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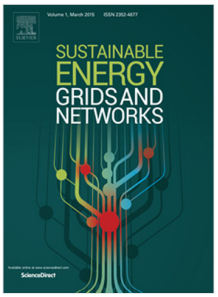

IEC 61850-based adaptive protection system for the MV distribution smart grid

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IEC 61850-based Adaptive Protection System for the MV Distribution Smart Grid

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***Abstract*—The installation of protection systems on the Medium Voltage (MV) network is probably the most pragmatic topic of the smart grid in those contexts where the regulation of distribution systems includes output-based incentives to Distribution System Operators (DSOs) related to the quality of service. One of the main obstacles to the diffusion of such a solution is related to the MV network configuration – e.g. the relation between the feeding primary substation and fed secondary substations – which is altered for various reasons, requiring different settings for the protection devices placed along the network. The present work describes an innovative approach to the dynamic reconfiguration of protection devices used to implement advanced fault location, isolation and service restoration solutions.**

The proposed solution, implemented during the activities of the FP7 European Project IDE4L, has been implemented based on the IEC 61850 standard adoption, in order to assure the interoperability, modularity and scalability of the proposed approach.

***Index Terms*—IEC 61850, distribution network automation, fault localization, smart grid.**

I. Nomenclature

ALSM	Faulty MV section monitoring (61850 logical node)
CDC	Common Data Class
CID	Configured IED description
CLSF	Faulty MV section management (61850 logical node)
DA	Data Attribute
DAT	Distribution Automation Technology
DMS	Distribution Network Management System
DN	Distribution Network
DO	Data Object
DSO	Distribution System Operator
FLISR	Fault Location, Isolation and Service Restoration
FP7	Framework Programme Seven
GOOSE	Generic Object Oriented Substation Event
HV	High Voltage
IDE4L	Ideal Grid for All
IEC	International Electrotechnical Commission
IED	Intelligent Electronic Device
LAN	Local Area Network
LN	Logical Node
LS	Logic Selectivity
LV	Low Voltage
MMS	Manufacturing Message Specification
MV	Medium Voltage
PS`	Primary Substation
PSR	Protection System Reconfiguration
PTOC	Protection Time Over Current (61850 logical node)
PTOV	Protection Over Voltage (61850 logical node)
RDIR	Protection Directional element (61850 logical node)
RREC	Protection Autoreclosing (61850 logical node)
RTU	Remote Terminal Unit
SAIDI	System Average Interruption Duration Index
SAIFI	System Average Interruption Frequency Index
SAU	Substation Automation Unit
SS	Secondary Substsation
TSO	Transmission System Operator

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II. Introduction

DISTRIBUTION Networks (DNs) are facing several challenges in recent years. The deepening penetration of distributed generation systems, as well as the higher quality of service required by national and international standards, are asking for an improvement of the DN management [1]-[2], particularly under faulted conditions [3]. Within this field, the maturity of Distribution Automation Technologies (DATs) technologies and the availability of a variety of communication technologies, gives to utilities the opportunity to considerably reduce non-scheduled service interruptions [4]. Furthermore, such a DAT based approach can be taken into account because of the cost reduction of Medium Voltage (MV) breakers capable to interrupt short circuit currents. Indeed, in past years, only on load breakers, capable to interrupt current values up to the nominal one were used [5].

In the context of DAT, self-healing strategies, also known as FLISR (Fault Location, Isolation and Service Restoration), play an important role to significantly improve network reliability statistics, increase the energy supplied and provide a high quality of service [6]-[10]. All these advantages entail a