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Telecommunication networks and infrastructures for IEC 61850-based substation automation systems

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Ethernet is the most widely used telecommunication technology in the office environment and even, in the last few years, it has become common in electric utilities. In fact, Ethernet is the data transmission technology adopted by IEC 61850 to link the different Intelligent Electronic Devices (IEDs) within a substation. The success of Ethernet in different environments is due to its simplicity, low cost and performance compared to other technologies such as Token Ring, FDDI or ATM.

Over the past 15 years, Red Eléctrica de España (REE) has developed ethernet-based Local Area Networks (LANs) in its substations in order to provide remote management services for Substation Automation System (SAS) devices. However, Ethernet is still not used to communicate the protection and control functions of the SAS. Asynchronous serial communications are used for this purpose.

This approach will change in substations where IEC 61850 standard is applied. Serial communications will be replaced by Ethernet LANs, which will support the information interchanges among the different Intelligent Electronic Devices (IEDs).

This paper describes telecommunication networks and infrastructures for the next IEC 61850 projects at REE. The organization of this paper is as follows. In the first section, a network architecture is defined in order to provide communication services in every substation level (process level, bay level and station level). This network architecture is designed taken into account the SAS requirements such as reliability, redundancy, architectures, fault-tolerance, recovery time, among others. The second section focuses on the physical network implementations. The placement of switches with respect to the IEDs and the cabling infrastructure required to connect the IEDs to the LAN are discussed and evaluated. In addition, the telecommunication elements, such as switches, fiber optic and copper data cables, optical distribution frames, and telecommunication racks are described. The third section deals with cybersecurity measures and solutions for remote maintenance. Finally, the last section includes future case studies where this telecommunication infrastructure will be implemented.