Collaborative Operations & Maintenance
Using MIMOSA's OSA-EAI and ISA-95/B2MML

OpenO&M™ For Manufacturing
Joint Working Group

Introduction

MIMOSA's Open Systems Architecture for Enterprise Application Integration (OSA-EAI) specification and the ISA-95 standard are powerful tools for achieving improvements in operations and maintenance of manufacturing facilities. While each set of work was developed independently, MIMOSA and the ISA's SP95 committee are now working as part of the OpenO&M™ initiative to harmonize them and share work going forward.

The first step in harmonization was the OpenO&M whitepaper on Condition Based Operation which showed the value that could be realized by using OSA-EAI and ISA-95 together to include real-time maintenance capability forecasts as part of production planning and scheduling activities. This whitepaper continues that work by explaining how the data models in OSA-EAI and ISA-95 can be used together. There can be some confusion in this area as each data model uses different terminology and relationships due to their independent histories.

This whitepaper addresses technical audiences who need to map data between OSA-EAI and ISA-95/B2MML systems. The mapping is discussed at both a high level using the UML models in OSA-EAI and ISA-95 as well as at an implementation level using OSA-EAI XML Schemas and the WBF's B2MML (Business To Manufacturing Markup Language) XML Schema implementation of ISA-95. This whitepaper only addresses the use of ISA-95 Parts 1 and 2 which are focused on production management interfaces between enterprise and control systems. On-going work by the SP95 committee will broaden the standard's coverage to maintenance, inventory and quality data interfaces; those will be addressed in later whitepapers.

This whitepaper explains the basic mappings between OSA-EAI and ISA-95/B2MML. These basic mappings address object to object mapping as well as conventions for how to reference data between systems supporting each interface. The target of this whitepaper is to publish common conventions covering the following areas for use when integrating OSA-EAI and ISA-95/B2MML enabled systems:

- Equipment references
- ID exchange

- Naming conventions
- Mapping of objects between the standards

Using these basic conventions, tighter, high-level integration between the two data models can be achieved. Two examples of higher level integration which OpenO&M is working towards are mapping ISA-95 maintenance objects to OSA-EAI Work interfaces and standardizing the capabilities dialog required to bring asset health data into operational systems.

Why Use Both ISA-95/B2MML and OSA-EAI?

The ISA-95 standard and the B2MML implementation are intended to define interfaces between enterprise and manufacturing systems. Its scope initially focused on production management interfaces but has grown to include inventory, quality data and maintenance interfaces. The maintenance interfaces are still under development and are being developed in cooperation with MIMOSA to ensure they are consistent with and build upon the OSA-EAI data model.

The OSA-EAI data model and interfaces are intended to provide rich support for, reliability and maintenance activities enabling asset lifecycle management. This includes vertical support within an enterprise integrating maintenance oriented shop floor and business systems, as well as inter-enterprise integration.

It is expected that enterprises will utilize multiple standard formats to accomplish their business goals. Among these will be both OSA-EAI and ISA-95/B2MML, each targeted to meet different business needs. While there is some overlap between the data models, each data model provides extensive functionality not found in the other that meets business needs. Therefore the ability to easily pass data between systems based on the different data models is critical to the successful implementation of these systems. This whitepaper explains how data can be passed bi-directionally between OSA-EAI and ISA-95/B2MML enabled systems.

Mapping OSA-EAI Core Objects to ISA-95

At the core of the OSA-EAI data model are the abilities to:
1. Differentiate assets from their role, which is called a segment
2. Track the use of assets in segments over time, even as an asset moves through multiple sites in various enterprises
3. Assign a life-time universal ID to every enterprise, site, agent, functional segment, and serialized asset and their roles
4. Classify all major objects using an extensible type system
5. Organize assets into segment hierarchies
6. Organize assets and segments into multiple network views.

To use OSA-EAI and ISA-95/B2MML together it is critical to start with these core features and determine how they map to ISA-95/B2MML. This will enable operational and maintenance systems to interoperate.

OSA-EAI's Common Conceptual Object Model (CCOM) defines these core features, a simplified version of the model focusing on key objects related to interfacing with ISA-95/B2MML is shown in Figure 1.
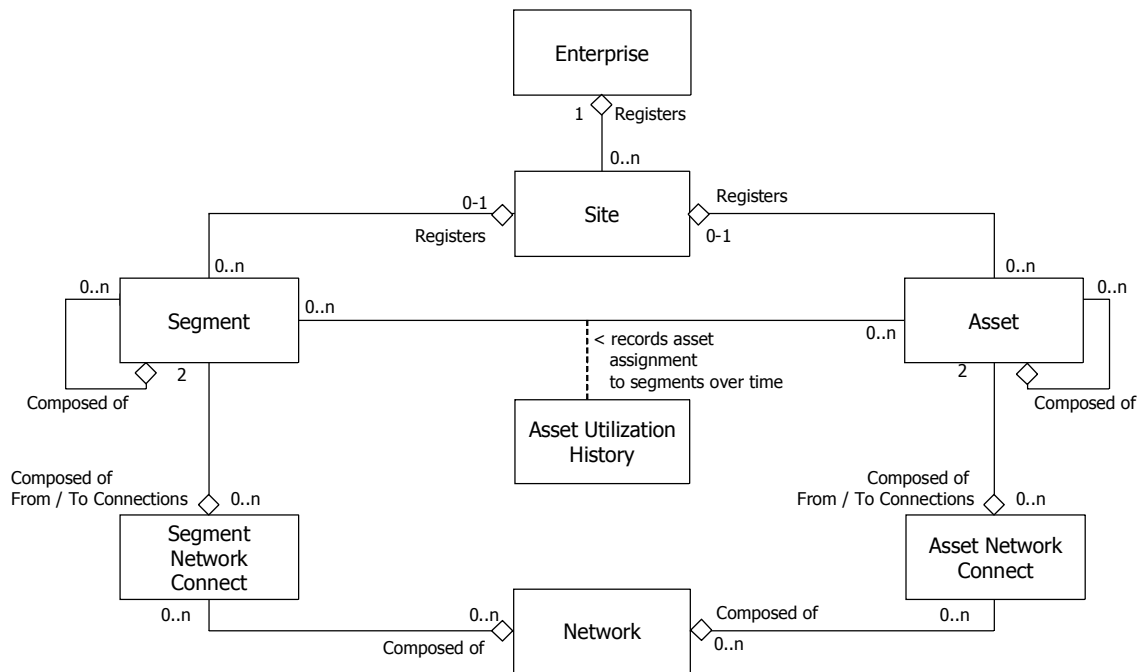

Figure 1
Simplified Version of OSA-EAI CCOM 3.1 RegCore and RegNetwork

With regards to interfacing with an ISA-95/B2MML enabled system, the key objects in these Figures are:

Enterprise	An enterprise is the corporate level of an organization, or the top organizational structure of a non-profit or military body. An enterprise is composed of many sites.
Site	An enterprise-defined entity which can be decomposed into segments and which generates new assets, agents, databases, and measurement locations.
Segment	A logical entity which is designed to perform a function at a site. A segment can be monitored, associated with work, decomposed into smaller segments, and serve as a "container" for a physical asset.
Asset	An instantiated entity which can be physically tagged with an asset identifier and/or depreciated by an accounting system. Assets are assigned an ID which uniquely identifies the asset for its entire lifetime even if used for different segments over time.

Asset Utilization	Records the assets used by segments over time.
Network	A named association of segments and/or assets from/to connections in a sequenced production process or as a named hierarchy of segments.

ISA-95 identifies equipment as one of the three resources (personnel, equipment and material) used for manufacturing. The ISA-95 equipment model is shown in Figure .
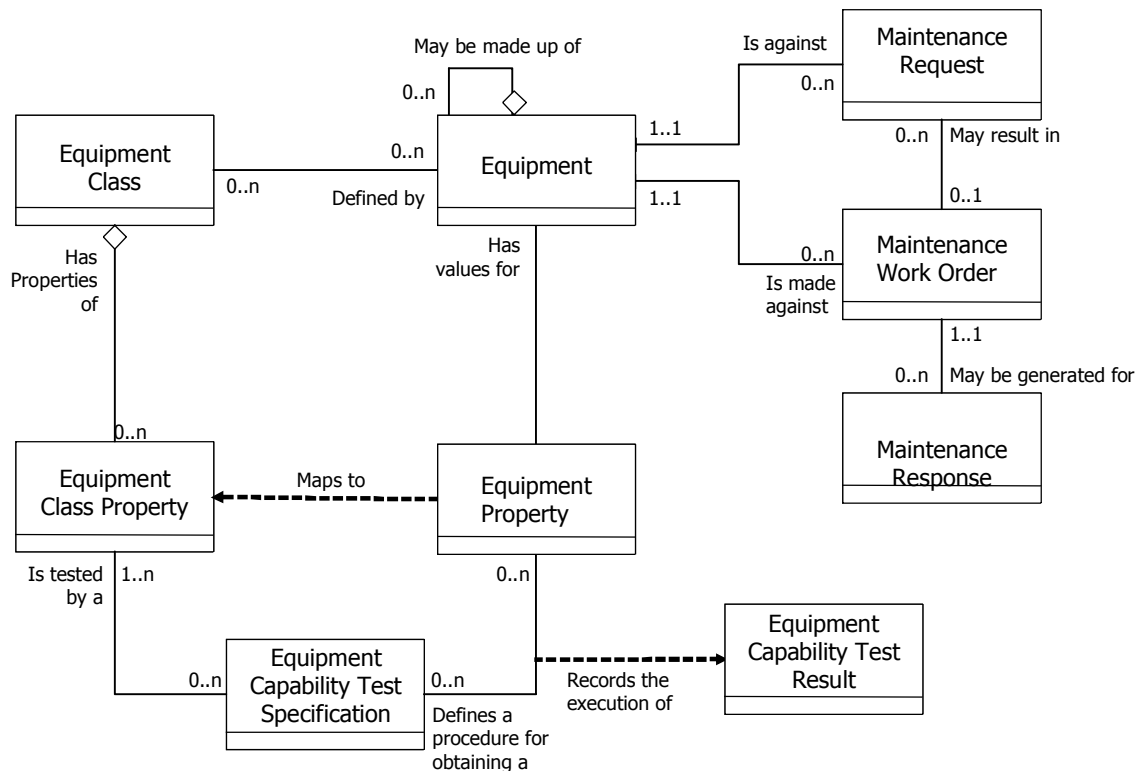

Figure 2 - ISA-95 Part 1 and 2 Equipment Model

This equipment model was developed to support production management functions as defined in ISA-95 Part 1 so equipment does not refer to a specific asset; rather it refers to the role an asset is performing at a point in time. Therefore the ISA-95 term "equipment" is analogous to the OSA-EAI term "segment". Also as a result of this ISA-95 does not support the concept of asset utilization as defined in the OSA-EAI model.

ISA-95 equipment objects are intended to cover all equipment levels in an enterprise that are required for planning purposes. This includes the enterprise and site levels which in OSA-EAI are separate objects.

OpenO&M recommends that when OSA-EAI enterprise, site and segment objects need to be mapped to ISA-95/B2MML they be mapped to equipment objects on a one-to-one basis.

ISA-95 does not have an object that is analogous to the OSA-EAI asset object. **OpenO&M recommends that if data for an asset associated with an OSA-EAI segment needs to be exchanged with an ISA-95/B2MML enabled system that asset data should be mapped to ISA-95/B2MML equipment properties.**

The ISA-95 maintenance objects in Figure 2 provide a limited amount of support for maintenance work orders and are analogous to the OSA-EAI Work objects. A separate OpenO&M whitepaper will address this mapping.

Using OSA-EAI Segments and ISA-95 Equipment

ISA-95 equipment objects are resources used to support the data exchanged between enterprise and manufacturing systems. Typical production management data exchanged between these systems that use the equipment resources are:

- Production Schedules
- Production Performance
- Production Capability
- Product Definition

ISA-95 equipment objects can be hierarchical, with any number of levels, with levels in any order and with any number of disconnected hierarchies defined in the same system. Typically the hierarchy will match the equipment hierarchy shown in Figure 3. While this whitepaper focuses on ISA-95 Parts 1 & 2 this figure is borrowed from ISA-95 Part 3 and has the addition of storage zones and modules.
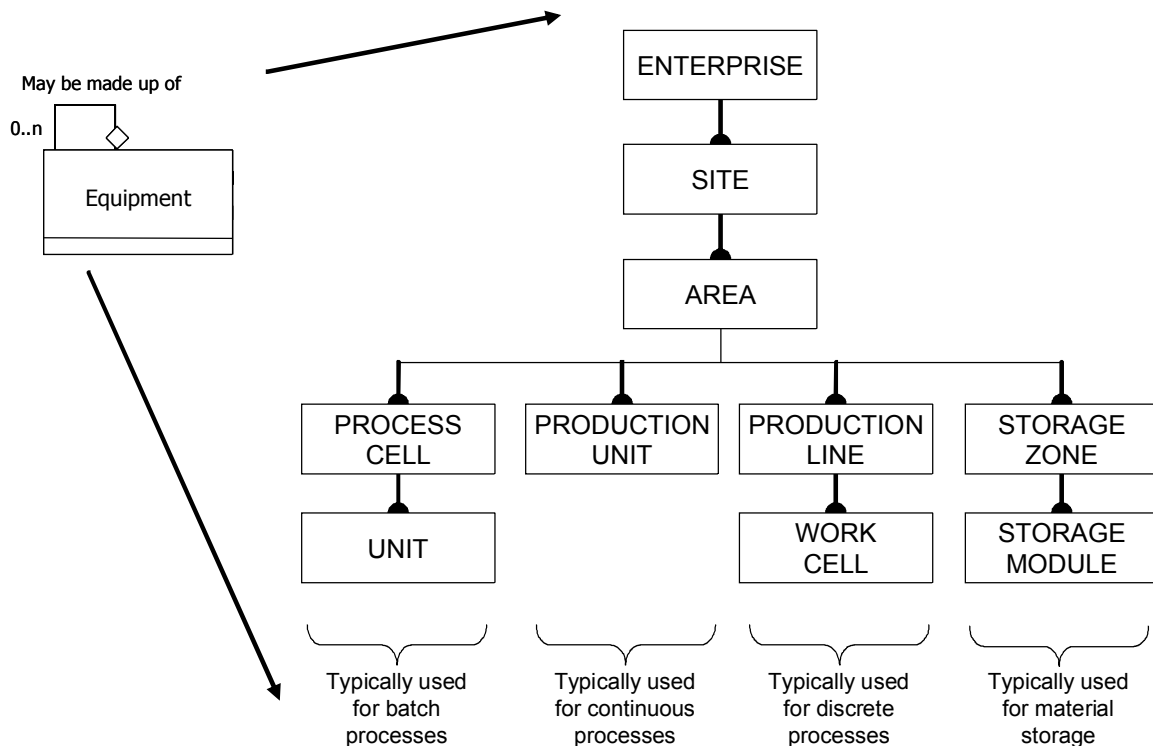
Figure 3 - ISA-95 Equipment Object, Typical Hierarchy Implementation

The number of levels and the granularity of the equipment hierarchy implemented for any given application is usually determined using a top down process driven by production planning & scheduling requirements as well as production performance reporting requirements. In some cases the equipment will only be defined to the level of a process cell, production unit or production line. In other cases additional lower levels will be defined such as units, specific machines or flow paths.

OSAEAI-enabled systems will generally use more of a bottom up approach, that is assets tracked for maintenance purposes are mapped to segments, with higher level segments built up to show how the assets are connected, or related.

Usually OSA-EAI segment hierarchies will be more detailed than ISA-95 equipment hierarchies for the same application. This is because they are driven by different requirements. It is recommended that ISA-95 equipment hierarchies be deep enough and the OSA-EAI segment hierarchy high enough so they overlap with common definitions thereby enabling the mapping of OSA-EAI segments with ISA-95 equipment.

OSA-EAI Segments and ISA-95 Equipment Classes

The ISA-95 equipment model defines equipment class objects. Equipment classes group identical types of equipment for organizational purposes and enable them to have common

properties. The equipment class property object may be used to define common properties for all equipment objects associated with an equipment class. One equipment object may be associated with 0-n equipment classes.

Depending upon the application, an ISA-95 enabled system may be configured to use either equipment objects, equipment class objects or both. ISA-95 equipment classes normally correspond to OSA-EAI Segment Types.

When using equipment classes in B2MML, it should be realized that maintenance actions are associated with an OSA-EAI Segments, not on a OSA-EAI Segment Type. Therefore when using equipment classes, ISA-95 enabled systems should also be configured to use equipment objects. The same is true for capability forecasts which are generated by maintenance systems and sent to operational systems. The capability forecasts will identify the expected future capability of ISA-95 equipment, not equipment classes.

OpenO&M recommends that ISA-95 equipment class objects be mapped to OSA-EAI segment types. When passing data between ISA-95/B2MML and OSA-EAI enabled systems it is recommended that equipment, not equipment classes, be the subject of the data exchange to make the best use of the instance/asset orientation of maintenance systems.

ISA-95 Product Segments vs. Process Segments

ISA-95 segments are of two types: Process Segments and Product Segments. Both of these types of segments are for planning purposes and therefore only contain the detail needed to meet planning and scheduling requirements.

There is sometimes confusion between process and product segments, the definitions from ISA-95 Part 1 are:

Process Segment:

> "…the collection of capabilities needed for a segment of production, independent of any particular product. This may include material, energy, personnel, or equipment capabilities."

Product Segment

> "…the overlap of information between product production rules and the bill of resources. It describes a job or task consisting of one of more work elements, usually done essentially in one location."

Essentially process segments are used to communicate the capabilities of a segment of production, or part of a process. Product segments are used to communicate the requirements for producing a specific product. Product segments would be used by an operational planning & scheduling system to understand the equipment resource requirements

for a product, the process segments would be used to understand the underlying asset capabilities projected by a maintenance system.

OpenO&M recommends that when communicating with OSA-EAI enabled maintenance systems ISA-95/B2MML process segments be used, not product segments.

Mapping OSA-EAI Networks to ISA-95 Process Segments

The OSA-EAI network object defines connectivity relationships between segments and/or assets, and allows segments and assets to be mapped into process flow chains. Using networks means that the design of OSA-EAI segments can be driven by maintenance needs while networks can be designed to map the OSA-EAI segments to ISA-95/B2MML process segments which have been designed to meet operational planning & scheduling needs.

This mapping will result in more flexible systems, if OSA-EAI segment hierarchies need to be reorganized for maintenance purposes only, then the network mapped to a ISA-95 process segment does not need to be modified. If ISA-95 process segments are changed, the OSA-EAI network can readily be modified without impacting the underlying maintenance oriented segment hierarchies.

OSA-EAI networks support multiple hierarchies and allow the association of a set of OSA-EAI segments to one network. Since any number of networks are available, they can be used to create custom "views" of the segments, for example from a maintenance or operational planning perspective there may be networks defined for multiple purposes, all using the same master set of OSA-EAI segments. Examples of different types of networks are:

- Safety networks
- Quality networks
- Personnel role specific networks
- Different networks for each type of maintenance – Electrical, mechanical, hydraulic, field control devices
- Reliability networks (used to model entities that fail as a whole if any of the constituent components fail)

Each network is decoupled from the others so an operational network and a maintenance network can each be modified as needed without impacting the other. If an underlying segment is modified it will impact all associated networks.

OpenO&M recommends that OSA-EAI networks be mapped to ISA-95/B2MML process segments.

OpenO&M Data Mapping Recommendations

To summarize, the following data mapping conventions are recommended for integrating OSA-EAI and ISA-95/B2MML enabled systems:

Table 1 - Recommended Object Mapping

OSA-EAI	ISA-95
Asset	No comparable object, store as Equipment Properties associated with Equipment
Asset Utilization	No comparable object
Enterprise* (see note #1 below)	Equipment
Manufacturer	No comparable object, store as Equipment Properties associated with Equipment
Model	No comparable object, store as Equipment Properties associated with Equipment
Network	Process Segment
Segment	Equipment
Segment attributes	Equipment Property
Segment related data such as, Asset, Agent	Equipment Property
Segment Type (when ISA-95/B2MML Equipment Classes are not used)	Equipment Property
Segment Type (when ISA-95/B2MML Equipment Classes are used)	Equipment Class
Site* (see note #1 below)	Equipment

Recommendations:

(1) OSA-EAI Enterprise and Site objects are used in OSA-EAI for registration purposes. It is recommended that an enterprise Segment object be created in OSA-EAI and associated with the appropriate ISA-95 Equipment object with Equipment Class of "enterprise". Similarly, a site Segment object should be created in OSA-EAI and associated with an ISA-95 Equipment object with Equipment Class of "site".

(2) OSA-EAI attributes, data items and object relationships that cannot be directly mapped to ISA-95/B2MML objects should be mapped to object properties.

(3) In order to clearly identify ISA-95/B2MML properties as OSA-EAI derived the following rules should be used for ISA-95/B2MML property IDs:

> ISA-95/B2MML property ID should be built by concatenating:
> > The string "mim_osaeai_
> > The string "v" + OSA-EAI major version + "_" + OSA-EAI minor version + "_"
> > OSA-EAI CRIS schema element
> > The string "_"
> > OSA-EAI CRIS attribute name

This property ID should be followed by the OSA-EAI attribute   value. This will clearly identify ISA-95/B2MML properties as OSA-EAI derived.

(4) In order to clearly identify an ISA-95/B2MML property which contains the entire primary key ID of an associated OSA-EAI CRIS schema element, the following property ID format should be used for ISA-95/B2MML property IDs:

ISA-95/B2MML property ID should be built by concatenating:
> > The string "mim_osaeai"
> > The string "v" + OSA-EAI major version + "_" + OSA-EAI minor version + "_"
> > The OSA-EAI CRIS schema element
> > The string "_@ID"

The property ID should be followed by the entire CRIS primary key(s) values associated with the entity. A multi-part primary key should be expressed as a single string with attribute values concatenated with decimal points ("."). The following table shows examples of this @ID mapping.

Table 2 - Examples of ISA-95/B2MML Property IDs for OSA-EAI CRIS Primary Keys

OSA-EAI	B2MML Object	Property ID	OSA-EAI Primary Key Attribute Values Associated with the ISA-95 Property Value
Asset	Equipment	mim_osaeai_v3_1_asset_@ID	*asset_org_site. asset_id*
Manufacturer	Equipment	mim_osaeai_v3_1_manufacturer_@ID	*manufacturer_db_site. manufacturer_db_id. manufacturer _id*

OSA-EAI	B2MML Object	Property ID	OSA-EAI Primary Key Attribute Values Associated with the ISA-95 Property Value
Model	Equipment	mim_osa_v3_1_model_@ID	*model_db_site. model_db_id. model_id*
Network	Equipment Segment Capability Properties	mim_osa_v3_1_network_@ID	*network_db_site. network_db_id. network_id*
Segment	Equipment	mim_osa_v3_1_segment_@ID	*segment_site, segment_id*

Figure 4 provides an abstract example of mapping OSA-EAI and ISA-95/B2MML objects.
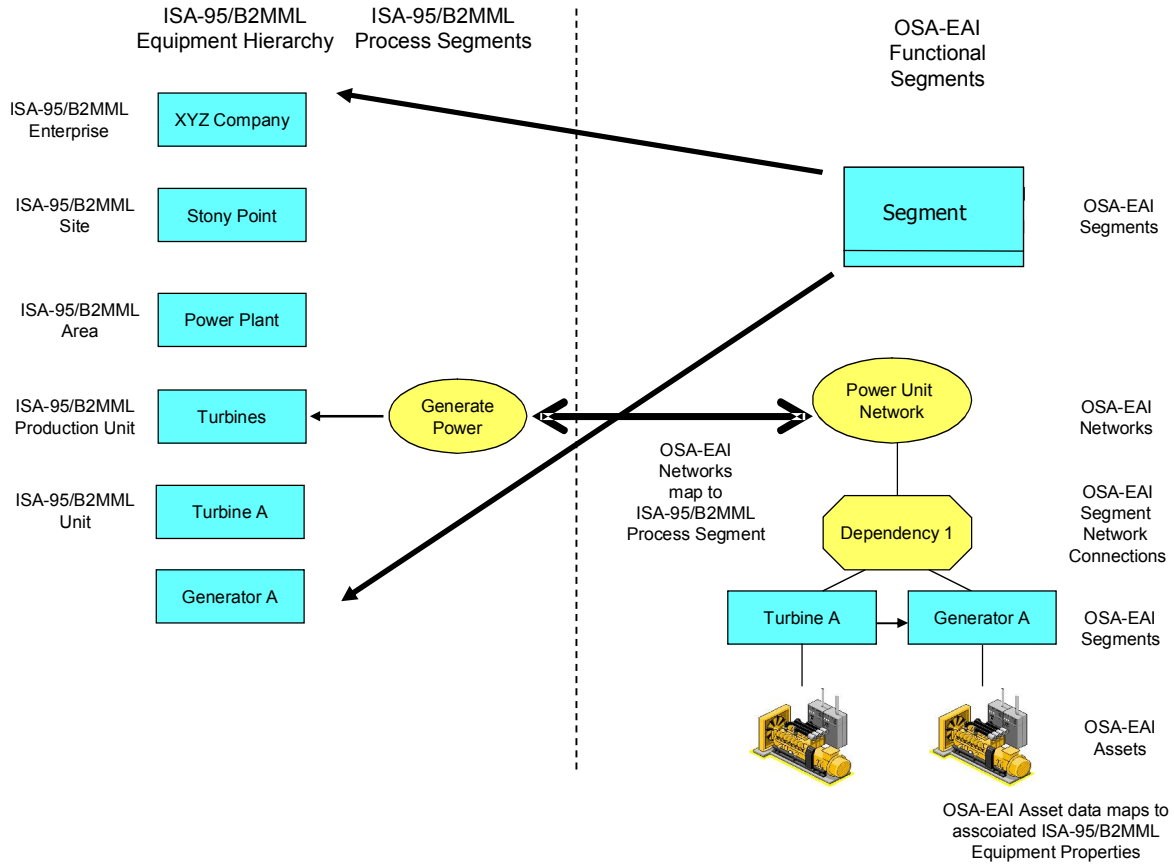

Figure 4 - Summary Example of OSA-EAI and ISA-95/B2MML Mapping

Conclusion

The integration of OSA-EAI and ISA-95/B2MML enabled systems is an important step to enabling operations and maintenance staff to work together more effectively. Sharing data between domains can increase a business's effectiveness. The first step in achieving this is to use a consistent mapping between OSA-EAI and ISA-95/B2MML based systems as recommended in this whitepaper.

The OpenO&M Initiative

The OpenO&M Initiative is an umbrella organization of like minded standards and industry consortiums working to enable the open flow of information between operations and maintenance organizations and systems in manufacturing industries.

Member organizations are:

ISA   **www.isa.org.**

> ISA is a leading, global, nonprofit organization that is setting the standard for automation by helping over 30,000 worldwide members and other professionals solve difficult technical problems, while enhancing their leadership and personal career capabilities.

MIMOSA   **www.mimosa.org**

> MIMOSA is a not-for-profit trade association dedicated to developing and encouraging the adoption of open information standards for Operations and Maintenance in manufacturing, fleet, and facility environments.

OPC Foundation   **www.opcfoundation.org**

> The OPC Foundation is dedicated to ensuring interoperability in automation by creating and maintaining open specifications that standardize the communication of acquired process data, alarm and event records, historical data, and batch data to multi-vendor enterprise systems and between production devices.

Open Applications Group   **www.openapplications.org**

> The Open Applications Group, Inc. (OAGi) is a not-for-profit open standards group building process-based XML standards for both B2B and A2A integration.

WBF   **www.wbf.org**

> The Forum for Automation and Manufacturing Professionals, is dedicated to supporting the process automation and operations needs of the technical and management professions in process manufacturing.

Abbreviations and special terms

B2MML   Business To Manufacturing Markup Language

ISA   Professional society

ISA-95   Multi-part ISA standard for Enterprise-Control System Integration

MIMOSA   Machinery Information Management Open Systems Alliance, an industry consortium

OPC   The OPC Foundation, industry consortium

OSA-EAI   Open Systems Architecture for Enterprise Application Integration

SP95   ISA's Standards & Practices Committee number 95

WBF   Professional society

XML   World Wide Web Consortium's eXtensible Markup Language