Minimum common IEC 61850 specification document published by the Spanish group of electricity companies 'E3'

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ABSTRACT

The "E3 - Spanish Electricity Companies for Studies on IEC 61850" is a working group formed by representatives and specialists from the main Spanish electricity companies, who have agreed on the urgent necessity to come to a set of unified criteria about minimal requirements to comply with by the devices to be installed in their substations under the IEC 61850 standard [1].

INTRODUCTION

The following Spanish Utilities:

- 'RED ELÉCTRICA DE ESPAÑA'
- 'IBERDROLA'
- 'ENDESA DISTRIBUCIÓN'
- 'GAS NATURAL FENOSA'
- 'HIDRO CANTÁBRICO'

Agreed in 2008 to set up the 'Spanish Electricity Companies for Studies on IEC 61850' working group (also known as 'E3 group on IEC 61850'). After a two years period of jointly efforts, the first edition of the minimum requirements specification document [2] was officially published on October 2010.

The specification document is a result of the common standpoint reached by all participants after the experience gathered through several pilot projects. It has been assumed that some of the requisites stated are more restrictive than IEC 61850 requirements, but it has been agreed that, from the user point of view, this is the best way to actually make technical benefit of IEC 61850 adoption within companies.

Figure 1: Capture of the E3 group document cover

As IEC 61850 has a major flexibility vocation, a specific company must take many decisions that are not prescribed by the standard before reaching a practical implementation. While it is true that different vendors will reach different implementations, which will still be interoperable to the extent that they fulfil the standard and with the sole exception of the aforementioned ambiguities, it is not less true that interoperability will be costlier, in terms of engineering effort, in some cases than in others.

From the standpoint of substation operation, the foregoing indicates the convenience of adding specifications that complement the IEC 61850 standard in the sense of restricting the possibilities of design and practical manufacturing of any electronic protection and control mechanism, so that interoperability is optimized and the complexity of the engineering and maintenance is reduced as much as possible. The foregoing must be carried out without contravening, under any circumstances, the contents or the spirit of the IEC 61850 standard, since the suitability of international procedures is accepted as a basic principle.

CHAPTER THREE: METHODOLOGY

As previously mentioned, and in order to better identify the needs established in the document, a set of standard cases are defined (qualitatively singular substation architectures) in this chapter. Three (3) case studies were chosen finally:

- *Type 1 case study*. Double busbar arrangement on the two main voltage levels.
- *Type 2 case study*. One-and-a-half breaker on the higher voltage level and double busbar on the lower voltage level.
- *Type 3 case study*. Topology commonly known as 'H'(High voltage to Medium voltage configuration).

Also, a classification of the different types of IED to which the contents of the document apply is specified in this chapter.

CHAPTER FOUR: APPLICATIONS (FUNCTIONALITIES AT ELECTRICAL LEVEL)

This chapter of the document indicates what current, and some future, functionalities, an electricity company requires or may require for the intelligent protection and control of its substations.

The ultimate objective of this section is to ascertain approximately how much information should be exchanged by the different IEDs of a substation. The present edition of the document only considers the exchange of information between IEDs located in different cabins.

CHAPTER FIVE: LAN TOPOLOGY FOR THE STATION BUS

This section discusses the different Local Area Network (LAN) topologies applicable to an IEC 61850 automated substation, including the concepts of redundancy and needed network features of IEDs. The network topologies described here are analyzed based on the IEC 62439 standard [3].

Only two topologies are analysed in the present edition of the document, namely the **multi-ring collar** and the **redundant double star**. The single ring and the single star topologies are implicitly contemplated as straightforward instantiations of the former and the latter, respectively.

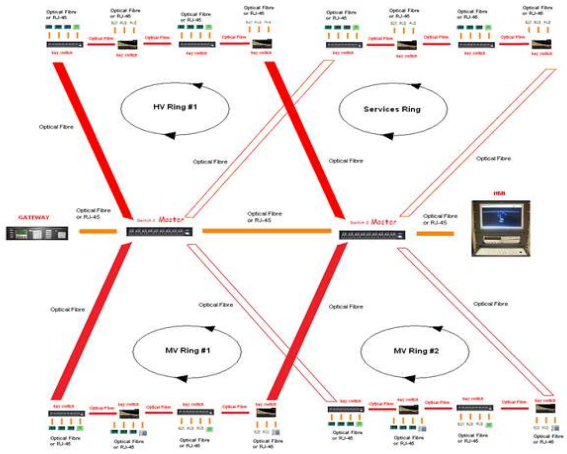

Figure 2: multi-ring collar topology

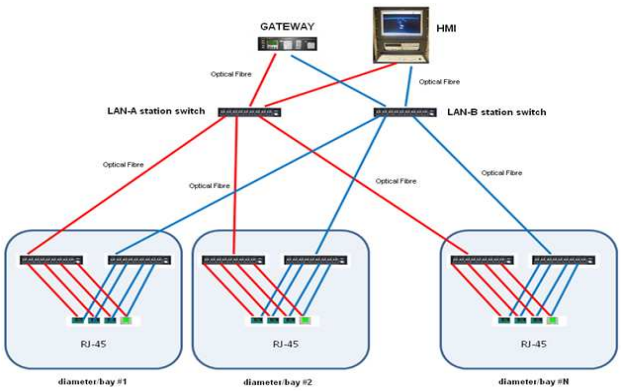

Figure 3: Redundant double star topology

As a conclusion of this chapter, it is stated that for the type 1 and 3 case studies, the multi-ring collar topology is considered the most suitable bearing in mind the technical needs as well as the economic constraints. For the type 2 case study, the application criticality suggests an implementation based on a redundant double-star topology.

The will of the E3 Group on IEC 61850 is to remain open to other network topology solutions, like HSR, etc., that might be proposed in the future by IEC or other authorized standard developers as long as these solutions comply with the requirements defined in the document.

CHAPTER SIX: ENGINEERING, EXPLOITATION AND MAINTENANCE

This chapter defines the configuration of the IEDs and the management of configuration file versions.

As basic principles of equipment configuration, **a single configuration file** (CID file) is demanded. The IEDs, whatever their type, must be totally configured with a single file, the CID. This CID file will contain a standard part (it will contain all the functions of the IED that are modelled, and it should be possible to edit it with IEC 61850 tools (SCL editors)) and a proprietary part (It will comprise all the functions that are not modelled and which must be configured only with the vendor's tool. The ultimate objective is to reduce the proprietary part until it disappears).

In order for the standard part of the CID file to contain as much configuration information as possible, some extensions of the IEC 61850 data model are considered:

- Application of 'InRef' Data Objects.
- Modelling of Control Logics.
- Modelling of GOOSE / SMV Client subscription.

Rules for naming and managing the CID file are also defined:

-) Two possible types of configuration modifications are identified: **Hot** and **Cold** modifications;
-) Apart from the ACSI services defined in the Standard, the uploading and downloading of CID files to/from the IED should be also possible by means of the FTP protocol, assuming the existence of a FTP server in the device, and by means of a USB connection, assuming the existence of a USB port in the IED.
-) Three different CID loading modes are defined (**Indifferent**, **Upload mode** & **Protected mode**).
-) Two different validation and activation modes are allowed (**Automatic** & **Controlled**).
-) A good version management shall be granted by the use of the **LLN0.NamPlt.configRev** and **LLN0.NamPlt.paramRev** attributes.
-) Some added value functionality is also specified: **Disturbance recording**, **Sequence of Events recording**, **Fault reporting** and **Internal event logging**.

CHAPTER SEVEN: COMMUNICATION SERVICES

This chapter specifies, with respect to communication services, the minimum quantitative requirements that devices must satisfy. It consists of four main parts:

·) GOOSE multicast communication: IEDs shall be able to:
-) Publish **8** GOOSE and subscribe to **64** GOOSE messages at least.
-) For validating incoming GOOSE messages, a two-steps process is described (checking of the **MAC address** first and secondly, checking of several incoming information: **GoCB reference**, **Dataset reference**, **Application ID**, **GOOSE ID**, **ConfRev attribute** and **Needs commissioning flag**).

·) SV (sampled values) communication: model and data set structure specified in the 'IEC 61850-9-2 LE' Guidelines [4] shall be follow, but including the possibility for **unicast** publishing. Both 80 samples per cycle and 256 samples per cycle sampling rates are contemplated.

·) MMS services (client-server): a server shall be able to provide up to:
-) **7 buffered reports**
-) **7 unbuffered reports**
-) 1 data set per RCB (**14 data sets** in total).

Control modes, Log service application modes, ACSI services related to the log service to be implemented and SOE log service, Profile log service, Clear log service, File transfer service and Substitution model are also specified.

·) Requisites for remote access and control: FTP remote access to the equipment will be required. This access will also be possible with the supplier's software.

OTHER CHAPTERS: SYNCHRONIZATION, SECURITY, PROCESS BUS AND SYSTEM DEPLOYMENT

Synchronization:
·) The synchronization requirements are individually analyzed for the distribution voltage level and for the transmission voltage level:
- Transmission level: an **IRIG-B** connection to the GPS clock is usually required. In the future, it could be replaced by an IEEE1588 solution.
- Distribution level: **SNTP** protocol as specified in the IEC 61850 shall be used for the synchronization of IEDs.

·) Every IED should be able to handle **2** different synchronization sources during operation and should be always synchronized, at any time.
·) The SNTP services to be used might be **Unicast** or **Broadcast** (Both allowed for both the client and the server).

Security:
·) **Threats** and **attacks** are classified according with the IEC 62351 Standard [5] (Repudiation, Denial of service, Masquerade, etc.).
·) As a consequence, **security requirements** are defined to face the previous possible attacks (Encryption, Digital

signature, MMS Association with authentication, etc.).
·) And also, the application of the previous security measures over each type of communication is described (for MMS, for GOOSE messages, FTP connection, USB connection, etc.).

Process bus:
·) Switched & point-to-point configurations are considered.
·) IEC 61850-9-2 LE Guidelines recommendation is used.
·) Performance impact is analyzed.
- The use of dedicated network interface cards for process bus is recommended.
- Transmission rate: 80 and 256 samples per cycle are considered.

·) A two-tier constraint is prescribed.
- No intermediate IEDs are allowed between the source and the final destination.

Implementations:
·) This part of the document proposes how to implement the IEC 61850 Standard without in-deep considerations about the economic or technical point of view, but considering different possible substation types:
- Outdoor Substation
- Indoor Substation
- Mixed outdoor & indoor Substation

The different scenarios are analyzed stating the advantages and disadvantages of each case.

ANNEXES

The specifications document is complemented with some annexes where additional solutions for achieving complete 61850 configuration information modelling are proposed:

A. Modeling of Logics: a solution for modeling the editable logic part of an IED with the use of 'InRef' DOs and using logic equations modeled in new DOs (new CDC) is described.
B. HMI and Graphical Screen modeling: a solution for modeling the HMI is described. A library of graphical elements inside the IED becomes necessary. With a new CDC with instances containing the graphical characteristics and elements, the IHMI LN can be easily modeled containing the graphical part of the IED.
C. Quality and Time Stamp: This annex studies how to manage the quality and timestamp data attributes when the information is received from GOOSE messages or MMS information messages and mapped to an IEC 61850 server.
D. GOOSE and SV Subscription Modeling: Precise rules for implementing the subscription to GOOSE or SV messages in an IED are given in this annex. Two options are contemplated.
E. ACSII Mirrored View of a SOE LOG: a proposal for the readable mirror of the SOE Log specified in the document is given.
F. Modifiable Parameters for controlling the CID Loading, Validation and Activation: New DOs are specified to be included in the LPHD LN.
G. Conventional Inputs and Outputs: physical binary inputs/outputs shall be modeled with a GGIO LN.

CONCLUSIONS

Objectives of the specification document

The main purpose of the document is to respond to the lack of a guide for the application of IEC 61850 in order to obtain a tangible benefit, technically and economically, from the implementation of this new technology in the operation of electricity substations.

The specification is carried out mainly on the basis of Ed. 1 of the IEC 61850 standard and the experience acquired by the group companies with many of the IEDs available on the market in their current state of development. The companies in the E3 group on IEC 61850 have agreed to demand compliance with all the requirements included in this document by their control and protection IEDs suppliers.

The E3 group on IEC 61850 wishes to share the study carried out with other national and international companies and analyse the contributions they might propose.

REFERENCES

[1] IEC 61850, 2004, "Communication networks and systems in substations", IEC TC57 WG10, Ed. 1.

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[3] IEC 62439, 2008, "High availability automation networks", IEC TC65, Ed. 1.

[4] IEC 61850-9-2 LE, "Implementation Guideline for Digital Interface to Instrument Transformers using IEC 61850-9-2", UCA International Users Group, Lite Ed.

[5] IEC 62351, 2008, "Power systems management and associated information exchange – Data and communications security", IEC TC57 WG15, Ed. 1.