Technology Refreshment Within DoD

Proactive Technology Refreshment Plan Offers DoD Programs Significant Performance, Cost, Schedule Benefits

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Technology Refreshment
The periodic replacement of Commercial Off-The-Shelf (COTS) components; e.g. processors, displays, computer operating systems, commercially available software (CAS) within larger DoD systems to assure continued supportability of that system through an indefinite service life.

C urrently, no firm consensus exists on what "Technology Refreshment" really entails within DoD, the Federal Government, or industry. World Wide Web and library research on this topic invariably turns up a wide multitude of definitions, but a scarcity of policy, regulations, or published academic work that would help bring consensus in terms of common understanding and implementation practices. Until this consensus exists, the purpose and scope of Technology Refreshment will continue to require careful definition in the acquisition/program support strategy for each DoD program.

This article more finitely defines Technology Refreshment, its scope, typical acquisition phases and funding, and its impact on DoD acquisition program management. It also discusses the divergent Technology Refreshment definitions, recommends a common definition and its impact on the 10 elements

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Virginia Class Attack Submarine
Image courtesy Electric Boat Corp.
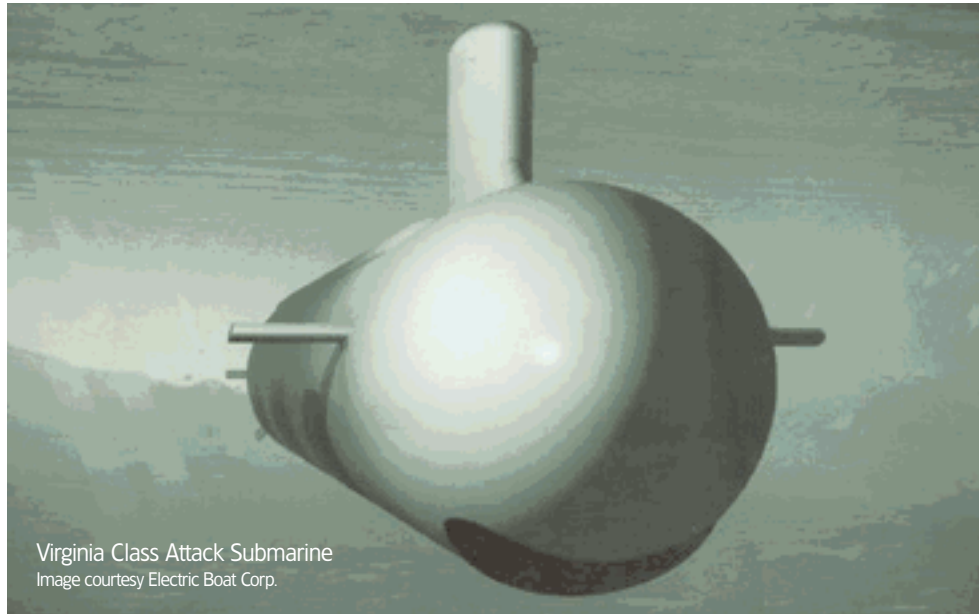
of logistics support, and concludes with the successful implementation of Technology Refreshment in two highly visible DoD programs.

A Concept, A Strategy, A Practice, A Process?

Just what *is* Technology Refreshment?

- Is it a concept centered on affordability initiatives such as Cost as an Independent Variable (CAIV), Single Process Initiative (SPI), Lean Manufacturing Thinking, Value Engineering, and Parts Obsolescence that includes technology upgrades, refreshers, and insertions?
- Is it "Modernization through Spares," the Army's new Continuous Technology Refreshment (CTR) initiative based on technology insertion and the use of commercial products, processes, and practices to extend a system's useful life?

- Is it a non-National Security System Information Technology (IT) technical obsolescence risk strategy?
- Is it replacement of "functionally obsolete" Navy desktop computers?
- Is it a procurement strategy?
- Is it a Federal Aviation Administration investment analysis-based periodic replacement of COTS/CAS components for the National Airspace System?
- Is it a corporate enterprise software financial management strategy?
- Is it outsourcing information technology (IT) infrastructure, seat management, and help desk functions at the National Aeronautics and Space Administration?
- Is it a Sun Microsystems, Litton/PRC, and TRW competitive strategy to provide DoD network systems security, systems administration, and training services?
- Is it replacement of DoD Software development tools with the latest tools?

Joint Strike Fighter
Photo courtesy The Boeing Company

Way of Doing Business," set the first clear policy for COTS/NDI use to meet future DoD needs. Today, COTS/NDI is a key strategy of DoD's "Revolution in Business Affairs" to fund needed force modernization with reduced acquisition, infrastructure, and support costs.[3]

Recent congressional authorizations and appropriations acts and rewrites of the DoD 5000 series stress COTS/NDI, reinforcing the belief that COTS/NDI is a way to do things faster, better, and cheaper.

Benefits vs. Risks

Use of COTS/NDI poses well-known benefits and perhaps less well-known risks to DoD. Benefits are fourfold:

- Quick response to operational needs or "reduced cycle time."
- Elimination or reduction of research and development and reduction in operations and support (O&S) costs.
- State-of-the-art technology.
- Reduction of technology, cost, and schedule risks.

Use of COTS to decrease O&S costs is particularly appealing, since these costs represent 72 percent of the life cycle costs of a typical DoD system.[4]

The risks associated with COTS, however, are primarily O&S concerns. Besides the mission trade-off that a system developed for commercial needs may fail to meet military requirements, risks include logistics support, product modifications, and continued product availability.

Technology Refreshment More Finitely Defined

Technology Refreshment is essentially a COTS/NDI information technology component and/or system support strategy to extend system service life by addressing COTS/NDI logistics concerns.[5] To reiterate, Technology Refreshment is then "the periodic replacement of Commercial Off-The-Shelf (COTS) components; e.g. processors, displays, computer operating systems, and commercially available software (CAS) within larger DoD systems to assure continued sup-

- Is it Air Force provision of the latest desktops and peripherals through the General Services Administration schedule?
- Or is it the Joint Strike Fighter's avionics computer chips obsolescence strategy through "evolutionary technology refreshment"?

While Technology Refreshment is apparently all of these things,[1] we know from the definition provided at the beginning of this article that, at a minimum, Technology Refreshment concerns the supportability of Commercial Off-the-Shelf hardware and software. As such, it remains rooted in DoD's strategic shift to a COTS/NDI (Commercial Off-The-Shelf/Nondevelopmental Item) procurement strategy in the 1990s. This shift is rooted in Acquisition Reform initiatives to reduce weapon system acquisition and support costs and to take advantage of the fast pace of commercial technological change.

COTS/NDI Linkage

The shift to COTS was first recommended (but not fully implemented) by the Commission on Government Procurement in 1972, to address the high cost of developing items to meet detailed government specifications and standards.[2] Former Secretary of Defense William Perry's 1994 special memorandum, "Specifications and Standards — A New

portability of that system through an in–definite service life."[6]

It provides "indefinite" service life by staying ahead of the obsolescence curve[5] with cost-effective planned technology upgrades, refreshers, and insertions, based on market research and system performance requirements. Robert Kennedy categorizes Technology Refreshment into three areas: technology upgrades, technology refreshers, and technology insertion.[7]

Technology Upgrades

A change that incorporates the next generation product or product upgrade to an existing technology or component that improves overall system functionality. This refreshment may not require redesign of the next higher assembly and is usually form, fit, and function (F^3). This type of change can occur at any time during product life.

Technology Refreshers

A change that incorporates a new product to avoid product end of life or product obsolescence, or to correct a problem based on customer feedback. This refreshment may or may not have F^3, can occur at any time in the life cycle, and re-certification or certification will be required.

Technology Insertion

A change that incorporates a new product or function capability, which is the result of industry growth or DoD advanced development. This type of refreshment will not have the same F^3, may require redesign of the next higher assembly, and re-certification.[8]

This type of Technology Refreshment strategy ensures military systems stay current with the latest commercial technology and, when appropriately planned, eliminates or at least reduces total system upgrades. Since some military systems are now expected to have 30- to 90-year service lives, this represents a significant potential life cycle cost reduction. However, Technology Refreshment should be designed into the system early in its life cycle because it will require an Open Systems Architecture

Department of the Navy New Attack Submarine Command, Control, Communications and In–telligence System Integrated Product Team receives the David Packard Award for Acquisition Excellence in May 1996. The award recognized their many "management and technological innovations, including use of a single design agent, COTS electronics, and a Technology Refreshment process to provide upgrades for the future."

design, or commercial standards-based architecture, to maximize COTS/NDI "plug and play" refreshments.

Technology Refreshments *within* the system's initial performance window that do not require developmental testing and occur after initial system fielding, would be funded with Service operations and maintenance (O&M) funds. Refreshments that occur *prior* to initial deployment, which exceed the "performance envelope" defined by the Operational Requirements Document, require developmental testing, or are done as part of a block upgrade, service life extension, or major modification would not use O&M funds. Depending on Service Financial Management regulations, these refreshments would use procurement and/or Research, Development, Test and Evaluation funds.[9]

Issues

Technology Refreshment equates to the life cycle support plan for the COTS/NDI system. The most effective Technology Refreshment strategy would address all 10 logistics support elements, with particular focus on technical data, maintenance planning, and supply support — areas that have been problematic for COTS/NDI systems.[10] This strategy

should result from early systems engineering trade studies and market research that determine the most cost-effective support strategies for the accelerated COTS/NDI acquisition.

In addition, the Technology Refreshment strategy should be developed by a cross-functional Integrated Product Team (IPT) that includes at least the system developer, user, contractors, hardware and software support facilities, trainers, and test and evaluation communities. Finally, given the lack of common military acquisition understanding of Technology Refreshment, the strategy should clearly identify its scope, processes, roles, and responsibilities.

The chart on p. 26 outlines the Technology Refreshment strategy impacts on the 10 logistics support elements. The overall support strategies could range from pure COTS, COTS/organic, to pure organic based on the system-use factors of: 1) how the item will be used ("as is" to full militarized modification); 2) operational environment (fixed/industrial/non-hostile to mobile/austere/hostile); 3) projected service life; 4) deployment schedule (immediate deployment to future use); and 5) reason for COTS/NDI selection (from ad-

vanced technology with upgrades to readily available, proven design).

Any of these strategies will have to address **data rights,** which are normally limited in proprietary COTS/NDI systems, and limit the **technical data** the government will have for system development, production, spares provisioning, operator and maintainer training, and life cycle logistics support. Given the data limitation and the desire to reduce costs and access commercial technology/upgrades in the first place, DoD is moving toward a preference for contractor **maintenance** support of COTS/NDI.

The technical data and maintenance decisions, in turn, will have a direct impact on the **spares/repair parts** requirements and sources of **supply support.** In all likelihood, the government will not have the technical data to compete spares and replacement purchases, but open systems **design interfaces** with "plug and play," "pull and replace" standard IT equipment, and timely Technology Refreshment limit this problem. For systems without these features, the government must proactively plan to mitigate the risk of discontinued COTS/NDI production and/or contractor support.

At least three options are available to mitigate such risk: 1) purchase commercial model upgrades as they evolve (this is the essence of Technology Refreshment); 2) a one-time or "life of type" spares purchase; or 3) "data rights escrow," purchasing sufficient technical data to solicit follow-on supply support concurrent with the manufacturer's end of production. The second two options must be planned and funded as early as possible because they are often quite expensive. For example, in Air Traffic Control systems, Air Force cost analysts have seen data rights packages for small, mobile systems that cost from $1-3 million, and "life of type" buys of flat panel displays at $25 million in a single year.

These decisions obviously impact **manpower and personnel,** reducing or eliminating maintenance personnel and po-

tentially creating new operator skill and **training** requirements. This is especially important for CAS, as the prerequisite software development skills required for any organic software maintenance and other **computer resources support** may not be available. Involvement of the Post Deployment Software Support facility in Technology Refreshment planning will ensure that the COTS/NDI impact on computer resources is addressed. A training advantage of COTS/NDI is that the vendor may have pre-existing training materials, computer-based and/or Web-based, that will easily support government training requirements. However, expected military system usage different from commercial usage would generate new training requirements. Finally, the COTS/NDI impact on **packaging, handling, storage, and transportation** (PHS&T) should be minimal, since commercial vendors must execute PHS&T in the conduct of normal business.

Program Application

The widespread use of COTS/NDI computer hardware and software in military IT and security systems, combined with diminishing sources of supply/support, rapid technological change, and the push for Open Systems Architecture, suggests that many DoD programs are applying some form of Technology Refreshment strategy. Two successful examples include the Joint Strike Fighter (JSF) and the new Virginia Class Attack Submarine.

Joint Strike Fighter

According to a May 2000 press release, the Lockheed Martin JSF team has achieved a "major breakthrough in technology management of aircraft avionics" by using Open Systems Architecture and Technology Refreshment to solve the constant problem of computer chip obsolescence, while positioning JSF to affordably exploit advances in technology.[10] This life cycle approach is being applied to the whole air vehicle to offset the two-year computer chip obsolescence cycle that used to drive life-of-type buys or major programmed retrofits with expensive redesign/re-certification of the computer hardware and recoded software.

JSF's life cycle technology management uses "true Open Systems Architecture" and "evolutionary Technology Refreshment" to achieve "software portability," or independence from hardware, both within the avionics box and throughout the entire aircraft. Significantly, this approach "allows the boards or modules, incorporating new technology, to be changed out as preferred spares on an attrition basis, with no impact to form, fit, or function." These boards can be procured from different vendors, eliminating large spares inventories with potential for performance growth, lower costs, and higher reliability.

The concept was successfully demonstrated in the laboratory with the flight control system. Due to safety of life, electronic flight control systems normally have triple or quadruple redundant channels of both hardware and software, with strict time synchronization requirements and identical chips in all channels. In the demonstration, Lockheed Martin used computer boards with different commercial technology produced by four different vendors, and showed no performance degradation with "mixing and matching" capability on the three channels. According to Lockheed Martin, the main accomplishment was "proving that a system can be designed using commercial standard interfaces — both internally and externally — to achieve computer board interchangeability and software portability."

Virginia Class Attack Submarine

The Navy's new Virginia Class Attack Submarine was awarded the Federation of Government Information Processing Council's "Best of Open Systems Solutions Award" in early fiscal 1995 for the submarine's command, control, communications and intelligence (C^3I) Open Systems Architecture. This was followed by the submarine's program team award of the David Packard Award for Acquisition Excellence in May 1996. This award recognized the team's many "management and technological innovations, including use of a single design agent, COTS electronics, and a Technology Refreshment process to provide upgrades for the future."[11]

The Open Systems Architecture design allows easy interchange of commercial components with existing components, and the Technology Refreshment strategy will insert technology updates to keep the system hardware and software baseline current with the rapidly changing commercial processing capabilities.

Lessons Learned

Four primary "Lessons Learned" emerged from my research on the true definition of Technology Refreshment:

Technology Refreshment Strategy Essential

First, COTS/NDI software and computer hardware and rapid technological advancement in processing capability, *require* a prudent Technology Refreshment strategy to provide cost-effective support and upgrade system components ahead of the COTS obsolescence curve.

Open Systems Architecture

Second, the most cost-effective strategy requires "true" Open Systems Architecture design with standard commercial interfaces to take advantage of "plug and play" commercial components and "true" software portability.

Technology Refreshment Strategy Offers Significant Program Benefits

Third, a well-planned and -funded Technology Refreshment strategy offers significant program benefits: indefinite service life through regular upgrades vs. major end-of-life modifications or follow-on systems; performance, reliability, availability, and readiness growth through newer-generation technology; reduced spares inventory and maintenance costs through "pull and replace" and Contractor Logistics Support; reduced operational manpower and personnel costs; and diminishing manufacturing support (DMS) and production line shut-down risk mitigation.

Expect Challenges

Fourth, these benefits come with some challenges that need to be managed throughout the system life cycle with cross-functional IPT planning. These include: limited technical data, increasing DMS exposure; lack of control of scope

Technology Refreshment Impact on Logistics Support Elements

Support Element	Technology Refreshment	Comment
Design Interface	↑	Open systems architecture (OSA) required for most cost-effective "plug and play" component spares/upgrades; non-form, fit, function upgrades require redesign and subsystem/system test/certification.
Maintenance Planning	↑	Limited control over vendor modification scope or schedules; technology upgrades, refreshers, and insertions more expensive than traditional production with end-of-life modifications; more frequent retro fit/fieldings; increased Configuration Management for multiple versions; vendor maintenance or "pull and replace" vs. repair levels likely.
Technical Data	↓	Limited or no data rights impact development and production baseline documentation, training, maintenance sources/levels, and supply support.
Supply Support	↓	Limited technical data and technology refreshment drive vendor supply support; DoD unlikely to source COTS through the supply system; OSA allows commercial supply with minimum "on board" system spares.
Support Equipment	↓	Limited data, vendor maintenance, "plug and play," "pull and replace" minimize/eliminate support equipment.
Training and Support	↕	Limited data, vendor maintenance, "plug and play," "pull and replace" minimize/eliminate organic maintenance training; COTS manuals, computer–based and Web training minimize/eliminate operator training; military operations and organic software support may drive increased training.
Computer Resources Support	↓	CAS may drive new software personnel support, skills mix, and training — especially with non–OSA legacy systems; new software development tools and training; Computer Resources IPT/Plan updates.
Manpower & Personnel	↕	Reductions in operator/maintenance personnel likely to be greater than increased Program Management Office Technology Refreshment oversight; other support decisions may impact skill levels and mix.
Facilities	↕	Potential change in storage space at operating locations, but reduction in maintenance and supply support should result in overall decrease in facilities requirements.
Packaging, Handling, Storage, and Transportation	↕	COTS/NDI components not likely to require special packaging, handling, or storage by nature of existing commercial operations; frequent upgrades potentially increase transportation and storage costs.

and timing of commercial upgrades, some of which could drive costly hardware and/or software redesign, re-certification and test; increased configuration control management; and most importantly, funding. Until Technology Refreshment is widely accepted as a prudent system life cycle support strategy with positive return on investment, it will be hard to justify out-year funds for potential cost-saving changes.

To Recap

In writing this article, I sought a more finite definition of Technology Refreshment, its scope, typical acquisition phases and funding, and its impact on DoD acquisition program management.

What I found, however, was a lack of Office of the Secretary of Defense, Federal Government, and industry consensus on Technology Refreshment and a scarcity of policy, regulations, or published academic work that would help bring consensus in terms of common understanding and implementation practices. Until this consensus exists, the purpose and scope of Technology Refreshment will continue to require careful definition in the acquisition/program support strategy for each DoD program.

The proposed definition of Technology Refreshment outlined in this article includes technology upgrades, refreshers, and insertion and represents the post-production support plan for COTS/NDI hardware and software components or systems. Open Systems Architecture design, coupled with COTS/NDI components and a proactive Technology Refreshment plan, offers DoD programs significant performance, cost, and schedule benefits with manageable risks. The key is up-front and early planning to fully leverage acquisition reform tools and commercial technology.

Editor's Note: The author welcomes questions or comments on this article. Contact her at **Linda.Haines@hanscom. af.mil.**

E N D N O T E S

1. An Internet search of "Technology Refreshment" on **www.google.com** produced over 20 pages of references, including the examples cited in this article.
2. Kennedy, Robert, "Technology Refreshment: A Management/Acquisition Perspective," available on the World Wide Web at **http://www.erols.com/scea/ Conference00-pdfs/Technology_ Refreshment-Kennedy.pdf.**
3. *Acquisition Logistics Guide,* Defense Systems Management College, December 1997, pp. 1-19.
4. Alford, L.D., "The Problem with Aviation COTS," *Acquisition Review Quarterly,* Summer 1999, pp. 297-303.
5. The Clinger-Cohen Information Technology Management Act and acquisition policy/regulations differentiate between Information Technology (IT), which is normally for non-national security systems and hardware and software components for National Security Systems (NSS). For example, FAR part 39, Information Technology, which implements the Clinger-Cohen procurement regulation, specifically applies to non-NSS purchases. However, IT is a commonly understood term that conveys the computers, software, and peripherals that are subject to Technology Refreshment.
6. Alford, L.D., "The Problem with Aviation COTS," *Acquisition Review Quarterly*, Summer 1999, p. 297.
7. Kennedy, Robert, "Technology Refreshment: A Management/Acquisition Perspective," available on the World Wide Web at **http://www.erols.com/scea/ Conference00-pdfs/Technology_ Refreshment-Kennedy.pdf.**
8. For a definition of Continuous Technology Refreshment (CTR), go to **http://www.monmouth.army.mil/ cecom/lrc/specstd/ve/def.html#** on the World Wide Web.
9. *Acquisition Logistics Guide,* Defense Systems Management College, December 1997, Chapter 21.
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11. Kaminski, Paul G., "Affordability in the Submarine Force," available at **http://www.defenselink.mil/speeches**.