TEAM SUBMARINE STRATEGY 2000

Commercial Off The Shelf

(COTS)

Acquisition Primer

6 August 1997

Preface

An overarching assumption of the Team Submarine Strategy 2000 initiative is that technology introduction to the fleet will be accelerated. The use of Commercial Off The Shelf (COTS) and Non-Developmental Item (NDI) products will be more prevalent, and will require new and innovative approaches to supportability. In light of this assumption, and to maximize uniformity across the Team Submarine community, a program is called for, for use by Program managers, which addresses these issues.

This Team Submarine COTS Acquisition Primer is intended to provide Program Managers and their staff with a useful and comprehensive tool when considering acquisition and life-cycle support of COTS applications for their respective programs.

Under the guidance of Group Chairman, P. Tamburrino, PMS425, and Group Co-chairman, G. Shaffer, PMS401, a team of government and industry experts were compiled to develop this document. Contributing to this effort were E. Stasiak, PMS425; J. Kulesz, SEA92, J. Slantis, SEA92; T. Ung, PMS425; R. Travis, PMS401; L. Didden, PMS401; C. Schmidt, SEA92; S. Adams, PMS396; N. Dellinger, PMS396; R. Gold, PMS450; D. Verma, Lockheed Martin Federal Systems, J. Wille, Acquisition Planning Corporation; F. Bowles, EG&G; and J. Ensminger, EG&G.

A wealth of information exists today on the subject of COTS. This COTS Acquisition Primer is not intended to be a substitute for any of this information. It is an attempt to capture current overriding principles and to instill a comprehensive strategy, useful across the Team Submarine community. Appendix B lists the documents which were consulted in development of this Primer. The Team Submarine community is grateful to the authors of these references.

Table of Contents

Table of Contents (Cont'd)

Table of Contents (Cont'd)

COTS ACQUISITION PRIMER

CHAPTER 1: GENERAL INFORMATION

1.1 Purpose

The purpose of this document is to describe generic processes that may be used to develop and execute a comprehensive and cost-effective Commercial Off The Shelf (COTS)-based submarine Non-Propulsion Electronics (NPE) systems acquisition and support strategy. The processes described in this document are derived in part from the Lockheed Martin Federal Systems (LMFS) approach for the New SSN C^3I program. They are consistent with DoD policy and sound systems engineering principles. These processes can be applied and tailored for any small- to large-scale COTS-based program.

This document will address options available to the Program Manager (PM) for cost effective selection and application of COTS products based on DoD policy, industry experience, and program lessons learned. The actual implementation of COTS acquisition and support strategies should be addressed in program specific plans.

Team Submarine, comprised of all United States Navy submarine electronic system acquisition program offices (PEO Submarines, SEA 92), recognizes that the acquisition and insertion of COTS technology is vital to lowering total ownership costs and improving submarine performance.

1.2 Scope

The principles detailed in this Primer are, in most cases, applicable to programs of any size. However, it is understood that larger programs are more easily able to conduct comprehensive market research or technology refreshment activities. Nonetheless, the concepts contained in this document should be considered by program managers whatever the program scale.

As stated above, this document focuses primarily on NPE systems. Acquisition of Hull, Mechanical & Electrical (H,M&E) equipments should be considered on a case-by-case basis using the applicable information described herein. Selection criteria for COTS-based H,M&E equipments should be tailored for specific application and operating environment constraints.

1.3 Definitions

For this document, Department of Defense Regulation (DODR) 5000.2 serves as a foundation document for the acquisition and support of COTS equipments. The following definition from the Federal Acquisition Regulation (FAR 2.101) and 5000.2R (para. 3.3.1.1) applies:

Commercial Item	"A commercial item is defined as any item, other than real property, that is of a type customarily used for non-governmental purposes and that: (1) has been sold, leased or licensed to the general public; or, (2) has been offered for sale, lease, or license to the general public; or any item that evolved through advances in technology or performance and that is not yet available in the commercial marketplace, but will be available in the commercial marketplace in time to satisfy the delivery requirements under a Government solicitation."

For the purposes of this document, the terms "COTS" and "commercial item" will be used interchangeably.

Additional definitions of terms used in this document regarding Open Systems Architecture include:

Open Systems Architecture:	A system that implements sufficient open specifications or standards for interfaces, services and supporting formats to enable properly engineered applications software(1):
Compliance	An information Systems product that has not been formally tested or certified but claims to be of a particular specification.
Conformance	An Information Systems product that has been formally tested and certified using a conformance testing standard. Tested to verify that an implementation performs in accordance with a particular standard, thus minimizing risk.

(1) The term open system has many definitions and interpretations. Though the various definitions have common elements, no formal agreement on any one definition exists. Refer to Next Generation Computer Resources (NGCR) Document No. AST 003 Ver. 1.0, 31 December 1996

Interchangeable	The ability of two or more products (hardware or software) to be transparent replacements for one another without other hardware, software, firmware, or wiring changes.
Interoperability	The ability of two or more computer and/or Information Systems or components of such systems to exchange information and to mutually use the information that has been exchanged.
Profile	Profiling means not only the listing of interface standards but further delineation of how these standards are applied to the design of the system or product being acquired to meet the requirements. It's one thing to identify what standard is needed to obtain interoperability but it's more

difficult to come to agreement on what part of the standard needs to be implemented to get to interoperability in the most cost effective manner to all.

1.4 COTS and Acquisition Reform

The U.S. Navy is faced with a formidable set of challenges. Recent global political changes and the resulting reduction in defense spending has forced the Navy to look to new ways to maintain superior tactical capability within a declining budget. To solve these problems, the Navy has turned to the commercial world and its products as a source of more current technology and associated support.

Rapid advances in hardware and software technology are reflected in the COTS products available to both friendly and opposing nations throughout the world. This dramatic technological progress makes the long development and production of electronic systems, with technology frozen in the year of contract award, very undesirable. In recent submarine combat system developments, for example, the technology is frozen 10 or more years before the submarine is commissioned. The traditional way of system development involving extensive design, test, and integration is too costly - both from a budget and a capability standpoint.

In addition, the use of COTS products will also require continuous interdependent and complementary engineering and support product development processes. Given the evolutionary nature of COTS items, the use of these products instead of the traditional engineered-for-life military products will require corresponding changes in the system design as well as its accompanying infrastructure support.

These challenges will require a shift in the way we acquire, modernize, and support our submarines. This requires a thorough understanding of both the advantages and constraints in doing business within the COTS environment.

DoDR 5000.2R (para. 3.3.1) states:

"In developing and updating the acquisition strategy, the PM shall consider all prospective sources of supplies and/or services that can meet the need, both domestic and foreign. Commercial and non-developmental items shall be considered as the primary source of supply."

This mandate to use COTS products was accompanied with recent changes implemented by the Federal Acquisition and Streamlining Act and the Federal Acquisition Reform Act which streamlined commercial product contracting, allowing contractors to sell to the Government without making them non-competitive within the commercial market place.

The use of COTS products to build military systems, accomplishes the following objectives:

- Reduces system acquisition costs by reducing development costs.
- Reduces the time required to field new military systems by reducing development time.
- Capitalizes on commercial research and development to field current technologies more quickly.
- Offers opportunities to reduce life-cycle costs.

The first three objectives can be easily realized. However, in order to realize the fourth objective—life-cycle cost reduction—a change is required in the way support is viewed. The traditional leader/follower relationship between engineering and logistics support will not allow this objective to be met. Life-cycle costs of a system are determined early in the acquisition process. Ninety percent of a system's life-cycle costs are usually determined prior to Critical Design Review (CDR). Therefore, in order to reduce life-cycle costs, cost reduction efforts must be stressed early in system development. The impact of early product selection and integration decisions on life-cycle costs must be recognized, and the system engineer must assume the responsibility for controlling life-cycle costs. Life-cycle costs must be considered on an equal basis with technical performance.

1.5 COTS Environment

Hardware processing technology has demonstrated a sustained exponential growth characteristic for more than 40 years. This sustained growth has been almost entirely stimulated by commercial and industrial demand for processing capability. Since the mid- 1980s, the computer industry has been driven by huge investments in workstation processors, spurred on by the development of Reduced Instruction Set Commands (RISC) processing technology. As this trend continues, additional significant investments in technologies for consumer multimedia, personal communications, and personal computer products will propel the industry into the next century. As these product areas expand, they will exert strong influence on the direction of open system standards and therefore on the future of open system based COTS applications, including combat systems. Monitoring and anticipating these future trends is vital for properly planning the evolution of Team Submarine NPE Systems.

Just as technology and products change over time, the industry standards used in commercial and industrial computing systems evolve as well. Standards have a definite life cycle. They emerge to support new and evolutionary technological capabilities with an emphasis on forward compatibility until giving way to new standards as emergent technologies and techniques take over. When developing COTS-based systems, it is important to understand and plan for this dynamic characteristic of standards. A key part of this planning is to ensure that only mature, widely used standards are used in the system design to act as buffers against transient or immature technologies. Standards that are widely used by industry are far more likely to have industry funded strategies and tools for migrating applications from old standards to new ones, avoiding the necessity for the Navy to pay for the migration entirely on its own.

A formal process for understanding and forecasting technology trends and product direction is a critical aspect of open system planning and risk mitigation. In general, it is desirable to avoid state-of-the-art technologies and products for deployed systems until those products have reached a level of stability and maturity to maximize cost benefits of a wide market base and minimize functionality and support risks to the system. The perceived risk associated with the use of COTS items when weighed against that of possibly more mature non-COTS items must be recognized. The ability to accurately anticipate technology evolution and product developments is required in order to properly plan and coordinate research and development, prototyping and evaluation efforts needed for timely assessment of the applicability and performance of emerging technologies.

Market Research conducted to determine the availability of commercial products and services is discussed in detail in chapter 4. Sources for assisting in the Market Research process are identified in the "Market Research for Commercial Items (Draft) SD-3 document dated June 10, 1997.

1.6 Assumptions for COTS Usage

Many things must come together to make the application of COTS work. This includes implementation of significant changes in the way systems are acquired and supported. Congress and DoD have passed initiatives to make it possible. It is up to the Program Manager to make it happen. The following considerations must be a part of any COTS implementation plan:

- The foundation of successful COTS application is to design a hardware and software architecture which will accommodate the insertion of new technology, for whatever reason, without significant impact to the special applications of the system. This requires use of an Open System Architecture, with strict adherence to COTS interface standards for hardware and software.

- Requirements should be defined (both hardware and software) in functional terms that enable and encourage the use of COTS.
- To gain the advantages presented by the commercial marketplace, neither the integrator nor the government should impose functional or data restrictions or requirements significantly outside the norm of the commercial marketplace. This would erode the cost and performance advantages inherent within the COTS concept.

- State-of-the-practice items generally interface via open interface standards. The performance of these interfaces is a known factor. Open systems interface standards are readily available to designers who in turn use the standards to speed design and achieve predictable performance levels. Because other designers are using the same interfaces, integration of competing or complementary products is easier. The achieved level of commonality and maturity reduces the risks (time and cost) associated with product integration, making system design, support, and upgrade easier to accomplish.

- Major emphasis in the systems engineering process should be on the selection of new technology through market research rather than Navy sponsored product development.

- The benefits of open systems are not limited to large integrators/manufacturers capable of taking advantage of economies of scale. Any contractor can build systems from lowest replaceable units (LRU) marketed by any other contractor. This makes contractors more competitive, yet cooperative, among themselves, encouraging higher quality products and services. Unlike proprietary system acquisition, users no longer must rely solely on the original contractor for sources of compatible products for system support, expansion, upgrades or replacement parts.

- Testing should be focused on integration of COTS products, including ensuring performance, operational effectiveness and operational suitability for the system application. This testing must be tailored to leverage commercial testing and experience.

- Due to vendor controlled changes, there is risk to the deployed system when COTS products are acquired and installed in a fielded system without testing within the fielded system configuration. Provisions should be made for identifying COTS items requiring such testing and for establishing adequate test ("hot box") facilities at an integrator or Navy facility.

- The number of fielded configurations should be kept to a minimum. Although COTS items evolve quickly, it is not necessary to react to all changes. The use of market research to ensure open systems compliance and downward compatibility and to forecast product obsolescence, combined with the blocking of changes, will minimize change activity.

- Configuration management is exercised instead of configuration control. Since COTS vendors own the product data rights (configuration control), it is necessary for the Government/Integrator to establish formal configuration management processes early in the design/prototyping integration phase.

- The application of a COTS strategy to submarine NPE will require a controlled evolution of the support infrastructure. This will also require objectivity on the part of implementing managers to ensure that the infrastructure evolves with the program rather than simply growing with it.

1.7 Life Cycle of a COTS Product

The acquisition and life cycle support concept revolves around intelligent selection and procurement of COTS equipment to ensure that the Fleet is adequately supported and that the system technology is up to date. This acquisition concept consists of a comprehensive implementation program which includes:

- Market research including surveillance and investigation of commercial products and technology trends
- Supportability assessment of selected COTS products
- Test and Integration of supportable COTS products
- Continuous support assessment of COTS products in the Fleet
- Proactive insertion of product upgrades, technology refreshers and technology insertions

This concept is used in a continuous and iterative manner to ensure that employed products remain within the broadest market possible and thus possess the most efficient leveraging opportunities for support. Planned system upgrades will provide an opportunity to achieve this objective.

Figure 1-1 represents not only the iterative and integrated application of the systems engineering processes involved in COTS acquisition and insertion, but also the inherent interdependencies. Each of these processes are explained in further detail later in this document.

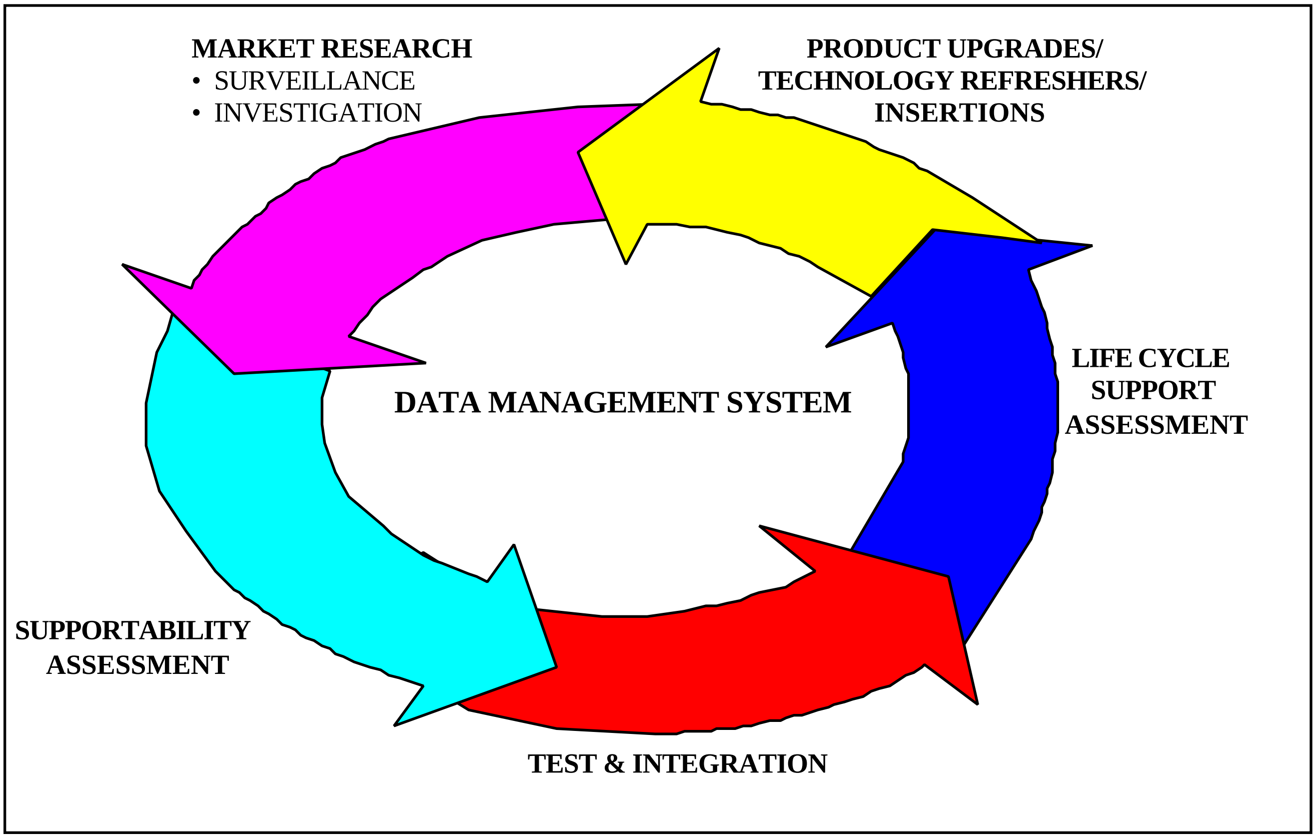

Figure 1-1. COTS Acquisition & Insertion

CHAPTER 2: COTS ACQUISITION PLANNING AND STRATEGY

2.1 The Program Objective Memorandum (POM) and Budget Process

In the past, submarine development programs proceeded independently with each Program Manager (PM) focused on meeting a given set of requirements on schedule within given cost parameters. In the past, there have been sporadic attempts to accomplish some level of coordination, but these have generally failed because of pragmatic program oriented vision.

The coordination of Team Submarine programs is critical to ensuring the common development and implementation of submarine programs. This will allow each program to take advantage of any team development efforts resulting in leveraging of funds and focusing of scarce technical resources. COTS enhances supportability by introducing increasing commonality between systems. This places responsibility on each Program Manager to ensure that previously unilateral budget decisions are now coordinated through Team Submarine and the OPNAV sponsor. Ongoing organizational changes and combat system commonality initiatives are addressing these issues to more effectively manage this convergence.

Figure 2-1 presents a notional overview of the current Team Submarine combat system efforts which could contribute to this Modernization Strategy.

Acquisition of COTS has the potential to reduce costs by reducing design, procurement times, and support programs. However, program size can affect the cost savings and therefore impact the decision to go with COTS. Careful coordination and cooperation between Team Submarine program elements for similar acquisitions could alleviate this problem and further reduce costs. Currently there are no differences in the budget process between using MIL STD and COTS acquisition. Program Managers will need to address Life Cycle costs and supportability. Due to the POM process, coordination of Team Submarine programs must begin now to impact any acquisitions planned 2 to 5 years in the future. PMs must assess the impact of rapidly changing technology against
future acquisition plans to insure that these plans fall within the budget forecast. Continuing vendor support for older technology balanced against replacement of entire systems in a “stepping stone” budget line , must be tailored into outyear budget projections.

Department of Defense Financial Management Regulation defines the different appropriations that should be used to acquire COTS. All COTS, including the first article and associated first article acceptance testing should be funded in the Procurement appropriations. If an end item requires design and development (e.g., system integration) in order to accept the COTS item (i.e., technology insertion or upgrade), then the entire effort is not COTS and funding for that effort should be budgeted in RDT&E. Follow-on purchases should be budgeted in the Procurement appropriations. The number of first articles procured should not exceed the quantity needed to conduct the acceptance tests.

2.2 Technology Upgrade/Refreshment Budget Forecasting

Budget forecasting in the COTS environment is a two tiered process.

In preparing long term budget forecasts, the PM should first determine which subsystems/equipments are most susceptible to changes resulting from technology advancements and define a succession of block upgrades that incorporate the then current technology. These forecasts should be based on industry growth trends in each of several areas including processors and computing technology, signal processors, storage technology, communications and networking, and packaging. The information required for these forecasts is a direct output of the market surveillance process. The results should be grouped into projected change packages and analyzed for life-cycle cost impacts. This process should result in a reasonably predictable budget projection for the life of the program.

The program manager will also need to budget for engineering changes resulting from the need to avoid product obsolescence. This should be based on the use of an aggressive technology refreshment program, with the objective of identifying replacement elements of the fielded system prior to when they become obsolete, or are no longer supported by their manufacturer. While this would seem like a very expensive solution, for one-for-one Lowest Replaceable Unit (LRU) replacements in computer intensive applications this approach can result in significant cost savings, given that the system architecture allows for efficient utilization of new technology and adequate tests are conducted to ensure compatibility.

These two forecasts should be compared to take advantage of replacement of common items, e.g. an obsolete part will be replaced by technology insertion. This should avoid any "dual budgeting" in the process.

The fundamental purpose of technology refreshments is to remove obsolete elements from fielded systems to avoid support issues resulting from the unavailability of spare parts and repair services. Each potential substitution/change must be analyzed and tested for open system compliance/compatibility to determine if introducing the substitution/change is the most effective way to manage the life cycle cost of the system. This strategy includes the re-use of replaced assets in back level configurations as part of a total asset management process.

The optimum technology refreshment scenario is to be able to go to multiple vendors for functionally equivalent COTS products. Alternatives to replacement should be a last resort. End-of-life buys of spare parts and/or special contract arrangements with vendors to supply extended support might, in some cases, be more cost effective than replacement of obsolete elements. However, in the computer intensive areas, periodic replacement at the LRU level will generally be more cost effective. If the program makes use of sound systems engineering processes and good cabinet design with the intent to modernize, then prioritization of upgrades can be accomplished: a) LRU, b) assembly (may be LRU), c) drawer replacement, d) cabinet replacement (swingset, non SHIPALT, e) SHIPALT.

An additional advantage of this approach (technology refreshment) is to change the approach to combat system modernization. Instead of large scale changes requiring extended shipyard availabilities and alteration planning, the modernization will be progressive, primarily kept at the LRU and/or software configuration item level, with minimum impact on the submarine operating cycle. This will result in additional cost avoidance over the life of the submarine.

Chapter 6 provides detailed discussion regarding the technology refreshment approach.

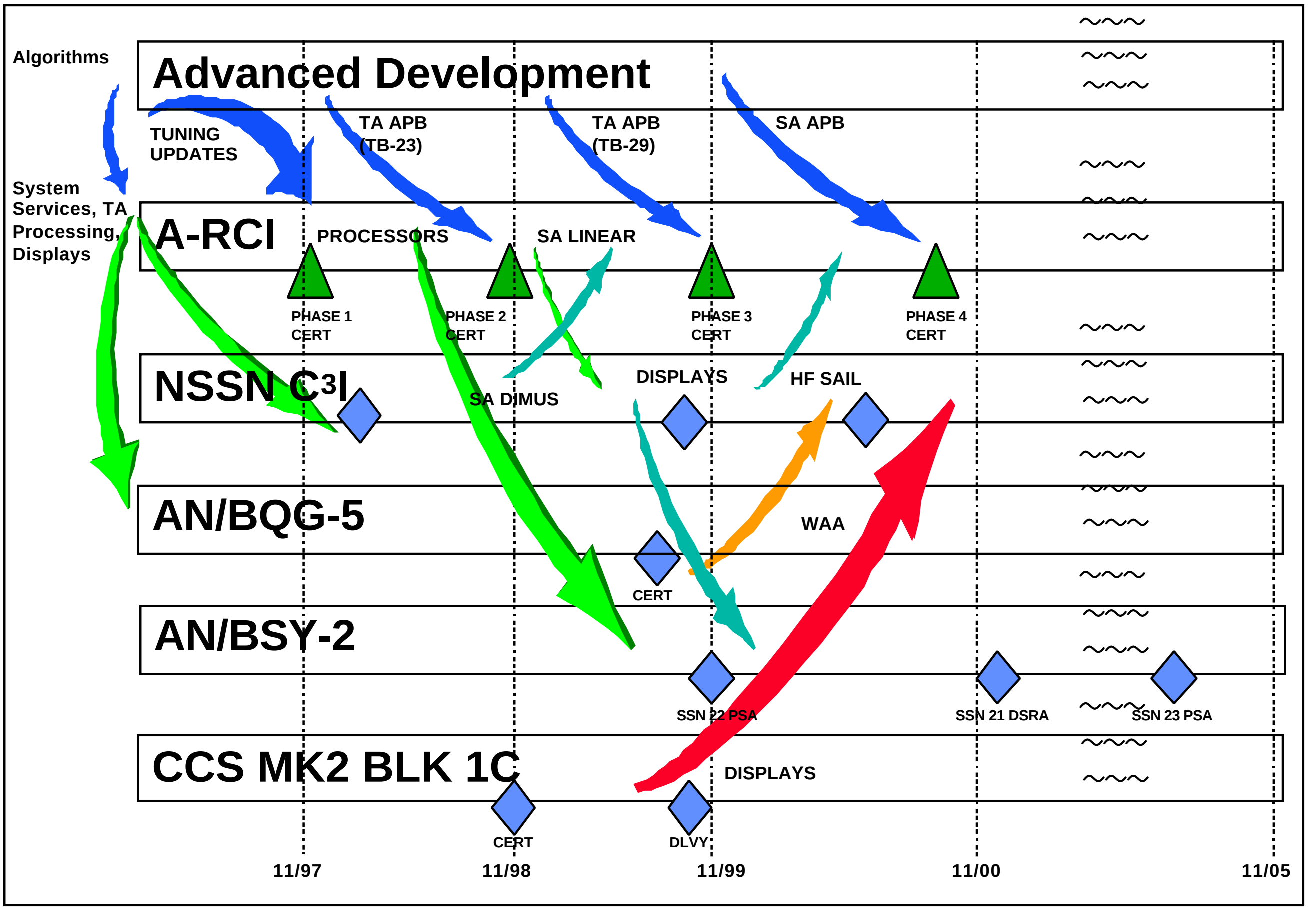

Figure 2-1. Combat System Leveraging Potential (Notional)

CHAPTER 3: THE ACQUISITION PROCESS

Acquisitions begin with a description of the Government's need stated in terms sufficient to allow a search of the market to determine if commercial items are available to meet the need. The extent of market research will vary, depending on such factors as urgency, estimated dollar value, complexity and past experience. Market research, which is discussed in detail in Chapter 4, involves obtaining information specific to the item(s) to be acquired and/or integrated at a system level to meet an initial or replacement need. According to FAR Part 10, the research should determine whether the Government's needs can be met by:

"(A) Items of a type customarily available in the commercial marketplace;
(B) Items of a type customarily available in the commercial marketplace with modifications; or
(C) Items used exclusively for governmental purposes."

If market research establishes that the Government's need may be met by a type of item or service customarily available in the commercial marketplace, the program can proceed to solicit and award a contract using the streamlined procedures of FAR Part 12.

If market research establishes that the Government's need cannot be met by a commercial item, the need should be re-evaluated to determine whether the need can be restated to permit use of commercial items.

For acquisitions of commercial items, many of the steps, procedures and requirements associated with the acquisition process may be different or even unnecessary. These standard acquisition process elements should be scrutinized to determine their applicability to a commercial item. Many standard process elements may have already been accomplished. For example, documented contractor test and performance data may be adequate to assess manpower and training requirements, supply support, reliability, transportability or other support requirements. Conversely, greater emphasis on prototyping or conformance testing may be required to mitigate integration risks. FAR, Part 12 encourages considerable tailoring of the acquisition process when procuring commercial items. Tailoring should reflect the environment and how the item is intended to be used.

3.1 Defining the Requirement

Operational requirements should be flexible and stated in performance terms to maximize potential commercial solutions. A distinction should be made between requirements that are mission critical and those that are mission enhancements. Early communication and cooperation with the sponsor is important to ensure flexibility in the system requirements and to share knowledge of potential commercial items that may be available to meet the requirement.

Requirements should be identified as objectives and thresholds as discussed in SECNAVINST 5000.2B, para. 3.2. An objective is a value beyond the threshold that potentially has a measurable beneficial impact on capability, operations, or support above that provided by the threshold value (SECNAVINST 5000.2B, para. 3.2.1). A threshold is the minimum acceptable value for a parameter that is necessary to provide a capability that will satisfy the mission need. Using the Integrated Product Team (IPT) process, cost, schedule, and performance may be traded off within the range between the objectives and the threshold without obtaining Milestone Decision Authority approval.

3.2 Identifying and Evaluating COTS Potential

Market research provides information on technologies, existing products, varying levels of product performance and quality, commercial practices, support capabilities, and industrial capabilities (DODR 5000.2R, para. 3.3.11). This information is used to determine the feasibility of using a commercial item to satisfy a need. This market research is required as part of the development of the acquisition strategy and is discussed in more detail in Section 4.0.

This market research should not identify a specific product but rather determine if the marketplace would support a full or partial COTS acquisition in support of the Operational Requirements. Through the solicitation process, competitive offers will be obtained from those manufacturers/suppliers who desire to provide the item to the government. These offers may even include manufacturers/suppliers who were not involved in the pre-solicitation activities.

In determining if use of a commercial item is feasible, it is important to assess the total operation and support effectiveness, not just performance. This assessment is particularly significant when evaluating commercial products or other items not designed for the defense environment. The acceptability of commercial items for DoD use depends on reliability, performance, logistics supportability, cost, and other factors. However, don't assume the defense environment is always more demanding than the commercial environment without investigating the commercial uses of that item. Commercial products developed for industrial or other harsh environment and high reliability applications may meet defense needs even though the general consumer products do not.

3.3 Describing the Agency Need

Once the Market Research process has identified that the program requirements can be met by the use of commercial items, it is necessary to convert that need into a solicitation for acquisition of supplies and services in terms of:

- Functions to be performed
- Performance required
- Essential physical characteristics

Product descriptions must provide the essential technical characteristics for the item being purchased and define the methods or procedures that will be used to verify the technical characteristics. There are several types of product descriptions to choose from:

- Non-governmental standards
- Commercial item descriptions
- DoD performance specifications
- DoD detail specifications
- Program peculiar specifications
- Purchase descriptions

3.3.1 Selecting and Developing Product Descriptions

To the extent practical, product descriptions should be written in terms of function and performance. Functional characteristics address what is to be accomplished; for example, "provide transportation." Performance characteristics address the level at which the function is carried out; for example, "provide transportation at speeds up to 60 miles per hour." A design characteristic, on the other hand, tells how the functional requirement will be met; for example, “provide a four wheel vehicle.” Product descriptions expressed in performance terms allow greater flexibility in meeting requirements and increase the potential for use of commercial items. Furthermore, functional and performance requirements have a long life because they allow continuous insertion of new technology to meet requirements.

It is essential to ensure that the product description accurately reflects the requirement and communicates information gained during market research.

The product description should reflect the requirements flexibility by defining functions to be performed and using such terms as acceptable ranges, targets, or desired and/or required values rather than exact values.

If the intended environment is similar to that for which the item was designed, existing commercial standards can be used. If a commercial item will be used in a more severe environment, it may be necessary to include those special characteristics. For instance, the ruggedization of a COTS item (e.g. COTS modules racked inside a MIL-SPEC enclosure) to meet severe environmental constraints may not impact the product integrity thereby maintaining the full benefits of COTS usage. For existing items, the market will have established standards for quality, production, and materials, as well as for item support, technical data, and warranties. Deviating from prevailing market standards and practices can erode the benefits of using commercial items.

Effective application and tailoring are particularly important for commercial item acquisitions. “Application” is the process of reviewing and selecting product descriptions and standards that have specific application to an acquisition and contractually invoking these wholly, or in part, at the appropriate point in the acquisition cycle. “Tailoring” is the process by which sections of a product description or standard are selectively invoked after a determination that they add value to the specific acquisition has been made. You may also modify the sections invoked to meet the needs of the specific acquisition.

When documents are not tailored, companies may not offer an item that meets the basic requirements because it does not have other specified characteristics--which have been unintentionally imposed and which may be unnecessary. Tailoring also makes it much easier for potential suppliers to understand the requirement and evaluate their existing products against it--especially suppliers who don’t routinely do business with the Department of Defense. All contract data requirements should also be reviewed and selectively applied.

3.4 The Statement of Work

In COTS procurements, it may be necessary to acquire contractor services (e.g. contractor logistics support, technical data) in addition to the hardware item. It is important that the solicitation documents, including Requests for Proposals/Quotations and Invitations for Bid, are carefully prepared and tailored so that the required services are also solicited and the proper information obtained to effectively evaluate the offer. This can be in the form of a Statement of Work (SOW) included in the Solicitation document. For system-level procurements, the solicitation documents should be structured to encourage COTS alternatives in full or partial fulfillment of the need.

The SOW is the document in which non-material requirements are defined either directly, or indirectly through cited documents. Examples of services that would be included in a statement of work are training, testing, maintenance, and repair services. The statement of work should establish tasks and identify work to be performed.

DoD-unique product descriptions and standards should be avoided when developing statements of work for commercial services. Standards set by private sector standards-setting bodies and regulatory agencies and commercial practices should be used to the extent possible. When DoD-unique product descriptions and standards are referenced, they must be tailored to the specific procurement.

For contracts utilizing COTS hardware and software as part of a system development, the PM should obtain an understanding of the integrator's plans and processes to select, evaluate, and incorporate COTS products during system development. The PM should understand the specific activities that the integrator plans to perform for COTS during each phase of the system development, including requirements analysis, system design, test and integration. The PM should understand the integrator's plans to document COTS products, including version information, customization details, and COTS vendor product information. The PM should also require the integrator to identify data rights and license information for all COTS software. The integrator may communicate this information in a Software Development Plan (SDP) or other program plans where appropriate.

3.5 Industry Input and Participation

Industry input on product descriptions and statements of work helps clarify technical aspects and helps reveal alternative ways to meet requirements. Several avenues are available for obtaining industry input including:

- Sources sought and requests for information advertised in the ***Commerce Business Daily***, trade journals, and other mass media.
- Draft solicitations issued before the formal solicitation.
- Electronic commerce information.
- Pre-solicitation conferences before finalizing product descriptions and solicitations.
- Coordination of draft product descriptions and statements of work with industry.

A industry mailing list should be developed based on the Market Research.. Bidder mailing lists and lists of historical suppliers for the same or similar products may be used.

3.6 Source Selection

Cost is no longer the primary factor for a contract award by the Government. In today's culture, other factors, such as past performance, have been a bigger player in the contracting arena. It is frequently in the Government's best interest to compare the quality of product and future service requirements against past performance of a contractor to meet current requirements. The FAR states that "Past performance should be an important element of every evaluation and contract award for commercial items. Contracting officers should consider past performance data from a wide variety of sources both inside and outside the Federal Government..."

Cost savings may result with the use of the Best Value approach in terms of how to meet current demands for quality goods at the most reasonable cost. Integrated Product Teams should be utilized to review performance and all life-cycle costs related to the acquisition. As discussed above, Requests for Proposals (RFPs) will reflect performance based product descriptions and a statement of work (SOW) written to allow offerors cost/technical trade-offs.

All requirements will be measurable or verifiable with clearly stated verification and acceptance criteria. This provides maximum flexibility to propose methods and management techniques consistent with “Best Value” source selection criteria.

Section M, Evaluation Factors for Award, should clearly indicate the Best Value nature of the source Selection and the significant importance/weight of individual evaluation factors. Past performance information is clearly a consideration as are supportability (e.g., warranty, repair support, vendor stability, etc.) and design to affordability/life cycle cost factors. Section M and L, Instructions, Conditions and Notices to Offerors, proposal and evaluation/award provisions should be tailored to the specific acquisition with no “boiler plate” requirements. Direction should be clear that offerors are to provide their unique technical approach which clearly meets stated objectives in the SOW.

CHAPTER 4: SYSTEMS ENGINEERING

Systems engineering activities involving requirements analysis, maintenance concept development, functional analysis, and requirements allocation are conducted in an iterative manner and provide the framework for the development of a system architecture consistent with Open Systems Architecture (OSA) standards. The adaptations to traditional systems engineering processes include a) the early Identification and assessment of relevant COTS products, b) the supportability engineering activities pertaining to reliability modeling and prediction, maintainability prediction and level of repair analysis, c) the use of a configuration model for “hot box” testing of new or replacement COTS products and d) a strong input into the design to affordability (DTA) process.

Furthermore, in order to ensure an affordable and effective system, this system engineering process must be robust in its active consideration and involvement of system supportability and producibility concerns. A COTS driven development paradigm results in increased dependence of the design team on the environment (economic environment, technology environment, vendor/supplier environment, etc.).

The significant early step in this adapted process (as depicted in Figure 4-1) pertains to the market research and COTS selection process.

Following the initial market research by the Government to evaluate COTS potential in an acquisition, a formal market research methodology is required for the assessment of COTS alternatives. This formal methodology will ensure that (a) the assessment criteria are keyed to relevant customer requirements, (b) the design independent parameters are included in the assessment, and that (c) the model is capable of handling incomplete and imprecise information characterizing early design.

In addition to assessing COTS products from the standpoint of performance and functionality, it is imperative that system-level concerns relating to commonality between sub-systems, commonality across programs, compliance with OSA standards and guides, and supportability are explicitly considered in the COTS assessment and selection process. This COTS assessment/selection process is facilitated through the use of Integrated Product Teams (IPTs) that comprise design, systems engineering, supportability and affordability representation. Supportability criteria should address not only the inherent design characteristics (such as reliability and maintainability, which impact inherent system availability and readiness), but also the design independent parameters (such as technology maturity, vendor maturity, client base, regulations and standards, warranties, and data rights, which impact affordability and operational system availability and readiness). This makes the selection process robust, allowing the formulation of a maintenance concept which evolves along with the evolving physical configuration, and which leverages the existing commercial support infrastructure to the maximum extent possible. Once COTS products are selected as viable candidates to meet the requirements, early prototyping and testing activity can further ascertain compliance and compatibility characteristics. The COTS assessment and selection process is portrayed in Figure 4-2.

4.1 Market Research

Systems engineering will develop the Form, Fit, and Function (F^3) requirements for a given architecture or LRU. F^3 compatibility by a product allows it to serve as a potential engineering solution or as a substitute for its predecessor without any change to the performance specification. These requirements are utilized to query the marketplace to determine which COTS vendors market products fall within the F^3 requirements. Systems engineering will identify COTS candidates with the potential for complying with the F^3 requirements. These candidates will then undergo a supportability assessment to determine which vendor alternatives perform best from a product supportability perspective. This assessment will then be used by program management and systems engineering to conduct trade-off studies against cost and performance. This proactive approach of determining the supportability attributes of a product prior to its selection as a LRU will allow program management to minimize and manage the risk associated with COTS hardware (H/W) and software (S/W) dynamics.

The market research process is essential to ensuring a proactive approach to minimizing the impacts of the highly dynamic COTS marketplace on submarine electronic system development and support. Information must be gathered that provides an assessment of where an existing COTS product is in terms of its life cycle. The information must also provide a comprehensive input to the supportability assessment process to determine COTS item impacts on the existing support products. The market research process is a continuous and iterative process which drives the selection of COTS products for both new system design requirements (technology insertion or upgrade) as well as application to the system Technology Refreshment (obsolescence avoidance) Program.

Market Research has the following components:

- Surveillance to stay abreast of advancements, changes, and trends; and
- Investigation to determine the availability of an item for a specific application.

4.1.1 Market Surveillance

Market surveillance is the continuing effort by acquisition and development activities (including laboratories) to remain abreast of advances, changes, and trends within their commodity areas. These activities must monitor marketplace activities, as well as technologies and products with potential for DoD use and provide a knowledge base for determining whether technology and products may be available to meet military needs as expressed in operational requirements. This knowledge of the market should be used to develop and modify operational requirements thereby creating greater opportunity for commercial item acquisition.

Market surveillance provides a broad knowledge of the potential for the use of commercial items to fill a DoD requirement. However, more specific, detailed information from the marketplace must generally be obtained before a final decision can be made, not

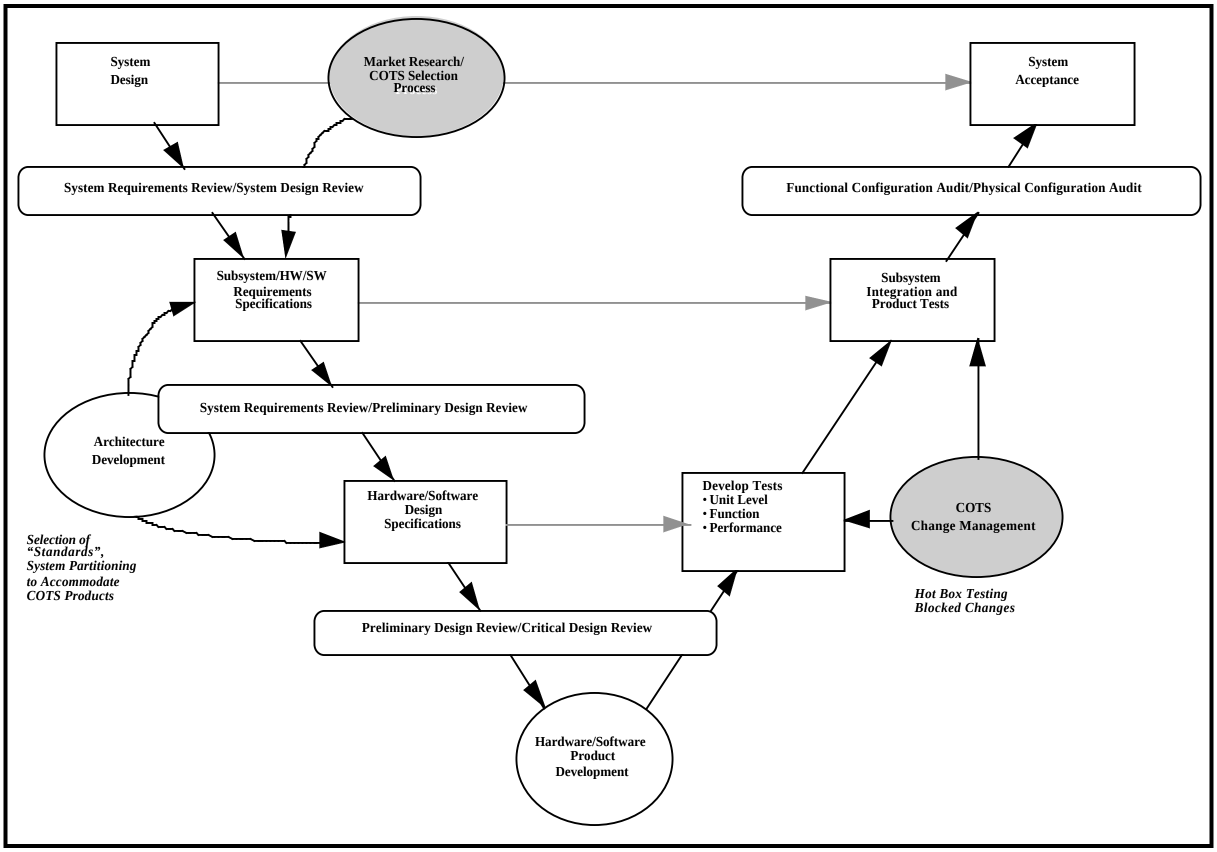

Figure 4-1. Systems Engineering Process

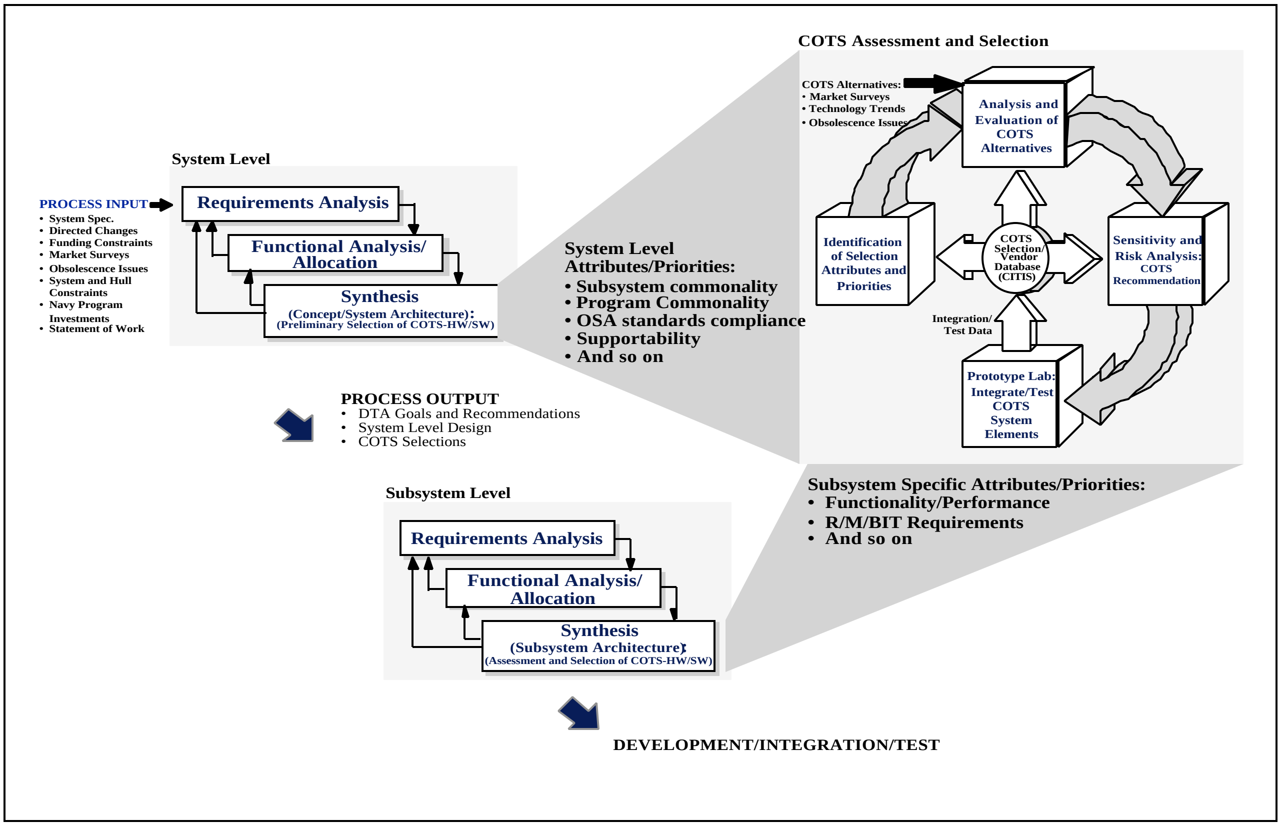

Figure 4-2. COTS Assessment and Selection

only from an operational performance perspective, but also considering reliability, supportability, cost-effectiveness, safety, manpower, and personnel.

Market surveillance will be performed by both contractors and the Navy. For large programs, the Navy may task a system developer to research the commercial markets for the best applications, ensuring that the system design is up to date. In addition to its own commercial market research efforts, the Navy will also research the military market to identify other Navy program developments which may have potential system application. This information could also be made available for use by small or medium sized programs. Sources of information are identified in Section 1.5.

4.1.2 Market Investigation

NPE design requirements include consideration of system performance, functionality, production, operations, and sustaining support. System level design requirements, together with allocations for these requirements at the equipment level, provide focus to the market investigation process. Surveillance to identify potential Navy developments and COTS technologies and vendors, combined with a focused investigation of the pertinent technologies and vendors through the use of tailored Requests-for-Information (RFI), constitute the front end of the market investigation process. The RFI is used to solicit information from vendors of candidate COTS products. Once candidate products are identified, they may be subjected to feasibility testing as discussed in Section 5.1.

COTS products and technologies which satisfy the necessary performance, functionality, and compliance/conformance requirements are considered feasible COTS alternatives and are candidates for the supportability assessment process. Although a subset of the overall engineering assessment for the selection of COTS products, the supportability assessment and its results are evaluated on an equal basis with the technical requirements.

The results of successful market investigation will provide proactive initiatives to maintain the technological integrity of the system. The continuous market research process and associated supportability assessment process will facilitate the identification and selection of supportable design candidates for system integration.

This COTS product research is performed iteractively throughout the life cycle of the product system and will ultimately lead to two general types of applications for the NPE:

- A change as a result of integrating a next generation product or product upgrade to an existing technology or component to improve system functionality.
- A change as a result of integrating a new item to avoid an ensuing EOL or product obsolescence issue, or to resolve a problem identified by Fleet feedback.

4.1.3 Supportability Assessment

Supportability assessment is a subset of the overall engineering assessment and selection process, and as such, only COTS alternatives “feasible” from an engineering standpoint (i.e., screened for functionality, compliance/conformance within the system architecture constraints, and performance [including logistics performance requirements]) can enter the supportability assessment process. Supportability factors that are defined in terms of data deliverables (technical data, training, etc.) also receive consideration. This ensures selection of alternatives that allow a support-friendly system. The supportability assessment process (Figure 4-3) is driven by the system maintenance concept together with the associated supportability attributes of the COTS product. A formal assessment is conducted from a supportability perspective on each feasible COTS product prior to product test and integration. Over and above a dependence on the market research process, the supportability assessment process (Figure 4-3) also includes establishing a repository or data management system to collect and access data with regard to the system once under test and deployed. This data will not only provide insight into the effectiveness of the support structure but will also contain the lessons-learned for the next iteration of the market research process. The supportability attributes (Figure 4-4) are determined at each support level, from the Lowest Replaceable Unit (LRU) up to the system level. The attributes are then given relative weights of importance and compared to determine the best alternative. The attributes and their relative importance may change depending on the item being assessed. The results of the comparative analyses are substantiated with sensitivity and trade-off analyses to identify critical parameters and priorities, leading to the delineation of potential risk factors. The supportability assessment will rank the feasible COTS alternatives identified during the front end of the market research process, and thus recommend selection of the most supportable COTS products for test and integration.

Because the selection is performed at the LRU level, much of the supportability data gathered during traditional logistic support analyses (i.e. maintenance task analysis, failure modes, effects and criticality analysis, level of repair analysis, etc.) is already available. This forces a re-examination and consequent tailoring of the analysis requirements and process.

Selection of COTS vendors and alternatives will have a major impact on system support and will drive costs through system development and production. As such, the analysis and evaluation activity leading up to this selection must be formal, and the ultimate COTS selection made traceable back to the system maintenance concept and Navy requirements. Furthermore, trade-off and sensitivity analyses, leading to a risk analyses, must be an integral part of this selection activity and should provide direct input into a formal Design To Affordability (DTA) modeling process.

Most vendors are willing to work with the Government within the framework of their business and processes. Attempts by either the Government of the integrator to control the vendor's process will be resisted. Key points in the selection of a vendor include:

- Establish an analytic selection process that captures all functional, environmental and supportability related requirements.
- Establish vendor's willingness to work with the integrator and the Government.
- Ask the right questions about licensing, access and the use of data, and configuration management process.

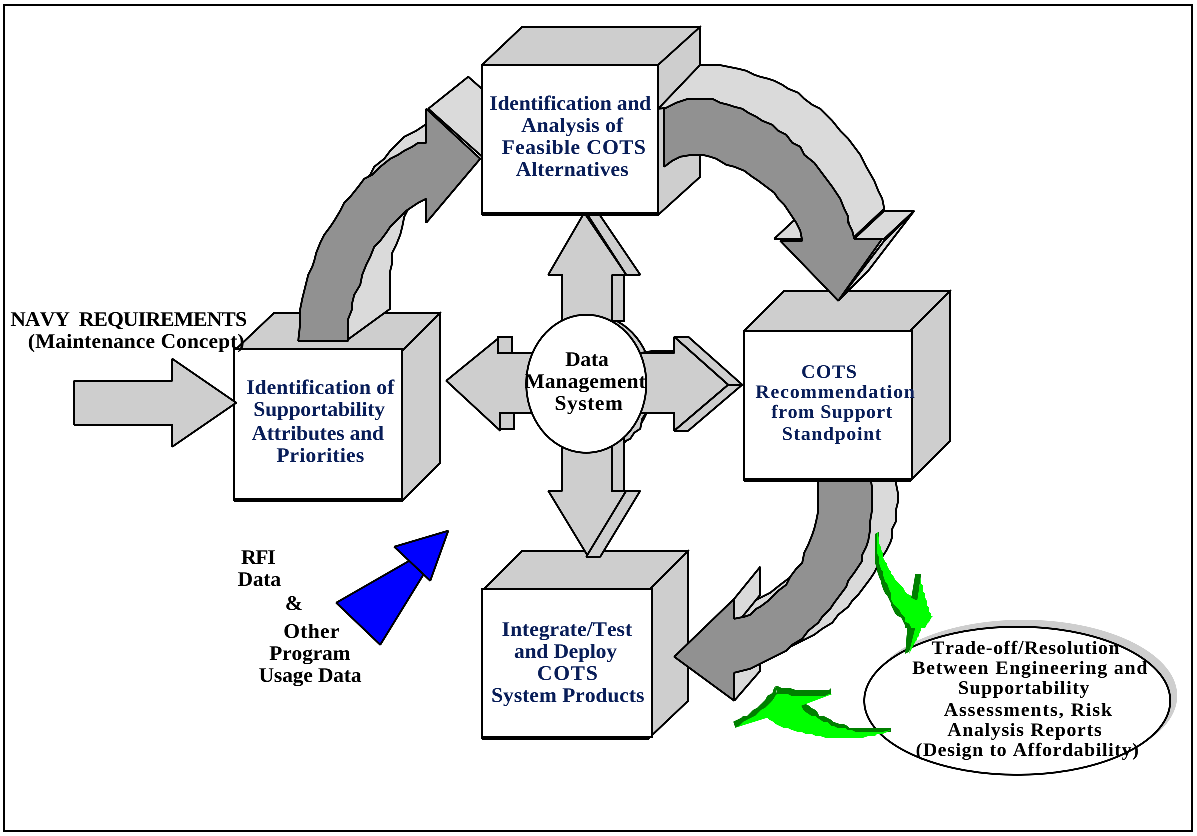

Figure 4-3. Supportability Assessment

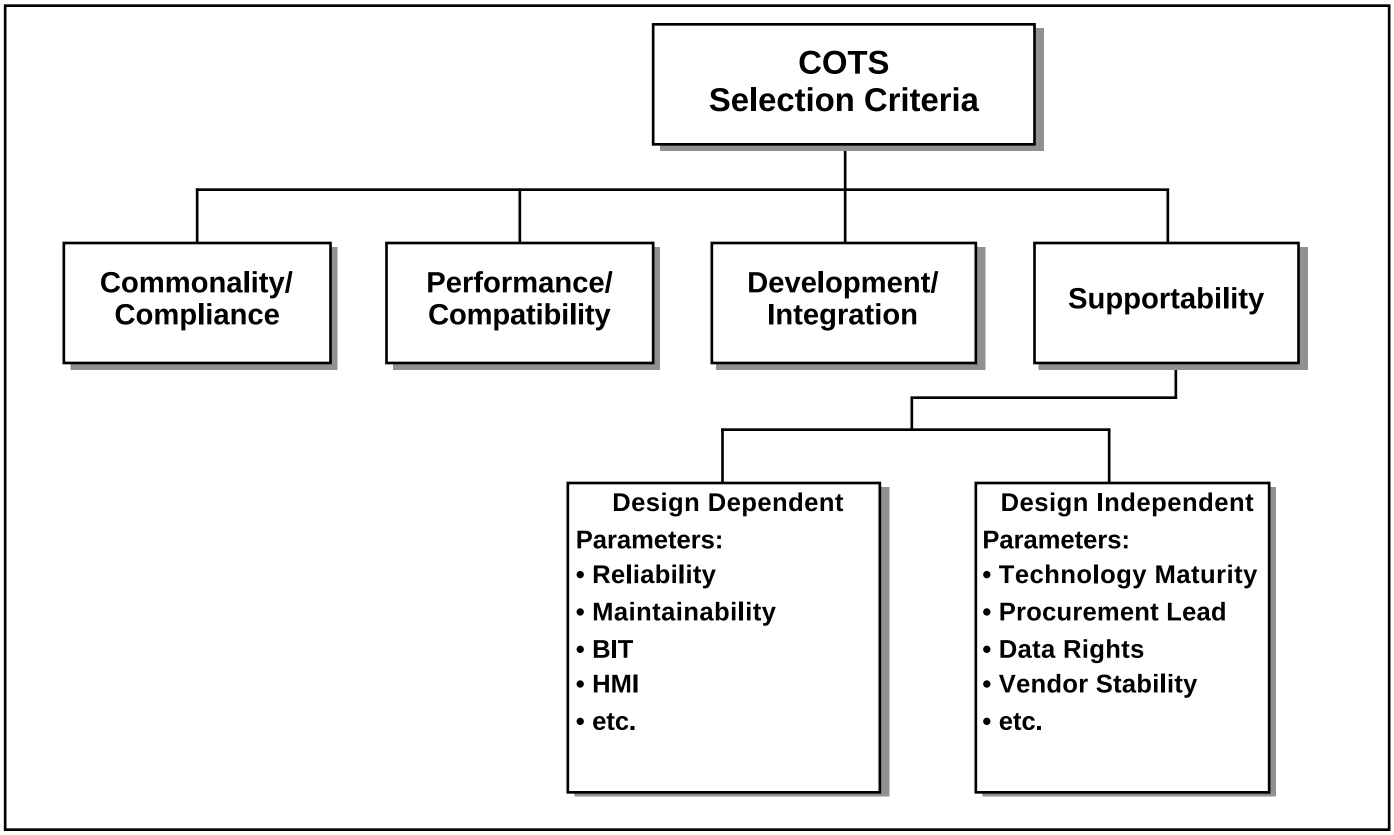

Figure 4-4. Supportability Attributes

4.1.4 COTS Change Management

The overall system, including the selected COTS system elements, needs to be integrated and tested prior to establishing the system's product baseline. Any incompatibilities are addressed through application of a strong configuration management process (see section 4.7). The selected and integrated COTS system elements impose requirements on and influence procurement of the various elements of support products. Since the item is selected by the market research and supportability assessment process, the integrated item inherently possesses the best potential for quality and cost-effective support.

In addition to the qualification and evaluation testing of new products being selected, testing and certification of spares within the system (i.e. "hot boxing") is required to prevent use of parts that have been changed by the OEM from those originally used in the baseline integrated system. The concern is that an untested part will be issued to a ship to replenish its spares stock and that, at some future time, the part will prove incompatible when used for at sea-maintenance.

Compatibility testing of COTS products is the only recognized way to provide assurance that these products continue to function properly in a specific integrated system configuration. The larger and more complex the system, the higher the probability becomes that small changes can cause incompatibilities.

4.2 Logistics Support Planning

Commercial item acquisition does have an advantage in terms of providing accelerated logistics support because the item has an existing support system. Programs using commercial systems or equipment should maximize the use of existing logistics support capabilities and data. Modification of a commercial item and/or development of new organic logistics support products/processes for commercial items should be limited to meeting a critical mission need or achieving substantial cost savings.

4.2.1 Supportability Objectives

The objective of logistics support planning for COTS equipment is the same as the logistics objective for military equipment, to ensure the Navy can operate, maintain and sustain the equipment at the lowest life cycle cost without impacting its performance. Logistics support planning for COTS equipment or COTS-based equipment must address traditional logistics products (Figure 4-5) to the extent necessary to meet that objective. Although the COTS logistic objective is unchanged, the rapid evolution of commercial equipment and the existence of commercial support for the products require and enable a different strategy for COTS support planning.

Due to frequent market-driven technology advancements, the life-cycle of a typical COTS product is more compressed than that of a military product. The availability of vendor support gives the Navy an opportunity to avoid investing in organic support, which may be expensive and potentially, as the Navy attempts to recover its investment, an impairment to upgrading the system to take advantage of new technologies.

The Navy and the system developer/integrator, using the IPT process, need to continuously and jointly explore all available support options to identify the most cost-effective support products and processes that are consistent with the operational requirements and the following support guidelines:

- Commercial support infrastructure will be used to the maximum extent practical and cost effective
- Support program will be based on meeting A_o MTTR, MTBF and minimizing life cycle costs
- Commercial standard products and OSA will be used to maximize sources
- Just-In-Time Sparing (See para. 4.2.3) will be used where appropriate
- Periodic technology insertions, upgrades and refreshers will be used to modernize systems, ensure supportability and reduce support
- Equipment will be supported with computer-based training and Interactive Electronic Technical Manual (IETM) where practical and cost-effective
- IETM and training development will be a cooperative effort
- Developer/Integrator will maintain configuration status accounting of all fielded equipments and support products

The dynamics associated with the support of COTS products in the submarine environment dictate the requirement for a responsive and adaptive support structure. Some considerations in developing a structure to support COTS products are discussed in the following sections.

4.2.2 Maintenance Planning

Developing maintenance plans is a subset of the supportability analysis. Supportability analyses form the basis of good maintenance planning. They provide the data and information needed to make economically sound support decisions.

Existing commercial facilities may be able to replace or supplement existing organic maintenance facilities reducing life cycle costs, personnel, training, and documentation requirements. If the item must be supported and maintained by the user, the maintenance plan for the item and supporting data must ultimately be developed/purchased.

The challenge in developing a maintenance concept for COTS will be how to best use existing commercial maintenance and support systems. Factors for consideration include:

- The degree to which manufacturers, other military services, or other sources already provide maintenance support to existing customers.
- The responsiveness of such support activity to meet military requirements in peacetime and wartime (mean logistic down time, need for priority service, wartime surge, etc.).
- The degree to which the military service will be able to provide organic maintenance support, and the need for support facilities or a training and rotational base for service technical personnel.
- A need to minimize "down time".

Manufacturers of commercial items may be willing and able to support their products with preventive maintenance, repair parts, and technical personnel through the item's expected service life. Possible support strategies might include:

- Use of system integrator as the centralized support activity and OEM coordinator.
- Return to factory for repairs--possibly with a pool of replacement items to minimize turnaround time.
- On-site repair by contractor personnel.
- A combination of the above.

It is important to remember that, due to the dynamic COTS environment, maintenance planning should be monitored to avoid surprises due to changes in vendor support. The feedback process discussed in Section 4.3 should be used to ensure maintenance planning is kept current.

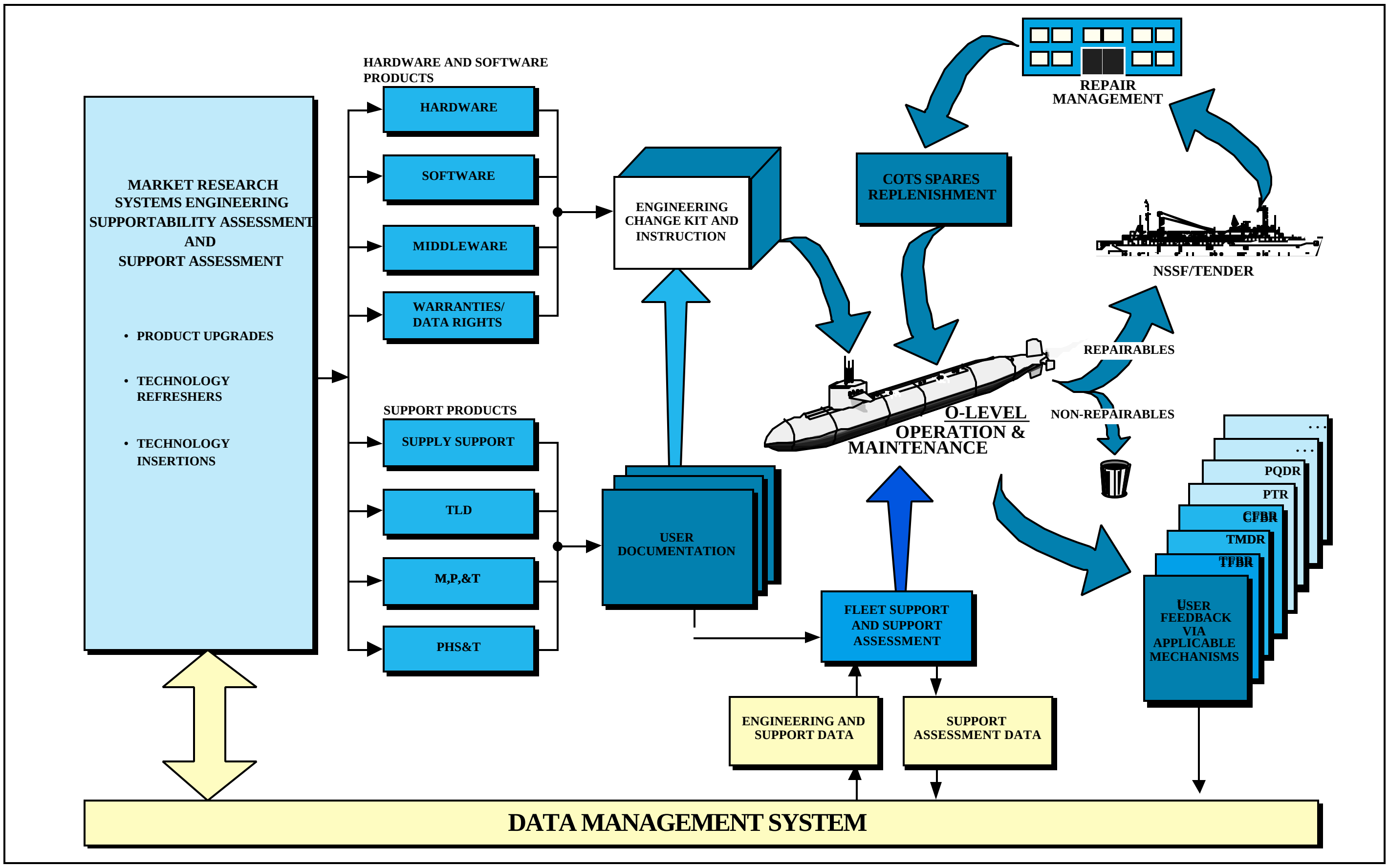

Figure 4-5. System Support Structure

4.2.3 Supply Support

In traditional development efforts, much of the support planning occurs before and during the Engineering and Manufacturing Development (E&MD) Phase with concurrent, integrated engineering techniques being emphasized to ensure the design meets supportability needs. This is not possible with COTS; it already exists and is in the production phase. The vendor/manufacturer for each COTS item being assessed during the selection process has a support plan and infrastructure in place to serve his customers. The proper approach in these cases is to examine that infrastructure to determine if it will satisfy the requirements of its intended use. If not, the next action is to determine whether the vendor of the COTS equipment will accommodate those requirements at an affordable and reasonable cost. If not, the requirements should be re-examined to ensure that they are, indeed, requirements and make adjustments as necessary. If adjustments are made, then the process should be repeated.

Availability of item history and previous user experience should be considered in determining the supply support concept. Parts lists and repair kits, as well as parts usage data, may be available from the manufacturer. Manufacturer and other historical usage data will significantly aid in the accurate prediction of initial provisioning requirements for repair parts and related support equipment and help estimate follow-on provisioning needs. However, government-unique environmental requirements and/or modifications to a commercial item may invalidate manufacturer and other historical data. Usage factors include service life, environment, and other factors that may differ between the intended military application and the original design application. Acquisition managers should take into consideration the possible obsolescence or discontinuation of production of the replacement parts when determining quantities needed to sustain or repair fielded hardware. This should be included in the market research process.

The effect of commercial items on the ability to use the military supply system must be considered. Alternative supply methods should be investigated and employed where cost-effective. Some possible alternatives are:

- Manufacturers or vendors store and distribute spares and repair parts as needed. (Just-in-Time or Direct Vendor Delivery support.)
- Prime system contractors provide supply support.
- Replacement end items are purchased as needed. (Discard upon failure.)

A major logistics consideration in commercial item acquisitions is the need to provide support for items that change from one procurement to the next. For example, an item may be F^3 compatible but may have a different arrangement of switches or buttons. These changes can strongly affect the logistics system because each time a new item is brought into the inventory, new manual changes and parts may have to be procured while, simultaneously, the existing equipment has to be supported. Some processes can make the change easier to handle. One is the parts interchangeability matrix (PIM), used to document applicability of new and old items to furnish support of product baselines being supported. The PIM documents which parts can be used with each other. It covers the interchangeability of hardware and software elements (generations of the part or part family) across the different system and unit level baselines. Contractor support may be a better alternative since the contractor has to understand and manage the differences as part of doing business. Metrics such as system availability and turn around time are useful in structuring a support contract.

A similar alternative is to limit follow-on procurement competition for the purpose of standardization. Part 6.302-1(b)(4) of the Federal Acquisition Regulation addresses the use of other than full and open competition when necessary for standardization purposes.

Because of space limitations and the rapid improvement of Readiness Based Sparing (RBS) models, consideration should be given to sparing a system to meet a specified A_o value rather than relying on the more traditional sparing models. A number of RBS models are available including the Navy supported TIGER model.

The use of COTS will also affect provisioning documentation generation. Given that COTS is procured to functional/performance specifications and that OEMs will not disclose their proprietary data, considerably less information is needed or available to develop Allowance Provisioning Lists (APLs) and reprocurement packages.

Although the use of COTS doesn't necessarily affect the Navy supply system requisitioning process, the method by which LRUs are identified needs to be considered. A common Stock Number for a generic OEM part number should guarantee F^3 equivalency in system application. However, there is a tendency on the part of COTS vendors to make changes without changing their part number. Testing of reprocured items is required to ensure F^3 compatibility (see section 5.2). Bar coding of LRUs by the testing activity can provide a supplemental means to ensure LRU compatibility.

4.2.3.1 Repair Methodology

The repair methodology for a system, regardless of its COTS content, is derived from a form of Level of Repair Analysis (LORA). Depending on the data derived from the market research process, this can range from a formal process to an informal screening. Generally, a component will not be repaired at the organizational level unless there are existing organic capabilities or a return on investment case can be made. Organizational repair actions will generally be limited to replacing an LRU and either discarding the LRU or sending it to a higher level of repair. Whether a defective component is repaired or discarded is largely a function of its replacement cost, repair cost, and reliability. Discarding LRUs that are reliable and inexpensive may be more cost effective than transporting and repairing them. With COTS, the least costly path is to accept and use the support system that is already in place for commercial customers.

Commercial repair by OEMs may be used to repair system repairables. Commercial repair is typically more economical than Navy organic repair for COTS. Also, COTS product OEMs will generally not release the proprietary technical data that is necessary to establish organic repair.

The Source, Maintenance and Recoverability (S,M&R) code will be based on the system maintenance concept and the COTS product OEM's repair policy. Based on the S,M&R code, failed LRUs will be either discarded at the O-Level or returned via the supply system to a prime integrator. After repair, the integrator will test repaired or replacement assemblies from the OEM in the appropriately configured test-bed ("hot box") to confirm the repair and verify the compatibility of the LRU with the system. This testing should be on a sample basis with sample size decreasing with increasing vendor confidence.

4.2.4 Support Equipment and Test and Measurement Systems

Requirements for support and test equipment must be identified as early as possible and included in contract specification documents. Use of DoD standard test equipment (which may be commercial) instead of unique test equipment recommended by the manufacturer is preferred, but may not be feasible for a commercial item. The need for new calibration standards and procedures to support the required test equipment must also be addressed. These requirements should be an integral part of the COTS selection criteria.

4.2.5 Technical Data

Technical data for logistics support includes specifications, drawings, technical manuals, calibration procedures and other data required to test and inspect, perform preventive and corrective maintenance, operate, and repair the item or its parts. The technical data required must complement the maintenance and supply support strategies. Where suppliers claim proprietary rights to data, as is normally the case for commercial items, the logistics manager should validate the supplier's claim and carefully review the data requirements to avoid buying unnecessary and expensive data rights.

The Navy owns the hardware and software data rights for data developed under Navy contracts. Under those contracts the Navy is procuring sufficient data to reprocure the system. The Navy does not own rights to design or manufacturing data for COTS products used in the system. An objective of an OSA design is to negate the need for COTS product data by avoiding the use of single source products or product features that are unique to a single manufacturer. This reduces the need for COTS product data to support reverse engineering or redesign and the need will be further reduced by obtaining timely information through market surveillance of COTS products to identify impending changes in COTS availability status. This will allow sufficient time to select replacement COTS products as part of the Technology Refresh cycle.

Data rights information may be a supportability assessment criterion factor during product selection. Data rights policies of COTS product manufacturers, regarding product data disclosure, vary among manufacturers from complete prohibition of disclosure to full disclosure. Information regarding escrow data can be obtained from vendors via the RFI during the market research. The cost of escrow data also varies, but usually consists of a one-time fee and a yearly maintenance charge for updating the data as products change.

If it is impossible to avoid the use of a product for which data rights may become an issue, the cost and availability of the data should be considered during market research, and then reevaluated along with other options in the event the need for the data arises. Because of the cost and shorter life cycle of the COTS item, data rights for data escrow will not normally be purchased.

4.2.5.1 Interactive Electronic Technical Manual (IETM)

Most of the NPE systems have shifted to the IETM. The IETM, like its predecessor the paper technical manual, serves two purposes. These are to present information necessary to operate and maintain the system, and to provide information to support training curriculum development and conduct training.

IETM COTS software tools designed and structured to take advantage of today's information technology can accomplish both purposes with a very high degree of effectiveness using commercial standards that are familiar to computer users in general. In contrast, the paper technical manual, because of its inherent inflexibility, is limited in its effectiveness. The selection of one is usually at the expense of the other. Where an IETM is not available, a cost trade off should be made to determine whether a shift from the paper copy is cost effective.

In addition to the IETM's effectiveness, its additional benefits are:

- ♦ Reduces system MTTR
- ♦ Reduces system life-cycle costs

♦ Maximizes onboard training capabilities
♦ Provides the potential for a major reduction in shore-based training requirements
♦ Provides a means to quickly update shipboard technical documentation at minimal costs
♦ Requires less development and production time
♦ Reduces shipboard storage requirements

Using COTS products, the system development, production and update cycle will be shorter and more frequent than that of past systems. The IETM development can be accomplished within the available time by:

♦ Eliminating the requirement to deliver a paper technical manual
♦ Eliminating process steps required only for a paper technical manual
♦ Conducting In-Process Reviews (IPRs) using electronic data delivery
♦ Performing concurrent Navy and contractor IETM Validations and Verifications (V/V)
♦ Eliminating the paper production printing cycle
♦ Delivering the IETM electronically by CD-ROM

4.2.5.2 IETM Technical Requirements

The IETM will contain information that supports system operation and maintenance information. Information will be displayed in a manner that maximizes both operator and maintainer proficiencies. The IETM contract Statement of Work (SOW) and Technical Manual Contract Requirements (TMCR) should specify the IETM content and presentation necessary to meet the Navy's requirements for system operation, maintenance and training. These requirements should be based on Technical Data Usage Analysis (TDUA) to determine the most cost-effective mix of tools, functionality and commercial acceptance. When generating the IETM, it is imperative that the authoring and presentation system be compatible with requirements for the electronic classroom and onboard training if applicable.

4.2.5.3 Planned Maintenance System (PMS)

The processes for planning, developing, distributing, and supporting Maintenance Index Pages (MIPs) and Maintenance Requirement Cards (MRCs) are driven by the system maintenance concept and the material available from the COTS vendor. However, the reliability centered maintenance (RCM) process by which PMS documentation is developed remains essentially the same as for non-COTS systems.

4.2.6 Manpower and Personnel

Manpower and personnel activities begin during formulation of the operational requirement. The requirement should be structured so that commercial items can meet manpower and personnel criteria. If this is not feasible, reevaluation of the basic acquisition decision or modification of the initial support concept will be necessary.

In structuring the MPT Program, consideration must be given to the number of people and levels of skill required to operate and maintain the system or equipment for all planned support and maintenance levels. Specific areas influencing Manpower and Personnel decisions should include:

· Human-machine interface (HMI)/display management features

- Number and type of people required for operation and maintenance, including goals to reduce manpower requirements.
- Use of embedded training to reduce shore-based training requirements.
- New skills, knowledge, or grades required.
- Changes due to use of COTS versus MILSPEC hardware.

4.2.7 Training and Training Support

The objective of any system training program is to ensure that Fleet and support personnel are adequately trained to operate and maintain the system. Past systems have relied primarily on shore-based training to accomplish this objective. The newer programs may use an IETM designed for training which may result in a reduction in the dependence on shore-based training. The attributes of Computer-Based Training (CBT) should be incorporated into the IETM to the maximum extent possible including Interactive Courseware (ICW). The IETM makes frequent updates to electronic onboard training material practical and cost effective. This will ensure that onboard training programs are current and effective.

In developing the training requirements, consideration should be given to the impact of COTS on traditional training concepts. Training based on functional principles vice specific hardware attributes can take advantage of open systems modularity by reducing data requirements, shortening the training pipeline, and the use of part task trainers for generic maintenance tasks. Materials should be developed for use in electronic classrooms or implementation onboard the submarine. Use of shore based training should be minimized where cost effective.

Maximum use should be made of existing training and training support, including consideration of permanent use of contractor training. Contractor assistance is often required for initial training on new equipment and for establishing the institutional training base. The requirement for training aids or devices may be minimized by use of contractor-owned or contractor-provided equipment.

4.2.8 Facilities

Use of COTS may permit significant reductions in training facilities. With the reduction of unique military hardware due to the use of more common and generic COTS hardware and software products, comes the reduction of unique maintenance training requirements. The move by the submarine training community towards the use of part task trainers for absolutely necessary “hands on” skills coupled with a greater reliance on interactive courseware (ICW) will also reduce the shorebased training pipelines and support infrastructure. Another impact to facilities through the use of COTS is the migration of operator trainers to networked multi-purpose COTS Personal Computer-based platforms that reduce unique facility and support requirements as well. There is little impact on other facilities requirements except for a possible reduction in assets used for system development. The need for determining facility requirements for test and integration, training, software maintenance, compliance testing, etc. will be unique for each program based on funding, end-item quantities, installation and support schedules.

4.2.9 Computer Resources Support

Open systems are those in which standards are adhered to, and incorporate modular design approaches, ease design interface problems, and allow for cost-effective innovation, upgrades, and flexibility. These approaches allow the government to capitalize on rapidly evolving technologies and to minimize dependence on specific products. COTS software is also discussed in section 4.10.

One aspect of computer resources support that is different in a COTS environment is the increased need for compatibility testing of new software products. It is important to test software acquisitions in each fielded configuration to ensure that there are no operability problems due to vendor changes. This typically requires a test facility or a Configuration Model. (See section 5).

Development contracts utilizing COTS software products should address deliverable COTS documentation requirements. In making choices of what COTS software product documentation to procure, the Program Manager must consider life cycle operation and support factors for the system. Plans for tailoring software product documentation for COTS Computer Software Configuration Items (CSCIs) such as Software Requirements Specifications, Software Test Plans, Version Description Documents and Software Product Specifications should be understood by the PM and the developer and should be documented in the Software Development Plan or other program plans as appropriate.

For COTS software (just as for newly developed software), it is important to determine and document how the system specification requirements are satisfied by the COTS software product and to ensure requirements traceability is established, maintained, and documented. COTS software products are usually described and documented in user's manuals. COTS product design information will normally be unavailable or proprietary. To provide adequate life cycle support of the system, the developer should document any COTS customization information and corresponding rationale in the Software Development Files (SDFs) or other software support documentation. In addition, the developer should maintain a record of PTRs for COTS software and notify the COTS vendor of any COTS product PTRs surfaced during system integration and test.

4.2.10 Packaging, Handling, Storage and Transportation

Commercial standards may be used to the extent they meet or exceed military requirements; however, any required modifications should be included in the solicitation package. MIL-STD-2073 should be used as a guideline for establishing methods of preservation, packaging and packing and MIL-STD-129 as the guideline for marking of all packages. ASST. D 3951-90 should be used if commercial standards are approved.

The potential exists that the COTS hardware will be subjected to temporary storage in adverse climatic conditions during the delivery to the submarine, or long-term storage in less than optimal environments. There are no existing commercial methods of packaging that will provide adequate protection under these adverse conditions; therefore, a MILSPEC preservation and packaging level of A/A is prescribed when these conditions are likely to be encountered. In extreme cases, packaging configurations may undergo environmental, accelerated life or shock testing to prove the adequacy of the packaging to protect the COTS hardware item. For continental U.S. point-to-point shipping, best commercial packaging will be used.

For storage on board the submarine, specific requirements must be tailored to the fragility levels of the particular COTS hardware. COTS LRU fragility and environmental susceptibility data should be analyzed to identify candidates for special handling and storage on board the submarine. COTS hardware that is determined to be too fragile for standard handling or storage procedures on board ship must be subpackaged in protective materials to be removed at time of system use.

4.3 Life Cycle Support Assessment

Once deployed, the system support structure (Figure 4-5) must be monitored to identify any support related concerns (to include consideration of End-of-Life (EOL) and COTS product performance issues). This allows for the proactive adaptation and management of the support structure, and the cost-effective and efficient support of the deployed systems. The ongoing market research process includes the support assessment feedback during the deployment phase through the identification of supportability relevant market developments. Alternative COTS products (primarily at the LRU level) will be evaluated from a supportability perspective, and evaluations conducted in order to select the most effective support (bridge buys, alternative COTS products, etc.). The approach selected then drives the procurement, integration, test, checkout, and ultimate deployment of system upgrades and associated support.

As Fleet and actual usage data is collected, it should be analyzed for opportunities to tailor the support structure and identify areas for potential improvements. Appropriate support assessment related improvement recommendations may be integrated into the next available system upgrade. In this manner, the market research, support assessment, and system upgrade processes are integrated to continuously improve the supportability posture of the deployed system.

One method of utilizing fleet data in the assessment process is Trigger Based Item Management (TBIM), which recommends assessment of fielded systems trends and a re-examination of the maintenance plan when “triggers” (such as changes in reliability or maintainability trends, a change in technology, or diminishing resources) are detected. TBIM is a cost effective tool to enable the team to “support the design”. This concept is discussed in detail in the NAVAIR Flexible Sustainment Guide.

4.4 Configuration Management

The ultimate success of any program is dependent upon the adequacy and accuracy of Configuration Management (CM) as applied to each and every selected Configuration Item (CI). The term CI refers to any combination of COTS assembled as an end-item. With the adoption of rapidly evolving and vendor-controlled COTS items, the early establishment of a strong CM process is vital. As defined by ISO 10007, “Configuration Management (CM) is a management discipline that applies technical and administrative direction to the development, production and support life cycle of a configuration item. This discipline is applicable to hardware, software, processed materials, services, and related technical documentation. CM is an integral part of life-cycle management.” This section is provided to assist the Program Manager with information that addresses the following disciplines of CM with respect to COTS:

Configuration Identification
Configuration Control
Configuration Audit
Configuration Status Accounting

These disciplines must be applied to all COTS items as well as legacy items. However, as each of these disciplines is applied to a COTS Configuration Item (CI), the range and depth of its application should be tailored. In the past, the types (range) and amount (depth) of information NAVSEA contracted for was substantial. In depth documentation was required to support our MIL-STD equipment to effect piece part level module repairs. This requirement remains even as the acquisition of new equipment shifts to a heavy infusion of COTS. What is changing is the type and level of detail required of that documentation. LRUs and CIs will be replaced at a higher assembly level than before requiring a lesser level of detailed life-cycle documentation. At the system level, however, there will continue to be a need to develop information that describes interfaces, troubleshooting, and network management.

4.4.1 Configuration Identification

Configuration identification is defined as "... the selection of configuration documents, the assignment and application of unique identifiers to a product, its components, and associated documents, and the maintenance of the documentation, regardless of its representation, in relation to the product configuration." (EIA/IS-649)

All CIs requiring support during their life-cycle must be identified. All CIs: hardware, software, firmware, middleware, and its associated technical documentation require unique identifiers. The methods used to identify CIs will primarily depend upon the performance requirements, the selected maintenance philosophy and the capability of the COTS to support those requirements. The final CI selection will be made by the cognizant Program Office.

Established unique methods of marking CIs should no longer be contractually required. COTS vendors will not be required to use a common method for identifying their CIs. If re-marking of COTS equipment is deemed necessary, the cost associated with this must be weighed against any benefits during the selection process. Functionally equivalent COTS equipment will probably not be marked in a consistent manner among manufacturers.

The challenge to the Configuration Manager will be to establish and maintain the identification of each COTS CI independent of how its manufacturer has marked it. This can be accomplished by identifying the CI by its manufacturer, part number and serial number and using techniques such as bar coding to provide additional information such as physical location where required. The use of database management tools to capture and maintain this information should allow adequate identification of any COTS CI with respect to its requirements, its physical location and to any documentation provided by the manufacturer or otherwise produced and provided to the end user. These identifying markings should be readable using available technology.

The Configuration Identification discipline will establish the level of effort required of the Configuration Control, Configuration Audit, and Configuration Status Accounting disciplines. If it is not identified, the CI is invisible to the user and support community. This could result in a serious impact to parts utilization, testing, and interchangability. For this reason, it is imperative that a thorough process of identifying and tracking all CIs be established and adequately managed throughout the life-cycle of the CI.

4.4.2 Configuration Control

Since OEMs individually control the configuration of their products, configuration Control for COTs-based systems occurs at the LRU level and above (next higher assemblies, subsystem, system, etc.). It is defined as ...systematic proposal, justification, evaluation, coordination, approval or disapproval of proposed changes, and the implementation of all approved changes, in the configuration of a CI after establishment of the configuration baseline(s) for the CI. Configuration Control begins with the establishment of the functional baseline and continues as further baselines are established for the CI. Configuration Control continues throughout the life cycle of the CI.

The acquisition manager is responsible for establishing the necessary processes for managing the CIs baseline throughout its life-cycle. ***Baselines which include COTS must be***

managed rather than controlled. Baselines containing rapidly changing COTS equipment should be established at a lesser level of detail, therefore requiring less cost to maintain. However, it is important that once established a defined process be used to maintain the baseline's integrity. The baseline, once established, must ensure that the CIs identity is not lost. Any departures from an established baseline should require the submission, for Government approval, of an Engineering Change Proposal (ECP) or a request for waiver.

4.4.3 Configuration Audit

The Configuration Audit will "...inspect documents, products and records, and review procedures, processes and systems of operation to authenticate that the product's required attributes (performance requirement and functional constraints) have been achieved by the product and the product's design has been accurately documented." (EIA/IS-649)

Whether the audited items are comprised entirely of COTS, a mix of COTS and newly developed CIs, or a totally new CI development effort, the Configuration Audit should be comprised of a Functional Configuration Audit (FCA) and a Physical Configuration Audit (PCA). These audits validate that the CI's functionally meet all performance specifications including conformance, compliance and interoperability testing (FCA), and is an accurate representation of any documentation that is procured to support it throughout its life-cycle (PCA).

With the utilization of COTS, CIs that meet all functional performance specifications (note that any absolute physical requirement should be identified as a performance specification) may not look the same. They may also provide more functionality than is required. This could apply to any CI (hardware, firmware, middleware, and software [including middleware]). The challenge in assessing the adequacy of a COTS CI will be to ensure that it meets all current baseline requirements while not degrading its functionality or interfaces with any higher level assembly. Since all absolute requirements should be identified in the performance specification it may be said that the FCA will become the critical portion of the Configuration Audit.

A major difference between an audit of COTS and a newly developed CI will be the range and depth of information reviewed during the audit. Many COTS vendors will retain the data rights to their detailed design and will not release them to the Government or the prime integrator without additional cost. For the vendors, releasing this data could adversely impact their business. The CI's life cycle support needs are met, however, with the verification by the Government of the CI's conformance to its baseline documentation and all form, fit, and function requirements.

After the Configuration Audit has been satisfactorily completed and the CI is delivered and installed, replenishment of CIs will be required. While the configuration audit will ensure the delivered CI is accurately identified and manufactured to the level of support documentation procured and functionally meets all requirements, it does not ensure that any additional procurement will be in accordance with all requirements. Therefore, follow-on compatibility testing, is recommended for each delivered lot of CIs. The cost of this additional effort may be mitigated by using vendors that have been certified by the International Organization Standards (ISO) permitting reduced test requirements. In any case, a Configuration Audit will insure that the CI's product baseline is maintained from one delivery to the next.

4.4.4 Configuration Status Accounting

Configuration Status Accounting (CSA) is defined as the formalized recording and reporting of the established configuration documents, the status of proposed changes and the status of the implementation of approved changes.

CSA is the focusing factor for all defined configuration items. The volatility of a COTS CI requires that an adequate CSA program be established and managed. This task should be accomplished by the activity responsible for the integration of the CI into a system environment.

4.4.5 Engineering Change

Using COTS will allow for a more rapid technology refresh throughout the life of the CI. These upgrades can and should be supported using the configuration disciplines defined and described above. Fleet introduction of COTS CIs must be supported during all of its phases with a strong Configuration Management process.

Engineering Change Proposals (ECPs) are used to fund and implement the approved ECs. ECPs can either stand alone or be aggregated (or blocked) into installation kits that are documented via an Engineering Change Instruction.

Engineering Changes (ECs) will be driven by either an upgrade program (performance enhancement or additional capability) or by the technical refresh process (Form, Fit and Function (F^3) substitution to avoid obsolescence). Typically an upgrade results in a specification change which is categorized as a Class 1 change. A technical refresh driven change that does not impact the F^3 specification is categorized as a Class 2 change.

Class 1 ECs will require the same level of testing as required for the baseline system. This drives the need for a “configuration model” or test bed that is at the same configuration as the intended platform receiving the EC kit.

Class 2 ECs will require a lesser degree of testing to ensure that the substitute item is F^3 compatible at the LRU as well as system level. The extent to which a substitute COTS item is one-for-one replaceable and therefore the amount of testing needed (no testing, first article testing, sample testing, continuous, etc.), will depend on the COTS selection factors such as product history, vendor history, upward/downward compatibility, interchangeability, change notifications, etc. This applies to spares testing (hot box testing) as well. If a one-for one substitution requires a part number change, an ECP will be needed to document the change and update logistic support products.

4.5 Installation Process

With the expanded use of COTS equipment in weapons systems and rapid advances in technology the need for changes requiring SHIPALTS will be minimized. Change installations will mainly be done outside scheduled depot availabilities using incremental upgrades. In planning for COTS installations requiring industrial assistance, the program should strive to minimize the time a submarine is “off line” receiving an upgrade/alteration. COTS installations planned for completion during pier side upkeep periods should not exceed four weeks. This limitation may lend itself to a phased (incremental) approach to upgrading COTS systems and should be one of the early considerations in the technology refreshment process as to how much hardware/software is added/replaced during any one installation period. A well-designed COTS-based architecture will have accounted for LRU/assembly level upgrades and minimized SHIPALT category installations.

Installation of a COTS system is similar to a non-COTS installation An installation schedule should be agreed upon with the TYCOMs that supports their needs, supports the budgeted installations for the fiscal year, and takes into account the quantity of installation teams available.

A shipcheck should be conducted sufficiently ahead of the scheduled installation so that the installation can be properly planned and unique configurations addressed to reduce surprises when the installation commences. Advantages of an early shipcheck can not be overemphasized.

Additionally, other alterations occurring at the same time as the COTS installation must be reviewed for interference. Workarounds may be required to ensure that all parties performing installations can complete on time.

Since most COTS installations are envisioned as Engineering Change Instructions (ECIs) or Title KP SHIPALTs and would be installed by Tiger Teams/Alteration Installation Teams (AITs) early liaison with the TYCOM and ship, including development of a Memorandum of Agreement (MOA) is necessary. Using this concept all material and ILS in support of the installation should be propositioned or kitted prior to installation start. This action allows the installation team to "hit the deck running" when the installation commences.

System testing following the approved testing requirements should be accomplished to verify proper installation/system operation.

4.6 Disposal

COTS equipment is governed by the same disposal requirements as non-COTS equipment. In general unmodified COTS equipment may be disposed similar to the commercial industry disposal process. However, the Navy has not always negotiated hazardous material disposal agreements with the Environmental Protection Agency (EPA) on the same basis as commercial industry. Therefore, presence of hazardous material contained in the COTS equipment must be identified and a review of Navy hazardous material agreements must be conducted prior to disposal of COTS equipment. Particular attention may be required for modified COTS equipment where the modifications add hazardous material (e.g. specific paints applied for service durability) which requires removal prior to disposal. Public Law allows for those that improperly dispose of hazardous material to be personally liable, subject to fine, and possibly a jail term.

In a non-COTS acquisition program, demilitarization requirements would be determined during initial provisioning and loaded into the Weapons System File (WSF). In a COTS program some of the equipment may not be provisioned in the Navy Supply System. Therefore the demilitarization requirement may not reside in the WSF. It is incumbent upon the Program and Life Cycle Managers to understand the demilitarization requirements and disseminate these requirements to the fleet and other users so that as parts/equipments are turned in for disposal the proper demilitarization is performed.

Material turned in for disposal is sold by the Defense Reutilization Marketing Office (DRMO), an activity of the Defense Logistics Agency (DLA). The equipment turn-in document must list the demilitarization action required prior to DRMO accepting the material for disposal. In many cases hardware demilitarization may not be required or it may be limited to removal of unique Navy name plates. However, it is much easier to determine these requirements during the acquisition phase than answering the frantic phone calls well into the programs life cycle on what demilitarization is required.

For those COTS programs which are electronic in nature and include software programs, potentially the most important aspect of the disposal process would include removal of any classified or sensitive information from hard drives, removable drives, and other storage media. These actions should be included as part of the demilitarization process/requirements. Consideration should also be given to making the prime contractor or OEM be responsible for asset disposal.

4.7 Warranties

Program Managers must implement a warranty program to take advantage of warranties available from COTS product vendors (DODR 5000.2R, para. 3.3.8). Most vendors of COTS hardware include a standard failure-free warranty in the price of the item. The length of the warranty varies from a few months to 3 or more years.
Warranties come in several variants, but basically there are four types:

- Standard Hardware/Software Repair/Replacement
- Extended Hardware Repair/Replacement
- Hardware Maintenance Services
- Software Maintenance Services

Standard warranties provide basic assurance that the hardware or software item purchased will be "defect free" and functionally correct for a defined period of time. Generally, that period of time begins when the item leaves the back dock of the vendor.

Commercial software warranties usually apply to the integrity of the media storage device (diskette, CD ROM or magnetic tape) and the operability of the software in a stand-alone environment. Integration with other software and the effects it has on other products is usually excluded. Testing of software upgrades must occur to determine system compatibility. There may be a need to modify the unique application software to ensure that vendor supplied upgrades are compatible.

Standard warranties may be of little use to the Government because:

- they generally do not convey beyond the original purchaser
- the time period is fairly short in duration when compared with system development time

Provisions can be taken to transfer warranty to the Government. However, this action implies the establishment of direct relationships between each vendor and the Government and may not be cost effective.

The terms of the extended warranty are usually the same as the standard warranty but with the coverage period extended. Extended warranties follow a pattern similar to term life insurance in that as the item under warranty gets older and the likelihood of failure increases, the cost of each extended term increases accordingly.

Hardware Maintenance Services are usually provided at a system (unit) level. Hewlett Packard, GE, IBM and others offer this service with installed products. These services can be purchased with varying response times depending on location and how much the user is willing to pay. The larger companies are willing to provide these services world-wide.

Software Maintenance Services provide the user with updates and upgrades to the purchased software on a renewable service basis. This option ensures visibility and accessibility to the latest versions including fixes to problems.

Each vendor's warranty must be analyzed to evaluate its cost, benefit, and effectiveness. The warranty evaluation should consider:

- Warranty Annual Cost
- Predicted Failure Rate
- Repair Cost (Out of Warranty)
- Change History
- Warranty Transfer
- Warranty Administrative Cost
- Support Period Warranty
- Anticipated Change Frequency

Warranty evaluation analysis and evaluation should be conducted as part of the supportability assessment performed during market research. Added cost warranties should not be procured unless there is a distinct benefit to the Government.

4.8 Reliability

"Reliability requirements shall address both mission reliability and logistic reliability, "(DODR 5000.2R, para. 4.3.6). Reliability requirements for COTS based systems should address both mission requirements and logistics. They continue to be based on an operational assessment of the military application within the expected military environment. In the unlikely situation where a single, completely assembled, packaged and functionally independent COTS item will satisfy the military performance requirement and is economically feasible, the integrator has virtually no impact upon the reliability design of the unit.

Where a number of COTS items are assembled into a functionally compliant package, the integrator has a number of choices to affect the overall reliability. In that case, reliability requirements can generally be satisfied through proper COTS selection and packaging for military environment. Redundant COTS components can also be used where necessary to meet a assembly reliability requirements.

Proper COTS selection can be accomplished by determining whether sound reliability practices were applied during the item's development and by selecting those items which approach the allocated reliability when combined to satisfy the system performance requirement.

Not all commercial products will have accumulated the required reliability data or the extensive testing required for military qualification. However, some items will have substantial market-generated performance data. This data may actually be more extensive than that generated through testing programs or experimental use. This market data can be useful even when more demanding environments are anticipated.

Packaging of COTS items can help to ensure satisfactory reliability in the military environment. The contractor selected to integrate COTS items and who is ultimately responsible for system reliability will also have the responsibility to select the COTS items which are to be packaged. As in a traditional development program, the reliability of the individual parts will drive the reliability of the component as a whole. Accountability for the unit reliability cannot be addressed if part selection and packaging design are split. Packaging of COTS should attempt to prevent any changes to the COTS items themselves.

Redundancy is a very important design consideration to promote reliability. The move to the use of COTS items in a military application was driven by the improvement in performance capability, diminishing footprint, and an economical price. These are all reasons which permit the increase of redundancy of items to increase overall system reliability and availability. This is feasible because the hardware costs have now shrunk below the cost of software development, and hardware can now be used more economically to support redundant capability and to increase system availability.

4.9 Maintainability

"Maintainability requirements shall address servicing, preventive and corrective maintenance." (DODR 5000.2R, para. 4.3.6). The maintainability features of the commercial item should be evaluated in these areas, including an understanding of the impacts on accessibility, interchangability of parts, power down conditions, built-it-testing and diagnostics run-time, and the use of dip-switches, jumpers and other commercially prevalent configuration altering items. These could affect documentation and training as well as overall system availability. Similarly, the location of external cable runs and cooling air intakes and exhausts must be compared to the installed location aboard ship to ensure access to the unit as a whole.

In the situation where several COTS items are being integrated for a military application, diagnostic software and built-in-tests are less likely to be standard and a diagnostic shell prepared by the integrator is needed to provide a single status indication and fault isolation capability to the operator. While considerably less costly to code than for a development system, the diagnostic shell is critical to meeting MTTR requirements.

As great progress has been made to provide a paper-less maintenance environment through the use of embedded training, on-line-help and interactive electronic technical manuals, consideration must be given to the availability of the on-line help during a failure of the tactical element. Separation of tactical and support application hardware and software is a sound maintainability attribute.

Maintainability Demonstrations have been common place in traditional development programs. There is still value in conducting these demonstrations to ensure that all mechanical accesses and maintenance spaces are adequate. However, the natural design of commercial parts may often conflict directly with long-held, maintainability practices. One example which is often observed is the use of front connecting cables which cover the accessibility of other components. The goal of the maintainability demonstration should be to assess the reasonable access and maintenance of the system within the specified repair time.

4.10 Software

4.10.1 COTS Software Challenges

COTS software differs from other NDI since commercial markets, independent contractors, and vendors control the design configuration and support (i.e., enhancements, modifications, and upgrades) of COTS, not the government. COTS software is customized (in a way intended by the vendor), but is not modified if it is to remain "COTS" software by definition. The advantages of COTS software include cost, schedule, availability, reliability, standardization, lower development risk, and ease of migration to future technologies. The program manager should not only be aware of the general challenges associated with COTS acquisition (market research, configuration management, supportability, etc.) but should also consider unique challenges such as Ada waivers, integration/interoperability and software architecture flexibility/growth potential.

4.10.2 Ada Waivers

IAW SECNAVINST 5234.2A, Non-Ada justifications are NOT required for “COTS applications software that is not modified by, or for, or maintained by the DoD”. Therefore, the use of COTS does not in and of itself require any special Ada waiver. See SECNAVINST 5234.2A for other situations which may require a Non-Ada justification approval.

4.10.3 Integration/Interoperability

COTS software products should meet known interface standards. RFPs and Information for Bids (IFBs) should require the integrator to choose COTS products considering compliance with known and widely accepted industry interface standards such as ANSI, ISO, IEEE, and NIST. Using controlled, standardized interfaces will facilitate future changes and upgrades without impacting the entire system. Interoperability, or the ability of two or more systems to exchange information and utilize the information exchanged, is a key issue with COTS products. Therefore, the Program Manager should plan for and allocate additional integrator time and resources to resolve COTS interface and performance problems during system development and test. As part of the COTS selection process, the integrator should communicate with the vendors to determine the COTS product’s interoperability with other COTS products to be utilized in the system under development. The use of a flexible “middleware” can also allow multiple products to interact without having to modify those products. For COTS products with no positive interoperability records, the integrator should either find another COTS product with interoperability data or flag the product as a risk item. For those critical COTS products, the integrator should consider prototyping as a means to identify interoperability issues early in the development. The PM should plan for possible cost and schedule impact during the integration and test phases resulting from integration and interoperability problems associated with COTS products.

4.10.4 Software Architecture Flexibility/Growth Potential

To take full advantage of COTS solutions and components during system development, an open systems architecture is key. Open systems architecture involves partitioning system interfaces, functionality and data schemes in a way that facilitates future commercial technology upgrades. To build an open systems architecture, the integrator should separate modules that will not change from those slated for evolutionary improvements. To achieve an open system, the integrator should select and integrate COTS products that are scaleable, portable, interoperable, conformance tested, and independent of their hardware platforms. Open system interface standards are key to successfully selecting and integrating COTS products from many different vendors. Open systems profiles which identify, document and baseline the interface features to be used in the system should be maintained. Conformance testing should be conducted to verify a product’s compliance with the baseline open systems standards. As a result of this process of documenting and verifying system interfaces, the program manager and the integrator have the engineering data necessary to accomplish technology insertions and product upgrades.

4.11 Information Security

Like most other aspects of designing computer systems for use in military applications, the use of COTS has brought its unique flavor to the security world. The proliferation of high performance, widely available commercial technologies has forced the military design community to grapple with information security with renewed emphasis. Commonality with the commercial marketplace means that our classified information is more accessible than ever to both insider and outsider threats. Software “viruses” abound and hacker tools for commercial technologies can be easily downloaded from the internet. Security holes in operating systems are commonly published in user groups. Fortunately, several commercial market arenas have been forced to deal with security for these technologies, the two leaders being the banking industry and the internet. Additionally, the National Security Agency is providing security tools certified to military standards which complement some widely used commercial technologies. The information security market is one of the fast changing commercial forums as tools keep pace with technologies, providing continuous challenges for systems engineers and hardware and software designers. The best strategy for success in information security is to limit user access to tactical code, limit or buffer external interfaces to the tactical system and initiate close relationships with those using and certifying the systems to ensure that a safe, yet operable, capability is fielded. Periodic information security technology updates, similar to those associated with other commercial technologies, are mandatory and must be based upon a detailed analysis of the operating environment and potential threats to the system.

CHAPTER 5: TEST AND INTEGRATION

COTS test and integration planning should consider selection, development and support phase testing requirements. Selection testing should be limited to that which is absolutely necessary to make the commercial product decision. For a COTS-based system development, the developer's test plans should address requirements and facilities for COTS evaluation and conformance testing as part of the system integration and test plans. However, the test program should be tailored to recognize commercial testing. During the support phases, the Program Manager should allocate resources for conformance and compatibility testing of fielded systems that will regularly undergo COTS product upgrades.

5.1 Feasibility Testing Prior to COTS Decision

This testing should be limited to those tests necessary to make and/or confirm a COTS selection decision. To minimize testing at this stage, maximum use should be made of contractor test results. Supplementary data could be obtained from other users.

If this initial data collection is not adequate to support a COTS decision, selected candidates must be evaluated. These tests should be limited to ensuring the product will work in the operating environment.

5.2 Integration Testing

COTS software products will contain bugs. COTS hardware products do not always perform as advertised in vendor flyers and spec sheets. COTS product documentation is often incomplete or wrong. These COTS product difficulties are not always evident until integration and test of the COTS components or integration and test of the system. Therefore, even with robust COTS selection process, early test and evaluation of COTS components in the system is important during COTS-based developments. To lower risk in a COTS-based system development, conformance, compliance and interoperability characteristics should be proven early in the prototyping and demonstration of critical items and functions. Quality vendor support of the COTS product is also important during system test and integration phases to provide COTS product troubleshooting assistance or other product information not readily available in standard COTS manuals and documentation. The level and quality of vendor support for a given COTS product should be considered in the COTS selection process.

One of the most critical issues with COTS integration and test is interoperability. Unfortunately, many COTS interoperability/integration issues may not surface until well into system integration and test. Therefore, estimating integration and test resources and schedules for a COTS-based system development is particularly challenging. Interoperability must be considered from the early stages of system development and be a key criterion in COTS product selection.

5.3 Compatibility Testing

Since newer COTS product versions are constantly being released, the frequency at which new product versions are incorporated in the system under development is a key cost/benefit trade. A program manager must consider that integration of a new COTS product release into a system may not be trivial, and additional time and effort will most likely be required to incorporate new versions in the system and to verify backward compatibility. This process must be applied continuously as COTS products evolve to ensure they can operate seamlessly within the system.

It is also important to ensure that functional upgrades and technology insertions do not introduce incompatibilities within the system. This will require the ability to maintain each fielded system configuration in a test bay environment for certification of each change or upgrade.

If spare parts are directly procured from the commercial vendor and provided to the Fleet, an incompatibility might not be recognized before an at-sea maintenance evolution. A loss of system function or mission could result.

This requires the capability to test to ensure compatibility of new items before they are added to the supply support pipeline and to verify repair to existing system parts. The selection of items to be tested is based on random sampling or vendor notification of change. Sampling should reflect the particular product’s turnover or upgrade rate within the commercial marketplace. In general, the greater the chance for turnover (or change), the more often new parts should be tested for compatibility. This should be determined by an IPT focused on repair management. In cases where vendor history or product stability factors dictate, new and repaired parts must be “hot box” tested to ensure compatibility with the system.

This also applies to incoming vendor software. The software products must be tested in an operational environment to ensure continued compatibility with each operational configuration.

CHAPTER 6: TECHNOLOGY REFRESHMENT

The primary purpose of any Technology Refreshment Program is the avoidance of obsolescence in the delivered NPE systems. In addition, periodic block upgrades planned for resolving software and hardware obsolescence issues may be used as opportunities for implementing functional upgrades and other engineering changes. The viability of any open system based COTS system that must be maintained over a long period of time requires a comprehensive market research and cataloging process for monitoring the evolving system baseline, assessing its elements against industry trends for comparable items, and working with vendors to anticipate end-of-life issues. The purpose of this process is to 1) to identify in advance software and hardware products that will become obsolete, 2) to identify potential replacement elements, either "plug replaceable" components or new superseding technologies; and 3) to monitor technology and standards trends. Planning for technology insertion and minimizing SHIPALT driven upgrades is an essential part of the initial systems engineering process.

The intensity of effort required for monitoring system elements will vary depending on the nature of the components. The most critical elements will require the most intensive monitoring. Products and standards included in this class are those experiencing the most significant development investments in the industry and are therefore the most technologically advanced, provide the best performance per unit cost and are the most volatile. Components in this class represent a significant portion of the system recurring cost and therefore avoidance of obsolescence is critical for managing system support costs. Developments in these product areas are intensely standards oriented, often defining the direction of standards evolution.

Other elements evolve at a slower rate but will none the less require continuous monitoring. Some system components will never require replacement during the life of the platform. Historically, system elements associated with sensor and weapons interfaces whose functionality does not change rarely require replacement or upgrading and this trend should continue. Other elements such as power supplies are based on relatively stable technologies and expected to rarely change, and then only for supportability reasons (e.g., component unavailability).

6.1 Technology Refreshment Process

The Technology Refreshment Process will maintain "state-of-the-practice " products in NPE systems, avoiding the risks and expense of using immature product developments too near the leading edge of technology. As technology advances significantly beyond the capability of a specific COTS item, the market surveillance process will identify the item as a candidate for technology upgrade. If the new item is backward compatible, the upgrade may be introduced into the system through replacement of existing products as they are retired from the system. Otherwise, the new items will be integrated into the next planned system upgrade.

The market research and support assessment process (described in section 4.1) will also flag items that are adversely impacting system Operational Availability (A_o), increasing system support costs, or approaching product or technology EOL. The process will also identify COTS alternatives for these items. If the impact on the system is minimal, such as a part number change only, the new item may be implemented via the supply system. If the new item affects interfaces or higher level software, introduction will be made via a planned system upgrade. Resolutions may manifest themselves as software or hardware updates, or support product improvements (technical manuals, training, sparing). Supportability driven changes having minor impact on support products may be implemented as standalone changes via electronic medium.

If supportability changes have a significant support product impact, they will be integrated via the system upgrade process.

Improvements in operability, simulation based training and concept of operations can be efficiently incorporated at the same time as the technology update. New or modified weapons changes can be accommodated and cost effective supportability changes such as redundancy to minimize at sea maintenance and the elimination of unsupported obsolete technology elements can be planned into these update cycles.

This surveillance/assessment process will ultimately lead to two general types of candidates for NPE technology refreshment:

- ♦ a change as a result of integrating a next generation product or product upgrade to an existing technology or component to improve system functionality.
- ♦ a change as a result of integrating a new item to avoid an ensuing EOL or product obsolescence issue, or to resolve a problem identified by Fleet feedback..

The Technology Refreshment Process is implemented in periodic updates which provide opportunities to incorporate hardware and software changes including functional and performance upgrades. This permits use of small manageable changes and results in progressive modernization, reducing the need for major change activity (SHIPALTS at regular overhauls.) These upgrades may consider both the technology evolution and the changes in the threat and warfare needs, such as those experienced with threat quieting, increased diesel electric boat threat, and future increases in the use of Unmanned Underwater Vehicles (UUVs). Budgeting or these updates is discussed in Section 2.2.

The reliability of COTS components will need to be monitored using existing processes such as 3M, TPR, TCPR etc. Usage and replacement factors derived from the supply support system (whether NAVICP or contractor supported) can also provide the necessary feedback on COTS component reliability that impacts overall system availability.

Market research, encompassing the iterative planning for technology upgrades/ insertions as well as technology refresh, is the primary driving and sustaining process to optimize the acquisition and support of COTS-based systems.

APPENDIX A

Acronyms

Acronym	Definition
ACO	Administrative Contracting Officer
ANSI	American National Standards Institute
APL	Allowance Provisioning List
A_o	Operational Availability
BIT	Built-In-Test
CBT	Computer-Based Training
CDR	Critical Design Review
CDRL	Contract Data Requirements List
CFBR	Consolidated Shipboard Allowance List Feedback Report
CI	Configuration Identification/Configuration Item
CM	Configuration Management
COTS	Commercial-Off-The-Shelf
CSA	Configuration Status Accounting
CSCI	Computer Software Configuration Item
DLA	Defense Logistics Agency
DoD	Department of Defense
DoDR	Department of Defense Regulations
DRMO	Defense Reutilization Marketing Office
DTA	Design To Affordability
EC	Engineering Change
ECI	Engineering Change Instruction
ECP	Engineering Change Proposal
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
EOL	End of Life
EPA	Environmental Protection Agency
F^3	Form, Fit and Function
FAR	Federal Acquisition Regulation
FMECA	Failure Mode, Effects and Critical Analysis
FTA	Fault Tree Analysis
H/W	Hardware
HMI	Human Machine Interface
IAW	In Accordance With
ICW	Interactive Courseware
IEC	International Electrotechnical Commission
IEEE	Institute of Electronic & Electrical Engineers
IETM	Interactive Electronic Technical Manual
IFB	Information For Bid
IPR	In-Process Review
IPT	Integrated Product Team
ISEA	In-Service Engineering Agent
ISO	International Organization for Standardization
LRU	Lowest Replaceable Unit
LSA	Logistic Support Analysis
MILSPEC	Military Specification

Acronym	Definition
MIP	Maintenance Index Page
MRC	Maintenance Requirement Card
MRIL	Master Repairable Items List
MPT	Manpower, Personnel and Training
MTBF	Mean Time Between Failure
MTTR	Mean-Time-to-Repair
NAVICP	Naval Inventory Control Point
NAVSEA	Naval Sea Systems Command
NDI	Non-Developmental Item
NESAC	NAVSEA Engineering and Support Analysis Center
NIST	National Institute of Standards and Technology
NPE	Non-Propulsion Electronics
NSN	Navy Stock Number
OASD	Office of Assistant Secretary of Defense
OEM	Original Equipment Manufacturer
ORD	Operational Requirements Document
OSA	Open System Architecture
PCA	Physical Configuration Audit
PCO	Procuring Contracting Officer
PHS&T	Packaging, Handling, Storage and Transportation
PIM	Parts Interchangeability Matrix
PM	Program Manager
PM/FL	Performance Monitoring/Fault Localization
PMS	Planned Maintenance System
POM	Program Objective Memorandum
PTD	Provisioning Technical Data
PTR	Program Trouble Report
RBS	Readiness Based Sparing
RCM	Reliability Centered Maintenance
RDT&E	Research, Development, Test & Evaluation
RFI	Request for Information
RFP	Request for Proposal
RISC	Reduced Instruction Set Commands
S,M&R	Source, Maintenance and Recoverability
S/W	Software
SDF	Software Development File
SDP	Software Development Plan
SHIPALT	Ship Alteration
SOW	Statement of Work
T&I	Test and Integration
TDUA	Technical Data Usage Analysis
TFBR	Technical Feedback Report
TMCR	Technical Manual Contract Requirements
TMDER	Technical Manual Deficiency/Evaluation Report
TYCOM	Type Commander
UUV	Unmanned Underwater Vehicle
V/V	Validations and Verifications
WSF	Weapon System File

APPENDIX B

Bibliography

The following references were consulted, in their entirety or in part, in the development of this COTS Acquisition Primer:

ARCI COTS Supportability Plan (Draft), June, 1996

"COTS/NDI Assessment and Selection," D. Verma, Lockheed Martin/G. Shaffer, NAVSEA PMS401-L, September 10, 1996

ADPA, COTS Supportability Study, Technical Report, August 22, 1994

DoD 5000.2-R, Mandatory Procedures for Major Defense Acquisition Programs and Major Automated Information System Acquisition Programs, March 5, 1996

DoDD 4210.15, Hazardous Material Pollution Prevention, July, 1989

SECNAVINST 5000.2B, Implementation of Mandatory Procedures for Major and Non-Major Defense Acquisition Programs and Major Programs and Non-Major Information Resources Acquisition Programs, December 6, 1996

Federal Acquisition Regulation (FAR) Part 10, October 1994, and Part 12, August 1996

SECNAVINST 5234.2A, ADA Programming Language Policy, April 1994

DoD 5000.1, "Defense Acquisition" , March 15, 1996

ISO 10007, Quality Management Guide for Configuration Management, April 1995

EIA/IS 649, National Consensus Standard for Configuration Management, August 1995

OPNAVINST 4110.2, Hazardous Material Control and Management, June 1989

MIL STD 498, Software Development and Documentation, December 1994

Executive Order 12856, Federal Compliance with Right-to-Know Laws and Pollution Prevention Requirements, Library of Congress EO 12856, August 1993

NDI/COTS Support Strategy Study for PMS425 Programs, Loral Federal Systems, Manassas, October 2, 1995

Trident 2005 Command and Control System (CCS) Acquisition Strategy and Management Plan, May 3, 1996

COTS Equipment Life Cycle Supportability - PEO Submarines, PMO450T2, December 1995

Engineering Off The Shelf Solutions: A Life Cycle View, Lockheed Martin Defense Systems under contract to the Department Of The Navy Strategic Systems Programs, September 1995

The Supply Support Handbook for NDI, SPCC

Technical Report. “American Defense Preparedness Association commercial-Off-the-Shelf (COTS) Supportability Study,” UNDERSEA WARFARE SYSTEMS DIVISION, American Defense Preparedness Association, August 22 1994.

“Buying Commercial & Non-developmental Items: A Handbook”, Office of the Under Secretary of Defense for Acquisition and Technology, April 1996.

“Market Research for Commercial Items,” (draft) Office of the Under Secretary of Defense for Acquisition and Technology, June 1997.

“Non-Developmental Item Procurement,” Budget Presentation and Formulation, Department of Defense Financial Management Regulation, Vol. 2A, para. 010209.

“Acquisition of Commercial Items,” Federal Acquisition Regulation (FAR), Part 12.

“Planning for Computer Resource Acquisitions: Contracting for Success” DSMC SAM Teaching Note 8.1

“Proceedings of the SEI/MCC Symposium on the Use of COTS in Systems Integration” CMU/SEI-95-SR-007. June 1995

“BSY-2 Lessons Learned Brief” PMS418

“Life Cycle Management of Open System Interfaces (COTS/NDI Symposium September 1996)”, M. Chesterwood, NSWC Crane Code 6021

“COTS Software Integration: State of the Art”, M. Vigder, W. M. Gentleman, and J. Dean, National Research Council of Canada, January 1996

“Special Requirements for the Acquisition of Commercial Items,” Defense Federal Acquisition Regulation (DFAR), Subpart 212.2.

“Solicitation Provisions and Contract Clauses for the Acquisition of Commercial Items,” DFAR, Subpart 212.3.

“Open Systems Acquisition and Supportability Guide, Next Generation Computer Resources (NGCR), Document No. AST 003 Ver. 1.0. December 31, 1996

“Applicability of Certain Laws to the Acquisition of Commercial Items,” DFAR, Subpart 212.5.

“Certifications--Commercial Items--Competitive Acquisitions,” DFAR, 252.211-7012.

“Contract Award--Commercial Items,” DFAR, 252.211-7014.

Team ICP Supply Support Handbook for Non-Developmental Items, August 15, 1994, Navy Ships Parts Control Center (SPCC) and Naval Aviation Supply Office (ASO).

COTS in the Fleet, Part One: Navy Perspectives, August 8, 1995, Mercury Computer Systems, Inc.

Program Report Update for COTS/NDI Supportability Analysis, April 15,1995, Systems Engineering Design Laboratory Industrial and Systems Engineering, Virginia Polytechnic Institute and State University

Acquiring Defense Software Commercially, Defense Science Board (DSB), June 1994.

Commercial Off The Shelf (COTS) Product Selection Report, SDRL T0012, May 30,1995 Digital Systems Resources Corporation

EIA Interim Standard Configuration Management EIA/IS-649, dated 21 April 1995

Use of Commercial-Off-the-Shelf (COTS) Technology in Military Systems, R.L. McCaig, Loral Federal Systems - Manassas, International Maritime Defense Exhibition & Conference, 30 March, 1995.

NDI/COTS Supportability Approach Trade-Off Model, Draft Review Copy, Loral Federal Systems - Manassas, January 25,1995.

COTS Product Identification and Evaluation (PIE) Process, November 21,1994 Loral Federal Systems Company

American Defense Preparedness Association Commercial-Off-the-Shelf (COTS) Supportability Study, 22 August, 1994.

Non-developmental Item Handbook for Supply Support, Space and Naval Warfare Systems Command, 30 June, 1992.
MIL-STD-973, Configuration Management, 17 April, 1992.

NAVSEA Program Manager's Guide. Provisioning Technical Documentation Requirements for Non-developmental Items Procured as Government Furnished Equipment, Naval Sea Systems Command, January 1991.

Buying NDI, Nondevelopmental Item Program SD-2, Office of the Assistant Secretary of Defense for Production and Logistics, October 1990.

Flexible Sustainment Guide, Joint Aeronautical Commanders Group, 17 December 1996

The COTS Book: Selecting and Supporting Commercial Products for the Military, United States Air Force.

NAVSO P-6071. Best Practices, Dept. of the Navy, March 1986

MIL-HDBK-61. MILITARY HANDBOOK. Configuration Management, Working Copy

Logistics Engineering and Management, Benjamin S. Blanchard, Prentice-Hall

Internal Notes. Interviews and Lesson's Learned, Loral Federal Systems Manassas

Commercial Off-The-Shelf Issues/Approaches For Naval Task Forces From Command. Control. And Communications To Weapon And Sensor Systems, Pat Watson, Loral Federal Systems - Manassas

COTS Circuit Card Supportability, Stauch R. Osburn, NUWC, Keyport

The COTS Book, PMS396, April 1995

Internet:
- http://www.acq.osd.mil
- http://www.acq-ref.navy.mil
- http://www.nacisa.nato.int/NOSE/Gloss1.htm
- CRANE “SHARP" Home Page on the World Wide Web