

Issue Paper—Software Quality and Interoperability

Group 4: Software Quality and Interoperability for Electronic Business

I. Introduction:

DoD in recent years has focused on purchasing Commercial-off-the-Shelf (COTS) products rather than developing software “in-house”. This change is in response to cost-cutting efforts and timeliness of software production. Recently, the DoD CIO challenged the U.S. software industry to provide better quality software that is interoperable and less vulnerable. This Working Group was formed to focus on the quality and interoperability of software to be used for Electronic Business in DoD. The working group defined meanings of software quality that are described below. One meaning involves vendor provided functionality compared to functionality expected by the user. In this context the working group examined the degree to which the method of process definition or lack thereof has led to the success and failure of COTS implementations within DoD. Conclusions and recommendations for improvement are provided.

II. Working Group Membership:

- Mr. Ron Torezan, DCIO **[CO-CHAIR]**
- Ms. Marilyn Kraus, DCIO/I3D
- Col. Joseph Catudal, JCS/JSIRMO
- Ms. Angelena Moy, OUSD/AT&L
- Mr. Mark Johnson, Oracle
- Mr. Jim Sturges, Lockheed Martin Corp.
- Mr. Jim Tully, Unisys
- Ms. Mary Polydys, IRMC
- Mr. Willie Williamson, Microsoft Corporation
- Mr. Harry Hixon , EDS
- Mr. Hays McCormick, The OTG
- Mr. Harold G. Wilson, Litton/PRC **[CO-CHAIR]**

Facilitator

Mr. John Weiler, Interoperability Clearinghouse

III. Background:

With the Department’s implicit acceptance of COTS solutions, there is concern over the quality of software and with interoperability among large numbers of COTS software packages interacting in complex system environments which includes non-COTS. The Department is, and will continue to deal with COTS software solutions in the world of Electronic Business/Electronic Commerce (EB/EC) because EB/EC will become the predominant way in which the Department does business. There is also some concern

over the fact that the Department does not have the influence it once had in the Information Technology market place.

Software Quality

In order to establish a common point from which to initiate discussions, the working group agreed upon a set of definitions for software quality and interoperability as follows:

-Product Integrity – whether the product maintains its operation without failures when performing the functions in the manner claimed in its documentation.

-Product Functionality – whether the product performs all the functions that it claims in the manner claimed in its documentation

-Product Connectivity – whether the product performs with all the interfaces/devices that it claims to support in the manner claimed in its documentation

-Product Configuration - whether the product performs in the configuration that it stipulates as part of its installation package.

-Product Environment – whether the product performs on all the platforms (as specified for capacity, characteristics, and speed) that it claims to support in the manner claimed in its documentation.

Interoperability might be defined from a similar set of perspectives:

-Interconnection – whether the product effectively connects and communicates with other devices and software that it claims to support

-Information (Data) Interoperability-whether the product supports user understanding of data (and therefore the ability to utilize data)

-Applications Integration – whether the product addresses the implications of the design of all the system's interconnected elements. (Whether the functional context of a product is equivalent to the context of the rest of the system.) This is the most complex of all the interoperability perspectives because it transcends data structure and begins to apply to data use within a complex system context. There is a presumption that, once a product is integrated into a system, all functions claimed by the product will work with all other elements of the system to the degree that the claims support those functions in the product-only environment. A simple example would be expecting the standard RFC 2459 functions associated with internationalization to perform flawlessly in a system with an X.500 directory system that contains no ability to deal with internationalization character sets.

The particular problems with the use of COTS products for Electronic Business applications include: the immaturity of the Electronic Business marketplace and the

general rush to market on the part of Electronic Business product vendors in response to unprecedented demand by businesses rushing to capitalize on promised savings and reduced cycle times; and the rapidity with which product changes and upgrades occur in this changing product niche. These problems can also result in interoperability being of less importance.

From the perspective of the DoD user, the application of COTS products to support DoD processes has a very checkered record. On the other side of the question, major commercial users of COTS software counter with the statement that they are using the same COTS products for critical functions with positive rather than negative experiences. The working group attempted to determine why this dichotomy exists.

IV. Problem Statement:

The essential problems appear to be threefold:

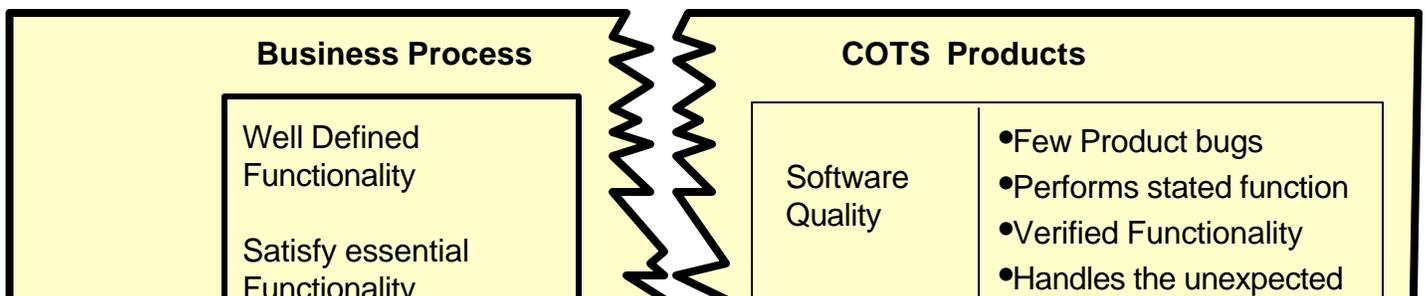
-The initial definition and detailed understanding of the business process is emphasized more by Industry prior to initiating the consideration of the COTS product than it is emphasized by DoD. Also, it appears that industry may be better able or more willing to change their processes to match COTS solutions.

-The number of variations allowed is minimized by industry and is generally not controlled or limited within DoD implementations.

-Industry seems to be able to effect process change more rapidly

The benefits of using COTS are overcome by modification of the product to fit the desired functionality or excessive variations. The situation could be described in terms of a gap between the definition of the desired functionality (the definition of the 'as is' and the 'to be' or desired business processes) and the detailed understanding of the essential functionality of the COTS product. This "gap" is depicted in Figure 1 below.

Matching Business Process to COTS Products is critical to e-Business success



Facilitated by an Interoperable & Secure Information Infrastructure

Figure1 Business Process to COTS Product Matching is critical to success

In discussions with industry integrators and COTS product vendors about success criteria within business applications of COTS products, it became apparent that industry, particularly in the integrator community, generally performs much more analysis of essential product capabilities prior to selection. Moreover, there is extensive definition of the 'as is' processes prior to initiation of analysis of COTS and there is even more extensive 'to be' process definition using COTS in the process model. Most importantly, when there is a difference between existing processes and COTS processes, there is a Return on Investment (ROI) analysis performed before the choice is made. The full cost of retaining the existing process is compared with the cost of adopting the COTS process. If there is an overbearing reason to retain the existing process, only then is a decision made to retain the existing process. If there are numerous localized variations that are executed in the existing process set, the variations are allowed only if the cost of allowing them is far below the costs of removing them. In general, COTS processes are acceptable and are adopted on the whole or the COTS solution is not selected.

V. Discussion:

The working group heard presentations from Government programs, Industry programs, and from product vendors. There were several major differences that were identified.

-The general trend throughout the presentations was that best practice in implementing COTS solutions, particularly in the Electronic Business arena, was to first define the current business processes and practices and endeavor to identify areas that were candidates for improvement prior to any attempt to investigate or evaluate COTS products. In general, DoD did not seem to incorporate this critical step in their

implementations.

-In addition, in successful industry projects, the projects seemed to thoroughly investigate the features and functions of COTS products for potential fit at a more detailed level than their DoD counterparts. Also, commercial initiatives demonstrate more flexibility in being able to change processes to reflect COTS capabilities. There is more flexibility in being able to change processes to reflect COTS capabilities. This is aided by dollar quantifiable justifications where the government's more qualitative justifications are less persuasive.

-Industry attempted to reduce the number of variations within implementations by comparing the cost of multiple implementations and complexity of long-term support versus the return on investment provided. It is much more difficult for the DoD to have a similar measure for assessment of the cost versus value of exception conditions. It was felt that the lack of a simple, understandable measure of value versus cost was one of the major reasons why the number of exceptions or variations by DoD implementations was far greater than in similar implementations by industry.

The first two items were recognized as critical to success for solution quality. The impact was depicted in Figure 1 above, created by the working group.

It is important to note that the definitions of software quality noted above in the Background section are those from the perspective of the product vendor and the product itself taken alone. These criteria for product quality are essentially stated for a pristine execution environment that would use the product only as the product designer envisioned. Product vendors do not envision their design or warrant their products for all possible uses when they validate and test their products. They test as many code paths as needed to satisfy the functionality of the product. Vendors do not test all possible paths through their products. Organizations that deliver highest quality products perform tests that eventually cover the vast majority of all possible paths, but none test all possible paths. If it were possible to test all possible paths and all possible implications, the issue of software quality would be easy for DoD to put to rest. It would be as simple as reviewing the software quality records of the product vendors. However, when the product is viewed in terms of its practical use, often with other products with which it must operate in an enterprise application, criteria for software quality become much more complex. Unfortunately, this multi-product use environment is precisely where the complex DoD Electronic Business applications will fall. While it is difficult to place responsibility at the feet of the vendor for software quality in complex environments that are outside of the specified product environment, it is, nevertheless, the problem that must be addressed. The gap that exists between product specifications and the conditions of a product's use is where solutions to ensuring software quality and interoperability must be addressed.

One means of discriminating between traditional COTS software quality as seen by the vendor community and the multiple product quality is to recognize that there are two concepts that are operative:

-Software product quality – that related to the product itself as defined by industry vendors

-Solution quality – that related to the final use of the product(s) as defined by the ultimate user where the report card for DoD systems is truly completed.

Solution quality is really what DoD must consider. Solution quality recognizes that even combinations of software products of the very best quality do not necessarily yield high quality solutions.

VI. Alternatives:

The People Factors

Cooperation –creating the environment that is the foundation for cooperation

The working group found that the underlying driver for effective use of Electronic Business is the need for effective change – the drive to make processes more effective and gain value through using technology. One of the watchwords of Electronic Business change within industry is the concept of partnership and shared gain. This is best seen in major cooperative activities among what have been traditional competitors. An example is the cooperation among Lockheed Martin, Boeing, Raytheon and British Aerospace in the Aerospace and Defense Exchange effort.

In the DoD environment, key gains using Electronic Business will require similar cooperative activities by owners of traditionally ‘stovepipe’ activities in order to achieve major gains. To address this situation, the Department must change from a “Point Solution” mentality and focus on “Enterprise” driven factors, much in the same way as large industries do. The role and rules of oversight, acquisition, budgeting, and accounting that ensure the functioning of an essentially paper intensive environment must be openly reviewed. It is critical that these roles be reviewed for their effectiveness in an electronic environment where review, resolution, and analysis can be executed almost instantaneously as a part of the execution of a new electronic process. Strict adherence to one or more facets of the paper based process could easily impede and counter the wide sweeping gains that might be made through the introduction of Electronic Business at the core of the process.

Education – identify techniques to improve software functionality and interoperability education

Providing definitive information on interoperability among software products is a bit like describing interoperability among sub-atomic particles. There is a lot more unseen than seen within the operating environment, so predictions of behavior often require extensive, often oblique observations at varying energy levels (or functional usage in the case of software). Education would be a true facilitator in fostering software interoperability if the software purchaser were taught two key processes and exposed to

the need for applying one process or the other. These are; (1) direct education of purchasers in requirements elicitation and management and (2) using process definition notation that would be directly valuable in properly defining and analyzing the space into which COTS products would be introduced. In effect, eliciting, knowing, and understanding the needs and requirements of the user are essential to effective purchasing. The movement away from just accepting statements of requirements toward a better understanding the true process needs of the using organization, would make the acquisition of COTS products for use as facilitators of complex process implementation far more effective in achieving solution quality.

In today's connected environment, purchasers need to be provided with and use new analytical skills that enable them to select successful interoperability solutions. These skills include the use of modeling and other systems engineering-like techniques that are used in determining the effectiveness of functional and physical interfaces. Exposure to these skills will better equip purchasers to recognize those circumstances in which more analytical depth is required and when additional analytical experts may be needed to determine interoperable solutions. Once exposed to the scope of the analysis that yields successful interoperability solutions, purchasers would be better equipped to recognize those circumstances in which the implementation is sufficiently complex, either in physical or functional interconnections, to ask for additional expert help in ensuring the interoperability of solutions. The Advanced Systems Information Acquisition Course series and the Advanced Software Management course series should be considered mandatory for the purchasing community as well as the management community.

The Process Factors

Best Practices – model best of commercial practices from industry

Business Practices – The processes used in performing the activities of an enterprise are clearly the final object of any process improvement, in so far as the processes match the goals of the enterprise and are judged to be effective. There are other business practices that impact the selection of solutions that are specifically related to the software quality and interoperability issues which are the subject of this working group. Those are the practices that have been considered.

Software Quality Practices - A distinction needs to be made between best practices used in the determining software quality and interoperability of a product and those used in ensuring the quality of a solution. The working group has concluded that the focus on COTS has misdirected the procurement emphasis toward COTS product quality rather than toward solution quality. The post implementation evaluation focuses quality more upon functionality of the solution in the context of the user. This almost guarantees failure for most DoD implementations, particularly the more complex ones. Since Electronic Business addresses business process as an essential element of its application, the gap between DoD's assessment of COTS products and its eventual application in Electronic Business implementations is a key reason for poor assessments of the quality of the solutions provided.

Business Process Definition— modeling processes in a way all those involved can understand and improve them

The Working Group concluded that the lack of an easily understood process modeling technique is a root cause for the lack of participation of the general user in the definition of business processes. Many of the techniques used are not easily understood and do not communicate the roles and “swimlanes” of the players involved in processes. Therefore, the user does not become involved in recognizing the potential improvements and simplifications that can bring success to Electronic Business implementations and, when faced with a new and potentially changed process, tends to reject the improvements out of hand. If the users can understand their processes and recognize potential improvements prior to being presented the changed process as a *fait accompli* at roll out, there is a higher probability that the natural human resistance to change can be overcome. Therefore compelling arguments must be made for process owners to be heavily involved in the modeling of their processes.

The Technical Factors

Architecture – institutionalizing standards - based software architectures

The working group concluded that architectures are an essential element of defining the ‘as is’ and an aid to understanding the impact of the ‘to be’ environment. The group also concluded that a “Process” architecture is more critical to Electronic Business applications than a “Technical” architecture.

The working group recognizes that architectures are a crucial means of defining the environment in which business change will be implemented, but they are not the determinant of the value or effectiveness of the business change itself. In fact, industry practice would indicate that desired business changes that have clear value in improving ROI would be a driving factor that would create changes in a current enterprise architecture. The business needs drive changes to architectures as opposed to architectures being the determinant of what changes can be implemented. That may be one of the factors in the ability of business to change their business processes more easily. The more progressive companies all have architectures but do not use them only as a constraining structure to dictate order, but as a means of ordering thought so that changes can be quickly and effectively evaluated.

Repository – supporting a concept that will establish a web based directory of validated standards, products and implementation services, for all to use, developers and users alike

The working group probably had the most difficulty with the scope and utility of a repository of information on products and standards. While it was felt that product quality and interoperability information would be useful, there was a corresponding concern that any repository data would be essentially generic rather than specific enough to provide detailed guidance. In addition, it was felt that it could perpetuate the belief that products

listed as generally acceptable would not be further researched to determine whether they would indeed fit the specific application under evaluation. In a sense, product information in a repository would be the next level of detail below the general market survey data that is available today. The information may not absolve the buyer from clearly defining and understanding the business process or system environment for which the product is being considered, or from analyzing the product itself in enough detail to determine whether it was 'fit for purpose'.

Concern was also expressed over the potential legal implications of certifying some products and not others.

After much discussion, it was undeniable that a purchaser might benefit from a compendium of COTS product and applications data if it provided the following characteristics:

- Were kept up to date as new products and product revisions occurred
- Provided adequate version quality information to facilitate decisions as to when a product was sufficiently stable to warrant selection
- Contained specific notes on ability or inability to tailor the product for organizational situations.

It was also undeniable that purchasers who do not have the resources available to thoroughly investigate the product that they are considering will probably attempt to use the repository information as a "magic bullet" to make the tough decisions for them. If repository data is misused in this fashion there will be little value returned from the investment in the repository.

VII. Recommendations:

◆ *Majority Opinions –*

Process Definition

- First understand the target business processes and their hidden costs
- Re-emphasize the enforcement of necessary business process changes for EB/EC to achieve potential – don't just apply EB/EC to existing processes
- No single person or organization can understand the entire process. Vendors,

SDOs, Users and Integrators must cooperate from end to end. Complete understanding of the entire domain set requires collective cooperation among all parties.

-Choose a commercially supported notation method for business process definition for use across DoD (e.g., UML, XML, ADL, RM-ODP) that is easy for a lay person to understand, comment upon, and buy into. (See Implementation Concerns)

Recommended Action:

The DoD CIO should promote improvements to work processes by leading a task force of all DoD business process owners, and industry as appropriate, to recommend, within 4 months:

- An easily understandable business process definition technique, for use across the Department, that will facilitate business process improvement and bridge the gap between process definition and software product selection.
- An implementation strategy and supporting tool sets that will enable the process improvements.

Choosing the Right COTS Products

-Develop a Common Structured Methodology for choosing COTS products based on value received and cost to achieve and maintain results

-Choose among candidate product capabilities based upon thorough understanding of features and benefits

- Understanding of COTS critical functions;
- Functions and limits of software products
- Implications of one product on other software products
- What can and can't be changed to reduce implementation risk
- Scalability of products selected

-Follow industry best practices of delaying upgrades until stable, while participating in beta programs to influence better software quality.

Recommended Action:

The DoD CIO should create a plan and initiate DoD participation in 6 months in key efforts, such as COTS Product Alpha and Beta test programs, user groups, and EB/EC standards bodies, to ensure DoD strategies and business and technical requirements are addressed by COTS Product developers. Results of the

participation will be reported to the CIO Executive Board

Interoperability

-Reinforce high priority on a common/secure information infrastructure (based on commercially adopted standards)

-Gather essential knowledge of legacy interfaces

- Must know details of critical interface parameters

-Address interoperability through the architecture and other means

Recommended Action:

The DoD CIO should ensure that:

- All aspects of EB/EC are fully supported in the FY 2001 Defense Planning Guidance.
- The Global Information Grid (GIG) architecture provides for a secure, interoperable infrastructure (to include industry infrastructures) that supports all EB/EC processes.
- The GIG employs best commercial practices in implementing this recommendation.

Making the Right Choices for DoD

-Apply COTS with efficiency / consolidation of cost and architectural fit as goals

-Establish compelling, quantifiable, accountable and measurable equivalents for ROI & "Bottom Line" for DoD to aid decision making and make it a standard measure for all COTS/process decisions

Recommended Action:

The CIO Executive Board should develop, in 6 months, a 'Return on Investment'-like mechanism that quantifies the value of process changes and information technology for EB/EC initiatives to facilitate DoD e-Business related decisions.

Facilitate and Support Identification of Quality COTS Products

-Prepare a study that identifies the costs, timelines, and benefits involved in creating and maintaining a compendium of COTS products and applications data with the compendium having the following characteristics:

- Information is kept up to date as new products and product revisions occur

- Information contains adequate version quality information to facilitate decisions as to when a product was sufficiently stable to warrant selection
 - Information provides specific notes on ability or inability to tailor the product for organizational situations.
 - Because repository implementations can vary widely in scope and cost, organizations proposing to implement repository solutions must provide justification of the value returned for the investment made.
- ◆ Minority Opinions

None

VIII. Implementation Concerns

There is no consensus choice for a process definition-modeling tool. The Joint Technical Architecture specifies IDEF0 (IEEE Std 1320.1-1998) as a prescribed standard and lists UML as an emerging standard. There are those who propose UML or other tools as more useable tools. There should be an objective look at all the emerging process definition tool sets to select one that is the most effective in bringing the untrained user community into process discussions at the outset.

IX. Resource Implications

Creation of task force will require staffing and appropriate resource commitments and Alpha and Beta Test participation will demand on-going commitment of resources for key product areas.