Paving the Bare Spots

Towards an Enterprise-wide Defense Service Bus

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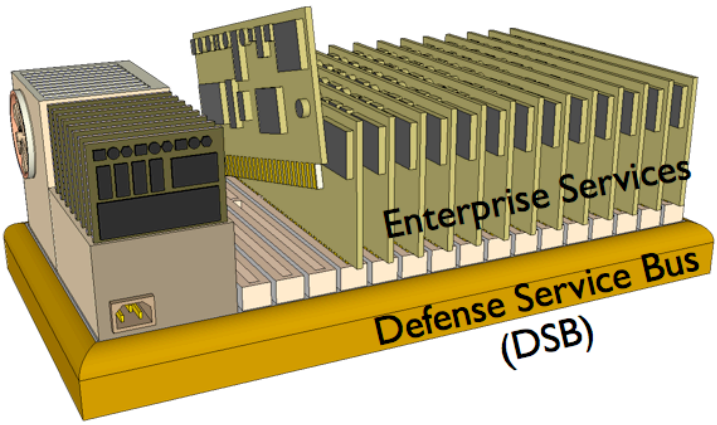
This white paper describes how Department of Defense (DOD) CIOs and policy groups responsible for net-centricity, interoperability, and transformation can facilitate the creation of a service bus that works for the whole enterprise instead of just within project stovepipes. Modeled after standards bodies like OASIS and open source development groups like The Apache Foundation, the approach defines an enterprise space for cross-project, enterprise-wide infrastructural development. This space is separate from the projects spaces in which projects manage their internal resources. Enterprise space is owned and managed by a foundation whose technical staff is contributed by projects rather than by building them within their project's space.

Defense Service Bus (DSB)

A service oriented architecture consists of more than just services and applications. These are only the bricks of a SOA architecture. They are embedded within and supported by mortar; the infrastructure that supports interactions between services. We call this mortar the Defense Service Bus (DSB)[1].



DOD has been a champion of standard interfaces since is role in introducing interchangeable parts during the industrial revolution[2]. Today, a stringent acquisition process requires each project to report the standards it uses in its DODAF TV-1 table. These are checked against the list of acceptable (mandated) standards in the DISR Online repository. The Net-Centric Operations and Warfare Reference Model (NCOW RM) describes the activities, services, technologies, and concepts that enable a DOD-wide net-centric enterprise information environment. Compliance with the NCOW RM is one of the Net-Ready Key Performance Parameters (NR-KPP), which describes net-ready attributes for the exchange

[1] I coined this term to avoid the term, Enterprise Service Bus (ESB). This is an effort to avoid distracting debates over what a "true" ESB is. For example, whether the DSB should support non-transport features such as mediation and orchestration is up to the DSB Foundation, not ESB marketeers.

[2] Planning the Software Industrial Revolution; Brad J. Cox; IEEE Software Magazine; Software Technologies of the 1990's. http://virtualschool.edu/cox/pub/PSIR/

of information and the end-to-end operational effectiveness of that exchange. The NR-KPP incorporates net-centric concepts for achieving Information Technology (IT) and National Security Systems (NSS) interoperability and supportability. These resources help program managers, testers, and milestone decision authorities in assessing and evaluating IT and NSS interoperability.

Yet in spite of this emphasis on standards, interoperability remains the exception more than the rule. The Army's Future Combat System (FCS) project is based on one bus, the System of Systems Common Operating Environment (SOSCOE). Net-centric Enterprise Systems (NCES) is based on another, the Service Oriented Architecture Foundation (SOAF). Until very recently[3], there was little coordination between these projects on crucial interoperability questions such as how message-level security should be handled. The interoperability plan was to use adapters, mediators and gateways to bridge the two systems. But as Rube Goldberg's cartoons showed, reliability and performance often suffers when adapters are allowed to replace intentional design. Financial and other resources are wasted on adapters that might have been spent on functionality.

But what else can projects do? DOD projects often have unique requirements for which there are no standard solutions. Interoperability policy is no solution because policy only adds to the requirements without providing a way of meeting them. Without a central enterprise space in which projects can collaborate on enterprise-wide infrastructural issues like security and interoperability, projects can only address their own needs while leaving interoperability as somebody else's problem.

Paving the Bare Spots

When my college wanted to stop students from taking shortcuts to class that resulted in bare spots in the lawn, it tried two entirely different approaches. The first was erecting "Keep off the Grass" signs and rope barriers and then punishing those who violated them. When that failed, they tried the "pave the bare spots" approach. They delayed building sidewalks until bare spots appeared and paved sidewalks over them. This solved the problem permanently and painlessly since the sidewalks were now exactly where students needed to go... the carrot instead of the stick.

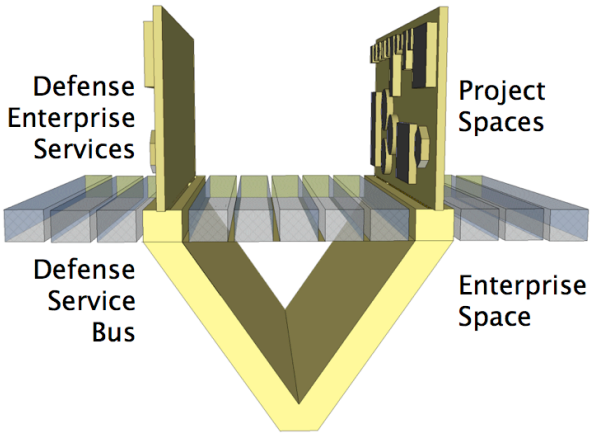
[3] Cooperation improved with the signing of a memorandum of agreement in early 2006. Initial interoperability meetings are scheduled to begin this summer.

The DSB is the SOA sidewalk; the path that enterprise traffic traverses. Like “Keep off the grass” signs, interoperability policy requirements are followed when convenient and otherwise ignored. Paving the bare spots goes further than just imposing requirements. It also provides a solution; a reference implementation that projects can pick up and use. This eliminates any incentive to circumvent policy requirements since a fully compliant solution is available at no cost. But being a reference implementation, projects with special needs are free to build their own if they must. In that case, they bear the burden of demonstrating that their solution complies with interoperability requirements.

The trick, of course, is defining a standard that meets most project’s requirements. How this can be done is the subject of this paper.

Enterprise Space and the DSB Foundation

This approach is modeled after the governance models of the Organization for the Advancement of Structured Information Standards[4] (OASIS) and The Apache Foundation[5] (ASF). To avoid premature specificity as to who might play a similar role within DOD, the paper calls it the DSB Foundation (DSBF).



The DSBF is responsible for creating and managing an enterprise space in which cross-project collaboration on enterprise-wide issues can occur. The foundation decides policy for this space such as who can participate and under what conditions. The new space is distinct from the spaces in which projects manage internal resources. It is accessible to authorized members via change management (and related) tools[6]. Contributors use these tools to define, develop and distribute the standard and reference implementation as a centrally managed, policy- and standards-compliant whole. Typically the foundation provides a web site as a portal for accessing enterprise space. Typically, but not necessarily, the foundation is the legal owner of property contributed by its members.

Although this is no simple task, it is simpler than building infrastructures in independent projects and expecting them to interoperate once deployed. By managing infrastructures in enterprise space instead of in projects helps to insure that upgrades can be distributed via the usual binary release procedures without impacting deployed projects.

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[4] OASIS Policies and Procedures http://www.oasis-open.org/home/index.php

[5] The Apache Foundation http://www.apache.org

[6] Any change management system could serve in this role. Subversion and its predecessor, CVS, are commonly used. See http://subversion.tigris.org

This does not mean that DOD should “get into the business of building software”. Off the shelf solutions are used when suitable to DOD requirements. The new approach is only used to fill gaps between DOD needs and what off-the-shelf solutions provide. The lower SOA support layers are readily available as off the shelf solutions. These are the substrate for building whatever is missing.

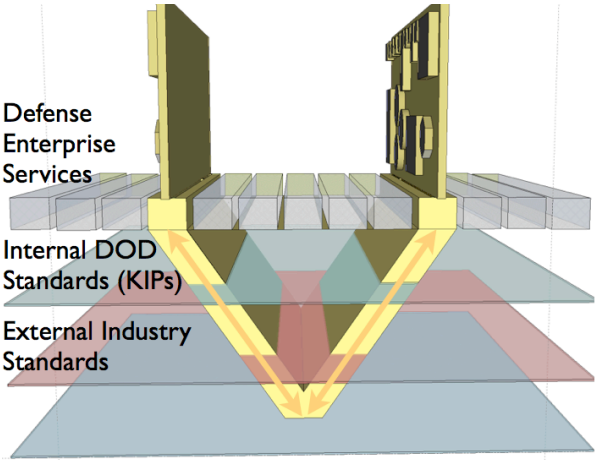
For example, synchronous messaging is supported by Apache’s Axis project (and others). A standard API for asynchronous messaging is defined by Sun’s JMS specification. With these (or similar) as the foundation layers, DOD can focus on bridging remaining gaps. For example, although Axis provides hooks (message handlers) for supporting secure messaging, it provides no security model that is adequate to DOD needs. Similarly JMS does not define a wire standard for asynchronous messages, so applications based on different vendor implementations don’t interoperate. And there is no off the shelf solution for enclaves; sites with intermittent or degraded connections to the rest of the enterprise.

Nor does this mean that everyone must agree on a “does-everything” protocol for the entire DOD System of Systems. “The” DSB only means that an standard has been defined and implemented for the enterprise. To paraphrase Einstein, this standard must be as simple as possible, but no simpler. If the consensus is that different communication pathways are required for parts of the DOD System of Systems, the DSB must provide them. The foundation only provides an enterprise-wide space within which parties collaborate on finding “simple as possible but not simpler” solutions for the enterprise as a whole.

This is not primarily a technical problem. The hard part is arriving at a consensus on a sound approach that meets legitimate project requirements. We’ll return to the hard part once I describe the DSB as a technical artifact.

Technical DSB Characteristics

Service oriented architecture is the latest in a long line of integration technologies. Each adds a new level of integration to earlier layers such as high-level languages, structured programming, object oriented programming, client-server, etc. The new layer is important because it is the first widely adopted layer that supports enterprise-wide integration; the ability to deploy services enterprise-wide.



From a service developer’s viewpoint, the DSB is the interface between their application and everything else in the enterprise. From this external perspective, the DSB is the largest and most complex part of any SOA, more so than any service. But internally, the DSB is just the topmost of a stack of standards-compliant layers that work

together to support interactions between services. The lowest layer (transport) contains the GIG and the hardware and operating systems that the DSB supports. Middle layers support the operations that services use as the message moves through the sending and receiving stacks to its destination.

The integration technologies of the past haven't been discarded. They remain available for when they are needed. That is, the DSB does not just support SOA. Only the highest layers do that. The lower layers are still accessible, as always governed by policy restrictions on their use. Internally, the DSB is a layered collection of libraries, operating system calls, and hardware. The lower layers are accessible for applications to use if they must in order to meet throughput or other requirements.

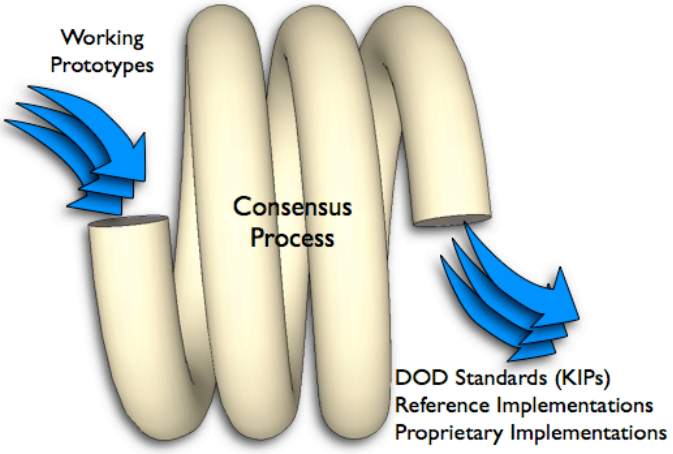
In practice, the Foundation decides where to draw the line between DSB- and service-provided functionality. That said, the top layer is unlikely to be standard SOAP. DOD security policies require *secure* messaging (among other things), and this is not supported by DISR-mandated standards. SOAP is nonetheless available in lower layers for when less than secure messaging can be used. Defining an enterprise-wide standard for message-level security, and building a reference implementation of that standard, is the obvious place for the foundation to begin. NCES's SOAF and FCS's SOSCOE are two sources of prototype implementations. A process for combining working prototypes to arrive at an internal consensus standard is described in the next section.

The DSB implements the interface between enterprise-wide applications so it must be strictly governed by standards. Standards govern interfaces, not how clients (services) work internally. By encapsulating standards within a concrete reference implementation, projects don't have to understand, interpret and implement the standard. This is a considerable simplification because standards documents are often voluminous, easily misinterpreted, and maddeningly vague. Clients must only understand how to use the DSB to interact with the service they're calling, not the stack of standards upon which the DSB is based.

The DSB is just a reference implementation. This means projects can use it if it meets their requirements but can develop their own if it doesn't. In that case, they bear the burden of complying with DOD interoperability (and other) requirements. The reference implementation is distributed as source code to serve as an executable demonstration of one way of meeting the standard's intent.

How the DSB Foundation Works

This paper has described the DSB's technical characteristics and the advantages of managing infrastructures by the enterprise instead by each project. That was the easy part. We turn now to the essential problem; how to get from a bus that works within stovepipes to one that works enterprise-wise.



Obviously, this is a issue that requires consensus and this can be a problem unto itself. Nonetheless, standards organizations and open source development groups have developed cooperative models that have demonstrated sufficient success to warrant consideration within DOD. Descriptions of these models, and comparisons between them, are available in the footnotes[7] so this paper concentrates on how the model applies within DOD.

Policy groups have political power but lack the technical expertise and local knowledge of project requirements to just impose their will unilaterally. A consensus process is needed mobilize the local knowledge that is distributed between the programs, their contractors, and industry as a whole. A similar distribution of power exists between OASIS or ASF and their members. This makes them a good model for how internal standards and reference implementations might be developed within DOD.

Although the proposed governance process is similar to those of standards bodies, there are several differences. The biggest difference is that the proposed DOD-internal process operates downstream of and separately from external standards processes. Its scope is internal, influencing how external standards are applied within DOD rather than influencing industry as a whole. In that respect, the process is similar to the existing Key Interface Profile (KIP) process, which also specifies how existing external standards apply at critical (key) internal interfaces. It differs in that the KIP process only produces KIP documents. It does not produce reference implementations of the KIPs; actual reference implementations that projects can pick up and use, assured that the implementation complies with internal and external standards.

In *The Rise and Fall or CORBA*[8]*,* Mitchi Henning uses OMG's experiences with the CORBA Component Model (CCM) to emphasize the importance of reference implementations for holding complexity in check. OMG focuses on standards, leaving implementations up to its members. Users vote to issue RFPs for specifications, members submit draft specifications in response, and the members vote on which draft to

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[7] Web Services and Service-Oriented Architectures; http://www.service-architecture.com/

[8] The Rise and Fall of CORBA; Michi Henning; ACM Queue vol. 4, no. 5 - June 2006; http://www.acmqueue.com/modules.php?name=Content&pa=showpage&pid=396

accept as the standard. Since working reference implementations are not part of the process, design by Powerpoint can sometimes dominate sound technical work. Complexity grows if changes are accepted that can't be efficiently implemented. And if there is no free reference implementation, users must buy them from OMG members. Henning claims that these issues caused CCM to be displaced by EJB (Enterprise Java Beans) and then SOA.

This example cautions that the activities of defining a standard and building its reference implementation should not be separated. In practice, the standard actually comes late in the process. The process begins when groups develop overlapping solutions to needs that only they perceive. Interest in a standard only emerges as these overlapping solutions are discovered. Only then is a foundation established to consolidate them. The process proceeds as contributing members critique the partial solutions to decide on a common approach, not primarily through top down abstract design. The reference implementation serves as a concrete harness for testing the abstract ideas being considered for the emerging standard. Often commercial implementations develop simultaneously within commercial members' home projects. As the consensus process evolves, it typically publishes interim (draft) releases which may contain not only the standard but the reference implementation as well. Commercial implementations often appear simultaneously or shortly thereafter.

The open source community uses a number of tools to support such work. The approach described here is based on the Apache Software Foundation (ASF)[9]. The ASF was founded to support the Apache web server but expanded its scope to include SOA infrastructure (Xerces for XML, Axis for SOAP, etc) and other less recognizable but important efforts. The following summary shows how DOD could use a similar model for those unfamiliar with open source development tools and procedures.

- Budget: The budget can be small even in absolute terms but certainly compared to today's approach. Foundation management is drawn from existing management already responsible for interoperability within DOD. Technical staff is drawn from those already working on infrastructural components within project stovepipes. Instead of confining infrastructural work to their home project, they publish it to the foundation's change management system. Several such systems are available[10]. The consensus process occurs within the change management tool as project members decide how to merge differences into the next release, supplemented as required by tools such as chat and email. Face-to-face meetings are seldom, if ever, required.
- Membership Classes: The foundation's board decides such membership issues as who can contribute to and read from the repository and how to balance the interests of policy-makers, project managers, consultants, commercial partners and technical contributors ("committers"). Most open source bodies recommend the notion of "meritocracy" which concentrates power in the hands of contributers with the technical knowl-

[9] How the Apache Software Foundation works; http://www.apache.org/foundation/how-it-works.html

[10] Subversion is a leading candidate. It is a version control system that replaces the older CVS system upon which most open source projects have been based to date. http://subversion.tigris.org.

edge to make far-reaching technical decisions. Change requests are submitted by the members who lack committer privileges via web-based tools designed for this purpose, such as Bugzilla.

- Requirement/Bug Reporting: DSB users submit bug reports and feature requests via any of several web based systems. These are automatically distributed to the volunteer committer community via mail or web based bug- and requirements-handling systems.
- Change Process: Changes are submitted electronically by anyone with commit privileges via the change management system. Privileges are typically granted by the committer community based on applicant's prior contributions. Such changes don't impact the current release, but are maintained separately in the submitters' "branch". These may be accepted into the release branch, the "trunk", during a merge process during which all changes are scrutinized and critiqued by the community as a whole. Accepted changes are merged with other changes, compiled, tested, and released as the next DSB release. All steps are digitally mediated, fully automated, and incur little cost.

Enterprise Space and Project Space

The proposed approach is is not at all the same as the one the FCS and NCES projects appear to be embarking on; a memorandum of agreement followed by meetings to align independent development in the two projects. The proposed approach provides an enterprise space, managed by the foundation, in which contributors from the two projects collaborate on designing and building a "simple as possible, but no simpler" infrastructure for the enterprise as a whole. Some signs of this approach in action are:

- A foundation is defined to manage enterprise space and to accept long-term responsibility for its contents. The contents originate as prototypes contributed by the members. These evolve through a consensus-building process to culminate in the internal DOD standard and reference implementation that make up the DSB.
- The foundation uses a change management system (and supporting tools) to support cross-project collaboration within enterprise space.
- Projects contribute internally developed infrastructures to enterprise space (SOSCOE and SOAF, for example) and remove them from the originating project's space.
- Personnel previously assigned to developing infrastructures in project space are encouraged by their management to continue work in enterprise space in collaboration with personnel from other projects.

In other words, a formal distinction between enterprise space and project space is the crucial sign of the proposed approach in action. Space refers to a change management system and supporting tools that is managed by the enterprise rather than by any specific project. Enterprise space is owned and operated by the DSB foundation to represent the interests of the enterprise as a whole.

Several recent articles propose wider adoption of open source development technologies (ODT) within DOD. One of these, The Open Technology Development road map[11] advises DOD to integrate a comprehensive open source strategy into defense department procurement and development policies. The present proposal is similar in that it also advocates open development methods and technologies. It differs in being far narrower, applying ODT approaches specifically to cross-project collaboration on enterprise-wide infrastructures such as the DSB.

Where to go from here?

This paper has summarized the advantages of distributing and managing a reference implementation of the DOD-internal enterprise infrastructure standard. It described cost-effective ways to define a consensus-based internal standard, and reference implementations of the same, under the leadership of a foundation that currently does not exist. The approach is modeled after the governance structures of standards bodies such as OASIS and open source development groups such as The Apache Foundation.

This paper concentrated on advantages for brevity. Although open source processes have made remarkable achievements, consensus-making is an inherently political process that defies concise description and has no guarantee of success. Although the SOAP, WSDL and UDDI standards converged quickly, similar efforts have failed.

Nonetheless, expecting project stovepipes to build interoperable infrastructure is like expecting homeowners to build their own roads. Isn't it time to try a new approach within DOD?

[11] http://www.acq.osd.mil/actd/articles/OTDRoadmapFinal.pdf