Technology Refresh
A System Level Approach to managing Obsolescence

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Abstract
As a result of declining defense budgets over the last decade, the Department of Defense (DoD) is faced with increasing support costs for aging military equipment. Funds needed to modernize our armed forces for the challenges of the 21st century are being siphoned off to meet growing maintenance costs, which continue to increase as equipment ages. The downturn in procurement of new equipment has produced a consolidation of the defense industrial base, including the lower tier suppliers. Diminishing Manufacturing Sources (DMS) is a major problem for the DoD, particularly in the area of avionics. Companies that have continued to supply the DoD have shifted their focus to commercial markets due to the downsizing of the U.S. military, decreased supplier demand, and the emphasis on the DoD to use commercial off-the-shelf (COTS) parts. As a result, fewer suppliers of legacy avionics components are available today, and available parts are going out of production at an accelerating pace.

Traditional efforts of addressing technology refresh have been reactive in nature. Decisions on DMS/obsolescence concerns are based on schedule, procurement cost, and other short term gains. Long term effects and total ownership cost (TOC) are often left out of the decision making process. The defense industry has implemented programs and developed tools to combat the aforementioned issues and manage DMS in a more systematic manner, following the DoD’s emphasis in acquisition reform. However, many approaches still rely heavily on obtaining information regarding obsolescence independently, reacting within the boundaries of a single organization with little cooperation across the supply chain.

The Technology REfresh for Navy Transformation (TRENT) program seeks to mitigate these problems by developing a new enterprise-wide strategy for proactive technology management at the system level. The goals of the TRENT program are to improve the readiness, mission capability, and life-cycle affordability of Navy weapon systems. The components of the proactive TRENT solution include:
- Collaborative technology management process
- Web-based information technology (IT) framework to link distributed tools, databases, and information sources
- Methods to share information across the supply chain and between stakeholders
- Broad industry collaboration

The benefits of the TRENT approach to proactive technology management will be validated through a pilot project on the Joint Strike Fighter (JSF) program at Lockheed Martin. The pilot project results will be used as the basis for a potential generic DoD-wide technology management solution for DoD weapons systems. The primary TRENT team consists of the Advanced Technology Institute (ATI), Altarum, American Competitiveness Institute (ACI), Lockheed Martin Aeronautics (LM Aero), Lockheed Martin Advanced Technology Laboratories (LM ATL), and Sandia National Labs (SNL). Blue Agave Software (BAS), a commercial software provider, is also providing key support.

Unrestrictions

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DMSMS, Proactive Technology Management, Technology Awareness, Technology Intelligence, Obsolescence Forecasting, TSPIR/PBL, Roadmaps, and Stakeholder Council.

1. Introduction

The U.S. Military is faced with a formidable set of challenges. Following more than a decade of declining defense spending and a gradual, continual aging of the fleet, the DoD is forced to look for new ways to maintain superior tactical capability within a declining budget. Because of this downturn in procurement of new equipment, the average age of many kinds of military systems has increased. This older equipment requires increased maintenance and is vulnerable to a lack of spare parts, which has frequently led to the cannibalization of one unit to keep another running. Even if these systems could be maintained, they are generally not adequate for dealing with the current and evolving missions, threats, and information intensive battlefield environments. One result has been lower mission capable rates and a decrease in operational readiness. This decline in readiness was due largely to the increasing age of the aircraft fleet, particularly aging avionics systems.

As the size of the U.S. military has decreased, there has been a corresponding consolidation of the defense industrial base, including a consolidation of the suppliers of avionics components. The reduction in the number of prime contractors, combined with the reduced procurement budgets, has led to a commensurate reduction in market opportunities for lower tier suppliers. This has further exacerbated the DMS problem.

2. Magnitude of the Problem

The average age of U.S. military aircraft is 20 years and increasing. Although extending the life of the airframe is relatively straightforward, avionics systems based on technology from the 1970s and 1980s are rapidly becoming obsolete. As aircraft age, avionics systems become more difficult to support and maintain. Many critical components are no longer in production or have become technologically obsolete, and former suppliers of military-grade components have gone out of business or have stopped production for the military market.

By 2015 the projected average age of U.S. military aircraft will be 29 years. The impact on Mission Capability Rates due to aging is dramatic. Across the USAF fleet, the Not Mission Capable (NMC) rate increased 53% between 1991 and 1998. This decline in operational readiness has been attributed largely to aging avionics. Operations and Support/Maintenance costs (O&S/M) are forecast to increase 40% for software and 50% for hardware between 1999 and 2005. At the same time, the budget for modernization is expected to decrease 35% from 2001 to 2005. Meanwhile the cost to modernize/upgrade complex weapon systems continues to increase.1

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Since 1995, the military market has constituted less than 1 percent of the commercial integrated circuit market, as shown in Figure 1. As a result, the military must rely increasingly on COTS technologies for both avionics system upgrades and new designs. Although COTS items are generally less expensive than comparable items designed to military specifications, the technology-refresh cycle for COTS is typically 18 months or less, which exacerbates the ongoing problem for aircraft with lifetimes measured in decades.

![Figure 1](image)

**Figure 1.** Military share of Commercial Electronics Market continues to decline.

3. **Technology REfresh for Navy Transformation (TRENT)**

The TRENT program objectives are to improve the readiness, mission capability, and life-cycle affordability of Navy weapon systems by developing an enterprise wide strategy for proactive technology management across the supply chain at the system level. TRENT defines technology management as the periodic replacement of both COTS and non-COTS components within DoD systems to assure supportability of that system through its service life. Technology management encompasses:

- Technology Upgrades – A change that incorporates the next generation component and is usually form, fit, and function (F3).
- Technology Refresh – A change that incorporates a new component to avoid obsolescence. This refreshment may or may not be F3 and requires re-certification.
- Technology Insertion – A change that incorporates a new component as the result of additional requirements or advanced development. Technology insertion will not have the same F3 and may require redesign of the next higher assembly, and re-certification.

The TRENT vision shown in Figure 2 indicates that for many weapon systems today obsolescence management is still accomplished through lifetime buys. The Government-Industry Data Exchange Program (GIDEP) is a step in the right direction by providing advanced warning of pending obsolescence problems. However, with the paradigm shift towards Performance Based Logistics (PBL) type contracts where the prime contractor has total responsibility for managing obsolescence
TRENT’s projected benefits are:

- Reduced cycle time for introducing new technologies and enhanced capabilities (Goal 25%).
- Reduced operations and support costs (Goal 10%).
- Avoiding unnecessary refresh actions based on adequate inventory, planned redesign, system phase out, or force reduction.

And technology refresh, we need the capability to forecast obsolescence and plan for periodic technology upgrades over the life-cycle of the system.

TRENT is jointly funded by the Supply Chain Practices for Affordable Navy Systems (SPANS) program, and the Transformational Manufacturing Technology Initiative (TMTI) program. SPANS is a Navy program initiated to provide support to the Office of Naval Research (ONR) by developing and deploying technologies and best practices that address affordability issues concerning the life-cycle of large weapon systems. TMTI projects are sponsored by ONR’s Navy ManTech, which is responsible for developing and implementing manufacturing technology that reduces life-cycle costs, improves schedules, and ensures quality.

4. **TRENT Process**

A major component of TRENT is the development of a comprehensive technology management business process. Figure 3 illustrates the traditional technology management process. An obsolescence
Figure 3. Traditional technology management process.

notification is received, the solution is selected, budgeted, and implemented. This process is linear and often does not produce the most optimal solution because it is not coordinated across the supply chain or across all changes.

Figure 4 contains the new collaborative TRENT technology management process. The events and functions of this process are categorized as a set of high-level activities that includes forecasting, evaluation, selection, implementation, and feedback.

Figure 4. TRENT collaborative technology management process.
The Forecast activity consists of Awareness and Intelligence Gathering. The Evaluate activity consists of Analysis and Selection. Each functional component has one or more applications associated with it, along with internal and/or external information sources. Forecast is split between developing an awareness of component availability and collecting data that can be analyzed to determine future component issues. The Awareness function provides the user with the ability to set up an alert mechanism that sends a notification of a future part obsolescence problem. This notification classifies the severity of the situation for the user. The Intelligence Gathering function includes the capability to collect support information on supplier health, supplier products, component alternatives, technology trends, market trends, in-house production plans, in-house budget constraints, in-house product plans, performance data and any other business or engineering data that can be applied to making a decision on component alternatives. Evaluate is split between analysis of alternative solutions and the selection of the best approach to component alternatives based on the appropriate balance of cost and performance and requirements. The Analysis function represents capabilities that can be used to examine performance, cost, risk, and schedule issues with regards to different solutions that include lifetime buys, technology refresh, technology insertion, capability upgrades, or any combination of the available alternatives. The Selection function represents a set of capabilities that can be used to model and simulate the different potential solutions within scenarios and generate parameters that can be applied to the final decision. The Implement activity represents the capabilities needed to control and monitor the implementation of the solution in the weapon system program. These capabilities can include roadmap development, contract generation, and customer support. The Metrics activity represents intelligence gathering and analysis that is implemented to monitor progress with the implementation of product changes that are identified through the technology management process.

5. TREN Framework

Another major component of TREN is the collaborative framework (Figure 5). The framework is a Web-based architecture developed using the Windchill commercial product data management (PDM) system. This architecture provides maximum flexibility and scalability for TREN. Major components of this architecture include the tools that provide user capabilities as defined by the process, a common repository for the storage and redistribution of information, access control for the roles called out in the process, and process control in the form of configuration management and change management.

The toolset provides the user capabilities of forecasting, analysis, selection, and implementation. The tools are a heterogeneous set typically developed independently of each other, with different approaches to user interface, data storage and data representation. Given the previous statement made about data storage and data representation and the fact that data generated by one tool will be needed as input to others, a common repository is required for general access. Data that is required for future use by the integrated toolset will be stored in the TREN database. The integrated toolset includes the capability to manage the data that is stored in the TREN database by controlling the version of
the data, tracking the history of changes to the data, limiting who is authorized to make changes to the current version of the data, and notifying responsible individuals of changes to the data.

6. **TRENT Stakeholder Council**

The TRENT program has organized a Stakeholder Council to provide the TRENT team with insight into current practices for technology management and to develop generic requirements for current and future technology management throughout the DoD and industry. The council is composed of key management and technical personnel from government, industry, academia, and vendor organizations who deal with issues of technology management.

7. **Conclusions**

The TRENT program is developing a new approach for proactive technology management across the supply chain that is focused at the system level rather than individual components. Technology management encompasses technology upgrades, technology refreshes, and technology insertions for new and legacy platforms. We have defined a new collaborative process for technology management that is designed to produce the optimal solution for all obsolescence problems based on increased supplier collaboration and the coordinated development of integrated product roadmaps. These product roadmaps are ultimately shared with the customer. We have developed a tool independent,
web-based framework for linking together the various tools that are used in performing technology management. We have initiated efforts to develop a standardized format for electronic bills of materials (eBOMs), product roadmaps, as well as developing an ontology for the domain area of technology management. The TRENT stakeholder council is continually looking for new members to join who share an interest in technology management.

8. Authors Biography

Jeffrey Stavash is the TRENT and the Defense Logistics Agency’s (DLA) aging systems programs project leader. Mr. Stavash has experience in the development of advanced collaboration systems for Integrated Product Teams (IPTs). He developed the Smart Product Model (SPM) for the Navy’s DD(X) next generation destroyer program. Mr. Stavash holds an MS in Computer Science (New Jersey Institute of Technology) and a BS in Computer Science (Seton Hall University).

Shanti Sharma is involved in the TRENT project’s system design and pilot implementation. He is developing a methodology for monitoring and controlling the operation of policy constrained ad-hoc networks across multiple policy domains. Mr. Sharma received his MS in Electrical Engineering (Villanova University), a Graduate Certificate in Object-Oriented Software Methodology (New Jersey Institute of Technology), and a BS in Electrical Engineering (BIT India). He holds three patents.

Thaddeus Konicki is involved in the TRENT project’s system design, tool evaluation, and pilot implementation. Thad has experience in embedded multiprocessor design and enterprise system development. He holds an MS in Computer Science (St. Joseph’s University), and an MS in Electrical and Computer Engineering and a BS in Electrical Engineering (Drexel University).