A MODULAR ARCHITECTURE FOR STEP

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ABSTRACT

This paper presents the current direction in the architecture of STEP (STandard for the Exchange of Product model data, formally known as ISO 10303). STEP is an international standard designed to enable the exchange of product data between heterogeneous computer systems used throughout the product life cycle. A new modular STEP architecture addresses some deficiencies of the initial architecture and is intended to speed development, facilitate implementation, and increase interoperability of applications of STEP. This paper describes the initial STEP architecture, requirements for improvements to the architecture, and features of the new modular architecture.

KEYWORDS: STEP, product data, data exchange, systems integration, information technology standards, modular architecture, ISO 10303

INTRODUCTION

STEP (STandard for the Exchange of Product model data, formally known as ISO 10303) is an international standard designed to enable the exchange of product data between heterogeneous computer systems used throughout the product life cycle. STEP is being developed under the leadership of ISO TC 184/SC4, the ISO sub-committee responsible for data exchange standards in the area of industrial and manufacturing applications [1][2]. A new modular STEP architecture addresses some deficiencies of the original architecture and is intended to speed development, facilitate implementation, and increase interoperability of applications of STEP.

This paper introduces the new modular architecture in the context of the initial architecture. First, the initial STEP architecture is described. Requirements governing the development of the modular architecture are summarized. Components of the new modular architecture are presented with an explanation of how the initial architecture is changed. Finally, the status of the modularization effort is presented.

INITIAL STEP ARCHITECTURE

The architecture of STEP is designed to support the development of standards for product data exchange and product data sharing [3][4][5]. The architecture is governed by the following concepts: (1) the scope of what is standardized and what is conformance tested is set at the level of "an application," (2) application requirements are based on a model of a business activity, (3) application requirements are standardized using natural language, and (4) a mapping is specified defining how the application requirements are satisfied using a STEP data model.

The key information models comprising the STEP standards are known as application protocols (APs). As illustrated below, an AP consists of the following major elements:

- An application activity model (AAM) describing the business process the information model supports.
- An application reference model (ARM) specifying the information requirements.
- A schema for data structures based on the STEP integrated resources (IRs), called an application interpreted model (AIM), that is the basis for implementations of the standard.

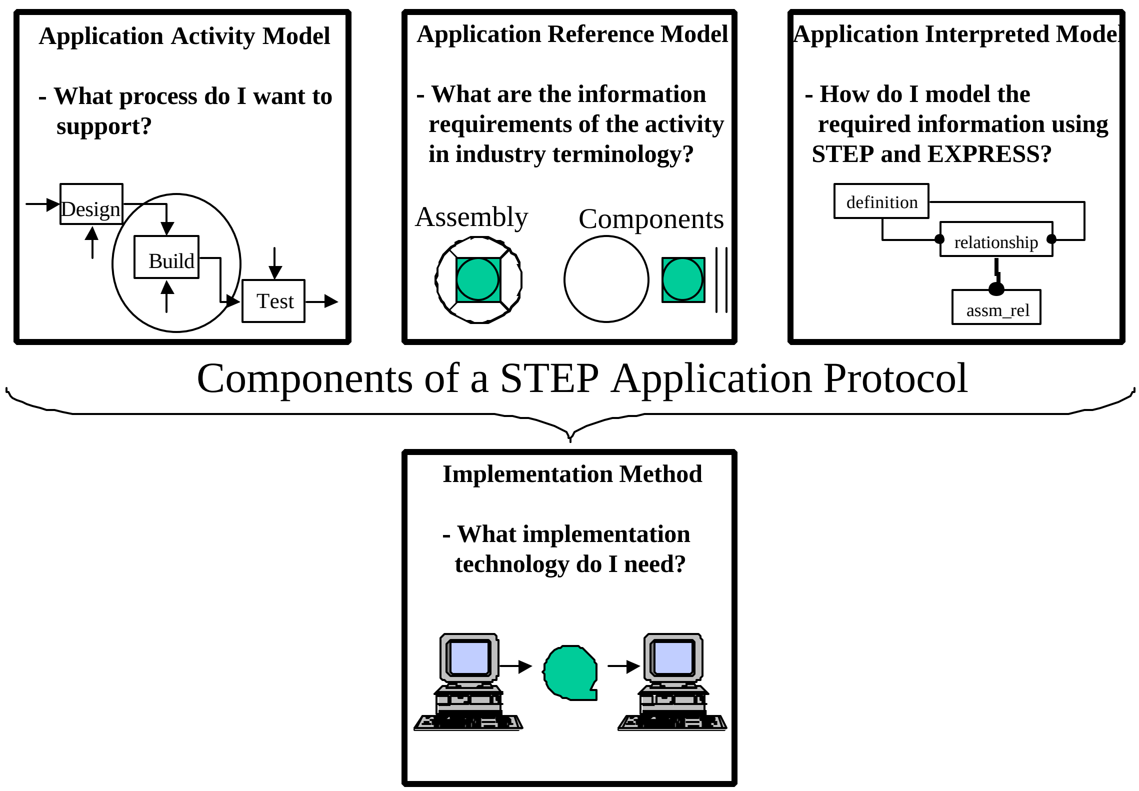

Figure 1. Initial AP Structure

STEP developers have made a conscious decision to focus on the information required by industrial processes rather than on the processes themselves as the processes may change over time while the underlying information requirements are longer lasting. This focus on information allows STEP to support data exchange, some forms of data sharing, as well as long-term data retention. To that end, the STEP community has created a data specification language, called EXPRESS [6], as well as implementation methods for file exchange and data access interface based on that language. The AIM of an AP is specified using EXPRESS. A conforming implementation of an AP must use the AIM schema in combination with one of the implementation methods. STEP standardizes conformance testing methods and abstract test suites to facilitate certification of AP implementations. An AP may specify conformance classes (CC) allowing certification of conformance to a specified subset of the AIM.

Application interpreted constructs (AICs) were introduced to the STEP architecture to enable cooperative use of multiple APs in a business enterprise. An AIC specifies a piece of an AIM that may be used to exchange product data common to two or more APs. However, an AIC does not document the common requirements or the mapping of those requirements into the AIM.

REQUIREMENTS FOR THE MODULAR ARCHITECTURE

Industry adoption of STEP initially focused on implementing the first AP, AP203 *Configuration controlled design*. As other APs with different capabilities have been standardized, it has become apparent that the "islands of APs" paradigm does not meet industry requirements for STEP. The capability of sharing the common information defined by two or more APs is an important requirement for companies to realize the full benefits of STEP. This capability is referred to as "AP interoperability." Industry is also asking for a "plug-and-play" environment where companies are able to choose from a set of comprehensive STEP capabilities to satisfy their data-exchange needs. APs are extremely large documents that take many years to standardize and are therefore not responsive to changes in industrial requirements.

Within the SC4 community, various types of modular capabilities have been developed, tested, and implemented. The SC4 shipbuilding community created a requirements level modular development and implementation architecture that was being used as a basis for developing a suite of APs. PDES, Inc., a consortium developing and deploying STEP, created modular extensions for AP203 to add new capabilities. ProSTEP, a European STEP consortium, created subsets of AP214 *Core data for automotive mechanical design processes* and AP212 *Electrotechnical design and installation* for implementers. Each of these modular efforts was using a different technical approach to achieve the same objectives. None was working toward a standard architecture.

Based on experiences gained through early implementation and the various modularization efforts within SC4, a comprehensive set of requirements on the modular architecture was gathered [7]. Some of the high-level industry requirements are to:

- Reduce the high cost and lengthy time to develop an AP.
- Allow implementation of a combination of multiple APs or extension of AP implementations with additional capabilities.
- Enable application software reuse.
- Eliminate duplication and repeated documentation of the same requirements in different APs.
- Reuse data generated by an implementation of one or more APs, by an implementation of one or more different APs (also known as AP interoperability).

MODULAR ARCHITECTURE

The stated objective of the STEP modularization effort is "to enable the more efficient technical development, standardization, implementation and deployment of STEP standards without changing the fundamentals of the current technical architecture." The STEP architecture will continue to be based on standardizing industry requirements and mapping those requirements to a data model based on the STEP integrated resources, a process known as "interpretation."

The primary change introduced by the new modular architecture is the explicit harmonization of common information requirements. Rather than relying on harmonization occurring as a by-product of consistent interpretation across APs, module requirements are first harmonized across domains and the resulting mappings are standardized in smaller packages, known as application modules (AMs). AMs are reused by other AMs and ultimately in APs.

The implementable portion of the STEP modular architecture has two core components:

- Application module (AM) - A small, reusable data specification documented with an ARM (application reference model); mapping; interpreted schema; and usage guide.
- Application protocol (AP) - The use of a data specification to meet the requirements of some business process.

The objectives and function of the architectural components are described below.

Application Module

An application module is designed to maximize reusability of the harmonized requirements and the associated interpretation into the Integrated Resources (IRs), the data specification, and thus, software implementations. This supports reusability by the standards developer, implementor, and user.

Application modules replace AICs in the STEP architecture. The objectives of AICs and AMs are similar. They both standardize interpretation results for reuse in multiple APs. However, AICs and AMs are created differently and have different content. AMs, unlike AICs, contain harmonized information requirements and specifications of the mappings of those requirements to the IRs. An objective of modularization is to document a concept one time and then to directly reuse that concept in other modules. An AIC is only created when a concept has already been documented in two or more APs.

The modular approach calls for the use of EXPRESS rather than natural language for the documentation of requirements, i.e., the ARM, in an application module. This allows the use of tools to validate the dependencies between application module ARMs. It has the added benefit of allowing for the future use of an in-development EXPRESS mapping language called EXPRESS-X [8] that will make the requirements-to-resources mapping computer interpretable as well.

Application Protocol

A modular AP is a documented use of an application module for a specific business process. A single, normatively referenced AM is the data specification for the AP. This

AM uses other normative AMs and may include specific business process rules or constraints. The AP document contains an activity model and conformance class definitions. Industry terminology mappings from the generic AM terminology may be defined in an AP to make it more understandable to reviewers from the application domain. In Figure 2, the current STEP architecture is contrasted with the proposed modular STEP architecture. A modular AP references, through a high-level module, a collection of related AMs that provide the documentation of its requirements and interpreted model.

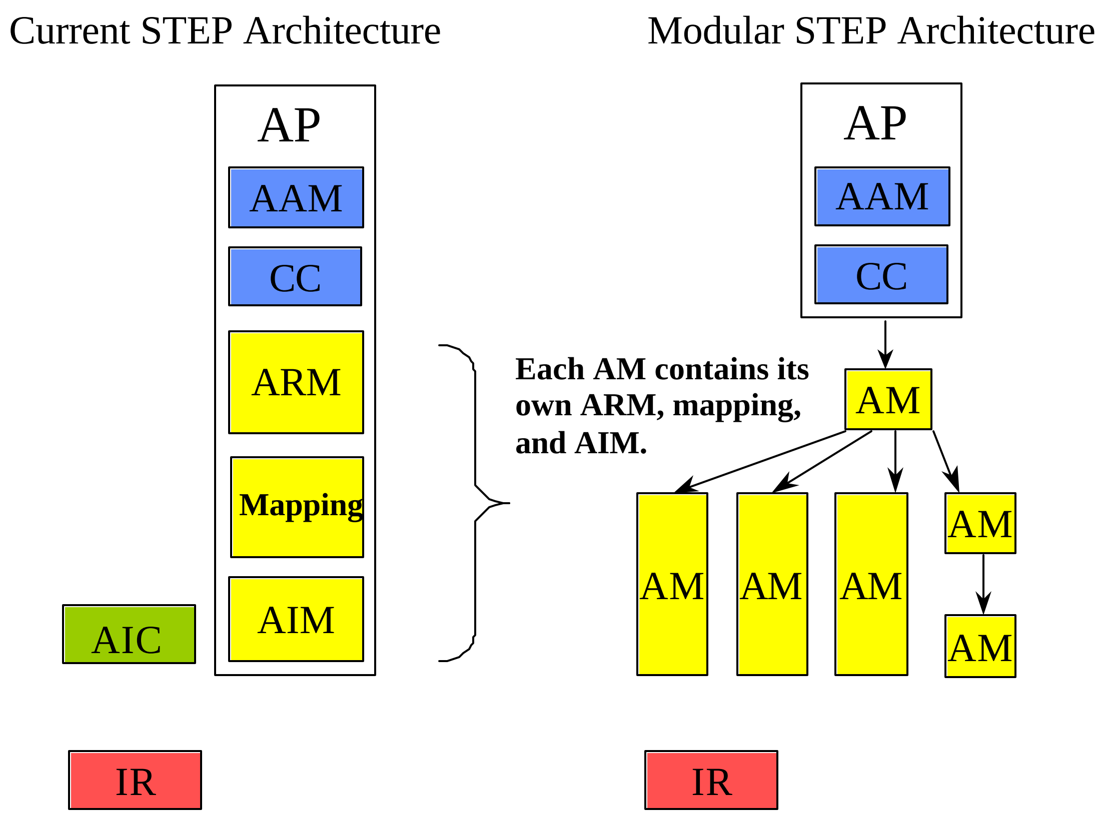

Figure 2. Modular Architecture vs. Current STEP Architecture

Modular Architecture Enablers

A technical architecture can only go so far toward meeting the requirements set out for STEP. There are organizational issues that must be resolved to facilitate harmonizing requirements and identifying solutions. Several mechanisms that enable division of the domain, re-use of solutions, and harmonization of requirements are also deliverables of the modular architecture project. These include a high-level application framework, a module catalogue, a web-based module repository, and a harmonization team.

STATUS OF STEP MODULARIZATION

The STEP modular architecture is an approved work item [9] in ISO TC 184/SC4 and has provisional approval of many documents detailing aspects of the modular architecture, including rules for specifying the content of the architectural components [10]. To meet standardization requirements set out for the architecture, application modules will be published as ISO technical specifications, a new type of ISO deliverable requiring only one ballot cycle.

Modules Under Development

SC4 has agreed to allow selected projects to pilot the modular architecture on an experimental basis. The first STEP application modules began their technical specification ballot in November 1999. These modules provide the capability to assign appearance to shapes and to assign geometric elements to layers. Modules for product data management, geometric dimensioning and tolerancing, drafting, and other capabilities are under development. All modules currently under development harmonize content from existing STEP application protocols.

Technical Issues

Technical issues do remain, but proposed solutions are being evaluated.

An amendment to the EXPRESS language is being proposed that will solve problems that arise from specifying a model across multiple subdocuments. These modifications to the EXPRESS language will provide the ability to define structures that may be extended and constrained outside of the schema in which they are defined.

The modular approach is designed to take advantage of the coming EXPRESS-X capabilities. EXPRESS-X is a STEP description method for mapping between two related EXPRESS schemata. The modular approach would like to leverage this new capability for mapping between the requirements and interpreted model schemata. How that will happen has yet to be completely resolved.

Changes may be made to the STEP conformance testing methods to support the new modular architecture. The way conformance classes are specified may also need to be changed for modular application protocols.

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