How NRECA's MultiSpeak® Specification Supports Interoperability of Diverse Electric Grid Automation Systems

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Keywords: Interoperability, MultiSpeak®, CIM, enterprise integration

Abstract

NRECA's MultiSpeak® specification is an industry-wide standard that facilitates interoperability of diverse business and automation applications used in electric distribution utilities. Interoperable MultiSpeak-enabled applications are already in place in numerous electric utilities and permit integrated operation of previously stand-alone systems. MultiSpeak provides similar capabilities to those included in the IEC 61968 distribution extensions to the Common Information Model (CIM).

This paper discusses how MultiSpeak implements key portions of the GridWise Interoperability Framework and illustrates such support by identifying examples of use cases where the most recent version of the MultiSpeak specification can already address the need for significant interoperability among systems. Such examples illustrate how the exchange of information using MultiSpeak has created the potential for utilities to perform services that were previously impossible.

The authors suggests an approach to enhancing future interoperability between MultiSpeak-enabled applications and those that support IEC 61968 CIM with the goal of achieving an integrated system using applications that support the different standards.

1. BACKGROUND

The MultiSpeak® Initiative is a collaboration of the National Rural Electric Cooperative Association (NRECA) and leading software vendors serving the small utility market. The initiative has developed and continues to refine a specification [1] that defines standardized interfaces among software applications commonly used by small electric utilities [2] [3]. Such interfaces can enable utility employees to gain a unified view of utility operations and thus improve customer service, enhance outage performance and cut operating costs.

The MultiSpeak specification defines (i) what data are typically required to be passed among software applications in utilities, (ii) the semantics of those data, (iii) a common message structure, and (iv) which messages are required to support specific business processes.

MultiSpeak defines business objects in the form of an extensible markup language (XML) schema, exchanges data in XML form, and uses web services to transport such data payloads or to invoke actions on another software system. Typically, one web service method will support a single business process step and sequences of multiple method calls will support complete utility business processes.

Additional general information about how MultiSpeak facilitates application integration can be found in a utility user's guide [4]. Additional technical information, complete XML schemas and web service method definitions in Web Services Definition Language (WSDL) format can be downloaded from the MultiSpeak Initiative web site (http://www.multispeak.org).

Taking the example of support for the exchange of metering data, MultiSpeak has a complete set of interface definitions for advanced metering infrastructure (AMI) systems and meter data management. It includes a flexible, efficient, and self-describing means to exchange large volumes of data of arbitrary content among such systems and other applications that require metering data. The authors believe that MultiSpeak can easily be extended to support the developing needs for collecting large volumes of data from in-home networks and for controlling customer equipment using an AMI system.

2. HOW MULTISPEAK SUPPORTS THE GRIDWISE INTEROPERABILITY FRAMEWORK

The GridWise Interoperability Framework [5] outlines principles that support functional interoperability. Principles can be either *categories* that are layered in application (i.e., one layer builds on the layers below, similar to the layering in the Open Systems Interconnection (OSI) seven layer reference model) or *cross-cutting issues*

that need to be addressed at all layers of interoperability. The layered categories are further separated into technical, informational, and organizational aspects, as outlined in Table 1.

Category 1 is adequately addressed by existing OSI physical layer standards; Category 2 by existing protocols that are described in the network, transport and session layers. MultiSpeak makes use of common physical layer standards along with web services over TCP/IP to address transport and session services.

Table 1
GridWise Framework Categories

- Technical Aspects
  - Category 1: Basic Connectivity
  - Category 2: Network Interoperability
  - Category 3: Syntactic Interoperability
- Informational Aspects
  - Category 4: Semantic Understanding
  - Category 5: Business Context
- Organizational Aspects
  - Category 6: Business Procedures
  - Category 7: Business Objectives
  - Category 8: Economic/Regulatory Policy

Syntactic Interoperability, Category 3, concerns data formatting and encoding – typically addressed by the OSI application and presentation layer standards. MultiSpeak makes use of extensible markup language (XML) and SOAP message encoding to address Category 3 interoperability. Since these issues are adequately handled by existing standards, MultiSpeak does not address them.

Categories 6, 7, and 8 are primarily concerned with the economic and regulatory landscape. Certainly business partners must agree on services to be exchanged and regulatory agencies will establish requirements for participating in the markets, but although these issues define needs for information exchange, they are outside the scope of the technical concerns of interoperability.

MultiSpeak primarily addresses the stickier issues of common syntactic understanding (Category 4) and business context (Category 5), along with defining a consistent set of Category 1, 2 and 3 protocols to support effective messaging using web services. MultiSpeak provides for common data semantics (Category 4) by clearly defining data objects and how these objects are exchanged in support of common business process steps. The MultiSpeak object model is described in the form of a set of XML schemas. Data object definitions are adequate to support common business processes in distribution utilities. An edited set of core data schemas, called "recommended-fields" schemas, document a common understanding of which data fields are typically necessary to support utility business processes.

Objects defined in the schemas typically constitute the data payload for messages exchanged between systems. Web service methods are defined to flexibly exchange data as necessary.

Category 5, Business Context, is addressed in MultiSpeak by defining a set of abstract application functionalities. The software functions can be thought of as a framework of roles that can be served by different applications. Each abstract function has data "ownerships", further defining the expected interaction among functions during business processes. Actual computer software can serve one, or perhaps several, of these abstract roles, thus flexibly defining the interfaces necessary to implement interoperable software in an actual utility.

Specific web service methods are defined in MultiSpeak to support a single step in a business process. Such steps can be strung together to define a complete business process by the sequential use of several web service methods. In many cases alternative web service methods are provided so that different software using disparate technologies can provide equivalent business functionality. An example of this feature richness is provision of support for different AMI applications that can determine the outage status of a customer service, one by directly querying the status of the meter (or "pinging" the meter), another by providing unsolicited report by exception functionality. Either capability provides equivalent business value. MultiSpeak supports a variety of web service methods so that a complete outage management business process can be constructed using either functionality. The web services are documented in openly-available WSDL files at http://www.multispeak.org/resources.htm .

In addition to the layered categories the GridWise Interoperability Framework includes cross-cutting issues that are appropriate for all of the categories. The cross-cutting issues are listed in Table 2.

All of these issues are important in concrete implementations, but many of the issues are addressed by existing standards. Where possible, MultiSpeak relies on existing industry standards and does not recreate necessary functionality. Thus, for instance, MultiSpeak relies on Secure Sockets Layer capability to provide security and privacy rather explicitly providing security services.

Table 2
GridWise Framework Cross-Cutting Issues

- Shared Meaning of Content
- Resource Identification
- Time Synchronization and Sequencing
- Security and Privacy
- Logging and Auditing
- Transaction and State Management
- System Preservation
- Quality of Service
- Discovery and Configuration
- System Evolution and Scalability

On the other hand, MultiSpeak specifically addresses (i) shared meaning of content, (ii) resource identification, and to some extent (iii) discovery and configuration. MultiSpeak provides clear definitions of what data objects mean and which objects are appropriate for passing specific information. Vendors of MultiSpeak-enabled applications can unequivocally rely on a shared understanding to provide context for interpretation of received data objects. Naming conventions and clear connectivity rules are established that unambiguously identify resources described in data exchanges. MultiSpeak also addresses discovery using specific web service methods that permit systems to identify what capabilities potential business partners support, the list of specific information types that can be obtained, and catalogs of codes or equipment lists used by other systems. Specific discovery or repository capabilities such as Universal Description, Discovery, and Integration (UDDI) are considered to be outside the scope of MultiSpeak, but can be applied as necessary on a site-specific basis.

3. MULTISPEAK IN OPERATION AT SAN BERNARD ELECTRIC COOPERATIVE

MultiSpeak has been in operation in utilities in some form for nearly seven years. Capabilities to support real-time business processes have been in operation for five years. San Bernard Electric Cooperative (SBEC), a rural electric distribution cooperative that serves about 21,000 consumers in coastal southeastern Texas provides an example of the power and flexibility of MultiSpeak interfaces. SBEC was an early adopter of real-time web services interfaces. SBEC has used MultiSpeak web services to fully integrate an outage management system (OMS) with an AMI used to detect customer outages, an interactive voice response (IVR) system used to take customer outage calls, and a SCADA system that can send device status changes to more accurately determine the cause of system disturbances. This level of integration enables the following capabilities:

- Outage calls taken by the IVR automatically show up as outages in the OMS.
- Customers, service locations and meters, obtained either from the AMI or a customer information system, can be correlated directly from the OMS display.
- The system dispatcher can determine the outage status of a meter directly from the OMS display, without the need to also run the AMI application. This capability can be used to determine the extent of an outage or to verify the restoration of a service without the need to send a line crew to the location.
- The AMI system can locate meters electrically on the system using information supplied by the OMS. Thus it is possible to address individual meters or meter groups that might be affected by the operation of a power system device, such as a distribution line fuse.
- The OMS automatically is provided with information about device status changes monitored by the SCADA system and thus can more accurately and quickly determine the cause of outages due to the lockout of a substation breaker.

Benefits gained from this integration include (i) enhanced customer service made possible by improved information about outage status, (ii) a reduction in outage time, (iii) a reduction in the “information overload” suffered by system dispatchers during extensive outages, (iv) a reduction in overtime wages during outages, and (v) improved employee efficiency. In addition, integration makes it possible to reduce the number of computer monitors necessary for the dispatcher to obtain the information required to handle a system outage, thus also reducing the number of application software seats and employee training on redundant applications.

A conservative estimate of the quantifiable savings gained from the integration of existing systems at SBEC is $111,533/year – which amounts to about $5.30 per customer per year. The specifics of San Bernard’s implementation and the business process benefits gained may be found in reference [6].

4. IEC COMMON INFORMATION MODEL (CIM)

Technical Committee 57 (TC57) of the International Electrotechnical Commission (IEC) is also developing a standard for integration of utility software. The TC57 standard is based on an object model called the Common Information Model (CIM). CIM is documented in the IEC 61970-301 standard [7]. CIM was originally developed to support transmission and control centers, but is being extended to address all aspects of a vertically-integrated electric utility. As a result, CIM covers a wider field than

does MultiSpeak, since currently MultiSpeak addresses only distribution.

Working Group 14 (WG14) of TC57 focuses on the distribution aspects of CIM. The extensions to the core CIM to address distribution issues are documented in the IEC 61968 series of standards. Of particular interest to this discussion are IEC 61968-1 [8], which outlines the basic architecture and message framework for distribution interfaces, and IEC 61968-11 [9], which outlines the information model for distribution interfaces. Since both address distribution issues, there is a substantial conceptual overlap in MultiSpeak and the 61968 standards.

CIM is targeted to larger investor owned utilities which typically have extensive information technology staffs and have more complex IT environments than are common among the electric cooperatives that are the target market for MultiSpeak. The CIM standards focus on message definition and content, leaving much of the transport and middleware as implementation issues. Such an approach would be inappropriate for smaller utilities and for the software vendors serving the cooperative market - many of which also have limited resources. As a result, MultiSpeak standardizes on web services as a means to transport data and does not assume the existence of a messaging middleware infrastructure.

5. A PROPOSAL FOR INTEROPERABILITY BETWEEN MULTISPEAK AND IEC CIM

One of the goals of GridWise that is clearly elucidated in the interoperability framework is the ability to "bridge between communities with independently evolved understandings". There is a clear need for building a semantic bridge between MultiSpeak and 61968 CIM so that eventually it will be possible to foster interoperation among MultiSpeak and CIM applications.

The ideal approach would be to use emerging semantic representation tools to provide a dynamic translation between MultiSpeak and CIM. The CIM community has recently begun to publish CIM in Web Ontology Language (OWL) format. MultiSpeak currently is considering making this step. It is believed that eventually tools will become available to facilitate electronic translation between semantic models expressed in OWL format; however, such tools are in their infancy.

A near-term approach would be to develop a translation adapter. Provided a mapping could be generated between the two data models, messages created using either standard could be electronically converted to the corresponding message generated by the other standard. That is to say, a translation table would be generated that indicates which pieces of data in a MultiSpeak message corresponded to which items in a CIM message, and vice versa.

This solution is achievable and consistent with the approaches already taken by the respective groups, as illustrated in Figures 1 and 2. Figure 1 shows the method used by MultiSpeak to allow two compatible software programs to exchange data, through a vendor-supplied MultiSpeak "translator" (indicated by the shaded ovals in Figure 1) without affecting the databases native to each piece of software. Many of the CIM implementations to date use an adapter layer to integrate a legacy application with CIM applications, as illustrated schematically in Figure 2.

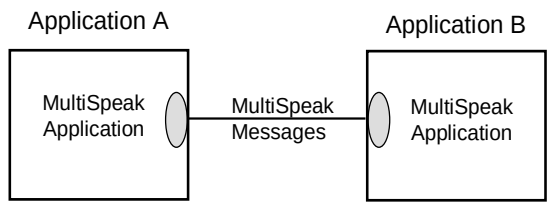

Figure 1
Data Flow between MultiSpeak-Enabled Applications

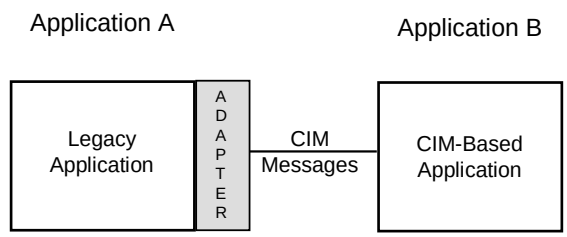

Figure 2
Data Flow between a Legacy Application and a CIM-Enabled Application

Figures 3 and 4 show conceptually how a translation might work between a MultiSpeak compliant application and a CIM compliant application. In either case, the adapter translates the output of the application to match the format expected by other applications on the network. Figure 3 is appropriate for the case where relatively few MultiSpeak-enabled applications are to be integrated into a predominantly CIM-based enterprise network; Figure 4 shows the case where relatively few CIM-based applications would integrate with a MultiSpeak-based enterprise network.

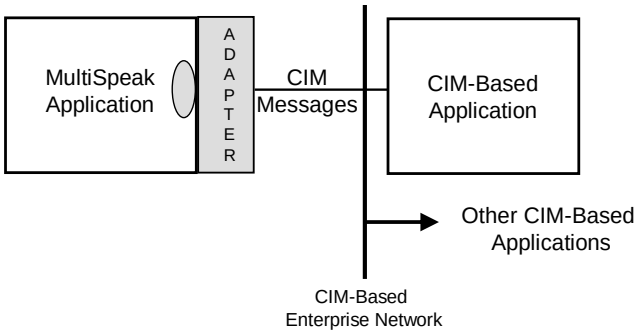

Figure 3
Integration of a MultiSpeak-Enabled Application into a CIM-Based Enterprise Network

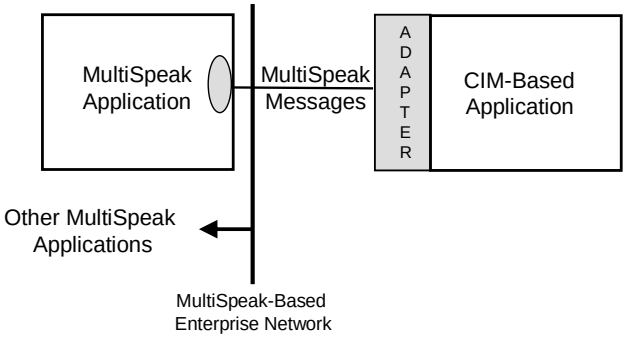

Figure 4
Integration of a CIM-Enabled Application into a MultiSpeak-Based Enterprise Network

Creation of the appropriate adapters requires several steps: first, a conceptual mapping between the two data models, and second, the development of an electronic translation using this conceptual mapping. Effort has begun in both MultiSpeak and WG14 to take the first steps to develop the conceptual mapping. It is anticipated that the creation of an XML style sheet translation should be straightforward once the conceptual mapping is completed.

6. CONCLUSIONS

MultiSpeak provides important capabilities that can assist utilities to implement interoperable enterprise networks. Many of the goals of GridWise can be achieved today with existing MultiSpeak interface definitions. MultiSpeak provides mature and complete functionality in support of AMI, meter data management, and other operational systems. Existing MultiSpeak functionality can easily be extended to provide the capability for AMI systems to return data from home networks or to control customer equipment, as the scope of these needs is further defined by the industry.

There is a great deal of conceptual overlap between MultiSpeak and the IEC 61968 extensions to CIM. Both standards have been applied in utility implementations and are likely to continue to be used going forward since each provides value to their respective markets. Thus, there is a need to develop a semantic bridge between the two data models. The authors have presented an approach to developing this bridge, which we believe is achievable in the near-term and will permit systems to flexibly evolve over time.

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Biography

Gary A. McNaughton is the Vice President and Principal Engineer for Cornice Engineering, Inc. He received a B.S.E.E. degree from Kansas State University in 1976 and an M.S.E.E. degree from the University of Colorado in 1980. Prior to joining Cornice in 1995 he worked as a Plant Electrical Engineer for Union Carbide, at the Oak Ridge Gaseous Diffusion Plant, at Oak Ridge, TN, as a Transmission Planning and Protection Engineer for Colorado-Ute Electric Association, a generation and transmission cooperative, located in Montrose, CO, and as Staff Engineer, Manager of Engineering, and Assistant General Manager for Engineering and Operations for La Plata Electric Association, in Durango, CO. Mr. McNaughton currently serves as the Project Technical Coordinator for NRECA's MultiSpeak® Initiative. Mr. McNaughton is a registered professional engineer in the State of Colorado.

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