Interoperability and Standards:
Developing International Standards for Demand-Side Communications

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Published in Power Grid International, August 2014

An International Standard for Electricity Information Exchange

Over the past decade, the electric utility industry has been slowly and quietly developing an international standard for information exchange. The initial pieces were developed at the International Electrotechnical Commission (IEC) as IEC 61970 and this standard now contains all of the elements necessary to describe an electricity grid, including classes and attributes for transmission lines, breakers, transformers, power generators, and load extraction points. The standard defines a model which is not simply static; it also can describe the state of the system at any given time by using model variables for elements like line limits, power flows, load schedules, plant generation levels, equipment outages, and a wide range of SCADA[1] information.

A second standard, IEC 61968, was developed in parallel to IEC 61970 in order to describe details of the distribution system, such as customer and meter information along with trouble call and crew management information. Like IEC 61970, IEC 61968 can also capture time series information and therefore can be used to hold meter usage data and customer bills. IEC 61970 and IEC 61968 together form the underlying model for many applications in the electricity industry today, including many Energy Management System (EMS), Distribution Management System (DMS), and Outage Management System (OMS) platforms from a variety of vendors.

More recently the need to model wholesale markets was identified and a third component, IEC 62325, was developed for this purpose. Within this standard, all of the elements necessary for real-time and forward energy markets are cataloged, including wholesale market participant information, generation offers and demand bids, congestion revenue rights, ancillary service awards, and market prices. IEC 61970, IEC 61968, and IEC 62325 are managed through IEC Technical Committee 57 (TC57) and the set is collectively known as the Common Information Model, or CIM.

Industry Adoption

The California ISO was one of the first North American ISO/RTOs to adopt the CIM with its Market Redesign and Technology Upgrade project. Since 2009, “all major functional areas rely on the CIM standard and its extensions.”[2] ERCOT found itself in a similar situation with its

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[1] SCADA stands for Supervisory Control and Data Acquisition and is a system used to communicate information to and from remote equipment. It is used across a wide range of applications from industrial processes to farming systems and is used extensively in the electricity industry.

[2] Haq, Haller, Rahman & Iverson, “Use of Common Information Model (CIM) In Electricity Market at California ISO.” 2011 IEEE Power and Energy Society General Meeting, 978-1-4577-1002-5/11

Nodal project when searching for an integration method to manage some 4,000 data exchanges. ERCOT determined that the "only way to complete integration in time was to use the CIM as the foundation to maintain, distribute and exchange the data."[3] PJM Interconnection recently completed its Advanced Control Center project where the CIM was "chosen as the foundation information model for messages."[4]

The CIM has been successfully utilized to transfer data between regional markets as well. For example, the Midcontinent Independent System Operator and the New York ISO both "exchange their detailed EMS models once a year in CIM format"[5] with PJM Interconnection. And while not every ISO/RTO has made the migration to a CIM-based system, most have this as a future goal. For example, the New York ISO has made plans to migrate its market and energy management systems on to a single CIM-based platform.[6]

Many utilities have also realized the benefits of the CIM related to system interoperability and Smart Grid transformations. Oncor, as a transmission owner and operator in Texas, must exchange transmission data with ERCOT and put a CIM data exchange process into production in 2009. Their CIM solution also supports advanced applications such as state estimation, power flow, and contingency analysis.[7] DTE Energy utilized the CIM as a central part of its enterprise semantic model for the integration of new smart grid information and implemented a number of related meter reading and maintenance services.[8] Progress Energy has also has success through the use of an advanced integration architecture rooted in the CIM and was able to implement reusable services, replacing their old interfaces.[9]

More system and transmission operators, distribution companies, and energy service providers will join these pioneers and recognize the importance and benefits of using the CIM standard, in the form of easier, more-standard data exchanges which lead to reduced implementation and operational costs.

The Demand-Side Push

Activity to create a standard for the electricity end-user does not have the clear path demonstrated by the segments of the industry which currently benefit from the CIM. But there have been attempts. Numerous proposals to define information flowing to and from the home and business to control and report on electricity usage have appeared; however the form has been primarily vendor-specific solutions not rooted in any open standard. So, can the CIM be used to deliver electricity information?

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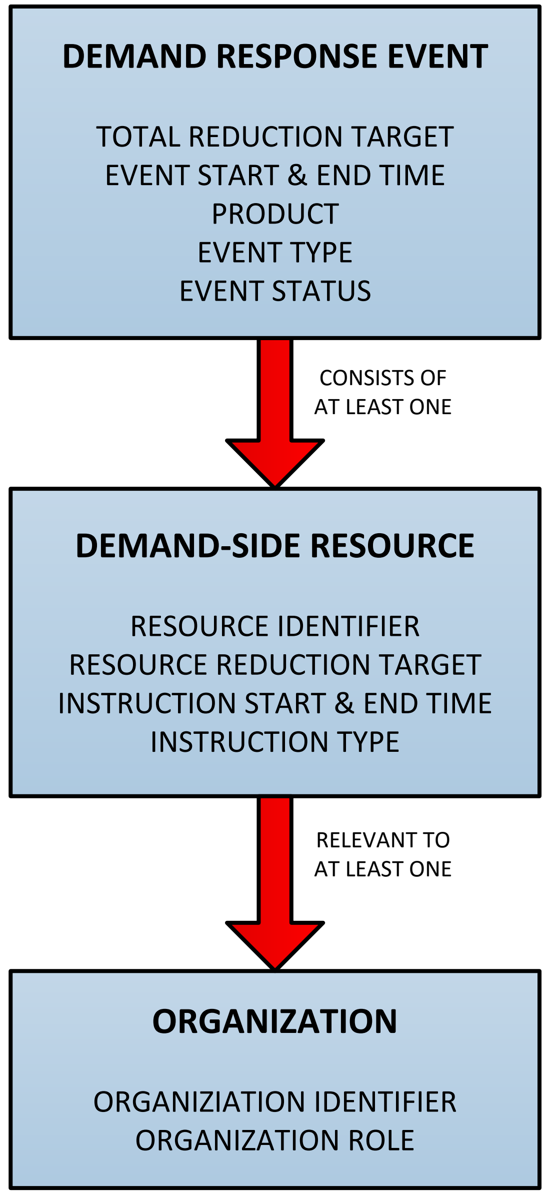
[3] Crews & Goodrich, "CIM and Utility Integration" EMS User's Group September 8, 2006
[4] Baranowski, "PJM Advanced Control Center Project (AC²): Adventures in SOA, CIM, and Virtualization." 2008 EMS Users Conference, September 8, 2008
[5] "Joint Operating Agreement between the Midwest Independent Transmission System Operator, Inc. and PJM Interconnection, L.L.C." December 11, 2008. Also "Joint Operating Agreement Among and Between New York Independent System Operator Inc. and PJM Interconnection, L.L.C." June 15, 2014
[6] Hurysz, "NYISO Market System Evolution." EMS Users Conference, September 8, 2008
[7] Bogen, "Role of CIM for Power System Model Exchange - ISO/RTO Exchanges with TOs." Transmission and Distribution Services Oncor Electric Delivery, 2014
[8] "DTE Energy CIM Experience." EPRI Conference, Washington DC, Sept. 8, 2010.
[9] Rice, "Progress Energy's Implementation of CIM." CIM User Group Meeting, November 12, 2009.

The CIM was initially developed to make transactions between utility systems easier to design, build and implement. Beyond these initial visions, it has been shown effective as a model for "outside the enterprise" messages too, with successful model exchanges among ISO/RTOs and between ISO/RTOs and transmissions owners/operators.

As a natural extension to this success, the ISOs and RTOs in North America developed extensions to the CIM in order to support traditional demand response signals. This work was delivered through a North American Energy Standards Board[10] process and incorporated into the Smart Grid Interoperability Panel[11]. A visualization of the main demand response control message is shown in the figure.

Visual Representation of CIM-Based Demand Response Message



These CIM extensions are a concrete example of the use of an open and industry-focused standard proposed for electricity consumer processing. And while focused on wholesale markets, there is nothing in the resulting model definitions that constrains activity to bulk-power transactions.

American Electric Power (AEP) was one of the first utilities in the United States to seriously consider the CIM as an option for customer communications. AEP's gridSMART project was initiated as a comprehensive approach to providing better service and lower costs to customers, while simultaneously allowing customers better control of their energy usage. With the CIM as a foundation, extensions were developed to handle customer meter data, end-use device controls and responses, and real-time pricing information.[12]

IEC working groups have been busy taking the developments from these two efforts and incorporating them into the CIM. This process was designed so that all stakeholders have the opportunity to review proposed changes and most of those goals have now been met. Therefore the next release of the CIM should have these demand-side extensions incorporated

[10] See "NAESB Subcommittee on Smart Grid Standards for Demand Response" at www.naesb.org
[11] http://www.sgip.org/PAP-19-Wholesale-Demand-Response-DR-Communication-Protocol
[12] Goodrich, "AEP CIM Experience", CIM User's Group. June 16, 2010

and available for implementation by the industry. When published, this new CIM will become a landmark in that it will be the first appearance of a model for electricity customer information that is both **open** (meaning the standard is not a vendor's proprietary solution) and rooted in a well-established **industry standard**.

The Future

But the CIM is not the clear answer to filling the gap for demand-side communications. Lawrence Berkeley National Laboratory developed the OpenADR protocol and piloted it in California to much success. Since these initial steps, the OpenADR Alliance was formed to promote the use of this standard, as well as evolve the standard based on the needs of the industry.[13] OpenADR does rely on open standards, but not necessarily those with high levels of adoption in the electricity industry. Despite this, OpenADR has many advocates and is making strong progress with adoption.

Members of both the IEC and the OpenADR Alliance realize that interoperability is key to success and have formed the CIM-OpenADR Harmonization working group under IEC TC57 to develop a mapping between the two protocols.[14] The CIM-OpenADR Harmonization members are currently working on developing "use cases" to illustrate how information can flow from one protocol to the other. Once multiple scenarios are completed, a full mapping will emerge – along with some mutual improvements to both standards in the process.

Predicting how this plays out is not easy. The electricity industry may ultimately end up with multiple protocols, perhaps with new entries not even under consideration today. Or we may see the harmonization effort focus originally independent protocols into a common, all-encompassing schema. What can be said is that those with a stake in the outcome, namely utilities, system operators, energy companies, and end-user advocacy groups, should follow, and whenever possible contribute to, the dialogue so that we arrive at the best – and not just a good – solution.

Authors

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[13] http://www.openadr.org/

[14] http://cimug.ucaiug.org/Projects/CIM-OpenADR/