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Should S1000D be Required by the Department of Defense?

by Curtis L. Blais, John S. Falby and Michael E. McCauley

27 August 2010

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Prepared for: Office of the Undersecretary of Defense
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1901 N. Beauregard Street, Suite 600
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ABSTRACT

The purpose of this analysis was to determine whether S1000D, an international specification for technical publications, should be required in Department of Defense (DoD) acquisitions. Based on the information and opinions gathered from nearly 200 participants in the study, we conclude that S1000D should be a required standard for technical publications across the DoD. This action should be taken in conjunction with a program to implement, transition, and promote its success. This program would include a set of critical provisions for DoD to: (1) manage/govern the use of the standard; (2) promote the use of the standard; (3) support adoption and evolution of the standard; and (4) establish and enforce use of the standard.

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I. INTRODUCTION

A. PURPOSE

The purpose of this analysis was to determine whether S1000D, an international specification for technical publications, should be required in Department of Defense (DoD) acquisitions. The Office of the Undersecretary of Defense for Personnel and Readiness (OUSD P&R) asked the Naval Postgraduate School (NPS) to weigh the arguments for and against making S1000D a requirement.

B. BACKGROUND

The S1000D specification was developed in the 1980s for civil aviation by the AeroSpace and Defence Industries Association of Europe (ASD). With the growth of Integrated Logistics Support (ILS) and Information Technology (IT), the European aviation industry developed a structured approach for documentation of air vehicle projects, resulting in S1000D. The most recent version, Issue 4.0.1, was released in 2009 and was jointly produced by ASD, the Aerospace Industries Association (AIA), and the Air Transport Association of America (ATA). In moving from Issue 3.0 to 4.0, the specification extended beyond technical data to include support for learning, training and human performance content. This version also included a number of changes submitted by the U.S. Army.

S1000D is the designation of the International Specification for Technical Publications Utilizing a Common Source Database (Issue 4.0.1, May 12, 2009). The S1000D suite of information includes the technical publications specification, examples (e.g., XML instance documents, PDF files, and style sheets), XML schemas, and any other software or information under the heading "S1000D suite of information" on the pages titled "S1000D On-line" and "Download" on the website http://www.s1000d.org. S1000DTM is a trademark owned by ASD. Copyright is held by ASD and Ministries of Defence of the member countries of ASD. S1000D maintenance and evolution is governed by the S1000D Council and the S1000D Steering Committee made up from members of defense organizations and industry. Recent history includes (ASD/ATA/AIA, 2009):

- In 2003, a Memorandum of Understanding (MOU) was signed between ASD and AIA establishing the parameters for an agreement between the two organizations harmonizing US and European guidance related to technical publications data.
- In 2004, the ASD signed an MOU with the US Advanced Distributed Learning (ADL) office. The two organizations are working together to harmonize S1000D with requirements of the Sharable Content Object Reference Model (SCORM) for computer-based training.
- In 2005, a MOU was signed between ASD, AIA, and ATA to promote common, interoperable, international technical publication data in the Aerospace and Defense Industries and to work in concert on the joint development and maintenance of S1000D.
- In 2007, the MOU between ASD, AIA, and ATA was renewed to enable the three organizations to jointly further develop, maintain, and promote S1000D in the international arena.

Over the past several years, interest in and application of S1000D have been growing in the US. All of the military services (as well as the US Coast Guard) have policies permitting the use of S1000D, or are investigating policies regarding the use of S1000D. The standard is currently being employed by a number of US DoD projects, including: Air Force F-117A and Global Hawk unmanned vehicle programs, Naval Air Systems Command Joint Strike Fighter program, Army Future Combat System, and the Naval Sea Systems Littoral Combat Ship Mission Module Program.

In 2008, AIA submitted a recommendation to the DoD to declare the S1000D standard to be the preferred specification for technical documentation in all DoD acquisitions (AIA, 2008). In response to that recommendation, OUSD engaged LMI (originally, the Logistics Management Institute) to assess the merits of the AIA recommendation to require the use of S1000D (Borek and Wilson, 2008). According to Borek and Wilson, the DoD "adopted" S1000D on 24 January 2005 as an acquisition standard, meaning it was listed as an option, along with several other alternatives, but was not required. In their analysis, Borek and Wilson found that some users of S1000D strongly favored it because it "solves many problems associated with larger technical documents: managing changes, controlling versions, providing a framework for content

development, and enabling web-based and paper publishing formats." On the other hand, Borek and Wilson suggested that some of the benefits attributed to the use of S1000D actually derive from the use of a structured information management solution, not necessarily the S1000D standard itself. They recommended that OUSD (AT&L) move forward in the area of technical publications by convening stakeholder organizations to address DoD enterprise solutions for managing technical publications, identifying authoritative data sources, and coordinating with product lifecycle management activities. According to the recommendations of Borek and Wilson, the decision about whether to require S1000D should be deferred until these enterprise-level issues are resolved. After the passage of two years, during which the use of S1000D has grown in DoD and a new version of S1000D (Issue 4.0) has been released, OUSD (P&R) wanted to revisit the issue of whether S1000D should become the required standard for technical publication and to support integration of training and technical data. That question was the impetus for the present analysis by the Naval Postgraduate School (NPS).

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II. TECHNICAL OVERVIEW OF S1000D

A. STRUCTURED DATA

Since the early days of computer-generated documentation, authors have employed "mark-up" or "tagging" to annotate the document content with information used by software for formatting (presentation in paper or electronic form), cross-reference (footnotes, indexing, table of contents), search (content description), document description (metadata), and other purposes. The Standard Generalized Markup Language (SGML) is an international standard (International Standards Organization, ISO 8879:1986) for the definition of markup languages. Two derivatives, the Hypertext Markup Language (HTML) and the Extensible Markup Language (XML), are principal underpinnings for the description of content on the World Wide Web. The first, HTML, largely provides a way of describing how to present document content when viewed by Web browser software. The second, XML, provides a way to describe the content itself, permitting greater automation in the interpretation and use of information contained in digital documents, and doing so in a highly standardized way for general applicability across all computer systems. In contrast to HTML, XML focuses on the structure and content of data as a separate concern from presentation of the data. Output formats of a product can vary widely, from printed media to electronic media in a variety of form factors (large screen, personal data assistant, cell phone, etc.). In the XML context, the document content does not change for each different presentation style; rather, the style of presentation is developed separately and as appropriate to meet the needs of the information consumer. Apart from its growing use in the World Wide Web, XML is a generally accepted practice for the description of any data and is seeing widespread use in software applications across all domains.

The structure and content of XML documents are governed by an XML schema, itself an XML document that describes the structure, vocabulary, and rules governing validity of data values. With its widespread adoption, numerous tools have been developed in virtually all computer environments and computer languages to manipulate XML documents, providing uniform ways for developers to create and process XML documents. XML instance documents that employ the defined schema can be automatically validated against the rules of the schema, helping to reduce creation and proliferation of invalid data.

The S1000D specification provides a set of XML schemas to specify content and processing of technical publications conformant to the specification. It is well accepted (and corroborated by subjects interviewed in this study) that much of the benefit of S1000D comes from its use of XML as the basis for describing data in a standardized, structured way.

B. DATA MODULES

S1000D discreetly organizes information in small files called "data modules." The data module can support the following types of content and constructs (brief descriptions are taken from various sections of the S1000D Specification to indicate the breadth of information that can be represented in the specification):

- **Applicability cross-reference information** – Declares product attributes. A product attribute is a property of the product that has an effect on the applicability of technical data. Product attributes are properties of the product that are typically set at the time of manufacture of a product instance and will usually not change throughout the service life of a product instance. Examples of product attributes are model, series, and serial number.
- **Business rules information** – Identifies decisions regarding the use of S1000D for a particular product.
- **Conditions cross-reference information** – Declares any condition that can affect applicability data. Conditions can be technical, operational, environmental, or any other type that can affect technical data. Technical conditions are typically tied to the configuration of the product. Examples of operational and environmental conditions are location of maintenance, availability of tools, regulatory rules, temperature, wind speed, and sandy conditions.
- **Container information** – Provides a mechanism to associate several alternate data modules representing the same data. The container data module helps to maintain the consistency of links by centralizing the link management and providing the capability to define the linking at the source instead of at the point of usage.
- **Crew-operator information** – Information needed to provide crew/operators with the necessary degree of understanding of the product and its systems and the

procedures to operate the product, its system and equipment to their full potential under normal and failure modes

- **Descriptive information** – Provides information relating to paragraph depth, occurrences of subparagraphs, and use of warnings and cautions.
- **Fault information** – Captures and represents fault reporting, fault isolation and fault correlation information.
- **Illustrated Parts Data (IPD) information** – Captures and represents parts lists and IPD.
- **Maintenance checklists and inspections** – maintenance planning information that can be used for items such as Preventive Maintenance Checks and Services, checking unpacked equipment conditions, preventive maintenance inspection forms, and criteria for special inspections.
- **Maintenance planning information** – Identifies time limits (periodicities and life details for a system), task definitions, inspection definitions (groups of maintenance tasks or inspection types), and maintenance allocation (maintenance functions along with maintenance levels and time associated for each task).
- **Procedural information** – Captures and represents maintenance procedural flow.
- **Process information** – Represents a procedural flow consisting of several data modules and/or steps that are sequenced. Decision points (branching), looping, and selective filtering are supported. An interface to external applications which can return results to direct procedural flow is supported. The process data module can be considered a procedural flow script.
- **Products cross-reference information** – A repository for defining product instances and associating values to product attributes and conditions for each product instance.
- **Technical repository information** – Identifies the use of technical repositories for such items as circuit breakers, parts, zones, tools, and supplies.
- **Training information** – Structures technical learning content and configures it to the system for which the instruction will be performed via harmonization with SCORM.

- **Wiring data information** – Captures and represents the wiring data of the product, such as wire data, harness data, electrical equipment data, and standard parts data.
- **Wiring data description information** – Defines the occurrence, names, and meanings of the elements and attributes that are used in the wiring data modules (above).

A principal component in S1000D information management is the Common Source Database (CSDB). It is an information store and management tool for all objects required to produce the technical publications within projects. Data modules stored in the CSDB are available for use by reference in any number of products. For example, in a new version of a product line, a particular component documented in a data module may be unchanged and can be reused in the updated documentation for that product. Or, a component used in one product also may be used in another product; the description of that component may not need to change for use in the second product. In these cases, the component description has been written and stored once and then used multiple times. Other benefits stated in the specification include (ASD/ATA/AIA, 2009):

- It is based on international neutral standards.
- It reduces maintenance costs for technical information.
- It transforms data into configuration items.
- It allows subsets of information to be generated to meet specific user needs.
- It facilitates the transfer of information and electronic output between disparate systems.
- Many different output forms can be generated from the same base data thus ensuring safety of data and that every user regardless of output form is getting the same message.
- The S1000D data module concept can be applied to legacy data.
- It is non-proprietary and allows neutral delivery of data and management of data.
- The specification incorporates the planning and management, production, exchange, distribution and use of data in electronic form for different types of output (from page-oriented to interactive electronic technical publications).

As will be seen later in this report, these statements are echoed in the testimony of current users of the specification.

C. SOFTWARE TOOLS

A number of commercial vendors have developed tools that produce S1000D-conformant documents. In addition, several DoD organizations working with S1000D have developed software and tools that work with S1000D XML files. In considering the question of whether or not DoD should require the use of S1000D, we did not believe it was in scope to conduct a market survey of products capable of working with S1000D, nor to identify or endorse any particular products. The important issue, we felt, was confirming whether suitable tools are readily available to support such a requirement. We are satisfied from our research that there is a substantial marketplace that has grown up around the use of the S1000D specification, so that a decision to require use of the standard would be supported by the availability of sufficient tools.

D. BUSINESS RULES

From the specification:

> *Business rules are decisions that are made by a project or an organization on how to implement S1000D. Business rules cover all aspects of S1000D and are not limited to authoring or illustrating. They can also address issues that are not defined in S1000D such as rules related to how S1000D interfaces with other standards, specification and business processes that are related to its implementation.*

Application of S1000D to any product development can be tailored to the particular needs of the project. Tailoring is performed by establishing a set of business rules guiding application of the specification to the particular project. The specification itself provides a large number of business rules that are intended to be either accepted or excluded for a particular project. The specification identifies ten categories of business rules described below (brief descriptions are taken from the specification to indicate the breadth of coverage of the business rules):

- **General business rules** cover decisions made by a project or an organization that are not covered by any of the other business rule categories. They serve as overall decisions for the implementation of S1000D. General business rules include but are not limited to decisions about which issue of S1000D is to be implemented,

identification of the parts of S1000D to be used in a project, and definition of terms used throughout the project.

- **Product Definition business rules** cover the data module coding strategy related to how the product is broken down. Included is the definition of the model identification codes to be used in the product and its subsystems. Supplier subsystems and identifications also need to be considered.
- **Maintenance Philosophy and Concepts of Operation business rules** cover the types of information that a project or an organization requires. They include, for example, a list or detailed specification of chosen information sets, an information codes specification which details the information codes, and information names that describe the data module content. Definition of these rules must be performed in conjunction with operation, maintainability, repair and other aspects of Logistics Support Analysis (LSA).
- **Security business rules** cover all security issues. They include security classifications, copyright markings, use or disclosure restrictions, destruction instructions and any other data restrictions.
- **Business Process business rules** cover how technical publications development is coordinated with other disciplines within an organization or within the project level at that organization or the project as a whole. For example, they describe the rules and relationships with LSA, S1000M compliant initial provisioning, engineering/design, and training (e.g., SCORM compliance).
- **Data Creation business rules** give information about the creation of text, illustrations, and multimedia objects. Data creation business rules for text include, but are not limited to, writing rules, markup rules, and requirements for text incorporation in multimedia objects. Data creation business rules for illustrations and multimedia objects include, but are not limited to, graphic style rules, interactivity detail rules, multimedia format rules, and linking rules.
- **Data Exchange business rules** cover how data is to be exchanged among partners and customers. This includes, for example, the use of data dispatch notes, how data module requirements lists as well as CSDB status lists are used, how the

- **Data Integrity and Management business rules** enforce the referential integrity within the CSDB. The rules include, but are not limited to, workflow business rules (both internal and external) and quality assurance business rules.
- **Legacy Data Conversion, Management, and Handling business rules** pertain to converting data from some other format to S1000D data modules (including mapping between elements and attributes of source and target specifications, as applicable) and rules for inclusion of legacy information in a technical publication.
- **Data Output business rules** specify the output formats for S1000D data, which can include page-oriented (e.g., paper) formats, interactive electronic technical publication (IETP) formats, multimedia formats, and SCORM formats. These rules include decisions regarding which portion of the data will be published and in what formats, and details on how to style element and attribute content.

Business rules are often specified in "layers" according to the hierarchy of projects within an organization, and organizations within a larger organization, to create an overall enterprise set of business rules. The number of business rules grows as one progresses from the highest layer to the lowest. Lower layers inherit business rules from the higher layer(s). The goal is to minimize the number of decisions made by the author of a publication. The practice of layering business rules can produce a tree-like structure as shown in Figure 1 (from the S1000D Specification). Several of the interview participants commented on business rules, as given later in this report.

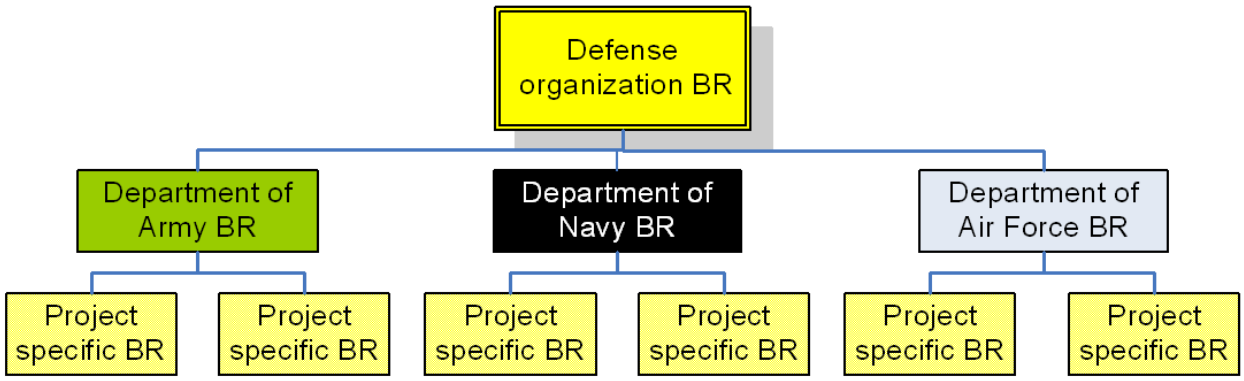

Figure 1. Example of a defense tree-like business rules model

The Business Rules Exchange (BREX) data module is a means to communicate business rules that have been developed and agreed upon within a project or organization. BREX data modules are stored in the CSDB. The BREX data module can be used, for example, to record and exchange rules while they are being developed in a project or organization, to support a correct interpretation of the CSDB objects, and to enable validation of the CSDB objects against agreed rules. A layered business rules structure can be represented in a corresponding layered BREX data module hierarchy.

E. S1000D GOVERNANCE

S1000D is an international standard sponsored by several industry associations and governed by participants from a wide range of backgrounds and affiliations. Refer to Figure 2 for a high-level view of the governing structure and organizational relationships.

1. S1000D Sponsors

S1000D is developed and maintained by an international community of business and technical experts from civil and defense aviation industries, as well as from the defense land and sea industries. Customers, suppliers, and solution providers are represented. The three sponsoring organizations of S1000D are:

- Aerospace and Defence Industries Association of Europe (ASD) (http://www.asd-europe.org)
- Aerospace Industries Association (AIA) (http://www.aia-aerospace.org)
- Air Transport Association of America (ATA) (http://www.airlines.org)

Figure 2. S1000D International Organization

2. S1000D Council

The S1000D Council was formed in accordance with a Memorandum of Understanding signed between ASD, AIA and ATA. The main mission of the Council is to conduct overall governance of the S1000D development. The Council provides the vision for the specification so that the mission can be achieved, together with overall administrative management and direction to the Steering Committee and general promotion of the use of the S1000D.

S1000D Steering Committee

The S1000D Steering Committee is a body of members representing nations and organizations who have a common interest in the specification. The Steering Committee maintains the currency of the specification by processing Change Proposal Forms and accepting or rejecting new and changed material for release in the form of issues of the specification, taking into account the visionary direction of the Council.

3. Working Groups and Task Teams

Within the organization several standing Working Groups and temporary Task Teams are formed to conduct the day-to-day work of developing, reviewing, and managing changes to the specification, XML schemas, and other associated products.

III. METHODS

A. OVERVIEW

To answer the question posed to NPS about whether DoD should require the use of S1000D, we pursued three main approaches: (1) review and analysis of documentation; (2) structured interviews with individuals knowledgeable and experienced in the use of S1000D; (3) and a survey questionnaire. The document review fed into generation of questions for the structured interviews, and both the document review and the interviews contributed to the content of the questionnaire. The previous section provided highlights from the document review. The methods and procedures for the interviews and the questionnaire are given here, followed by the results and discussion.

Prior to recruiting interviewees or participants for the survey, the project investigators obtained NPS Institutional Review Board (IRB) approval for the conduct of human subject research in accordance with Department of the Navy Human Research Protection Program policies and procedures.

B. STRUCTURED INTERVIEWS

A series of questions was developed to capture information about the nature of S1000D, the potential benefits or drawbacks of its use, and the implications of a DoD decision to require its use. A copy of the structured interview is given in Appendix A.

The structured interview included the following:

- Initial questions
  - Basic demographic information (organization, title, duties)
  - Whether the interviewee's organization is currently using or has used S1000D
- If the interviewee's organization is using or has used S1000D, the content of the questions covered:
  - What benefits were being experienced from the use of S1000D
  - What expectations were not being met from the use of S1000D
  - Estimates of costs and availability of cost data from initial use of S1000D
  - Use of S1000D for legacy systems

    - Linkage with SCORM for training applications
    - Would you favor a DoD requirement to use S1000D?
        - If yes, discussion of issues relating to implementation of the requirement
        - If no, does the interviewer prefer a different standard or keeping the status quo, and/or discussion of what needs to happen that might change their view
- If the interviewee's organization is NOT using S1000D, a different set of questions was asked:
    - Why did your organization decide against using S1000D?
    - Do you plan to use it in the future; why or why not?
    - If yes, do you have an estimate of the time or cost to begin using it?
    - Is your technical data strategy based on DoD policy or on internal corporate procedures?
    - Would you favor a DoD requirement to use S1000D?
- Both sets of interviewees, those whose organizations were or were not using S1000D, were asked this final question:
    - Do you believe that the DoD should determine a comprehensive enterprise-wide approach to product data before making S1000D a requirement?

The project sponsors and supporting personnel provided an initial list of candidate interviewees. These were generally key individuals leading S1000D working groups or similar organizations. Also, because we were seeking individuals who were knowledgeable about S1000D, we identified candidate interviewees from a list of participants at a recent S1000D user's group conference. Initial telephone conversations and subsequent interviews contributed to an expanded list of interview candidates, and so on. In other words, we "bootstrapped" the list of interview candidates through an expanding network of telephone and email contacts. Because this method of developing candidates tended toward S1000D supporters, we made proactive attempts to identify and include individuals who were not advocates of S1000D. In short, our interviewees were a "convenience sample" drawn almost entirely from U.S. sources, both DoD

organizations and industry, based on finding individuals who were knowledgeable of S1000D, technical publication, and similar areas.

Each interview was conducted as a telephone conference call and lasted approximately 40-60 minutes. In a few cases, two individuals at the same institution were interviewed simultaneously. A local company was engaged to provide transcription services. A court reporter participated with the interview team and transcribed the questions and answers. In most cases, all three authors participated in the interview; at no time were fewer than two of the authors present. A total of 24 individuals were interviewed in twenty interview sessions.

C. SURVEY QUESTIONNAIRE

The survey questionnaire was developed from material obtained in the review of documentation and the telephone interviews. We attempted to consolidate the issues into a small set of questions conveyed as Likert five-point rating scales. A course in survey methodology is taught at NPS by Professor Ron Fricker of the Operations Research Department. He generously agreed to review and comment on the draft questionnaire. One objective was to limit the time required to complete the questionnaire. People frequently are asked to participate in long and tedious questionnaire surveys. We wanted to get to the point quickly and obtain quantifiable data on key questions. Survey Monkey http://www.surveymonkey.com/, a web-based survey tool, was used to create and administer the questionnaire. The first question was used as a filter. We wanted people with some knowledge or experience with S1000D to participate in the survey. The first question asked how much knowledge or experience the individual had with S1000D. If the answer given was “Strong” or “Medium,” they proceeded. If the answer was “Weak,” the web-based survey branched to the end, thanking the person for their willingness to participate. The questions are duplicated in Appendix B.

The link to the web-based questionnaire was distributed via email, directly from the authors to an email merge list. The email distribution list was developed with the cooperation of a leader of a S1000D users group. We added all of the individuals on our interview list, including those who indicated an interest to do the interview, but could not be scheduled during the time of the study. At the end of the questionnaire, we asked the participants to forward the URL link to anyone who was knowledgeable about S1000D. This introduced an interesting aspect in that the exact return rate cannot be determined because of the networked nature of the

invitation to participate. In any case, we estimate that the size of our initial distribution list was approximately 150.

IV. STRUCTURED INTERVIEW RESULTS

A. SAMPLE SIZE

We conducted a total of 20 interviews with a total of 24 interviewees. In four of the interviews, two subjects participated at the same time, in accordance with their wishes. Court reporter services were used to create transcripts of the interviews for purpose of follow-on review and analysis. Interviewees were from organizations across all four military services, the Coast Guard, defense industry representatives, S1000D product vendors, S1000D governance bodies, and other relevant organizations.

B. RESULTS

In this section, we provide a summary of viewpoints from the interviews. The section includes numerous excerpts from the transcripts to allow the reader to "hear" the same things we heard in the interviews. Excerpts from the transcripts are shown in italics. A minor amount of editing has been performed to enhance readability. We organize the findings from the interviews into the following categories: (1) benefits experienced from using S1000D; (2) challenges or issues experienced in the use of S1000D; (3) whether DoD should require the use of S1000D; and (4) actions DoD must be prepared to take if the decision is made to require the use of S1000D. Short synopses of the comments from the interviews are included in this section. Additional interview material is provided in Appendix C.

1. Benefits

- Reuse was one of the primary benefits identified by interviewees:

  Data reuse… it should reduce the lifecycle of that information because you're only creating it once and using it many [times]

  …the basic business benefits of S1000D would be reusability of the information

  …the pieces of information that you create in S1000D are very small pieces of information that are referred to as data modules. What this means is that these small pieces of information can be reused in multiple contexts, multiple scenarios throughout a range of systems, platforms, or weapons systems

  …the government is only buying the data once and not buying the data 6 or 7 times for every different end item that the system is going to be used on.

  The capability of reusing the data, creating data once and using it multiple times for various products.

The fact that my systems change so rapidly, I have to come out with new versions of IETMs on a very rapid, repeatable basis. S1000D enables me to reuse the portions of the IETMs that are applicable to earlier versions without having to redevelop them.

…that's one of the benefits that we've seen, the modularity and the reuse from some of the programs.

…because the data is broken down into smaller chunks of information and we're able to reuse this information, that the information is going to be more accurate, the user is going to get more timely changes.

Once we have it authored the first time, we've verified it, we've made sure the information is correct, and then we'll be able to reuse that over and over again.

- A number of interviewees described data exchange / data sharing as a benefit:

The benefit of the specification is that it allows for data exchange across platforms and between companies. If companies are truly developing compliant S1000 data, the tagging scheme within a specification allows those parties to share and reuse data.

If you tag the data properly in one format, S1000D, you can exchange information with S3000L, and you can exchange information with S4000M and S5000F.

It's the data exchange and the underlying schemas and the data type definitions, DTDs, that allow you to exchange across multiple IT systems, integrated technology systems.

…there are definitely benefits of reuse. … a recommended area for further development is the data exchange between program services and industry.

S1000D, using the XML and the tagging structure, of course, also lets you find the data more easily, as well as being able to use the attributes. So … it does make it easier to share information.

…the data sharing between the various levels of maintenance is there, whether it's organization or intermediate or depot or whatever it is, and then also the shared data between U.S. and our foreign military customers as well as shared data which is consistently applied. … if you're using S1000D, it certainly makes it easier to share data from multiple vendors. … keeping it in S1000D makes it easier to share the data between vendors and with us.

- Several interviewees described real and potential cost savings related to the benefits cited above:

Just going to an IETM, we found about a 25 to 28 percent reduction in maintenance man-hours and a significant percentage in reduction of false removals.

We do have the E-2D, which took the E-2C data, converted it to S1000D so that they could use it in the D, and they are finding a reduction of 30 percent, time and cost, in terms of updating the manuals.

I have a number of circumstances where the implementation of S1000D has been demonstrated to produce savings, and those savings vary in amounts. Twenty to forty percent are reported reasonably often. Twenty percent, those figures are related to programs that are moving from one as a standard generalized markup language, or

XML kind of implementation, into S1000D. Those don't achieve as big a savings as people who are moving from some unstructured kinds of offering into S1000D. Those savings are even greater. Those will approach the 40 percent, and I have some indications of those kinds of savings from some customer studies that have been done for several customers. There are also some savings associated with the production of illustrated parts catalogs, and those savings based on implementing a relational database for the parts information. That's not required by S1000D, but is a technique that's often employed. Those savings can range from -- almost up to 90 percent, where the technical data has been produced in a linear fashion. So that a particular screw or nut, a part, might be used hundreds of times within a technical publication; and each time you would have to specify all the information about it for procurement. When it's maintained in a relational database, you need to specify that only once. And it's possible then to generate from this relational parts information, the S1000D information. Those instances can really provide substantial savings, savings that are almost unbelievable. And we have some cases where this kind of implementation has been done, not because it was required by specification, not by law; nobody said you had to do this. We had an oil pipeline company implement S1000D simply as a means of improving their operation, and they are the ones who have reported this substantial savings of 90 percent.

…the ability to reuse data and not have to recreate data, on a very small scale, has saved me between 15 and 25 percent of my overall development cost. I see that that should go up significantly once all of my programs are doing S1000D.

- Specific data regarding actual cost savings realized using S1000D were not generally available from the interviewees. A recent study for the US Navy (Levine, et al., 2010) examined potential cost savings for production of technical manuals and training courses while improving shipboard readiness. The study considers new software and technical and business procedures to integrate (or "Bridge") the production of technical manuals and training courses. Through an aggregate analysis (involving the Navy's yearly production of Hull, Mechanical, and Electrical technical manuals produced by the Naval Ship System Engineering System and all Computer-Based Training courses delivered by the Naval Education and Training Command Navy eLearning organization), the study found that the "Bridge" can achieve net benefits of $78M over 10 years.[1] A second part of the study, from the perspective of a single Program Office (the AN/AQS-20A mine hunting sonar for the Littoral Combat Ship), found that the

[1] Levine, *et al.*, 2010, p ES-2 and 5-1. The study states (p 5-2) that the results depend strongly on several uncertain inputs. When variations on ranges of values for those inputs are included, the net benefits range from $32M to $166.5M (p 5-4).

"Bridge" can produce savings of almost $306K.[2] Other data across the services likely exist that can be researched and included in future cost-benefit analyses. There is also discussion in the S1000D governing organizations about collection and publication of such data to assist members and others interested in the standard.

- The availability and capabilities of tools operating on S1000D data were highlighted by a number of interviewees, as well as the openness of the standard:

  Economy of scale; just have one S1000D tool. The tool that we have provides the means to display multiple versions of S1000D data modules at the same time.

  …the neutral format has allowed content to be used in different formats. The neutral format allows us to use it in different viewers.

  …the main benefit is that the source information in S1000D is created in a completely nonproprietary format….also…the specification … is freely downloadable from the internet and there's no cost associated with using the specification.

  …it can be used on multiple different software systems, multiple databases and multiple platforms, without having to alter or modify the actual information itself, so there's no locking to a particular software view or platform.

- Some benefits were attributed to the nature of the S1000D specification itself, as well as its foundation on XML:

  The industry – U.S. industry, DOD industry – saw S1000D as an opportunity to pick up a standard that was current, continually being updated.

  … there is no other specification that exists that's as well developed to talk about how to construct data to produce technical publications. I believe the U.S. civil aviation industry has said that now with the incorporation of changes for Issue 4.1 that they were ready to say that they could use that S1000D specification for all makes and models of civil aviation.

  I would say different people … in different functional areas, including distance learning, including acquisition and including logistics transformation, have all come to the conclusion on their own that S1000D has merit and that they would invest in it. And we have made an investment in trying to deliberately implement this program within our service. And everything so far to date points to the potential for really great benefit.

  Also, … because it's being used internationally and it's such a supported standard, when you come to things like military equipment or planes or any aerospace … the tool set is there, people are trained up on it … So it just makes it easier. … It makes it a lot simpler when you have one standard.

  …it's a consistent structure that seems to fit everything we need to do.

[2] *Op. cit.*, p ES-2 and 5-1.

Doing technical manuals, maintenance manuals … S1000D supports pretty much any format. Using the description data modules; the procedure data modules … illustrations … we created ICNs; starting to use some of the process logic modules in data modules

S1000D has been used in Europe for 20 years. It's not something new and bleeding edge. It's new to us. But there are a lot of people out there that have a lot of experience with it and can help in these projects.

- Integration of training into S1000D content has been a recent addition to the specification that is highly valued by a number of interviewees:

S1000D I think is the first technical data standard that addresses the integration between the IETM tech data community and the E-learning and training content community. … S1000D provides a mechanism of sharing the data so you can have common illustrations between the learning content and the technical content. You can have common text and common theory of operations and system descriptions between the technical data and the training content.

Integrate the production of technical manuals and training courses… with integration, there will be a reduction in the cost of producing future tech manuals and then training courses… the integration would reduce the possible incidence of disparate information given in technical manuals and training courses

…integration may speed up the production of technical manuals and training courses, and therefore that may reduce the possibility -- or give some insurance against the possibility of lags in the fielding of new systems and equipment upgrades, and the delivery of up-to-date technical manuals and training courses to the fleet. …the benefits in terms of reduction in future costs far outweigh the investment and implementation costs.

…it's a lot easier to understand how a system is put together. … I see the training aspect as a major, major plus.

…the 4.0 version of S1000D does give you the framework in order to do that. It provides the learning side of S1000D. So I can put in all of my standard learning content…it provides the framework for someone on the outside, whether it's the database person or someone else, to say "If you give me this information I can create a SCORM package for you."

We found that we can at least make sure the training people know when the data changes, because that's been a big disconnect… for the training data, keep it more in synch with the actual equipment and the manuals.

Our S1000D information set uses a job duty task structure. We did that before S1000D really started embracing training, so we haven't started out with what the S1000D spec offers for training reuse, but we're definitely in support of that and trying to support it technically with how we're going to implement S1000D.

2. Challenges and Issues

- Use of S1000D brings a number of technical and programmatic challenges. Several interviewees commented on the need for leadership, policy, transition support, and comprehensive vision:

  Policy has not caught up with use….

  Without OSD or DOD policy, programs can choose not to implement the specification. There's nothing saying that they should look at it.

  What we in the industry have run into is that when we get to a certain level of leadership within the services, the lack of understanding or knowledge of the specification and what it can do has hindered that policy decision.

  …historically when we issue a standard, we just throw it out there and have the folks use it. We have also identified supporting documentation such as handbooks and rules checkers, business rules that are used to implement S1000D. We've got that all identified and started and put into place before the programs were able to use S1000D.

  A lot of times the decision is made to go with S1000D when we don't even know whether or not we can use the data that's produced or what we would have to do to it.

  [regarding S-series specifications]…one of the challenges is to figure out how all those specs could be mingled together to do cross-disciplinary storage of ILS data, to see how that data can all be integrated together. That's obviously something that's being explored right now at the international level. … We have so many standards already in the US for a lot of these things. Figuring out how or when or if we migrate to any of those other standards is a bit of a question mark.

  Within the Army, there's absolutely no interest in talking about training being standardized and using S1000D to author training and store training or anything like that. In fact, there's just very little effort going on for them to integrate training with any spec or standard in a meaningful way. … So there's this big hole for what goes on with training and the integration of training and tech publications and S1000D, just because there's not the right organizations to respond to it. … as much as it may seem like an OSD ATL effort, I think if you really look into it, it's not including most of the services in any meaningful way.

- The cost in staffing, training, and tool support can be an issue in moving to the S1000D:

  [There is] definitely a ramp-up cost to support the conversion or the transition over to an S1000D implementation. [There is a] learning curve, and we lack of project business rules. There's probably a lack of data module coding strategy… but the big one is the learning curve and the business process piece.

  …like all standards, you need to make an investment up front to move to that standard…

It does require an investment in personnel, training, and infrastructure, because it's a very advanced information process and it's not until later on down the line you start to realize those benefits. Like all content reuse standards, the payoff comes downstream.

There needs to be infrastructure in place to be successful, and that is IT infrastructure, software tools, and personnel and training… that's probably the biggest challenge facing an organization that is looking at adopting S1000D.

There is definitely a learning curve with S1000D. It's a very big document, it's a process, and it's a standard of handling tech data that's different than what programs are used to doing.

…if you've ever looked at the specification, it's about 3,000 pages long. 3,000 pages long puts a lot of people off. They don't want to deal with that. They think this thing is way too hard, who would want to go there. But in reality, if you build tech manuals for a living, it's really a blessing because the answer is in there. Everything has been thought through. And if the answer is not there, then the way to ask the question is there. [other standards] … a lot of times the tagging structures are there, but they're not clearly defined. So you really don't have consistency, you don't have interpretation being the same. So that's why I really like S1000D … it was a lot of information, but I did definitely find clearly defined structure.

…the downside is there's a lot of up-front work in terms of developing the business rules…

…that's where we struggled internally quite a bit, was as we established these business rules and made the interpretation of what the spec was telling us … what does this mean and what's its applicability in these particular cases? But once we got there, then the actual effort required to begin to produce data and get product became all that much more efficient for us.

The objection [to adoption] I hear most often is the overhead, this whole need to fill out all of this information about the information, about data.

- Some interviewees expressed concern about the rapid change in the standard over the past several years:

The specification has been changing at a very rapid rate in the last few years…the scope is expanding too fast to keep up

Multiple versions – the UK is just going to switch up to 2.3

…it's no sooner you get done with determining what your higher-level business rules are for one issue, then the next issue comes out and you've got to go back in and revisit…figure out where all the decision points are. You've got that with any spec, it's just we've made it a more formalized process with S1000D.

S1000D has been written so as to be appropriate for the military, and up until about issue 2.2 there was no interest in commercial aviation. With issue 3.0 we included a lot of stuff for the commercial environment, stuff that I think the military is better off without. But it was all added as optional components. So you don't have to buy into those optional components, but they are available. And so I think that this whole

business then of going through the specification and deciding which components of it are going to be most suited, provides some difficulty.

- One interviewee indicated success in working with S1000D inside his/her own organization, but sees challenges ahead in working across programs and organizations:

  We've selected a tool set, we've developed business rules, and we have style sheets or schemas that the program is using. Where you start -- or where I anticipate having some difficulties or possibly some issues is when we start interfacing with other programs or other communities.

- Some interviewees see limitations in the standard (at least, with respect to the version they are currently using) or employment of the standard:

  From a program perspective, I could envision reducing my costs if I'm developing products for training and for IETMs at the same time or very closely in tandem. The specification doesn't allow me to do that today.

  …the drawback today is that the way the spec is written, it doesn't do everything it's purported to be.

  Individual interpretations of the standard lead to confusion sometimes, and inaccurate data.

  The biggest issue we have, [is that] you can't really print a full-out manual with S1000D… it's not impossible to do, but it's harder to do.

  …the business rules, and then the printed output is a challenge… The other challenge is the electronic display of large wiring diagrams.

  [S1000D is an] International specification, so you may not necessarily get what you ask for and either have to rework stuff or you have to conform to the spec…

  Some of the up-front work demanded by the use of S1000D is the establishment of business rules. Several interviewees described challenges in this regard (although, sometimes leading to positive outcomes in the end):

  Their design decisions… aren't really conducive to understanding. There are very short, nondescriptive element names. You basically need their 2,000-page spec to understand what the XML is supposed to be representing, whereas with some vocabularies it's very obvious what the XML is representing. [coming from a more descriptive XML] …you are losing some of the semantics' robustness. When people, even S1000D proponents, did an evaluation of our schema, they decided it was not a business case for us to move to S1000D. Some even said it would be a step backwards because of the robustness of our own vocabulary and the tools around it. S1000D is using very generic and sometimes very cryptic names for their elements. Some of their naming or some of the new elements [in Issue 4.0] are certainly more descriptive than in version 3. There's a significant loss in meaning when you go from our vocabulary to S1000D.

  Some of the element names, just very short abbreviations, looks like they came from table headers from 20 years ago; they really are not following ISO 11179, for example,

which is what most best practices use for naming data items. … They don't do that. So it makes it a lot more difficult to try to understand the XML when looking at it. … a result of having the separate schemas, sometimes they have the same element name in two different schemas, but their content is different. So that's something else that makes a learning curve a lot more difficult. That makes the translator more complicated, because you can't use the same process for one type of document that you can for the other, because there's inconsistency in their definitions.

3. Should S1000D be a DoD Requirement?

- There was wide diversity in responses to this fundamental question. While generally positive about potential benefits of S1000D (see above), many interviewees were cautious in their response to this question, expressing concern about the notion of a mandated standard that would be applied across the board, especially to legacy systems, without concern for business case or cost:

…such a requirement would make sense for all new systems…by mandating or requiring that with the new systems, what the DoD is doing is they're setting themselves up for success in the future.

…why not start today and why not start with S1000D

…at this point, probably not… You could mandate it for new system. I think that would be more of a logical step as far as mandating anything. Mandating for legacy systems is going to be a big price tag that they're not going to be able to pay for.

After a while, you're going to see more and more programs using it, and at that time, I think it would be very sensible to mandate something like this.

The mandate – the mandate is harsh. Guidance, yes, you should look into it and see if it makes sense.

Enthusiastic "yes."

I have a problem with "required," because there's always that legacy issue. If you're building something new, you're always going to go back and you're going to be using some existing information, some existing equipment. The Navy has the same electronic warfare system on all its airplanes, or the IFF…are you going to require that vendor to change the way they're doing business just because you want to put them in S1000D format? …there's policy that needs to be written, there's guidelines that need to be in there, but to mandate everything is overkill.

If I were doing it today, from an OSD perspective, I'd make it [required] for all new acquisitions regardless of size. …Most programs today are going to have some sort of electronic data system, and if you're doing that, then why not do an IETM based on S1000D?

I would almost hate to say required because there is a cost involved, and you are taking some of the decisions away from the Program Manager. So who knows what the constraints are going to be within that project? I think that there has to be a lot of qualifiers on that statement.

We have been working with it. We have a production department set up to do it. … From a general perspective, from a larger perspective, I think that it would be beneficial for the DOD to have one schema … to have a common schema that is used for all of their technical data.

I think S1000D is only applicable to fairly complex, large, high-value end items.

Yes, for standardization and more priority for funding to go forward with the S1000D.

- Some interviewees believe S1000D is already an ad hoc standard and will continue to grow in application across DoD, even without it being made a requirement:

I would be in favor of it [making S1000D a requirement]. Is it absolutely necessary? No. I think programs are starting to see it. I think the programs are starting to do it on their own because it does make sense.

I have always felt like the market will make or break this thing. So if it's sensible to use S1000D, everybody's going to use it anyway and there's really no purpose in requiring anybody to do it. … by the time you try to get into all the nitnoid details of what's really required in a mandate, you may as well be letting the programs decide themselves. It's either going to be sensible for them or it's not, and ultimately what it boils down to is that a program is going to do what they want to do anyway, because they're in a separate funding stream from anything anyone has any control over. There's not so many new [DoD] programs, and I think S1000D is already out there and everyone's already – the OEMs are putting in the support for S1000D because it's sensible for them, and when they go to bid on a new weapons system, they're just going to bid S1000D because [they] want to use their existing tools .. I just think it's going to work itself out as it should in the free market.

{S1000D] is going to be the answer, when they're trying to figure out which spec to use… it will be obvious when they get there. And the more tools there are, the more programs will be using it, the more resources that learn it and are comfortable with it, the more international tools that are built, the more cool tools that are built to support specific business processes by the services. All of that is just going to make people move to S1000D.

Regardless of whether or not OSD has made {S1000D] a mandate, it looks to us like it makes real sense to use this standard. Programs are going to go there anyway, only because either there isn't anything better. … it makes it better or easier for programs to just have someone else make some of these kinds of decisions for them, so they can start focusing more on specifics.

- Interviewees also provided their opinions about waiting to make S1000D a requirement in order to focus first on establishing an enterprise-wide approach to the management of technical data:

We don't want to wait. This is something that should occur simultaneously, so that the enterprise-wide approach can evolve using best practices from those programs with a

head start, while launching the S1000D requirement to be phased in using logical steps.

There is great benefit to be realized by coming up with an enterprise architecture…. [before S1000D being mandated?] No. …it's a piece of it, and if you do it that way, in pieces where you can manage it, it makes it much easier than trying to do it all at once. You've got to mandate it with the enterprise architecture plan in mind.

The data requirements are built in CDRLS, and they're kind of antiquated. …the real challenge is that this is really a text document and publication standard which if implemented would yield some operational efficiencies within the publications organizations, but it's thought that it probably would do that at the expense of the maintenance community that they are servicing, and for the reasons that were noted in the document [previous LMI study] …the purpose of it is to reuse content. …they want to create an environment where they are not just reproducing chapters in books, but reproducing content and sentences … and they want to do this in a way that allows them to always maintain relevance of the information that is in the document to the specific activity that's being performed

We need data standards that say this is what the data is and this is exactly what it needs and how you interpret it. So if we can look at S1000D as being part of that enterprise of data standards, not enterprise of applications, then that's what I'm for… If we can define how the data goes together in the enterprise for the whole life cycle, then we win.

There should be a collaboration [between DoD and industry] … but I'm not sure that that would be the determining factor on whether to require the use of S1000D or not.

- Some interviewees did not believe S1000D should be required:

I would recommend a DOD endorsement of the spec, not necessarily a mandate…. and then each service and each organization would have to decide for themselves if they want to endorse it across their organizations or whether they just want to just allow it as an option.

Before I would recommend it becoming a requirement, I would again make sure it does everything that we think it is going to do.

Requirement? No. Definitely, without a doubt, no. [S1000D] is not something that I think is yet to the point where somebody should consider it becoming a requirement. It would indeed be a step back for me if I was required to use S1000D. There'd be a lot of costs of investing in new tools, learning curve, training – and all for no added functionality, and actually some loss in the meaningfulness of the vocabulary. It would be a step backwards as far as functionality, as far as potential use of the data, as far as automated evaluation of the data. It would all be for naught -- all the effort we've put into creating a schema that follows all of the Department of the Navy naming and design rules and ISO standards. [If S1000D were required,] we would be moving to a vocabulary that didn't do all those things.

Explain in great detail what is the value proposition of S1000D.Where are the economies associated with this standard, and what needs to be suboptimized in order to achieve those efficiencies? … My suspicion is that there is suboptimization in the development of the maintenance systems associated with the standard. …articulate

the value of S1000D from the perspective of the end-user [edge maintainer in the case of maintenance]. There may be better ways to achieve that objective if you make the assumption that there are no economies associated with S1000D. … If there is [negative] impact to the semantic relevance of the actual maintenance activities being performed at the edge because you have done this [adopted S1000D], then where is your advantage? … you might as well go with a best in class commercial tool. Who manages the common object repository? …the TechDoc and publications community? If so, then how do you maintain it in terms of work flow and ensuring change management and control, etc?

If you have a business case for moving to it, if there are advantages in your program for moving to S1000D, then certainly, go for it. But, include some of the caveats in the NAVSEA guides-- "Well, you can use it; but if you do, make sure that these things hold, that you have the necessary expertise, that you assume any added risks or costs." Make sure you have the necessary expertise. Otherwise, it's going to be increased cost in getting the expertise. And you have to assume also the added risks: the risk being maybe a delay in delivery while people are getting up to speed with the specification, and certainly increased upfront costs. But for someone who already has a working vocabulary, an XML vocabulary that is generally considered to be a quality vocabulary and follows all the best practices and policies, procedures and ISO specifications,[Yes, go ahead and use it]. But, I don't think it would be in the best interests of the DOD to force them to move to S1000D. Generally speaking, I think that if the policy were to produce S1000D compliance from whatever vocabulary you are developing, … I would certainly have less a problem than an outright mandate for people to develop in S1000D.

[S1000D] would still have to evolve to a point where everyone is being cognizant of best practices, again, such as ISO naming conventions, more meaningful element names, being able to capture some semantics better than they currently are, as well as consistencies between their schemas.

Everything that we do, whether it is in OSD or in industry, should be backed up by a solid business case. I think there is a pretty solid business case to use S1000D for new programs, and for those programs going through midlife update or modernization. But, make that decision on a business case basis, rather than mandate it. The problem with a mandate is that people follow it blindly, and it might not necessarily be the most sensible or cost effective decision to simply blindly follow a mandate.

4. DoD Actions Needed to Promote Successful Implementation of S1000D

- Simply making S1000D a requirement will not necessarily result in successful implementation. The success of using S1000D is likely to hinge on the vision, commitment, leadership, and actions by DoD management. Interviewees identified a number of actions that DoD ought to perform so that S1000D can be implemented successfully:

I would like to see some kind of a policy statement from DOD. If it's not a requirement to use S1000D for this category of items, maybe it is something along the lines of

NAVAIR's [guidelines]. With that, you could get some of these other DOD entities to develop more standards for the specific tools, and we could share licenses, you would get more bang for your buck. And it would support the decision to require use of the specification. If it became much more cost effective and you saw all these other benefits, [it becomes] a no- brainer.

Funding is needed to transition [to S1000D].

More support from OSD for the use [of S1000D] would be as appropriate, but even more appropriate would be more involvement [of DoD] on the international side with AIA, as opposed to just a mandate to us to use it.

[DoD should] institute some kind of training course, maybe through the Defense Acquisition University. If a standard is going to be required and its use his going to be far-reaching within the DOD and have implications for the next 20 or 30 years, I believe that good training on the use of that standard [is essential]. Likewise, for things like the business case of when to convert, and also the associated "S" series standards, which may have value to a project, all of those topics should be trained, perhaps through the DAU. [This training should] be made available to the prime contractors and OEMs and members of the different services that are going to be involved in acquisition programs.

…you have got to have a comprehensive methodology for managing the asset class as you're taking it to fight. And so the government has a certain amount of obligation to own and maintain and invest in that.

You need to have a more holistic approach to developing these sophisticated maintenance management tools, and it involves a lot of different parties that need to be brought to the table as part of a common enterprise.

- The DoD policy would need to clearly distinguish between a requirement for new systems and its application to legacy systems:

If you're doing something new, go ahead and use S1000D. If you are a legacy program that has a legacy system in place, consider a migration path, but there's no reason for you to stop the presses and switch courses midstream

…there should be a business case analysis for any project that is less than five years [duration]

I think that the suite of "S" standards should be looked at for anything that has major modifications to it in the future, or any new weapons platforms, which probably won't be many for the next few years.

But the business case tells me if I've got 5 years left on a weapons platform that I'm going to migrate all my data, there's no return on investment. That's why the business case should be performed, to show if there is a return on investment or not.

…if it [legacy system] was going to be phased out in 5 years, there's probably no benefit in converting that data to S1000D. If the system had a service life of, say, 20 more years, then there's probably a good case for converting that data to S1000D.

- Interviewees also made an appeal for senior DoD to take a leadership role in working groups and governing bodies responsible for maintenance and evolution of the S1000D standard:

  Most of the services, independent of a DOD mandate, are developing their own acquisition policy and guidelines for S1000D information now, and they're collaborating … at a multi-service level. What we don't have yet is top-down coordination at the DoD level. I think that's something that we need, and I think it's something that would be extremely welcome from the Joint Services.

  Currently, within the S1000D organization there is a group called USSMG, United States Specification Management Group, which is part of the big overarching leadership group for S1000D. Technically, OSD has a spot as the co-chair of that group. That spot has been filled on an ad hoc basis by a rotating -- an Air Force rep, an Army rep, a Navy rep, over the last 8 years. But we really don't have the authority to say, yeah, this is what OSD or DOD says. And if they could get involved in that group and do those things, from our point, that would help.

  What the industry has struggled with, is that there are committees that both have industry representation and leadership as well as slots for Department of Defense and OSD leadership within those organizations, working groups, etc. for the S1000 work. And those DoD or OSD positions have basically been held temporarily by individuals, but no formal appointment has been assigned for those services or OSD. …we have no concurrence from the Government in those positions, whether they represent the entire DoD, OSD, or they represent their service.

  We have members from all the services that are either working or they have subcontractors working for the services, actually writing out the change proposals, sitting in on committees, traveling to some of the committee meetings to incorporate the service's requirements into the specification. … The problem that we've had in industry is that, because of changes in the administrations and changes in leadership at OSD, once it looks like we get our foot in the door and get a name, that person moves on.

  [DoD/industry collaboration on an enterprise-wide approach]…I believe that this is happening right now… the Joint Services IETM working group … is trying to standardize wherever possible on technical data requirements from a multi-service perspective. There's no reason why OSD or DoD couldn't or shouldn't have a seat at that table and perhaps be the authority that the Joint Services IETM working group reports to.

  When it comes to a battle on changes [to S1000D], if we had somebody [at the DoD level], I think it would resonate a little more with the international community that we're a little more serious about it.

  …it would be great if the DOD increased its presence [in the international S1000D organization]…to be able to be in that community, to learn from it, to gain insight would be valuable.

  The immediate primary need is that DOD needs to have somebody involved at the North American level [USSMG] on the committee to work alongside industry at that

level and establish some real basis for DOD business rules… There's never really been anybody appointed at the DOD, a representative overall to the international S1000D community. … the largest problem right now is the coordination across all these DOD organizations as far as business rules, and there's a lot of disparity in people's beliefs as to what level of control should be exercised from the top-down. … the coordination through the groups moving vertically from the top down needs to be there, with the appropriate levels of control

At the enterprise level, you ought to be able to share your meta data so I can know that you're writing this kind of content based on the information code, and I can look and see it's going to be released on this date, it's going to be this hardware, the other information, and plan whether I'm going to reuse that content. And once I can find it, then what's the mechanism to get a copy of it or point to it or borrow it? How do I do that? Take it in steps; have the meta data library initially and then find a way to develop collaboratively.

- Another key activity for top-level coordination is in the establishment of organization-wide business rules:

If you had an OSD set of S1000 business rules, it would really work. At the top you would have the OSD set of business rules, and then that gets handed down to the services. And the services may have some unique requirements for their platforms, so they modify those business rules, and then they pass it down to the program. And the program may have a modification that they may be tightening the specification requirements you have, not loosening them up.

Mandating [the use of S1000D] is okay if you've got your ducks in a row… if you have a set of government business rules. The higher level business rules really put the structure around what the government's looking for, and then the services can tighten those up, not loosen them up, tighten them up, for the programs and for their services.

Typically, I would expect to see DoD-level rules, service- level rules, then project- level rules.

Step in and take ownership [of joint service business rules], because there's actually no way for us to publish these business rules. We have no resources to do that for joint services. So currently all the services are publishing joint service rules, with a little marker in their own service business rules.

Industry and government need to consult. And unfortunately, I think the current branches of the DOD need to consult and see if they can't bring these things nearer to the same. S1000D has quite a bit of flexibility within it, and in some cases the flexibility that is allowable is being made differently between the services; and that is going to lead to not achieving as much efficiency as could be achieved.

I think that the DOD would be best served if there were a Department of Defense set of business rules that made that specification. Look at and establish that DOD set of business rules that all of the services would be required to adhere to.

Will we be doomed to failure without DOD arbitration across services on [S1000D] business rules? No. I believe that there still will be substantial benefit because the organization of the information will be consistent. It's not [consistent] today. And

that consistency has, I think, a considerable value in and of itself. I think the maintenance of the information will be lower for military kinds of equipment because the data is in smaller chunks.

The only thing we need is the top level business rules for DOD to be basically sanctified, because a lot of things are being handled at the lower levels because there is no policy at the top level.

[The business rules] are the decision points. There are business rules at certain levels that we know are joint service business rules. They just need to be officially [acknowledged] as the rules of DOD. … It would be a tiered environment. There are hundreds of decision points in S1000D, but there are some that should be common to all of the services, and then you break it down to service-level business rules, then within the Navy you have the NAVSEA business rules, then you would have Panama City business rules, and then you would have the last few of them are the project rules.

V. QUESTIONNAIRE SURVEY RESULTS

A. SAMPLE SIZE AND SOURCE

Responses to the survey were received from 180 individuals during the three-week period that it was available at the designated web site. The first question asked for a self-rating of knowledge of S1000D. The response options were "Strong," "Marginal," and "Weak." Only 8 of the 180 indicated that they had "Weak" knowledge of S1000D. Those 8 were re-routed to the end of the survey and thanked for their participation, leaving 172 respondents who provided data on the survey. Because of the nature of recruiting participants for web-based surveys, it is not possible to calculate a return rate. Nevertheless, the authors felt that a sample size of 172 was excellent and certainly sufficient to support any statistical testing, as needed. Figure 3 shows the distribution of representatives whose professional experience was associated with the various military services, either as a Government representative or industry.

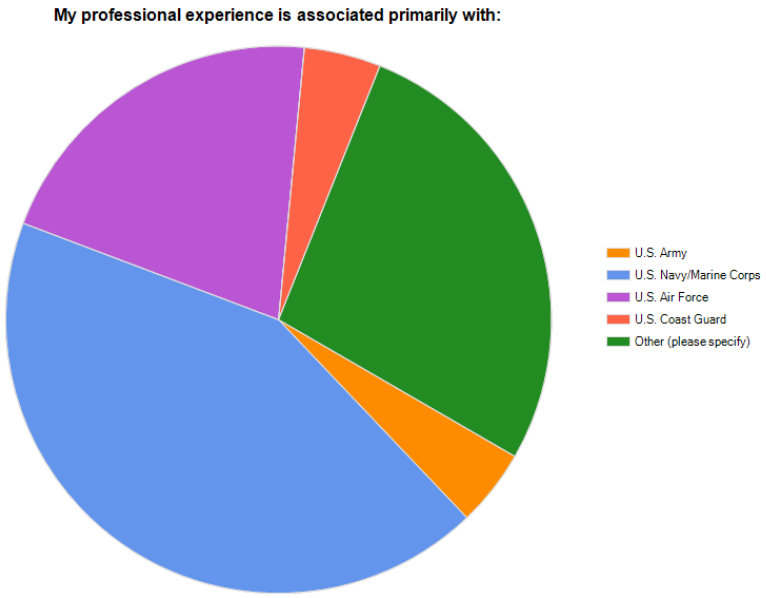

Figure 3. Distribution of questionnaire participants by service

The Navy/Marine Corps was the largest group, representing 43% of the total, followed by "Other" at 27%, the Air Force with 21%, and the Army and Coast Guard with approximately 5% each. A wide range of affiliations was provided in the "other/specify" category, including some

with multiple or "all" service affiliation, general DoD contractor, and some non-US affiliation including UK Ministry of Defence, German Air Force, and Australia.

B. RESULTS

Most of the questions in the survey were framed as a five-choice rating: "Strongly Agree," "Agree," "Disagree," "Strongly Disagree," and "Don't Know/ No Opinion." For purposes of data analysis, we combined the Strongly Agree and Agree into one category.

1. Benefits

The following question was asked regarding expected benefits: "From your experience, which of the following benefits do you believe are likely to be realized with S1000D?" In response, 84% of the respondents agreed that there would be "Efficiencies from 'Reuse" of Data." Furthermore, 74% agreed that there would be benefits from S1000D in the area of "Links between logistics/technical data and training (SCORM)." In short, there was very strong agreement among the 172 respondents regarding these two expected benefits from the use of S1000D.

The open-ended question at the end of the "Benefits" section requested the respondents to specify other expected benefits from the use of S1000D. A total of 71 respondents offered comments regarding potential benefits. These comments are reproduced in Appendix D. In general, the potential benefit most commonly mentioned was standardization across systems and military services. Potential cost savings also was mentioned frequently as an expected benefit from the use of S1000D.

2. Key Question: Should S1000D be Required?

In response to this key question, Table 1 shows the percentages of respondents who agreed that S1000D should be required in the three categories indicated.

DoD Should Require S1000D for:	*Agree or Strongly Agree*
ALL DoD systems?	40.6%
New Acquisitions but not legacy?	62.7%
Large (CAT I/II) but not small Acquisitions?	51.3%

Table 1. Percentage who Agree with three levels of Requirement: All Systems; New versus Legacy; Large versus Small Acquisition.

Despite the long list of potential benefits mentioned above and listed in Appendix D, less than a majority (40.6%) felt that S1000D should be mandated for all DoD systems. On the other hand, a substantial majority, (62.7%) agreed that S1000D should be required for all new acquisitions. Two interpretations can be made of these data: (1) the expectation of benefits from the use of S1000D does not necessarily justify making it a requirement for all systems; and (2) there is strong support for requiring S1000D for new acquisitions, but not for legacy systems. This latter point also was discussed in the interviews, discussed previously, where several participants suggested that legacy systems should not be transitioned to S1000D unless they were expected to have a long life cycle remaining, i.e., the "business case" must support the decision to apply S1000D to a legacy system.

Follow-up questions were asked in the questionnaire regarding the core issue of whether S1000D should be required by DoD. The results of those questions are shown in Table 2.

In my opinion, DoD should:	*Agree or Strongly Agree*
Allow Program Managers to decide whether to require S1000D	44.1%
Allow each Service to establish policy on whether to require S1000D	43.4%
Promote and encourage the use of S100D but NOT require it	47.4%
Require S1000D but allow an "opt out" if the business case is not supported for specific program or system	75.6%

Table 2. Percentage of respondents agreeing with statements of potential DoD policies on S1000D

None of the first three options garnered a majority in agreement. But, whatever the lingering doubts about requiring S1000D, they seemed to be substantially reduced by allowing the possibility of an "opt out" when the business case is not supported.

In the end, we can assume that all parties share the same goals of increased efficiency and accuracy in developing technical data and publications. This set of questions supports that notion, because it avoids the threat of mandating the use of S1000D in cases where, for any reason, it would not be cost effective. The unstated assumption underlying this issue, however,

is that all parties can agree on a process for performing an analysis of the business case and agree on the criteria for when it has been "made" or "not made."

3. Potential Drawbacks

In the search for a balanced approach to understanding the benefits and drawbacks of S1000D, a set of questions was developed to elicit opinions about potential downsides. Table 3 provides the percentage of respondents who agreed with each item.

Please rate your agreement with the following items:	*Agree or Strongly Agree*
Software tools for implementing S1000D can create incompatibilities	60.0%
S1000D is changing rapidly; let's wait until it becomes more stable	28.4%
The DoD should avoid using a Standard that is controlled by an International body	20.3%
DoD has not sufficiently investigated the adoption of the entire "S-series" of Standards	37.7%

Table 3. Percentage of respondents in agreement with the listed risks or downsides

The survey participants exceeded a majority in agreement on only the first issue – incompatibilities can result from S1000D software tools. This was a relatively strong response (60.0%) and warrants further analysis. Perhaps DoD should consider ways to promote compatibility among software tools supporting S1000D. Incompatibilities caused by the vendor-specific tools seem to be at odds with the core intent of standardization to promote reuse and interoperability.

4. Contributing Activities by DoD

In a number of the interviews, participants stated that active participation by DoD will be crucial to achieve the intended benefits from the use of S1000D. Simply requiring its use will not be enough. This set of survey questions attempted to identify potential DoD activities that would increase the likelihood that the S1000D requirement will have the intended benefits. Table 4 provides a summary of the results of these questions.

Some people feel that DoD should participate more vigorously in activities related to the management of technical data. Please indicate your agreement with the following potential DoD/ OSD activities	Agree or Strongly Agree
Promote an enterprise-wide solution to managing technical data	84.5%
Advertise and promote the use of S1000D	81.9%
Participate actively in S1000D international policy boards	88.4%
Provide funding for training and transition to S1000D usage	87.2%
Promote the consistency and compatibility of S1000D Business Rules (BREX) across services	89.6%

Table 4. Percentage of respondents who agree with various roles and activities by DoD

This set of questions may be the most important in the survey. A very strong majority (>80%) of the respondents agreed with all five items in this category. The two highest rates of agreement (88% and 90%) were (1) the DoD should participate actively in policy boards governing S1000D, and (2) the DoD should promote the consistency and compatibility of S1000D business rules across services. Collectively, this set of questions can be taken as a plea for help or, perhaps, a call for leadership. Simply requiring the use of S1000D is not enough. DoD is being requested to take an active leadership role in developing an enterprise-wide solution, advertising and promoting that solution, providing funds for training and transition, taking an active role in the international governance of the S1000D standard, and ensuring that implementation of S1000D via "Business Rules" is consistent across services.

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VI. RECOMMENDATIONS

Based on the information and opinions gathered from nearly 200 participants in the study, we conclude that S1000D should be a required standard for technical publications across the DoD. This action should be taken in conjunction with a program to implement, transition, and promote its success. This program would include a set of critical provisions for DoD to: (1) manage/govern the use of the standard; (2) promote the use of the standard; (3) support adoption and evolution of the standard; and (4) establish and enforce use of the standard.

Specifically, we recommend the following:

1. Require the use of S1000D for new acquisitions unless the business case clearly shows otherwise (e.g., possibly in the case of a very small, one-off item).
2. Require the use of S1000D for legacy systems only when a business case (cost-benefit analysis) supports its use for a specific program or system.
3. Establish a DoD Technical Information Governance Office to provide top-level, enterprise-wide leadership and guidance for technical publications and technical data across acquisition, logistics, maintenance, training, and other relevant endeavors. This enterprise-level view should include evaluation of the full S-Series family of specifications with a vision toward fully integrated technical data across the system lifecycle.
4. Actively participate in the S1000D governing organizations to act as a proponent for the technical and business interests of DoD agencies, organizations, and component services. Applicable S1000D organizations include the S1000D Defense Working Group, the S1000D Steering Committee, the S1000D Council, and the Joint Service IETM Technology Working Group.
5. Develop a plan for transition and introduction of S1000D across the DoD including responsibility for training acquisition personnel and program managers in the S1000D standard.
6. Develop Department-level business rules and coordinate creation of layered business rules across the Services and DoD agencies and organizations.

7. Monitor, evaluate, and establish requirements, as necessary, to ensure compatibility of commercial and open source tools for production of S1000D-compliant publications and courses among the Services, organizations, programs, and systems using the standard.
8. Make the financial commitment to support the transition to the use of the S1000D standard throughout the DoD. Supportive efforts should include assisting in cost benefit analyses, training and education of acquisition and management personnel, and guidance for legacy conversion (in cases when such conversion is deemed beneficial).
9. Require S1000D format for all interchange, reuse, and storage of technical publication data and technical training content, while allowing and encouraging innovation in different approaches (formats, tools, etc.) at the authoring level.

REFERENCES

AIA (April 25, 2008). A Recommendation to the Department of Defense to Adopt the S1000D – the International Specification for Technical Documentation. Unpublished work. The Aerospace Industries Association, Inc.

ATA/ASD/AIA (2009). International specification for technical publications utilizing a common source database. S1000D. Issue 4.0.1 2009-05-12 Errata for Issue 4.0. Air Transport Association, AeroSpace and Defence Industries Association of Europe, and Aerospace Industries Association.

Borek, K.J. and Wilson, R.F. (2008). An Analysis of S1000D and Its Adoption by the Department of Defense. LMI Report LG802T2. McLean, VA: LMI.

Levine, D., Horowitz, S., Gafford, W., and Fletcher, D. (2010). The "Bridge" Project Cost-Benefit Analysis 1: Reducing Total Ownership Costs Increasing Fleet Readiness by Integrating Learning Content and Technical Information Development Processes. (Draft) June.

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APPENDIX A - STRUCTURED INTERVIEW

S1000D Study Data Collection Instructions and Scripts

[*Instructions to researcher: The following is a script for use in a recruitment e-mail or for recruitment over the phone. It is followed by a script for introducing the study questions and obtaining the subject's consent to participate, notification that the interview is being recorded, and subject's decision to allow or disallow attribution of comments.*]

[*Researcher and study introduction*]

Hello _____. My name is _____. I am on the research faculty of the Naval Postgraduate School in Monterey, California. We have been tasked by the Office of the Under Secretary of Defense, to conduct a study investigating the potential benefits and challenges of promoting the S1000D International Specification for Technical Publications as a required standard for Department of Defense acquisitions. We are seeking expert perspectives from government and industry and would like to invite you to contribute to the study by participating in a [structured interview / survey]. It will take approximately 50 minutes to complete the interview.

Do you have any questions? [*deal with any questions the subject may have*]

[*Inform the subject of the procedures, subject's rights, and obtain consent.*]

Did you receive the consent form that we sent you and have you had a chance to review that form?

We want to remind you that your participation in this study is strictly voluntary. You can change your mind at any time and withdraw from the study. There are no negative consequences if you choose not to participate or to withdraw.

We will record your name, organization, e-mail address, and phone number for our records. All personal identifiable information will be protected and only used in study publications by your approval. You may choose to allow any information you provide us to be attributable to you by name and organization, or you may choose to disallow attribution. You may also change your decision at any point during the interview.

Do you have any questions at this time? [*deal with any questions the subject may have*]

At this time, we will begin recording this interview for the record. We have hired the services of a local company to create a transcript of this interview. The transcript will be used solely for data collection and analysis purposes.

For the record, your name is _____.

You work for _____. [*organization/company*]

You are _____. [*title/rank*]

If you consent to be identified by name in this study, any reference to, or quotes used from the transcript will be published in the final research finding only after your review and approval. If you do not agree, then you will be identified broadly by position or title (for example, "V.P. Logistics"). Again, you may change your decision at any time during the interview on individual questions and answers.

Do you consent to have your statements be identified by name and organization?

Thank you.

Do you have any questions before we proceed? [*deal with any questions the subject may have*]

[*Research Questions*]

Does your program or organization use S1000D? [*if yes, proceed with the questions below; if no, jump to the next set of questions*]

If yes, you are using S1000D:

1. What benefits are you experiencing from using S1000D?
    a. Are you experiencing benefits in reuse from using S1000D?
    b. Are you experiencing benefits in system interoperability from using S1000D?
    c. Are you experiencing benefits in information sharing from using S1000D?
    d. Are you experiencing benefits in lifecycle management from using S1000D?
    e. Are you experiencing benefits in system acquisition from using S1000D?
    f. What expectations are not being met from the use of S1000D?
        i. Why are they not being met?

2. Are you collecting any cost or performance data in the use of S1000D?
    a. What do the numbers indicate?
3. Have you used S1000D to convert technical data on legacy systems?
    a. In your experience, what was the cost to convert legacy technical manuals to S1000D?
    b. How long did it take to convert the data to S1000D?
    c. Were all legacy materials able to be converted or were there materials that could not be converted to S1000D?
4. For what types of technical data are you using S1000D?
5. What components of the S1000D specification are you using?
6. Do you use S1000D to integrate technical and training data?
    a. [*If "yes"*] How was that done?
    b. [*If "no"*] Given what you know about benefits of S1000D for technical data, could those same benefits be realized for technical training?
7. What challenges have you encountered in using S1000D?
    a. How have you overcome those challenges?
    b. Do you have any specific objections to using S1000D based on the challenges you have encountered?
8. Would you favor a DoD requirement to use S1000D?
    a. [*If "yes"*] Why would you favor S1000D becoming a DoD requirement?
        i. What does DoD need to do to help implement a requirement to use S1000D?
        ii. What would your program or organization need to do to comply with a S1000D requirement?
        iii. Do you think a S1000D requirement should apply to all DoD technical information procurement or is there a class or size of procurement to which the requirement should not apply?
        iv. Do you think DoD and industry should collaborate to develop an enterprise-wide approach to technical information before making S1000D a requirement?

1. If so, what would be some key components of that approach?

v. Do you believe S1000D should be adopted for uses beyond the structuring of traditional technical publications?

1. If so, what kinds of uses?

b. [*If "no"*] Why are you not in favor of S1000D becoming a DoD requirement?

i. Would you prefer the status quo or for DoD to make some other standard a requirement?

1. If some other standard, which one?

ii. What would be needed to enable you to support S1000D becoming a DoD requirement?

If no, you are not using S1000D:

1. Did you or your organization consider using it on any programs?
   a. If so, why did you or your organization decide against it?
   b. Did you choose an alternative specification?
2. Do you plan to use S1000D in the future? Why or why not?
   a. If planning to use S1000D in the future, do you have an estimate of cost and time to convert or "re-tool" to employ S1000D?
3. Is your technical data strategy based on DoD policy or internal corporate procedures, processes, tools, and standards?
4. Would you favor the government establishing a requirement to use S1000D?
   a. [*If "yes"*] Why do you favor S1000D becoming a DoD standard?
   b. [*If "no"*] What are your objections to having S1000D become a DoD requirement?
      i. What would need to change to enable you to support S1000D becoming a DoD requirement?

ii. Do you believe the Government should determine a structure for developing a comprehensive enterprise-wide approach to product data before making S1000D a requirement?
    1. If yes, what would be the key components of that approach that would enable you to support S1000D becoming a DoD requirement for technical publications?

[***Closing Question for all participants***]

Is there anything else you would like to add regarding this study to determine if S1000D should become a DoD requirement for technical publications?

[***Conclusion of the interview***]

That concludes our interview. Thank you for your participation. We have a short set of follow-up questions we would like to send you. These will help us perform some quantitative analysis of aspects of this study. It will only take about 5 minutes to respond to that set of questions. May we send you the follow-up questions?

Thank you again for your time and the information you provided. If you want additional information from us about this project at any time, feel free to contact [*researcher name, phone, e-mail*].

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APPENDIX B - QUESTIONNAIRE SURVEY

S1000D Survey

Background

S1000D is an international standard for technical publications. It was developed in Europe by the aerospace industry and has grown and spread to encompass all types of transportation systems and many military systems. DoD has "adopted" S1000D by stating that it is approved for use in DoD acquisition programs and systems, but is not required. S1000D is based on XML and establishes a standard for metadata to index all data on system components and supports technical documentation and Interactive Electronic Technical Manuals (IETM). DoD/OUSD/AT&L is interested in evaluating the question of whether S1000D should be required. The present study was designed to gather information and opinions of experienced users relevant to that decision.

Directions

Please do NOT put your name on this survey. Responses to this survey will remain anonymous.

My level of knowledge of S1000D is (Select one):

1	***2***	***3***
I----------I	I----------I	I
Weak	Marginal	Strong

If you selected #1 above, thank you for your time, we will not be able to use your data. Please submit your Questionnaire now.

Each Question below is constructed as a 5-point scale, anchored with "Strongly Agree" and "Strongly Disagree"

1	***2***	***3***	***4***	***5***
I----------	**I----------**	**I----------**	**I----------**	**I**
Strongly Agree	**Agree**	**Disagree**	**Strongly Disagree**	**Don't Know/ NoOpinion**

Some people favor a DoD requirement for S1000D in all systems; some think it should be required only for certain categories of acquisition; some only for new systems; etc. This first set of six questions provides you with the opportunity to convey your opinion on these issues.

DoD should require S1000D for:

- ALL DoD acquisitions.
- All NEW DoD acquisitions (but not legacy systems).
- All large (ACAT I/II) acquisitions (but not small ones (ACAT III/IV)

In my opinion, DoD should:

- Allow Program Managers to decide whether of require S1000D
- Allow each Service to establish policy on whether to require S1000D
- Promote and encourage the use of S1000D, but NOT require it
- Require S1000D but allow an "Opt Out" when preliminary analysis of the "Business Case" does not support the use of S1000D for specific programs or systems

Several potential benefits have been suggested as flowing from the use of S1000D. From your experience, which of the following benefits do you believe are likely to be realized?

- Efficiencies from "Reuse" of data
- Links between logistics/technical data and training (SCORM)

Other: Please specify _____

Some people believe that DoD/OSD should participate more vigorously in activities related to the management of technical data, whether or not the use of S1000D is made a requirement. Please indicate your agreement with the following potential DoD/OSD activities

- Promote an enterprise-wide solution to managing technical data
- Advertise and promote the user of S1000D
- Participate actively in S1000D international policy boards
- Provide funding for training and transition to S1000D usage
- Promote the consistency and compatibility of S1000D Business Rules (BREX) across Services

Several potential drawbacks or downsides to the use of S1000D have been mentioned. Please rate your agreement with the following items:

- Software tools for implementing S1000D can create incompatibilities
- S1000D is changing rapidly and has some problems; let's wait until it becomes more stable
- The DoD should avoid using a Standard that is controlled by an International body
- DoD has not sufficiently investigated the adoption of the entire "S-series" of Standards

Please provide any other comments or opinions regarding whether S1000D should become a DoD requirement.

My professional experience is associated primarily with:

____U.S. Army ____U.S. Navy/Marine Corps ____USAF ____USCG
____Other (Please identify)

Please describe the strength of your background and experience in these areas: Note: ACAT = Acquisition Category

- DoD ACAT I/II Acquisition Programs
- DoD ACAT III/IV Acquisition Programs
- Large company experience
- Small (<500 employee) company experience
- NON-DoD Acquisitions and Systems

Thank you for participating in this survey on S1000D

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APPENDIX C - ADDITIONAL EXCERPTS FROM THE STRUCTURED INTERVIEWS

Excerpts from the structured interviews are shown in italics. Minor editing was done to improve readability.

A. BENEFITS EXPERIENCED FROM USING S1000D

1. Reuse

…by creating data modules, we can build the various levels of procedures [for naval technical procedures] from the same source data. So there's a lot of reuse in that respect. … And that reuse, I think, is advantageous for any number of reasons, not the least of which is efficiency, but also consistency in the data, because then you get the same information written the same way time after time, and it's understandable, then, at the user level because they see it the same way every time. The other way that we're getting reuse would also be [to] provide the fleet training, so … you can use that same data again for training. Also, we do foreign military sales, and so then they have their own version. … all of these can be pointing to the same data modules and can be reused to be consistent. That also makes a huge difference … when you're looking for cost impacts on life cycle changes.

[benefit of using S1000D] …it would be the same benefits of using XML in general, which would be reuse and repurposing of the data so that you end up saving some maintenance time, some development time.

…standard way to house the information that we're looking at… can be placed into a database that other people can access and shared among other people in the community that can also use that information… Reuse would be a large benefit, because anyone that's familiar with technical data realizes that there are procedures, and there are items that are repeated, depending on what the user's going to be doing… maintenance becomes easier because of that reuse and because it's not simply copying something to show it in a different procedure. It's actually linking or using the same information so that changes are made in one place and updated in multiple areas.

We have found reuse is readily available within a particular project or type of equipment, but we have not found as much across the board. [because of the diversity in the kinds of systems being documented] So within a commodity, there's a lot of reuse, but when you move outside of a commodity, there's not as much reuse.

In Europe, the implementation of S1000D was begun as a means of ensuring that multiple agencies, multiple countries could work together efficiently. If their machining programs were to take place in Germany, France, Italy, and Spain, then the implementation of S1000D ensured that when they were complete, the technical data had the same look and feel without regard to where it was written.

2. Cost Savings

Particular case of a radio procured by the United Kingdom. It's used on their airships, on aircraft, on their surface vehicles, on their sea-surface vehicles. It's used everywhere in the military. … They bought the S1000D data for this radio in terms of its operation instructions one time, and now they can simply reuse those operating instructions in all of those different vehicles.

…You may not save any money initially, but over the lifecycle [you will]

I can see where the standardization would be beneficial for all of DoD because, as we go forward, we know our budgets are going to get tighter and tighter, and if we're out there using different software and different procedures to do the same job, it's only going to cost DoD more money overall.

…as more programs decide to go down this road and use this information, the reuse capability will pay off in the long run because it's going to cut down on program funding required to develop the IETM.

We have seen a benefit in the training area in that a lot of the training information is the same information that's used in the IETMs

…we're being able to leverage our support contractors, who are also supporting other S1000D-based efforts, … we are then reaping the benefit of both their experience and their expertise and their cost savings because they are able to leverage their overhead costs and pass that savings to us, their customer.

[cost data]… it's too early, but as the project lead I'm encouraged, and I think my customers are pleasantly surprised relative to (a) our initial estimates; (b) our actuals; and (c) what we've accomplished for the amount that we've invested so far.

The government did not pay for the conversion. We paid for it out of our funding, and did so because we could, and in fact did achieve a savings in technical data maintenance cost, and in the amount of time it took to perform maintenance, and in the time that it took us to turn around changes in technical publishing. We could produce changes in technical data much quicker with the S1000D format.

The government is paying a fortune for information and having it maintained multiple times, and these are costs that could be avoided.

We're seeing a reduction in cost as well as an emphasis now more on the technical content of the writing instead of the style and format.

…if you're considering just the beginning of the life cycle, the acquisition phase, you're going to see benefits in terms of shortened authoring times, the immediate update of data throughout all applicable publications that that data module touches. It's a little too early for the most part to say that we see benefits in sustainment and operations and support and all of that, but I can definitely see that that is going to be a benefit.

I would say that, in terms of what people expected to get from contracting for S1000D, tools and data, it surpassed their expectations for their project.

3. XML and Other Benefits

…one of the advantages that I see in S1000D is that it does offer a level of flexibility, so that when there are requirements to tailor based on customer requirements or

technical requirements, it allows for that flexibility while still providing the structure and the road map that you need for the commonality and consistency.

To me, the best thing about S1000D, for joint services and internationally, is that we are all using the same spec. If we're all using the same spec, we can all develop tools that support that same spec, and we can all speak the same language to each other, amongst the services. And for those who have to develop policy, we can reuse policy letters, we can reuse presentations, training, tools, and research. Just about anything that you can think of related to policy now becomes something that we can do joint service or even internationally. … With S1000D, we just look at one spec and one way to make that work with engineering models, and then the services make that work in their business practices.

S1000D … offers us an opportunity for a flexible set of technical data products for our current customers.

So S1000D not only permits content reuse for training deliverables, it borrows content itself from engineering databases that are further back in the product lifecycle process. So it's an integral part of a wider set of specifications that, when you bring them all together, are focused on the threefold support of this system from its inception and design and manufacture through to its in-service and ultimately demilitarization phases. …the use of these complementary standards is now becoming what's considered best practice in the U.S.

S1000D has a way to place each and every piece of technical data under configuration control. And that configuration control ensures that you are always getting the right piece of technical information to make the repair to the components that you have. So that, I think, is a particular value over the lifecycle of equipment, the ability to configure, to have configuration control over the technical components of the technical publications and the ability then to make sure you get a right piece to make the repairs you need to make. I think that will reduce overall the cost of maintaining that equipment over time.

…now everybody will be able to find data arranged in the same style and format; and that, I think, will facilitate working with our NATO and other partners.

The thing that's nice about S1000D is that it's XML. … So if you have a standard Web person that is used to working with markup languages like XML, it's very easy to train them a step further. … For the majority of your production workforce, they just need to be trained on the tool that's going to be used. Then you have a small group that know the S1000 schema in and out and can troubleshoot or plan for those type of things.

The other major advantage I see is for customers on the acquisition side because of the fact that S1000D is XML. It's internationally accepted technical data standard for tech docs. …because of the tools that are available and the expertise, I think it mitigates risk for customers because they have people that know how to use S1000D and know how to use the tools, and they can easily migrate the data.

…the other major advantage is the customization and tailorization that's build into the specification.

…the data-centric nature of the spec makes it easier to find ways to take legacy data and convert it over, because you can model almost anything with the spec once you're experienced with it

…the primary benefit that I see is the general capability of modularization of data and the data module codes that allow you to take various pieces of data by information type and correlate them together.

We are using the S1000D for all types of data that you would normally find in a maintenance level IETM for on-board use, so we have typically units or enclosures that have various types of electronic systems, hardware in them, like servers and switches, and all kinds of things like that, various electronics components; and we're obviously documenting things like operating procedures and remove-and-replace procedures and functional descriptions, cabling diagrams and wireless tables, troubleshooting procedures, which usually in our case right now take the form of flow charts….physical description of parts data…documenting a lot of system-level data. We have system-level functional descriptions, but we are also documenting our operational displays and things, software itself, graphical user interfaces and controls, indicators and so forth, which isn't something that typically S1000D is used for because it's typically used for hardware maintenance-type manuals.

A lot more process maturity, it's a scheme that they're going to bring greater control over quality of the document and structure and reusability of the document. And, if we do any collaboration with allies, they're using S1000D in Europe.

[S1000D] is allowing us to get consistent data and data element names and everything that feed into our maintenance capture system.

B. CHALLENGES, POLICY AND GETTING STARTED

I think when we first started developing policy for S1000D, we really thought there would be a better organized and funded approach to supporting the U.S. side of the spec, because it seemed clear that it's a good idea to add S1000D into the mix for all the services because it's someplace that we can go to. … the expectation was that OSD would provide some intelligent support for S1000D in a joint service capacity… Basically over the years it's just come to be realized that OSD is not going to support this, fund this, look at this, or do anything with it. And so the services have protected their needs by just being friendly and getting together and coming up with answers to things. … So I guess what's disappointing to me is that OSD has not stepped up and said, you know what, this is clearly something that the U.S. has to protect their interest in, because our services and our programs are using this spec. … that doesn't make sense that all these U.S. programs, these military programs are depending on the spec to support them, and yet OSD is not funding it and has no way to do so, not even thinking about it.

There are issues with life cycle maintenance, when you consider the infrastructure of the Navy is not really geared to tracking and maintaining the DMs, so … we sort of had to work through that. … It's difficult when in some ways you're doing something before the infrastructure is caught up.

If you don't have the service business rules in place, then you would have to interpret all of the existing policy for that service and think about it yourself in terms of what does that mean I need to do in S1000D. That's a lot of work.

…And then the challenge with the S1000D piece of this [neutral file format for CAD data] was that they were attempting to create kind of a virtual environment for the sustainment enterprise, [but no discussion] where this S1000D formatted document would fit within the framework of a product life cycle management environment. The answer is that the document and/or process is subordinate to the product structure. … they didn't understand productization and they didn't understand product sustainment. What they really understood is the creation of tech documents and publications and viewers.

We're starting to have some concerns with the proliferation of contractor unique tools and applications for our acquisitions. So I would like to see a little bit more standardization in that area. … I would like to see more standardization of applications in the acquisitions environment across programs.

I would say that trying to standardize the implementation of the program across the various acquisition projects and sustainment has been a challenge because people started using it and buying the data before we had any business rules established.

I think because it's not required, most organizations have their own system for storing technical data.

Sometimes people may have an expectation that the production of S1000D information will be inexpensive. There is substantial overhead. Every data module has a block of information associated with it. This is all the metadata, the information that describes pretty much what's going to be contained in the data module, and provides all of the configuration control information; and that's a little expensive to maintain. And I think sometimes that they believe that legacy information prepared to another specification can be easily transported into S1000D, and that too is not the case.

One area we have not seen and really thought we would, would be the reduction in the initial authoring cost.

[Expectations] may not be met as quickly as some might hope, like as far as return on investment … because there is a lot of effort and a lot of costs up front, and it will take a while to start seeing return on investment from that. First of all, training is important. It's an extremely complex vocabulary. So training and learning curve is certainly part of it. …The good news is there are several companies out there … that are building these tool sets around S1000D, to try to reduce the complexity. … The bad news is they are all extremely expensive.

The benefits of using S1000D are probably going to show up a little bit later in the life cycle. … in the beginning it's the same amount of work, but your savings come about later in the process.

…because some of my end products are fairly complex and fairly large…our start-up cost is pretty significant. …And there are going to be a lot of process changes that are going to have to happen compared to what we do now. …I think these costs can be recouped over the life cycle.

I think the only problem is that, for people who work on primarily on very small projects, it's hard to get started. You have to take a step back and figure out a phased approach to get past the learning curve and establish written business rules and coordinating with all the organizations. For example, I'm trying to work with the Joint

Services Department and NAVSEA on one of my projects, where I'm trying to coordinate across those, make sure that my business rules are compatible with theirs. That takes some time.

…the paradigm shift of contractors as well as government employees has been a major problem at the beginning. But once they have seen how we compartmentalize data and everything, they actually like it better than the old way we did business.

When we first started, it was difficult to find people to do S1000D. But over the last four years that we have been doing it, it's relatively easy. We have a whole slew of contractors that now can produce this data. So we have done some home-growing internally as far as the contractors around us, and mentored them. In fact, they have gone as far as built their own users group outside the fence, and they actually interact with each other and help each other with S1000D.

Subsequent iterations of the standard have become more and more complex and more nuanced, to the degree now where the doc for the specification itself was in excess of 2,700 pages, and that's unwieldy by any measure. And then it begs the question of how you define the product support enterprise, and then what other ancillary systems and what interactions are necessary to support other systems and facilitate the maintenance of those weapons systems. So it's a very difficult problem, and it's not one that many people appreciate or fully understand. … it's the nuance and it's the specificities that sit beneath this that make it difficult to implement. … Today it's being done with the Tech Doc and publications world, and it's being done on a service vertical, and more specifically than that on a platform vertical. And it's not being done within the framework of the context of the actual enterprise that's responsible for supporting that asset. Really, the documentation needs to be structured within the framework of the overall enterprise and not within the framework of the way a specific asset is going to be used in a specific environment. [issues with who stores the data in what repository when the information is being used in multiple products] …the content associated with those documents is really compartmentalized to whatever is in those repositories. Meaning that, unless they're tracked from a revision change management perspective with the asset class that those support, you lose your … authoritative relevance. … It's a higher order issue than just S1000D, but it's very much manifested and comes to the surface when you talk about creating this environment.

[customization and tailorable] …some people would see that as a negative and potential to share data, but I think as long as your business rules are in place across the groups that you work with and you're following those and as well as within your communities of practice, that could be managed.

There are many challenges. …it's necessary to understand how products are delivered and then how they're sustained in order to appreciate that this is probably not possible in this environment. And the reason is that the products that are in inventory, if you look at the -- like an aircraft, are built of subsystems and components, and the product structure is built from catalog items which then moves into subassemblies which are built into product configurations and then are fielded and maintained. And you have as designed, as built and as maintained, building material and other artifacts associated with supporting those items once they're in inventory. The common item data that these folks in the tech pub environment want to use as content is not changed in synchronization with the assets that are fielded. Consequently, you don't

have an authoritative link between the bits and pieces that fit within the common objects and database and the items that are actually in use. There is no direct linkage or connection there. One of the things they tried to do in later issues of the standard is to build a mini product life cycle management or product data management environment within the common object database such that repair parts could be ordered. Likewise, the training -- linkages to training videos or other training aids could potentially be enabled or facilitated. They're really attempting to do a lot with a document management environment. That's essentially what it is. And without the work -- work pools and the work flow and the work flow management, without an understanding of the content with respect to the actual end items that are being maintained, it's extremely difficult to do that. You know, there is no linkage to the catalog of end items and lists and the things that are being done with content space. So it really becomes a sub-optimization routine in the sense that you may be optimizing the generation of documentation, but you're doing that to the disadvantage of other enterprises within the -- within the organization. And in order to maintain semantic relevance in this environment … another point that I think is very important -- changing the tire in the desert is different than changing the tire in a jungle. Unless you understand the distinctions associated with [these environments] -- if you try to generate a document which can apply to this level of semantic relevance to specific environments on the fly, without human intervention, you're probably going to end up with sort of a Chinese bicycle manual. And the problem is that the folks who are typically associated and involved with this activity are, for the most part, content developers in the publications environment. They really are not maintainers or sustainers or the people who are working at the edge and are responsible for supporting those weapons systems.

The biggest challenge with S1000D just getting started is that it is front-loaded as far as the work in doing a project. So, for example, you have to be able to answer all of those questions about how you're going to do a project. You have to be able to answer all the questions about what kind of data module coding you're going to use. You're going to have to look at the project and decide how you're going to divide up your data. You have to do a sort of an analysis of the reuse. So we did like a matrix of the different types of manual output and then where the different pieces of data were reused, so that we could get a map. That's a lot of work up front when you're really not sure how it all works anyway, you know. That's the hard part, getting started. It's really front-loaded with a lot of analysis. … the real essential up-front analysis and planning that has to be done. Otherwise, the risk of rework and re-rework and having one step forward, 2 steps back, there is risk there. But what we're finding is the more familiar we are with our S1000D requirements and where we have limitations and where we have flexibility really lends itself, then to expediting that planning project.

C. WHETHER DOD SHOULD REQUIRE THE USE OF S1000D

If you're starting from a brand new platform, new boat, new plane, new cutter, I would think it would be the default [specification]. … that would be my personal recommendation.

The services are moving ahead. They are, for the most part, proponents of the specification. The actual use and application of it needs to be a little bit more defined to make it more cost effective … and to be able to really exchange data better. But if

you don't make it a requirement, then what are your chances of getting the funding to actually be able to try to execute some of these enhancements to the specification?

I think it would make sense for … new content. Anything above ACAT Level II should be using S1000D.

Personally, absolutely. I think its way overdue. I don't believe in all or nothing. And what I mean by that is that, for new acquisitions, you could make a really good case of why it's a good idea. Specifically, especially in aerospace and with planes, it's already mandated. The private sector has already mandated it for commercial airlines.

It would make sense to use a singular data structure that we would simply be able to transfer the data when we're doing a manual that NAVAIR uses and Air Force uses. … There are not only the Navy's NAVAIR/NAVSEA differences, at the DOD level, there's Army, Navy, Air Force. Any commonality is, in my mind, a good thing.

Sometimes when people talk about S1000D, I feel like they're making it into a bigger shift that it really is. We already have a requirement for XML to be used for technical manuals, and the spirit of that is so that we can share data. The problem is that we allow everybody to go by, or create, the structure rules that they want, as long as it's in XML, which means that we don't have consistency and we can't share the data. S1000D is a specification that brings a consistent structure … and what you're saying is we're just going to apply consistent rules to the way we purchase the data.

I think the objection would be about all the caveats that they would mandate. If it were a brand-new, huge weapons system, I don't think anybody would object if that's the criterion. … So if you can be very clear about which ones are the things that are actually mandated and leave everybody else alone to make the decisions that they need to make, and not require this long, complicated list of, if this happens, then you have to do it, but if this doesn't happen, then look at this and then give us this cost … all this is too time-consuming and not something anyone really needs to define. This is going to confuse the issue.

Across the board would not work. It just doesn't make sense in so many environments to convert that data.

If there is no old stuff, then it seems really clear that, if you don't have any existing data, you're not reusing anything. This is a whole new development, S1000D seems like a no-brainer.

I think the short answer is yes. Speaking as a contractor, it's extremely helpful to have top-down directional flow for policy and guidance…also beneficial to have clear, concrete acquisition guidance flowing down.

I wish the outcome, the recommendation by LMI to OSD, would have been to say "yes," make the decision [to require S1000D]. Unfortunately, I believe my interpretation of the study is that they delayed; they did not in the end make that recommendation. And I certainly was part of the camp that was looking for and very hopeful that we would have gotten a direction from OSD to strongly recommend something in those terms.

I think the OSD guidance may be a strongly suggested use of the standard with a caveat to allow acquisition managers – based on a business case or a set of business rules, either one – to at some point opt out of it, if that truly makes sense. I worry a bit about the word "mandate". There's got to be some common sense applied. So I would

really applaud an OSD strongly embracing the standard, but not a black and white, cut and dried, you-will-or-will-not kind of thing.

Not appropriate to use S1000D if you have something that has short technical life, like a telephone. To document a telephone in S1000D would be impractical. There are other mechanisms for structured data that are better for a piece of equipment that has a short shelf life or a short [operational] life and doesn't have a lot of technical changes.

I feel pretty strongly that it ought to be [required]. I believe that it's going to save the government money. I believe it's going to make it easier for people to find technical information. I think it's the right thing to do.

I think it [a requirement] would help a lot because right now, people are unsure … there doesn't seem to be any policy. If it was just a policy that said it's okay to use it, it would even be better than no policy at all.

Most assuredly. I think in the end it will save them a fortune.

D. ACTIONS DOD SHOULD TAKE TO ACHIEVE SUCCESSFUL IMPLEMENTATION OF S1000D

I think what the DoD has to do is take a look at what the service has done and look for commonality across the board and then really latch onto their areas of commonality, and they would be obvious candidates for DoD policy. Where there are gaps, DoD is the glue that brings things together in a coordinated fashion.

First and foremost, DoD would need to coordinate with the actual body that's responsible for identifying those requirements for the services [Joint Service IETM Technology Working Group]... and then, second, any potential funding to transition [to S1000D] and to set this up would be another good thing. Third, they should make sure that they staff someone from the IETM technology working group to represent these services and OSD at these S1000D meetings. We do not have an OSD representative sitting on that panel!

DoD needs to ensure vendor products are S1000D-compliant and that needs to be validated.

The problem is the acquisition folks may have heard of [S1000D], and sometimes they do put it into the contract, but we haven't laid out any road map for the infrastructure to support it. Then you have the Program Managers. Technical Documentation is kind of the bottom feeder of their problems. They're not really looking at the data structures of their technical manuals as high on their list of concerns. They are leaving that to the technical manual managers to do what makes the most sense or make a compelling case. However, if you have structures in place, then most tech manual managers and most program managers aren't going to go switching your systems unless there is a requirement. So it's kind of a vicious cycle. They've got "That's the way we've always done it" syndrome. … the documentation is kind of a redheaded stepchild of new hardware that they're buying. And until that gets mandated to them by either a Navy spec or a DOD spec, they're not going to deal with it. The other thing is cost. If there's an up-front investment that a Program Manager is going to have to incur and they can't be readily convinced of the value-added in life cycle support … then they [won't support it].

It would help if there was at least some type of support and structure in place before putting in these requirements, because otherwise you're going to have each branch developing their own structures and you're still going to be stovepiped.

I think putting out a specification that provides policy and guidance for the development and conversion of technical data is important. My biggest caution would be that it is only one piece of what an office would be responsible for. Giving us policy and direction on how to develop the data, but an organization that would stand up to help guide that needs to have a much broader scope of responsibility beyond just simply how the data is developed. If OSD directed that, they also should then follow that up with a group that would provide oversight, direction, and assistance to programs to those who were developing and fielding products. Support [is needed] in a holistic approach to fielding the product, not just a spec to guide you on how to develop it.

From an organizational standpoint, you are going to have to see if all of those different organizations that maintain technical information have the capability to house and then make available S1000D information. … If it doesn't, then you have a cost involved with bringing into that organization a system that does. People would have to be trained, would have to be converted over. You have a cost of making sure that the organization can manage the information, and making sure that the workforce is trained in that.

DoD should help with transition costs. They are definitely going to get those requests from the field. Anytime you make a change like this, globally or system-wide, you are going to have pushback, because people don't like change, [or upfront costs], and you are going to get requests to help them get there.

If it's legacy system, something that is going to be used for a long time, conversion [to S10000D} would need to happen. But, it doesn't make sense from a system perspective to say that every piece of legacy information needs to be converted. I think it has to be done on a case-by-case basis: how stable is it?; how long are we going to be using this technical information?; is this on a system that's being retired? If I see that I have technical information on a system that's going to be used five, ten years out … then that's probably a good use-case for conversion.

DoD could provide leadership to expand the knowledge base and the training and the learning of the specification, and especially the way it can be implemented. Teach people how to implement and design business rules, facilitate collaboration, facilitate information sharing, collaboration, and learning.

[DOD should instruct the acquisition personnel on S1000D what it's about, benefits, limitations, you know, the pluses and minuses, again so that they would be able to make determinations on whether to include it as a requirement in certain procurements] I think that's a big need, because I think there's a huge knowledge gap out there among acquisition people … there's a lot of folks clamoring for guidance, people looking for some kind of guidance, or questions about S1000D, everything from tools to processes

There are a multitude of things that have to be built here. Number one, we have to buy business rules and we also have to buy the tool, the database to actually use the

standard. We currently don't have that level of funding right now. It is a significant investment up front.

There needs to be some improvement in the acquisition process that makes it an imperative that contractors do that level of sharing during the development of a document. As of now, the contractors develop their documents in their own pools that the government doesn't provide and they deliver the final document. But with S1000D, you'll need to have access to content that is at various points of completeness and maturity, and so you will want to be reusing -- you'll want to reuse what somebody wrote about the operating system that my software is running on or the hardware that my software is running on. So I'll need to be able to read it, I'll need to track where it is in its life cycle of maturity, what it's going to look at like by the time my document needs to go to publication. So I need to be working in an environment where I can have access to that end work content, which is something that typically the current culture contractors don't share until they're done.

If they [DoD] were going to require it [S1000D], money would help.

When the DOD initial working group a few years ago went through all those decision points in the S1000D spec and allocated them to the different levels which one should be defined by DOD -- which by DOD and which by SYSCOMs -- and which by the individual project or program, they allocated some of the security decision points. We would also need DOD to be a participant for the parts of the spec that they are responsible for because we'll need to all play in the same sand box. We need somebody in charge of the sand box. Besides just the business rules at the DOD level, we'll need some enterprise- level oversight to keep us all on track and sharing and looking at each other's meta data and acquiring this the same way so that we can share -- we know what we're going to be getting when we share with each other.

Find out what different schemas are being used within the DOD to capture technical data, what percentage are currently using S1000D. Look at the capabilities. What databases are being used and how many of those are compatible with S1000D. Then I'd also look at the current workforce, how many people in the DOD are currently working with technical data information and what percentage S1000D. Then you get an idea of training costs.

[We need] a policy letter from OSD authorizing the use of S1000D for acquisition of life cycle support

The DoD needs to do marketing … showing the benefits of S1000D and how you can manipulate data, which you couldn't do in the past. Some kind of DAU type environment would be appropriate.

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APPENDIX D - POTENTIAL BENEFITS OF S1000D

As Suggested by Survey Respondents

1. Standardization of presented information
2. Standardization, ease of reuse, keeping up with technology advancements
3. Common Commercial off the Shelf software platforms (authoring, presentation) allows commonality across services, common format familiarizes user with S1000D capabilities, format, etc.
4. Ability to directly link to logistics support data
5. Increased likelihood of receiving accurate data; reduced cost of maintaining data
6. Data sharing between services
7. Standardization of technical data across platforms and services
8. Increased Interoperability, more application standardization, lower authoring costs, improved timeliness of data updates through all applicable tech pubs
9. The ability to have both training and technical data available at all times
10. Consistency across programs promotes familiarity in preparation and use of data
11. Lower data ownership costs
12. These benefits can be achieved using XML in general, not S1000D specifically
13. Improved process maturity for acquiring, building, and maintaining S1000D data
14. Uniformity of processing; future (unforeseen) uses of data being in XML and being meaningfully cataloged by virtue of the data module code
15. Cost savings over the lifecycle of projects
16. Interchangeability across services; built-in compliance through templates, schemas, DTDs
17. S1000D will allow tying Configuration Management data and spares data to technical manual data and SCORM all electronically
18. S1000D in XML is an enabler. It will allow DOD and DON to move forward in the area of electronic sharing of data in XML. The benefits will gradually build over time.
19. The only purpose and benefit of the S1000D is to support the "management" of prescriptive data modules within a close-system, proprietary CSDB which is yet to be defined within any Defense system
20. No benefits over existing US based standards. This European standard cannot support links without use of a proprietary tool
21. One standard format of publications and links to other ILS disciplines
22. Facilitate true “interactivity” of technical, maintenance, and repair data
23. Ensure the user has access to various equipment/Hull/program configurations and being able to ensure the data within each applicability DM is for that configuration.
24. The assurance and confidence that data is presented the same from LSA - to Tech Data - to Training
25. Reduce the numerous man-hours spent on the training/developing/maintain the numerous MIL-SPECs/STDs and the DoD/NAVSEA/NAVAIR /USAF/Army directives sent to notify of updates/obsolescence on just the presentation and content of a manual/training

26. Knowing that multiple contractors on a program will interpret and supply the data with the same look-and-feel
27. Standardization of data formats
28. Standards become standards for a reason. If everyone is on the same page (organizationally), life is just easier.
29. If properly implemented (DoD has not!), provides opportunities for reduced training costs and improves interoperability
30. Move production focus toward content vice format/style and proprietary software
31. A clear and uniform standard across the services
32. Interactive publications will simplify maintenance activities
33. Common Source Database benefits (sole source of truth)
34. Reduced cost and increased efficiency of integration (interfaces) between systems
35. Consistency in titling of Data Modules. Joint development between partner companies using a single CSDB. Elimination of file naming collisions. Reusability of display engines/ transforms/ support
36. Rapid updates to the field-- Days verses months
37. Lower TOC
38. Get everyone on the same path for future upgrades
39. Decrease in life cycle cost to maintain fielded data. Also, updates to data can be fielded much quicker
40. Tech Data Support for International sales
41. Standardization between commercial and military use
42. Richer data set allows for more post publishing functionality
43. Sharing of data between suppliers, OEM's and end users
44. Exchange of data between OEM and Vendors.
45. XML format is beneficial, however the data models are weak in many cases and often ambiguous (read NOT standard)
46. The more completely a program uses S1000D the more efficiencies are realized
47. Consistency & configuration control
48. Link between Material Support data (ASD S2000M) and Tech Pubs (S1000D) to build-up Illustrated Parts Catalog
49. Commonality of data handling procedures
50. Good tech data configuration management
51. The business rules and infrastructure are not in place to allow maximum benefit from using S1000D. Also the funding is not available to fully implement the concept.
52. Links with the physical system through new technologies, e.g. RFID
53. Enables electronic data mining of raw data behind displayable information
54. Potential for closer integration of development activity in the product support phase through the use of data exchanges
55. Quality of authoring data and [reduced] cycle time of updates to data after conversion.
56. Reduced support costs through a single standard
57. Logistics traceability, the 'integration' in ILS
58. Standardization
59. A tighter logistical environment is a prime benefit, Configuration control of data is mandated into S1000D

60. Common software/infrastructure, common knowledge base
61. Cost effective for updates; no more paper; for producing documents, focus on content and not on shaping
62. Create new uses of the S1000D documentation: efficient upgrades, I.T. help documentation, statistics, use returns
63. Universality - land/air/sea; civil & military, worldwide use ==> mature spec, COTS products
64. Via the new S3000L and S1003X you will have a direct connection between LSAR and the tech pubs and learning information
65. Much higher data quality
66. Standard formats
67. Reduced costs of data sustainment
68. The process module makes a great fault troubleshooting tool but is difficult to learn.
69. Potential for common/interchangeable IETP viewers; strong organization supporting the spec
70. Interoperability between services and FMS partners who rely on joint tech data.
71. Improved cross service data sharing -- V22, C-130J, F-35, and Army vehicles used by other agencies

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