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Business Integration Scenarios

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ISA 95, Transactions, Business Process, ERP, Manufacturing, Manufacturing Integration, Manufacturing Operations Management (MOM)

ABSTRACT

The ISA 95 Part 5 Business to Manufacturing Transactions standard defines message transactions for business to manufacturing integration. Users however need to think in terms of business processes, and not the low level Part 5 transactions. Business processes use the standard transactions to achieve their goals and an annex in Part 5 describes typical business scenarios. This paper explains the business issues and a system practicality associated with each scenario, and explains the advantages and disadvantages of the Part 5 transaction methods for different integration problems. Business scenarios are used to explain how the ISA-95 standard (Parts 1, 2 & 5) can be applied to solve today's common business problems and support future business goals such as the utilizing the production capability model. The paper also describes typical application scopes and architecture for integration.

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NEED FOR PART 5 TRANSACTIONS

The ANSI/ISA 95 standard parts 1 and 2 define data models for manufacturing information passed between business and control systems, such as a production schedule, production performance and material information. The WBF's XML Working Group implemented the models as XML schemas in B2MML (Business To Manufacturing Markup Language) which is being used to exchange ISA-95 format information.

However, the ISA-95 models, and the corresponding B2MML schemas only define the data to be exchanged and do not provide a means to pass contextual information with the core data. Contextual information is required to implement an effective and interoperable interface, such as the sender, the purpose for sending the information and the expected response, if any. As Figure 1 illustrates this is analogous to receiving an envelope under the door with no address, return address or postmark on it – so it is not explicitly clear where the contents of the envelope came from, who it is for, when was it sent, or why it was sent.

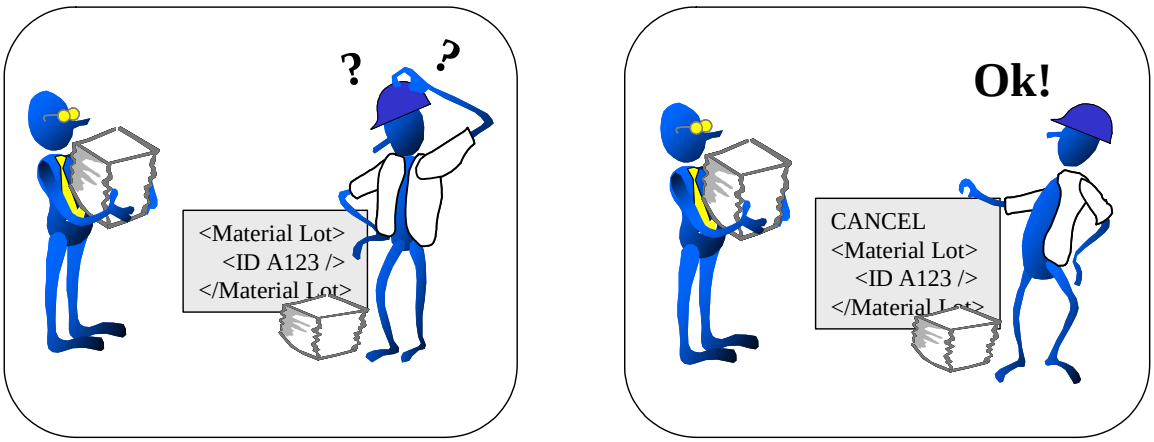

Figure 1- What a Difference Verbs Make!

The lack of a transactional standard for ISA-95 and B2MML information has caused the four W's (where, who, when, why) to be determined as part of each implementation, a result that hinders interoperability. Part 5 of the ISA-95 standard defines standard transactions for use when exchanging ISA-95 format data. The WBF XML working group intends to enhance B2MML to support this part of the standard. This standard defines the requirements for "data envelopes" which will provide the contextual information.

ISA 95 PART 5 TRANSACTIONS

The ISA 95 Part 5 standard defines "transactions" for the data elements defined in the ISA-95 Part 1 and Part 2 standards. The SP95 committee drew upon existing work done by the Open Applications Group and published as OAGIS 9.0 (Open Applications Group Integration Specification) to create an envelope for the ISA-95 Part 1 objects. The envelope object contains information that explains where the data was sent from, who should receive it, when it was sent, and why it was sent. It is made up of a data message with an Application Identification Area and a Data Area as show in Figure 2.

- The Application Identification Area contains contextual information, such as the sender of the message, confirmation expectations, and dates.

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- The Data Area contains two components, a verb area, and a noun area.

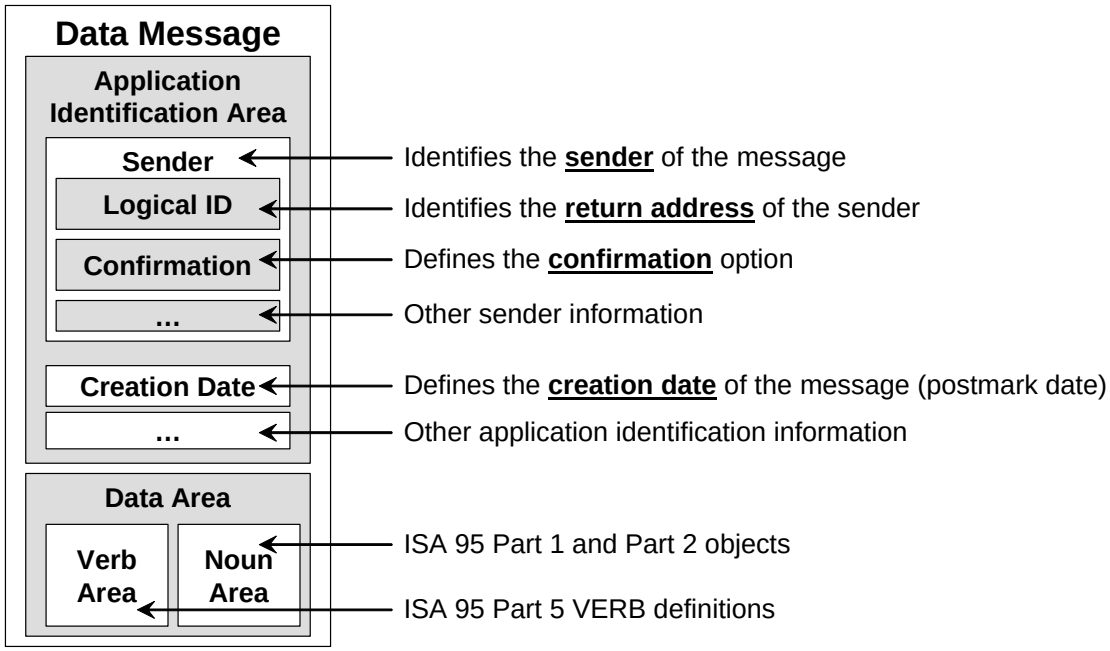

Figure 2- Typical Transaction

The verb area identifies the action associated with the message. ISA Part 5 defines the set of verbs listed in Table 1, again drawing from OAG definitions.

Table 1 - Defined verbs

Verb	Description
ACKNOWLEDGE	Acknowledgement of a PROCESS request.
CANCEL	Request to a receiver to remove existing information.
CHANGE	Request to a receiver to change existing information.
CONFIRM	Confirmation response to a request.
GET	Request to a receiver for information on one or more objects.
PROCESS	Request to a receiver to process new information.
SHOW	Response to a GET.
SYNC ADD	Request from the owner of the object to add new information.
SYNC CHANGE	Request from the owner of the object to change existing information.
SYNC DELETE	Request from the owner of the object to delete existing information.

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The verbs in a message are used by the receiving system to understand the actions to perform. For example, “Change” indicates a piece of information within the receiver’s domain must be changed, and “Process” indicates the message contains new information the receiving system must act on.

The noun area defines the objects. For example, production schedule, production performance, or material lot information. Overall 88 nouns are defined based upon one or more objects defined in parts 1 and 2 of the ISA-95 standard, as summarized in Table 2. For each verb and noun combination the expected action and the use of wildcard identifiers is defined.

Table 2 - Defined Nouns

Consumable Actual Property	Maintenance Work Order	Material Sublot Property	Product Parameter
Consumable Actual	Manufacturing Bill	Material Sublot	Product Parameter
Consumable Expected Property	Material Capability Property	Person Property	Product Production Rule
Consumable Expected	Material Capability	Person	Product Production Rules
Equipment	Material Class Property	Personnel Actual Property	Product Production Rules
Equipment Actual Property	Material Class	Personnel Actual	Product Segment Dependency
Equipment Actual	Material Consumed Actual Property	Personnel Capability Property	Product Segment
Equipment Capability Property	Material Consumed Actual	Personnel Capability	Production Capability
Equipment Capability Test Result	Material Consumed Requirement Property	Personnel Class Property	Production Data
Equipment Capability Test Specification	Material Consumed Requirement	Personnel Class	Production Parameter
Equipment Capability	Material Definition Property	Personnel Requirement Property	Production Performance
Equipment Class Property	Material Definition	Personnel Requirement	Production Request
Equipment Class	Material Lot Property	Personnel Segment Specification Property	Production Response
Equipment Property	Material Lot	Personnel Segment Specification	Production Schedule
Equipment Requirement Property	Material Produced Actual Property	Personnel Specification Property	QA Test Result
Equipment Requirement	Material Produced Actual	Personnel Specification	QA Test Result
Equipment Segment Specification Property	Material Produced Requirement Property	Process Parameter	QA Test Specification
Equipment Segment Specification	Material Produced Requirement	Process Segment Capability	Qualification Test Result
Equipment Specification Property	Material Segment Specification Property	Process Segment Dependency	Qualification Test Specification
Equipment Specification	Material Segment Specification	Process Segment Parameter	Requested Segment Response
Maintenance Request	Material Specification Property	Process Segment	Segment Requirement
Maintenance Response	Material Specification	Process Segment	Segment Response

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The combination of verb and noun defines the action to take place and the data the action is to operate on. Some of these actions are simple, such as obtaining information using a GET verb. Other may be more complex, such as requesting that an application act on new information through a PROCESS verb.

For example, in Figure 3 the information user uses the GET verb with the Equipment noun and an equipment ID of "ABC". This means the receiver is to respond with all information it contains about the equipment object identified as "ABC".

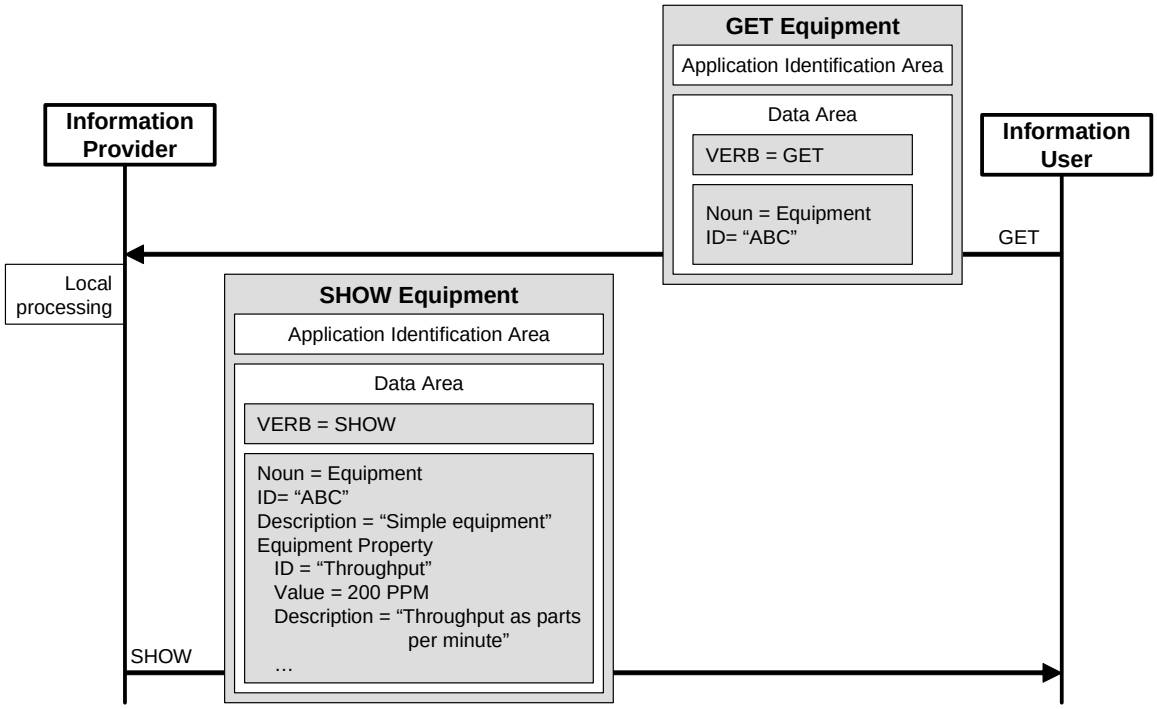

Figure 3- Typical Transaction

The transactions in Part 5 can be used in the construction of higher level and more sophisticated scenarios. These scenarios are used to illustrate how ISA-95 can be used to support business processes.

BUSINESS PROCESSES

A "Business Process" is a common term in the real of business systems, defined by the U.S. Government Accountability Office (GAO) as:

> "A collection of related, structured activities--a chain of events--that produce a specific service or product for a particular customer or customers."
>
> www.gao.gov/policy/itguide/glossary.htm, Dec. 8, 2005

As manufacturing systems are increasingly integrated with business systems it is important for manufacturing professionals to explain how industrial standards, such as ISA-95 and the WBF B2MML schemas, can be used to implement business processes.

While the ISA-95 Part 5 standard does not define standard business processes, example business processes are used in Part 5 Annex A to show how the transactions may support business processes similar to the one shown in Figure 4. In the example business process below, material is received at a

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plant, the material is registered and made known to all systems, the vendor is paid, inventory is adjusted, material is allocated to production, used by production and then inventory is adjusted to reflect actual usage. As Figure 4 illustrates this business process requires data to be exchanged between level 4 and level 3 systems.

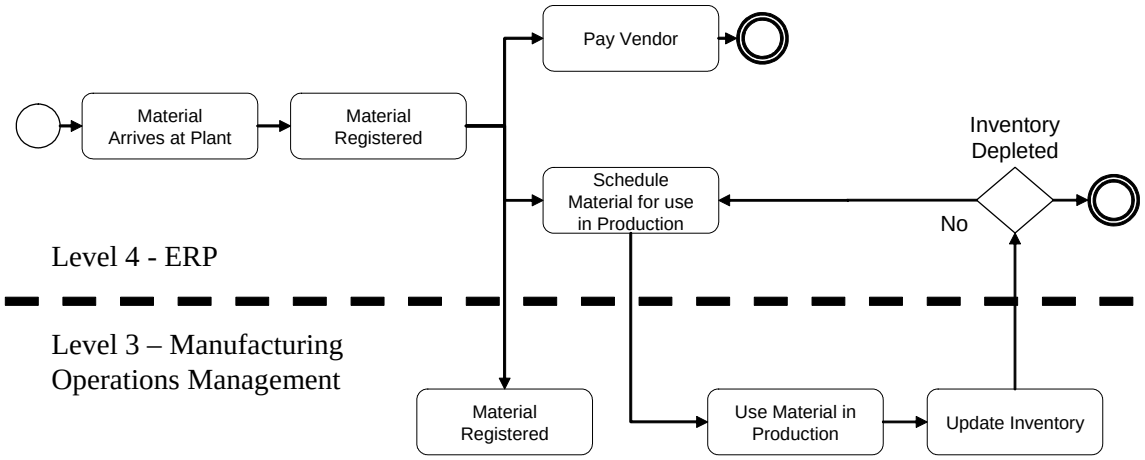

Figure 4- Example of a Business Process

There are multiple ways to use the ISA-95 transactions to implement this business processes. Part 5 of the ISA-95 standard identifies three models:

1. A PUSH model where a provider of data requests an action (processing, changing, or canceling) on the data by another user.
2. A PULL model where a user of data requests the data from a provider of the data.
3. A PUBLISH model where the owner of data publishes it to users (subscribers) of the data.

All three models are valid, the one which is appropriate for an application depends upon the IT infrastructure and level 3/4 applications. Conforming application may support one, two, or all three models.

PUSH MODEL

The PUSH model is used when one application pushes unsolicited requests to process information to another application. Requesting applications may use the PROCESS, CANCEL or CHANGE transaction verbs, while the responding application responds with an ACKNOWLEDGE or CONFIRM transaction verb. The transaction definition does not describe what is to be done with the information, just that new information is sent to the receiver, and is to be acted on by the receiver.

The PUSH model is shown in Figure 5. The level 4 ERP system pushes a PROCESS request to record that a new material lot has been received to the level 3 Manufacturing Operations Management (MOM) system. The MOM system signals receipt of the process message with an ACKNOLWEDGE and updates its records. The application identification area of the transaction envelop provides the MOM system with the identity and address to receive the acknowledgement.

When material is used in production, the MOM system updates its level 3 records and sends a CHANGE message to level 4 so that the ERP records can be updated. When the material lot is fully consumed the MOM system sends a CHANGE message that the quantity is 0 with a confirmation flag. This causes the

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ERP system to close out the lot and send a CONFIRM message to level 3 which in turn closes out its record of the lot.

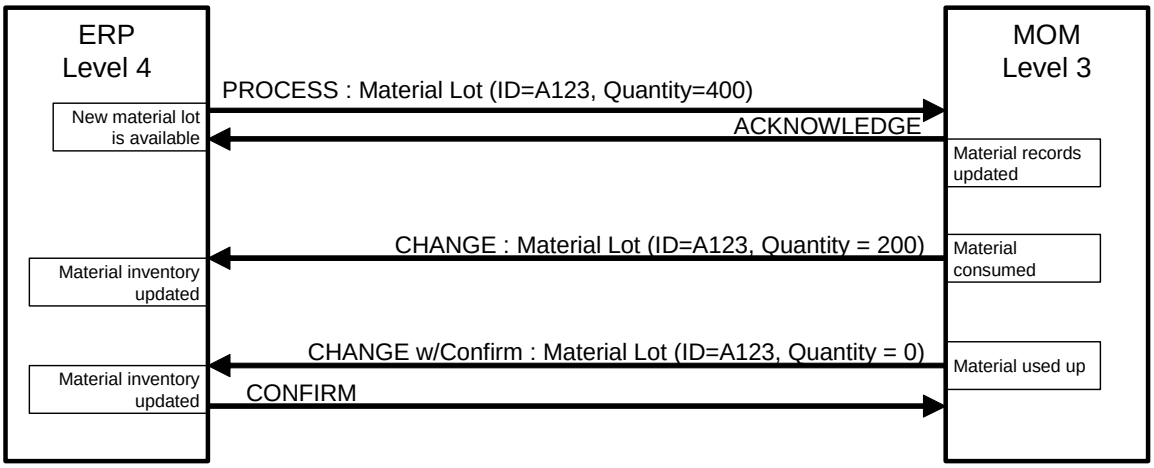

Figure 5- Push Model

In this scenario using the PUSH model requires the MOM and ERP systems will always be listening for PROCESS, CHANGE, and CANCEL messages and will act on unsolicited requests.

PULL MODEL

The PULL model is used when one application requests information from another application. The requesting application uses a GET message to make the request. The responding application replies with a SHOW message. The transaction does not say anything about what is done with the information once it is received, it only provides a way to specify what information is requested.

The PULL model is shown in Figure 6. The level 3 MOM system requests material information from the level 4 ERP system using the GET message, probably on a periodic basic (every shift, every day, etc.). In this case, the ERP system must be listening for an unsolicited request, to which it responds with the SHOW message.

To update its records, the level 4 ERP system periodically issues a GET message to the level 3 MOM system. The MOM system replies with a SHOW message that provides the current inventory levels. When a SHOW transaction indicates a quantity of 0 for a material lot the ERP system can close out the lot.

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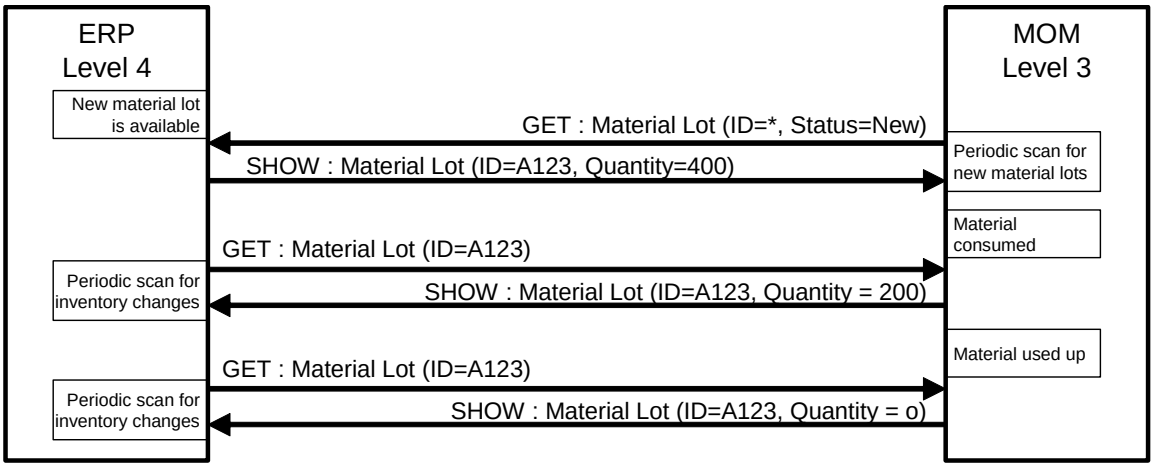

Figure 6- Pull Model

In this scenario using the PULL model requires the MOM and ERP systems will always be listening for GET messages and will act on unsolicited requests.

PUBLISH MODEL

The PUBLISH model is used when the receiving application sets up a subscription with the owner of the information to receive updates when they occur. The requesting application uses the SYNC ADD, SYNC CHANGE, and SYNC DELETE transaction verbs. Normally there are no responses, but the requester may request a CONFIRM message from the subscribers. The transaction does not describe what is done with the published information, just that the information is made available to the subscribing applications.

A combination of the PUBLISH and the PUSH models in a single business process is illustrated in Figure 7. The level 3 MOM system sets up a subscription with the level 4 ERP system to receive material lot information updates. The ERP system is prepared to accept PUSH messages.

When a new material lot is registered in the ERP system, it sends a SYNC ADD message to all subscribers. MOM updates its records to reflect the new material lot. As material from the lot is consumed CHANGE messages are sent to the ERP system. The ERP system in sends SYNC CHANGE messages to the subscribers.

Although not shown in Figure 7, multiple systems could subscribe to material lot changes and be notified whenever any one of them changes material information (quantity, status, location, etc.). When the MOM system sends the CHANGE message to the ERP system indicating the quantity of the lot is 0 the ERP system sends all subscribers a SYNC DELETE message indicating the material lot has been closed and subscribers should update their information appropriately.

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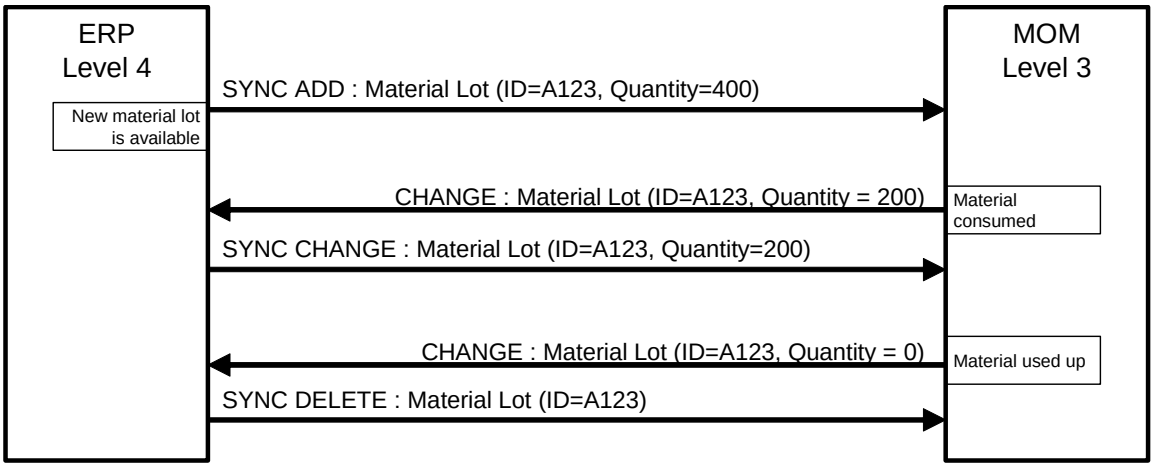

Figure 7- Publish Model

The publish model requires subscribers to listen for unsolicited SYNC ADD, SYNC DELETE, and SYNC CHANGE messages. The publish model is useful when there are multiple systems that must have a synchronized copy of the master data.

It is important to note that the actual subscription process is not defined in ISA 95 Part 5. The timing of publications and the scope of the published information is not defined in transaction messages but is determined by an out-of-band agreement between the publisher and subscriber. This is consistent with the OAG specifications and allows technology specific implementations of subscription services based on the message system selected.

CONCLUSION

Part 5 of the ISA-95 standard defines transactions for the data models from Parts 1 & 2 that enable meaningful, standards based, transactions to be exchanged between applications. The Part 5 transaction definitions provide an envelope for the Part 1 and Part 2 objects, defining where the data is to go, who sent it, when it was sent, and why it was sent.

Using the transaction definitions and the data models from Parts 1 & 2 it is possible to support business processes. This demonstrates the value of manufacturing standards, such as ISA-95 and the WBF B2MML schemas in supporting business processes and business-to-manufacturing integration.

The ISA-95 Part 5 transactions follow the same model defined in the OAGIS specification. The WBF XML Working Group has started work on an XML schema implementation of Part 5. The Open Application Group (OAG) is cooperating in the B2MML schema development. Therefore the ISA-95 standard and its B2MML implementation represents the first steps in convergence of two manufacturing industry enterprise data exchange implementations.

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