ABSTRACT: Low Cost Telemetry Communication Technologies for Balancing the Electric Grid Using Non-Generation Resources

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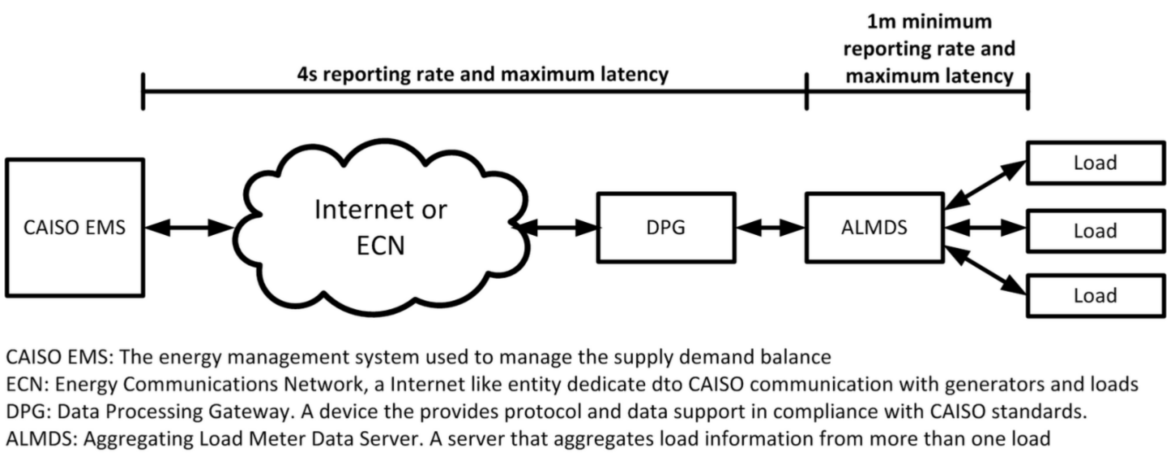
On March 15, 2011, the Federal Energy Regulatory Commission ("FERC") issued Order 745, which established a new approach for compensation for demand response resources. Under Order 745, wholesale energy market operators—otherwise known as an Independent System Operator ("ISO") or Regional Transmission Organization ("RTO")—are required to pay demand response resources the market price for energy, known as the locational marginal price or "LMP," when a two-step test has been met: (1) the demand response resource has the capability to balance supply and demand as an alternative to a generation resource; and (2) the ISO or RTO dispatches the resource when it is cost-effective to do so.

Extensive research and deployment by private companies has proven the effectiveness of Demand Response as a grid balancing resource. While shedding electric loads can have a similar effect on the grid as ramping up electric generation, there are important differences; 1) typically many loads are shed in aggregate in order to reach the power capacity of a generator 2) Telemetry systems used for communications between the grid operator and generators is too costly to deploy in each demand responsive load. 3) Advances in information communications technology may be able to meet the requirements of grid operators (ISOs, RTOs) using primarily off-the-shelf products, thus significantly reducing the cost of telemetry per instance.

This paper will explore the telemetry requirements of each communications link between the grid operator and the end-use electric loads including the ability to dispatch sheds and monitor the effectiveness as required.

This paper is primarily focused on evaluating and selecting appropriate communication channels and protocols as required. This report will detail the efficacy, security, cost, and availability of the technologies that we explored.

FIGURE 1: TELEMETRY SPECS FOR GENERATORS PREFORMING FREQUENCY REGULATION - RIG PLACEMENT BETWEEN LOAD/GENERATING UNIT AND ECN



EMS to Rig Communication

The telemetry links have some general physical requirements. The loads must communicate with the DPG or ALMDS (for single or multiple loads respectively) using a communication medium that is not a dial-up connection. However, there is no requirement on the data rate of this link. Communication between the CAISO EMS and the RIG requires DNP3 (Distributed Network Protocol v3.0) carried over TCP/IP.

DNP3 is a SCADA (supervisory control and data acquisition) communication protocol that was developed for communication between various types of data acquisition systems and control equipment. It is primarily used the utilities such as electric and water companies. The connection between the RIG and the Internet or ECN must be an always-available connection (i.e. not dial up), but it does not need to be dedicated to only providing ancillary services. The DNP3 protocol was designed to allow reliable communications in the adverse environments that electric utility automation systems are typically subjected to; specifically it was designed to overcome distortion caused by EMI (Electromagnetic Interference), aging components, and poor transmission medium. While DNP3 was designed to be reliable, it was not designed to be secure. However, much work has been completed to add secure authentication features to the DNP3 protocol. The two most common solutions are cryptographic technologies placed at both ends of the communication media, or security enhancements placed directly in the protocol.

A DNP3 frame consists of a header and a data section. The header section specifies the frame size, contains data link control information and identifies the DNP3 source and destination device addresses. The data section contains data or payload passed down from the application layers above.

Rig to Load Communication

The protocol to the right of the RIG in Figure 2 is unspecified and can be selected by the implementer. The primary concerns about this communication are balancing latency, data integrity, and cost.

One of the most cost effective methods for 2-way communication between the Rig and Load is TCP/IP. Roughly 90% of round trip TCP connections using a high quality, wired Internet connection exhibit less than 1s in latency. About 99% of links exhibit less than 4s latency. These statistics are across the Internet in the U.S., and it stands to reasons some links have characteristically longer latency than others. The fact remains, however, that the existing Internet provides low-latency data communication. Using existing wired LAN technology in buildings, round trip latencies in excess of 100ms represent less than 0.1% of the time [2]. Therefore, a system using standard, wired Internet connectivity from the site to the ISO and standard wired LAN connectivity from the Internet connection to the sensing and actuation points would easily meet the latency requirements of the project. In addition, many sites will already have a high quality Internet connection. If this connection is available, it's a good candidate solution. If we are required to install the Internet connection and associated IT infrastructure, this method is cost prohibitive for widespread deployment. However, coordination with an IT organization at the site may also bring significant costs. These costs may be absorbed into an existing IT budget for the site, however, with no apparent cost to the DR site enablement.

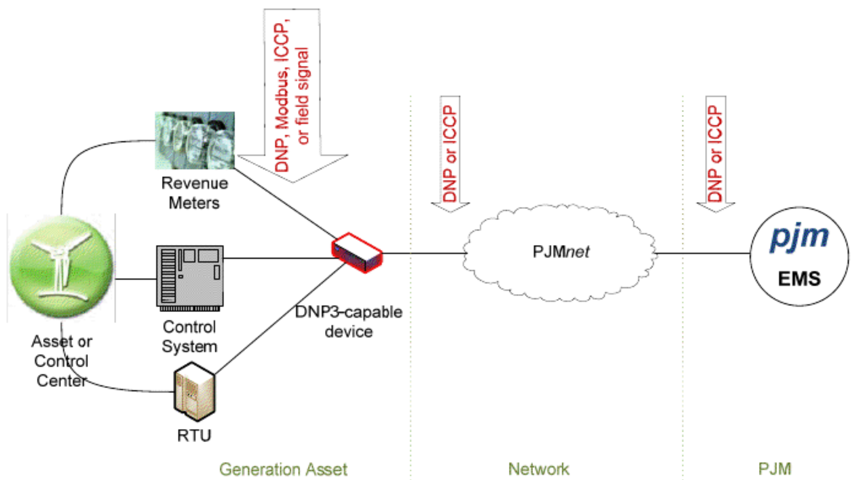


FIGURE 2: LINE DIAGRAM OF GENERAL NETWORK MODEL FOR PJM

References

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