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Communication through B2MML – is that possible?

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ABSTRACT

Many of you have certainly heard about the ISA S95 standard, and you know that it treats the subject of how Enterprise/business systems should be integrated with manufacturing and control systems You might also be aware that of B2MML (Business to Manufacturing Markup Language), a set of XML schemas corresponding to the S95 object models, is intended to be used for data exchange between a business system and a manufacturing system.

This paper describes experiences of using the B2MML schemas in real applications. What happens if the Business system does not export the data in a format compliant with the schemas? What about reliability for the data being exchanged? Were extensions or restrictions needed on the schemas? Which are the reasons for choosing to use B2MML? Is it practically possible to communicate using B2MML?

Benefits, difficulties, compromises, challenges etc of using the B2MML schemas in practical applications will be described in the paper.

INTRODUCTION

Many of you have certainly heard about the ISA S95 standard. You know it is titled: Enterprise Control System Integration, and from that you can conclude that it treats the subject of how Enterprise systems should be integrated with control systems. First question that arises is then "Why should these systems be integrated after all?"

The short and somewhat simplified answer is that the flow of information from control systems to business systems and vice versa has become very important. The correct information must be exchanged without unnecessary time delays, all in order to optimize the production. The quicker the business system can be aware of what has happened in the plant the quicker it can react. The quicker the business system can communicate its directives to the control system, the quicker the control system can respond.

Ok, so the two systems will have to communicate in some way, but how? Well, first of all they have to agree upon WHAT information they need from each other and what to name this information. When this is clear, they can agree upon HOW to exchange this information.

The two systems are lucky! The information that should be exchanged, as well as the correct terminology to use, is defined in the standard ISA S95 Part1 (ISA 95.00.01), and the information to be exchanged is further detailed in the standard ISA S95 Part 2 (ISA 95.00.02). In addition, B2MML, an implementation proposal for data exchange, is available.

All of this sounds very promising – but, the big question still remains, does it work in reality?

This paper will describe the work of trying to use the B2MML schemas in a real application. Benefits, difficulties, challenges, etc, will be presented.

ISA S95

ISA S95 Part 1 defines the categories of information that should be exchanged between the Business System and the Manufacturing Operations System. 4 categories are defined;

- Product Definition
- Production Capability
- Production Schedule
- Production Performance

This is shown in Figure 1 (see also figure 3 in ISA S95 Part3 (daft15)). NOTE: in S95 part1, the two categories Production Schedule and Production Response were combined into one category referred to as Production Information.

Each of these 4 categories relies on 4 resources, defined in ISA S95 Part 1.

- Personnel
- Equipment
- Material
- Process Segment

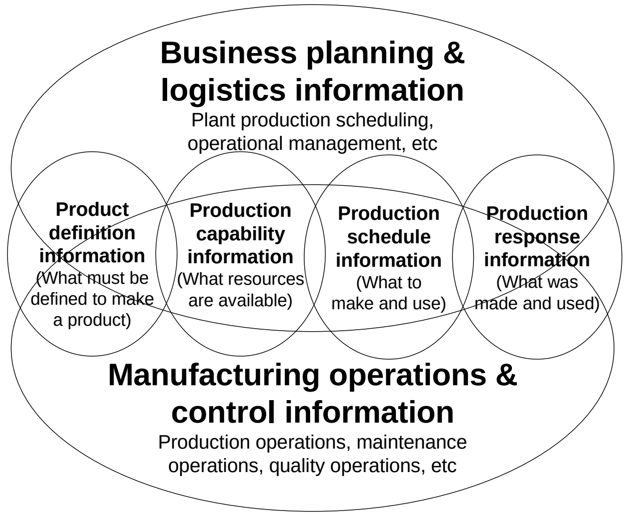

FIGURE 1: The 4 categories of information as defined in ISA S95-part 1.

Each one of the 4 categories and the 4 resources are specified through object models. The object models are defined in ISA S95 Part 1 and they are presented using UML (Unified Modeling Language) notation. ISA S95 Part 2 further defines the attributes for each of the objects contained in the object models. Thanks to the UML notation, the object models are software independent. They contain a description of the interface content i.e., the data to be exchanged between the Business System and the Manufacturing Operations System.

Figure 2 shows a part of the object model of the “Production Performance” (the entire object model is shown in Figure A1 in Annex A). The figure contains three objects; production performance, production response and segment response, it also contains information about how these objects are related. As indicated in the figure, a production performance should be given in terms of one or many production responses, a production response is given in terms of one or many segment responses, etc. Each object in the object model has an associated set of attributes; these are presented in ISA S95 part2.

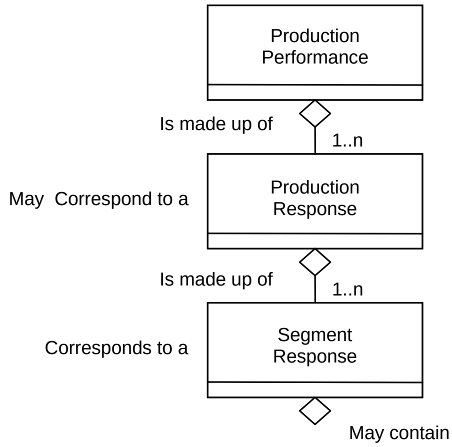

FIGURE 2: Part of the object model of the Production Performance

The attributes associated to the Production Performance object are shown in Figure 3.

Attribute Name	Description	Example
ID	A unique identification of the *production performance* and could include version and revision identification. The ID shall be used in other parts of the model when the *production performance* needs to be identified.	1999-10-27-A15
Description	Contains additional information and descriptions of the *production performance.*	"Production performance report on Oct 27, 1999 production schedule."
Production Schedule	An identification of the associated *production schedule*, if applicable. *Production performance* may not relate to a *production schedule*, it may be a report on all production for a specific time, or reported on by plant floor events.	1999-10-27-A15
Start Time	The starting time of the associated *production performance*, if applicable.	10-28-1999
End Time	The ending time of the associated *production performance*, if applicable.	10-30-1999
Published Date	The date and time on which the *production performance* was published or generated.	10-27-1999 13:42 EST
Location	An identification of the associated element of the equipment hierarchy model.	East Wing Manufacturing Line #2
Element Type	A definition of the type of associated element of the equipment hierarchy model. For example: enterprise, site, area.	Production Line

FIGURE 3: Attributes for Production Performance

B2MML

Having a software independent description like UML is very useful, but in a real application, it is even more useful to have a technical solution for how to exchange the information between the Business system and the Manufacturing and Control system. B2MML stands for Business to Manufacturing Markup Language and it is a XML translation of the object models defined in ISA S95. Figure 4 shows a part of the B2MML schema for Production Performance.

```
<xsd:complexType name = "ProductionPerformance">
  <xsd:sequence>
      <xsd:element name = "ID"                    type = "IDType"/>
      <xsd:element name = "Description"           type = "DescriptionType"
                              minOccurs = "0" maxOccurs = "unbounded"/>
      <xsd:element name = "Location"              type = "LocationType"
                                                  minOccurs = "0"/>
      <xsd:element name = "PublishedDate"         type = " PublishedDate Type"
                                                  minOccurs = "0"/>
      <xsd:element name = "ProductionScheduleID"  type = " ProductionScheduleIDType"
                                                  minOccurs = "0"/>
     <xsd:element name = "startTime"              type = " startTimeType"
                                                  minOccurs = "0"/>
    <xsd:element name = "EndTime"                 type = "EndTimeType"
```

```
                                                      minOccurs = "0"/>
        <xsd:element name = "EquipmentElementLevel"    type = " EquipmentElementLevelType"
                                                      minOccurs = "0"/>
        <xsd:element name = "ProductionResponse"       type = "ProductionResponseType"
                                                      minOccurs = "0" maxOccurs = "unbounded"/>
        <xsd:ant namespace=”##any”
                                                      minOccurs = "0" maxOccurs = "unbounded"/>
    </xsd:sequence>
</xsd:complexType>
```

FIGURE 4: B2MML schema for Production Performance

Theoretically, it should now be possible to let the manufacturing/control system fill in the information regarding the Production Performance and send it to the business system, this, of course, only holds if both systems are compliant with the ISA S95 standard and if both systems supports XML.

Practical Application

Now let’s see how the ISA S95 object models and the B2MML schemas can be applied in a real application. The application described concerns one medium-large sized company in the food and beverage industry. They had standardized the business system, but the manufacturing system could still vary between plants. The four main reasons for them choosing to follow the ISA S95 standard and using the B2MML schemas were;

- B2MML provides a single interface format for every enterprise-control integration requirement
- B2MML is vendor independent (they do not have to tie the integration to any particular vendor)
- B2MML is open to the future
- ISA S95 and B2MML have been developed with a lot of thought – they did not want to reinvent the wheel.

The company decided that the most useful B2MML schemas to deploy in the first step are the Production Schedule schema and the Production Performance schema, which allows exchanging the production information between business system and the plants through a single point of entry.

The architecture in place before deploying ISA S95 and the B2MML schemas is illustrated in Figure 5.

Let’s have a look at the issues that were encountered while starting to use the ISA 95 object models and the B2MML schemas.

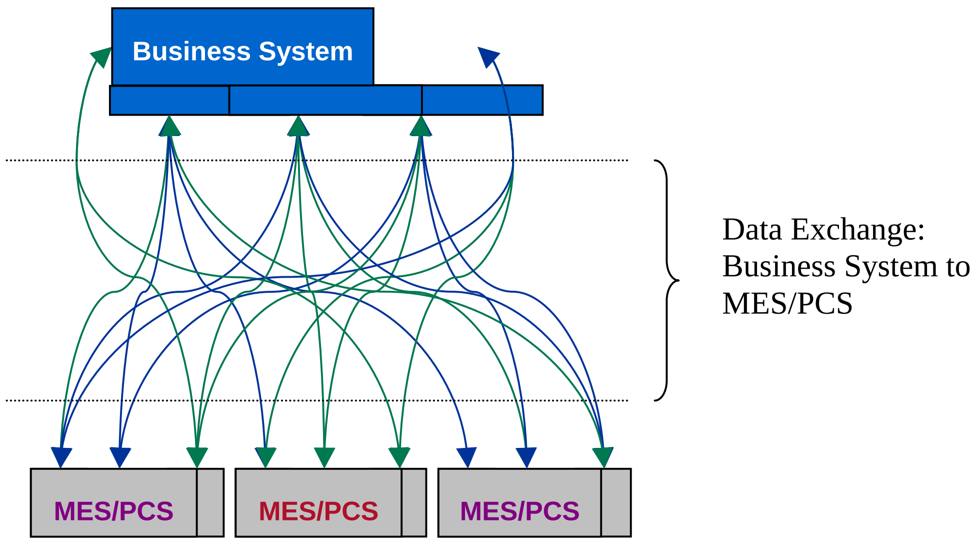

FIGURE 5: Architecture before deployment of ISA S95 and B2MML

Issue 1

The first problem that had to be solved was that the business system that they used did not support ISA S95. The business system used several different portals and proprietary interfaces for sending and receiving information. In order to hide these portals and to provide one single interface to the MES systems, an intermediate layer was inserted, referred to as the middleware. The middleware had to be able to map the information received from the business systems into B2MML messages, or vice versa. The middleware also had to be able to route the messages to the correct MES/control system (plant).

Issue 2

Not all of the MES/control systems used had a native support for XML and B2MML. For those that did not, an adapter had to be developed. The communication with the adaptor was assured by proprietary protocols, OPC or ODBC.

Issue 3

The message exchange had to be handled in a reliable way. This was assured by letting the middleware support with store & forward capabilities

Issue 4

The B2MML message was extended with a header, in order to allow routing of the message based on the header information, and the adapter was extended with the capability of adding and removing header information. When a Production Schedule was sent from the Business system, the adapter removed the header info in order to extract the pure B2MML Production Schedule information and when a Production Performance data set was to be sent to the Business system, the adapter added the header information in order to allow proper routing to the business system.

Result

Applying ISA S95 and B2MML allowed to move from a “spaghetti scenario” in which the business system, through its different interfaces connected directly to the different MES systems, see Figure 5 to a scenario with only one standard generic interface, see Figure 6. The new architecture also clearly defined the borderline between the business system and the MES/control system.

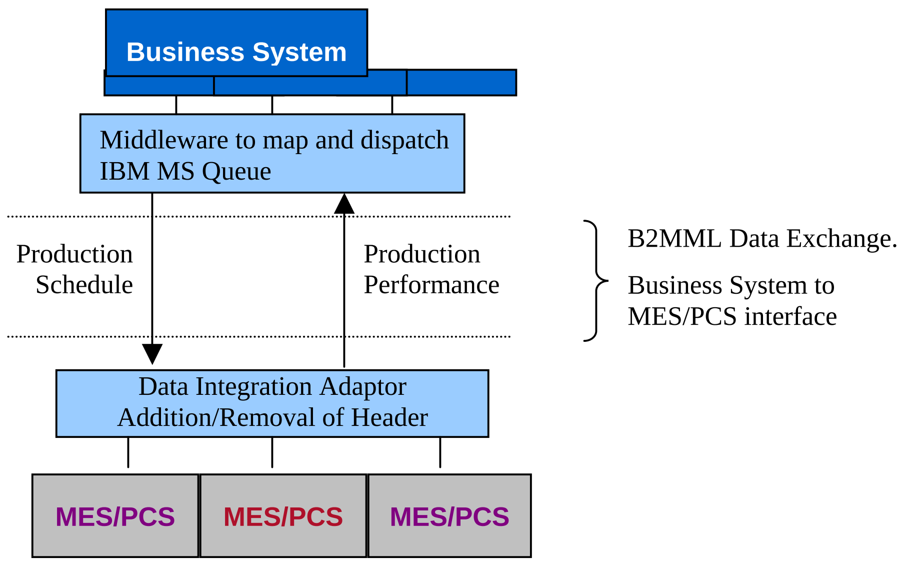

Figure 6: the architecture after the deployment of the ISA S95 standard and B2MML schemas

Furthermore, it was possible to connect various MES systems to the same interface, without any need of changing the integration application. In this way, the vendor independence, achieved by complying with the S95 standard, was clearly demonstrated.

SUMMARY

The ISA 95 standard is a standard entitled: Enterprise-Control System Integration. The purpose of the standard is to specify the interface content for the date exchange between Business systems and Manufacturing Operations system. The interface content is defined through a set of object models presented as UML diagrams. In addition to the implementation independent object models, an implementation proposal in XML is given, and referred to as the B2MML.

A medium sized company in the food and beverage industry had the following important goals

- One standard interface format to be used for every enterprise-control integration
- The interface format should not be vendor-dependent and should be open for the future

By using the ISA S95 standard and applying the object models and the B2MML schemas the goals were met. Issues that they encountered were

- ISA S95 support on the Business system

- Extended support for ISA 95 on some of the Manufacturing Operations Systems
- The B2MML message had to be extended with a header in order to support proper routing of the messages

By applying the ISA 95 standard and the B2MML schemas, the overall architecture was made cleaner, and additional Manufacturing Operations Systems could be connected without any modifications requested in the integration application.

The new architecture also clearly defines the borderline between the business system and the MES/control system.

REFERENCES

[1] ISA 95.00.01 (2000); Enterprise-Control System Integration Part 1: Models and Terminology. Instrumentation, Systems and Automation Society.

[2] ISA 95.00.02 (2001); Enterprise-Control System Integration Part 2: Object Model Attributes. Instrumentation, Systems and Automation Society.

[5] ISA 95.00.03-draft15 (2003); Enterprise-Control System Integration Part 3: Models of Manufacturing Operations Management. Instrumentation, Systems and Automation Society.

Annex A