COMPARISON OF THE MULTISPEAK® DISTRIBUTION CONNECTIVITY MODEL AND THE IEC COMMON INFORMATION MODEL NETWORK DATA SET

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ABSTRACT

There are two standards for enterprise integration in electric utilities, the MultiSpeak® specification, which is sponsored by the National Rural Electric Cooperative Association (NRECA), and the Common Information Model (CIM), which is an international standard maintained by Technical Committee 57 (TC57) of the International Electrotechnical Commission (IEC). A number of papers have presented general comparisons of the two standards, but until recently it has not been possible to perform a detailed comparison for specific corresponding profiles of the two standards.

MultiSpeak first published a distribution connectivity model exchange specification and tested applications for compliance with that specification in 2001. Currently, MultiSpeak-compatible connectivity data exchange is in operation at dozens of utilities. Working Group 14 (WG14) of TC57, which deals with work processes germane to distribution utilities, has recently defined the NetworkDataSet message that specifies how the CIM can be used to exchange detailed models for distribution engineering analysis. CIM-compatible NetworkDataSet model exchanges are in operation at several utilities. However, until now no analysis has been published on the correspondence between the two models and the potential for development of an automated means for interchange between the power system models supported by the two specifications. This paper will present a comparison of the corresponding power system models and illustrate how such an automated conversion between them could occur.

BACKGROUND

Both MultiSpeak and CIM are intended to support standards-based inter-application integration. It is assumed by both groups that such integration needs to connect disparate applications that support a variety of databases and different runtime environments. Both groups thus focus on loosely-coupled integration methods using extensible markup language (XML) to encode message payloads. [1, 2, 3]

CIM is designed to use a variety of messaging middleware frameworks in order to maximize the flexibility of implementation at utilities that may have a number of different middleware solutions already in place. Thus the CIM message protocol supports a standardized message header using a noun/verb grammar along with a well-defined message payload. In addition to the message-oriented profile, WG14 plans to develop a web services profile for implementation of its interfaces.

MultiSpeak also has developed a messaging framework that was based on the CIM approach, but has found that web services implementations are more desirable for the small utility marketplace since small utilities rarely implement messaging middleware. The MultiSpeak messaging framework is still provided as an option in the specification, but currently MultiSpeak interoperability testing only supports web services and nearly all real-time utility implementations of MultiSpeak make use of this technology.

Despite these disparities, the two standards are conceptually more similar than different. Since CIM and MultiSpeak both serve the electric utility industry, there is value to sharing information and moving towards harmonization of the standards. It is also apparent that both standards will continue to gain acceptance in the marketplace; thus it is inevitable that they will be implemented simultaneously in some utilities. A mutual effort is underway to investigate ways that applications designed to be compatible with one of the two standards can be integrated with applications designed to support the other.

The approach being investigated to address this need for interoperability is to (i) find a work process that is well-defined in both specifications, (ii) determine what data payloads are exchanged in each case, and (iii) develop a means to electronically transform one payload into the other. Once a means to transform the payload supported by one standard into the corresponding payload for the other standard, it will be possible to construct a software adapter to perform this transformation and hence to integrate between the disparate applications.

This paper describes a first effort in this process. The work process chosen for study is the exchange of distribution network data between a geographic information system and an engineering analysis application. In MultiSpeak this is referred to as the exchange of connectivity information [1]; in CIM this is accomplished using a NetworkDataSet message [4, 5].

PHILOSOPHICAL DIFFERENCES IN THE APPROACHES

MultiSpeak arose out of a need to foster "out-of-the-box" interoperability to as great an extent as possible, since the distribution cooperatives that are members of NRECA typically have few, if any, IT staff members and typically do not implement messaging middleware. Few cooperatives develop their own software suites; rather they typically rely on vendor-supplied solutions. Co-ops place a high value on interoperability of those vendor-supplied solutions, preferably at low cost for integration and with little customization being required. Hence, MultiSpeak has focused from the first on the development of tightly specified profiles of data objects and standardized implementations that vendors could install, largely unchanged, at many utility sites. Although MultiSpeak does have extensive capabilities for customizing these standardized profiles using extensions, both the vendor and user communities prefer to have nearly identical implementations of interfaces between any given pair of vendor-supplied products. The MultiSpeak community values interoperability over flexibility.

The CIM standard serves a community with somewhat different needs. Typically, CIM is considered for adoption by a large utility that has an extensive IT staff, a large number of legacy applications, often a number of utility-developed solutions, and a complex middleware environment. With few exceptions, there are no requirements for the exchange of data among utilities; hence each utility is free to implement CIM in the manner that best suits their specific needs. One exception is the transfer of transmission power system data using the CIM Common Power System Model, which is described below. Utilities facing these conditions place a high premium on flexibility and the ability to significantly customize the solutions. Hence, there is a greater variety in CIM implementations than there is in MultiSpeak implementations. In the CIM community, there is more value placed on flexibility than on interoperability.

When considering harmonization of the two efforts it is important to keep these philosophical differences in mind and to develop an approach to harmonization that recognizes the value that each community brings to the table and addresses both sets of unique needs.

DEVELOPMENT OF PROFILES

The process that typically is used in implementing CIM is: (i) a business need is outlined, (ii) message types are cataloged to support the stated need, (iii) data objects are identified to carry the required data, (iv) an XML message schema is developed and tuned to meet the needs of the utility, and (v) applications, or adapters to legacy applications, are developed to generate and consume the messages.

When this process is performed to suit the needs of a specific utility, the result is inter-application interoperability within one company, but not necessarily uniform interoperability between companies. When industry-wide interoperability is desired, it is necessary to go through the first four steps of this process in a standards body. The result is a clearly defined profile that can then be rigorously interoperability tested.

At this point there are two defined profiles of CIM that have achieved interoperability testing: (i) the Common Power System Model (CPSM), a profile for the exchange of transmission system data, and (ii) the Common Distribution Power System Model (CDPSM), which serves the same need for distribution data. CPSM is widely used for the exchange of transmission system data for planning purposes between utilities in the same power pool. CDPSM has been developed as a specialization of the CPSM. Several utilities and vendors have developed CDPSM data exchanges and have successfully passed interoperability testing. However, currently there are several shortcomings in the CDPSM that make it inappropriate for the exchange of data about distribution systems in North America; notably it does not support the exchange of unbalanced or reduced phase networks and it does not support induction motor load.

There is an alternative approach to CDPSM for the exchange of distribution system data which has been developed by WG14, the NetworkDataSet. The NetworkDataSet is very flexible, and locally-customized versions of this message are in production use at several North American utilities. However, the NetworkDataSet profile has not yet reached the point where it is adequately defined to support interoperability testing.

CORRELATION OF THE MULTISPEAK AND CIM DATA MODEL

An initial review of the MultiSpeak connectivity data exchange and the CIM NetworkDataSet indicates that each serves the need for exchanging distribution system data for modeling purposes, as is to be expected since both are in production use at utilities. In MultiSpeak, elements can be considered as either line sections with nodes on each end (a section-oriented model) or as equipment that is attached to two connectivity nodes, one on each end (a node-oriented model). An element in the CIM model can be associated with an unlimited number of connectivity nodes. As an alternative, a CIM element can have multiple terminals, and each terminal can be associated with a connectivity node. There is no concept of a terminal in MultiSpeak.

In MultiSpeak, all devices are one or two-terminal devices. One terminal devices are assumed to be connected shunt to ground and ground is not explicitly modeled. In CIM, ground may be explicitly modeled, or not, as desired. If ground is explicitly modeled then, in CIM, an autotransformer for instance would be a three terminal device - high voltage, low voltage and ground. In MultiSpeak, this would be modeled as a two terminal device - high voltage and low voltage; a common ground is assumed.

Despite these differences, the connectivity models are semantically identical in the two approaches and conversion between the two models is possible provided (i) the node-oriented model is chosen in

MultiSpeak, (ii) terminals are not explicitly specified in the CIM model, and (iii) three (or higher) terminal devices are modeled as two-terminal devices in CIM. None of these limitations significantly affects the usability of the respective data models.

Figure I schematically illustrates a simple distribution system. It includes a representative sample of power system devices that might be found on a North American distribution network. Table I identifies each power system element from Figure I and indicates which data object would be used to represent the element in the MultiSpeak or CIM NetworkDataSet.

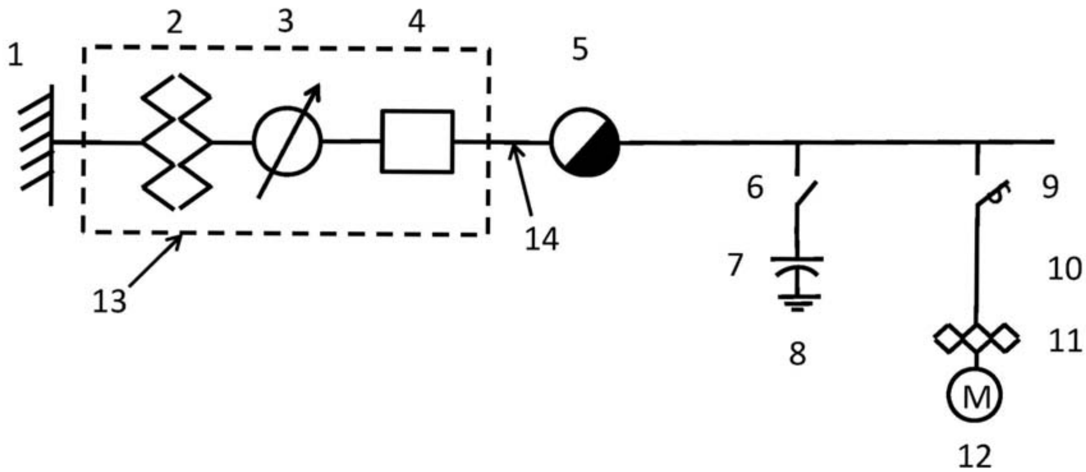

FIGURE I
SAMPLE DISTRIBUTION CIRCUIT

In order to complete harmonization of the two models using the guidelines outlined above, it will be necessary to (i) develop a concrete profile for the NetworkDataSet, (ii) compare the data objects as correlated in Table I, and (iii) map the correspondence between the important fields in each model. Once such a mapping is complete, it will be possible to electronically transform the data payloads of a MultiSpeak connectivity set and a CIM NetworkDataSet. An additional benefit of this approach would be that both groups could become more familiar with the data model of the other so that synergies could be achieved in the longer term.

TABLE I
CORRELATION OF MULTISPEAK AND NETWORKDATASET OBJECTS FOR SAMPLE DISTRIBUTION FEEDER

Power System Element	MultiSpeak Object	NetworkDataSet Object
1) Equivalent source	Included in **Substation** object.	**EnergySource**
2) Power transformer	**TransformerBank** (containing one or more transformer units)	**PowerTransformer** (containing two or more **Windings**)
3) Voltage regulator	**Regulator**	Modeled as a **PowerTransformer** with a **TapChanger** and **RegulationSchedule.**
4) Breaker	**OvercurrentDeviceBank** (containing breaker object(s))	**Breaker**
5) Recloser	**Recloser**	Modeled as a **Breaker** with **RecloserProperties.**
6) Switch	**SwitchDeviceBank** (containing switch units).	**Switch**
7) Shunt capacitor bank	**CapacitorBank**	**ShuntCompensator**
8) Ground	Assumed to be part of **CapacitorBank**.	**Ground**
9) Fuse	**Fuse**	**Fuse**
10) Single phase distribution line	**ohPrimaryLine** or **ugPrimaryLine** as appropriate.	**ACLineSegment**
11) Distribution transformer	**TransformerBank** (containing one or more transformer units).	**PowerTransformer** (containing two or more **Windings**)
12) Customer service location	**ServiceLocation**	**ServiceDeliveryPoint**
13) Substation	**Substation**	**Substation**
14) Three phase distribution feeder	**FeederObject** in substation. Upon leaving the substation, the line is modeled as a set of **ohPrimaryLine** or **ugPrimayLine** objects which model line sections between connectivity nodes.	**Circuit** in substation. Upon leaving the substation, the line is modeled as a set of **ACLineSegment**s (also called CircuitSections) between connectivity nodes.

APPROACH TO INTEROPERABILITY

The ideal approach to harmonization would be to use emerging semantic modeling 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 two similar models expressed in OWL format; however, such tools are in their infancy.

A near-term approach would be to make use of translation adapters. This solution is attractive because it is consistent with the approaches already taken by the respective groups, as illustrated in Figures II and III. Furthermore it is achievable, once the data object mapping described above is complete. Figure II 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 II) without affecting the databases native to each piece of software. Similarly, many of the CIM implementations to date use an adapter layer to integrate a legacy application with CIM applications, as illustrated schematically in Figure III.

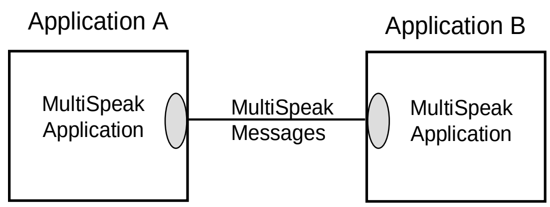

FIGURE II
DATA FLOW BETWEEN MULTISPEAK-ENABLED APPLICATIONS

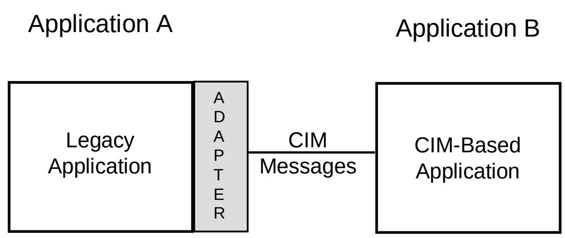

FIGURE III
DATA FLOW BETWEEN A LEGACY APPLICATION AND A CIM-ENABLED APPLICATION

Figures IV and V 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 IV is appropriate for the case where relatively few MultiSpeak-enabled applications are to be integrated into a predominantly CIM-based enterprise network; Figure V shows the case where relatively few CIM-based applications would integrate with a MultiSpeak-based enterprise network.

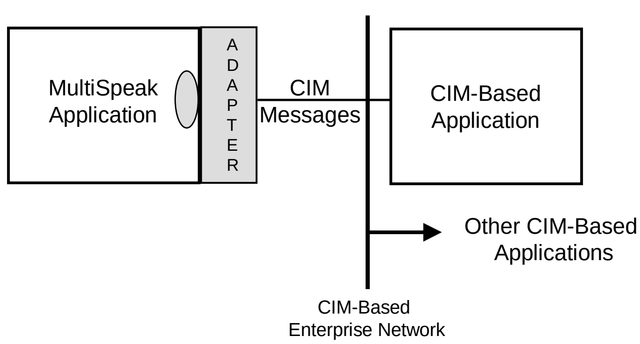

FIGURE IV
INTEGRATION OF A MULTISPEAK-ENABLED APPLICATION INTO A CIM-BASED ENTERPRISE NETWORK

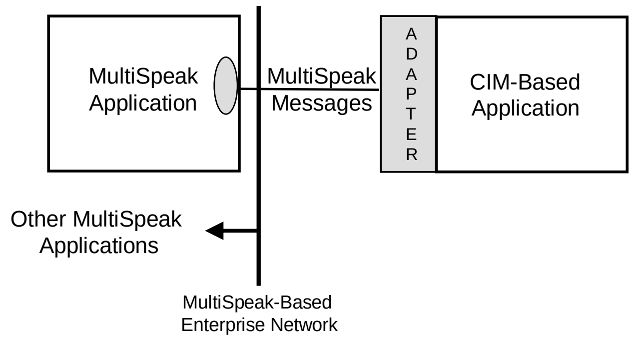

FIGURE V
INTEGRATION OF A CIM-ENABLED APPLICATION INTO A MULTISPEAK-BASED ENTERPRISE NETWORK

CONCLUSIONS

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. There is value to developing a semantic translation between the two approaches on several levels: (i) working towards harmonization will enable each effort to become more familiar with the work of the other, (ii) synergies may be gained when the two efforts compare each others' work, (iii) utilities that support a mixed CIM and MultiSpeak network can gain additional levels of interoperability, and (iv) it will become easier for software vendors to support both integration standards. It now appears that harmonization of the two efforts is achievable in the near-term and will permit systems to flexibly evolve over time.

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[4] Working Group 14 of Technical Committee 57, *System Interfaces for Distribution Management – Part 4: Interfaces for Records and Asset Management*, Committee Draft for Vote IEC 61968-4, Geneva, Switzerland, International Electrotechnical Commission, 2006.
[5] Working Group 14 of Technical Committee 57, Sample 61968 Message Set, based on IEC 61970cim11v09, dated October, 2007.

BIOGRAPHY

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