Evolution of Standards for Smart Grid Communications

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ABSTRACT

A diverse range of telecommunications standards is available and in development for the correspondingly diverse areas of the smart grid. In this paper, the author details and analyzes their current status, the direction of ongoing work, and application in transmission and distribution networks, as well as distributed generation. The author also examines the interface to residential and business customers.

Keywords: Demand Response, Distributed Generation, Electric Vehicles, Smart Grid, Standards, Telecommunications

INTRODUCTION

This paper provides an analysis of the standards available and under development for telecommunications applications throughout the entire smart grid.

The grid, seen in Figure 1, consists of bulk generators, such as coal and nuclear power plants which feed into the transmission network that takes power long distances across the country to where it is needed, typically in cities. Within a city, power is taken from the transmission network and delivered to individual customers using a distribution network. Small scale power generators such as residential wind and solar installations also feed power into the distribution network.

All the equipment in the electric power grid shown in Figure 1 needs to be controlled, and monitored, much of it remotely and telecommunications networks have been used for decades for that purpose. The transmission portion of the grid is the most advanced in terms of telecommunications implementation. These “smarts” are now being deployed in distribution networks and distributed generators, as well as the interfaces to business and residential customers. Although many people are familiar with the term “smart grid” in connection with residential electric power use, the term in fact applies to the entire grid shown in Figure 1.

Before the term “smart grid” was coined, the grid included many “smarts”, with extensive proprietary SCADA (Supervisory Control and Data Acquisition) systems providing monitoring and control. Local automation provided protection for many devices and systems, and control centers provided both automated and manual remote control. Deregulation of the industry resulted in many players who need to communicate with each other, for which standardization is preferable to proprietary systems. At the same time, environmental concerns are
bringing about the need to integrate renewable power sources, many of which are small scale, into the grid. Cost control requires that the grid needs to be operated close to its capacity limits, and large scale blackouts have resulted in demands for increased reliability. Standardized telecommunications plays an essential role in addressing each of these concerns, providing control for renewable power sources even though they are distributed throughout the grid, monitoring operations more accurately so that higher capacity utilization can be achieved, and providing overall control of the whole grid as opposed to the more localized control that had been responsible for some blackouts.

The upcoming sections describe the telecommunications standards that are available for transmission, distribution, generation and the customer interface.

**TRANSMISSION AND DISTRIBUTION NETWORKS**

The transmission network is the part of the grid where telecommunications is already widely used for monitoring and control. Increasingly it is also reaching further along the feeder lines to the customers in the distribution network. Although these networks are very different from each other and are typically operated by different companies, the need for integrated control of the whole grid is resulting in telecommunication standards that apply to both networks, a major example of which is the IEC 60870-6 Inter Control Center Protocol. Within and among countries, transmission, distribution and generating companies and system operators need to communicate for integrated control of the grid. IEC 60870-6, IEC (2005), is widely used for that purpose and is also known as TASE-2, Telecontrol Application Service Element 2. It provides real-time data exchange for monitoring, control and event reporting over wide area networks based on the client-server model. It can establish telecommunication links with high QoS for real-time data and links with low QoS for non-real-time data. Ongoing work on IEC 60870-6 is expected to result in a stable document in 2012 for publication in 2013.

**Phasor Measurement Units**

A major new addition to the existing monitoring capabilities is the deployment of Phasor Measurement Units, PMUs, sometimes called Synchrophasers. These devices measure the amplitude and phase angle of the AC power about 20 times per second and link the measurements to timing information obtained from GPS clocks, resulting in highly precise phase measurements. The standard for quantifying
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