AIA AEROSPACE INDUSTRIES ASSOCIATION

Utilizing S-Series Specifications to Optimize Operational Readiness

An AIA Report
How the S-Series Specifications Transform Your Digital & Interoperable Product Support Strategies

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Foreword

Model-based approaches to design and the power of simulation have been woven into most conversations about the future of aerospace engineering and defense acquisition strategies. However, the data sources, associated analytics, and traditional approaches to evaluating key performance parameters for product support (e.g., reliability, availability, predictive maintenance, and supply chain optimization) are in the infancy of digital transformation. To achieve a future where model-based simulation is the core of product support analysis, this data must be integrated.

To address this challenge, standardize this data, and enable more seamless integration, the aerospace and defense industry created **S-Series specifications**. The S-Series bring together previously disconnected pieces of data into an internationally recognized order, based on Unified Modeling Language (UML)[1]. The S-Series provides both an overview of processes and analysis for creating product support data as well as a common data model for the organization and documentation of data across all product support activities. As a result, S-Series specifications provide an integrated, standards-based approach that enables the automated creation of logistics product data at the heart of defense and commercial systems.

This document provides a brief overview of the innovative S-Series Specifications and how they can be applied to critical systems used by the Department of Defense and beyond to increase operational readiness and maximize efficiency and cost-effectiveness throughout a product's life cycle.

Background

A standards-based approach has been at the heart of data organization since the mid-20th century. However, each standard was created to organize either engineering or product support data. The intent of each was to solve a distinct issue with little regard for the interoperability of that information. In the late 1990s, NATO and European defence agencies recognized a gap in consistent logistics data creation for Logistics Support Analysis (LSA), provisioning, documentation, training, and feedback.

With this in mind, the AeroSpace and Defence Industries Association of Europe (ASD) began creating the S-Series Specifications for Integrated Product Support (IPS) and in July 2010, partnered with the Aerospace Industries Association (AIA) in the United States to develop specifications as an interoperable advancement to legacy, bespoke U.S. Department of Defense specifications. The S-Series Integrated Product Support (IPS) specifications were developed as a result of that effort and are available today at no cost for both defense and commercial use.

Today, the development and government of the S-Series specifications is operated jointly by industry members of AIA and ASD (and the Air Transport Association e-Business program for S1000D only) alongside representatives from the U.S. and other government defense departments. While they were developed for the aerospace and defense industries, they can also be applied to maritime, subsurface, railway, construction, and agriculture applications, among others.

[1] UML is a widely adopted industry standard for modeling systems. It is a graphical language for specifying, visualizing, constructing, and documenting system artifacts, and is useful in a variety of engineering problems, from single-process, embedded systems and stand-alone user applications to concurrent, distributed systems. UML provides a mechanism for expressing the constructs and relationships of complex systems, in particular software systems. More specifically, it is a graphical notation that can be used to describe the various models of a software system.

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The S-Series Specifications include:

- SX000**i**, which defines the **I**PS process and how the other specifications relate
- S1000**D**, which governs Technical data and **D**ocumentation
- S2000**M**, which governs Provisioning and **M**aterial Supply
- S3000**L**, which governs **L**ogistics Support Analysis
- S4000**P**, which governs **P**reventive Maintenance and In-Service Maintenance Optimization
- S5000**F**, which governs **F**eedback
- S6000**T**, which governs **T**raining Needs Analysis
- SX001**G**, which is the **G**lossary
- SX002**D**, which is the Common **D**ata Model

Integrated Product Support (IPS)

An integrated approach to product support allows for In-Service Maintenance Optimization (ISMO) to respond to monitored fleet feedback, which enables equipment modifications, improves maintenance at a reduced cost, improves fleet availability, and heightens levels of operational readiness. This is made possible through analysis (i.e., reliability, availability, and maintainability analysis) of technical data derived from actual engineering sources. The current approach requires individualized data creation and program-unique tools that drive stand-alone efficiency choices over affordability and reusability at the enterprise level. Opportunities for best practices and tool duplication across programs are lost due to non-standardized approaches.

IPS, when implemented via the S-Series Specifications, enables a model-based approach to product support. The S-Series supports the data requirements of a variety of customers (e.g., defense or commercial), via a single UML-based data model that can enable data *creation* via a standardized approach. However, data extraction (reports, lists, publications, Training Needs Analysis, etc.) can be based upon a customer's preference. In short, the product support analyses are stored as raw data within the model, but can be extracted and delivered based on contractual requirements.

Model-Based Engineering (MBE)

Model-Based Engineering (MBE) emphasizes the application of visual modeling principles and best practices throughout the System Development Life Cycle (SDLC).

> *"MBE uses models as an integral part of the technical baseline that includes the requirements, analysis, design, implementation, and verification of a capability, system, and/or product throughout the acquisition life cycle."*
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> *Final Report, Model-Based Engineering Subcommittee, National Defense Industrial Association (NDIA), Feb. 2011*

Today's focus on MBE goes beyond the use of disparate models. MBE moves the record of authority from documents to digital models (e.g., M-CAD, E-CAD) managed in a data-rich environment. Shifting to MBE enables teams to more readily understand design change impacts, communicate design intent, and analyze a system design before it is built.

Aspects of MBE specifically associated with systems engineering such as behavioral analysis, system architecture, requirement traceability, performance analysis, simulation and test, are known as MBSE.

> *"Model-based systems engineering (MBSE) is the formalized application of modeling to support system requirements, design, analysis, verification and validation activities beginning in the conceptual design phase and continuing throughout development and later life cycle phases."*
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> *INCOSE SE Vision 2020 (INCOSE-TP-2004-004-02, Sep 2007)*

The model-based engineering paradigm is model-based to the extent that the visual modeling artifacts it generates are sufficiently precise and complete. They can also serve as a software or systems blueprint for improving efficiency and productivity. It is model driven to the extent that it partially automates (i.e., "drives") the SDLC via requirements that are precisely and completely specified as part of the system model and which can be fully traced across the SDLC.

Summary Overview of the S-Series Specifications

The need for a consolidated and harmonized data model was recognized as a fundamental requirement for the S-Series Specifications. The **S-Series Data Model** is a consolidation of concepts across the suite of specifications. This common data model is referenced as SX002D.[2] SX002D is designed and maintained to harmonize data modeling activities performed within the respective S-Series Specification and consolidates data requirements into one coherent S-Series data model using UML.

The following summary introduces each of the specifications within the S-Series suite and illustrates how the S-Series builds upon current concepts, processes, and standards (e.g., UML, SysML,[3] ISO 10303,[4] GEIA-STD-0007C[5]) to enable a model-based approach to Integrated Product Support.

- **SX000i** (www.SX000i.org): SX000i provides the basis for sharing and exchanging data securely through the life of products and services. It provides guidelines on how to exchange program-level data between the different specifications, and between contractors and customers.

- **S1000D** (www.S1000d.org): S1000D uses a Standard Numbering System (SNS) to structure equipment data in line with the equipment breakdown structure. Technical data within S1000D is organized by unique Data Module Codes (DMC) that are the identifiers of data modules, which are the basic information units containing description, procedures, or operational data.

  The data is created in XML[6] and allows the different types of data modules to be created based on its category for procedure, description, etc. S1000D enables the ability to use a common Work Breakdown Structure (WBS) for all systems and sub-systems that can be mapped directly to the physical and functional requirements of both S2000M (Material Support) and S3000L (Logistics Support Analysis (LSA), Maintenance Task Analysis (MTA), Level of Repair Analysis (LORA), and Failure Mode, Effects, and Criticality Analysis (FMECA)).

- **S2000M** (www.S2000m.org): The S2000M specification describes the provisioning process and requirements of supply chain management. S2000M provides governance for the development of provisioning data, aligning the Initial Provisioning List to the Figure Item, and Figure Item Realizations of the Illustrated Parts Catalog as implemented in S1000D. It also provides a process for developing NATO Codification of Items of Supply (NSN Assignment). The S2000M data model utilizes the UML based Units of Functionality that aligns with the rest of the S-Series, the Common Data Model in SX001D, and XML data exchanges between any of the specifications that require partial data.

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[2] The creation and maintenance of the S-Series Data Model its associated glossary (SX001G) is assigned to the S-Series Data Modeling and Exchange Working Group (DMEWG).
[3] UML was extended to create *system modeling language* (SysML) to apply the UML model to the development of general systems and hardware entities. While UML calls for object, class, component, and deployment diagrams to cover the physical structure of the software. SysML replaces the UML diagrams with block definition diagrams and internal block diagrams.
[4] ISO 10303 is an ISO standard for the computer-interpretable representation and exchange of product manufacturing information. It is an ASCII-based format.
[5] SAE GEIA-STD-0007C defines logistics product data generated during the requirement definition and design of an industry or government system, end item, or product. It provides users with a uniform set of data tags for all or portions of logistics product data using XML.
[6] XML, or Extensible Markup Language, is a text encoding system and file format that allows for storing, transmitting and reconstructing data.

- **S3000L** (www.S3000L.org): The S3000L specification describes the process by which Logistics Support Analysis (LSA) is implemented in an IPS program, including the traditional areas of engineering support (reliability, availability, maintainability, and testability) with configuration management, human factors analysis, software support analysis, life cycle cost considerations, obsolescence, and disposal.

  The same UML-based data model that is employed by the other specifications within the suite is implemented within S3000L and fully integrates with Parts Provisioning (S2000M), Publications (S1000D), Preventive Maintenance (S4000P), and Training (S6000T). It is recommended that S3000L be treated as a central repository for the analysis outputs of each specification within the suite. Each output has a receptacle within the S3000L data model that can link data exchanges between the others for a holistic view of the entire product life cycle.

  When further integrated with S5000F, the S-Series data model allows for the full digital thread to be implemented with the S3000L Common Source Database (CSDB) serving as the central node.

- **S4000P** (www.S4000P.org): S4000P provides for the creation of Preventive Maintenance Task Requirement Analysis. S4000P combines the needs of a commercial fleet with the unique requirements of military aircraft, making it useful for both customer bases.
- **S5000F** (www.S5000F.org): S5000F provides a structured way to handle operational, maintenance, and other feedback from operators, contractors, vendors, suppliers, and any other involved stakeholders. By using the common data model for the S-Series Specifications, it serves as the basis for defining a robust system for integrating operational data along the digital thread to engineering sources, parts, and publications.
- **S6000T** (www.S6000T.org): S6000T defines the process for performing a Training Needs Analysis, including the definition of training requirements, learning objectives, and the identification of training curricula.