Roadmap Plan

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Executive Summary

The future has arrived; it's just not evenly distributed.
— William Gibson

To complete its missions, the Department of Defense (DoD) must continually reinvent itself as threats and technologies shift and evolve. Advanced Systems & Concepts (AS&C) is tasked with evaluating new trends, capabilities, and practices for maintaining DoD superiority while responding to new challenges. But even as emerging capabilities are tracked and assessed, DoD's design and acquisition methods are ill-suited to keep pace with accelerating shifts in technology, particularly software and information technology. Consequently, DoD finds itself behind the curve in software, leading to upward-spiraling information technology (IT) costs, obsolescent systems, and the loss of agility for commanders on the ground.

In the private sector, changes in design methodologies for software development are enabling enormous gains in productivity and efficiency. Individuals and companies are able to leverage open technology platforms to rapidly deploy new solutions and capabilities to improve their competitive advantage. These open technology platforms may be open source or proprietary software applications with open standards and published interfaces that allow the rapid development of new capabilities by third parties without coordination agreements.

DoD needs to leverage the corporate mindset that goes along with the shift to OTD.

Fundamentally, companies have realized that technology is now a commodity and the business model is providing professional services for solutions versus closed products.

IBM provides a good example of engineering a corporate culture change away from proprietary implementations to leveraging and heavily investing in open solutions.

U.S. National Interest

DoD has two competing interests:
1) Provide for the defense of the U.S., and;
2) Support and grow the U.S. industrial base, which provides materiel and systems so that DoD can accomplish its mission.

These trade-offs are well understood for physical goods and services, but not as well understood for digital ones. DoD can easily calculate the cost difference between developing or acquiring a physical good or service by simply comparing make or buy costs. There is however a fundamental difference between physical and digital products. Digital goods (software code, music, movies, etc.) once created can be copied perfectly with relative ease: limiting distribution enforces scarcity, but that scarcity is arbitrary and negotiated, rather than an innate property of the product. Software's ability to be replicated also means it can be incorporated into other software systems without "using up" the original component, as one would with physical components.

The business model of purchasing physical goods and services has served DoD well in the past; but it falls short when applied to software acquisition. By treating DoD-developed software code as a physical good, DoD is limiting and restricting the ability of the market to compete for the provision of new and innovative solutions and capabilities. By enabling industry to leverage an open code development model, DoD would provide the market incentives to increase the agility and competitiveness of the industrial base.

Currently within DoD, there is no internal distribution policy or mechanism for DoD developed and paid for software code. By not enabling internal distribution, DoD creates an arbitrary scarcity of its own software code, which increases the development and maintenance costs of information technology across the Department. Other negative consequences include lock-in to obsolete proprietary technologies, the inability to extend existing capabilities in months vs. years, and snarls of interoperability that stem from the opacity and stove-piping of information systems.

DoD needs to evaluate the impact that locking into one set of proprietary standards or products may have to its ability to react and respond to adversaries and more importantly, to technological change that is accelerating regardless of military conflict. In order to remain competitive in a rapidly shifting technological landscape

(including the disruptive technologies leveraged by our adversaries), DoD's software development and business processes must break out of the industrial-era acquisitions mold.

If DoD charts a course to increase the use of open source software (OSS) and create an internal DoD collaborative code repository the effects would be transformative.

U.S. National Security

Software code has become central to the warfighter's ability to conduct missions. If this shift is going to be an advantage, rather than an Achilles' heel, DoD must pursue an active strategy to manage its software knowledge base and foster an internal culture of open interfaces, modularity and reuse. This entails a parallel shift in acquisitions methodologies and business process to facilitate discovery and re-use of software code across DoD.

The national security implications of open technology development (OTD) are clear: increased technological agility for warfighters, more robust and competitive options for program managers, and higher levels of accountability in the defense industrial base. DoD needs to use open technology design and development methodologies to increase the speed at which military systems are delivered to the warfighter, and accelerate the development of new, adaptive capabilities that leverage DoD's massive investments in software infrastructure.

To summarize: OSS and open source development methodologies are important to the National Security and National Interest of the U.S. for the following reasons:

- Enhances agility of IT industries to more rapidly adapt and change to user needed capabilities.
- Strengthens the industrial base by not protecting industry from competition. Makes industry more likely to compete on ideas and execution versus product lock-in.
- Adoption recognizes a change in our position with regard to balance of trade[1] of IT.

[1] China is striving to become a leader in open source (http://www.linuxinsider.com/story/32421.html, http://business.newsforge.com/article.pl?sid=05/11/04/1727259&tid=110)

- Enables DoD to secure the infrastructure and increase security by understanding what is actually in the source code of software installed in DoD networks.
- Rapidly respond to adversary actions as well as rapid changes in the technology industrial base.

This roadmap outlines a plan to implement OTD practices, policies and procedures within the DoD.

Open Technology Development

There is one thing stronger than all the armies in the world, and that is an idea whose time has come.
— Victor Hugo

Software code has become central to how the war-fighter is able to conduct missions. If this shift is to be a strength, rather than an Achilles' heel, DoD must pursue an active strategy to manage its software knowledge base and foster an internal culture of open interfaces, modularity and reuse. This entails a parallel shift in acquisitions methodologies and corporate attitude to facilitate discovery and re-use of software code across DoD.

Open Technology Development combines salient advances in the following areas:

1. ***Open Standards and Interfaces***
2. ***Open Source Software and Designs***
3. ***Collaborative/Distributive culture and the and online support tools***
4. ***Technological Agility***

OTD methodologies rely on the access ability of a software community of interest or practice to accessible access software code or application interfaces that enable decentralized development of capabilities that leverage the existing code base. OTD methodologies have been used for OSS development, open

standards architectures, and the most recent generation of web-based collaborative technologies.

OTD includes OSS initiatives (e.g., Linux and Apache), but is not limited to open-source software development and licensing regimes (e.g., GPL), which enforce unlimited redistribution of code. It is important, in the context of this report and resulting policy discussions, to distinguish between OSS and OTD, since the latter may include code whose distribution may be limited to DoD, and indeed may only be accessible on classified networks. Nor does the promotion of OTD within DoD impinge on the legal status of software developed by with private sector money by commercial vendors.

Rather, the hinge issues are:

- How can DoD leverage military-funded software development more effectively?
- How can OTD's business-process advantages increase both the rate of innovation and the sustainability of software developed using DoD funds?
- What changes in acquisition practice and policy may be required to capture the benefit of OTD within and across the Defense Department?
- How can DoD leverage existing external OSS resources?

Building on previous OSS studies, experiments, projects, and initiatives, this report recommends shifts in the process of technology acquisition from closed, locked-in black box systems to open and modular approaches. These open approaches are based on open standards, services based architectures, open source collaboration, and reference open source implementations. These shifts, in turn, enable a business process migration from proprietary products that can only be changed by one vendor, towards a marketplace for professional services to extend and adapt capabilities on demand.

This roadmap charts actionable tasks and phases to introduce this change into DoD acquisition and technology development over the next two years, in a way that immediately and aggressively expands DoD's technological agility and the ability of program managers to enforce accountability in software development funded by the military.

Objective: Adapt the current technology acquisitions process to default to OTD implementations.

The objective of this project is to facilitate the transition to OTD practices. The recommended approach is to modify the current system and processes so that OTD practices become default behavior for DoD technology acquisitions programs.

The current environment encourages total control versus sharing and risk taking.

Key to this transition will be a rewards system for encouraging the leveraging of external solutions, taking intelligent risk for substantial gains, and factoring in life cycle costs and advantages that can be passed to other projects.

These new approaches contrast sharply with traditional requirements-based development and procurement programs that do not leverage software development efforts across DoD, either by using existing DoD software or engineering software that can be leveraged from outside of the system in question. Currently, there is little incentive for a program manager to find this leverage, for a variety of reasons:

- Discovery: DoD-developed software that would be relevant to a program is impossible to find because no- one knows what's been developed outside their purview.
- Contractual Intellectual Property (IP) Silos: Contracts are written so that it is difficult to access source code in another program (even by the program manager responsible), much share that source code across programs
- Incentives: Even if they could access source code across DoD, program managers currently have little or no incentive to do so. The current culture encourages and rewards based on budget and organizational size. In this environment saving time by re-using software would reduce their budgets (and thus their prestige) and entail collaboration with a software community of practice, rather than status as sole master of their program domain. Similarly, there are few incentives for a program manager to publish or disseminate code developed by his program,

because doing so does not generate funding to sustain that software.

Incremental changes in requirements, policies, procedures and reviews are necessary to establish OTD as default behavior in the acquisitions and development process.

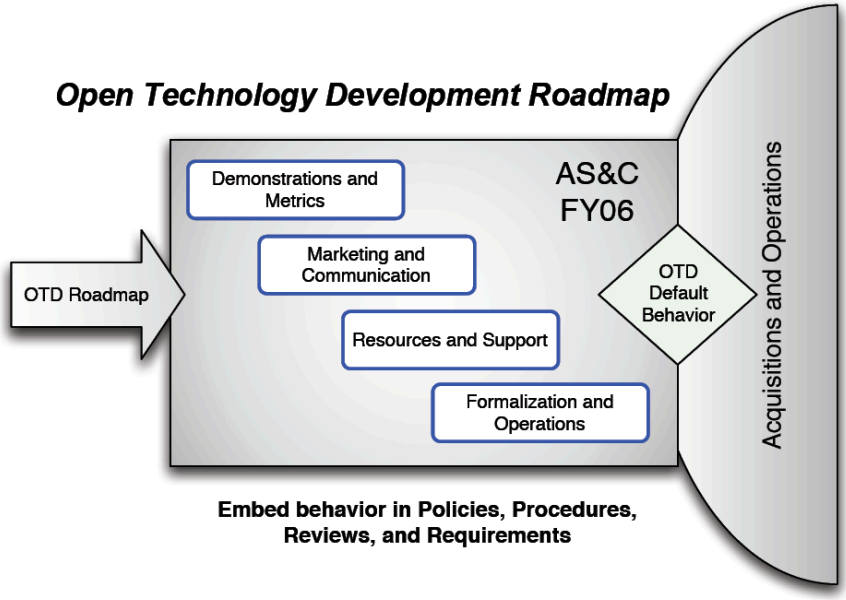

Figure 1 Overall OTD transition approach

Approach

Key to the transition will be the dissemination of OTD as a transformative business process that increases technological agility, expands the range of competitive options for program managers, and fosters accountability in the defense industrial base.

Implementation of OTD can be phased as follows:

- Near term - Demonstrate on AS&C Projects
- Mid term - OTD requirements and process in FY07 AS&C project selection
- Long term - Transition practices to external agencies

The plan will target the following areas:

1. Leverage open source infrastructure and technologies
2. Apply open source collaborative technologies to smaller communities
3. Change the default acquisitions and development behavior to default to technology services vs. products

Ultimately, the government will need to embrace OTD, integrate it into formal acquisition directives and policies and enforce its application through appropriate procedures and review processes.

Recommendations

This roadmap effort proposes a transition to OTD practices in the DoD, initially focusing on the projects and activities within AS&C. Success is defined as a programmatic environment in which policies, procedures, requirements, and practices establish DoD source code access, open interfaces and systems, and collaborative development methodologies as the default baseline for technology development and business process. Once established within AS&C, those processes can be spread to larger programs and acquisitions using the metrics and information gathered along the way.

A multi-prong approach is recommended for FY06.

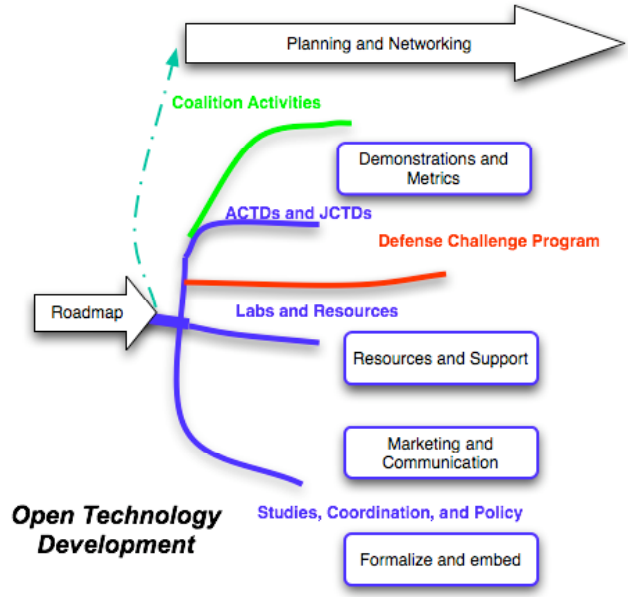

Figure 2 Projects and practices within AS&C will provide the near term focus for the OTD transition activities

The roadmap planning team recommends the following steps to accomplish these objectives:

- Create an Evolutionary Planning activity to oversee and guide transition efforts and establish a government lead
- Create an AS&C Advisory Board to review OTD material, provide advice and activities
- Establish formal relationships with external programs and communities promoting this approach
- Initially focus on AS&C projects, create leveragable software assets and gather metrics.
- Network and communicate these efforts externally
- Establish review gates, policies and processes to reinforce the new behavior

As with any transition, the ultimate goal is to institutionalize the changes. The critical path for OTD is to demonstrate benefits, build

advocacy, and modify the existing system with new OTD requirements, processes and reviews. These changes should be positioned as ways to drive agility, accountability and risk mitigation into design processes and program management, in anticipation of the quicker delivery of a more cost effective, better performing product. An important element of accountability in this context is to consider long term operational, maintenance and lifecycle costs, not only for the current project, but also for the software acquisitions and development process at large.

Introduction & Background

This report provides a roadmap for the meaningful introduction of OSS, open standards, and advanced collaborative technology development into the DoD. The mission, projects, and resources of AS&C provide a logical starting point for these transitional activities. This roadmap focuses on near term actions activities that can be coordinated and managed through the AS&C with the goal of transitioning these activities into the larger acquisition, information technology, and operational structure of the DoD.

Recently, Hon. Ken Krieg (Under Secretary of Defense for Acquisition, Technology and Logistics) stated a potential concern that in less than a decade the projected number of lines of code required for complex software compared to software coders could be overwhelming[2]. The dilemma is clear: if there are not going to be enough engineers to design, build and test software with current methodologies, new methodologies must evolve to better leverage the distributed population of engineers and scientists developing DoD warfighting systems and IT infrastructure.

What is OTD?

OTD refers to a number of practices for development and implementation of current and next-generation software. These changes and paradigm shifts are enabled by the Internet and related technologies, which enable distributed groups of programmers to collaboratively develop and manage code libraries in a decentralized fashion.

The key elements of this approach are:

1. Open Standards and Interfaces
2. Open Source Software and Designs
3. Collaborative and distributed online tools
4. Technological Agility

[2] Conversation with Sue Payton, DUSD - AS&C

Open standards and interfaces were initially established through the Advanced Research Project Agency and distributed via OSS reference implementations. User to user messaging evolved into user-to-user chats, email, and social software such as weblogs, wikis and user-generated data tagging. Distributed communities of interest were able to form and evolve in response to technical gaps and pain points. The resulting set of tools and conventions for agile software development have evolved, coalescing over the last ten years into robust and well-documented methodologies.

Open Standards and Interfaces

As software becomes increasingly networked, design and engineering methodologies have evolved towards services-based architectures that communicate through open and standardized interfaces. Often, these services and interfaces are provided with OSS reference implementations. Once this type of open, service-based architecture is implemented, the system naturally decomposes into a modular design — each service is free to improve and evolve independently as long as it communicates through the standard interfaces.

In this context, any given software service may be COTS, GOTS,[3] or open source — the best implementation can be chosen, evolved and replaced if a better technological option is available. Properly implemented, open standards and solutions create a level playing field that allows the underlying technologies to evolve while minimizing interface complexity. In addition, the modularity afforded by open standards and interfaces radically reduce technological risk by eliminating cascading software dependencies, and reduce financial risk by eliminating the need to re-engineer or re-integrate the system when new capabilities or requirements are introduced.

[3] COTS – Commercial off-the-shelf, GOTS – Government off-the-shelf

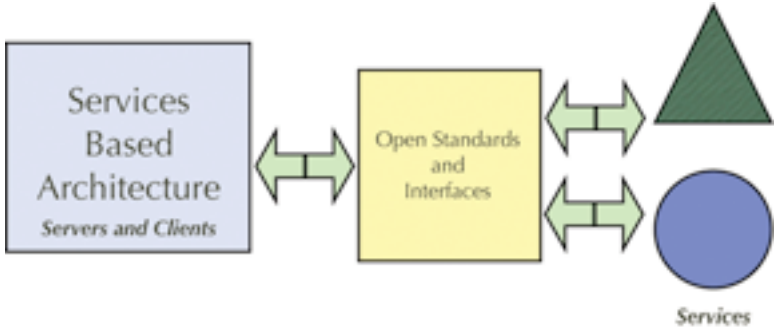

Figure 3 Services based architecture with open standards

- Reduces Technological/Financial Risk and Lock-In
- Component Services can Improve and Compete over Time
- Enables New Technology Insertion Without System Re-Engineering or Re-Integration

To reap these benefits, DoD programs must replace closed systems and proprietary API's with open standards and interfaces. Open Source reference implementations of these interfaces and services validate implementation details; provide basic functionality and a starting point for more evolved implementations.

Open Source Software and Designs

There are over 100,000 publicly available open source projects available spanning most functional areas.[4] Many of these projects provide mature and robust solutions in their areas of focus. When possible, OSS components should be leveraged rather than funding the development of equivalent proprietary components for specific programs.

Initial opportunities for OSS use include Information Technology infrastructure, communications technologies, as well as advanced geospatial infrastructure. Information exchange, geospatial awareness, and advanced collaborative services, which are common requirements of many modern DoD systems. Existing

[4] http://sourceforge.net

open source solutions typically promote and comply with published interface standards, providing systems interoperability. Given the resources being externally applied in these areas, programs should follow, adopt, and leverage these solutions, cognizant of open-source licensing requirements.

Rather than subsidizing the rewriting of existing private-sector code, government resources and funding should be focused on areas where external investment is not being made, areas where military requirements are not being addressed, and classified technologies. Within these areas smaller communities of interest should be encouraged to use the same tools and processes that have proven successful in external open source development. The government has legal and valid military reasons to encourage or require OTD within those communities of interest, allowing specific systems and technologies to evolve more quickly in response to emerging threats and capabilities.

Collaborative Tools and Technologies

Most OSS projects nurture communities of interest whose members have vastly different skills and backgrounds and may never have met face to face. Consequently, a number of tools have evolved to enable efficient network-based communication, configuration management, error tracking, and online collaboration.

In many cases, the tools and distributed nature of the collaboration serve to refine and distill communications, and to drive communities towards the best technological solution for a given problem. Because these communities share both resources and technological needs, the competitive and evolutionary nature of these collaborations quickly leads to standardization on the best-of-breed tools for a given function. When something better comes along, it doesn't take very long for that capability to disseminate between various projects.

A current snapshot of some of these tools and functions would include:

- Mailing lists
- Internet relay chat rooms
- Wiki [5] web sites for communications
- Bugzilla [6] for discrepancy reporting and tracking
- CVS[7] or Subversion[8] for source code configuration management
- Doxygen[9] for source code documentation
- RSS[10] feed for notification
- gcc tools[11] for software development
- Collabnet and others are offering on-line tools for overall project and program management

This genre of tools and technologies should be deployed within DoD software development community to drive OTD. Indeed, “the medium is the message” in this regard, since open source development is inextricable from the collaborative tools used to facilitate it. Without affordances for distributed collaboration between programmers and the formation of decentralized software communities of interest, OTD is not feasible.

Because the pace of evolution of these tools is rapid, it would be counter-productive to lock in particular implementations. DoD development teams need the flexibility to follow and implement the "best of breed" of these tools and services. Similarly, it would be folly (and a contradiction of OTD’s underlying logic) if DoD insisted on the engineering of a top-down code management system or collaborative tool suite specifically for military use, rather than leveraging existing, mature and well-documented COTS capabilities designed specifically for the development and stewardship of source code by distributed communities of interest (including large enterprises which use COTS for this purpose). Current system administration policies and practices of government and contractor

[5] http://www.mediawiki.org/wiki/MediaWiki

[6] http://www.bugzilla.org/

[7] http://www.nongnu.org/cvs/

[8] http://svnbook.red-bean.com/

[9] http://www.stack.nl/~dimitri/doxygen/

[10] http://www.xml.com/pub/a/2002/12/18/dive-into-xml.html

[11] http://www.gnu.org/software/software.html#TOCDescriptionsOfGNUSoftware

organizations will need to be modified to allow the installation and operations of these tool sets.

Technological Agility should be a metric
— Col John Boyd

The pace of technological innovation continues to accelerate as new tools and practices continue to evolve. The government should avoid standardizing and requiring specific operating systems and applications and encourage the continuing refresh and applications of the latest approaches. To maintain a technological lead, it will be increasingly important to provide the flexibility to adopt new solutions and services as they are developed externally.

Appropriate review and validation of various technologies will be incorporated into the plan. Specialized or critical areas such as real time code, guidance systems, and cryptographic processing areas will require more stringent testing than generic information technologies that are in wide use. Contractors that deliver solutions will need to test and validate their deliverables in all cases.

Continued emphasis on spiral and evolutionary programmatics will be required. The current pace of external technological advancement needs to be factored into our programs. Large hierarchical management and design teams need to be re-factored into more autonomous design teams that communicate through collaborative tools.

Information Gathering

Open Technology Design practices are expanding in many areas of commercial and government business. To assist AS&C in its adoption of these practices the team has begun to gather relevant information and make contact with some of these efforts. Information gathering will be an ongoing component of the OTD transition plan so that we may apply existing resources and lessons learned to our efforts.

Historical Background

Government Research and Development is best applied to evolving technology and science in areas where commercial business cases

have not yet formed. In these areas, it is often the case that a commercial return on investment argument is difficult, even when the desired capability would be in the national interest. To support these initiatives the DoD has evolved advanced projects through DARPA followed by cost plus contracts with requirements based development through the acquisitions system. Cost plus contracts mitigate the risk and establish a workable business model for government contractors to pursue national objectives while developing unique and complex systems.

This structure has evolved and created its own culture and processes within the DoD and its associated contractors. When this system was originally created, the government generated the vast majority of research and development funding. The government was able to guide and control these technologies due to this control. Today, there are still many cases where this funding, leadership, and control remain with the DoD. Examples include advanced aircraft, ships, tanks, and weapons systems.

In many other areas the technological leadership is now external to the DoD. Business models have evolved to support higher levels of research and development funding as well as new development practices. In the case of computer and information technology the innovation is primarily coming from outside of the government. Often, the government lags in adopting these technologies and practices. The current DoD requirements process and approval process is slower than the rate of technological advances in these industries. In many functional areas it can be argued that technology is now a “commodity” — especially areas where robust open source solutions exist. Commodities should be acquired in an open market using commercial practices. Technological development and integration on these commodity open source technologies should be treated as a professional service — not a product.

Some of the more innovative DoD projects have involved small teams working outside of the standard acquisition and development practices. Government decision makers have recognized this in recent years. The 845 contracting mechanism employed within the NGA National Technical Alliance, DARPA challenges, and other DoD programs are just a few of the mechanisms that are attempting to address this growing gap between internal and external technologies. A number of agencies are currently looking into ways

to speed up decision and contracting cycles to close the gap with commercial cycles.

The pace of technological change continues to accelerate and more technology is being developed externally. Additionally, Internet based collaborative technologies and distributed development tools have created a paradigm shift with OSS and open standards. At a minimum, these advances need to be effectively leveraged and applied in government activities. Given that these same advances are openly available and can be accessed internationally - it becomes strategically important that our existing acquisition practices do not put us at a disadvantage. Agility of capabilities deployment needs to become the mantra for the DoD acquisitions community.

Fortunately, there are prior examples where agility of technology development was a virtue not a vice. In the book *Skunkworks*, by Ben Rich and Leo Janos, they describe the process of how Lockheed's advanced airplane design division, Skunkworks, rapidly assembled some of the planes they are known for:

> "We [...] were able to keep costs down by incorporating the flight controls of the General Dynamics F-16 fighter and using the engine from the McDonnell Douglas F-18. We didn't start from scratch but adapted off-the-shelf avionics developed by others"

Parts and pieces were scavenged off of existing platforms; this lowered the risks that a major technology project would not fail due to a new flight controller or engine. This is the essence of OTD: using and improving what is already present, so that new time and energy can be spent on future technology challenges, not building existing systems.

Currently, within DoD acquisitions programs software code is reused on a limited basis. For example, within an individual DoD program office, software code from a previous contractor may be shared with a new contractor taking their place. But as a rule, sharing of code across the DoD enterprise does not occur. As a result the possibility that development funding is wasted by multiple efforts is high.

Champions and How They View OTD

> *CIO's who don't come to term with this [open source] revolution in 2003 will be paying too much for IT in 2004*
> *CIO Magazine* [12]

Champions — Public & Private Sector

- U.S. Federal Government, Component Organization and Registration Environment (CORE), [13]

CORE.GOV provides a collaboration environment for component development, registration, and reuse. CORE.gov began operation in March 2004. Over time, it will become a networked community of component developers and users and will offer numerous components of various types and complexities, including business components, e-forms, and technical components.

CORE.GOV grew out of the Federal Enterprise Architecture Project Management Office, the goal of which is to support cross-agency collaboration, transformation and government-wide improvement. CORE.GOV offers an environment where component developers and users collaborate seamlessly and easily.

- International Business Machines (IBM) [14]

In a word, open source is collaboration. More specifically, it's public collaboration on a software project. IBM has committed to open source in a big way with contributions to more than 120 projects, including more than $1 billion in Linux development. According to the Open Source Initiative (OSI), it can be defined this way: "Open source promotes software reliability and quality by supporting independent peer review and rapid evolution of source code. To be OSI certified, the software must be distributed under a license that guarantees the right to read, redistribute, modify, and use the software freely."

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[12] http://www.cio.com/archive/031503/opensource.html

[13] http://core.gov/

[14] http://www-128.ibm.com/developerworks/opensource/

The community source approach at IBM is a means to an end. We believe in an Internet connected world with the business requirements that the on-demand era of information technology is suggesting. There is going to be an important shift and to deliver technology that addresses that shift in both customer requirements as well as our technological capacity, we have decided to systematically componentize and modularize our software. That is allowing us to get to the market much more quickly to address these requirements in a much more time and cost effective manner.

So with that recognition that this is the way we are going to develop software going forward it is clear to us that the way we traditionally develop applications is sub-optimal to achieve this goal. It's a very ambitious goal; no one has tried to do it on the scale and scope that we are doing it.

We very much believe that the software industry is moving through the same kind of componentization transition that many other industries ranging from the automotive industry to the disk drive industry and chip industry have all gone through. And the companies that emerge from this transition and have successfully broken their products down into sub-assemblies to reusable components will have tremendous advantage in the marketplace. So that's the driving motivator. Community Source is a way to get there.

- Computer Sciences Corporation (CSC) [15]

The lure of OSS is that it is free — anyone can use it or modify it without license fees, and no vendor can lock users in for fixes and enhancements. Open source has spawned a worldwide development community that improves and fixes the software, often much faster than in the proprietary vendor world. The disruptive nature of OSS makes it the focus of the 2004 CSC Leading Edge Forum report, Open Source: Open for Business.

[15] http://www.csc.com/features/2004/48.shtml

- Hewlett-Packard (HP) [16]

HP has more than 200 products that ship with OSS. HP hosts more than 50 open source projects on SourceForge, the online open source repository.

- Apple [17]

Apple's open source projects allow developers to customize and enhance key Apple software. Through the open source model, Apple engineers and the open source community collaborate to create better, faster and more reliable products for our users.

As the first major computer company to make Open Source development a key part of its ongoing software strategy, Apple remains committed to the Open Source development model. Major components of Mac OS X, including the UNIX-based core, are made available under Apple's Open Source license, allowing developers and students to view source code, learn from it and submit suggestions and modifications. In addition, Apple uses software created by the Open Source community, such as the HTML rendering engine for Safari, and returns its enhancements to the community.

Apple believes that using Open Source methodology makes Mac OS X a more robust, secure operating system, as its core components have been subjected to the crucible of peer review for decades. Any problems found with this software can be immediately identified and fixed by Apple and the Open Source community.

- Google [18]

Chris DiBona, Google's open source program manager, said, "Google is promoting, supporting and using open-source software." Google currently supports OSS such as Jabber, GoogleMaps and uses open API's to Google's platform.[19]

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[16] http://opensource.hp.com/

[17] http://developer.apple.com/darwin/

[18] http://www.eweek.com/article2/0,1895,1877924,00.asp

[19] http://code.google.com/

- Merrill Lynch

Merrill Lynch sees software as an enabler of their competitive advantage. They have more than 4,000 developers working on open source technology. Merrill is both actively contributing to the public open source code base as well as reusing specific Merrill-enterprise software code.

- Sun Microsystems

Sun has already released most of Solaris as open source, and is now promising to release the Java Enterprise System, N1 System Manager, Identity Management Suite, SunRay server software, developer tools, and more. [20] They are also planning to fully integrate all of this software into the Solaris OS, to provide an integrated stack called the Solaris Enterprise System. The Sun Java Enterprise System and developer tools are also available for other platforms, including Linux, HP-UX, and Windows.

Scott McNealy Founder and CEO, Sun Microsystems — “You learn to share in preschool. Later you learn that if you make the pie bigger, everyone gets a little more. These lessons came together when we started Sun. We didn't have the resources to do everything ourselves, so we shared what we had to attract customers and get their help in building the business. There are now 4.5 million Java developers and about 950 companies worldwide all collaborating on a technology Sun shared with the community.

This is possible because sharing creates communities, which create new markets. It's also changing business models: Companies can no longer expect to lock in customers with proprietary standards. They must now compete on the value of their business execution. They monetize that value a little bit, spread over the entire community. With 1 billion people on the network today, and several million more joining every week, there's a lot of opportunity. So while it may seem counterintuitive for a company to share, it's the key to larger economic growth — not only for Sun, but also for everyone in the world.”

[20] http://trends.newsforge.com/trends/05/12/01/1422245.shtml?tid=138

Benefits

OSS development and integration emphasizes a spiral development approach. Software baselines are periodically tested and released. Internally, most projects are managed in a hierarchical and modular structure. Systems integration ties the various capabilities together through open standards, linking to project functionality, or wholesale integration of working source code into other projects. In other words, OSS does *not* imply laissez-faire project control — there are management controls, deadlines, etc. in OSS development just as there are in any other product delivery activity.

The "Open Source Model" is a very practical way of evolving technology in a rapidly changing environment. The supporting collaborative tools that have enabled open source development harnesses the collective wisdom, experiences and requirements of its most demanding users to ensure that needs are rapidly met. In recent years this model has rapidly transitioned from a small group of technical early adopters to widespread deployment in the corporate world. OSS technology stacks now form the basis of the bulk of Internet and information sharing technologies.

The latest innovative advances in languages, services based architectures, and standards based approaches have their roots in open source projects. Most successful OSS projects have the same features as proprietary software: [21]

- Commercially available technical support
- Training classes
- Managed Release Schedules at reasonable intervals
- Binary distributions for popular platforms
- Active User's Groups exchanging experiences

[21] http://www.theaceorb.com/product/benefit.html

A summary of some additional advantages offered by OSS:

Encourages software re-use

OSS development allows programmers to cooperate freely with other programmers across time and distance with a minimum of legal friction. As a result, OSS development encourages software re-use. Rather than endlessly reinventing wheels, a programmer can just copy someone else's elegant tire from another machine.

Can increase code quality and security

With closed source software, it's often difficult to evaluate the quality and security of the code. In addition, closed source software companies have an incentive to delay announcing security flaws or bugs in their product. Often this means that their customers don't learn of security flaws until weeks or months after the security exploit was known internally.

Open source software is potentially subject to scrutiny by many eyes

Therefore bugs, security flaws, and poor design cannot hide for long, at least when the software has a community of programmers to support it. And since fixing the code doesn't depend on a single vendor, patches are often distributed much more rapidly than patches to closed source software.

Decreases vendor lock-in

Businesses no longer have to be locked-in to the whims of a sole-source vendor. No more paying a vendor for a needless upgrade, simply to maintain compatibility with others using the same software. Business data is also more "future-proof", since most open source programs save text files in ANSI standard ASCII files, instead of proprietary binary formats. If the vendors training materials are inadequate, because they have access to the source code, external vendors can supply as good or better manuals. Most successful OSS programs have extensive online FAQ's, manuals, and mailing lists.

Reduces cost of acquisition

Most OSS is available for a nominal cost, often the price of the media, or the time of the download. No more "per-seat" license fees. Reduced acquisition cost means that start-ups don't have to part with precious capital when they need it most. Established companies can try the software with minimal risks. If the company wants to develop a piece of software that they don't plan to use to

differentiate them, they can reduce the cost by collaborating with several companies on the same code base. If you want to incorporate the code into your product, you don't have to pay a license fee.

Increases customizability

Every organization has unique needs or desires. Linux has been ported to everything from embedded microcontrollers, to IBM mainframes. If there's a nagging bug you want fixed, you can hire someone else to fix it. If two programs don't play well together, one or both can be modified to eliminate the incompatibility.

Meritocratic community

A true meritocracy, in the open source community, a programmer's status and fame depends on programming skill. Open source expertise travels well, and you can reuse software you developed for one company at future employers. When one government agency develops or modifies a technology, that benefit is available to other government agencies by default unless restricted by security processes. [22]

"If I have seen further it is by standing on the shoulders of Giants." — Isaac Newton

The scientific process has become one of the most successful areas of human endeavor due to its openness, the free exchange of ideas and the steady accumulation of knowledge available to all. It has overtaken all competing methods of analyzing the world around us, by showing that it can consistently deliver better results. The status achieved by science took a long time to arise, and even though we find its power now utterly compelling, this wasn't always obvious to everyone throughout much of history.

The open source development process will eventually become the most successful due to its advantages of openness and the free exchange of ideas, and the steady accumulation of program source code available to all. The open source development method will overtake competing software development methods to achieve this status by consistently delivering better results. While we now

[22] http://www.openknowledge.org/writing/open-source/scb/why-open-source.html

glimpse the compelling nature of this promise, this has not always been the case throughout much of the IT industry's history. [23]

[23] http://www.cyber.com.au/users/conz/shoulders.html

Roadmap Activities

The Open Technology Development roadmap activities were accomplished from October to December of 2005. The team employed the same collaborative tools and practices that are used in online development to coordinate and prepare this report. Many studies and initiatives[24] have been previously accomplished in this area. As in a typical OSS project, the study has attempted to reuse and leverage much of that work. A Wiki (online collaborative space) was employed for communication and collaboration; online publishing resources were used for the final report.

Goals

The practices, tools, and resources employed by OSS projects and solutions have consistently outperformed traditional closed source methodologies. These practices are also being applied to hardware design and collaboration between communities of interest.

Ultimately, there are three defined goals:

1. Leverage open source infrastructure and technologies
2. Apply open source collaborative technologies
3. Change the default acquisitions and development behavior to default to technology services vs. products

Success occurs when these methodologies are applied by default in the development of technology within the DoD. The transition includes multiple tasks and sub-goals in near, mid, and long term phases.

Creating an index that would allow DoD to discover source code is key to this project. Initially the index would be person -entered lists of types of software projects; later more advanced and automatic-indexing services could be deployed. These needs have already

[24] MITRE Open Source Software Report, OSD-CIO Office OSS Memo

been addressed with the proliferation of open source projects; repositories, indexes, and rating systems have been developed and deployed as open source solutions.

AS&C Role in Open Technology Development

AT&L, and AS&C specifically, have already played a central role in changing how technology is developed and deployed for the military. OTD would continue that trend by enabling DoD as an enterprise to be more agile and innovative delivering solutions to the warfighter at an increased rate.

AS&C can create and lead the community of interest by fostering and investing in methods leading to the adoption of open technology methods. Key areas need to be researched for DoD in the policy (contracts and acquisitions) and legal (such as copyright and software distribution) arenas. Investments also need to be made in basic enterprise collaboration infrastructure, such as websites, etc. AS&C can be the organizing node for DoD OTD and develop the standards for new communities to index, search and discover new software code.

The Advanced Concept Technology Demonstration (ACTD) program could also promote the use of OTD by forcing contractors to use OSS and promulgate those changes (where applicable) back into the private sector or DoD enterprise. ACTD could also pay for code delivery, support, and integration.

Senior Leadership Role

For OTD to flourish, AS&C will need to provide top level cover for these bottom-up efforts. It is recommended that the senior leadership focus on internal and external communications supporting the OTD benefits and transition. The planning staff should assist with the drafting of letters, policy statements, and news stories that discuss both the need and implementation for the OTD transition.

In roadmap meetings, DUSD (AS&C) Ms. Sue Payton outlined the following talking points that she intends to focus on in the near term:

1. Increased military jointness
2. Manufacturing needs to be at lower costs
3. OSS software process provides better producibility

Clear and periodic communication with OSD oversight personnel, program managers, contractors, and other senior OSD staff will be key in assisting this transformation. Reinforcement through formal communications, policies, processes, and advisory teams will help to embed this behavior into the system.

The OTD transition is consistent with external initiatives in other areas of DoD and should be linked with those efforts when possible:

- The Secretary of Defense (SecDef) is being briefed every month about how we can shrink the force (by lowering workload because OSS may help reduce the workload and yield other benefits. The SecDef should be briefed on these benefits).
- 2002 Defense Bill – entitlements were $4 billion; in 2009 it will be $20 billion. Need to do more with less
- Defense Business Transformation Efforts
- Initiatives emphasizing networking vs. hierarchical control structures
- Disruptive technology evaluations

A component of the leadership role for AS&C is to develop DoD sponsors and dedicate internal human resources for coordination and transition of the OTD effort within OSD. An OTD point person within AS&C would enable the OTD effort to more successfully navigate OSD policy, legal and acquisitions structures as well as facilitating the deployment of these methodologies within programs and projects. This position could be either an IPA or a federal government employee. It is important for AS&C to designate this position as a means of maintaining persistent focus on the OTD agenda and deflecting industry-sponsored efforts that could dilute or change the vision.

Finally, the continuing support of the DUSD AS&C in periodic OTD status and planning meetings will be key to the success of the transition.

Challenges

Culture and Process

The primary challenges to this transition will be cultural, not technical. Over time, government acquisitions and development processes have built a bureaucracy and rewards system that encourages and supports the status quo. Careers are advanced primarily on program size, not necessarily overall efficiency. Furthermore, government contractors are measured by revenue; government program managers are measured by the size of their organization and their overall budget. The canonical government contracting process creates high entry costs for small innovative companies — the established contractors attempt to control their positions through proprietary implementations and interfaces. The system is very good at protecting itself — new approaches, such as OTD, will have to endure legal, security, and process challenges. The current infrastructure will attempt to delay change, claim they are adapting by trying to assume control of the innovative process.

To accomplish this transition, outside resources, contractors, and practices need to be brought in. The system and current processes will need to be incrementally modified to impose new requirements, processes, metrics, and reviews. In the end, budgets and contracts will drive the change as new business models are implemented. The challenge is to change the environment and the current system defaults. In this regard, the system and bureaucracy is our friend and it will be necessary to sell “Accountability” as the driver for the changes. It is hard to argue against accountability.

Program managers and leaders need to take ownership of the life cycle costs of their solutions. Metrics and reviews will need to be imposed that highlights this accountability. Credit and rewards should be provided when those solutions are leveraged. The OTD process has to ensure that the Program manager is properly supported as OTD projects are measured against the current system. Recognition and rewards need to be established for Program managers that deliver open solutions.

There are a number of technical and process changes that will be required — again these are not technical issues, but cultural ones. The collaborative tools, databases, discrepancy reporting,

configuration management, and testing tools exist and work well in the unclassified network environment. Experts and supporters of the external projects are in the best position to introduce the rapid spiral and collaborative teamwork practices. Support and education of these new practices to government contractors will occur, as the functionality is integrated and applied to government use.

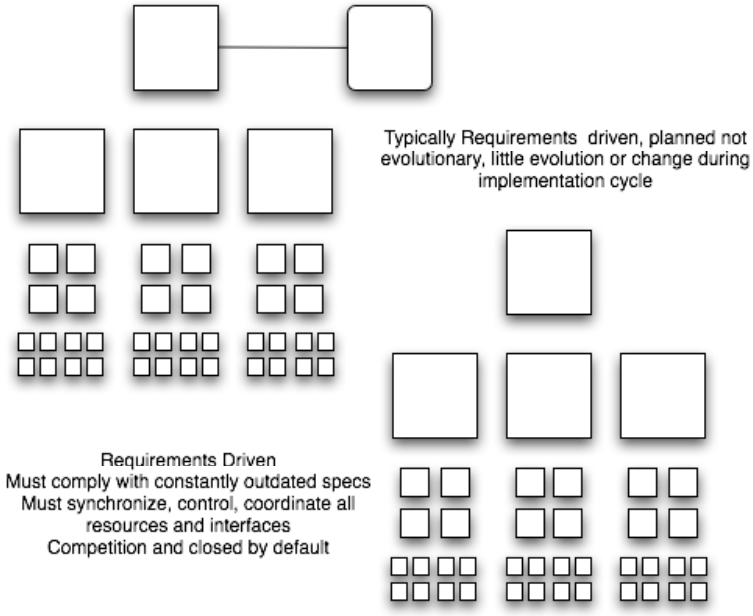

Figure 4 Hierarchical structures of traditional programs

In the extreme, traditional government acquisitions are managed on fairly long timelines beginning with requirements definition followed by resource allocation and scheduling and then implementation. These processes and structures typically don't respond well to change once the waterfall schedules have been generated and reviewed. Tasks are decomposed into sub-tasks and programmers are assigned to implement. Programmers are forced to live within their sub-task boxes — Program Managers keep everyone focused on their assigned area. New functionality is discouraged in this process. It requires a new validated requirement and an engineering change request before implementation.

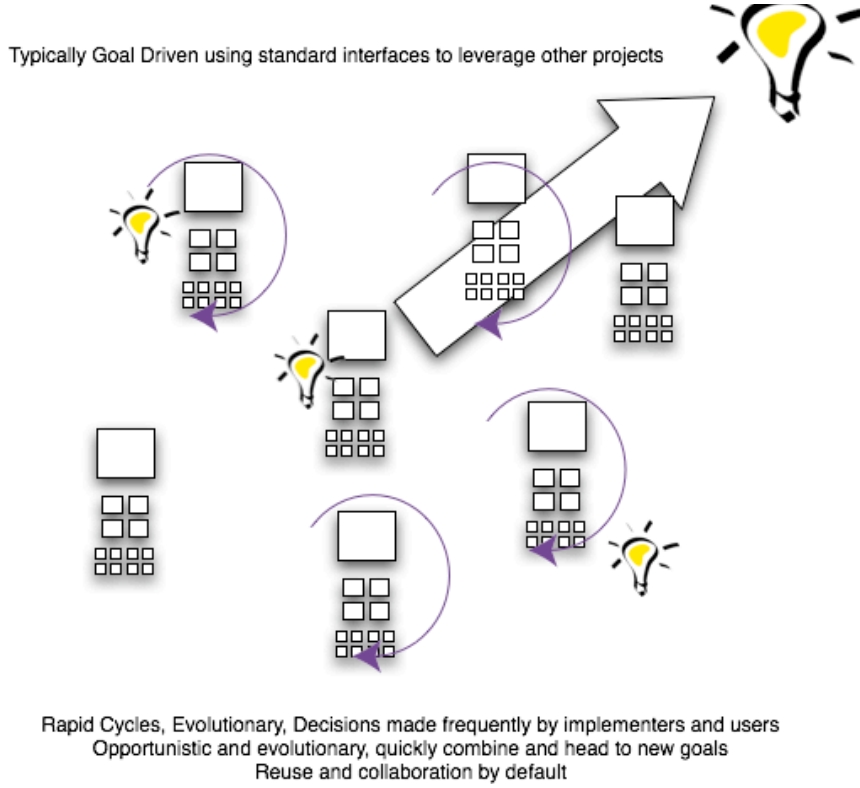

Figure 5 Goal driven collaborative projects, with internal hierarchies

Open source projects are goal driven and very opportunistic. Contrary to popular belief, they are often hierarchically managed with defined areas of responsibility assigned to module leads. Implementations can quickly change direction to take advantage of other open source code that is discovered. Innovation and communication is rewarded with increased recognition and responsibility. Standardization of interfaces allows decisions to be made by the implementers. Automation, efficient communication, and access to the latest tools is expected and required in this environment.

Obviously, there will be a number of challenges in integrating these two approaches. Some of those challenges are:

- Velocity of Change
- Requirements based vs. Goal driven spiral development
- IT culture — transition from meetings to groupware
- Adoption of OTD practices that are emerging in academia and the commercial world
- Industrial Base business plan
- Lack of Open Source Skill Set in Government
- Metrics for evaluating OSS products

Software Project Governance

As mentioned previously, traditional software development projects are managed in a top-down hierarchical fashion. OTD projects instead rely on different models of governance to decide the direction of software code. Some of the better know software projects have the following governance structures[25]:

1. Benevolent Dictator(s). In the case of the development of Linux, Linus Torvalds makes the final decision with respect to direction of the code, but has lieutenants who have responsibility over various pieces of software code. Lieutenants organize the various people who wish to play a part, accepting and modifying code as it submitted.
2. Exclusive Group. The Apache webserver group is composed of about a dozen people. Only these people are allowed to make changes to the releasable version of the code. Suggestions are submitted, but the core group members are the only ones who make and release changes in the code.

It should also be noted that no individual within these communities is being directly paid by the code-group for their involvement with the community. Each person volunteers his/her time to work on the software code, some individuals may have support as part of their job responsibilities with an employer while others work these projects on their own time.

Community governance is a key issue to developing the OTD model within DoD. The OTD team needs to develop a governance model that will enable the development users and

[25] The Success of Open Source, Steven Weber

developers, and those who fund it to feel that their contribution matters and is needed by the community.

Software Policy and Licensing

There is a clear distinction between using open source code developed in the private sector and fostering an OTD development methodology within DoD. A distinction has been made for use of OSS by both the White House (Federal Government Policy on the use of OSS[26]) and the DoD Chief Information Officer (CIO) (OSS in the DoD[27]); both state that OSS can be treated like proprietary software as long as the software meets DoD requirements (acquisitions rules, security, etc.).

What is less clear, however, is how the U.S. Government (USG) deals with distribution of software code it has paid for or how federal government employees deal with copyright, since current OSS licensing uses copyright as its foundation. Legal and contract issues may arise when contractors and federal workers modify and distribute code into the public domain. Also, for government contractors there is a desire to negotiate away any rights the government has to distribute new code, either internal to the DoD enterprise or into the private sector. Current literature[28] defines several significant areas with IP law, created versus purchased software, services and contracts that need to be evaluated and policies created before a large scale DoD-wide OTD rollout.

There currently is not any DoD mandated policy on how to deal with copyrighting of software created, or modified by government employees, since copyright is automatically granted to the creator of the software work. There are a few groups within DoD who have begun researching the legal issues (Dept of the Navy CIO) around OTD, but these groups have access to only limited funding, which will slow the adoption of OTD methods by DoD.

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[26]Federal Government Policy on the use of open source software, OMB Memorandum M-04-16, SUBJECT: Software Acquisition, http://www.whitehouse.gov/omb/memoranda/fy04/m04-16.html

[27] Open Source Software (OSS) in the Department of Defense (DoD), May 28, 2003, DOD CIO Memo

[28] Licensing Software and Technology to the U.S. Government, M.S. Simchak, D.A. Vogel, CCH Incorporated, IL, 2000

It is important to note that many of the legal and IP issues surrounding OSS in the private sector do not necessarily apply to software that is developed exclusively for DoD use and not released outside of DoD; IP issues for this software can be navigated within the Federal Acquisition Regulation (FAR) by well-informed contracting officers and program managers. In order to reduce contracting officers' and program managers' "fear uncertainty & doubt" factor regarding OTD and increase the level of leverage in negotiations with vendors, one concrete step towards clarifying the legal status of OTD within DoD is the creation of an OTD License (OTDL) by DoD through the general counsel's office. This license would clarify that the software developed under OTDL will become source accessible across DoD and/or the federal government (for software likely to be used by multiple federal agencies, the latter may be desirable). Such a license would clarify the distinction between DoD or government rights to the source code and commercial rights to the software, which may be retained by developers, as they already are under the FAR.

A DoD/USG Open Technology License is a tool that would greatly facilitate the adoption and dissemination of OTD practices in the face of cultural resistance from vendors and business-as-usual program managers. It would require resources for the legal time to craft such a license, but the investment would reduce friction for OTD as it scales.

DoD Acquisitions Process

Developing a robust underlying code base for the DoD enterprise is important. Unfortunately, the current DoD acquisitions process limits the ability of DoD to reuse software code to scale solutions across the enterprise. Instead, contracts and DoD rules encourage individual offices to not share code. The end result is that DoD software cannot be rapidly changed to meet new missions and DoD becomes less agile as an enterprise.

OSD AT&L has created the Defense Acquisitions Performance Assessment (DAPA) Report[29] to review acquisitions capability delivery to the warfighter.

[29] http://www.dapaproject.org, January 2006

Relevant recommendations for OTD include:

- Strategic technology exploitation is a key factor that allows the U.S. to maintain dominant military capabilities. Militarily critical technologies need to be identified and documented early in the acquisition process to ensure that cutting edge technologies have appropriate export controls.

- The fundamental nature of defense acquisition and the defense industry has changed substantially and irreversibly during the past 20 years. New and emerging global markets have substantially affected the dynamics of acquisition reforms envisioned in the Goldwater-Nichols Act. In 1985, defense programs were conducted in a robust market environment where more than 20 fully competent prime contractors competed for multiple new programs each year. The industrial base was supported by huge annual production runs of aircraft (585), combat vehicles (2,031), ships (24) and missiles (32,714). In 1985, threats were well-known and well-defined. This allowed the Department to conduct stable strategic planning. Today, the Department relies on six prime contractors who compete for fewer and fewer programs each year. Reductions in plant capacity have failed to keep pace with the reduction in demand for defense systems (188 aircraft, 190 combat vehicles, 8 ships, 5,072 missiles). The security environment has become unpredictable — threats are often difficult to define and situations often require asymmetric responses. The world dynamic has changed.

- The Department must be agile — to an unprecedented degree — to respond quickly to urgent operational needs from across the entire spectrum of potential conflicts.

- The Department compounds the chaotic nature of its financial model with a program oversight philosophy based on lack of trust. Effective oversight has been diluted in a system where the quantity of reviews has replaced quality, and the tortuous review processes have obliterated clean lines of responsibility, authority and accountability.

- Complex acquisition processes do not promote program success — they increase costs, add to schedule and obfuscate accountability.

Implementation Plan

The roadmap activity has created a forward action plan for beginning OTD transition efforts in 2006. The approach is shown in the following diagram:

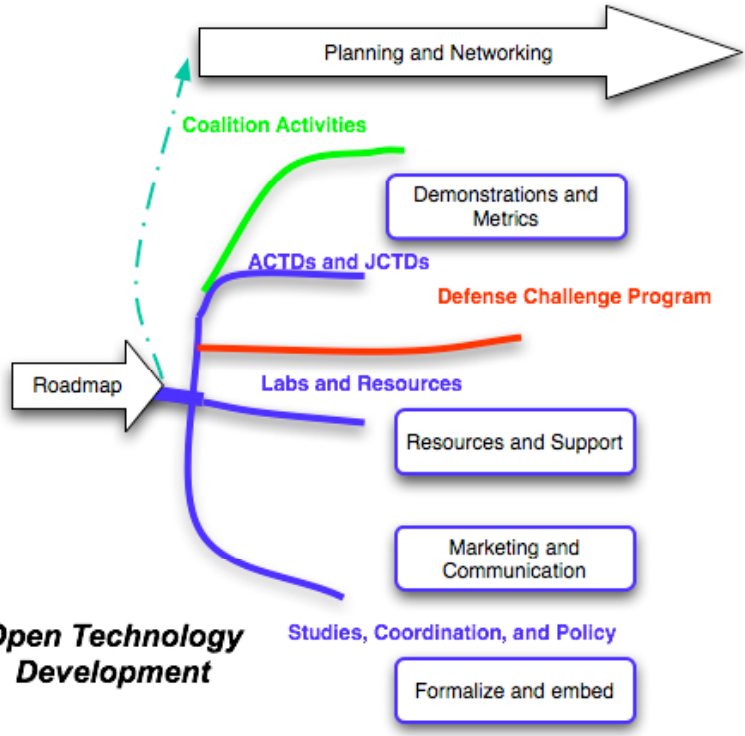

Figure 6 Functional activities for FY06

Each of the functional areas is covered in more detail in the following pages.

1. Planning and Networking

The OTD team augmented with additional technical support will continue to coordinate, plan, and gather information to support the transition. These activities will be funded through the Large Data JCTD, as this is one of the first projects that intend to implement

these practices. The main function of the core OTD team will be to oversee and assist efforts in the OTD Implementation Plan:

- Near term — Demonstrate OTD with AS&C Projects
- Mid term — Address OTD requirements and review in AS&C Project selection process
- Long term — Conduct external coordination and collaboration

2. Demonstrations and Metrics

To accomplish the transition, initial emphasis should be placed on bringing in external OSS resources and projects to demonstrate the methodology and educate projects on these practices. Where possible, existing key contributors and developers of open source projects should be subcontracted for technical implementation.

Demonstration

ACTDs and JCTDs

- Educate
- Target specific activities for implementation*
- Carrot & Stick approach
- Communities of Interest that have no formal support (GIS, Modeling & Simulation)
- Identify leaders and champions

Coalition Activities

Coalition activities should be a key area to focus for the adoption of OTD activities. Historically, technology development between coalition partners has been a goal that has proven difficult to achieve. Good ideas and projects are often bogged down in import/export or intellectual property issues. In some cases, a solution is imposed on participating members, thus denying the benefits that might be achieved through collaborative development.

OTD in general and OSS in particular provides a logical mechanism to demonstrate international technology collaboration. Starting with information technology and information exchange, there are many open source projects that could be quickly applied to meet mission requirements. Since the underlying technologies are already being

developed online with international communities of interest, many of the historical problems do not exist with this approach.

Recommendation: *Evaluate the potential use of the Defense Acquisition Challenge (DAC) program to demonstrate Open Technology alternatives to projects or programs that have implementation issues; e.g., make application of open source based products or development methodologies a specific interest item for DAC.*

Metrics

DoD must work to increase transparency of software in programs (costs, reuse, etc.), and enforce modularity in programmatics: one proprietary element cannot be allowed to zero the reuse value of an entire system developed on DoD's budget.

Shifting Program Evaluation & Incentives

- **Software Architecture is Transparent and Modular**

  System is Transparent: Developed and managed as a set of self-contained or loosely coupled functional components. If components interact, there is an explicit and non-proprietary set of inputs and outputs for each functional component

  System is Adaptable: Functional components can be updated or replaced without ripple effects to the system as a whole, as long as new components address non-proprietary input and output requirements.

Modularity is important not just because it increases DoD's agility, but also because it allows OTD to accommodate proprietary software applications without compromising this agility. There are a lot of great proprietary applications in the DoD software space, and there is nothing wrong with using them. But DoD cannot allow one proprietary software element to compromise the sustainability and leveragability of its investment in an entire IT system. Modularity ensures that proprietary elements can be part of the IT ecosystem without contaminating the source-use of DoD-funded systems.

- **Lock-in Quotient**

To what degree is the program "locked in" to a proprietary software application? The development of quantitative metrics for lock-in quotient, from completely modular and open to "if we want to make a change, we have to deal with vendor X or else start over" would force the evaluation of both technical architecture and contracting/legal agreements. Differential flow of money to less locked-in projects would heighten program managers' awareness of these issues, which they might not have heeded before. That is, they let their contracting officers take care of the paperwork, and the paperwork puts DoD in a straightjacket with regard to IP and re-use.

Lock-in metrics also allow DoD to avoid an untenable "all or nothing" policy position about OTD. Rather than declaring that all DoD IT development will be open by a certain date, the lock-in quotient for programs funded by AS&C (or other DoD agencies) can be lowered over a period of time, which gives the industrial base both a competitive incentive and time to adjust.

- **Leverage Quotient:**

What proportion of a proposed system leverages existing GOTS or OSS components? Leverage quotient is a measure of software development efficiency — leveraging use of existing software rather than re-inventing the wheel. Leverage should be positively rewarded and viewed as an innovation driver, not just a cost savings mechanism. The question is, if a contractor could find GOTS components for x% of the system, what would it do to build new or better capabilities with the money it otherwise would have spent rewriting code?

Leverage quotient metrics, like lock-in metrics, can be ratcheted towards OTD over time. The goal is to create a rewarding niche for high leverage technology proposals, while preserving a niche for projects that are lower-leverage because they are truly cutting edge.

- **Multiplier Metrics:**

For ongoing DoD programs, a Multiplier Metric is the flip side of the above Leverage Quotient — how many times have software components of a program been leveraged by other programs or

projects? If a program ABC spends $1M on a given software capability, and that capability is used by four other systems that otherwise would have re-developed the same capability, then program ABC has a 4x multiplier on investment for that software component.

This metric, combined with money incentives, provides incentives for PM's to not only share, but to evangelize re-use of their systems, which drives participation in software repositories and information sharing vs. hoarding. We must remember that a lot of the behaviors we want to encourage, i.e., promoting awareness of existing software and facilitating code transfer across services, are largely voluntary behaviors and must be worthwhile for the individual program manager. We have to answer the "what's in it for me" question. If a program manager can demonstrate that he is a force multiplier in DoD software development, his IT budget should reflect that DoD gets a disproportionate bang for its buck from this program.

Conversely, program managers who see that the other guy is getting more money because his software is getting more reuse will be forced to consider the possibility that they might be missing out because no-one knows how much better their code is than that other guy's, and then do something about it. In a zero sum federal budget game, the threat of lost resources is often a more powerful incentive than the hope of new resources. In the current system, fear of lost resources drives people to secrecy and hoarding. The role of policy (and shifts in funding) is to tilt the game so that fear drives people to open development methodologies and networked communities of interest.

3. Resources and Support

Resources and support will be required to move forward with this transition. Much good work has been previously accomplished with regards to policy, evaluation, and development of relevant technologies. Where possible we will want to leverage these assets towards the end objective. OTD transition activities should include collaboration with national labs, academic institutions and supporting government agencies that are already engaged in OTD activities in a variety of domains. This section identifies some of those resources and communities of interest, which should be

networked and leveraged to achieve greater-than-sum-of-the-parts effects in transition and dissemination of OTD.

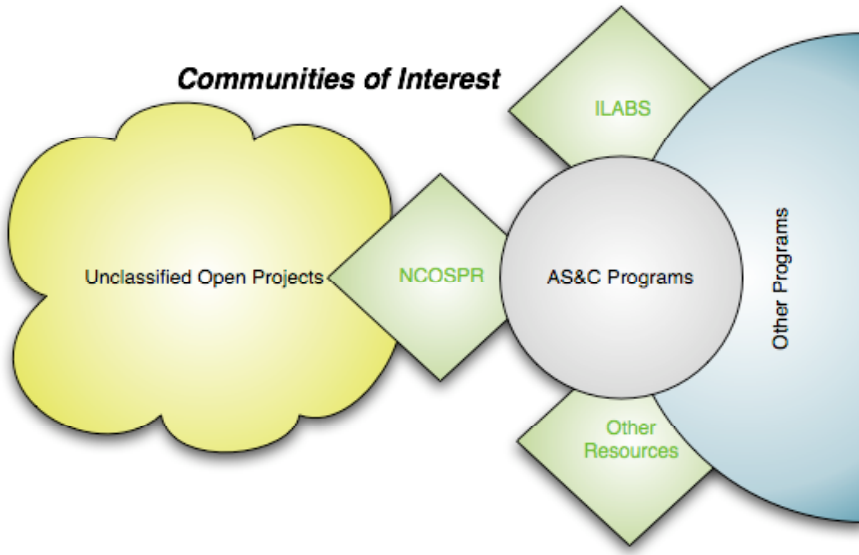

Figure 7 Communities of Interest (COI) for OTD

DoD Organizations and Agencies: A number of DoD organizations have expressed interest in being a part of the OTD effort. These include:

Defense Business Transformation Agency (BTA)

This new DoD organization is charged with coordinating/organizing business systems (human resources, accounting, etc.) spending across DoD. Overall OSD budget for this Agency is $780 million; they also have leverage with the Services' budget of $3.5 billion. BTA would be a good partner to cultivate as they are new and able rapidly to set and create operating standards.

Department of the Navy - CIO Office

The Navy has initiated a project in concert with the National Center for Open Source Policy and Research (NCOSPR), to examine how

to apply and use OSS within the Navy. They specifically have been examining the legal aspects of DoD developed software code, contractors and government employees. We anticipate being an active part in this effort for DUSD (AS&C)/OSD.

Within OSD, informal discussions are ongoing with the Joint Staff J6 and OASD (OSD/NII).

National Lab Resources

Several supportive external resources have been identified during this initial study. Formal relationships should be evaluated and pursued with these resources. The NCOSPR is unclassified and has experience with open source projects and methodologies. The ILabs has adopted OSS infrastructure and has established formal interfaces that can be leveraged on classified networks. These resources and their previous work can be used to assist in the transition process.

NCOSPR (NASA with Stennis and WPAFB MSRCs)

As a National Open Source Resource Center, NCOSPR's[30] mandate is to serve the public by helping to identify the "common technical needs" within government agencies and bring to bear the resources, applications and expertise of the IT industry and independent open source development communities to meet these needs. The NCOSPR provides a valuable resource for coordinating external open source projects and activities against AS&C transition goals.

Futures Lab (Aerospace/NRO)

Aerospace Corporation is an FFRDC primarily supporting the Air Force, NRO and the Intelligence Agencies. Recently they have setup an experimental lab to explore various technologies that sync with their clients missions. The lab is interested and available to host and be a proponent of OTD.

ILabs (NRO/NGA)

[30] http://www.ncospr.org/

The ILabs consists of several classified facilities within the intelligence community. OTD practices are being advocated and supported within their activities. Significant computational and networking resources exist to support classified networks and capabilities within the labs. Significant groundwork for access to live operational classified data has been accomplished through collaboration of the NRO and the NGA. The labs have recently chosen the OSSIM OSS baseline to demonstrate the advantages of an open systems approach. Recommend a briefing tour be established.

The OTD effort will also coordinate and recruit the following organizations as well for OTD:

- Intelligence community (CIA/NRO/NGA/NSA)
- NASA
- National Counter Terrorism Center (NCTC)
- Modeling & Simulation community
- Government Accountability Office

Open Source Projects

Geographic Information Systems (GIS) Community

The OTD transition plan will initially focus on leveraging existing OSS capabilities and practices into AS&C projects. An advanced open source geospatial capability is one of the functional areas that can be quickly applied in addition to generic information technology.

The GIS community has already embraced open-source development to develop highly interoperable systems. Distributed organizations have already been set up in the form of OSSIM (OSS image map), open GIS Consortium and Remote Sensing. We anticipate cultivating relationships with these groups to develop case studies and increase their visibility within DoD.

- **OSSIM**

The OSS Image Map (OSSIM)[31] project has been sponsored and applied to a number of government programs over the last several years. Geospatial awareness is a desired capability for many modern projects. This project support national and commercial geospatial formats and has been evaluated in previous government studies. Technical support with advanced security clearances is available for technical assistance allowing the technology to be quickly applied and modified to the needs of a specific project.

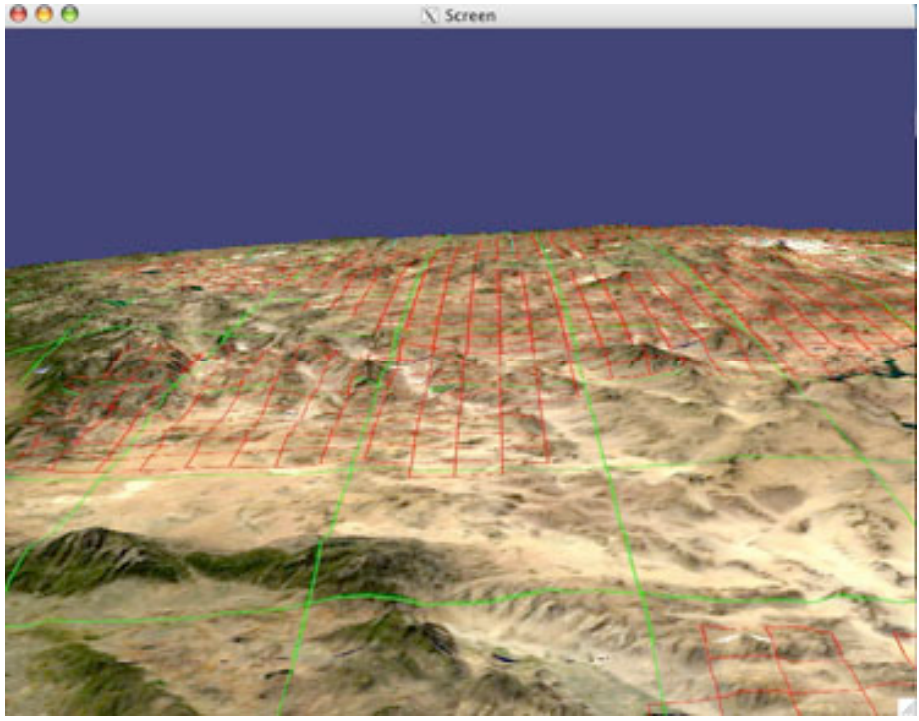

Figure 8 Accurate 3D Geo-spatial view from OSSIM

[31] http://www.ossim.org/

- **Open Source Geo-spatial Foundation**

The Open Source Geo-spatial (OSGEO) Foundation [32] has become a standard for online mapping interfaces. Complying with Open Geospatial Consortium, Inc. (www.opengeospatial.org/) standards, mapservers, and underlying OSS databases can quickly be implemented to provide standardized online collaborative mapping capabilities. Several commercial companies have focused on supplying support and development services for these projects.

The foundation hosts the leading open source geo-spatial projects at http://osgeo.org. Founding projects include:

- GDAL
- GeoTools
- GRASS
- Mapbender
- MapBuilder
- MapGuide
- MapServer
- OSSIM

[32] http://mapserver.gis.umn.edu/

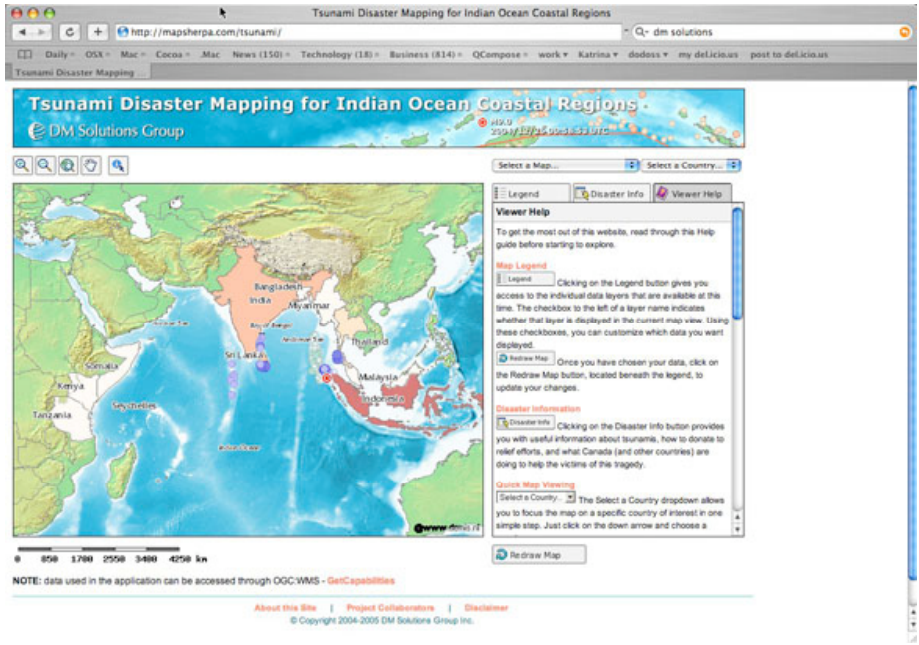

Figure 9 MapServer is the standard for web based geo-spatial mapping services

- **Postgres/Postgis**

The postgres relational database with the PostGIS[33] spatial database engine is currently the preferred open source solution for layering attributed geospatial data in more complex systems. Several commercial companies provide support and technical services for this project. In effect, Postgis "spatially enables" the PostgreSQL relational server, allowing it to be used as a backend spatial database for geographical information systems (GIS), much like ESRI's SDE or Oracle's Spatial extension. PostGIS follows the OpenGIS "Simple Features Specification for SQL"[34].

[33] http://postgis.refractions.net/

[34] http://www.opengeospatial.org/docs/99-049.pdf

- **LAMP Stack**

LAMP[35] is an acronym for Linux Apache MySql (PHP/Perl/Python) integrated services. This standardized "stack" of open source technologies enables robust web based information services. Many applications services have been built on top of the LAMP stack. Integration of these capabilities into government projects and activities will provide significant benefits for information-based services. LAMP represents the open source web platform. Most importantly, LAMP is the platform of choice for the development and deployment of high performance web applications. It is solid and reliable. [36]

DoD Contractors and Industry

In the next year we will actively engage various contractors who work for DoD. A majority of contractors are using open source systems internally and a few are actively supporting public open source projects. Our goal will be to enlist the community to make open source part of their business activities. A key element of these discussions is to underscore that OTD is not an effort to undermine defense contractors, nor an ideological movement like the Free Software Foundation. Rather, it is a set of business processes that supports a commercially validated business model for software services. In the shift from business as usual to OTD, there are greater incentives for companies that are able to be innovative and agile. Part of the OTD communications campaign will be to engage companies (large and small) who are willing to respond to those incentives.

4. Marketing

OTD is more than just technology; it includes changes in how systems are acquired. As such, education within DoD, the U.S. government, industry, and Congress is paramount. Specifically the OTD projects needs to:

[35] http://www.onlamp.com/pub/a/onlamp/2001/01/25/lamp.html

[36] http://www.onlamp.com/

- Publicize Program
- Distribute Reports
- Develop community and network
- Sell OTD within DoD and educate senior leadership and Congress
- Gather Stories from AS&C and OS Advocates

These efforts include creating a website and other materials. The OTD effort also needs to coordinate with other DoD organizations such as JFCOM, the Combatant Commands, and the Services.

The OTD transition team will network with other organizations, resources, champions, and change agents. Formal relationships will be recommended and established with these entities to leverage efforts where possible. In some cases, these formal relationships will present opportunities to demonstrate inter-agency collaboration and the benefits of the OTD approach. Those activities should be highlighted and pursued where possible.

5. Formalization and Operations

The goal of the OTD transition team is to change the default behavior of development and acquisitions projects. The approach will be to modify current system requirements, policies and procedures. These changes will need to be formalized and embedded into the current system, beginning with AS&C and eventually expanding into other organizations. Where practical, the team will create and encourage formal relationships with resources and organizations that will support the change.

OTD Planning Activity and Formal Reports

An OTD Planning Activity should be established to oversee and coordinate transition efforts for AS&C. The current roadmap planning team augmented with additional technical support will provide the baseline for FY06 activities. The transition activities will require ongoing review and adjustment. The team will be responsible for day-to-day coordination of the transition effort, reporting to AS&C.

Formal status and reports will be generated during the transition process. These reports will document the lessons learned and

provide recommendations for future efforts. One of the prime areas of focus will be identifying processes, procedures, and reviews that will need to be modified to support OTD efforts. Additional recommendations will be documented for the generation and approval of program requirements for future projects and acquisitions.

Shared Web-Based Resource for OTD Community

The OTD team will establish a web site equipped with open-source collaborative tools to pool together knowledge and help make connections among OTD developers, program managers, customers, and DoD personnel interested in learning more. While not a comprehensive IT architecture or metadata indexing regime for all open-source across DoD, the OTD site, sponsored by AS&C, will go a long way towards establishing a marketplace of ideas and a user-created repository of OTD lessons learned. In addition, it will enable the loosely coupled cross-linking of existing OTD repositories within DoD via social networking (i.e., an index of OTD projects with descriptions and contact information) in the absence of a centralized .mil software repository (which, given .mil IT policy, may never exist), while fostering a ready-made user population for more formal IT repositories as OTD scale across DoD.

Establish Review Gates and Embedded Process

A combination of OTD requirements, reviews, processes and gates will need to be defined and integrated into the current AS&C program selection and review process. The goal is to institutionalize OTD behavior into the technology integration and development efforts. One example would be adding OTD criteria to the Software Resources Data Report. An example of levers in the process is to use already generated reports (like DD Form 2630 Software Resources Data Report or SRDR[37]) to influence how DoD projects are rated and ranked according to how they use promulgate OTD methods.

[37] http://dcarc.pae.osd.mil/srdr/srdr_ch4_rfp_020204.doc

Business Model Study

Business model analysis to develop recommendations and a business transition plan for government contractors from current to OTD practices. This study is planned for the first phase allowing plan recommendations to be initiated in the mid term phase.

Legal Study & Review

A detailed legal study on the issues involving open source, intellectual property, copyright, U.S. government law and contracting needs to be coordinated. AS&C can be a nexus for the coordination and assembly of legal knowledge and groundwork (e.g., documentation of methods to harmonize DoD IP with various OSS licenses) that are relevant to the Services as well as OSD.

OTD Guidebook for Program Managers and Contracting Officers

One of OTD's hurdles within DoD is the uncertainty of program managers and/or contracting officers who are unfamiliar with OTD. Many such managers are reluctant to change their business practices for fear of making legal or contracting mistakes and they are easily intimidated by vendors who make sweeping but unfounded statements about the IP and security implications of open source. The OTD team will produce and distribute simple, easy-to-understand OTD guidebooks for program managers and contracting officers (possibly in conjunction with Defense Acquisition University) to equip DoD personnel with the knowledge to implement OTD business processes with legal and policy confidence.

AS&C Advisory Board

A formal advisory group is proposed for the AS&C OSS and Methodologies project. The group will provide advice and ideas about how to move OTD methodologies through DoD. Duties and responsibilities might include:

- Review material generated by the project team
- Advise the OTD Team and AS&C on strategy
- Facilitate contacts with champions within and outside DoD

Interactions will be accomplished via email, online collaboration and in person interviews. Currently no formal meetings are planned, but future needs may entail a formal meeting. If so costs of travel would be paid for by the project.

OTD Project Phases

Implementation will proceed in three phases:

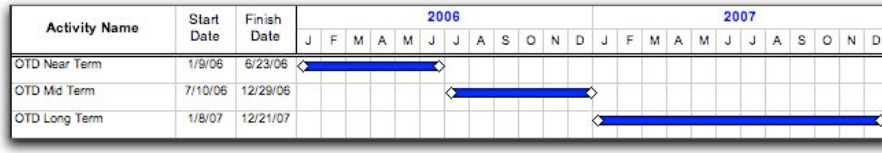

Figure 10 OTD Implementation Phases

Near Term Goals, First half of FY06

Near term goals will focus on activities that are under the control of AS&C and parallel efforts with external OSS initiatives within the government. Resources and activities will be prioritized on projects that demonstrate the advantages of the new approach and allow open source methodologies and practices to flourish. Projects will be encouraged to engage “non-traditional” OSS companies and communities for implementation expertise. AS&C will implement financial incentives to participating projects and participating contractors. AS&C and the OTD team will prioritize evolutionary planning for mid-term and long-term efforts. The OTD team will establish initial relationships with other related activities and organizations. Success in the near-term requires that the OTD team achieves the following objectives:

- Understand the existing OTD skills within a project
- Experiment in a politically low-risk environment, with open source of the appropriate maturity applied to well-understood requirements
- Gradually build OTD skills within the project—start with outside expertise
- Institutionalize those skills
- Work with Montana State University and other universities for OTD repository and analysis of software
- Increase adoption of open source as opportunities arise

- Demonstrate on currently funded ACTDs, JCTDs, and Coalition Activities. Near-term focus will place emphasis on getting key AS&C projects on board with OTD practices.

The Short-term tasks include:

- Define Metrics
- Project Support: provide a minimum level of project support (web-hosting, etc.).
- Build and Distribute an OTD handbook for project leads.
- Support at least 3 projects; focus on those projects that cut horizontally across various DoD missions.
- Find one major program that will commit to OTD.
- Education, involvement and training plan: execute education plan for the greater DoD community
    - Website development (classified and unclassified),
    - Creating collateral material, and
    - Speaking at conferences.
- Educate ACTD program managers.
- Educate Congress on the merits of OTD.
- Have GAO publish reaction to OTD.
- Develop relationship with the Defense Acquisition University. Find champions to push message.
- Develop small Industry support group.
- Publicity: place editorials and stories in DoD journals. Develop material for national publications.
- Submit report to Congress for comment from GAO
- Initiate a study on how to transition the business model

We anticipate the short-term plan shall last six months and will also include refinement of medium and long term plans. Specific goals within this timeframe include:

Demonstration and Metrics

- Apply OTD to cooperating projects
- Prioritize and challenge opaque implementations
- Define, gather, and report metrics
- Carrot and Stick begins
- Business Model Demonstration and study
- Geo-spatial Replacements
- IT and communication infrastructure

Resources and Support

- OTD Web Site
- Participation in relevant conferences
- Informal collaboration with external resources
- Technical Support in advising projects

Marketing and Communication

- Coalition Activities
- Start working Requirements, Process, and Gates
- Letter of intent to all projects
- OTD Meetings with managers and teams

Formalization and Operations

- Leverage related activities
- Press releases and briefings
- Advisory Board review
- Kick off Business Plan Study

Mid-Term Goals

Embed new OTD requirements, review gates for FY07 Approval and review cycle.

During the second phase we will continue to support and expand AS&C OTD related projects while continuing to formalize relationships with external organizations, champions and resources. The main objective of this phase will be to insert requirements, process, metrics, and review of OTD practices into the AS&C project approval cycle. Formalization through the system will begin to encourage default OTD behavior.

Mid-term goals will be pursued starting in the second half of FY06. Concrete steps for AS&C during this period include:

- Modify review and approval process for FY07 projects
- Insert OTD requirements, metrics, processes and procedures that will be used in the selection process
- Conduct additional expansion and demonstration of these practices into other ACTD and JCTDs

- Demonstrate of the benefits of these activities on coalition activities
- Identify and pursue a Defense Acquisition Challenge Program initiative based on open source approaches

One of the key goals during this phase will be a robust business case study that provides recommendations on how to transition from the current acquisition structure to the new practices on major DoD programs.

During this phase we will also begin to organize objectives in the following key areas:

- Open source repositories within DoD programs and projects
- Leverage of external Open Source resources into the infrastructure and programs
- Application of this approach to hardware design and specialized systems with smaller communities of interest

Mid-term focus includes:

- Project support: increase the number of projects supports by an order of magnitude
- Develop plans to establish an OTD government support center
- Create DoD guidance group for how to use, reuse and develop OS software and hardware
- Education, community development, and training plan: building upon the previous plan, gather case studies, and publicize within DoD
- Visit combatant commands
- Examine how to connect DoD source site to that of the greater U.S. government and continue to document
- Industry Support: scale industry support group
- Publicity: continue conference-meeting attendance
- Plan for DoD open source conference/meeting

Specific goals within this timeframe include:

Demonstration and Metrics

- Gather metrics and success stories on projects
- Evolve support to AS&C projects

- Recognition for early adopters
- Focus on a showcase coalition activity

Resources and Support

- Demonstrate resource sharing between projects
- Define plan for long term OTD support infrastructure
- Build initial project hosting website
- Core OSS Technical Support
- Marketing and Writing Support

Marketing and Communication

- Brief new FY07 projects and candidates on OTD
- Actively pursue DoD data and contract rights with software

Formalization and Operations

- Establish OTD requirements and guidelines
- Begin to impact reviews with OTD checks
- Formalize “Lock In” evaluation system
- Identify Regulatory and Acquisitions obstacles
- Deliver Business Plan Study (Deliverable)
- First Year Report (Deliverable)

Long Term Goals

For the FY07 timeframe: The long-term goals will apply the results of the previous phases towards changing the culture and processes associated with technology development on major acquisitions programs. The results of the previous activities and business studies will be reviewed and applied towards these objectives. The success condition of this phase is that OTD technology development processes, resources, tools and methods are applied by default when acquisition programs are built and implemented.

- Analyze and improve the process
- Create Supporting Infrastructure
- Export the processes and methods (FY07)
- Translate AS&C success stories outside of AS&C
- Demonstrate interagency collaboration

- Start to influence larger DoD processes

- Showcase to high-level government decision makers

Long-term focus includes:

- Project support: complete transition of website(s) to DoD organization
- Education, involvement and training plan: continue to publicize the program and ideas
- Publicity: continue conference-meeting attendance. Plan for DoD open source conference/meeting. Create a list of success stories (public and private)
- Create champions list, public-private — people, companies, Congress
- Create awards for code reuse by companies?
- Formulation of OTD security and governance policies

Specific goals within this timeframe include:

Demonstration and Metrics

- Target Major Cross Agency collaboration e.g., NASA and DoD using same OSS code, both contributing to development
- Expand AS&C project participation
- Expand Coalition project participation

Resources and Support

- Begin to implement OTD support Infrastructure

Marketing and Communication

- Showcase to Government decision makers

Formalization and Operations

- Begin to modify external requirements, reviews, and processes

Formulation of OTD Security and Governance Policies

As part of next year's plan, the OTD team will review and make recommendations about how to deal with security issues and OSS. Currently there is a Defense Science Board study being conducted

to review DoD policy on this matter. We anticipate using their guidance on the issues.

These issues include:

- How to deploy a development environment
- Classified versus unclassified versus compartmentalized
- Vetting centers for getting OS into DoD
- Search across a number of OS libraries
- Code fork issues

OTD for Senior Leadership

Senior leadership will need to constantly reinforce and communicate the vision and benefits of Open Technology Demonstration. They will need to provide the resources, flexibility, and top cover that will allow innovative implementers to flourish. To guide the initial transition a dedicated OTD government transition manager should be hired or designated to coordinate the efforts of the team. When challenges inevitably arise from the status quo, that person can “block and tackle” from inside the building.

Senior Leadership will need to define and implement changes to the current review and approval process to establish new requirements, processes, procedures, and gates that embed OTD practices into the infrastructure.

Initially, senior leadership will need to seek out talented change agents and innovators to spearhead the first projects. These teams will need the support of upper management, the flexibility to experiment and even fail as they system adapts. AT&L’s OTD leadership should foster an environment that allows and rewards teams that take reasonable risk for large potential gains.

As the metrics are developed and success stories accumulate, management will be able to ratchet technology collaboration up to the next level and seek out interagency projects.

Finally, with any transition, there are system anti-bodies that will attempt to stifle change. The OTD transition can expect challenges from bureaucratic forces in legal, acquisitions, and security organizations. Entities that have become successful within the current practices will see OTD as a threat and attempt to subvert it. Senior leadership will be challenged to navigate through these obstacles in order to realize the benefits of OTD business process with and across programs and organizations.

OTD for Program Managers

OTD will present new challenges and rewards for Program Managers. A successful program manager must manage the schedule, resources, and interfaces for the activity in question. During implementation, most program managers will guard against requirements creep, strive to insure the developers remain confined to their tasks, work problems as they arise, and hopefully deliver what was promised within cost and on schedule.

But often, changes are forced on the project. These changes can be the result of new technological advances, changing external environments, new people, or changes in user needs. The larger the project and timeline, the more likely the need for change during implementation. These changes are often disruptive and unwelcomed by the team, and lead to conflicts with the PM pitted between a restive end-use community and a project spiraling out of control.

Programs often struggle to deliver their requirements and seldom outperform initial estimates. Approaches such as rapid prototyping and spiral development have emerged in recent years to address the need for evolution during implementation. Open standards and interfaces have begun to modularize and simplify overall system complexity. Open source implementations often bring new functionality within range of the project and many implementation decisions can safely made within lower levels of the organization. Successful adoption builds a community of interest that includes managers, users, developers, and key decision makers on a collaborative team.

OTD practices are agile, opportunistic, and are well suited for dynamic environments. In this capacity, they provide a new set of tools and controls for program managers in the face of shifts in technology and customer. Properly implemented, an OTD approach involves all parties in the difficulties and opportunities that will present themselves in the design and implementation process. This leads to team “buy in” and less contention between the various parties involved. OTD certainly has the potential to dramatically reduce the cost of adding functionality to a program. It also presents the opportunity to add “pleasant surprises” as the latest advances in systems and technologies can be added to the solution.

The collaborative technologies will enable all participants to take an active role in the development process while the program manager assumes the role of “benevolent dictator” to minimize serious conflict and guide the best overall solution.

OTD for Developers

There is evidence that developers will be strong supporters of an OTD approach. Many have already experienced the benefits of OSS collaborative techniques which are proliferating on the internet. Developers have also experienced some of the frustrations that are typical of a hierarchically managed top down approach.

The transition path for developers and implementers should focus on increasing proficiency in OSS skills, researching and participating in relevant projects, and helping to identify barriers to adoption of these practices within their government projects. The transition will depend on internal champions to educate and identify changes that will be needed for efficient collaboration and OTD practices.

During implementation, developers will be crucial in assessing the maturity and applicability of available open solutions and projects. Ideally, technology staff will be at the forefront of technical implementation decisions, but must also understand the larger implications of those decisions: a good design will not just solve the problem at hand, but will be leveraged by other projects and programs. License fees, training, maintenance, and system flexibility are factors that the development staff will have to consider as implementation decisions are made. Open standards and interfaces will allow a program to evolve and improve over its life cycle. Open versus closed implementations will have dramatic impact on the life cycle costs for the system.

With OTD, developers have an opportunity to exert more control over design details, but they also take on additional responsibilities for that design. Successful OTD developers will demonstrate collaborative communication skills within the community of interest. This implies effective communication with members of widely varying technical backgrounds and interests in the system. This networking of loosely coupled individuals and organizations, in turn, accelerates cultural shifts which further enable the dissemination of OTD business processes across the enterprise.

OTD for Transition Managers

Transition Managers have a vested interest in the success of the OTD approach. Historically, the most difficult phase in any system transition is from technical prototype to operational implementation. The worst scenario is when a large complex system is developed and modified over a long period of time without significant input from the users of the system. Even when there is significant operational participation in the requirements definition phase — changing environments, mission requirements, and technological advances can render the delivered system obsolete.

OTD provides a mechanism to involve operations in an interactive community of interest as the system evolves through rapid technology spirals. Currently, systems try to address this problem through user's conferences or testing phases. While these meetings and milestones are a step in the right direction, they can not compare to an effective online community of interest. Collaborative tools provide a mechanism to provide a tighter coupling between real world users and the technology implementers as the system iterates on ideal solutions. When well run, the community of interest acts as a team with a common goal versus groups with competing interests.

As a Transition Manager, an important consideration will be the life cycle costs of the system. Open systems approaches with standard interfaces and highly leveraged technology components will present more options for systems evolution and support. Some of the same collaborative tools and resources can easily transition into the support mechanism for the delivered system.

OTD for Contractors

Established government contractors face some of the most difficult challenges in the OTD transition. Over the years, successful government contractors have optimized and adapted their policies and procedures to the current system. Cost plus contracts, requirements based procurements, and intellectual property rights have been tuned to create successful business models within the structure imposed by government rules and regulations.

OTD requires a shift from emphasis on intellectual property and products to professional services and open collaboration. During the first year of transition, the government will place emphasis on a business model transition study that encourages the new practices. Early adopters will gain increased exposure and will be able to strategically position themselves for the future through successful demonstration of OTD results.

Appropriate financial models and rewards need to be structured for this behavior. In the end, the government will establish the requirements and successful government contractors will adopt and adapt to the new practices.

The team will cultivate OTD champions within the contractor community to open up systems interfaces, change system administration policies to allow online collaboration, and demonstrate rapid technology implementations with open source technologies.

Contractors who take this approach should benefit from a more integral role within collaborative teams. As technology continues to evolve as a commodity they will have a competitive advantage in demonstrating customer oriented professional services and domain expertise.

Recommendations

This roadmap effort proposes a transition to OTD practices in the DoD initially focusing on the projects and activities within AS&C. Success is achieved when policies, procedures, requirements and practices establish OSS, open interfaces and systems, and collaborative technology methodologies as the default baseline. This will occur after the correct checkpoints, reviews, and policies are evolved towards those objectives. Once established within AS&C, those processes should be spread to larger programs and acquisitions using the metrics and information gathered along the way.

To accomplish these objectives the following recommendations are made by the roadmap planning team:

1. Create an OTD strike team to oversee and guide transition efforts
2. Establish formal relationships with external activities promoting this approach
3. Initially focus on AS&C projects, open the solutions, gather metrics
4. Establish review gates, policies and processes to reinforce the new behavior for the FY07 approval cycle
5. Network and communicate these efforts externally
6. Create an AS&C Advisory Board to review OTD material and activities

Recommendation 1: Approve and Fund an OTD Strike Team

The OTD Strike Team would include the current roadmap team augmented with technical support for evaluating projects and construction of the OTD Wiki and online infrastructure. This team will be initially funded out of the Large Data JCTD as part of the effort to introduce open source geospatial capabilities into the project. The team will coordinate with additional ACTDs and JCTDs and establish separate efforts through those projects. Nominally, the ACTD or JCTD would provide the additional funding to support open technology implementation. In some cases, additional funding may be required to "challenge" an embedded implementation. In those cases, project off-sets may be required to support the challenge.

Senior Leadership Role

As mentioned previously AS&C should take a central role in organizing OTD activities. It is recommended that AS&C focuses on internal and external communications supporting the OTD benefits and transition. AS&C's OTD point person would be in the position to draft letters, policy statements, and news stories that talk about both the need and implementation for the OTD transition.

Recommendation 2: Establish formal relationships with external activities promoting this approach

OSS and its associated collaborative technologies have already been internally adopted by much of corporate America. It is being used in many critical operations within government agencies as evidenced by the OSS Institute CRADA with the Navy. AS&C's OTD node should collaborate with and leverage previous activities, policy and security investigations, and resources to accomplish the transition. Open source champions should be networked together through the AS&C transition efforts. The OTD Strike Team will establish relationships with these entities as part of the overall process of formalizing and embedding these methods into the system and acquisition processes.

Recommendation 3: Focus on AS&C Projects

Initial transition efforts should focus on projects and programs within AS&C. The projects should be prioritized based on the ability to demonstrate the advantages of the OTD approach. This will include an evaluation of the open source technologies that can be quickly brought to bear, the willingness of the project team to participate, and the ability to gather supporting metrics.

Prioritize ACTDs and JCTDs

The OTD Strike Team will coordinate with the decision makers and technical staff of FY06 ACTDs and JCTDs. Each will be evaluated and encouraged to participate in the OTD effort. The various projects will be prioritized based on the applicability of OTD practices to the proposed solution. Factors will include initial development costs, long term operations and maintenance implications, willingness of the team to participate, and availability of open source resources to support the effort. The preferred

approach will be to bring in outside open source domain expertise to perform critical support and modification functions on open technologies with the support of the existing project team. It is anticipated that there will varying degrees of participation. Ideally, open systems design with standards based interfaces will be applied to the solutions. Other projects may provide individual functions or services with open technologies in lieu of proprietary alternatives. Finally, there may be cases where open technology options are pursued as competitors to existing closed implementations.

Gather Metrics

Metrics and analysis will need to be gathered and updated to support the transition. Part of the effort will be researching and networking with other efforts to gather previous analysis. The implementation efforts with the ACTDs and JCTDs will provide an additional source of information that will be analyzed to gather benefits and concerns with the approach. The underlying transition is expected to be challenging and the team will need to remain flexible and responsive during the initial demonstrations.

Recommendation 4: Establish Review gates, policies and processes to reinforce the new behavior for the FY07 approval cycle

Recommendation 5: Network and Communicate Vision to External (to AS&C) Agencies and Initiatives

The OTD transition is consistent with external initiatives and should be linked with those efforts when possible:

- SecDef is being briefed every month about how DoD can shrink the force (by lowering workload. OSS is something to brief to him on and benefits) [See page 27].
- 2002 Defense Bill — entitlements are $4 billion in 2009 it will be $20 billion. Need to do more with less
- Defense Business Transformation Efforts
- Initiatives emphasizing networking vs. hierarchical control structures
- Disruptive technology evaluations

The OTD transition team will network with other organizations, resources, champions, and change agents. Formal relationships with these entities will be recommended and established these entities to leverage efforts where possible. In some cases, these formal relationships will present opportunities to demonstrate inter-agency collaboration and the benefits of the OTD approach. Those activities should be highlighted where possible.

Recommendation 6: AS&C OTD Advisory Board

As the planning and transition activities progress, we will depend on the advice and guidance of national experts on the AS&C OTD Advisory Board. An initial list of candidates has been contacted and appears in this report. The advice of this board will be invaluable in how to use the existing system to meet our objectives. By imposing new requirements and seeking long-term operations and maintenance accountability within the design phase, we intend to transition the default behavior to open systems design. It will be necessary to structure appropriate reviews and metrics while working within the existing culture will be critical to success. The formalization of a well-respected advisory board will be one of the first critical steps along that path.

Appendices

Appendix A - Meetings and Interviews

List of a few of the interviews performed in the roadmap study:

- Paul Brinkley, OSD, Business Transformation Office
- Dale Christensen, SECNAV, DON CIO Office
- Robert Gold, Associate Director for Software and Embedded Systems, OUSD DDR&E/S&T
- John Grosh, OUSD DDR&E/S&T
- James Hoffman, NRL
- Mike Kreiger, Director Information Management, OASD(NII)
- Dardo Kleiner, NRL
- Mike Knollmann, JCTD Office
- Dick Lee, ACTD Office
- Pat Neher, Navy JAG
- Andy Marshall, OSD, Office of Net Assessment
- Dawn Meyerricks, VP-AOL
- Terry Mitchell, ACTD Office
- James O'Bryan, The O'Bryan Group
- Chuck Riechers, OASD/NII
- Dr. Chuck Perkins, ACTD Office
- Sue Payton, AS&C Office
- LTG Robert M. Shea, Joint Staff, J-6
- David Scantling, OSD, Business Transformation Office
- Fritz Schultz, DISA
- John Weathersby, NCOSPR Organization
- Lin Wells, OASD/NII
- Dennis Wisnosky, Wizdom Systems, Inc.

Appendix B - Measuring the Maturity of Open Source

Maturity Criteria	Immature	Reasonably Mature	Very Mature	Criteria Description
Product Criteria				
Age	< 6 mos	6 mos – 2 years	>2 years	OSS efforts that are just getting underway are risky for enterprises.
Multiple Supported Platforms	One Platform	Many related platforms	Multiple heterogeneous platforms	Products that work on Windows and Unix are most desirable
Momentum	No release in last 6 months	< two releases in past year	Regular releases	This is key to helping separate vital products from ones that are withering
Popularity	Unknown product	Viable alternative	Category leader	Popular OSS products are well tested and therefore more mature. They are also likely to be interoperable with a large number of other products
Design quality	Monolithic application	Multiple components	Well-defined API	This criterion is key in determining the effort required to extend and adapt the product.

Use Criteria				
Setup cost	Poorly documented install process; poor documentation; help available from developers	Well documented install process, reasonable documentation; help available from developers; help available in support forum	Well documented install process; install wizards/scripts available; reasonable documentation; help available from developers; help available in support forums; third party install services	Most products should require a setup effort of hours or days, not weeks or months.
Usage cost	Poor or non-existent documentation; help available only through direct contact with developers	User manuals available; help available in support forums	Third party training services available	This criterion is often overlooked when evaluating a product
End-user support	No forums or mailing lists	Some forums or mailing lists	Well-run forums and mailing lists with archives and search; third-party support options	User community (forums, mailing lists) and third party support are vital to a product's success

Figure 11 from Open Source for the enterprise[38]

[38] Open Source for the enterprise, Dan Woods and Gautam Guliani, Copyright 2005, O-Reilly Media

Appendix C - Open Source Geo-spatial Capabilities

Figure 12 OSSIM advanced 3D visualization

The Large Data JCTD will demonstrate advanced geo-spatial capabilities with the OSSIM software suite.

OSSIM is an open source software project that is being used by various national laboratories and is embedded in several commercial and government solutions.

Advanced geo-spatial web services, analysis and production tools, and accurate three dimensional visualization clients will be demonstrated and provided. The Large Data JCTD will demonstrate remote access, manipulation, and viewing of very large commercial and government data sets.

Additional information about the OSSIM project can be obtained through the Open Source Geospatial Foundation http://osgeo.org or directly from the OSSIM project site at http://www.ossim.org.

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Additional References:

Memo: CIO John P. Stenbit SUBJECT: *Open Source Software (OSS) in the Department of Defense (DoD)*, May 28, 2003

MITRE Corporation Report: *Use of Free and Open-Source Software (FOSS) in the U.S. Department of Defense*, Version 1.2.04, January 2, 2003, Report # MP 02 W0000101

OSXP Project Documentation: SourceForge Open-source Software projects, http://sourceforge.net/

IBM VC calls for 'open' hardware, Richard Goering, EE Times, 04/08/2005, www.eetimes.com/news/design/showArticle.jhtml?articleID=160502705

Raymond, E.S., *The Cathedral & the Bazaar: Musings on Linux and Open Source by an Accidental Revolutionary*, O'Reilly Publishers, 2001

Weber, Steven, *The Success of Open Source*, Harvard University Press, 2004

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J.C. Herz is a researcher and designer with a background in ecology and computer game design. Her focus is multiplayer interaction design for systems that leverage the intrinsic characteristics of networked communication. Current Defense projects include work on the Office of Force Transformation's TacSat micro-satellite program, a disruptive technology which makes satellite tasking and data annotation accessible to anyone on SIPRNET. Pending OSD projects include the creation of a civ/mil collaborative web site for humanitarian relief workers, NGO's and reconstruction personnel, under the auspices of OSD/NII Office of Contingency and Migration.

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