A ‘Standards’ Foundation for Interoperability

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Abstract - Participants of ISO TC184/SC 5/WG 1 will present a series of papers that address the group’s work and our thoughts on the direction we feel appropriate for the establishment of new international standards in manufacturing automation. The focus of WG1 is on architecture and modelling aspects in support of the automation standards objectives of TC184. This paper sets the stage, so to speak, upon which current and future group efforts will play out.

1. OVERVIEW

Members of ISO TC184/SC 5/WG 1 are presenting a series of papers that address the group’s work and our thoughts on the direction we feel appropriate for the establishment of new international standards in manufacturing automation. The focus of WG1 is on ‘architecture and modelling’ aspects in support of the automation standards objectives of TC184. To set the stage, this paper describes the backdrop that frames our current work, identifies a few key terms of our dialog (including a note of caution), introduces the actors in leading roles, and presents an overview of past performances now published as international standards. Upon this stage, Kurt Kosanke will address current draft documents, David Chen will address efforts related to our interoperability standard objectives, and David Shorter will address the topic of meta-modelling as a means to achieve our modeller and model view objectives.

2. BACKDROP

Central to WG1, and many other groups, is the effort to bring standardization that supports integration and interoperability to manufacturing enterprises. Today we are far from achieving the levels of interoperability among manufacturing system components that many believe are essential to significant improvement in manufacturing efficiency [IDEAS, 2003]. We continue the exchange of capital and labor to reduce cost and increase productivity per unit of expense, and we improve the communication channels that are now essential to production systems. However, our dynamic response to changes in strategy, tactics, and operational needs continues to be limited by the paucity of interoperability between systems, and between components within systems [National, 2001].

The extent to which we are successful in component and system interoperability is expressed in the current international standards and de-facto industry standards that define the extent of information exchange in use today. Having emerged from the automation of tasks and the adoption of information management as a key factor in modern manufacturing, the need for interoperability of the kind we seek is rather new. Reliance upon human mediated interoperation is no longer sufficient.

3. DIALOG TERMS

3.1 Unified, integrated, interoperable

Systems and components thereof interact in different ways ranging along a continuum from isolated action to complete interoperability. When all connections between components are direct, almost in a physical sense, we can say that the components of a system are unified. A model of this system is a unified model and model components have essentially the same conceptual representation although distinctions in levels of detail resulting from decomposition, and of properties emerging from aggregation, remain.

When a component connection becomes indirect, i.e., a transformation from one representational form or view to another occurs, and system behaviour results from specific knowledge about the means to transfer information, products, and processes, then we can say that the system is integrated. The models of this system, often with distinct conceptual representations, form an integrated system model wherein individual components interact using fixed representations known by other components a-priori.

When component connections become malleable or ad-hoc in their manifestation, then system behaviour must move from static descriptions to incorporate dynamic features that enable interoperability. This situation allows one component, or agent as it is often called, to act as if it were another component while maintaining its own distinct features. Interoperable components interact effectively because they know about effective communication.

These same distinctions, unified, integrated, and interoperable can be used to classify the relationships between systems as well. Systems integration is now the standard of practice and the area of interest to most practitioners. In fact, the vast majority of our standards effort to date has targeted enablement of integration. But interoperability, especially in a heterogeneous setting like a supply chain, goes beyond our methodologies for integration and offers new challenges for system and enterprise understanding. WG1 is pursuing the codification of that understanding into new international standards.

3.2 The ‘resource’ example

Since standards, both international and de-facto, are developed by working groups, each standard bears a perspective on word choice and meaning that represents an agreement among those approving adoption of the standard. And even then, we tend to allow wide latitude in word use. Take, for example, the use of the term ‘resource’ that is commonly found in our manufacturing standards, and focus on just one sub-committee – SC5 of TC 184 [Kosanke, 2004]. Within SC5 some groups consider ‘resource’ to include material consumed by manufacturing processes as well as the capital and human resources required to conduct those processes. Other groups, like our WG1, restrict ‘resource’ to non-consumables. Some even advocate including processes as a deployable resource. All are valid uses of the term but one must be aware of the usage context.

To be interoperable, components and systems must correctly interpret words used as labels and data in an appropriate context. While resolving this aspect of interoperability is beyond the charge of WG1, we are constantly reminded of its importance to our efforts.

4. ACTORS

WG1 is one of several working groups in SC5 developing standards for manufacturing automation. A complete listing of ISO Technical Committees is found at http://www.iso.ch where TC184 is charged with 'Industrial automation systems and integration'. SC5 is now responsible for six working groups and has working group collaboration with TC 184/SC 4 'Industrial data' [SC 5, 2004].

In addition to the collaborations between ISO committees and sub-committees, ISO partners with other international bodies to promulgate standards of common interest. ISO TC184/SC 5 and IEC TC65 are working together at the boundary between automation control systems and production management systems that encompass the information exchange content necessary to direct and report manufacturing operation and control [ISO 62264-1, 2003].

WG1 is working closely with CEN TC310/WG 1 [International, 2001] to produce two standards that are the subject of Kurt Kosanke's presentation and we expect to receive substantive material from other European efforts including those detailed by David Chen in his presentation.

5. PAST PERFORMANCES

5.1 Describing industrial data

The development of international standards is an evolutionary process that mimics the evolution of industrial practice as supported by academic and industrial research. One of the more successful standardization efforts toward integration began in 1979 and continues to his day with the efforts of TC 184/SC 4. At that time NIST (National Institute of Standards and Technology, USA) began work in establishing standards for the exchange of engineering drawing elements, beginning with IGES [Goldstein, 1998], that has evolved through several iterations into ISO 10303 and its many application protocol (AP) parts [Kemmerer, 1999]. Today ISO 10303, better know as STEP (STandard for the Exchange of Product model data) by many practitioners, is a robust foundation for the exchange of information about product components and, increasingly, system attributes codified as data elements. ISO 10303 continues its evolution with new APs and revisions to established parts.

A recent study commissioned by NIST concludes that the STEP standard accounts for an annual two hundred million dollar benefit for adopting industries [Gallaher, 2002]. One key factor in the success of STEP related to that savings is the enablement of information migration between product and process versions. This reuse of data through changes in operations comprises half of the standards benefit to industry.

One feature of ISO 10303 is the EXPRESS language [ISO 10303-11, 1994] and its graphical extension subset that enables the programmatic description of primitives identified in the standard. In a manner similar in concept to ISO 10303, the new PSL language standard [ISO 18629-1, 2004] seeks to emulate the success of STEP.

5.2 Describing industrial processes

PSL (Process Specification Language) and its extension parts target the exchange of process descriptions among process modelling and enablement tools. Note that these two language standards, EXPRESS and PSL, go beyond the format definition of descriptive information exchange, e.g., EDI, to allow a more flexible resolution of rule based semantic exchange for well defined situations.

A distinguishing characteristic of PSL is its origin as a joint effort between the data centric charge of ISO TC 184/SC 4 and the process centric charge of ISO TC 184/SC 5. SC5 collaboration with SC4 also involves a multi-part standard for ‘Industrial manufacturing management data’ known as MANDATE [ISO 15531-1, 2004].

5.3 SC5 Integration standards

ISO TC 184/SC 5 is producing a series of standards devoted to integration and interoperability:

- component to component information exchange protocols under the ‘Open System application integration frameworks’ multi-part standard [ISO 15745-1, 2003],
- the establishment of ‘Manufacturing software capability profiles’ [ISO 16000-1, 2002],
- and recently a Technical Report on Common Automation Device Profile Guidelines’ [IEC/TR 62390, 2004] was approved.

These standards codify existing industry practice and focus industrial efforts on common feature support. These are detailed descriptive standards that can be utilized to enable integration and to support interoperability.

5.4 WG1 integration standards

At the other end of the spectrum is ISO 14258 [ISO 14258, 1998] that describes concepts and rules for enterprise models. This WG1 produced standard provides an overview of the issues that must be considered when modelling in the context of enterprises. It establishes system theory as the basis for modelling and introduces the primary concepts of modelling that include: life-cycle phases, recursion and iteration, distinctions between structure and behaviour, views, and basic notions of interoperability.

Upon this conceptual foundation, ISO 15704 [ISO 15704, 2000] constructs a more detailed model representation and adds concepts for life history, and model genericity. This standard also begins the elaboration of methodologies to support enterprise modelling. A significant feature of ISO 15704 is its informative Annex A that presents the GERAM (Generalised Enterprise Reference Architecture and Methodologies) developed by the IFIP/IFAC Task Force on Architectures for Enterprise Integration. Currently we are amending ISO 15704 to add user centric views, Economic View and a Decision View, as informative annexes. ISO 15704 identifies the structural features available for further development of model and system interoperability.

6. ON WITH THE SHOW

All of these standards support the interactions necessary to construct unified manufacturing operations and enhance integration among systems of differing origin. But the difficult tasks of dynamic interoperation are yet to be addressed in a standard way. These past efforts lay a solid foundation and begin to articulate the system and component features necessary to achieve robust interoperability. We invite your support for international standards and our efforts. Should you wish to participate, please contact the author.

The presentation of Kurt Kosanke will describe in more detail two standards now in preparation that continue our articulation of enterprise representation through models.

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