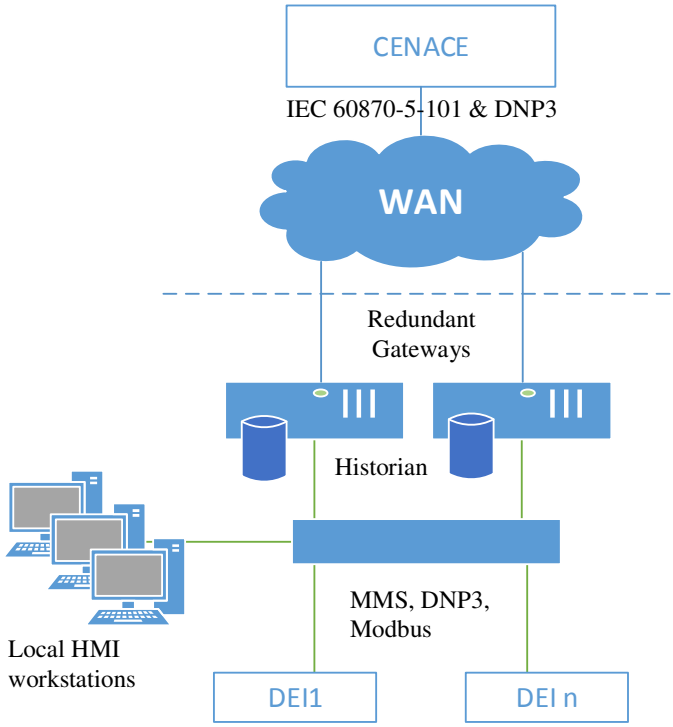

Figure 1 – SAS Architecture

The architecture of the substation Azogues 2 is composed by multiple devices of protection, control and metering according to the following detail:

GE F650 with IEC 61850 (MMS) Protocol - Bay Controllers
Schneider ION 8600 Meters with DNP3 Protocol
GE B30 Bus Differential Relay with IEC 61850 (MMS) Protocol
ABB RED670 Line Differential Protection with IEC 61850 (MMS) Protocol
GE T60 Transformer Protection System with IEC 61850 (MMS) Protocol
Schneider PM800 Power Meters with Modbus Protocol
Hanyoung Nux Panel Gauges with Modbus Protocol
Calisto Gas Meters with IEC 61850 (MMS) Protocol
Deep Sea Meter with Modbus Protocol
Rochester Annunciators with Modbus Protocol

The communication protocols used in Substation Automation System in real time are IEC 61850 (MMS), DNP3 and Modbus.

The substation uses an Ethernet network as a data communications system for the redundant Gateways, as well as RS232 and RS485 for the majority of devices with Modbus Protocol.

Redundant Gateways obtain data from the devices and transmit the information to the CENACE Control Center using the DNP3 Protocol.

Substation Gateways also store and archive its historical database for the generation of reports.

The substation has three (3) local Human Man Interface (HMI) displays simultaneously allowing viewing and local control of the SAS.

INTEROPERABILITY AND TECHNICAL CHALLENGES

The technical challenges that have been encountered and successfully resolved in the Azogues 2 project are summarized as follows:

1. The modifications and expansions in the Azogues 2 Substation are integrated in the system in a simple manner, without the need of additional Gateways, HMI equipment or interfaces.
2. Interoperability between the redundant Gateways to the substation protection, control and measurement devices from various manufacturers using IEC 61850 (MMS), DNP3, and Modbus have been achieved.
3. Azogues 2 Substation has the critical requirement of redundancy for Gateways to guarantee continuity of operation with failure occurs.
4. The data obtained above were easily provided to the CENACE Control Center.
5. Generation of Trending Reports from its Metering data is accomplished.
6. In line with ease of maintenance and asset management, the configuration of the substation automation system through automated tools have been provided. This included fast and automatic information archival into a database. This database has the capability to be exported to different file format, as required.

SUCCESSFUL IMPLEMENTATION

The success of the project was primarily the implementation of a Substation Automation System that has the capability of open architecture, it enabled the integration of multiple devices and protocols.

The easy replacement and integration of redundant Substation Gateways, the archiving of their historical databases and the capability of having multiple local HMI control consoles was provided.

The configuration tool allow fast re-configuration of Gateways as well as HMI consoles from the Factory Acceptance Tests (FATs) conducted in Canada then for the Site Acceptance Tests (SATs) in Ecuador, to eventually, adjust to the site conditions.

CONCLUSION

Azogues 2 project showed that interoperability with IEC 61850 (MMS) was achieved even with devices from different manufacturers. The SAS solution provided is able to easily integrate devices with different MMS implementations.

It was demonstrated, and now in operation, that it is possible to integrate advanced technology like IEC 61850 (MMS) protocol and traditional protocols like DNP3 and Modbus within the same SAS solution.

Redundant configuration of Gateways ensured the continuity of the operation and the ability to maintain control of the substation in the event that a Gateway fails.

HMI consoles operate simultaneously allowing the visualization and operation of substation regardless of which substation Gateway is in operation.

Future expansions and/or modifications in the Azogues 2 substation will not require any additional gateway for the integration of a new bay devices. Gateways and HMI consoles will be able to integrate new devices without changing the SAS architecture allowing the Azogues Electric Company to select any device in the market.

Finally, the company objective to guarantee its reliable operation, continuity and quality of its power delivery is more achievable with the SAS of Azogues 2.