Batch Control Standards Status

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ABSTRACT
The ISA-88 batch control standard is now over 10 years old and has become widely adopted by batch processing companies and batch control system suppliers. The international version, IEC 16512-1 has helped spread use of the standard around the world. The models and terminology in Part 1 of the standard have not only been used in batch automation but are also being applied to continuous control applications and packaging line automation.

In addition to the well known Part 1 of the standard, which defined models and terminology for batch control, there are other parts that are not as well known. These are Part 2 addressing data structures and guidelines for languages; Part 3 addressing general and site recipes; and due to be released this year, Part 4 addressing batch production records.

In 2006 the SP88 committee has reaffirmed the need for Parts 1 and 2, which must be done for ANSI/ISA standards every five years, and has started new work items. The new work items include updating Part 1 and possibly Part 2 as well as starting work on Part 5 to formalize and build on work done by the joint WBF-OMAC Make2Pack joint working group regarding the integration of process and discrete applications. WBF is the new name for the World Batch Forum and OMAC is a group technical and non-technical issues in the development, implementation, and commercialization of open, modular architecture control (OMAC) technologies. Make2Pack is one of the work groups in OMAC; it is dedicated to creating standards for applying modular control strategies to packaging applications.

This paper provides a brief overview of the contents and status of each part of the batch standard, reports on current activity in the SP88 committee, and describes BatchML, an XML implementation of the standard. The paper also discusses joint work by the SP88 and SP95 committees to write a technical report explaining how the two standards are complementary.
INTRODUCTION

When the ISA’s Standards & Practices Committee number 88 (SP88) was first formed in 1989 the state of the batch control industry was radically different from today. In 1989 batch processing companies had to navigate each vendor’s terminology and organization of batch control software. The disparate set of batch control offerings made comparisons difficult and increased costs of learning, operating and maintaining each system as there was little commonality in how the systems attacked the challenges inherent in controlling batch processes.

The original goals of the SP88 committee were accomplished upon the release of ANSI/ISA-88.01 (ISA-88 Part 1) in 1994 and ANSI/ISA-88.00.02 (ISA-88 Part 2) in 2000. While these two standards accomplished the original goals of the committee’s work items they were further augmented by ANSI/ISA-88.00.03 (ISA-88 Part 3) covering general and site recipes and ANSI/ISA-88.00.04 (ISA-88 Part 4) addressing batch production records.

Of the four parts of the standard, Part 1 has clearly had the most significant impact demonstrated by the broad adoption of the standard throughout the industry by both batch processing companies and control system and MES suppliers on a world wide basis. While there is still competition among batch control system vendors and differences in how batch processing companies implement the standard it is clear that adoption of the standard has provided a common set of terminology and models for engineering, learning, operating and maintaining batch control systems. This has led to a reduction in costs for control system vendors and batch processing companies.

CURRENT STATUS OF THE SP88 COMMITTEE

In existence for over 15 years the SP88 committee has strived to produce new parts of the standard to address the needs of the batch processing industry. Over the years the membership has continually changed as new members join and other members leave. In 2006 the committee has had a change in leadership, released a new part of the standard and adopted two new work items, so the committee remains committed.

The new chairman of the committee, Dennis Brandl, a long-time committee participant, succeeds Lynn Craig who served many years as chairman and before that as an active participant. Lynn is still active in the committee and is currently leading production of a joint SP88-SP95 technical report to explain how the two standards (ISA-88 and ISA-95) relate.

The new part of the standard is ANSI/ISA-88.00.04 Batch Production Records. This standard builds on the work of parts 1 & 2 as well as more recent implementations of the standards to define a UML (Unified Modeling Language) for a batch production record.

The new work items are a work item for Part 5, Modular Concepts for Automated Control Systems, and an updating of part 1.

The SP88 committee is open to all interested parties and maintains a web presence at www.isa.org/community/sp88.
CURRENT STATUS OF ISA-88

There are four released parts of the ISA-88 standard and one part under development, as listed below. While ISA-88 denotes the U.S. national standard, and is the best known name for the standard, it has become an international standard as issued by the IEC. The IEC version signifies the concurrence of many different geographical batch processing markets with the original ISA-88 standard. There are some minor differences in the ANSI/ISA and IEC versions but these are not material differences and the ANSI/ISA version is expected to be updated to include the IEC changes when it is next revised.

TABLE 1 – CURRENT STATUS OF ISA-88

<table>
<thead>
<tr>
<th>Part</th>
<th>U.S. Standard</th>
<th>International Standard</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>ANSI/ISA-88.00.02-2001</td>
<td>IEC 61512-2:2001</td>
<td>Batch Control - Part 2: Data Structures and Guidelines for Languages</td>
</tr>
<tr>
<td>3</td>
<td>ANSI/ISA-88.00.03-2003</td>
<td>Out for CDV/DIS vote</td>
<td>Batch Control - Part 3: General and Site Recipe Models and Representation</td>
</tr>
<tr>
<td>4</td>
<td>ANSI/ISA-88.00.04-2006</td>
<td>In Progress</td>
<td>Batch Control - Part 4: Batch Production Record</td>
</tr>
<tr>
<td>5</td>
<td>ANSI/ISA-Draft 88.00.05</td>
<td>Work item not submitted yet</td>
<td>Batch Control – Part 5: Modular Concepts for Automated Control Systems</td>
</tr>
</tbody>
</table>

ISA-88 BATCH CONTROL PART 1: MODELS AND TERMINOLOGY

The oldest and best known part of the standard is now 11 years old. By ANSI/ISA rules a standard must be reaffirmed or updated every five years to ensure it remains relevant. Reaffirming a standard means deciding if the standard is still relevant, still correct, and still used by the community.

In 2000 the SP88 committee reaffirmed ISA-88 Part 1, and in 2005 it delayed the action for one year. In 2006 the committee chairman, Dennis Brandl, surveyed the committee to see if there was sufficient need and commitment to update the standard. The result was an affirmative to update the standard. Therefore a new work item has been started, led by Paul Nowicki, to update part 1. This activity is open to all interested persons, to participate please contact Paul Nowicki at pnowicki@ra.rockwell.com. Currently Paul is leading a working group which is preparing a revised draft of the standard which will then be submitted to the full committee for review and comment. This will then lead to a committee ballot, currently targeted for the first half of 2008.

The purpose of the update is to clarify issues that have come up over the past 10+ years. These may include more, or clearer, definitions of equipment modules and control modules, a clarification of the types of control defined (coordination, procedural, and basic) and where they fit into the equipment modules, and updates on the activity model to clarify alignment with the ISA 95 Part 3 Production Operations Management module.
ISA-88 BATCH CONTROL PART 2: DATA STRUCTURES AND GUIDELINES FOR LANGUAGES

Part 2 of the standard grew out of work started during part 1 but not included in the original standard as it went beyond the models and terminology scope of part 1. Part 2 has had a subtle impact upon batch processing companies as it has been the “intellectual property” contained in this standard that has been of value to implementations such as OPC Batch and BatchML, more recent batch control products and the newly released part 4 document. Due to the indirect effect on end users and the software oriented nature of the document this can be considered the “quiet” part of the ISA-88 standards.

ISA-88 Part 2 contains three clauses, or primary sections:

1. Data Model
2. Relational Database Schema for Batch
3. Procedure Function Charts (PFC)

The data model is a high-level, abstract, model of batch objects. This provides a tool for understanding to software developers, but is of little use to batch processing companies which are end users of batch control systems. This model provides a Unified Modeling Language (UML) model based on part 1 and serves as guiding principals and a statement of intent for work done in part 1, but by itself is too general to be used as a compliance document.

The second clause in the document which along with an annex provides a SQL (Structured Query Language) definition for a relational database containing tables based upon ISA-88 part 1 objects. SQL was used as at the time (mid-late 1990’s) it proved to be the most popular software tool for defining data structures required for exchanging batch data. With the advent of XML (eXtensible Markup Language) in the 1999-2001 time period it rapidly became clear that XML would grow to become the preferred method of exchanging data in the IT world. As a result very few companies implemented SQL databases based on this clause. However, this work proved to be very influential in the creation of the OPC Batch and BatchML specifications as it clearly identified batch control objects and their attributes in a way they could be implemented in other technologies.

The third clause defines Procedure Function Charts (PFC). Part 1 carefully does not address how a procedure is defined; it only defines its functions and uses. Upon the completion of Part 1 the SP88 committee issued a technical report (ISA-TR88.0.03-1996 Possible Recipe Procedure Presentation Formats) providing examples of how procedures could be defined in a recipe. It was clear after this report that there was not consensus on a standard representation so it was decided to add this work to Part 2.
ISA-88 BATCH CONTROL PART 3: GENERAL AND SITE RECIPE MODELS AND REPRESENTATION

In March 2003 Part 3 of the standard was released addressing general and site recipes. While Part 1 mentions general and site recipes it’s main focus is on master and control recipes. Likewise in Part 2 general and site recipes are shown in the data model but are not covered by the SQL definitions and the PFC definition is targeted for master and control recipes, not general and site recipes.

With the wide adoption of master and control recipes based upon ISA-88 Part 1 many end user companies pushed for a new standard to enable standardization of recipes at a corporate level, or at least between multiple process cells. This business need, and previous solutions to it, actually existed prior to the release of ISA-88 Part 1, but without a standard format for general and site recipes each of the previous solutions proved to be point solutions that were costly to maintain, were not supported by commercially available systems and required significant investment to adopt.

The general and site recipe definitions in Part 3 now provide a standard means for implementing higher level recipes across process cells. While this still requires significant investment, use of the standard can decrease the investment compared to developing proprietary solutions.

ISA-88 BATCH CONTROL PART 4: BATCH PRODUCTION RECORD

Released early in 2006, Part 4 of the ISA-88 standards defines a data model for a batch production record. Batch production records are a collection of information about a batch, including the material used and produced, activities performed during the batch and the environment the batch was run in.

While Part 1 identified batch history functions and provided examples of batch history items and Part 2 defined SQL tables to contain batch history events, neither provided a focused set of data structures to store batch history data. As the introduction states “The intended use of the batch production record standard is to provide a reference model for developing applications for the storage and/or exchange of batch production records. Implementations based upon this standard will allow retrieval, analysis and reporting of selected batch production record data.”

ISA-88 BATCH CONTROL PART 5: MODULAR CONCEPTS FOR AUTOMATED CONTROL SYSTEMS

In 2006 the SP88 committee agreed to start work on a new part of the standard to define how the modular automation concepts defined in Part 1 could be applied in different types of manufacturing environments. The proposed title is Modular Concepts for Automated Control Systems and will be identified as Part 5 of the standard.

Dennis Brandl, the committee chairman described the work as “The proposed scope of work is to define methods for the development of a library of automation components consistent with the ISA 88 Part 1 models that can be supported by automation vendors across all types of manufacturing. The
components provide a common base of commonly used automation functions that encourages modularity and defines common methods for components to interact.”

This work is an outgrowth the WBF-OMAC Make2Pack joint working group, which was a WBF and OMAC sponsored effort to evaluate the viability of merging packaging machinery and ISA-88 batch control standards work. Make2Pack refers to the transition from production control (the Make) to packaging control (the Pack). The SP88 working group continues to use the Make2Pack name which has helped the work gain visibility in the industry.

The initial SP88 announcement proposed the following tasks for the Part 5 working group:

1. Refine the ISA-88 models for automation across all types of manufacturing that will encourage and support a layered and hierarchical architecture that provides modularity and common methods for the automation modules to interact with one another. This model will encompass the control module, equipment module and unit layers in the ISA 88 physical model.

2. Refine the definitions in ISA 88 Part 1 that relate to 4 different types of control:
   a. Coordination Control
   b. Recipe Procedural Control
   c. Equipment Procedural Control
   d. Basic Control

3. Develop a method/approach that will guide the development of a library of automation components which can be supported by all automation vendors to provide a common base of functionality provided by these commonly used automation functions.

4. Develop Physical Models that support the concepts of this standard and can be used to clearly communicate the concepts and approaches for batch, continuous and packaging.

5. Refine the definitions of modes to support use across all of manufacturing.

6. Inclusion of any PackML (Packaging Markup Language) guidelines which are consistent with S88 Part 5 as an appendix.

This work is being done by a SP88 committee working group which is lead by Dave Chappell of P&G. To participate on the working group, contact Dave via e-mail at chappell.da@pg.com. More information can be found at www.make2pack.org.

**ISA-88 & ISA-95**

With the release of the ISA-95 Enterprise-Control System Integration standard in 2000 there has been some confusion over how the ISA-88 and ISA-95 standards relate to each other. In 2005 a joint SP88 and SP95 working group was formed to write a technical report explaining how the two standards relate. This work is on-going but should provide better positioning of the standards when complete.
OPC BATCH AND BATCHML

While not part of the ISA-88 family of standards and not produced by the SP88 committee it is worthy to note two implementations of the standard that can be used to exchange data between systems and applications.

The OPC Foundation developed a specification based on their DCOM (Microsoft’s Distributed Common Object Model technology) family of specifications called OPC Batch. This specification builds upon work done in Part 2 on the SQL definitions. While technically interesting this specification has failed to find widespread adoption and is not well known today.

The BatchML (Batch Markup Language) is an XML Schema implementation of the ISA-88 standard developed by volunteers from the WBF’s XML Working Group. BatchML has support for the following ISA-88 Part 1 and 2 defined objects:

- Master Recipe
- Recipe Building Block
- Control Recipe
- Batch
- Equipment Element
- Batch List (aka Batch Schedule)

With XML accepted as the mainstream IT tool for exchanging data between applications and systems BatchML has been adopted by most batch control vendors. While typically not exposed as an end user tool BatchML is used in many systems as an integration or interface tool.

The WBF XML Working Group intends to add support for ISA-88 Parts 3 and 4 to BatchML in the near future.

CONCLUSION

Since its release in 1995 as a U.S. standard and it subsequent release by the IEC in 1997 as an international standard ISA-88 has had a profound impact on the batch process industry, providing a standard set of terms and models to enable more efficient communication within the industry and ultimately helping to drive down costs of engineering, operation and maintenance of batch control applications.

The SP88 committee remains committed to keeping the standard up to date with the renewal process started in 2006 and to keep addressing new issues as batch processing companies identify business needs for further standardization.