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THE STATE OF THE ART AND THE STATE OF THE PRACTICE

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Transitioning Research Concepts to the Command and Control Community Quickly

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Lessons Learned

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Transitioning Research Concepts to the Command and Control Community Quickly

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ABSTRACT

We present a business model providing an extremely fast method of transferring new research to the command and control community. As any software developer or user knows, there is a vast gulf between research beta prototypes, and commercial quality software. By shortening the time between concept and commercialization, command and control programs increase their technological advantage.

We demonstrate that a marketplace of multiple competing vendors of similar products works much better than a single anointed government-subsidized solution. In particular, using Small Business Innovative Research (SBIR) grants to transition to commercial-off-the-shelf (COTS) software is more effective than monolithic decade-long programs

We briefly mention the products, as concrete examples of successful commercialization, but defer any detailed description of the products themselves to other literatures. The emphasis in this paper is on the process, not the specific grants or products.

MOTIVATION

At ICCRTS 2005, a number of people were interested not only in the technical component of our visualization papers, but in the commercialization process which provided an extremely fast method of transferring research to the command and control community.

We take the results of Small Business Innovative Research (SBIR) grants, and create commercial toolkits. These toolkits are purchased by other companies to provide the software framework for C2 programs and for further research in the field.

During the two-year Phase II portion of our current SBIR on visualization (grant AF02-109 "Multi-sensory display toolkit") we experienced a double layer of commercialization. ("Double" was the key point which generated interest from many others). We created a new product, the MAK Stealth-XR that supports 3D visualization. OPNET (amongst others) purchased this toolkit. They used it as the 3D viewer for their existing communications model, and created a new product called 3DNV, which in turn has been commercialized, generated revenues, and more importantly, has been used by others in the C2 community to further their work.

"CLASSIC" ACQUISITION BUSINESS MODEL

The typical acquisition methodology for DoD systems is a top-down, waterfall model roughly consisting of the following steps:

- Identification of a capabilities gap (requirement)
- Approval of requirement as a program
- Development of formal requirements document
- Solicitation of a Cost Plus Fixed Fee (CPFF) contract via a classic defense contractor to develop the system
- If and when the product is finished, give it away for free to users inside the DoD as a "Government-Off-The-Shelf" (GOTS) product
- Attempt to kill off any competing programs inside the DoD under the pretext of "duplicative effort"
- Pay a long maintenance tail
- Start the whole thing over 10 years later

Common characteristics of these programs include a too ambitious vision, unnecessarily excessive budget that allows waste to go undiscovered, very long schedule that allows problems to go undiscovered or ignored for long periods, and a requirements process that permits unrealistic, unnecessary, and excessively costly features to be enshrined in the requirements document. The sales pitch (rarely achieved) is that the monolithic solution will solve every problem for every customer.

Typically, the average defense contractor bids a CPFF labor contract for the development of the entire system, attempts to do all the work themselves, inflates the gross dollar size to be as large as possible, and locks the government into exclusive long-term maintenance. The current acquisition process financially rewards this behavior. These are For-Profit companies, and as such, their primary goal is to maximize and protect their future profit stream. In the CPFF marketplace, there are only two basic ways to increase profit: increase the profit on hourly labor rates, or increase the total number of hours being sold. As the DoD has honed CPFF to the point of invariably constraining profit to 5-10% of cost, the only remaining way to increase profit is to maximize the number of hours billed out. This leads to the very unfortunate dynamic of financially incentivizing contractors to remake products they could otherwise purchase off-the-shelf for a fraction of the price. As far as protection of future profit streams, there are several common strategies employed: "stovepiping", "legislated monopoly", and establishing "brand equity":

- ***Stovepiping*** is the intentional development of a new system for the government that does not interoperate with other systems. By making sure that all database formats, networking protocols, and software interfaces are unique to that system, the developer maximizes the barrier for someone else to replace a component. This maximizes the probability that the government comes back to the original contractor for any upgrades, fixes, etc. This increases the expected value (EV) of future profits.

- ***Legislated Monopoly*** is the strategy of having a product or component from one company declared a "standard" by the government customer. The product is then written into future Requests for Proposal (RFPs) for other contracts. This effectively eliminates the possibility of competition, locking industry into using the declared winner, often for years. Even more bizarre is that the winner is usually declared long

before the product is actually finished. Legislated monopolies greatly increase EV of future profits.

- ***Brand Equity*** is the legitimate practice of building a good reputation and name recognition for a company by performing well on contracts. Individuals who have earned reputations for consistent success also enjoy brand equity. Companies often acquire other companies, or poach employees, just for brand equity. Intellectual property is another valuable asset used to win future contracts.

Other detrimental side effects of the monolithic GOTS model are:

- Today's training, operational and technology gaps are irrelevant. They will change every few months. Locking in a long-term, multi-year program to solve today's gaps with a single solution guarantees the final system will be obsolete
- The GOTS business model stifles competition, dissuades private investment, and keeps innovative new products and technologies off the market. Private investors won't invest in a market space where a 100% subsidized, government-mandated product is freely distributed
- Obsolete GOTS products that are subsidized from program funds and don't require sales revenue from end users can live forever
- End users have no power to purchase new, competing innovative solutions from alternative sources. They are stuck with the government solution
- Procurement organizations like controlling money flow. There is no incentive to allow multiple commercial vendors to obsolete its GOTS business and remove the agency from the value chain

Compounding the financial incentive problem, government and contractor researchers that perform more basic investigative research dislike planning for the promulgation of prospective new technologies throughout the defense industry. Researchers believe that a successful demonstration is sufficiently compelling in and of itself such that others will be inspired to transition the technology to practical use within the armed forces and/or commercially. Sadly incorrect, this results in many successful projects never seeing practical use, being forgotten, and worse yet, being endlessly repeated by other researchers.

The Office of the Secretary of Defense understands these defects in the classic acquisition system, and has recently re-drafted the DoD 5000 series of acquisition regulations to demand the use of Commercial-Off-The-Shelf (COTS) products to the maximum degree possible, and allow free market forces to work inside the DoD. Change is coming slowly to an entrenched culture of "make it from scratch every time", but the trend is positive. There are several outstanding efforts within the DoD to push acquisition more towards a market-model, the SBIR program among them.

SBIR PROGRAM BUSINESS MODEL

The SBIR program is a grant program to provide small businesses "venture capital"-like investment money to develop and prototype a product or technology that is needed by the DoD (actually all branches of the Federal Government have SBIRs). Grants are of relatively short duration. Phase I is generally a 6 to 9 month design or prototype ($100K), while Phase II (if awarded) is typically 2 years ($750K). In order to successfully complete the contract

requirements and commercialize within that time frame, it is necessary to balance the two conflicting customer goals of breadth and depth, and leverage the benefits of both. SBIR grants provide the depth by focusing on the needs of one particular funding agency. Commercial off the shelf (COTS) products provide breadth, by catering to a large, diverse customer base.

A positive feedback cycle ensues. The first round of SBIR grants funds the development of code from the initial concepts. Once commercialized, the code can be resold as part of a shrink-wrapped product. The product profit supports maintenance, and non-research features. (Specifically, those features which are not technically novel, but necessary for COTS quality). This internally supported product becomes the basis for the next SBIR. As the next SBIR has a basis from which to start, the contract does not need to pay to develop that basis. Instead, the next SBIR can spend more resources developing innovative features.

The SBIR program is one of the few DoD programs that has an intentional commercialisation strategy. By encouraging small businesses to commercialise their research products and sell them back to the DoD and other customers, free market forces will act on the market space. By fostering multiple competing vendors of interchangeable products, the DoD benefits from price pressure, pressure to innovate, motivation to invest private funds to improve the product, etc. The lengthy, expensive logistics tail associated with monolithic programs is eliminated, obsolete products are quickly driven from the marketplace by new innovations, and the end-user is empowered to "vote with their wallets" for the best solution that most accurately meets their true needs as compared to the chronically obsolete requirements document. Surprise technological innovations coming from outside the DoD are warmly welcomed and easily adopted as long as the user base is not constrained to the GOTS solution. By DoD standards SBIR investments are very small, enabling many different attempts to solve a technical challenge, with the failures cut off after Phase II.

The commercialisation paradigm of the SBIR program is a model to be repeated wherever possible throughout DoD procurement in order to create markets where the very best state-of-the-art products are available to the warfighter at the lowest possible cost.

ROLE OF OPEN INTEROPERABILITY STANDARDS

Key enablers of a commercial market are open interoperability standards. High quality, plug-and-play open standards enable end users to switch from older obsolete products to the newest state-of-the-art products with minimum time, effort, and cost. Popular open standards also provide a marketplace for vendors, as the confidence in a large potential customer base rewards investment in compliance with the standard. Open standards effectively lower the barrier to exit an obsolete product for the user, and lower the barrier to entry into the market for a new vendor.

OMB – A119 - *Federal Participation in the Development and Use of Voluntary Consensus Standards and in Conformity Assessment Activities*, February 10, 1998, defines, and requires the use of "voluntary consensus standards" in lieu of "government-unique" standards in the following policy statement "*All federal agencies must use voluntary consensus standards in lieu of government-unique standards in their procurement and regulatory activities, except where inconsistent with law or otherwise impractical. In these circumstances, your agency*

must submit a report describing the reason(s) for its use of government-unique standards in lieu of voluntary consensus standards to the Office of Management and Budget (OMB) through the National Institute of Standards and Technology (NIST)."

This regulation can be considered an "anti-stovepipe" law. By compelling the DoD to use the most popular commercial standards when available, and to take new standards developed inside the government and push them out into open standards organizations (i.e. IEEE, ISO, OMG, SISO, etc.) the larger potential customer base drives more COTS products to adhere to the standards, effectively producing more options for the DoD to satisfy their needs.

As noted above, large programs don't like open standards because it enables outside companies to replace components with competing offerings. Oftentimes a contractor will justify a new, unique data standard on the pretext of some missing capability, in order to close a system to competitors. The Command and Control space has recently been moving towards open standards for C4I interoperability after a long history of stovepipes. New standards such as JC3IEDM, CBML, etc. will enable end users to switch to new C4I subsystems with relative ease. These standards will foster a market of competing C4I COTS products.

RISKS

The SBIR business model, and similar commercialization models are in widespread use within the DoD, and are actually dominant outside the US. DARPA's Strategic Plan, The National Automotive Center's Dual Use model, Privately Funded Initiatives (PFI), and the CIA's In-Q-Tel venture capital group are all successful examples of aspects of this model. The SBIR program has achieved its goals over the last 20 years, producing hundreds of COTS products and technologies for DoD use, saving billions of dollars in custom development. There are risks, however, in the transition from the classic CPFF model to a COTS market model throughout the DoD:

- Switching from the relatively risk-free Cost Plus Fixed Fee (CPFF) model to Firm Fixed Price (FFP) for results produced will be a painful transition for some contractors unaccustomed to head-to-head competition
- Multiple vendors must be in constant competition with each other in order for the government to realize the maximum savings. Having only one vendor supplying a particular product is better, but not much better than the GOTS model.
- There exists the possibility that no COTS product vendor will want to support some very narrow, low-volume capability. In this case, GOTS will be the fallback

The biggest risks by far, however, are the cultural change problems associated with simply trying something different inside the DoD:

- Large defense contractors like the current model, are well organized to take maximum advantage of it, and have no good reason to cooperate with a transition plan that will force them to become more competitive
- Government-side program managers are comfortable with the current system, know it well, and are rewarded by its stability, predictability, and security

- Contractors and government PMs alike will not understand why COTS products that must be purchased from vendors are better than the "free" products they produce

SUMMARY

The Department of Defense is beginning a slow process of transforming the way it buys defense articles. The classic large system procurement model is giving way to a more market-driven commercial products model. This new model can replicate the efficiencies of commercial market economics inside the DoD, giving the warfighter the products they need much faster, of higher quality, more suitable to their needs, and at a much lower price. The Small Business Innovative Research Program is an excellent example of a program intentionally designed to foster this acquisition reform. The dynamics of the SBIR program should be replicated elsewhere in the DoD. Open interoperability standards for the C4I community will be the key enabler for the creation of a market of competing COTS C4I components. The greatest challenge to this transition, however, is the entrenched cultural and business interests that prosper from the status quo. Institutionalization of this new model will require sustained, concerted efforts from both inside and outside the DoD for some time to come.

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Basic Rule of Human Behavior

"All Sales/Purchase decisions are EMOTIONAL!"

"Facts and figures are later used to rationalize an emotional decision previously arrived at"

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Basics of SBIR Program

Grant program for small businesses to develop commercial products to sell back to the government and to the general public

- Phase I - $100K fixed price grant for feasibility study
- Phase II - $750K prototype development
- Phase II+ - funds from other sources (usually matched by SBIR)
- Phase III – commercialization. Company productizes and sells product publicly. SBIR program funding ends
- Company retains intellectual property rights to product
- Government must refrain from distribution for 5 years (but retains government use rights)

Government essentially acting like a Venture Capitalist

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Benefits of COTS Model

Investors - spending money out of their own pockets. Won't waste money on ideas which they don't think will make a return.

Entrepreneurs - accountable to investors. Vast wealth for entrepreneur if product is successful. Strong motivation to succeed.

Customers - Purchase decisions are "apolitical". Spending own money on best product. Collective marketplace determines winner

Government Regulators - Don't need to interfere with the will of free market in determining winner.

Survival of the Fittest - Bad products die fast! Minimal drain on society to keep inferior products and companies around. Best ideas win and are rewarded. Multiple differentiated products can win.

Price Pressure - If one product is making too much profit, competitors will enter the market and drive prices down.

Normal US DoD Business Model

Gov't pays Procurement Agency to develop single over-specified "annointed" product (OneSAF, JSIMS, etc.)

Contract with hourly contractor to develop software

Give away product for free to end users (source and executables)

Pay long-term maintenance to contractor

Start the whole process over again every 10 years

"Serial Monopoly" model resembles Soviet centralized economy model

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Problems with Hourly Model

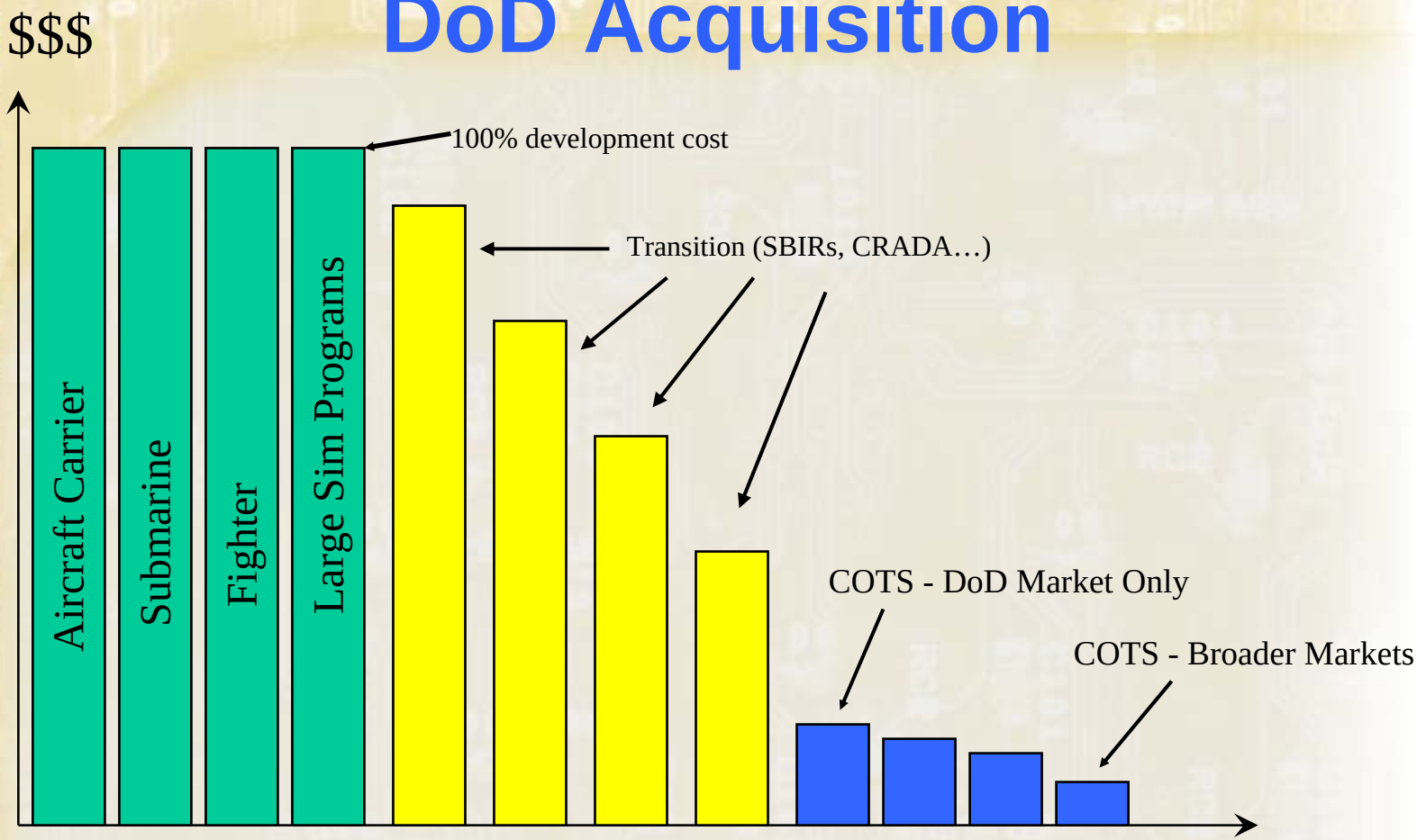
Customers - Little influence over features, quality. Product may be inexpensive to end user, but the wait is often years, quality poor, and follow-on support non-existent. End user has no leverage

DoD - Purported fair competition in proposal effort, however, 0% of proposals reflect actual end product or development cost.

Contractors - Bad product can live forever. No incentive to innovate, take risk, or improve products. Customer is Program Manager, not end-user. Financially incentivized to maximize cost. Emotionally prefer to remake instead of reusing!

No competition - Leaves no choices for consumers. No price pressure, no pressure to innovate, the weak survive forever. Actual cost of GOTS shielded from competition. Better products that cost money are frozen out of market.

Ideal Commercialization Path for DoD Acquisition



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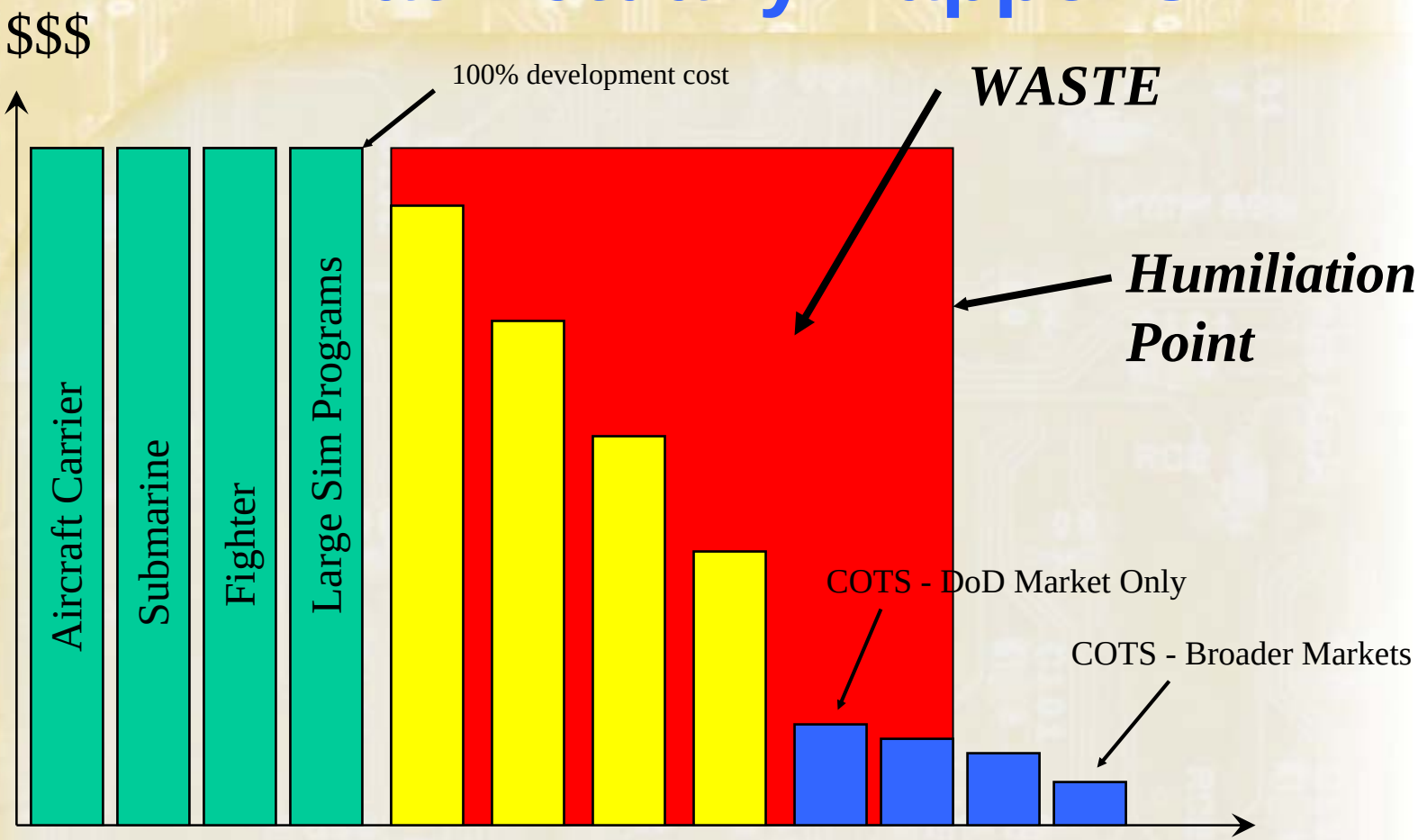
What Actually Happens



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Other Regulations Requiring COTS

- Clinger-Cohen Act
- Office of Management & Budget Memorandum of October 25, 1996 ("Raines Rules")
- DoD Directive 5000.1
- DoD Regulation 5000.2 (5000.2-R)
- DoD Joint Technical Architecture (version 1.0)[1]
- Defense Information Infrastructure (DII) Common Operating Environment (COE) (baseline version 3.1)

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Open Standards Critical

No Gatekeeper – No single vendor or Program can force a market to pay it a tax for access to an interface

Consensus Process – Naturally slower, but product reflects the diverse needs of the whole market. No one organization has more control than any other

Low Barrier to Enter – Open standards create markets and aids vendors in making plug-compatible products

Low Barrier to Exit – End user can easily switch from old obsolete products to new technologies, less expensive replacements

Open Systems enable free market competition to drive quality up and prices down

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OMB – A119

*"**Voluntary consensus standards**"* are standards developed or adopted by voluntary consensus standards bodies…

"***Voluntary consensus standards bodies***" :

- Openness.
- Balance of interest.
- Due process.
- An appeals process.
- Consensus.

"All federal agencies must use voluntary consensus standards…"

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Market Incumbents Don't Like Open Systems!

Long Term Lock-In – Large defense contractors don't want ongoing head-to-head competition! Would rather win a decade-long contract, sit back and relax without fear of displacement

Prefer Contract Model to Commercial Model – In the real world, vendors invest in their own products and must succeed. Vendor pays for its own failures out of profits. In DoD, vast bulk of development is CPFF. Government pays for all losers, contractors MAKE profit off of losers. No risk for contractor

Open Systems enable upstarts to displace incumbents
Incumbents like the old system

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Therefore, They Cheat!

Need to *Appear* to Salute Open Systems Flag – Vast bulk of regulations (OMB-A119, DoD 5000…) require Open Systems approach. Contractors must APPEAR to be complying with regulations

While Covertly Retaining Control – Using clever interpretations of definitions of "Open System", delayed processes that continue closed control, etc.

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Common Tactics to Cheat

"The Blob" **-** My particular implementation is an "open standard" because I've published the APIs.

"We'll get to the "Open" part later" **-** but we'll start requiring its use now.

"Puppet Master" **-** Apparently open process, but with a Czar or Kabbal that has back-room control.

"Not-So-Open Source" **–** Give out source code under restricted conditions and confuse terminology with Open Standard

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Bottom Line Problems

Motivations are in the wrong direction:

- Cost Plus Fixed Fee contractors rewarded for duplication – look for any excuse to replicate
- Government Program Managers not rewarded for reducing the cost or schedule of their programs
- Government Program Managers not rewarded for pushing technologies out of government into the commercial market
- Government engineers viewed as “free” resources, therefore their work product is viewed as free

Solutions are Very Hard Cultural Changes

- Firm Fixed Price for large systems
- Reward PMs on *reduction* of program budgets or schedule
- Reward PMs for pushing technologies into the commercial market
- Truthfully account for the cost of government employees developing “free” product
- Institute attitude of disdain, and punitive measures for government programs that duplicate COTS

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Excellent Progress to Date

- New DoD 5000 series of regulations requires use of SBA to prove concepts before funding
- JSIMS Analysis of Alternatives business game resulted in new open market model for M&S (being adopted in several places)
- Maximum COTS use required in most RFPs
- Many large M&S procurements switching over to firm fixed price or PFI
- Common Joint Mapping Toolkit (CJMTK) core of all C4I systems is COTS (ESRI)
- Still a long way to go to change local incentives

SBIR Program is a shining example of how to do it!

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