Chapter 13

Efficient Communication Interfaces for Distributed Energy Resources

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ABSTRACT

The IEC 61850 standard originally was developed for the substation automation. During the past years it was adapted for the integration of distributed energy resources into communication networks, however, with specific requirements. Many small and midsize manufacturers are using, as controllers, a big variety of different microprocessors with limited performances. Such controllers need an interface for IEC 61850 communication networks with a basic functionality which can be implemented with limited costs. Based on their experiences during the realization of an IEC 61850 communication stack, the authors propose ways to support these requirements. In particular, communication interfaces for photovoltaics systems and wind power plants are considered.

INTRODUCTION

At this time in the power supply of electrical energy a dramatic change is going on. In former times this power supply was mainly provided by big centralized power stations. The technology of the devices implemented in such power stations was designated by a few big enterprises. These days more and more small power supplies like wind power plants, hydro electric power plants, photovoltaic systems and others are implemented all over the countries (DER - distributed energy resources). The devices for these small power stations are developed by many big and small enterprises. So the technology is designated by many different participants. This causes a big
variety of technical approaches. During the installation of the distributed energy resources they have however to be integrated into one common electrical power grid. For the maintenance of the devices, for the management of the energy flow in the power grid and for the electricity billing many of these devices also have to be integrated into a common communication network (Figure 1) (Palensky, 2008; Haas, Ausburg, & Palensky, 2006). For this a standard developed and supported by the big enterprises for the operation of their already existing power grids has to be used. Therewith it can be assumed, that the IEC 61850 standard will become the standard for this type of communication networks in the future.

Originally the IEC 61850 standard was developed for substation automation (IEC 61850, 2002; Schwarz, 2005). During the last years it was adapted for wind power plants (IEC 61400-25, 2006; Timbus, Larsson, & Yuen, 2008) hydro-power plants (IEC 61850 Part 7-410, 2006) and other distributed energy resources (IEC 61850 Part 7-420, 2008). Compared to controllers for the substation automation the controllers for distributed energy resources however have specific requirements for their integration into a communication network:

- The devices to be connected have low prices, so the controllers often have only limited performances and storage capacities.
- Many different manufacturers are producing such devices. They are using a big variety of hardware, operating systems, programming languages and tools.
- Many of the manufacturers are small companies, which want to implement the communication interfaces with limited costs.

To meet these requirements in this paper several proposals are made to optimize the communication according to the IEC 61850 standard for distributed energy resources.

The IEC 61850 Standard

The basic concept of the IEC 61850 standard will be described with the example of a small photovoltaic system (Figure 2). Such a system can consist of the following components:

- A photo voltaic array,
- A DC-circuit breaker,
- An inverter,
- An AC-switch,
- A 3-phase circuit breaker and
- An electric meter.

For the integration of this PV-system into a communication network a microcontroller is required. According to the IEC 61850 this computer is named as intelligent electronic device (IED).

Modelling of the Automation Functions

In an IED the automation functions can be divided into sub-functions and functional elements. For modelling these functions logical node classes are standardized at the level of the functional elements. For the example shown in Figure 2 the following logical node classes can be used:
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