Defense Acquisition Guidebook

Chapter 5 – Life Cycle Logistics

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5.0. Overview

DoD Directive 5000.01 requires Program Managers to:

"develop and implement performance-based logistics strategies that optimize total system availability while minimizing cost and logistics footprint."

Within the Defense Acquisition Management System, DoDD 5000.01 requires that:

"Planning for Operation and Support and the estimation of total ownership costs shall begin as early as possible. Supportability, a key component of performance, shall be considered throughout the system life cycle."

5.0.1. Purpose

This chapter provides the associated guidance the Program Manager (PM), Product Support Manager (PSM), and Life-Cycle Logisticians can use in influencing the design and providing effective, timely product support capability to achieve the systems materiel readiness and sustain operational capability. Emphasis is placed on integrating life-cycle management principles by using performance-based life-cycle product support strategies to provide effective support. This synchronized with the systems engineering process results in affordable materiel readiness at an optimal life-cycle cost (LCC) by reducing the frequency, duration, and related costs of availability degrader events to reduce manpower and logistics footprint. An executive summary

of key chapter principles is provided below.

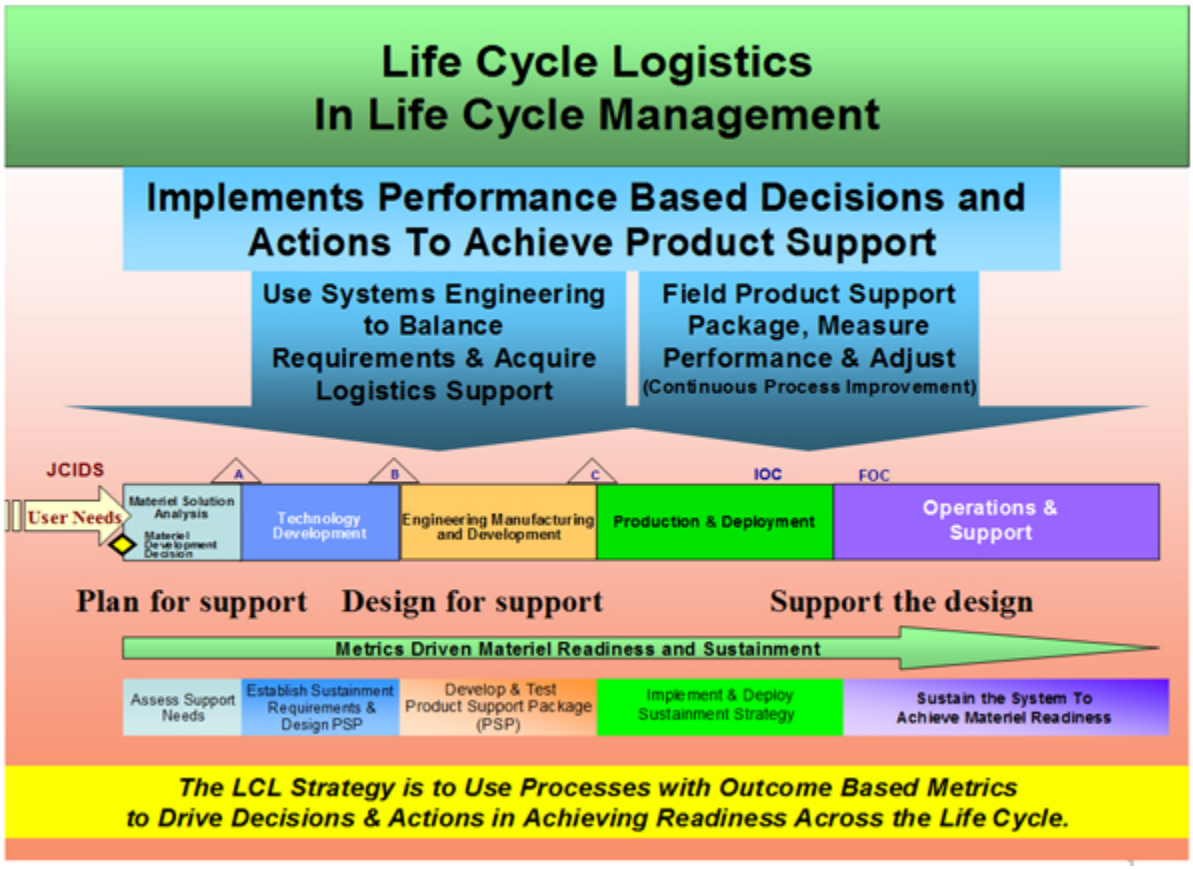
The PM, as the life-cycle manager, is responsible for accomplishing program objectives across the life cycle, including the operating & support (O&S) phase. Employing performance-based life-cycle product support tied to sustainment metrics is the overarching Department of Defense (DoD) concept for providing materiel readiness to the user. This logistics aspect of the life-cycle management approach is depicted in Figure 5.0.1.F1 and discussed in subsequent sections.

There are three DoD Decision Support Systems - Joint Capabilities Integration and Development System (JCIDS) , Defense Acquisition System , and Planning, Programming, Budgeting and Execution (PPBE) process - that frame the environment for implementing life-cycle management. In addition, there are three related but distinct communities, with corresponding reporting chains, within the DoD -- the acquisition, user, and sustainment chains involved in implementing the decision support systems. Working in tandem these communities share responsibilities which vary depending on the life-cycle phase. Consequently, the PM needs to be involved with each chain. The Defense Acquisition Guidebook focuses on the acquisition chain (e.g. the OSD, Service Secretariat, Program Executive Officer chain, etc.). Chapter 5 addresses the acquisition chain and highlights interfaces with the user chain (e.g. the type commander, Theater Commanders, etc.) and sustainment chain (e.g. supply chain (including the transportation system, maintenance facilities and depots, industrial base), in-service engineering organizations, etc.).

During acquisition the focus is primarily through the acquisition community with requirements input from the user and sustainment communities. These requirements include:

- Specification of design parameters for sustainment related system performance capabilities.
- Application of systems engineering to determine the right balance between the systems design requirements and the logistics support requirements to sustain the operational capabilities at an affordable price. This includes using supporting sustainment metrics (e.g. Mean Down Time, Logistics Footprint, etc.) as well as enablers (e.g. condition based maintenance, diagnostics, prognostics, corrosion protection/mitigation, etc.) with their associated metrics to achieve the mandatory sustainment metrics.
- Planning for, resourcing, and executing the design, acquisition, management, and fielding an integrated product support package to sustain the maintenance and support concepts that meet the materiel availability requirements.

Figure 5.0.1.F1. Life-Cycle Logistics Overview



During operations the focus is primarily through the user and sustainment communities with support from the acquisition community. The PM's focus is on supporting the user's ability to effectively meet mission requirements through the application of systems engineering to implement continuous process improvement initiatives. This involves monitoring performance to identify major readiness degraders (e.g., reliability, cycle time and cost) and to:

- Align and refine the product support package (e.g. the product support elements) and sustainment processes to achieve the sustainment metrics
- Engage the various communities to achieve optimum materiel readiness
- Optimize or reduce the logistics demand (including the logistics footprint) and support processes (e.g., training, technical data, supply chain, maintenance, etc.) based on actual conditions
- Reduce operating and support costs
- Identify and implement design changes to address evolving requirements, technological obsolescence, diminishing manufacturing sources, or materiel availability shortfalls.

To accomplish this life-cycle product support concept outcomes are estimated in the design phase then measured during testing and operations and become the basis for actions to achieve materiel readiness. The sustainment metrics, including the Sustainment Key Performance

Parameter (KPP) with its supporting Key System Attributes (KSAs), provide the common thread to integrate the product support elements and align the behaviors required to achieve the desired materiel readiness outcome across the entire enterprise. The goal is to use consistent outcome metrics as the basis for actions to provide and sustain affordable materiel readiness across the entire life cycle.

5.0.2. Contents

Section 5.1 5.3 present information applicable across the lifecycle, while the information in Section 5.4 has been tailored to specific portions of the lifecycle.

Section 5.1, Life-Cycle Sustainment in the Defense Acquisition Management System , describes life-cycle sustainment, explains it's role, and identifies the PM's primary life-cycle logistics and sustainment responsibilities. It provides the context for conducting sustainment-related activities relative to performance-based life-cycle product support and the sustainment metrics.

Section 5.2, Applying Systems Engineering to Life-Cycle Sustainment , focuses on the process to plan for, achieve and sustain affordable systems operational effectiveness. The concept of applying life-cycle cost, modeling and simulation, and supportability analyses to design out "sustainment disablers" to optimize the support system is presented in this section.

Section 5.3, Supportability Design Considerations , focuses on design features that should be incorporated to help make a system more sustainable, including reliability, diagnostic, and predictive monitoring capabilities.

Section 5.4, Sustainment in the Life-Cycle Phases , focuses on how life-cycle sustainment integrates into life-cycle management and the acquisition process/decision points. It identifies key activities in each program phase, whether it is a major new system, a modification to a fielded system, or a redesign of the product support system. This section applies the concepts discussed in sections 5.1, 5.2, and 5.3, placing them in the Defense Acquisition Management System to demonstrate when sustainment related activities take place. It also contains specific focus areas for consideration and the results expected in preparing for each milestone or review.

Section 5.5, References , provides references for further explanation and information.

5.1. Life-Cycle Sustainment in the Defense Acquisition Management System

5.1.1. Life-Cycle Sustainment

5.1.1.1. Product Support

5.1.1.2. Sustainment Metrics

5.1.1.3. Performance-Based Life-Cycle Product Support Implementation

5.1.1.4. Sustaining System Performance

5.1. Life-Cycle Sustainment in the Defense Acquisition Management System

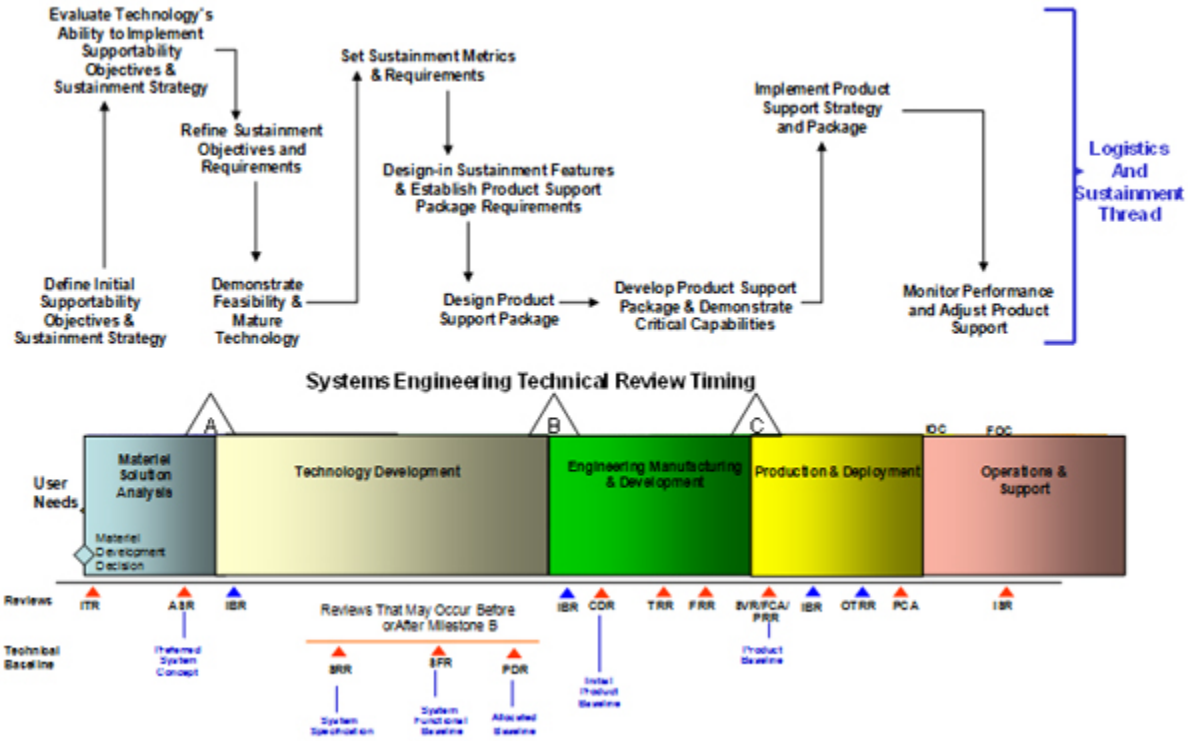
This section highlights important sustainment related activities a program manager should consider. Topics discussed in this section are applicable to multiple phases and it addresses the major deliverables to be prepared or updated during subsequent phases or increments. DoD Instruction 5000.02 provides a complete discussion of the activities and requirements encompassed in the Defense Acquisition Management System. More detailed sustainment related information can be found in subsequent sections and the references.

5.1.1. Life-Cycle Sustainment

Life-cycle sustainment involves the early planning, development, implementation, and management of a comprehensive, affordable, effective performance driven logistics support strategy. It plays a key role during all phases of the life cycle as Figure 5.1.1.F1 illustrates. The goal is to ensure sustainment considerations are integrated into all planning, implementation, management, and oversight activities associated with the acquisition, development, production, fielding, support, and disposal of a system across its life cycle. This includes:

- Participating in the design process to acquire a highly supportable and sustainable system
- Providing affordable, reliable, effective support strategies and systems that meet the users requirements with optimum materiel availability
- Developing the appropriate metrics to validate and verify the system engineering design process, and measure the performance of the support strategy/supply chain
- Providing the user effective systems with the minimal logistics footprint (e.g., the measurable size or "presence" of logistics support, including manpower, required to deploy, sustain, and move a system).
- Developing more integrated and streamlined acquisition and statutorily compliant logistics support processes
- Facilitating iterative technology enhancements during the system life cycle

Figure 5.1.1.F1. Sustainment Thread in the Defense Acquisition Management System



The goal can be accomplished by using metrics-driven outcome-based processes to drive decisions and actions by the stakeholders across the enterprise and life cycle. It should be carried out by a cross functional team of subject matter experts ensuring sustainment requirements are both consistently and comprehensively addressed and balanced with cost, schedule and performance. Sustainment should be considered in the systems engineering process to ensure decisions focused on the ability to operate and support a system are implemented during its design, development, production, and sustainment. Key tenets in accomplishing the goal include, but are not limited to:

- Single point of accountability for accomplishing program sustainment objectives including the logistics system and support;
- Incremental acquisition and statutorily compliant product support strategies;
- Comprehensive integration of hardware, software and humans throughout the life cycle to optimize usability, availability, maintainability, sustainability and affordability. This includes follow on modifications to address deficiency reports and sustainment issues.
- Metrics-driven decisions based on a meaningful user outcome measure (e.g., Materiel Availability) supported by a materiel quality measure (e.g., Materiel Reliability), a sustainment quality measure (e.g., Mean Down Time), and a cost measure (e.g., Ownership Cost);
- Understanding industrial base capabilities and service capabilities;
- Ensuring competition, or the option of competition, at both the prime and subcontract

level throughout the program life cycle;
- Performance-based life-cycle product support strategies to project and sustain the force with minimal footprint that support the Sustainment KPP, it's associated KSAs, and overall affordability goals;
- Continuous process improvement including assessing the life-cycle product support strategies, to include end-to-end sustainment chain planning, assessment, and execution.

5.1.1.1. Product Support

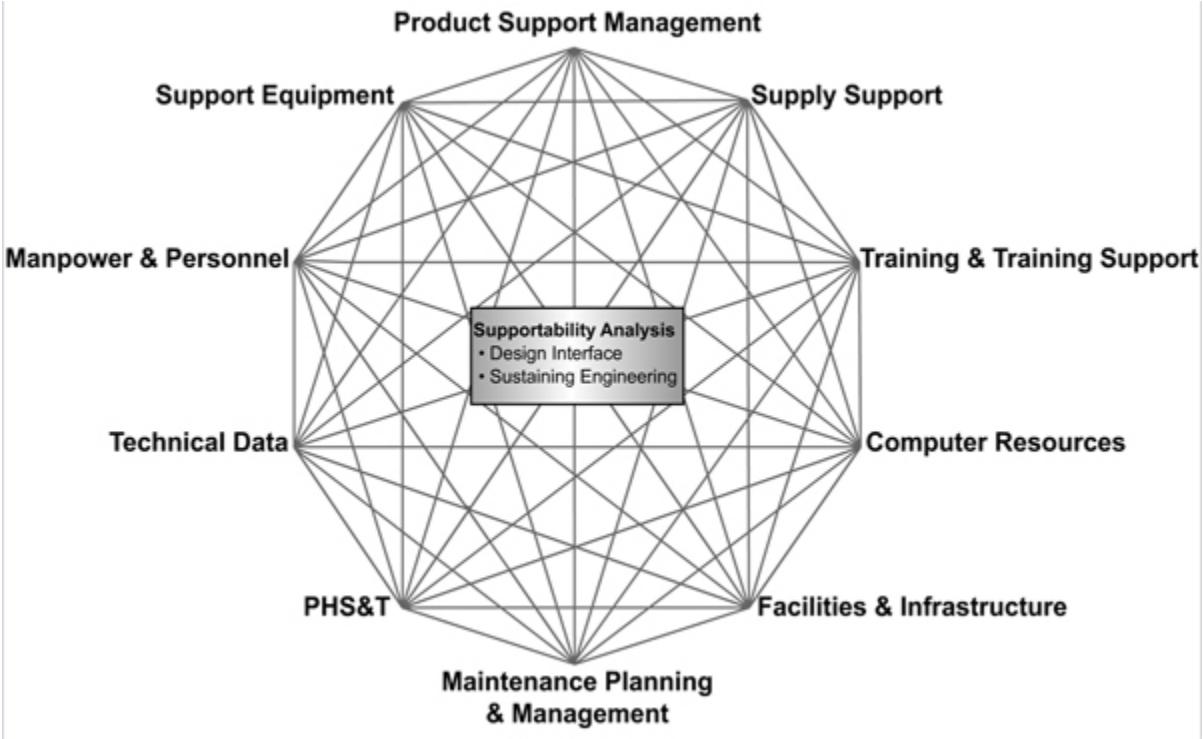
Product Support is the application of the package of integrated product support elements and support functions necessary to sustain the readiness and operational capability of the system. While it varies by organization typically, the product support package (PSP) includes the product support elements contained in Figure 5.1.1.1.F1. They must be integrated because they impact each other and Materiel Availability. During the acquisition process the focus is on influencing the design for supportability and by fielding the support concept to satisfy user specified requirements for sustaining system performance at the lowest LCC. This applies to each increment of capability to be developed. Features include:

- Availability of support to meet Warfighter specified levels of combat and peacetime performance;
- Logistics support that sustains both short and long term readiness;
- Management of life-cycle cost (LCC) through analysis and decision prioritization;
- Maintenance concepts to integrate the product support elements and optimize readiness while drawing upon both organic and industry sources;
- Data management and configuration management that facilitates cost-effective product support throughout the system life cycle;
- A diminishing manufacturing sources and material shortages management process that ensures effective, affordable, and operationally reliable systems;
- Operator and maintainer training to encompass the full capability of the system.

Developing the **Product Support Strategy** that defines the overall end state is the first step in achieving product support. In developing the support strategy, each program should develop an affordable strategy that:

- Positions and delivers materiel to satisfy highly variable readiness and combat sustainment needs in a variety of unique and demanding environments.
- Meets all materiel management and maintenance statutory requirements.
- Supports rapid power projection.
- Improves readiness through performance-based sustainment strategies.
- Establishes end-to-end processes focused on outcomes.
- Implements contemporary business systems and practices that enable the integration of people, information, and processes.
- Protects critical program information including as it moves through the supply chain, as required in DoD Instruction 5200.39 .

Figure 5.1.1.1.F1. Product Support Elements



The support concept has to address the hardware and its associated technical data and computer software (including Commercial Off The Self (COTS) software) since software can be a major sustainment issue as systems become more software intensive. Programs need to plan for technology refreshment and maintaining the software after production. This includes how changes (for obsolescence/ technology refreshment and maintaining the software) will be budgeted and executed along with the necessary computer software documentation required to sustain the software throughout the system life. In addition to sustaining the software, aspects such as customer support, systems administration help desk support, etc. need to be considered.

Achieving the support concept and sustaining operational capability requires the involvement of the logistics, engineering, testing, program management, contracts, supply chain, and financial management experts. The overall support strategy, documented in the Life-Cycle Sustainment Plan, should include life-cycle support planning and address actions to assure sustainment and continually improve product affordability for programs in initial procurement, re-procurement, and post-production support. A performance-based product support plan will be used to align the support activities necessary to meet these objectives.

5.1.1.2. Sustainment Metrics

In a performance based environment, sustainment related requirements, with a specified range of minimum mandatory (threshold) and target (objective) performance capability design parameters are established with accompanying metrics covering the entire enterprise. This includes the system and the supply chain supporting it. (The same basic model holds for the supply chain, but

this chapter focuses on the program manger's role.) Sustained materiel readiness of war fighting capability can then be achieved by developing optimally effective and affordable life-cycle costs investment strategies to achieve the sustainment metrics. The metrics should possess the following key attributes.

Traceable to User Requirements: Sustainment metrics must reflect user requirements. The metrics and their values should be derived from the systems operational requirements and expected use, (as articulated in the Capabilities-Based Assessment (CBA) process) and the product support strategy to sustain it. They should also be supported by comprehensive and early supportability planning and analyses to balance technology feasibility, life-cycle costs and operational needs.

Achievable and Verifiable: The sustainment metric requirements must be obtainable. (Unrealistic requirements adversely affect the development process, result in unachievable performance levels, and drive higher acquisition and sustainment costs.) They should also be stated in demonstrable terms reflecting the projected range of military operations (e.g., design reference missions) and intended operating environment that must be supported. These attributes are critical for sustainment requirements to be used within the design tradeoff process along with cost, schedule, and performance.

Minimum Reporting: The specific metrics should be tailored to the program and it's operational and sustainment needs. At a minimum, they should consist of four interrelated metrics: an outcome metric meaningful to the user in achieving and sustaining the operating tempo; a materiel metric to measure the systems quality; a response metric to measure the quality of the logistics system; and a cost metric. They should be consistently defined within the program and traceable to the operational need. At the top level, the sustainment metrics should focus on providing an effective system that is available and reliable with minimal down time at a reasonable cost. Exact definitions and details can be found in the JCIDS Manual . However, programs have the flexibility to tailor the metrics (including adding additional sustainment metrics (e.g. footprint, manning levels) as long as the intent is met. The following describes the general intent of each of the metrics:

- **Materiel Availability** the percentage of the total inventory (not just the operationally assigned assets) operationally capable at a given time based on materiel condition. This "total inventory" aspect is critical because it not only measures the ability to execute "today's" missions but also provides an indication of the "surge" ability. Materiel availability is primarily an indication of the percentage of time a system is operationally capable of performing an assigned mission. In addition to the planned missions/scenarios, operating tempo, and sustainment concept of operations (CONOPS), this metric is dependent on system reliability and the mean downtime resulting from, but not limited to failures, scheduled downtime, general maintenance or servicing actions.
- **Materiel Reliability** - the probability the system will perform without failure over a specific interval. This metric focuses on reliability of the entire system and should not be confused with the mission success rate. Defining the criteria for measuring relevant failures (including consistent definitions for failures (e.g., criteria for counting assets as "up" or "down") and mission critical systems) and clearly defining how time intervals

will be measured are important and must be consistent with the other metrics.

- **Mean Down Time** - the average time an end item is unavailable to perform it's assigned mission after it experiences unscheduled or scheduled maintenance actions. It includes all time where the system is not at the disposal of the Force Provider to initiate missions. In addition to the projected supply chain approach with its resultant logistics footprint, the impact of surge/deployment acceleration requirements should be determined for this and the Materiel Availability metric.
- **Ownership Cost KSA** - a subset of the operating and support costs, excluding manpower, training and indirect support cost. However, to address affordability it is important to use operations and support costs to influence program design, acquisition, and sustainment alternative decisions. Consequently, pending the official JCIDS Manual change, OSD is now requiring programs report the O&S costs along with the Ownership Cost KSA because the programs cost model must be consistent with the design specifications as well as the assumptions and conditions used for Materiel Availability, Materiel Reliability and Mean Down Time metrics. In all cases it is critical the cost structure being used be clearly defined (along with the cost estimating relationships/models, and assumptions) and all relevant costs for the trade-off decisions are included regardless of funding source. (see chapter 3).

The selection of the specific performance metrics should be carefully considered and supported by an operationally-oriented analysis, taking into account technology maturity, fiscal constraints, and the timeframe the capability is required. In implementing performance-based life-cycle product support strategies, the metrics should be appropriate to the scope of product support integrators and providers responsibilities and should be revisited as necessary to ensure they are motivating the desired behaviors across the enterprise. During operations the program can consider measuring additional metrics for configuration control, training effectiveness, overall user satisfaction, etc. The specific metrics selected should tie to existing user performance measures and reporting systems. In addition, existing logistics and financial metrics should be related to these top level user performance metrics and considered as supporting metrics to help provide confidence they can be met as well as identify risk areas.

5.1.1.3. Performance-Based Life-Cycle Product Support Implementation

DoD Directive 5000.01, E1.1.17 , requires program managers (PMs) to:

"develop and implement performance-based product support strategies that optimize total system availability while minimizing cost and logistics footprint. Sustainment strategies shall include the best use of public and private sector capabilities through government/industry partnering initiatives, in accordance with statutory requirements."

Building on the best features of the public and private sectors is a key component of the support strategy. The Performance-Based Life-Cycle Product Support Implementation Framework (Figure 5.1.1.3.F1) captures the range of capability solutions that could be employed. The framework is incremental, in that each alternative builds on the previous category. In all cases the systems sustainment parameters are projected and measured during the design process and then re-assessed once the system is operational so appropriate actions can be taken to achieve the

Materiel Availability objective. Within each category, the program manager is responsible for working with the stakeholders to ensure the appropriate actions are taken to meet the user's needs. The difference is the amount of financial risk shared with the product support integrator or provider and sustainment aspects covered. The categories do not imply a level of "goodness" but only provide a means to illustrate the wide range of implementation options available to the program. Each category description is described below.

Category 1: In a life-cycle management environment, all programs should perform to at least this level. This is the traditional support concept where the program buys the various individual support elements. The government develops the requirements, integrates, procures, and balances the product support elements to achieve the material availability outcome. The contractor metrics are usually cost and schedule. The difference from the traditional approach is what happens once the system is operational. Once operational, the program manager measures the materiel availability and takes appropriate actions with the stakeholders to meet the user's needs. However, most of the fiscal risks are on the government side and the PM works with the product support element functional offices, government infrastructure/supply chain, and contractors to determine and ensure corrective actions are taken.

Category 2: At level 2 fiscal risks begin to transition, but only in narrow but critical supply chain functional areas. Typical functions falling within this level include providing material, inventory management, transportation, and/or maintenance where the provider is accountable for the responsiveness required to meet customer requirements. This level generally concentrates on providing parts with the government making design decisions. Part availability, mean down time (MDT) or logistics response time (LRT) are the typical metrics for Level 2 implementations where the time it takes the supplier to deliver the part, commodity or service to the user determines their payment. In using the approach, care must be given to the requirements and contract terms to ensure they drive the supplier's behavior so the government achieves an affordable material readiness outcome.

The PM is still responsible for taking the appropriate actions with the providers; however, more risks are shared because there are fewer providers with whom to coordinate. The PM still procures many of the individual product support elements and manages the systems configuration. The program has to develop performance requirements, integrate, procure, and balance the elements not included in the Performance-Based Agreement (PBA) to achieve an affordable materiel availability outcome.

Category 3: This level expands the provider's fiscal risk level by transferring life-cycle support activities to the product support integrator (PSI), making them accountable for sustaining overall system materiel availability. Category 3 typically focuses on maintaining the required availability of key components or assemblies, such as a wing flap or auxiliary power unit, but can include the entire system. In Category 3, there is an additional PSI focus on life-cycle support, training, maintenance, repair and overhaul including logistics planning and execution, in-service engineering, configuration management and transportation. In Category 3, the PSI may also make repair or replace decisions. The preferred metric is materiel availability.

At this level the product support integrator is assigned specific life-cycle responsibility, solely or

in partnership, for the breadth of processes affecting materiel availability. This includes aspects of sustainment engineering and configuration control, since reliability and maintenance of equipment and effectiveness of the supply chain influences continually affordable operational availability.

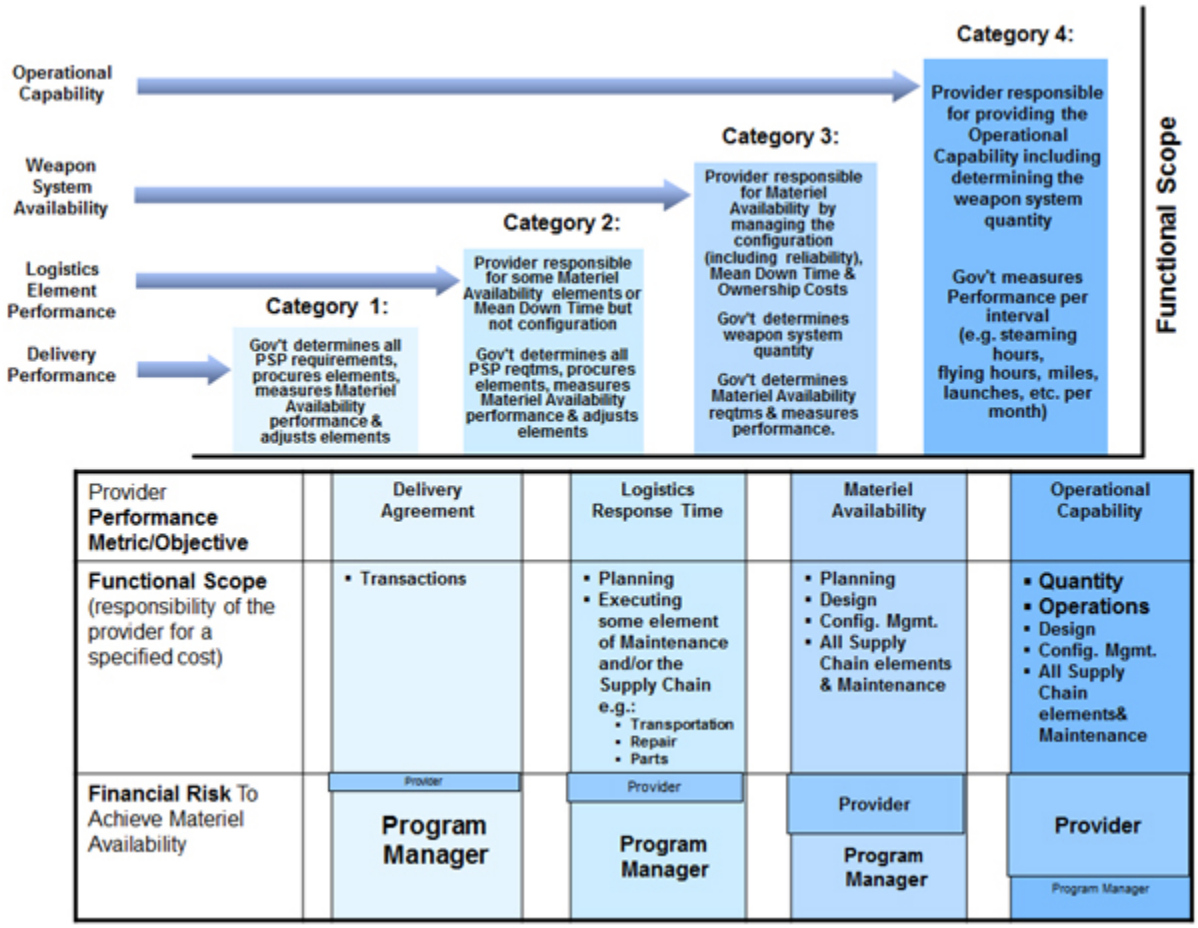
Category 4: This level transfers life-cycle support and design performance responsibilities making the product support integrator responsible for assuring operational availability (Ao) or operational capability. Typically this level applies to systems in the form of operational capability, such as "steaming hours, flying hours or miles per month"; "launches per month"; "power by the hour"; etc. The PSI is assigned responsibility, solely or in partnership, for the breadth of processes that influence Materiel Readiness. This gives the PSI the flexibility to adopt any practices and technology enablers needed to meet required performance levels, including the number of systems deployed and where they are located or staged.

Performance-Based Product Support Contracts (PBL): The DoD intent is to use performance-based support. This includes, where it provides the best long term value, using performance based contracts rather than transaction based contracts (i.e. buying Materiel Availability vice buying spares or support equipment). Any best value assessment has to consider not only cost, but also all other quantifiable and non-quantifiable factors associated with any resultant investment decision. The assessment should stand on its own and be able to withstand rigorous analysis and review by independent audit agencies. PMs should strive for the right mix of implementation in terms of functions provided and the extent to which they are applied to the system.

Contracting for performance based logistics is a multiple step process that can be applied to new, modified or legacy systems. The process is detailed on the web-based PBL Toolkit as a best practice. It is a proven process focusing on legacy programs that can be tailored and adapted to individual systems, subsystems or components to meet its needs and its business and operational environments.

Figure 5.1.1.3.F1. Performance-Based Life-Cycle Product Support Implementation

Framework



5.1.1.4. Sustaining System Performance

Conditions change over the life of any system so it is critical that performance be measured against a plan and corrective steps be taken as conditions warrant. These steps can range from corrective actions anywhere within the program or it's supply chain to re-baselining the metrics. Care should be taken to ensure the appropriate stakeholders are involved with any requirements change decisions and that the baseline is not changed too often to avoid rubber baselines.

Monitoring actual performance (or projected performance during design) then taking the appropriate corrective actions when needed is critical in achieving and sustaining performance. During testing, monitoring allows early corrective actions before the system is deployed. During operations, it can help the PM determine if the metrics are driving the desired behaviors (or if different metrics are needed) to achieve the desired behavior or performance. Consequently, the PM should have a strong monitoring and assessment program structured to fit the unique program conditions. Representatives from each of the functional areas that drive the metrics should be involved in the process.

The Condition Based Maintenance Plus (CBM+) is a specific initiative which can be useful in cost effectively sustaining performance. It is the application and integration of appropriate processes, technologies, and knowledge-based capabilities to improve the reliability and maintenance effectiveness of DoD systems and components. At its core, CBM+ is maintenance performed based on evidence of need provided by Reliability Centered Maintenance (RCM) analysis and other enabling processes and technologies. CBM+ uses a systems engineering approach to collect data, enable analysis, and support the decision-making processes for system acquisition, sustainment, and operations. CBM+ policy is established in DoD Instruction 4151.22.

The program team can often be too close to the day-to-day decisions, so independent program reviews can be useful in helping ensure the system will be able to maintain or improve performance. The DoD components each have their own structures to do this, usually tied to formal program reviews, but the PM should consider bringing in their own independent reviewers to help in the process and gain lessons learned from other programs.

5.1.2. Life-Cycle Sustainment and the DoDI 5000.02 Acquisition Environment

5.1.2.1. Key Program Documents

5.1.2.2. Life-Cycle Sustainment Plan (LCSP)

5.1.2.3. Replaced System Sustainment Plan

5.1.2. Life-Cycle Sustainment and the DoDI 5000.02 Acquisition Environment

Acquisition programs are structured in phases separated by milestone decisions in accordance with the Life-Cycle Management System established in DoD Instruction 5000.02 . (An on-line, interactive version of the Integrated Defense Acquisition, Technology, and Logistics Life-Cycle Management System is also available.) In each phase, from defining user needs to disposal, there are important sustainment issues and actions to address. Figure 5.1.2.F1 provides an overview of key sustainment activities by phase. In addition, under the evolutionary acquisition strategy, each block should address support implications. In those cases a thorough assessment of the existing support strategy vis--vis any new sustainment requirements should be conducted to ensure the support implications for each block are understood, and changes are made as necessary, to ensure an affordable materiel readiness strategy.

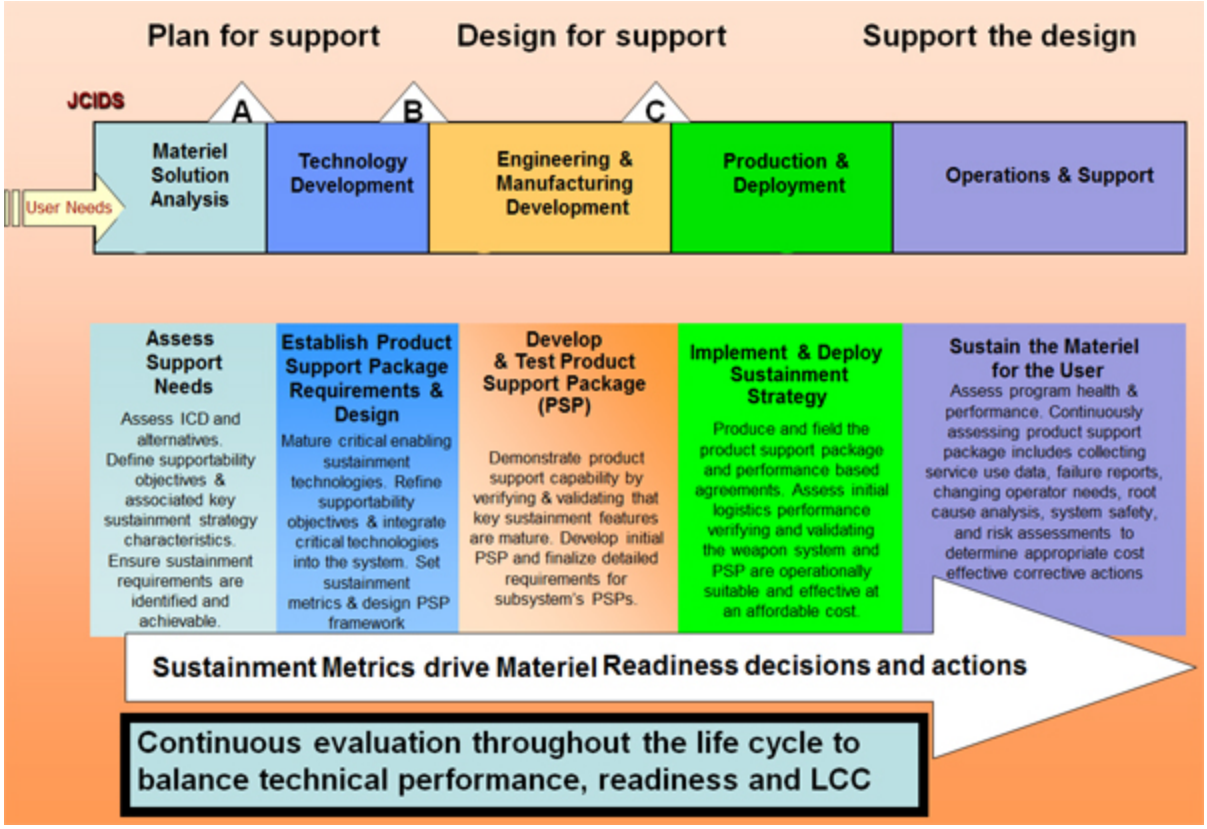
Statutory, Policy, and Guidance Factors. While the PM has latitude in developing the acquisition strategy, there are statutory requirements that must be taken into account. Congress has enacted a number of statutes capabilities to assure availability of a ready and controlled (i.e. government owned) source of technical competence and resources to ensure effective and timely response to a national defense contingency requirement (10 USC 2464) and ensure that there is a balance between the private and the public sector industrial base (10 USC 2466 and 10 USC 2474). The support strategy must ensure compliance with all statutory and regulatory requirements. These legislative and statutory requirements must be considered as an integral and evolving aspect of all Life-Cycle Management decisions. The PM must also follow Federal

Acquisition Regulation (FAR) and Defense Federal Acquisition Regulation Supplement (DFARS) guidance, as well as appropriate DoD Directives and Instructions. Instructions, including the DoDD 4151.18 (Maintenance of Military Materiel), DoDI 4151.19 (Serialized Item Management (SIM) for Materiel maintenance), DoDI 4151.22 (Condition Based Maintenance Plus (CBM+) for Materiel Maintenance), DoDI 8320.04 (Item Unique Identification (IUID) Standards for Tangible Personal Property) need to be addressed.

Support strategy. PMs must balance multiple objectives in designing the strategy to achieve operational effectiveness while maintaining affordability. PMs accomplish this by laying out and executing a support strategy so every part of the product support package is integrated and contributes to the users mission capability. To ensure there is a means to assess performance the PM and product support provider(s) should redefine and augment system sustainment metrics used to meet system capability requirements. (Support providers may be public, private, or a mix, to include public private partnerships. Examples of public support providers include DoD maintenance depots, DoD Component and Defense Logistics Agency (DLA) inventory control points and distribution depots.) The PM and the support provider(s) should enter into Performance-Based Agreements that define the sustainment metrics necessary to meet the system performance requirements.

A program manager's best means of ensuring a system will meet its sustainment objectives and satisfy user sustainment needs, is to ensure sustainment considerations are infused in all phases of the program's life cycle. It is especially important that sustainment considerations are included in Pre-Systems Acquisition and Acquisition activities, including the Joint Capabilities Integration and Development System (JCIDS) process, structured program reviews, and tracking sustainment performance drivers during Test and Evaluation. Even after the Initial Operational Capability (IOC) date, the support strategy should be periodically reviewed and revised when sustainment metrics are not being met or requirements change. These actions should be defined in the Life-Cycle Sustainment Plan (LCSP) and other appropriate program documents.

Figure 5.1.2.F1. Key Sustainment Activities by Phase



5.1.2.1. Key Program Documents

This section addresses the sustainment aspects that should be included in key program acquisition documents that cut across life-cycle phases. (Phase unique documents and focus areas are addressed in subsequent sections). To help ensure a shared understanding of the program's intent, it is important the documents used by the PM in the acquisition process and program reviews be updated during subsequent phases, especially prior to milestone decisions.

Initial Capabilities Document (ICD) / Capability Development Document (CDD) / Capability Production Document (CPD) . These documents are the sponsor's means to specify authoritative and testable, performance capabilities for the program. The ICD prefaces a system materiel decision and evolves into the CDD, which prioritizes KPP and subset KSA performance capability design and development parameters. The baseline CPD is finalized after the system level Critical Design Review and before Milestone C. In addition to supportability related KPP/KSAs, the ICD, CDD, and CPD should also address the following:

- System maintenance/support concepts and usage scenarios
- Operational and support environments. This should include the general support categories relative to the logistics support infrastructure (remote sites, organic depots, commercial facilities, air bases or ship yards, etc. without naming specific locations)
- Expected durations of support
- Support or maintenance effectiveness metrics and key enablers, such as diagnostics/

prognostics
- Conditions conducive to joint sustainment and to performance-based support strategies

Analysis of Alternatives (AoA) . The AoA should describe and include the results of the supportability analyses and trade-offs conducted to determine the optimum support concept as part of the preferred system concept. It should also include the assumptions used in the analyses.

Technology Development Strategy (TDS) . The TDS should also include the specific new sustainment related technologies required to achieve the Sustainment KPP/KSAs. Specific emphasis should be placed on technologies required to achieve logistics performance (including reliability) over what is currently achieved in today's operational environment.

Acquisition Program Baseline (APB) . The APB documents the performance requirements, schedules, and program cost funding and estimates. The program sponsor and program manager will ensure content includes Sustainment KPP/KSAs parameters, measurement metrics, and all programmatic direction affecting life-cycle support strategy planning and execution.

Acquisition Strategy . The Acquisition Strategy describes the PM's approach for acquiring the system and its support. The program manager must include the acquisition strategy for achieving the sustainment metrics and acquiring the product support package. The Acquisition Strategy should include the key upcoming contracting actions and the timeline to acquire the product support elements necessary to maintain the systems readiness and operational capability. Specifically, it should address how the product support package required to support the materiel management, distribution, technical data management, support equipment, maintenance, training, configuration management, engineering support, supply support, and failure reporting/analysis, functions will be acquired. It should also include a summary of the approach for acquiring key enablers for achieving the sustainment metrics (e.g., using diagnostics, prognostics, modular open systems approach, reliability growth).

Test and Evaluation Master Plan . Proper testing is critical to achieve the sustainment metrics thresholds and objectives. The program manager should therefore ensure the TEMP includes a description of the requirements and test points/methods for each of them as well as any appropriate enabler or logistics consideration.

Systems Engineering Plan . The systems engineering approach is an integral part in designing for sustainment and supporting the design. (See the Systems Engineering Plan (SEP) Outline) Accordingly, in developing and updating the SEP, the PM should integrate sustainment into the program's technical approach described by addressing how the:

- Sustainment metrics are to be integrated and managed with other requirements.
- Maintenance, sustainment and other support personnel aspects included in the Human Systems Integration (HSI) plan / process will be integrated with the Systems Engineering Process.
- Program will organize and staff it’s Integrated Product Teams (IPTs) to address sustainment.
- Process for ensuring sustainment is considered, including the development and update of

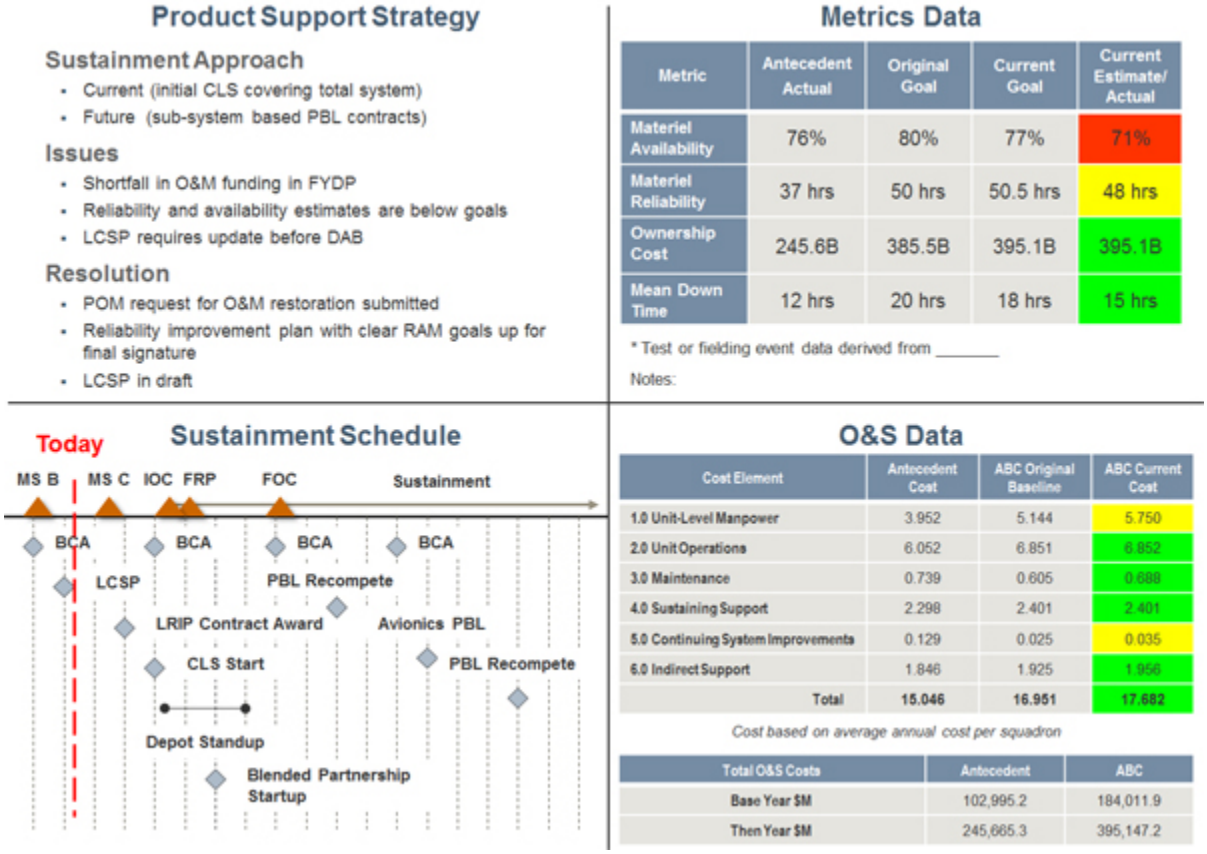
the Failure Mode, Effects & Criticality Analysis (FMECA) matrix; identification of critical safety items (CSIs); Failure Reporting, Analysis & Corrective Action System (FRACAS); and trend analysis for maturation purposes of the system and its support system.

- Technical baselines (functional, allocated, and product) will address the end item system and its product support package elements.
- Technical reviews will be used to define and assess sustainment and product support package technical maturity against the baselines. This is important because the reviews provide opportunities to ensure sustainment features are being designed into the system. They also provide the opportunity to assess the supportability design feature's maturity so the product support package can be adjusted as needed to achieve the sustainment metrics.

Diminishing Manufacturing Sources/Materiel Shortages (DMSMS) Plan. An efficient, proactive DMSMS management process is critical to providing more effective, affordable, and operational systems by proactively identifying and mitigating DMSMS issues that affect their availability and supportability. Actively addressing DMSMS concerns throughout the entire life of the program will help ensure effective life-cycle support and reduce adverse impacts on readiness or mission capability. The DOD DMSMS Guidebook (SD-22) provides a compilation of the best proactive practices for managing the risk of obsolescence. Establishment of the DMSMS program and proper planning during design will ensure successful implementation in sustainment and throughout the life cycle.

Sustainment Quad Chart. The Quad chart provides sustainment information in a standardized format (Figure 5.1.2.1.F1) that ACAT 1D PMs shall use in reporting status at Overarching Integrated Product Team (OIPT) and Defense Acquisition Board (DAB) reviews. It is used to strengthen sustainment governance by providing senior management visibility of key sustainment factors to help ensure the PMs sustainment strategy meets the Warfighter materiel readiness and long-term affordability objectives. Reporting begins at program initiation and continues through each subsequent milestone, the production decision, and at other reviews when directed. (Detailed instructions for how to fill out the chart can be found at Sustainment Quad Chart web site).

Figure 5.1.2.1.F1. Sustainment Chart



5.1.2.2. Life-Cycle Sustainment Plan (LCSP)

DoD Instruction 5000.02 requires that a LCSP be developed and provided as part of the program approval process to document how the sustainment strategy is being implemented. The LCSP documents the Program Managers plan for formulating, implementing and executing the sustainment strategy so that the systems design as well as the development of the product support package (including any support contracts) are integrated and contribute to the Warfighters mission requirements by achieving and maintaining the Sustainment KPP/KSAs. The LCSP is a living document describing the approach and resources necessary to develop and integrate sustainment requirements into the systems design, development, testing and evaluation, fielding and operations. The LCSP should be tailored to meet program needs documenting the current program plan in the following areas:

- The maintenance and support concepts
- How the sustainment metrics will be achieved and sustained throughout the life-cycle
- How sustainment is addressed as an integral part of the programs acquisition strategy and system design process
- The assigned responsibilities and management approach for achieving effective and timely acquisition, product support, and availability throughout the life-cycle including the Program Managers role in planning for and executing sustainment

- The funding required and budgeted by year and appropriation for the main sustainment cost categories including operating & support costs
- The plan for identifying and selecting sources of repair or support
- The sustainment risk areas and mitigation plans
- Product support implementation status
- Results and recommendations from DoD Component Independent Logistics Assessments (ILA)

Figure 5.1.2.2.F1 provides the outline that will be used to document the PMs plan for how the Product Support Manger will implement the sustainment strategy. Details for each section and additional information including mandated content can be found at the LCSP web site .

Figure 5.1.2.2.F1. LCSP Outline

1 Introduction

2 Product Support Performance

2.1 Sustainment Performance Requirements

2.2 Demonstrated (tested) Sustainment Performance

3 Product Support Strategy

3.1 Sustainment Strategy Considerations

3.2 Sustainment Relationships

4 Product Support Arrangements

4.1 Contracts

4.2 Performance Based Agreements (PBA)

5 Product Support Package Status

5.1 Program Review Results

5.2 Product Support Package Assessment

6 Regulatory/Statutory Requirements That Influence Sustainment Performance

7 Integrated Schedule

8 Funding

9 Management

9.1 Organization

9.1.1 Government Program Office Organization

9.1.2 Program Office Product Support Staffing Levels

9.1.3 Contractor(s) Program Office Organization

9.1.4 Product Support Team Organization

9.2 Management Approach

9.2.1 Product Support Manager Roles and Responsibilities

9.2.2 Sustainment Risk Management

10 Supportability Analysis

10.1 Design Interface

10.1.1 Design Analysis

10.1.2 Technical Reviews

10.2 Product Support Element Determination

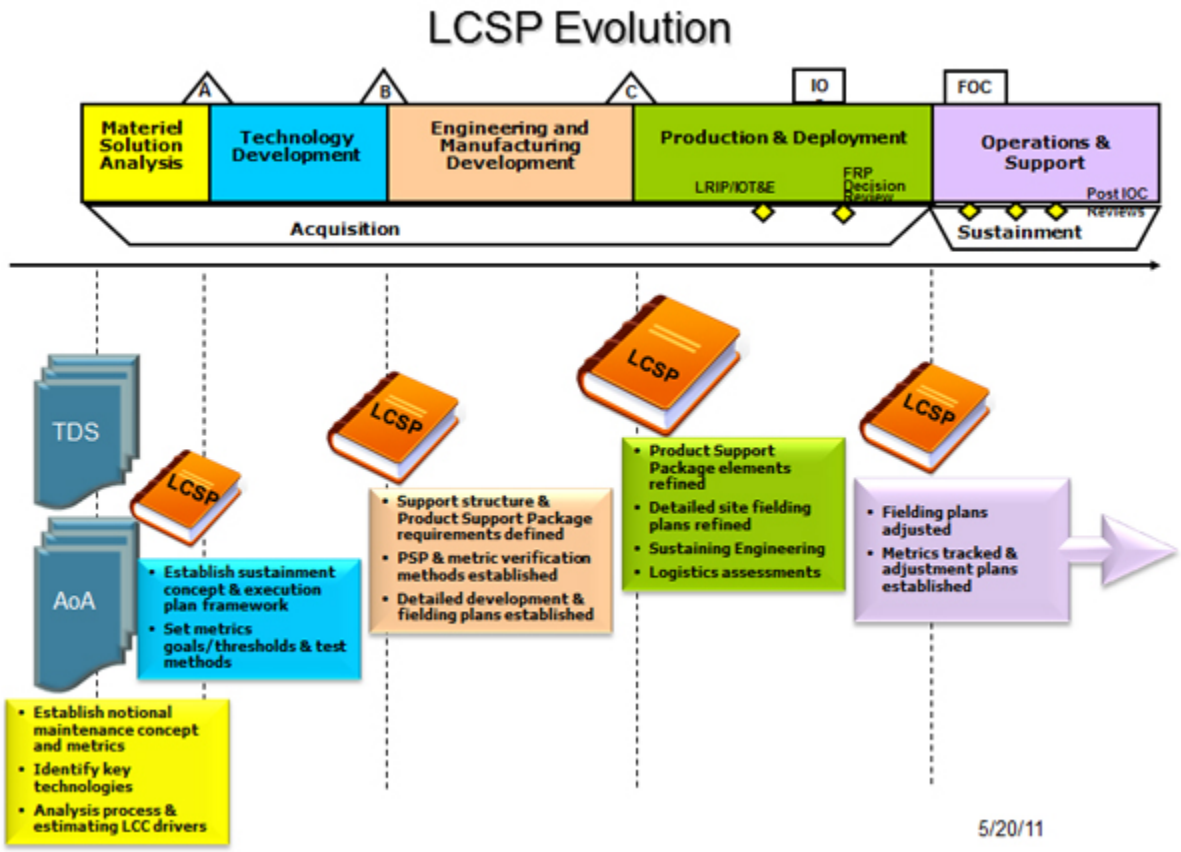
10.3 Sustaining Engineering

11 Additional Sustainment Planning Factors

LCSP Annexes

LCSP Evolution. Life-cycle sustainment planning and execution seamlessly span a systems entire life-cycle evolving over time (see Figure 5.1.2.2.F2). The LCSP begins in the Materiel Solution Analysis Phase by describing the notional product support and maintenance concepts used to determine the sustainment requirements optimizing readiness outcomes and minimal life cycle-cost. The LCSP evolves from a strategic outline to a management plan describing the sustainment efforts in the system design and acquisition processes to achieve the required performance and sustainment outcomes necessary to ensure required Warfighter capabilities. It evolves at Milestone B into a detailed execution plan for how the product support package is to be designed, acquired, sustained, and how sustainment will be applied, measured, managed, assessed, modified, and reported from system fielding through disposal.

Figure 5.1.2.2.F2. LCSP Evolution



By Milestone C, the LCSP describes the implementation status of the product support package (including any sustainment related contracts, e.g. Interim Contractor Support, Contractor Logistics Support) to achieve the Sustainment KPP/KSAs. In addition to sustaining the system performance capability threshold criteria and meeting any evolving user readiness needs, the LCSP details how the program will manage O&S costs and reduce the logistics footprint. After the Full Rate Production Decision Review update, the LCSP describes the plans for sustaining affordable materiel availability as well as accommodating modifications, upgrades, and re-procurement. It should be updated for any Post-IOC Sustainment Reviews and shall be updated, at a minimum every 5 years, or when:

- Subsequent increments are approved and funded to reflect how the support strategy will evolve to support multiple configurations.
- Significant changes are required to the product support package to achieve the objective sustainment metrics including major support provider changes.

As the program matures, the LCSP is updated to reflect increasing levels of detail as they become available. The detail and focus will vary depending on the life-cycle phase but in all cases the information should be in sufficient depth to ensure the acquisition, design, sustainment, and user communities have an early common understanding of the sustainment requirements, approach, and associated risks. Section 5.4 expands on the primary focus areas for each life-

cycle phase.

LCSP Development. The Program Manager is responsible for the content and preparation of the Life-cycle Sustainment Plan. The Product Support Manager is the PMs focal point for developing this document to function as the programs tool in managing all sustainment efforts. (**Note:** If this objective is achieved, then the same LCSP should effectively serve the needs of decision reviews.)

The Product Support Manager must capitalize on the product support expertise of the programs Sustainment Integrated Product Team (IPT) to produce a plan that can be useful, and credible to all stakeholders charged with executing the plan. Specifically in developing and executing the LCSP, the PM should work with the user, the Product Support Manager, Product Support Integrator(s), and Product Support Providers to document performance and sustainment requirements specifying objective outcomes, resource commitments, and stakeholder responsibilities. Once developed, to help ensure an integrated team approach, the LCSP should be approved by the Program Manager, Product Support Manager, Contracting Officer, lead financial analyst and lead engineer. Last but not least, the best way to ensure that the secondary purpose of supporting decision reviews is satisfied is to include a representative (Action Officer) from the appropriate Milestone Decision Authority as a member of the Sustainment IPT.

An effective LCSP services as the nexus of critical thinking for not only logisticians and sustainment stakeholders, but among all functional disciplines required to comprehensively deliver effective and affordable product support. The PSM Guidebook (section 4) addresses the process that should be used to generate the Product Support Strategy and the associated plan to implement the strategy. In addition, each section of the LCSP may require the integration of multiple sections of this chapter, and indeed multiple sections of the broader Defense Acquisition Guidebook. The following table provides a mapping of the individual LCSP sections to key relevant sections of this guidebook that the PSM will find useful for both context and direct guidance in formulating planning content.

Table 5.1.2.2.T1.

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2.2 Demonstrated (tested) Sustainment Performance	5.3, 5.4 2.0, 2.2, 2.3, 9.1, 9.4, 9.7

3 Product Support Strategy	5.1, PSM Guidebook (section 1) 2.2, 4.3.18, 6.3, 9.9, 11.7
3.1 Sustainment Strategy Considerations	5.1, 5.2, 5.3, 5.4 4.3.18, 11.2
3.2 Sustainment Relationships	5.2, 5.4 4.1.4, 6.2, 6.3, 9.2
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5.1.2.3. Replaced System Sustainment Plan

Once a decision has been made that a system will replace another and it is required, the Service Secretary sponsoring the new Major Defense Acquisition Program (MDAP) (or the Commander of the United States Special Operations Command) shall prepare a Replaced System Sustainment Plan for the existing system. (10 USC 2437) It will include at a minimum the following which will require close coordination between any effected programs:

- The budget estimates required to sustain the existing system until the new system

assumes the majority of mission responsibility. Consequently, it is critical that once a program is operational, it's LCSP contain the current and required funding levels through the FYDP so that the additional funding through disposal can be easily added.

- The milestone schedule for developing and fielding the new system, including the scheduled dates for low-rate initial production, initial operational capability, full-rate production, full operational capability and the date of when the new system is scheduled to assume the majority of the mission responsibilities of the existing system.
- An analysis of the ability of the existing system to maintain mission capability against relevant threats including:
    - Anticipated funding levels necessary to ensure acceptable reliability and availability rates and maintain mission capability against the relevant threats.
    - The extent to which it is necessary and appropriate to transfer mature technologies from the new system or other systems to enhance the mission capability against relevant threats and provide interoperability with the new system during the period from initial fielding until the new system assumes the majority of responsibility for the existing system mission.

5.1.3. Life-Cycle Sustainment in the Integrated Product & Process Development (IPPD) Framework

5.1.3.1. The Program Manager's Role in Life-Cycle Sustainment

5.1.3.2. Product Support Manager (PSM)

5.1.3.3. Integrated Product Teams (IPTs)

5.1.3.4. Stakeholders

5.1.3. Life-Cycle Sustainment in the Integrated Product & Process Development (IPPD) Framework

The IPPD is a management technique using multidisciplinary teams (Integrated Product Teams (IPTs)) to optimize design, manufacturing, maintenance, and logistics processes. The IPPD facilitates meeting cost, statutory, and performance objectives across the life cycle. It is a broad, interdisciplinary approach that includes not only the logisticians, engineers, technical specialists, contract specialists, and customer's in the IPTs, but also business and financial analysts as well. (See also Guidebook sections 10.3 , 11.8 , and the IPPD Handbook .)

5.1.3.1. The Program Manager's Role in Life-Cycle Sustainment

Per DoD Directive 5000.01 , the Program Manager (PM) is accountable for accomplishing program objectives over the life cycle, including during sustainment. Consequently the PM is responsible for the implementation, management, and/or oversight of activities associated with the systems development, production, fielding, sustainment and disposal. Life-cycle management emphasizes early and continuing emphasis on translating performance objectives into an

operationally available and affordable capability over the program life cycle including:

- Developing and implementing a life-cycle sustainment strategy acquiring an integrated product support package based on achieving key sustainment performance metrics (e.g., materiel availability, materiel reliability, mean down time, ownership costs, footprint, etc.).
- Providing continuous, reliable, affordable support in accordance with performance agreements with force providers.
- Ensuring the system is supported at optimum levels in accordance with performance agreements among government and industry support providers throughout the life cycle.
- Maintaining visibility into cost/capability/risk decisions across the life cycle.

The PM's responsibility is to provide the user with a sustainable system and product support that meets specified performance effectiveness and affordability requirements. PM's should continually measure, assess, and report program execution in terms of performance, schedule, sustainment, and cost outcomes. In addressing affordability, PMs should continuously perform Should-Cost analysis that scrutinizes every element of government and contractor costs. This includes driving productivity improvements into the program during contract negotiations and throughout program execution including sustainment as directed by the implementation of Will-Cost and Should-Cost Management. These efforts are critical both for establishing budgetary requirements and for tracking execution success over time for both new and legacy programs. In accomplishing this, the PM should examine and implement appropriate, innovative, alternative logistics support practices, including the best public sector and commercial practices and technology solutions. PMs should determine specific discrete and measurable items or initiatives that can achieve savings against the Will-Cost estimate. These actionable items will be presented via the Should-Cost estimate and will be tracked and managed as part of Should-Cost estimate progress reporting. (See Chapter 2.8.8.3 for additional information) The choice of logistics support practices is based on the PM's documented assessment that they can satisfy users in a manner meeting statutory requirements that are fully interoperable within DoD's operational, logistics systems and enterprise; will improve schedules, performance, or support; or will reduce LCC. Regardless of the chosen support strategy, PMs should collaborate with other key stakeholders, especially the user, to refine and establish logistics support program goals for cost, customer support, and performance parameters over the program life cycle. The resultant decisions and planned actions are critical components in the Acquisition Strategy and the Acquisition Program Baseline.

During acquisition, the PM's focus is to base major decisions on system-wide analyses with the full understanding of the life-cycle consequences of those decisions on system performance and affordability. The emphasis should be on reducing system downtimes and reducing Life-Cycle Costs through deliberate use of systems engineering analysis to design out the maintenance burden, reduce the supply chain, minimize mission impacts and reduce the logistics footprint.

An important performance-based life-cycle product support aspect is the concept of a negotiated agreement between the major stakeholders (e.g., the PM, the force provider(s)/users, and the support provider(s)) that formally documents the performance and support expectations and commensurate resources to achieve the desired outcomes. Per DoD Instruction 5000.02,

Enclosure 2, paragraph 8.c.(1)(d) , "The PM shall work with the user to document performance and sustainment requirements in performance agreements specifying objective outcomes, measures, resource commitments, and stakeholder responsibilities." The term "performance agreements," as cited in DoD 5000-series policy, is an overarching term suitable for policy guidance. In actual implementation, the more specific term "performance-based agreements" is used to ensure clarity and consistency.

Demilitarization and Disposal: From the very beginning of a program, it is important that program managers consider and plan for the ultimate system demilitarization and disposal once it is no longer militarily useful. The PM should minimize DoD's liability due to information and technology security, and Environment, Safety, and Occupational Health issues. During the systems engineering process as the design requirements are established, the PM should carefully consider the life-cycle impact of any hazardous material component requirements to minimize the impact on the end item regarding item storage, packaging, handling, transportation, and disposition. (See section 4.3.18.7.)

5.1.3.2. Product Support Manager (PSM)

The day-to-day oversight and management of the product support functions are delegated to a product support manager who is responsible for managing the package of support functions required to field and maintain the readiness and operational capability of major weapon systems, subsystems, and components. This includes all functions related to weapon system readiness including:

- Providing weapon systems product support subject matter expertise . The PSM shall provide weapon systems product support subject matter expertise to the PM for the execution of his or her duties as the total life cycle system manager, in accordance with DoDD 5000.01. In support of this PM responsibility, the PSM shall have a direct reporting relationship and be accountable to the PM for product support consistent with Public Law 111-84 National Defense Authorization Act for Fiscal Year 2010.
- Developing and implementing a comprehensive product support strategy . The product support strategy is designed to assure achievement of warfighter capability-driven life cycle product support outcomes documented in performance-based agreements, generally expressed in the preferred terms of weapon system materiel availability, reliability, and operations and support cost affordability. The strategy should identify the execution plan to deliver integrated product support (IPS) elements to the warfighter, producing the best value balance of materiel readiness and life-cycle costs.
- Promoting opportunities to maximize competition while meeting the objective of best-value long-term outcomes to the warfighter . Tradeoffs between the benefits of long-term relationships and the opportunity for cost reductions through competitive processes should be considered together with associated risk.
- Seeking to leverage enterprise opportunities across programs and DoD Components . Joint strategies are a top priority where more than one DoD Component is the user of the respective major weapon system or variant of the system. Likewise, product support strategies should address a programs product support interrelationship with other programs in their respective portfolio and joint infrastructure, similar to what is

performed for operational interdependencies.

- Using appropriate analytical tools to determine the preferred product support strategy . Analytical tools can take many forms (analysis of alternatives, supportability analysis, sustainment business case analysis, life cycle impact analysis), dependent upon the stage of the programs life cycle. These analytical tools shall incorporate the use of cost analyses, such as cost-benefit analyses as outlined in Office of Management and Budget Circular A-94, Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs, as well as other appropriate DoD and Service guidance consistent with Public Law 111-84. These tools are used to help identify the best possible use of available DoD and industry resources at the system, subsystem, and component levels by analyzing all alternatives available to achieve the desired performance outcomes. Additionally, resources required to implement the preferred alternative should be assessed with associated risks. Sensitivity analyses should also be conducted against each of the IPS elements and tracked to determine those IPS elements where marginal changes could alter the preferred strategy.
- Developing appropriate product support arrangements for implementation . Development and implementation of product support arrangements should be a major consideration during strategy development to assure achievement of the desired performance outcomes. These arrangements should take the form of performance-based agreements, memorandums of agreements, memorandums of understanding, and partnering agreements or contractual agreements with product support integrators (PSIs) and product support providers (PSPs), depending on the best-value service integrators or providers.
- Periodically assessing and adjusting resource allocations and performance requirements to meet warfighter needs during strategy implementation . Planning, programming, budgeting, and execution of the product support strategy need to be accomplished and aligned to the warfighters performance-based agreements with the PM and PSM. PSMs, working in concert with the PM, users, resource sponsors, and force providers, should adjust performance levels and resources across PSIs and PSPs as necessary, but not less than annually, to optimize implementation of the strategy based on current warfighter requirements and resource availability.
- Documenting the product support strategy in the LCSP . The LCSP describes the plan for the integration of sustainment activities into the acquisition strategy and operational employment of the support system. The PSM prepares the LCSP to document the plan for formulating, integrating, and executing the product support strategy (including any support contracts) to meet the warfighters mission requirements. In accordance with Public Law 111-84 and DoDI 5000.02, the LCSP shall be updated to reflect the evolving maturity of the product support strategy at each milestone, full rate production (FRP), and prior to each change in the product support strategy or every 5 years, whichever occurs first. The LCSP is approved by the milestone decision authority at each milestone and FRP decision. Updates to the LCSP for all major weapons systems after the FRP decision shall be approved by the CAE, in coordination with the Deputy Assistant Secretary of Defense for Materiel Readiness.
- Conducting periodic product support strategy reviews . The product support strategy evolves with the maturation of the weapon system through its various life cycle phases. At FRP, the LCSP should describe how the system is performing relative to the performance metrics and any required corrective actions to ensure the metrics are

achieved. Reviews and revalidations of the strategy should be performed at a minimum of every 5 years or prior to each change in the strategy to ensure alignment across system, subsystem, and component levels in support of the defined best-value outcomes. In those situations where a support strategy is at the weapon systems level, the PSMs reassessment should explore potential opportunities for evolving toward a portfolio approach. In those situations where an LCSP is based on a collection of outcome-based product support strategies at the subsystem or component level, the periodic review should explicitly address integrated performance at the weapon systems level. In all situations, the reassessment should consider opportunities to make better use of industry and DoD resources. (See the Logistics Assessment Guidebook for additional information.)

Specific guidance in accomplishing these functions can be found in the Product Support Manager Guidebook . In developing and implementing the performance-based product support strategy the PSM can delegate responsibility for delivering specific outcomes. In doing so, while remaining accountable for system performance, the PM and PSM may employ any number of sub system PSMs or product support integrator(s) to integrate support from all support sources to achieve the performance outcomes specified in a performance-based agreement. They can be further supported by product support providers (PSPs) who provide specific product support functions.

In accomplishing the outcomes, PSIs should have considerable flexibility and latitude in how the necessary support is provided. The activities coordinated can include functions provided by organic organizations, private sector providers, or partnerships. The following, or any combination of partnerships between them, are candidates for the role:

- A DoD Component organization or command.
- The systems original equipment manufacturer or prime contractor.
- A third party private sector logistics integrator.

While product support execution is accomplished by numerous organizational entities, the PSI is accountable for integrating all sources of support necessary to meet the agreed to support performance metrics as specified in product support arrangements. To effectively coordinate the work and business relationships necessary to satisfy the user agreement the product support integrator should be knowledgeable about the system, involved early in the program life, and incentivized to continuously improve reliability, maintainability, and sustainment technology.

Regardless of the approach taken, the government is ultimately accountable for delivering performance and warfighting capability to the user. Consequently the PSM is responsible for accomplishing the overall integration of product support either directly through government activities or via a contract when commercial organizations are involved. If any part of the product support strategy is contracted, a description of how it will be acquired should be documented in the Acquisition Strategy and LCSP.

5.1.3.3. Integrated Product Teams (IPTs)

The PM should establish multidisciplinary teams to develop and manage the implementation of the performance-based support strategy. The IPTs should consider all factors and criteria necessary to achieve an optimum support strategy using the best capabilities of the public and private sectors in a cost effective manner. DoD Component and DLA logistics activities should participate in support strategy development and IPTs to ensure the support concept is integrated with other logistics support and combat support functions and provide agile and robust combat capability. These participants can help to ensure effective integration of system oriented approaches with commodity oriented approaches (common support approaches), optimize support to users, and maximize total logistics system value.

The teams should be structured to provide a system orientation focused on the performance outcome instead of focusing on the individual logistics support elements or technical disciplines. The teams can consist of government and private sector functional experts; however, it is important they are able to work across organizational and functional boundaries. Consequently, representatives from DoD Component headquarters, operational commands, engineering, procurement, test, comptroller, information technology and logistics representatives from supply, maintenance, and transportation organizations should be considered for inclusion on the IPTs.

5.1.3.4. Stakeholders

Stakeholders consist of any group or organization with a related or subsequent responsibility that is directly related to the outcome of an action or result. Generally speaking they can influence the outcome or are the recipient of the results. The range of personnel selected to participate as stakeholders is based on the outcome and processes involved. Typical stakeholders are: users or operators, acquisition commands, test communities, depots, manpower, personnel & training communities, maintainers, and suppliers (e.g., DLA, the Inventory Control Point (ICP), US Transportation Command (TRANSCOM), industry, and other organizations associated with the sustainment chain).

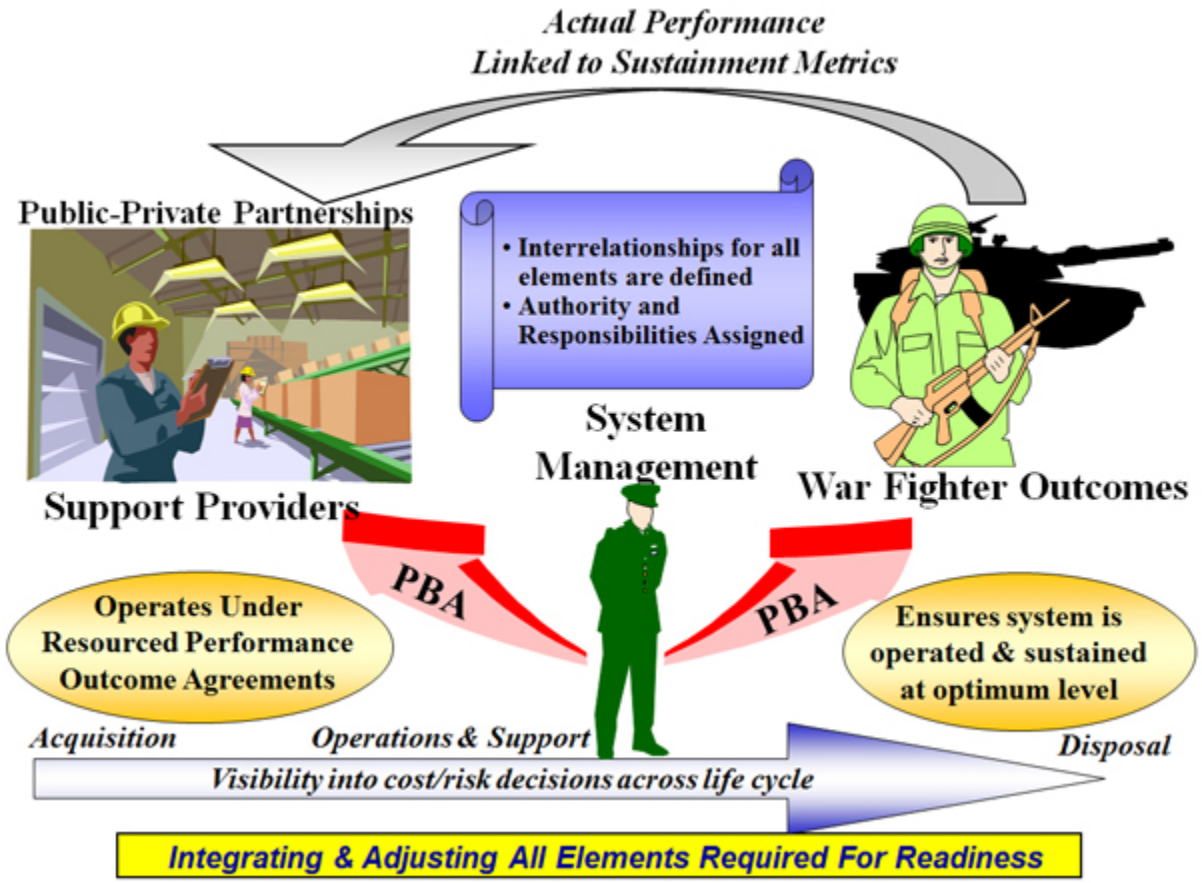
5.1.4. Performance-Based Agreements (PBAs)

5.1.4. Performance-Based Agreements (PBAs)

PBAs formally document the agreed to level of support and associated funding, required to meet performance requirements. The PBA with the user states the objectives that form the basis of the performance-based product support effort. They establish the negotiated baseline of performance and corresponding support necessary to achieve that performance, whether provided by commercial or organic support providers. The PM negotiates the required level of support to achieve the users desired performance at a cost consistent with available funding. Once the performance and cost are accepted by the stakeholders, the PM enters into PBAs with the user community which specify the level of support and performance. Likewise, PMs enter into performance-based agreements with organic sources and/or contracts with commercial sources which focus on supporting the users in terms of cost, schedule, and performance. Consequently, PBAs can describe agreements between 1) user and PM, 2) PM and support integrator(s), or 3)

support integrator and support provider(s). The agreements should maintain flexibility to facilitate execution year funding and/or priority revisions and spell out the 1) objective outcomes, 2) performance measures, 3) resource commitments, and 4) stakeholder responsibilities. (See figure 5.1.4.F1.)

Figure 5.1.4.F1. Performance-Based Agreements



Sustainment metrics should provide the objectives that form the basis of the PBAs. The PBA performance metrics should reflect the highest level of metrics that are most critical in producing the desired performance outcome(s). Generally, a focus on a few properly incentivized performance-based outcome metrics such as materiel availability, materiel reliability, etc. will lead to more effective solutions. However, in developing the agreements, it may not be possible to directly state these high level performance objectives as metrics due to lack of support provider control of the support activities necessary to produce the user performance (e.g., availability). This is because some DoD Component logistics policies and/or guidance mandate a preference for DoD Component performed maintenance and retail supply functions that cut across multiple organizations. Accordingly, the PM may select the next echelon of metrics for which the support provider can be held accountable and which most directly contribute to the sustainment metrics.

The outcome metric to achieve the user requirements (e.g., materiel availability) should be a

balance between a quality metric (e.g., materiel reliability), a response metric (e.g., turnaround time), and a cost metric that are appropriate for the outcome needed. Many existing logistics and financial metrics can be related to top level user performance outcomes. These include, but are not limited to, logistics footprint, not mission capable supply (NMCS), ratio of supply chain costs to sales, maintenance repair turnaround time, depot cycle time, and negotiated time definite delivery. In structuring the metrics and evaluating performance, it is important to clearly delineate any factors that could affect performance, but are outside the control of the support providers.

While objective metrics form the bulk of the evaluation of a provider's performance, some elements of product support might be more appropriately evaluated subjectively by the user and the PM team. This approach allows some flexibility for adjusting to potential support contingencies. For example, there may be different customer priorities to be balanced with overall objective measures of performance.

Agreements with Organic Providers: Organic providers, like commercial providers, will have a set of performance metrics that will be monitored, assessed, incentivized, and focused on the system. For support provided by organic organizations a performance-based agreement, similar in structure to a memorandum of agreement, memorandum of understanding, or service level agreement, may be used to represent and document the terms of the agreement for organic support. One important distinction, however, between PBAs and other types of agreements and understandings is that PBAs contain the agreed to performance and/or sustainment metrics meeting the user requirements tied to funding.

5.1.5. Contracting for Sustainment

5.1.5.1. Contract Characteristics

5.1.5.2. Methodology for Implementing Sustainment Contracts

5.1.5. Contracting for Sustainment

For support provided by commercial organizations, the contract is the PBA reflecting the agreed to user performance requirements. Note that the source of support decisions do not favor either organic or commercial providers. Non-core source of support decisions should optimize the best public and private sector competencies based on a best value determination of the provider's capability to meet set performance objectives. The major shift in the performance-based environment from the traditional approach is how programs acquire support, not from whom it is obtained. The Sustainment Strategy normally results in a blend of commercial and organic product support providers built on the strengths of each to achieve an affordable strategy.

Implementing a performance-based acquisition and sustainment strategy begins with Supportability Analysis to establish the right performance metrics and organic/commercial blend. This upfront analysis is required because instead of buying set levels or varying quantities of spares, repairs, tools, and data, the focus is on designing in sustainment features and buying a predetermined level of readiness to meet the users objectives. (See section 11.6 , Implementing a

Performance-Based Business Environment.) Executing the Performance-Based Product Support Strategy also relies on the optimum blend between the organic/commercial providers. For example, when executing commercial product support strategies, the use of on-hand and due-in government inventory should be standard practice of all Performance-Based Logistics and partnering agreements.

5.1.5.1. Contract Characteristics

The preferred contracting approach is the use of long term firm fixed price contracts with incentives tied to outcome performance to fulfill the product support and integrated sustainment chain management responsibilities. Consequently, the contract should provide support over a specific period of time for a predetermined fixed cost per operating measure. Sustainment contracts should require the delivery of a capability to the user using a Statements of Objectives or a Performance Work Statement approach. (Level of effort or labor hour type contracts are not preferred because they limit the contractor's ability to make necessary trade-offs to meet and/or exceed the threshold performance outcomes within the funding profile.)

A sustainment contract may take many forms and the degree to which the outcome is defined varies. It should purchase support as an integrated performance package designed to optimize system readiness. It must specify performance requirements; clearly delineate roles and responsibilities on both sides; specify metrics and their definitions; include appropriate incentives, maximize the use of government-owned inventory before procuring the same parts from private contractors; specify how performance will be assessed. The contract should cover the procurement of a capability to support the user versus the individual parts or repair actions and provide the ability to manage support providers.

Award term contracts should be used where possible to incentivize industry to provide optimal support. Incentives should be tied to metrics tailored to reflect the DoD Component's specific definitions and reporting processes. Award and incentive contracts should include tailored cost reporting to enable appropriate contract management and to facilitate future cost estimating and price analysis. Sustainment contracts should strive to specify a fixed cost per outcome (e.g., operating hour (e.g., hour, mile, cycle) or event (e.g., launch)) vice a cost plus contract. However, lack of data on systems performance or maintenance costs or other pricing risk factors may necessitate cost type contracts until sufficient data is collected to understand the risks. Full access to DoD demand data should be incorporated into any contracts. The contracts should be competitively sourced wherever possible and should make maximum use of small and disadvantaged businesses.

Contracts must follow Federal Acquisition Regulation (FAR) and Defense Federal Acquisition Regulation Supplement (DFARS) guidance, as appropriate, for the acquisition of logistics services and support throughout the program life cycle. In addition, competition over the entire life cycle can be a valuable tool for achieving affordable sustainment. Consequently, early in the program, the PM should consider the cost versus benefit of the data and other support elements required to achieve competitive versus sole source contracting for sustainment functions (e.g. parts, repairs and other supply chain processes).

5.1.5.2. Methodology for Implementing Sustainment Contracts

The contracting methodology is a multiple step process that can be applied to new, modified, or legacy systems at the system, subsystem, or major assembly level covering a range of functions depending on program unique circumstances. Additional guidance is contained at https://acc.dau.mil/pbl but the steps can be summarized in the following general areas:

Define the Requirements: The initial step is to relate or determine the performance outcome metric meeting the user's needs rather than to rely on discrete transactional logistics functions. Care should be given to ensure the costs and performance metrics selected focus measurable contractor behavior in terms of the metrics selected. Defining and documenting the requirement involves answering three key questions: Who are the key stakeholders? What are the operations and sustainment environment and infrastructure? What are the total system cost and performance objectives? To develop an effective contracting strategy, the PM needs to identify the risks and benefits to achieve the desired outcome. Evolving system sustainment requirements should be constantly equated to long term financial resources.

In determining the extent to which contracts will be used, the PM should determine the best mix of public and private sector capabilities to meet evolving user requirements, joint sustainment opportunities, and the statutory requirements. (DoD Directive 5000.01, E1.1.17) This involves identifying the best mix in terms of: capability, skills, infrastructure, opportunities for partnering, compliance with Title 10, public/private flexibility, and affordability for each support function. As operating scenarios and technologies change, supportability related performance requirements may change. Thus, refining and resources for system requirements is a continual management process.

Sustainment contracts should produce measurable performance outcomes that cumulatively contribute to the sustainment of system KPP/KSAs, to their threshold or objective levels. To motivate the contractor to achieve the desired behavior, appropriate contract incentives (including award fee, incentive fee, award term, and cost sharing) need to be developed to promote and facilitate contractor performance.

Develop and Award the Contract: From a sustainment perspective, contracts should be structured to balance three major objectives throughout the life cycle of the system: 1) delivering sustained materiel readiness; 2) minimizing the requirement for logistics support through technology insertion and refreshment; and 3) continually improving the cost-effectiveness of logistics products and services. Careful balancing of investments in logistics and technology to leverage technological advances through the insertion of mature technology is critical. In addition, the PM should ensure the contract addresses user requirements during peacetime, contingency operations, and war and provides for the capability for the government to compete or take over the sustainment responsibility in the future.

Contract development is a lengthy, complex process, led by the PM, involving multiple stakeholders. No two contracts are exactly the same each must be tailored to the unique requirements of the system considering, at minimum, the factors and criteria listed below:

- **Statutory requirements:** Title 10 U.S.C. 2460 , 2464 , 2466 , 2469 , and 2474 (Core, 50/50, public/private partnering, etc.). Depot maintenance partnerships can be effective tools to implement performance-based product support arrangements if properly structured. The contracts should allow partnering with public depot maintenance activities to satisfy the requirements. (Examples and further discussion of public private partnerships can be found on the Acquisition Community Connection web site.)
- **Regulatory requirements:** DoD (e.g., DFARS) and DoD Component policy (including contractors on the battlefield, service performance of organizational level support functions, etc.).
- **Financial Enablers:** Ensuring the financial enablers are commensurate with the risks.

Implement and Assess Performance: The life-cycle management concept includes assessing actual system performance, readiness, and LCC and then revising the sustainment strategy and contracts as necessary. During contract execution, the program manager also acts as the users agent to certify performance and approve incentive payments. Since no contract/agreement is self-regulated, the PM must accurately capture, analyze, and report sustainment related performance and cost data. PMs should periodically validate the contract business case with actual cost and performance data to ascertain if projected returns on investments are being attained and whether the basic support strategy still save the government money and should be continued.

5.1.6. Technical Data, Computer Software, and Intellectual Property Rights

5.1.6. Technical Data, Computer Software, and Intellectual Property Rights

Technical data is critical in executing a PMs life-cycle management responsibilities. Affordable product support and the ability to maximize competition require that the PSM be involved in the development and execution of the programs approach to intellectual property rights identified with the Technical Data Rights Strategy (See Chapter 2, Paragraph 2.8.7.6.) As discussed in Chapter 2, a programs Acquisition Strategy must be forward thinking with respect to intellectual property. Unless data rights considerations are considered up-front when developing an acquisition strategy, critical data and software may not be specified for delivery, rendering it unavailable (or unaffordable) years later for use on a program during its sustainment phase. For these reasons sustainment strategies need to be considered early on in a programs life cycle.

The PSM needs to pay particular attention to the following areas of the Technical Data Rights Strategy as well as it's execution to ensure that all data and software required to successfully sustain the system is available throughout the systems life cycle:

- Data deliverables included in the RFPs and subsequent contracts
- Data rights, including the responses to the contractors data assertion lists
- The data management approach including how the data will be delivered, accessed, maintained, and protected

5.1.7. Configuration Management

5.1.7. Configuration Management

Program Managers establish and maintain a configuration control program, and are required to "base configuration management decisions on factors that best support implementing performance-based strategies throughout the product life cycle" (DoD Directive 5000.01). An effective configuration management program should include configuration control over the functional and allocated baselines as well as the physical baseline. The approach and responsibility for maintaining configuration control will depend on a number of program specific factors such as design rights, design responsibility, support concept, and associated costs and risk. Nominally the government maintains configuration control of the system design specification and retains the authority/responsibility for approving design changes impacting the system's ability to meet specification requirements. The contractor(s) has the right to access configuration data at any level required to implement planned or potential design changes and support options.

Section 4.3.7 provides additional configuration management (CM) information including useful references. In addition, the ANSI/EIA-649 National Consensus Standard for CM and corresponding handbook are key joint government/industry developed documents intended to give guidance on the development and execution of a Configuration Management Plan. These configuration management discussions generally apply to legacy programs with traditional CM programs; however, the use of performance-based product support contracts and public private partnerships necessitate DoD logisticians understand, apply and address the CM impacts as they implement the sustainment strategy. This is because if the configuration of the system is not monitored closely, design control could be lost, resulting in procuring a useless product support package. This would make it difficult to provision or ensure the proper support equipment, spares, and data are available to complete repairs, thereby adversely affecting materiel availability and increasing program costs.

The logistician's involvement in the configuration management process is vital throughout the systems life cycle. The logistics process enters into the configuration management world through support and maintenance planning, since the maintenance plan drives the level of government configuration control and support element requirements. During the maintenance planning process, factors such as reliability and volatility of the design technology are used to determine how the system/component will be supported, e.g., throwaway or repair, and commercial or organic repair.

In commercial support strategies, it is not uncommon to delegate broad Class II (no change in form, fit, function, or testability of an item) configuration management to the product support provider. Since the provider is tasked to deliver performance outcomes with broad flexibility regarding how to provide those outcomes, it is consistent to also provide him flexibility to implement configuration changes (with government knowledge) stemming from his investments to improve reliability, availability, and repair processes that benefit both the government in terms of improved readiness and the commercial provider in terms of profit opportunities by reducing

cost over the contract term.

Also, in PBL contracts, provisions should be made to protect the government in the event the contractor is unable to provide the contracted performance and at contract conclusion. Technical Data and Computer Software are important components of the configuration management process so it is vital the PM understand the level of access to Technical Data Packages (TDPs) and the appropriate levels of computer software (to include source code when necessary) required to successfully procure, compete, and sustain the system over its entire life cycle. This level will vary from system to system and often down to the component or part level. Specific clauses must be included in the contract to ensure the government retains access to or takes control of the necessary TDP(s) and software and their corresponding updates. This ensures the government will have the data necessary to duplicate the existing configuration with little to no interruption in the support provided to the user if the support provider changes or the contract is re-competed. Without this exit ramp, the government will not be able to cost effectively re-compete a system and/or component.

5.2. Applying Systems Engineering to Life-Cycle Sustainment

5.2. Applying Systems Engineering to Life-Cycle Sustainment

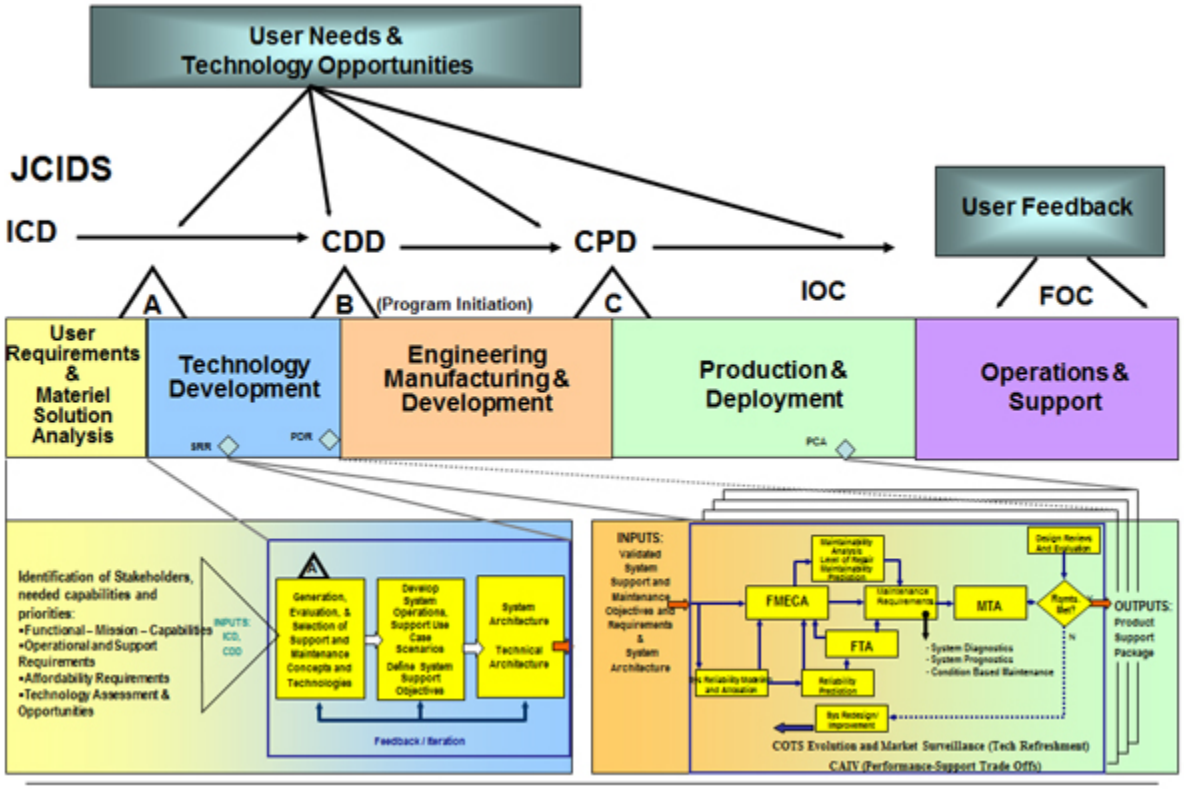
Figure 5.2.F1 depicts the Life-Cycle Management System and relates key sustainment design and systems engineering activities. (Figure 5.2.F1 provides an overview roadmap during the acquisition process. Expanded versions are shown by phase in section 5.4 .) These system engineering processes are not carried out in a strictly linear progression; they are typically carried out iteratively, expanding into lower levels of detail as the design evolves. Incremental acquisition present challenges in both acquisition and sustainment activities. An obvious challenge is the potential cost and configuration management challenges that can arise with multiple configurations of end items as well as the support system. This should be addressed early in development and evolution of the acquisition strategy. If planned correctly, configuration management efforts combined with rapid prototypes can provide the PM the opportunity to observe and evolve the success of tentative support strategies. Conversely, poor management of multiple system configurations can create a significant sustainment burden.

Program teams manage programs "through the application of a systems engineering approach that optimizes total system performance and minimizes total ownership costs" (DoD Directive 5000.01). In doing so, the PM's overriding program objective should be to maximize system effectiveness from the users perspective. To accomplish this, sustainment considerations are addressed in the JCIDS process, demonstrated in test & evaluation, and implemented by fielding and sustaining the system. To reach that objective within resource and statutory constraints, trade-offs are continually conducted to balance performance, availability, process efficiency, risks, and cost. This requires the PM to think in both long and short terms.

Short term pressures to achieve system performance and schedule imperatives are very real, and cannot be ignored in a financially and statutorily constrained environment. However, system sustainability and affordability are also important program elements to be considered. Consequently CJCS Instruction 3170.01 established the Sustainment Key Performance

Parameter and KSAs to reinforce the total life-cycle approach to program decisions. This is because a system that meets performance requirements but saves acquisition dollars by not expending the resources to make it reliable, maintainable, or supportable is a liability to the user. Ultimately, over the system life cycle, balancing this composite of long term objectives will provide greater benefit.

Figure 5.2.F1. Supportability Analysis in Acquisition



Achieving Affordable System Operational Effectiveness. The PM can address the long versus short term issue by designing for the optimal balance between performance (technical and supportability), life-cycle costs, schedule, and process efficiency. A development program that targets only some categories of technical performance capability; or fails to optimize system Reliability, Availability, and Maintainability (RAM) technical performance, risks financial burden during operations and support. The PM should therefore design for the optimal balance between technical performance (including RAM), categories of LCC, schedule, and process efficiencies. The affordable system operational effectiveness concept is important because it is what the user sees in terms of how well the system is able to perform it's missions over a sustained period as well as the ability to surge given the users operating budget. In this concept the emphasis is not only on the system's ability to execute its mission or its reliability and maintainability, but also on the cost effective responsiveness of the supply chain. The challenge is in how to relate these interrelated elements into an integrated shared vision across the wide range of stakeholders. The major elements impacting a systems ability to perform its mission that

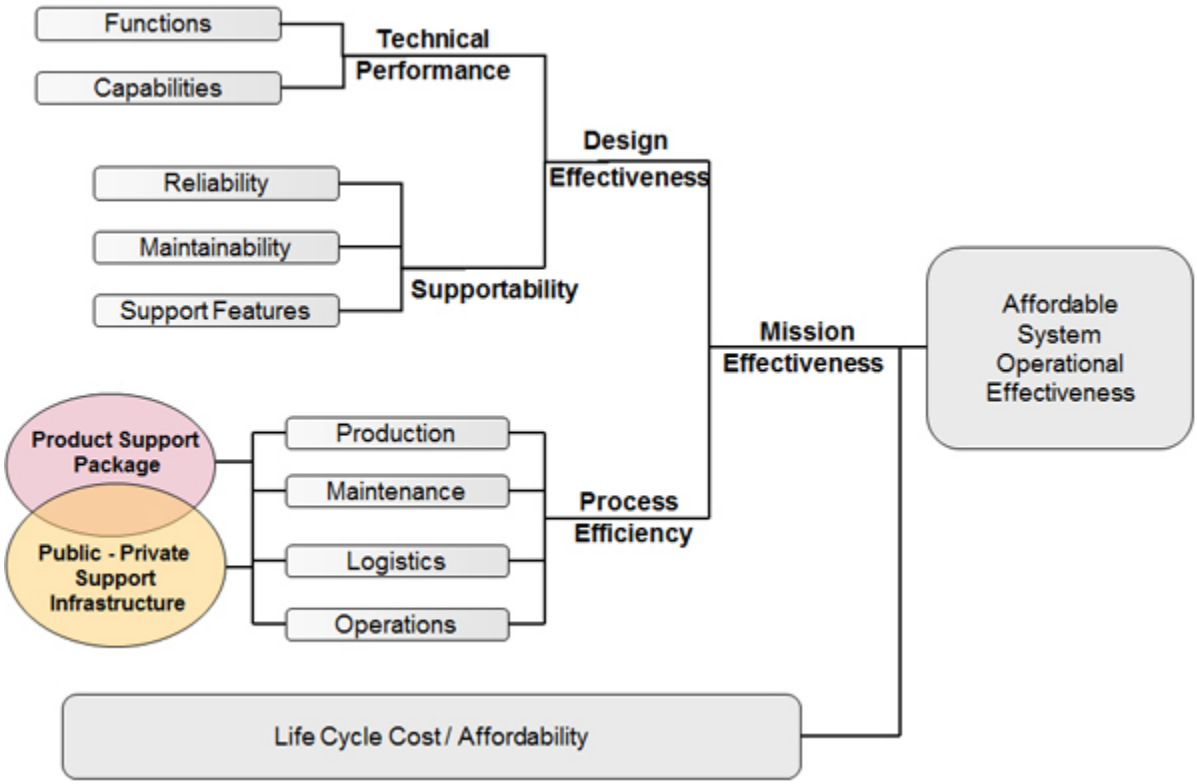
should be considered in the design process are depicted in Figure 5.2.F2 and addressed below:

Mission effectiveness is critical because it reflects the Warfighter's ability to accomplish the mission (including the number of systems/sorties required to accomplish the mission) and directly impacts their workload. It reflects the balance achieved between the design and the process efficiencies used to operate and support the system, including the product support package and the supply chain. In addition, each of its elements directly influences the life-cycle cost. The key is to ensure mission effectiveness is defined in terms meaningful to the Warfighter over a meaningful timeframe. (e.g., number of systems required to move X ton miles in a 30 day period, or number of systems required to provide continuous surveillance coverage over 60,000 square mile area for a 6 month period).

The design effectiveness reflects key design features - technical performance and supportability features. These system aspects should be designed-in synergistically and with full knowledge of the expected system missions in the context of the proposed system operational, maintenance, and support concepts. To be effective, technical performance and supportability objectives should be defined in explicit, quantitative, testable terms. This is important to facilitate trade-offs as well as the selection and assessment of the product and process technologies. Each of the major elements controlled by the program manager in the design process is addressed below.

Technical performance is realized through designed-in system functions and their corresponding capabilities. In this context, functions refer to the desired mission abilities the system should be capable of executing in the operational environment. This includes high level functions such as intercept, weapons delivery, electronic jamming, surveillance, etc. down to the lowest subsystem level supporting functions (e.g., process signal). Capabilities refer to the various desired performance attributes and measures, such as maximum speed, range, altitude, accuracy (e.g., "circular error probable") down to the lowest subsystem level (e.g., frequencies). Each of these must be prioritized and traded off to achieve an acceptable balance in the design process.

Figure 5.2.F2. Affordable System Operational Effectiveness



In this context, supportability (see sections 5.3 and 4.3.18.22) includes the following design factors of the system and its product support package:

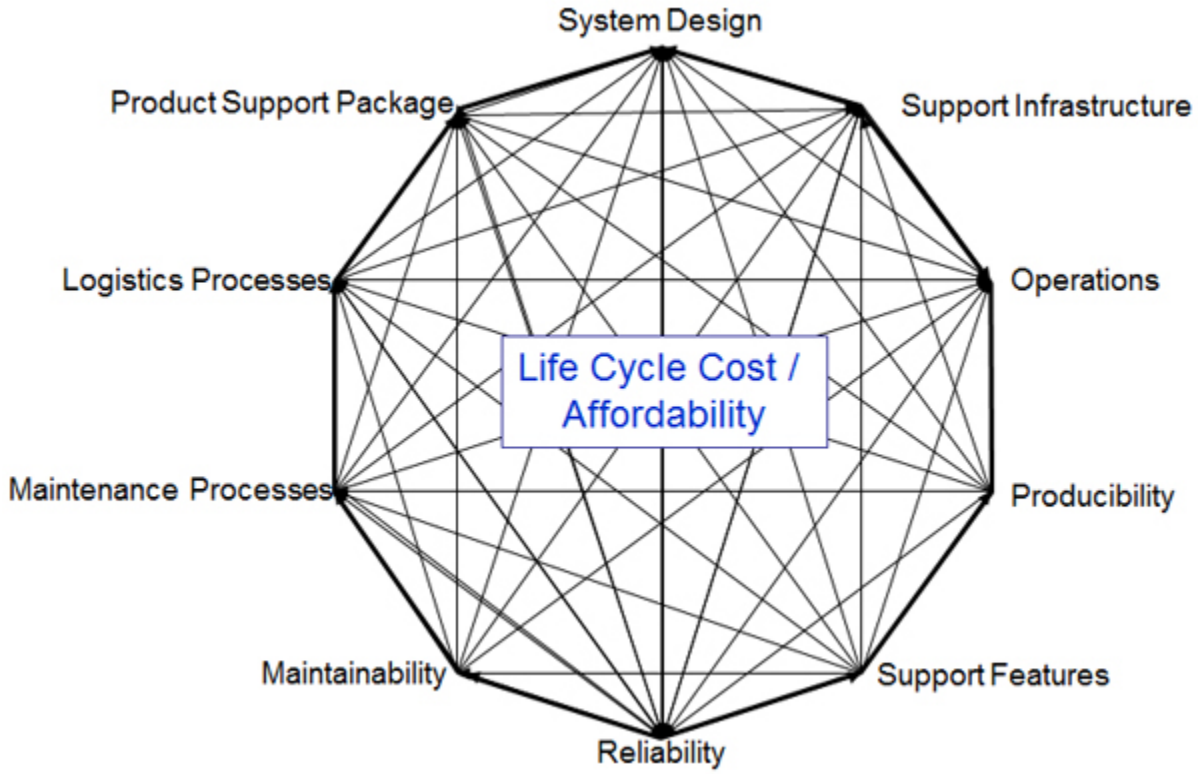
- **Reliability** is the ability of a system to perform as designed in an operational environment over time without failure.
- **Maintainability** is the ability of a system to be repaired and restored to service when maintenance is conducted by personnel using specified skill levels and prescribed procedures and resources (e.g., personnel, support equipment, technical data). It includes unscheduled, scheduled maintenance as well as corrosion protection/mitigation and calibration tasks.
- **Support features** include operational suitability features cutting across reliability and maintainability and the supply chain to facilitate detection, isolation, and timely repair/replacement of system anomalies. It also includes features for servicing and other activities necessary for operation and support including resources that contribute to the overall support. Traditional factors falling in this category include diagnostics, prognostics (see CBM+ Guidebook), calibration requirements, many HSI issues (e.g. training, safety, HFE, occupational health, etc.), skill levels, documentation, maintenance data collection, compatibility, interoperability, transportability, handling (e.g., lift/hard/tie down points, etc.), packing requirements, facility requirements, accessibility, and other factors that contribute to an optimum environment for sustaining an operational system.

Supportability features cannot be easily "added-on" after the design is established. Consequently supportability should be accorded a high priority early in the program's planning and integral to the system design and development process. In addition to supportability features, the associated product support package, along with the supply chain, are important because they significantly impact the processes used to sustain the system, allowing it to be ready to perform the required missions. While not specifically identified in figure 5.2.F2, producibility (i.e. the degree to which the design facilitates the timely, affordable, and optimum-quality manufacture, assembly, and delivery) can also impact supportability. This is because easily producible items are normally faster to obtain and have lower life-cycle costs.

Process efficiency reflects how well the system can be produced, operated, serviced (including fueling) and maintained. It reflects the degree to which the logistics processes (including the supply chain), infrastructure, and footprint have been balanced to provide an agile, deployable, and operationally effective system. While the program manager does not fully control this aspect, the program directly influences each of the processes via the system design and the fielded product support package. Achieving process efficiency requires early and continuing emphasis on the various logistics support processes along with the design considerations. The continued emphasis is important because processes present opportunities for improving operational effectiveness even after the "design-in" window has passed via lean-six sigma, supply chain optimization and other continuous process improvement (CPI) techniques. Examples of where they can be applied include supply chain management, resource demand forecasting, training, maintenance procedures, calibration procedures, packaging, handling, transportation and warehousing processes.

The relationships illustrated in figure 5.2.F2 are complex and not as clean as shown in the figure. Figure 5.2.F3 is more accurate relative to how the basic system operational effectiveness elements interface. For example, each of the supportability elements influences the process aspects which in turn can impact supportability. (e.g., while reliability drives the maintenance requirements, the implemented maintenance processes and the quality of the spare and repair parts as reflected in the producability features can impact the resultant reliability.) In addition, how the system is operated will influence the reliability and both can be influenced by the logistic processes. Last but not least, each of the design and process aspects drives the life-cycle costs. Achieving the optimal balance across these complex relationships requires proactive, coordinated involvement of organizations and individuals from the requirements, acquisition, logistics, and user communities, along with industry. Consequently, because of the complexity and overlapping interrelationships full stakeholder participation is required in activities related to achieving affordable mission effectiveness. Models that simulate the interactions of the elements, as depicted in Figure 5.2.F3, can be helpful in developing a balanced solution.

Figure 5.2.F3. Affordable System Operational Effectiveness Interrelationships

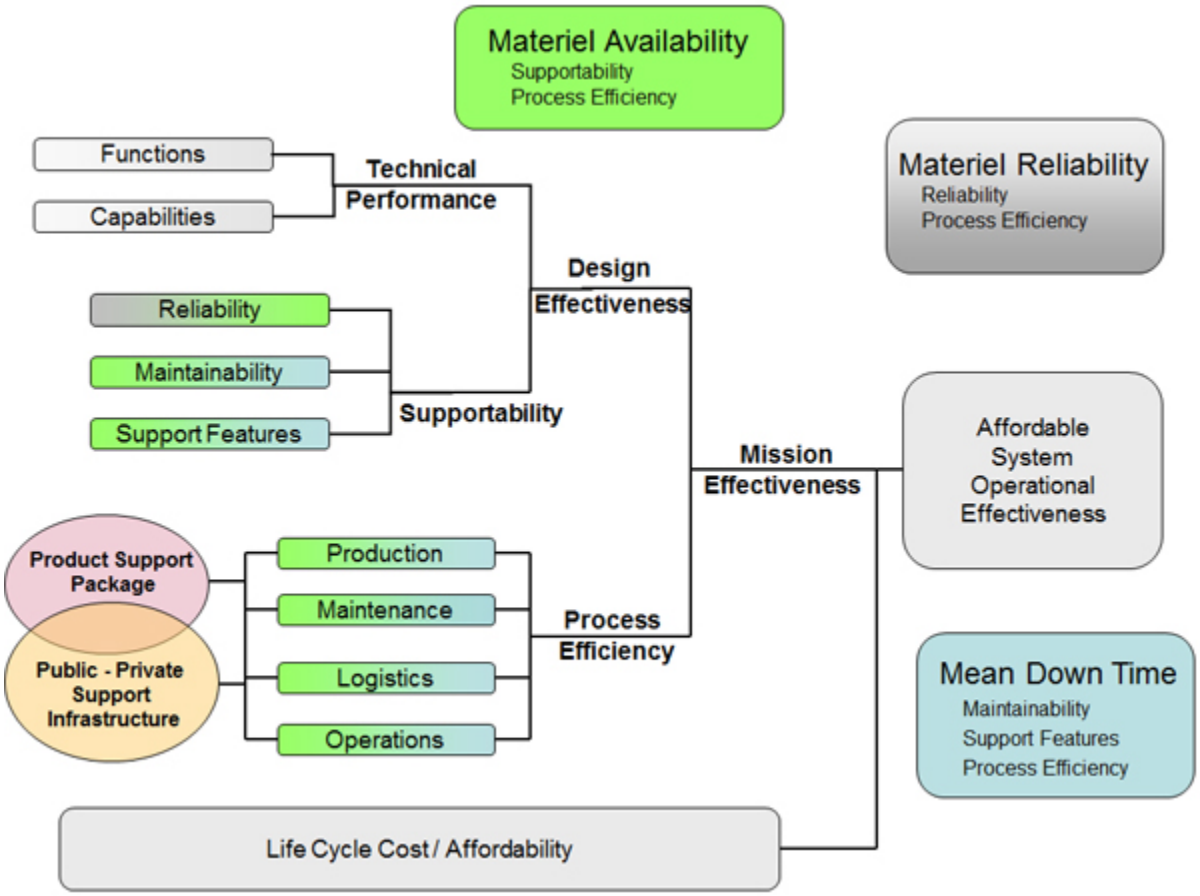


Each of the elements reflected in Figure 5.2.F2 contribute to achieving the top level affordable operational effectiveness outcome and have associated metrics which can be measured to assess efficiency and effectiveness. However, they don't mathematically add up as implied in Figure 5.2.F2. This is because, in addition to the complex interrelationships between the elements, the various stakeholders only measure portions of the supply chain and often use different metric definitions. Consequently DoD has adopted 4 key sustainment metrics (including the Sustainment KPP and 2 KSAs) for projecting and monitoring key affordable operational effectiveness performance enablers to:

- Provide a standard set of encompassing measures to continuously estimate and assess affordable operational effectiveness
- Complement the traditional readiness metrics to help overcome the overlapping interrelationships,
- Provide a common communications link across the diverse systems and organizations
- Provide the programs latitude in determining the optimum solution.

Figure 5.2.F4 indicates the minimum set of sustainment metrics the PM should use to facilitate communication across the stakeholders and the elements affecting them. The color code indicates the elements measured by Materiel Availability, Materiel Reliability and Mean Down Time metrics. The metrics are interrelated and along with the CONOPS impact the LCC.

Figure 5.2.F4 Sustainment Metrics & Affordable System Operational Effectiveness



This overarching perspective provides context for the trade space available to a PM and for articulation of the overall objective of maximizing the operational effectiveness. This is critical because trade-offs outside the trade space (i.e., program parameter changes) can require approval of both the Milestone Decision Authority and Validation Authority since validated KPP threshold values cannot be reduced without Validation Authority approval. Consequently, it is critical the design trade space established by the values selected for the sustainment metrics are established early and be acceptable to the user and acquirer communities. As a result, the user and sponsor should be involved with the determination of the design trade space. Finally, to help ensure the metrics goals are met, the program should establish supporting metrics for key drivers (e.g., logistics footprint, manning levels, ambiguity rates for diagnostics) uniquely tailored for the system and the projected operating environment as the design requirements are allocated.

5.2.1. Supportability Analysis

5.2.1.1. Supportability Analysis Phases

5.2.1.2. Supportability Analysis Steps

5.2.1.3. Key Depot Maintenance Analysis Elements

5.2.1. Supportability Analysis

Sustainment requirements should be an integral part of the systems engineering design process. (A detailed discussion of the systems engineering process can be found in section 4.3.) Regardless of the life-cycle phase, effective supportability begins with the development of sustainment requirements to drive the design and development of reliable, maintainable and affordable systems through the continuous application of the systems engineering methodology focusing on affordable system operational effectiveness. The key is to smoothly integrate the systems engineering processes and design maturation processes together with the Defense Life-Cycle Management System and it's milestones. A key product of the supportability analysis is the maintenance plan which evolves and drives all sustainment resource requirements throughout the life cycle.

5.2.1.1. Supportability Analysis Phases

Section 5.4 provides areas of focus for each acquisition phase. In general, however, life-cycle management can be thought of in terms of three broad periods.

- **Pre-Systems Acquisition:** Determining the capabilities and major constraints (cost, schedule, available technology) that frame the acquisition strategy and program structure for both the system and its support concept
- **Acquisition:** Designing, producing and deploying the equipment and it's support system
- **Operations:** Adjusting to the operational environment by assessing readiness trends/issues, cost trends, evolving materiel conditions, and taking timely corrective actions to support the users

Pre-Systems Acquisition: Here, supportability analysis should be used to evaluate the suitability of material alternatives, shape life-cycle sustainment concepts and determine the product support capability requirements. Each alternative should be assessed to determine the likely materiel availability and it's life-cycle affordability. Generally the analysis starts at the system level but can selectively go to lower levels of indenture if key enabling technologies are required to meet the CONOPS (for both the system and the product support system). This includes using supportability analysis to:

- Evaluate alternatives until an optimum balance is achieved between mission effectiveness and the KPPs (including the Sustainment KSAs). Specifically it should be used to ensure the preferred System Concept & Support CONOPS, are consistent with the projected Operational CONOPS taking into account "real world" constraints including "core", statutory requirements, existing supply chain, etc. Generally this is done by considering the sustainment effectiveness and O&S affordability of systems currently performing the same or similar capabilities. These are analyzed and serve as benchmarks to assess alternatives; with the intent of incremental improvement over current (legacy) system capability readiness and cost.
- Evaluate product support capability requirements using a notional Support CONOPS for

trades and LCC estimates in evaluating the alternatives.

- Identify enabling sustainment technology needed to meet life-cycle sustainment goals especially when the risk of achieving the incremental improvements is high (e.g., a robust software architecture, health management, diagnostics, prognostics. etc.).
- Assess the operational and life-cycle risks associated with sustainment technologies, especially those requiring development.
- Assess the intellectual property considerations needed, to include the technical data rights and computer software needed to sustain and support a system.
- Integrate supportability performance into systems engineering, initial acquisition strategic planning, and as benchmark criteria for test and evaluation.
- Refine associated performance requirements based on technology development results (positive and negative) to achieve the preferred system concept & Support CONOPS.
- Refine supportability performance requirements and life-cycle sustainment concepts, based on evolving technology and changes in the CONOPS.

Acquisition: Here, supportability analysis helps reduce risks and create/field the system and its supply chain with provided feedback into the design process. This is accomplished by assessing the effect of system plans, development, and production on sustainment effectiveness, readiness, and O&S affordability. The intent is to act early to mitigate evolving circumstances that may adversely impact deployed readiness. This includes using systems engineering in designing the system and its supply chain; producing both concurrently; and testing to verify the total system requirements have been achieved. Specifically systems engineering is used in designing for support and:

- Taking Warfighter requirements (Including the Operational CONOPS) and developing the sustainment objectives, Support and Maintenance CONOPS and determining their detailed "design-to" and "build to" requirements. (It also includes identifying the performance requirements for the supporting supply chain segments to support the Operational CONOPS.) In accomplishing this, the trades/analyses are used to identify:
    - The key metric values (e.g., the drivers) required to meet the operational/campaign model assumptions/requirements as well as the impact on Warfighter mission capability (e.g., ability to generate a mission (operational readiness) and perform during a mission) of the various trades.
    - LCC drivers for the system, it’s support concept and maintenance concept/plan.
    - The optimum mix of driver values to meet KPPs and their corresponding confidence levels.
    - Effectiveness (KPP/KSA Outcomes) if the supply chain performs at today's levels (as well as if current trends continue or with anticipated trends).
- Taking the test/initial operations results and predicting likely mature values for each of the KSA and enabler drivers.
- Providing integrated Sustainment KPP/KSA estimates into the Defense Acquisition Management Information Retrieval (DAMIR) system.

During this period more realistic and detailed data is used in the models/simulations to reduce risk and define achievable performance & sustainment requirements. Consequently, a mix of design estimates/contract requirements, sustainment, and Maintenance Plan metrics are used

when conducting sustainment trades/analysis depending on the period and objective. In addition, expected trends for system, enabler & supply chain metrics and their confidence levels are also needed requiring the use of data models. This requires that:

- Data realism is based on systems engineering/technology assessments.
- Metric values can be evaluated and re-adjusted as necessary.
- The required data elements performance requirements can be defined in contract terms.
- There is a means to verify the maturity growth over time.

Operations: Here, supportability analysis is used to help in adjusting the program based on the sustainment program's achieved effectiveness as well as on changing hardware and operational conditions. This includes using supportability analysis to:

- Analyze the impact of proposed re-design alternatives on the sustainment metrics and mission effectiveness.
- Analyze the impact of proposed process changes on the sustainment metrics.
- Take use data and user feedback including Failure & Discrepancy Reports to:
    - Project trends (with confidence levels) so proactive actions are taken as conditions warrant to minimize adverse impacts on the users.
    - Identify areas in the supply chain where performance is adversely affecting materiel availability, increasing LCC or missing areas of potential savings/improvements. (Note, that care is needed, since, in some cases, an increase within a specific system may be significantly offset by a major saving elsewhere within the DoD Component or DoD. Consequently, higher level organizations may have to be engaged in the final decision.)
    - Identify and analyze readiness risk areas and develop corrective action alternatives.
- Relate/quantify various business process outcomes with resources.

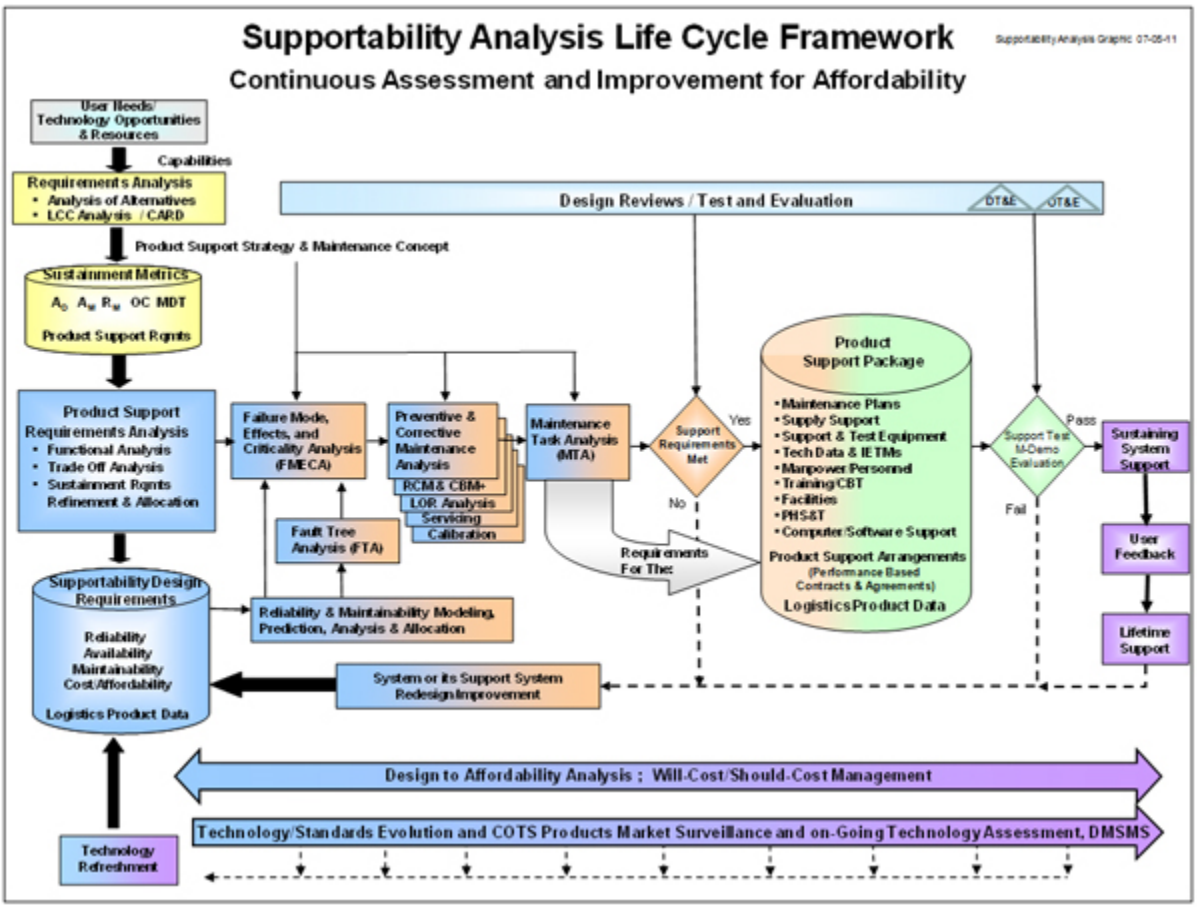
During this period, the system program measures and tracks the supply chain and its effectiveness and use models that include the driver metrics to determine root causes of problems or anticipate future problems.

5.2.1.2. Supportability Analysis Steps

As discussed in section 4.3.18 , designing for optimal system affordability and operational effectiveness requires balance between mission effectiveness and life-cycle cost. The emphasis is not only on the reliability and maintainability of the system to achieve mission capability, but also on human systems integration and optimization of all human interfaces across the HSI domains to ensure the cost-effective responsiveness and relevance of the support systems and supply chain. This is critical since a significant portion of LCC are human related and are locked in early in the acquisition life cycle. Consequently it is important that a comprehensive HSI program be initiated early in the life cycle to address the major LCC drivers. These objectives can best be achieved through integration with the system design and CONOPS (both operational and sustainment) and by focusing on the sustainment requirements. As depicted in Figure 5.2.1.2.F1, the supportability analysis process is most effectively carried out through inclusion

from the very beginning of a program, starting with the definition of required capabilities. The colors in the figure provide a rough idea as to the life-cycle phase in which specific tasks are conducted. However, in reality, the time Supportability Analysis phasing for a specific piece of hardware is really dependent on the maturity of the design process, not strictly based on the programs milestone reviews.

Figure 5.2.1.2.F1. Supportability Relationships



Implementation of a disciplined supportability analysis approach, including systems engineering activities such as CBM+, Failure Mode Effects and Criticality Analysis (FMECA), Fault Tree Analysis (FTA), Reliability Centered Maintenance (RCM) (see Enclosure 3, DoDI 4151.22 RCM Process), and level of repair analysis (considering cost and availability implication of the maintenance level and locations) will produce a Maintenance Task Analysis (MTA) directly linked to the systems reliability and maintainability characteristics. The Maintenance Task Analysis is the opportunity to determine whether the design has met the supportability requirements defined in the system specification, and provides a feedback loop to the Systems Engineer that is either positive (design has met requirements) or that there is a need for re-evaluation of either the requirement or the design itself. The results of the re-evaluations permit's the trade space required for the PM to make a justifiable decision. The RCM analytical process which determines the preventive maintenance tasks is critical in providing recommendations for

actions necessary to maintain a required level of safety, maximize materiel availability, and minimize operating cost. In addition to DoD Component guides and handbooks (e.g. MIL-P-24534A), SAE JA1011 (Evaluation Criteria for RCM Programs) and SAE JA1012 (A Guide to the RCM Standard) are illustrative commercial standards for this method.

The technical input and maintenance task analysis provide a detailed understanding of the necessary logistics support element requirements to sustain required materiel availability. The MTA process identifies support tasks and the physical location where they will be accomplished considers the costs, availability implications, and statutory requirements. (The Depot Source of Repair (DSOR) process is key in determining location.) This in turn produces a product support package that identifies support element requirements and associated product data based on the system reliability and maintainability. The product support package provides descriptions of the following topics:

- Supply Support (Spare/Repair Parts)
- Maintenance Plan and Requirements
- Support, Test & Calibration Equipment
- Technical Data (Paper Based and/or Electronic Interactive)
- Manpower & Training including Computer Based Training
- Facility Requirements
- Packaging, Handling, Storage, & Transportation
- Computer Resource Support

The steps shown in figure 5.2.1.2.F1 are not necessarily carried out in a linear progression. Design increments and the continuous assessment of test results and in-service system performance will identify needs for system improvements to enhance reliability, and maintainability and to overcome obsolescence, corrosion, or other sustainment problems. Additional information including a detailed process description, considerations in implementing the process and data element definitions, can be found in MIL-HDBK-502 . (**Note:** This document is currently in the update process.)

5.2.1.3. Key Depot Maintenance Analysis Elements

Program managers should analytically determine the most effective levels of maintenance and sources based on materiel availability and cost factors. 10 U.S.C. 2464 and DoD policy require organic core maintenance capabilities be in place to provide effective and timely response to surge demands and to ensure cost efficiency and technical competence. In addition per 10 USC 2464, core sustaining workload must be accomplished in Government owned facilities with Government owned equipment and personnel. The PM should perform an analysis to determine the maintenance source that complies with statutory requirements, operational readiness and best value for non-core workloads. (Initial organic depot maintenance source of repair assignments must employ merit-based selection procedures to select among alternative sources. Depot maintenance workloads previously accomplished at organic facilities, with a value of at least three million dollars, must also be subjected to merit-based selection procedures when deciding between alternative organic sources of repair. Additional information including exceptions to the

requirement can be found in DoDD 4151.18 and DoD Instruction 4151.20 .)

Core Logistics Capability. Title 10 U.S.C. 2464 and DoDI 4151.20 require core logistics capability that is government-owned and government-operated (including government personnel and government owned and operated equipment and facilities) to ensure a ready and controlled source of technical competence with the resources necessary to ensure effective and timely response to mobilization, national defense contingency situations, or other emergency requirements. These capabilities must be established no later than 4 years after achieving IOC. These capabilities should include those necessary to maintain and repair systems and other military equipment that are identified as necessary to fulfill the strategic and contingency plans prepared by the Chairman of the Joint Chiefs of Staff. (Excluded are special access programs, nuclear aircraft carriers, and commercial items, as defined by (Title 10 U.S.C. 2464).) Core logistics capabilities should be performed at government owned-government operated (GO-GO) facilities of a military department. Such facilities should be assigned sufficient workload to maintain these core capabilities and ensure cost efficiency and technical competence in peacetime while preserving the surge capacity and reconstitution capabilities necessary to fully support strategic and contingency plans.

Depot Source of Repair (DSOR) Analysis. The process to help the PM select the best value in depot maintenance support is implemented through the Depot Source of Repair (DSOR) analysis. The Depot Source of Repair Guide provides additional information for accomplishing the required Core Logistics Analysis/Source of Repair Analysis in determining the source of repair for depot level workload. The DSOR decision process is an integral part of sustainment planning and mandatory for systems/equipment requiring depot maintenance. DoD Directive 4151.18 , Maintenance of Military Materiel, requires DSOR assignments be made by the PM using the DSOR assignment decision logic. The process should be completed before entering into firm commitments or obligating funds for other than interim depot support. The DSOR decision is typically made during the Engineering & Manufacturing Development and the Production and Deployment phases.

The DSOR decision process consists of two major elements, normally performed sequentially: The first is the organic versus contract source of repair determination. This determination is made by the PM using a DoD Component approved analysis process that gives consideration to core requirements. Title 10 USC 2464 , Core Logistics Capabilities; Title 10, USC 2466 , Limitations on the Performance of Depot Level Maintenance of Materiel, and DoD Directive 4151.18 provide further guidance for this process.

The second element in the DSOR decision process is consideration of interservice depot maintenance support. This element, known as the Depot Maintenance Interservice (DMI) review, is required regardless of the outcome of the contract versus organic selection. The DMI review is prescribed in the Joint Depot Maintenance Program regulation Logistics, Joint Depot Maintenance Program with individual DoD Component details spelled out in OPNAVINST 4790.14A, AMC-R 750-10, AFI 21-133(I), MCO P4790.10B, and DLAD 4151.16 . All new acquisitions, equipment modifications, and items moving to or from contract depot maintenance support are to be reviewed for interservice potential in accordance with this regulation.

The DSOR decision process has the potential to reduce program costs by effectively using commercial and organic depot maintenance resources. The process helps ensure the DoD Components maintain the core depot maintenance capability, as required by statute that meets military contingency requirements and considers interservice depot maintenance support and joint contracting. In performing this analysis, the PM should ensure that maintenance source of support decisions comply with the following statutory requirements.

Depot Maintenance 50 Percent Limitation Requirement. Title 10 U.S.C. 2466 requires not more than 50 percent of the funds made available in a fiscal year to a military department or defense agency for depot level maintenance and repair workload as defined by Title 10 U.S.C. 2460 be used to contract for performance by non-federal government personnel. As this is a military department and agency level requirement and not a system specific requirement, the PM should not undertake depot maintenance source of support decisions without consultation with accountable military department logistics officials to get the DoD Component position on this statutory requirement.

5.2.2. Life-Cycle Costs (LCC) and Product Support Business Case Analysis (BCA)

5.2.3. Sustainment Modeling and Simulation (M&S)

5.2.4. Process Models

5.2.2. Life-Cycle Costs (LCC) and Product Support Business Case Analysis (BCA)

LCC is the cost to the government to acquire and own a system over it's useful life. LCC includes all life-cycle management costs (e.g. development, acquisition, operations, support, and disposal). As such it consists of the elements of a program's budget, as well as supply chain or business processes costs that logically can be attributed to the operation of a system. Section 3.1.5 provides additional information but generally LCC includes direct program costs as well as any allocable "indirect cost" elements. This can include such costs as delivering fuel/batteries, recruiting/ accession training of new personnel, individual training, environmental and safety compliance, management headquarters functions, etc.

Early program decisions ultimately determine and drive the LCC, the majority of which is incurred after a system is deployed. Consequently beginning with the requirements determination and during each life-cycle phase, LCC estimates should play a major role in the program decision process for evaluating affordable alternatives during the design and trade-off processes. (See DoD Directive 5000.01, E1.1.4, E1.1.17, and E1.1.29 .) As a result, the operating and support portion of the LCC is now treated as a military requirement via the JCIDS's Ownership Cost KSA. For this reason, LCC analysis should be performed to the level appropriate for the decision and alternatives considered. However, since projections are based on assumptions, cost estimates shall include an assessment of confidence levels and should also include the associated cost drivers.

The Product Support Business Case Analysis (BCA) is used to assist in identifying the product support strategy that achieves the optimal balance between Warfighter capabilities and

affordability. (Other names for a BCA are Economic Analysis, Cost-Benefit Analysis, and Benefit-Cost Analysis. Regardless of the name, is it a structured analytical process that aids decision making in identifying and comparing alternatives by examining the mission and business impacts (both financial and non-financial), risks, and sensitivities.) The PSM should prepare a Product Support BCA for major product support decisions, especially those that result in new or changed resource requirements. The BCA should consider organic and commercial alternatives when determining the optimal support solution (e.g. DLA, TRANSCOM, Service activities and commercial options). Each of the key stakeholders should be informed of the BCA process and support the analysis by providing the information needed to make an informed decision. To aid this process, the Product Support BCA Guidebook provides an analytic, standardized, and objective foundation upon which credible decisions can be made.

In general, traditional life-cycle cost estimates are adequate in scope to support decisions involving system design characteristics, with indirect cost elements being handled via standard cost factors/surcharges/burdened rates. However, in special cases depending on the issue, the broader perspective may be more appropriate than just the traditional life-cycle cost elements a program can directly influence. For example, when determining the materiel solution to meet requirements (e.g., manned vs. unmanned, or space based vs. ship based, etc.) cost elements dealing with the supply chain will need to be considered since each materiel solution has a significantly different cost impact to the tax payer. During the design and sustainment phases, indirect cost elements may also be broken out rather than using cost factors when considering decisions directly impacting the wholesale logistics infrastructure processes. Examples of these types include decisions dealing with required skill levels to maintain the system, alternative system support concepts and strategies, reengineering of business practices or operations, and competitive sourcing of major supply chain activities.

Life-cycle cost analysis can be very effective in reducing the LCC of the system and its support strategy. (Within DoD, reduction and control of LCC is also done through a variety of initiatives including Will-Cost and Should-Cost Management, etc.) However, one cost model is not sufficient to address all of the alternatives a PM must consider. The level of detail, analysis process used, and LCC elements considered should be tailored to the decision being made, focusing on cost drivers and costs that will be incurred by the government and not just on direct program office costs. The objective is to seek and eliminate low-value added ingredients of program costs.

For most decisions, the sunk costs, costs that will not be impacted by the alternatives and absolute value of the alternatives can be ignored. The analysis should be focused instead on the relative cost element differences between the alternatives considered and the cost drivers for each. Consequently, the cost analysis should include appropriate key performance measure, such as O&S cost-per-operating-hour, cost-per-pallet miles, cost-per-seat miles, etc., when assessing alternative solutions. The Cost Analysis Requirements Description (see section 3.4.4.1) reflects the life-cycle sustainment requirements for preparing the LCC estimate and the Cost Analysis Improvement Group Operating and Support Cost Estimating Guide also provides useful information relative to the cost estimating process, approach, and other considerations.

5.2.3. Sustainment Modeling and Simulation (M&S)

M&S can be an effective tool in the supportability analysis and evaluation process in implementing life-cycle management principles because all the sustainment/materiel readiness driver metrics can be considered in parallel (also see section 4.3.19.1). Consequently, the sustainment M&S objective should be to use validated models to consider materiel availability/readiness implications when assessing the merits of alternatives throughout the life cycle. M&S should be used in assessing the alternatives for major decisions affecting the design and deployment of both the end item and it's support system. Properly applied M&S encourages collaboration and integration among the varied stakeholders (including the test and transportation communities) facilitating materiel availability and system effectiveness.

The models should be used throughout the life cycle and should include the multiple materiel availability stakeholder contribution and funding streams for the supply chain components. (The level of detail used varies based on several factors including, but not limited to, the systems complexity, criticality to the user, program phase, and risk.) In all cases, M&S efforts should consistently and credibly look at/trade off life-cycle alternatives in a repeatable fashion. In addition, the underlying assumptions and drivers for the values of each of the sustainment metrics should be documented as thresholds, objectives, and estimates evolve through the life cycle. (See the RAM-C Guide for additional information.)

5.2.4. Process Models

M&S and continuous process improvement initiatives are dependent on defined processes. The government and industry have undertaken a series of initiatives to define generic multi-level processes with associated metrics that might prove useful when developing new analysis models. The following general models have been developed.

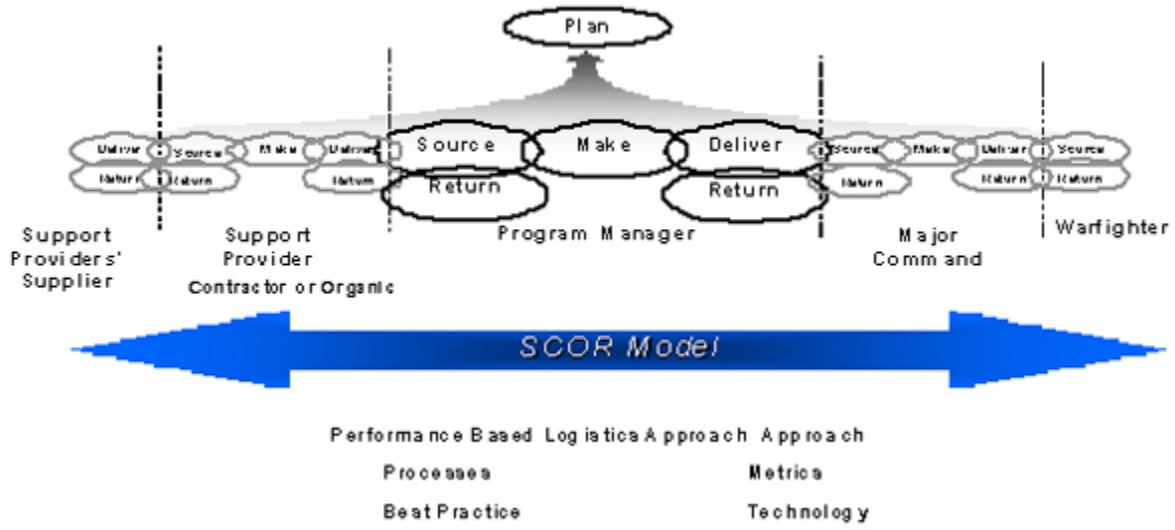
The Supply Chain Operations Reference (SCOR) model, figure 5.2.4.F1, captures a consensus view of the supply chain plan, source, maintain/make, deliver, and return, processes in a framework linking business process, metrics, best practices, and technology features into a unified structure for effective supply chain management and for improving related supply chain activities. In this context, the supply chain includes the transportation and maintenance chains as well as the spare/repair parts chain required to provide the user flexible and timely materiel support during peacetime, crises, and joint operations. Most of these supply chain activities are governed by DoD regulation 4140.1-R, Supply Chain Materiel Management Regulation which provides further DoD guidance and information. Maintenance requirements within the supply chain are governed by DoD Directive 4151.18 , Maintenance of Military Materiel.

Building off the SCOR efforts, the **Design Chain Operations Reference (DCOR)** model links business process, metrics, best practices and technology features into a unified structure to support communication among design chain partners and to improve the effectiveness of the extended supply chain. The model is organized around five primary management processes which focus on product development and research & development. As is in the case of SCOR, this consensus model can be used to describe design chains can be simple or complex using a

common set of definitions.

The **Customer Chain Operations Reference (CCOR)** model captures a consensus view of the feedback processes including the health and welfare of the customer supplier relationship. This model is the least mature and also undergoing refinement by practitioners. However, combined and tailored, the 3 models can provide an end to end view of the entire enterprise wide process covering processes, activities and metrics.

Figure 5.2.4.F1. The Supply Chain Operations Reference (SCOR) Model



[5.3. Supportability Design Considerations](#)

[5.3.1. Architecture Considerations](#)

[5.3.2. Reliability](#)

[5.3.3. Maintainability](#)

[5.3.4. Other Logistics Technologies](#)

5.3. Supportability Design Considerations

Logistics Infrastructure and Footprint Reduction. Programs can best support evolving military strategy by providing forces with the best possible system capabilities while minimizing the logistics footprint. Consequently, programs are responsible for achieving program objectives throughout the life cycle while minimizing cost and logistics footprint (see DoD Directive 5000.01, E1.17 and E1.29). To achieve these goals, the support posture of a system needs to be designed-in up front (i.e., logistics and availability degraders are designed out) since the opportunities for decreasing the logistics footprint decline significantly as the system evolves

from design to production to deployment. Minimizing the logistics footprint through deliberate and integrated logistics/engineering design efforts means that a deployed system will require fewer quantities of support resources especially:

- Spares and the supply chain
- Test, support and calibration equipment
- Manpower and personnel requirements (including highly specialized or unique skill/ training requirements)
- System documentation/technical data

Sustainment analyses should include a basic understanding of the concept of operations, system missions, mission profiles, and system capabilities to understand the rationale behind functional and performance priorities. Understanding the rationale paves the way for decisions about necessary tradeoffs between system performance, availability, and LCC, with impact on the cost effectiveness of system operation, maintenance, and logistics support. There is no single list of sustainment considerations or specific way of grouping them as they are highly inter-related. They range from: compatibility, interoperability; transportability; reliability; maintainability; manpower; human factors; safety; natural environment effects (including occupational health; habitability); diagnostics & prognostics (including real-time maintenance data collection); and corrosion protection & mitigation. The following are key considerations that should be considered for the System Specification.

5.3.1. Architecture Considerations

Figure 5.3.1.F1 lists key system architecture attributes which can provide a solid sustainment foundation. The focus on openness, modularity, scalability, and upgradeability is critical to implementing an incremental acquisition strategy. In addition, the architecture attributes that expand system flexibility and affordability can pay dividends later when obsolescence and end-of-life issues are resolved through a concerted technology refreshment strategy. However trade-offs are required relative to the extent each attribute is used as illustrated in the Commercial Off-the-Shelf (COTS) case.

Figure 5.3.1.F1. Illustrative attributes for System Architecture Supportability Assessments

Physical Commonality (within the system) **Hardware Commonality** **Software Commonality**	**Requirements Allocation and System Packaging** **Interfaces – Minimization of Types & Quantity**
Physical Familiarity (from other systems)	**Modularity**
Operational Commonality	**Testability**
Use of COTS	**Configuration Consistency and Compatibility**
Redundancy	**Open Systems Orientation**

Maturity and use of Commercial Off-the-Shelf (COTS) Items . Technology risk should receive consideration as the system is developed. Maximum use of mature technology (including non-developmental and/or standards based COTS software or computer hardware) provides the greatest opportunity to adhere to program cost, schedule, and performance requirements by leveraging industry's research & development and is consistent with an incremental acquisition approach. However, this is not a one-time activity. Unanticipated changes and the natural evolution of commercial items may drive reconsideration of engineering decisions throughout the life cycle. In addition, the program must consider the logistics implications of supporting commercial items in a military environment. Finally, because COTS items have a relatively short manufacturing life, a proactive diminishing manufacturing sources and material shortages / obsolescence approach should also be considered. Consequently, care must be taken to assess the long term sustainability of COTS options and to avoid or minimize single source options.

Modular Open Systems Approach (MOSA) . Open system architectures help mitigate the risks associated with technology obsolescence and promote subsequent technology infusion. MOSA can also help to provide interoperability, maintainability, and compatibility when developing the support strategy and follow-on logistics planning for sustainment. It can also enable continued access to cutting edge technologies and products and prevent being locked into proprietary technology. Applying MOSA should be considered as an integrated business and technical strategy when examining alternatives to meet user needs. PMs should assess the feasibility of using widely supported commercial interface standards in developing systems. Closely related to MOSA is the Open System Architecture (OSA) approach to software development. This concept,

which relies upon the sharing of software code can significantly enhance affordability. For a detailed discussion of OSA see the Open Systems Architecture Guide (insert hyperlink here to the Guide and BCA). MOSA should be an integral part of the overall acquisition strategy to enable rapid acquisition with demonstrated technology, incremental and conventional development, interoperability, life-cycle sustainment, and incremental system upgradeability without major redesign during initial procurement and re-procurement.

Standardization . Parts management is a design strategy that seeks to reduce the number of unique, specialized, and defined problem parts used in a system (or across systems) to enhance standardization, commonality, reliability, maintainability, and supportability. In addition to reducing the need and development of new logistics requirements (e.g. documentation, spares, etc.) it reduces the logistics footprint and also mitigates parts obsolescence occurrences due to diminishing manufacturing sources and material shortages.

Materiel and Interoperability/Joint Architecture. The Materiel and Interoperability/Joint Architecture concept can be used to help reduce the logistics footprint. (For further discussion on this topic see Chapter 7 .)

5.3.2. Reliability

Reliability is critical because it contributes to a systems war fighting effectiveness as well as it's suitability in terms of logistics burden and the cost to fix failures. For each system, there is a level of basic reliability that must be achieved for the system to be militarily useful, given the intended CONOPS. Reliability is also one of the most critical elements in determining the logistics infrastructure and footprint. Consequently, system reliability should be a primary focus during design (along with system technical performance, functions, and capabilities). The primary objective is to achieve the necessary probability of mission success and minimize the risk of failure within defined availability, cost, schedule, weight, power, and volume constraints. While performing such analyses, trade-offs should be conducted and dependencies should be explored with system maintainability and integrated with the supportability analysis that addresses support event frequency (i.e. Reliability), event duration and event cost. Such a focus will play a significant role in minimizing the necessary logistics footprint, while maximizing system survivability and availability.

The requirements determination process offers the first opportunity to positively influence a system from a reliability perspective. Trade-offs among "time to failure," system performance, and system life-cycle cost are necessary to ensure the correct balance and to maximize materiel availability. Options that should be considered and implemented to enhance system reliability and achieve the Materiel Reliability KSA include:

- Over-designing to allow a safety margin;
- Redundancy and/or automatic reconfiguration upon failure allowing graceful degradation;
- Fail safe features (e.g., in the event of a failure, systems revert to a safe mode or state to avoid additional damage and secondary failures). Features include real time reprogrammable software, or rerouting of mission critical functions during a mission;

- Calibration requirements; and
- Reliability Growth Program.

Reliability estimates evolve over time. Generally, the initial estimates are based on parametric analyses and analogies with like or similar systems operating in the same environment and adjusted via engineering analysis. As the design evolves and as hardware is prototyped and developed, the engineering analysis becomes more detailed. In addition to estimates and modeling, testing at the component, subsystem, or system level may be necessary to assess or improve reliability. Approaches such as accelerated life testing, environmental stress screening, and formal reliability development/growth testing, should be considered and incorporated into program planning as necessary. To assure the delivery of a system that will achieve the level of reliability demanded in field use, a methodical approach to reliability assessment and improvement should be a part of every well-engineered system development effort. The Reliability Availability and Maintainability (RAM) Guidance provides a structure, references, and resources to aide in implementing a sound strategy. It is crucial the reliability approach be planned to produce high confidence the system has been developed with some margin beyond the minimum (threshold) reliability. This will allow for the inevitable unknowns that result in a decrease between the reliability observed during development and that observed during operational testing and in-service. In addition to reliability, the Reliability, Availability, Maintainability & Cost (RAM-C) Rationale Report Manual provides guidance in how to develop and document realistic sustainment Key Performance Parameter (KPP)/Key System Attribute (KSA) requirements with their related supporting rationale; measure and test the requirements; and manage the processes to ensure key stakeholders are involved when developing the sustainment requirements.

5.3.3. Maintainability

The design emphasis on maintainability is to reduce the maintenance burden and supply chain by reducing the time, personnel, tools, test equipment, training, facilities and cost to maintain the system. Maintainability engineering includes the activities, methods, and practices used to design minimal system maintenance requirements (designing out unnecessary and inefficient processes) and associated costs for preventive and corrective maintenance as well as servicing or calibration activities. Maintainability should be a designed-in capability and not an add on option because good maintenance procedures cannot overcome poor system and equipment maintainability design. The primary objective is to reduce the time it takes for a properly trained maintainer to detect and isolate the failure (coverage and efficiency) and affect repair. Intrinsic factors contributing to maintainability are:

- **Modularity:** Packaging of components such that they can be repaired via remove and replace action vs. on-board repair. Care should be taken not to "over modularize" and trade-offs to evaluate replacement, transportation, and repair costs should be accomplished to determine the most cost effective approach.
- **Interoperability:** The compatibility of components with standard interface protocols to facilitate rapid repair and enhancement/upgrade through black box technology using common interfaces. Physical interfaces should be designed so that mating between components can only happen correctly.

- **Physical accessibility:** The designed-in structural assurance that components requiring more frequent monitoring, checkout, and maintenance can be easily accessed. This is especially important in Low Observable platforms. Maintenance points should be directly visible and accessible to maintainers, including access for corrosion inspection and mitigation.
- **Designs that require minimum preventative maintenance** including corrosion prevention and mitigation. Emphasis should be on balancing the maintenance requirement over the life cycle with minimal user workload.
- **Embedded training and testing** , with a preference for approved DoD Automatic Test Systems (ATS) Families when it is determined to be the optimal solution from a LCC and Materiel Availability perspective.
- **Human Systems Integration (HSI)** to optimize total system performance and minimize life-cycle costs. (For further discussion, see Chapter 6 and section 4.3.18.10 .) This includes all HSI domains (Manpower, Personnel, Training, Human Factors Engineering, Environment, Safety, Occupational Health, Survivability, and Habitability) to design systems and incorporate technologies that require minimal manpower, provide effective training, can be operated and maintained by users, are suitable (habitable and safe with minimal environmental and occupational health hazards), and survivable (for both the crew and the equipment).

Condition Based Maintenance Plus. When it can support the materiel availability, prognostics & diagnostics capabilities/technologies should be embedded within the system when feasible (or off equipment if more cost-effective) to support condition based maintenance and reduce scheduled and unscheduled maintenance. Health management techniques can be very effective in providing maintainers with knowledge, skill sets, and tools for timely maintenance and help reduce the logistics footprint. Condition based maintenance plus (CBM+) (the application of technologies, processes, and procedures to determine maintenance requirements based, in large part, on real time assessment of system condition obtained from embedded sensors), coupled with reliability centered maintenance can reduce maintenance requirements and reduce the system down time. (CBM+ references include the DoDI 4151.22 , the CBM+ Guidebook , and the CBM+ DAU Continuous Learning Module (CLL029) .) The goal is to perform as much maintenance as possible based on tests and measurements or at pre-determined trigger events. A trigger event can be physical evidence of an impending failure provided by diagnostic or prognostics technology or inspection. An event can also be operating hours completed, elapsed calendar days, or other periodically occurring situation (i.e., classical scheduled maintenance). Key considerations in implementing this concept include:

- Use of **diagnostics** monitoring/recording devices and software (e.g., built-in test (BIT) and built-in-self-test (BIST) mechanisms) providing the capability for fault detection and isolation, (including false alarm mitigation) to signal the need for maintenance. It should include user friendly features to convey system status and the effect on mission capabilities to the operator and maintainer.
- Use of **prognostics** monitoring/recording devices and software monitoring various components and indicate out of range conditions, imminent failure probability, and similar proactive maintenance optimization actions to increase the probability of mission success and anticipate the need for maintenance. (As in the case for diagnostics

prognostics includes BIT and BIST mechanisms with user friendly features and false alarm mitigation.)
- Maintenance strategies that balance scheduled (preventive) maintenance and minimize unscheduled corrective maintenance with risks.

Key characteristics in implementing the CBM+ concept include:

- Hardware-system health monitoring and management using embedded sensors; integrated data
- Software-decision support and analysis capabilities both on and off equipment; appropriate use of diagnostics and prognostics; automated maintenance information generation and retrieval
- Design-open system architecture; integration of maintenance and logistics information systems; interface with operational systems; designing systems that require minimum maintenance; enabling maintenance decisions based on equipment condition
- Processes-RCM analysis; a balance of corrective, preventive, and predictive maintenance processes; trend-based reliability and process improvements; integrated information systems providing logistics system response; CPI; Serialized Item Management (SIM)
- Communications-databases; off-board interactive communication links
- Tools-integrated electronic technical manuals (i.e., digitized data) (IETMs); automatic identification technology (AIT); item-unique identification (IUID); portable maintenance aids (PMAs); embedded, data-based, interactive training
- Functionality-low ambiguity fault detection, isolation, and prediction; optimized maintenance requirements and reduced logistics support footprints; configuration management and asset visibility.

In accordance with DoDI 4151.22 , it is envisioned that elements of CBM+ should be revisited as the life cycle progresses, conditions change, and technologies advance. Consequently CBM+ should be considered and revisited in each life-cycle phase. See CBM+ Guidebook , Section 4 which provides basic steps for planning and implementing CBM+ throughout the life cycle.

5.3.4. Other Logistics Technologies

Program managers can minimize life-cycle cost while achieving readiness and sustainability objectives through a variety of methods in the design of the system and its maintenance / sustainment program. Below are technologies that should be considered to improve maintenance agility and responsiveness, increase materiel availability, and reduce the logistics footprint:

- **Serialized Item Management (SIM).** SIM (DoDI 4151.19) can be used to aid asset visibility and the collection and analysis of failure and maintenance data. (Also see section 4.3.18.14) The SIM program should be structured to provide accurate and timely item related data that is easy to create and use. While SIM is a DoD wide initiative, the primary function for the program is in ensuring the marking of the population of select items (parts, components, and end items) with a universal item unique identifier (IUID) (DoDI 8320.04). IUID should be used on tangible property, including new equipment, major modifications, and re-procurement of equipment and spares. As a minimum

populations from the following categories should be considered for marking:

- Repairable items down to and including sub-component repairable unit level;
- Life limited, time controlled, or items with records (e.g., logbooks, equipment service records, Safety Critical Items); and
- Items that require technical directive tracking at the part number level.

Serialized item management techniques including the use of automatic identification technologies (AIT) such as item unique identification (IUID) technology, and radio frequency identification (RFID) using data syntax and semantics should conform to International Organization for Standardization (ISO) 15418 and ISO 15434 .

- **Automatic Identification Technology.** AIT is an integral element of serialized item management programs. IUID markings and accompanying AIT capabilities facilitate paperless identification, automatic data entry, and digital retrieval of supply and maintenance related information. The program has a wide range of technologies from which to choose, ranging from simple bar codes to radio frequency identification technology. In choosing the specific technology, the PM should consider that the technology will change over the life cycle both for the program and the supply chain management information systems using the information. Consequently, it is important the PM take into account the need to plan for and implement an iterative technology refreshment strategy. In addition, since AIT is used by supply and maintenance management information systems it is important that items selected for serialized item management be marked in conformance with MIL STD 129.
- **Need for special handling or supportability factors.** This includes the need for special facilities or packaging, handling, storage, and transportation (PHS&T) considerations. This is usually driven by physical needs (e.g., size, weight, special materials) but can also include eliminating excessive set up and teardown times or the in ability to transport systems without disassembly and reassembly.

5.4. Sustainment in the Life-Cycle Phases

5.4.1. Developing the Support Concept and Establishing Requirements

5.4.1.1. Sustainment in the Joint Capabilities Integration and Development System (JCIDS) Process

5.4.1.2. Materiel Solution Analysis Phase Overview

5.4.1.3. Activities/Processes

5.4.1.3.1. Identifying and Evaluating Alternatives

5.4.1.3.2. Sustainment Metrics

5.4.1.3.3. Technical Reviews

5.4.1.3.3.1. Sustainment Considerations in the Initial Technical Review (ITR)

5.4.1.3.3.2. Sustainment Considerations in the Alternative System Review (ASR)

5.4.1.4. Materiel Solution Analysis Phase Results/Exit Criteria

5.4.1.5. Sustainment Considerations in the Materiel Solution Analysis Phase

5.4.1.6. Best Practices during the Materiel Solution Analysis Phase

5.4.1.6.1. Life-Cycle Cost

5.4.1.6.2. Modeling and Simulation

5.4.1. Developing the Support Concept and Establishing Requirements

Effective sustainment begins with the supportability analysis to form CDD specifications for each supportability parameter to be designed, developed, or procured as proven commercial technology. It is these analysis-driven supportability parameter specifications, once integrated through systems engineering with all other technical parameters, which drive deployed system operational availability, sustainment effectiveness, and operator ownership affordability. As discussed below, supportability analyses establish supportability performance capability KPP/KSA parameters for Sustainment in the Joint Capabilities Integration and Development System (JCIDS) requirements documentation and are central to the systems engineering process of identifying and refining all system technical performance capabilities.

5.4.1.1. Sustainment in the Joint Capabilities Integration and Development System (JCIDS) Process

Performance-based life-cycle product support implementation begins in the JCIDS process with the exploration of capabilities defined in terms of overall performance and linking sustainment to performance. Every system is acquired to provide a particular set of capabilities in a specific concept of operations, and sustained to an optimal level of readiness. Understanding user needs in terms of performance is an essential initial step in developing a meaningful support strategy because changes to the CONOPS or the sustainment approach may impact the effectiveness, suitability, or cost of the system. Consequently, operational commands and organizations supporting the combatant commanders should be involved in establishing the requirements since they are generally the system users. Their needs should be translated into performance and support metrics to serve as the primary measures of support system performance.

An effective and affordable logistics support program should be represented as a performance capability priority. As discussed in section 1.3, the JCIDS process documents performance capabilities where Warfighters, or their operational user representatives, identify needed supportability and support related performance capabilities parameters (e.g., sustainment metrics, footprint limitations, cost per operating hour, diagnostic effectiveness). Sustainment planning and resource requirements should be mapped to these specific user needs for support related

system performance. Further, programs can more easily invest in sustainment features such as condition based maintenance plus (CBM+) and related embedded instrumentation technology, when they are tied to JCIDS performance parameters.

The JCIDS analysis process is composed of a structured methodology that defines capability gaps, capability needs, and approaches to provide those capabilities within a specified functional or operational area. Based on national defense policy and centered on a common joint war fighting construct, the analyses initiate the development of integrated, joint capabilities from a common understanding of existing joint force operations and doctrine, organization, training, materiel, leadership and education, personnel and facilities (DOTMLPF) capabilities and deficiencies. The JCIDS analyses are led by the sponsor and linked into the Life-Cycle Management System at each phase and milestone.

The JCIDS Instruction (CJCS Instruction 3170.01) and Manual require that key considerations for sustainment be addressed early in the analysis as indicated below:

- A Key Performance Parameter for Sustainment has been mandated which treats logistics supportability as a performance capability inherent to the systems design and development
- A Sustainment Key Performance Parameter (Materiel Availability) and two mandatory supporting KSAs (Materiel Reliability and Ownership Cost) are required for all JROC Interest programs involving materiel solutions.
- Logistics supportability becomes an inherent element of operational effectiveness.
- The Capability Development Document and Capability Production Document (CPD) must state the operational and support-related/sustainment performance attributes of a system that provides the desired capability required by the Warfighter -- attributes so significant that they must be verified by testing and evaluation
- The DOTMLPF includes analysis of the entire life cycle, including the sustainment; environment, safety, and occupational health (ESOH); and all Human Systems Integration (HSI) domains.
- The process to identify capability gaps and potential materiel and non-materiel solutions must be supported by a robust analytical process that objectively considers a range of operating, maintenance, sustainment, and acquisition approaches and incorporates innovative practices -- including best commercial practices, HSI, systems engineering (including safety and software engineering), collaborative environments, modeling and simulation, and electronic business solutions.
- The approaches identified should include the broadest possible range of joint possibilities for addressing the capability gaps. For each approach, the range of potential sustainment alternatives must be identified and evaluated as part of determining which approaches are viable.

Initial Capabilities Document (ICD). JCIDS analyses provide the necessary information for the development of the ICD. The lessons learned, cost drivers of current systems, and/or constraints impacting the supportability related design requirements of the planned system, and support system should be documented in the ICD. In addition, the sustainment metrics and the following supportability drivers should be included in the ICD because they guide the acquisition

community in refining the concept selected and identify potential constraints on operating and support resource requirements:

- System maintenance/support profiles and use case scenarios;
- Reliability and maintenance rates;
- Support environment and support locations;
- Support and maintenance effectiveness needs; and
- Duration of support.

5.4.1.2. Materiel Solution Analysis Phase Overview

The purpose of this phase is to assess potential materiel solutions and developing a Technology Development Strategy (TDS). This includes identifying and evaluating affordable product support alternatives with their associated requirements to meet the operational requirements and associated risks. Consequently, in describing the desired performance to meet mission requirements, the sustainment metrics should be defined in addition to the traditional performance design criteria (e.g., speed, lethality). This is because reliability, reduced logistics footprint, and reduced system life-cycle cost are most effectively achieved through inclusion from the beginning of a program and therefore should be addressed in the AoA Plan.

Along with articulating the overall system operational effectiveness objective, this phase is critical for establishing the overarching trade space available to the PM in subsequent phases. User capabilities are examined against technologies, both mature and immature, to determine feasibility and alternatives to fill user needs. Once the requirements have been identified, a gap analysis should be performed to determine the additional capabilities required to implement the support concept and it's drivers within the trade space.

5.4.1.3. Activities/Processes

While considered pre-system acquisition, this phase is critical to acquisition program success and achieving materiel readiness because it is the first opportunity to influence systems supportability and affordability by balancing technology opportunities with operational and sustainment requirements. The phase provides the widest latitude for considering requirement alternatives and has the greatest impact on the life-cycle cost. In determining the optimally balanced requirements, emphasis is not only on the reliability and maintainability of potential materiel solutions, but also on assessing cost-effective responsiveness and the relevance of support system and supply chain alternatives.

5.4.1.3.1. Identifying and Evaluating Alternatives

During this phase, various alternatives are analyzed to select the materiel solution and develop the TDS to fill any technology gaps. Key activities involve identifying and evaluating alternatives and their system sustainment and product support implications. This process is critical because the resulting details guide the acquisition community on refining the concept selected and identifying potential operating and support resource constraints.

Analysis of Alternatives (AoA) . The analysis should evaluate the mission effectiveness, operational suitability, and estimated life-cycle cost of alternatives to meet a mission capability in determining the system concept. The AoA team should include functional sustainment performance and associated life-cycle cost analysis expertise to help ensure the AoA assesses the ability of each material alternative candidate to meet and sustain the systems JCIDS performance sustainment capability parameters. It is important that the analysis of alternatives includes alternative maintenance and sustainment concepts consistent with the physical and operational environment of the proposed system. Specific consideration should be given to the associated performance metrics to achieve the required effectiveness goals and the overall ability to accomplish a mission, including the ability to sustain the system. Consequently, during this phase the focus is on determining the system level sustainment metrics and values that provide the balance between mission effectiveness, LCC, logistics footprint, and risk that best represents Warfighter needs. This needs to be done for each system alternative analyzed and for their associated sustainment and maintenance strategies. The strategies must then be broken down to their respective drivers to determine the gaps between what is needed to achieve the mission capability and what is currently achievable. The drivers then become performance-based metrics for sustainment enablers. The gaps indicate risk areas and become candidates for potential technology development initiatives. Since operational suitability is the degree to which a system can be used and sustained satisfactorily in the field (in war and peace time), consideration should be given to reliability, availability, maintainability, compatibility, transportability, interoperability, sustainment, documentation, and all the HSI domains (Manpower, Personnel, Training, HFE, Environment, Safety, Occupational Health, Survivability, and Habitability).

This analysis should be accomplished by:

- Forecasting the physical and maintenance environment of the proposed system. This should include the projected sustainment demands.
- Using the forecasted environment to assess the functional characteristics of the proposed system, it's complexity, and the obstacles and enablers for effective sustainment.
- Assessing the impact of the proposed system on the maintenance capabilities planned for the period in which the system will be introduced.
- Assessing the preliminary manpower and personnel requirements and constraints in both quantity and skill levels.
- Compiling initial information and requirements for the logistics footprint, deployment requirements, and other factors affecting the in-theater operational concept. Even this early Rough Order of Magnitude (ROM) estimates can be performed with comparisons to prior systems or systems of similar capability.
- Developing initial operating and support reliability objectives and their corresponding benefit's and resource requirements. This can be done by comparing the performance histories of prior systems or systems of similar capability where feasible for the critical maintenance/sustainment enablers required to achieve the operational requirements.
- Developing ROM life-cycle cost estimates.

Data collected and analyzed during the analysis of alternatives should be retained because it can be useful for subsequent performance-based product support analysis including providing the baseline for logistics footprint and other factors affecting the in-theater operations concept. (See

section 3.3.3) As a result, the sustainment related data should be maintained in a manner to make it easy to update program deliverables during subsequent phases, especially prior to milestone decisions.

5.4.1.3.2. Sustainment Metrics

During the Capabilities-Based Assessment (CBA) process, the operational framework and the Combatant Commander's priorities should be defined sufficiently to guide the development of alternative materiel and sustainment solutions. Relevant sustainment criteria and alternatives should be evaluated and addressed in the Initial Capabilities Document in sufficient depth to support the analysis of alternatives and establish the foundation for developing the Sustainment Key Performance Parameter and supporting KSAs in the Capability Development Document and Capability Production Document . At this time, the metrics should be defined and analyzed against the alternatives and a rough plan as to how they will be measured should be developed.

The focus should be on ensuring the metrics are traceable to the ICD, CDD, other JCIDS analysis, or agreement with the user community on the values for each metric and on documented analyses. The analyses should use the most appropriate data sources and include comparisons of corresponding values for analogous existing systems. Where there is a wide difference between values being achieved by today's systems and those needed for the projected environment, further analysis should be done to determine the enabler technologies (e.g., diagnostics, prognostics) required to achieve the sustainment metrics. The analysis should identify the corresponding performance requirements for key enabling technologies. The results should be included in the TDS and Draft CDD.

5.4.1.3.3. Technical Reviews

Many of the actions and subsequent results in this phase are reviewed during technical reviews. The actions and results discussed in this section should be accomplished even if the specific referenced reviews do not occur. The actions and results are tied to the reviews to reflect the relative timeframe in which the actions should be accomplished.

5.4.1.3.3.1. Sustainment Considerations in the Alternative System Review (ASR)

The ASR helps ensure the preferred system and product support solution satisfies the Initial Capabilities Document. Generally, the review assesses the evaluated alternative systems to ensure that at least one of the alternatives has the potential to be cost effective, affordable, operationally effective and suitable, and can be developed to provide a timely solution at an acceptable level of risk. See section 4.2.9 for additional information on how the ASR ensures the requirements agree with the customer’s' needs and expectations.

For this review to be fully effective, the support concept should be addressed as an integral part of the system concept. During the review, the system concept should be assessed with particular attention to understanding the driving requirements for reliability, availability, maintainability, down time, life-cycle costs, and the enabling technologies required to meet user requirements.

Completion of the ASR should provide:

- An agreement on the support concept to be used as the baseline for subsequent trade studies. The support concept should include the conceptual description, scope, and risk for both the system, as well as any supply chain system/software needs beyond what is currently available.
- The results of any sustainment and support concept trade studies/technical demonstrations to develop the concept or reduce risks.
- Refined thresholds and objectives (initially stated as broad measures of effectiveness). This should include a comprehensive rationale for the preferred solution and the proposed sustainment requirements based on an analysis of alternatives that included cost, schedule, performance (including hardware, human, software), and technology risks.
- Product support constraints to enable integration with the operational and support environments.
- Planning for the Technology Development phase addressing critical sustainment enabling hardware and software to be developed and demonstrated/prototyped, their cost, and critical path drivers. Planning should be based on a comprehensive assessment of the relative risks associated with the preferred support concept including commercial off-the-shelf items in the program. It should emphasize host platform environmental design, diagnostic information integration, and maintenance concept compatibility.
- Sustainment requirements for the draft system requirements document, consistent with technology maturity and the proposed program cost and schedule for the technical baseline and preferred support concept. This should include any commonality, compatibility, interoperability, integration or joint requirements.

5.4.1.4. Materiel Solution Analysis Phase Results/Exit Criteria

The focus of this phase is on identifying the initial concept and any critical product support capability requirements. Affordable operational effectiveness is the overarching sustainment objective that should be considered during the JCIDS process. Implementing the process contained in figure 5.4.1.3.1.F1 results in the preferred system concept and the planning to mature the enabling technologies. The conclusion of this phase produces the initial acquisition strategy (including the sustainment strategy), contractual documents required to continue into the Technology Development Phase and includes the initial support & maintenance concepts as well as LCC and manpower estimates for the system concept.

Table 5.4.1.4.T1 identifies the most critical documents that should incorporate or address sustainment/logistics considerations. Entry documents should be complete when the phase is initiated and include the specific product support issues to be addressed in the phase along with a notional Maintenance & Sustainment Concept of Operations (CONOPS) consistent with the projected Operational CONOPS. Exit documents are completed or, in the case of the Maintenance & Sustainment CONOPS, updated based on the analysis of alternatives results. The key sustainment elements to be addressed in the next phase should be included in the Acquisition Strategy, the Technology Development Phase RFP, and Source Selection Plan.

Table 5.4.1.4.T1. Sustainment Considerations in Materiel Solution Analysis

Entry Documents:
Initial Capabilities Document
Analysis of Alternatives Plan
Alternative Maintenance & Sustainment Concept of Operations
Exit Documents:
Analysis of Alternatives (including Market Research results)
Draft Capability Development Document
Test and Evaluation Strategy
Technology Development Strategy
SEP
Life-Cycle Sustainment Plan

The **Analysis of Alternatives Report** should describe the alternative maintenance and sustainment concepts consistent for each alternative analyzed along with the support capabilities drivers and any gaps.

The exit documents should contain the following sustainment related information for the preferred system concept:

- **ICD/Draft Capability Development Document** the description of the specific enabling technology capabilities required to achieve the drivers and/or to reduce risks in achieving the sustainment metrics values required to meet the operational requirements. The same should be done for each of the corresponding enabling technologies
- **Technology Development Strategy -** the approach for achieving the required enabling sustainment technologies (including design criteria in the Preliminary Design Specification for each of the sustainment drivers). It should also identify the required associated performance metrics and their values.
- **Test and Evaluation Strategy** the identification of the metrics and the key design features to be evaluated in subsequent phases along with the approach for evaluating the likely achievement of each

Life-Cycle Sustainment Plan In this phase and preparing for MS-A, the LCSP focuses on the approach for developing the sustainment metrics and product support strategy. Emphasis is on the:

- Sustainment metrics (including their threshold and objective values) as well as the supporting design characteristics included in the contract along with the corresponding test methods incorporated in the T&E Strategy/TEMP
- Support and Maintenance Concepts including any real world constraints or limitations (including "core" requirements, statutory requirements, etc.) as well as the extent to which the program is taking advantage of existing supply chain processes and

maintenance capabilities.

- Critical sustainment technologies requiring development, their corresponding development plan and how their maturity will be demonstrated.
- Management approach and analytical process for determining affordable metrics (for both the weapon system operational performance and supply chain performance) and for identifying cost and availability degraders so that they can be addressed in the design process.

5.4.1.5. Sustainment Considerations in the Materiel Solution Analysis Phase

Use of M&S should be considered to gain an understanding of the dependency and interplay between designed-in capabilities, processes, availability, and life-cycle cost. While at a high level during this phase, each design alternative examined within the operational concept should be considered as to system availability, LCC, and maintenance and sustainment concept drivers. It is important the analysis of alternatives consider the physical and maintenance environment of the proposed systems in the assessment of the alternative system support concepts.

During this phase, support considerations should address the degree to which a systems design and planned logistics resources support its readiness requirements and wartime utilization. This includes consideration of activities and resources (such as fuel) necessary for system operation as well as real world constraints and environment. It also includes all resources that contribute to the overall support cost (e.g., personnel; equipment; technical support data; and maintenance procedures to facilitate the detection, isolation, and timely repair/replacement of system anomalies).

5.4.1.6. Best Practices during the Materiel Solution Analysis Phase

Modeling and simulation combined with LCC analysis are critical best practices and should be included in the AoA Plan. In addition, both should be used as a source selection factor in the Technology Development Phase selection process and to define the desired ranges for the sustainment metrics thresholds and objectives.

5.4.1.6.1. Life-Cycle Cost

During this phase, both acquisition and O&S costs need to be considered in evaluating affordable alternatives. Also during this phase, key sustainment related cost performance criteria, such as O&S cost per operating hour or cost per ton-mile, can be considered when conducting design trade-off analyses.

Logistics footprint minimization in projecting and sustaining the force is an overarching DoD goal because minimizing the logistical burden a system will place on deployed forces benefit's the user, improves deployment time, and can help reduce the LCC. During this phase, footprint metrics appropriate to the system and its operational environment should be analyzed and considered as subsequent KPP, KSA, or design requirements. At a minimum, logistics footprint metrics to meet the concept of operations should be established to be used in baseline trade analyses throughout the life cycle to help impact the design and establish a minimal logistics

footprint for the system concept.

5.4.1.6.2. Modeling and Simulation

During this phase M&S supports the requirements determination efforts by analyzing the impact of various alternatives to determine an achievable range of the sustainment metrics values to meet the functional requirements. M&S should be used to assess the alternatives, ensuring all sustainment metrics are considered in parallel and not at the expense of the others. In addition, sensitivity analyses should be used to determine the:

- Optimum mix of key metric values (e.g., LCC and readiness drivers) required to meet the requirements and identify corresponding confidence levels for each of the alternatives
- Impact on sustainment, LCC, and readiness drivers if the supply chain performs at today's performance levels.
- Associated sustainment/maintenance concepts for each of the alternatives to be used as the baseline in subsequent phases

Combining these factors will help identify specific areas where new technology is required to achieve or to reduce risks and increase the probability of achieving the requirements.

5.4.2. Sustainment in the Technology Development Phase

5.4.2.1. Overview

5.4.2.2. Activities/Processes

5.4.2.2.1. Initial Life-Cycle Sustainment Plan

5.4.2.2.2. Maintenance & Sustainment Strategy Development

5.4.2.2.3. Technical Reviews in Technology Development

5.4.2.2.3.1. Sustainment Considerations in the System Requirements Review (SRR)

5.4.2.2.3.2. Sustainment Considerations in the System Functional Review (SFR)

5.4.2.2.3.3. Sustainment Considerations in the Preliminary Design Review (PDR)

5.4.2.2.3.4. Sustainment Considerations in the Technology Readiness Assessment (TRA)

5.4.2.2.3.5. Sustainment Considerations in the Integrated Baseline Reviews (IBR)

5.4.2.3. Technology Development Phase Results/Exit Criteria

5.4.2.4. Sustainment Considerations in the Technology Development Phase

5.4.2.5. Best Practices during the Technology Development Phase

5.4.2.5.1. Supportability Analysis

5.4.2.5.2. Modeling and Simulation

5.4.2.1. Overview

The purpose of this phase is to reduce technology risks (including required sustainment technologies to achieve the needed materiel availability) and determine the technologies to be integrated into the system. The focus is on developing the preliminary design (down to the subsystem/equipment level), reducing integration and manufacturing risk, and, from a sustainment perspective:

- Designing-in the critical supportability aspects to reduce sustainment technology risks and ensuring features (including CBM+ technologies) are incorporated into the system specifications and test plans.
- Developing the initial product support package framework, options, and requirements for the long-term performance-based support concept.

This phase is the most critical for optimizing system sustainment through designed-in criteria to help ensure sustainability. Particular attentions should be paid to reducing the logistics footprint, implementing human systems integration, and designing for support to help ensure life-cycle affordability. Also, during this phase detailed plans for organizing to manage the implementation of the product support package should begin.

The support concept should be defined going into this phase. The phase should be used to define the design-to requirements and to design the product support package. Technology demonstrations and prototyping should be conducted to help determine mature, affordable technologies to be included in the system and support system designs. The demonstrations results coupled with analysis should be used to refine requirements and the LCC estimate, narrow the ranges of all program metrics, and increase confidence the values can be met at an affordable cost.

5.4.2.2. Activities/Processes

This phase is important because cost/schedule/performance/sustainability trade-off analyses linked to demonstrated technologies increase the confidence performance, cost, and schedule thresholds can be achieved. During this phase, the logistics emphasis is on maturing the technologies that enable achievement of supportability objectives, on performing requirements refinement and trade-offs to evaluate the achievable performance given the demonstrated technologies, on refining the supportability objectives in both range and depth, and on identifying any constraints that will limit the system or it's supply chain to achieve the operational readiness or mission effectiveness.

Cost/Schedule/Performance/Sustainment Trade-Offs. In all life-cycle phases, cost, schedule,

performance, and sustainability may be traded within the trade space between the objective and the threshold without obtaining Milestone Decision Authority approval. Consequently, it is critical the trade space be established early and be acceptable to the user and acquisition communities. As a result, the operational user and sponsor should be involved with the determination of the trade space and involved in trade-off decisions during this phase. The following are the key steps for establishing the trade space and determining the specific developmental requirements:

- Include sustainment requirements and/or considerations in Advanced Concept Technology Demonstrations, Advanced Technology Demonstrations, and other technology oriented demonstrations and prototyping. The demonstrations should be used to help assess the maturity of available and planned technology required for:
    - The preferred operating and support concepts.
    - Achieving the best balance between mission effectiveness, life-cycle cost, logistics footprint, and risk.
    - The sustainment performance driver parameters that best represent user needs in achieving operational readiness.
- Forecast the physical and operational environment of the proposed system along with corresponding notional operating and support concepts. The forecast should include consideration of future projections of domestic and foreign facilitation and logistics infrastructure. Specific consideration should be given to the performance-based requirements to achieve the objectives / thresholds for each of the alternatives considered and determining gaps based on technology availability. The gap analysis needs to take into account the complexity and the obstacles to, as well as, the required enablers for effective sustainment likely to be available when the system is deployed considering the current state of the art and likely funding. These gaps should then be used to eliminate alternatives or to determine specific technologies to be developed. It should also form the foundation for a corresponding technology development and verification strategy.
- Perform a market analysis (both public and private) for the needed system and product support capabilities to fill the gaps. The analysis should address the extent and scope of opportunities for using commercial items and processes. It should consider and assess the:
    - Elements of support currently provided (for any legacy systems to be replaced).
    - Current measures used to evaluate support effectiveness.
    - Current effectiveness of required support.
    - Existing support data across the logistics support elements.
    - Existing technologies and associated support that impact the new system.
- Develop the functional characteristics and performance specification of the system and its support system based on the best balance between mission performance, life-cycle cost, logistics infrastructure and footprint, and risk. An analysis should be conducted to identify key performance and related support parameters for inclusion in the CDD. The analysis should form the basis of design requirements for subsequent phases and will affect the KPPs/KSAs and the overall capability of the system to perform and endure in the required mission environment. ROM LCC estimates should be developed and included in the analysis results based on the following key elements:
    - Preliminary manpower and personnel requirements estimates. This should also

include an assessment of any constraints in both quantity and skill levels and the use of contractor support.

- Operational effectiveness, reliability, maintainability, supportability and interoperability drivers. This should include embedded and external diagnostics, prognostics, and other maintenance enabler technologies that will be required based on suitably mature new design technology. In identifying the drivers and their threshold and objective values, performance histories of similar systems should be examined to determine the feasibility/risks of achieving the required levels and develop a risk mitigation plan. If one has to be developed, the corresponding benefit's and resource requirements for each of the drivers should be identified.
- Logistics footprint metric estimates, deployment requirements, and other factors affecting the in-theater operational concept. This should include the elements the program will be responsible for and the supply chain performance requirements upon which the program will require to meet operational effectiveness objectives.

Depot Maintenance: During this phase, the following actions are required:

- Finalization in the determination of the organic source of repair to be assigned primary responsibility for maintenance and repair of each system and each sub-system having a core capability requirement.
- Estimate the ROM for the depot-level maintenance workload to be performed at organic facilities for the system and each subsystem.
- Determine the technical data, facility and equipment requirements to ensure the capability to support these workloads.
- Program the resources for the technical data, facilitation, and equipment requirements.
- Summarize the results of these actions in the Acquisition Strategy submitted for Milestone B approval.

5.4.2.2.1. Initial Life-Cycle Sustainment Plan

During this phase, and in preparing for MS-B, the program focuses on finalizing the sustainment metrics, sustainment requirements integration into the design, expanding on the sustainment strategy and maintenance concept and an execution plan describing the design, acquisition, fielding, and competition of sustainment activities to deliver the product support package. The LCSP documents the maintenance & support concepts based on the results of any technology demonstrations and analyses performed to date. It should describe the envisioned sustainment capabilities as viewed by the user and major support providers (e.g., the maintainer, supplier and transportation providers). Taking into account the real world constraints and limitations (including "core" requirements, statutory requirements, etc.), it should include the:

- Sustainment metrics (including their threshold and objective values) as well as the supporting design characteristics included in the contract along with the corresponding test methods incorporated in the TEMP.
- Envisioned Product Support Arrangements, including the level that will be covered by performance-based incentives tied to metrics.

- Approach for developing and fielding the product support package describing who is doing what, where, and when with the associated budgets.
- Analytical process for determining affordable design to metrics goals and thresholds at the subsystem level and for the supply chain are established including how they will be kept aligned/balanced as the design and the supply chain evolve.

5.4.2.2.2. Maintenance & Sustainment Strategy Development

The maintenance & sustainment strategy should be refined from the projected systems reliability and the preliminary sustainment concept of operations to meet the operational requirement in the planned environment. They are then used to determine the supply chain performance requirements, along with the key enabling features needed to implement the strategy. These enablers can range from system design features (e.g. condition based maintenance) to supply chain features (e.g., rapid distribution of tailored support packages, just in time training / distance support, total asset visibility anywhere in the support chain, dedicated rapid response support teams analyzing real time data). The details should be described in sufficient detail to provide assurance that risks are understood and the gaps can be filled.

Core logistics and repair sources are critical elements in establishing appropriate repair and support capability. New and emerging systems may lack mature data at this stage, but by using data from similar current systems and subsystems, planning for a sustainment strategy can evolve. Key activities should include establishing the baseline for trade studies by identifying notional maintenance levels and activities for major subsystems, taking into account system/subsystems with a core capability.

The gaps between the current state of the art and current sustainment/maintenance capabilities versus what is required (along with the risk) should be used to identify technologies needing to be developed and demonstrated in subsequent phases. They should also be used in developing the implementation plan for proceeding with the best value alternative and summarized in the LCSP. The following are key considerations in developing the performance/cost/schedule/ sustainment and risk tradeoff analysis:

- The relative cost vs. benefits of different support strategies.
- The methods and rationale used to quantify benefits and costs.
- Data required to support and justify the best value support strategy.
- Sensitivity of the data to change.
- Analysis and classification of risks.

Core Capability Planning and Analysis. The requirement for determining core requirements and applying this methodology extends to all weapon systems and equipment operated by each DoD Component, regardless of where depot-level maintenance is actually performed (DoDI 4151.20 , "Depot Maintenance Core Capabilities Determination Process"). The following depot maintenance core capability requirements determination methodology is used to determine essential DoD depot maintenance capability requirements for each DoD Component, and the workloads needed to sustain those capabilities.

- Programs requiring a core capability/DSOR decision shall be identified by the managing Service Acquisition Program Manager (PM) (or Joint Program Office (JPO) in the case of Joint Service acquisitions) to the Service organization(s) responsible for depot-level maintenance management (hereafter referred to as MMOs). Joint programs, and those having depot-level maintenance inter-servicing potential, shall be identified by each DoD Component MMO in conjunction with the PM/JPO.
- The identification of the need for a core determination will occur at least 180 days prior to the Acquisition Milestone B decision need date. For systems entering the acquisition process after Milestone B, identification will occur immediately following the acquisition approval.
- It is the responsibility of the Acquisition Program Manager (PM) (or Joint Program Office (JPO)) in conjunction with the DoD component that owns the depot-level maintenance assets to ascertain the potential need for establishing an organic core capability requirement by addressing, at a minimum, the following questions. Other considerations may be applied, as appropriate.
- Is the system replacing a system having a core capability requirement at either the system or the subsystem level? If the answer is "Yes" then it can be assumed that this system and it's subsystems will require the same core capability requirements as the system being replaced, adjusted for known inventory and workload differences.
    - If not, will the system be used or is it planned to be used in support of a JCS contingency scenario? If the answer is "Yes" then Section 2464 of Title 10, United States Code requirements for the establishment of organic core capability apply.
    - If the answer to either question is 'yes', an initial core capability requirement determination analysis must be conducted and candidate Depot Source of Repair (DSOR) depot-level maintenance facilities identified by the DoD Component(s).
- After core requirements have been determined, the PM/JPO shall take appropriate steps to assure that the requirements for the establishment of organic capability are included in all product support acquisition requirements (e.g. need for tech data, peculiar support equipment, facilities and/or Public Private Partnership).
- While not part of the core determination process it is at this stage that any requirements to assign a portion of the proposed workload to an organic depot to provide reasonable assurance of future compliance with the 50/50 requirements be identified and provided by the DoD Component(s) MMOs to the PM/JPO along with justification and documentation for use in designing the product support strategy.

5.4.2.2.3. Technical Reviews in Technology Development

Many of the actions and subsequent results in this phase are reviewed during technical reviews. The actions and results discussed in this section should be accomplished even if the specific referenced reviews do not occur. The actions and results are tied to the reviews to reflect the relative timeframe in which they should be accomplished.

5.4.2.2.3.1. Sustainment Considerations in the System Requirements Review (SRR)

The SRR is conducted to ascertain the results of the prototyping and demonstrations relative to

the system technical requirements. It determines the direction and progress of the systems engineering effort and the degree of convergence upon a balanced and complete system baseline. (See section 4.2.10 for additional information.) The purpose is to ensure all system requirements (performance requirements and sustainment requirements) derived from the Initial Capabilities Document (ICD) or draft CDD are defined, consistent and achievable within cost, schedule and any other constraints. Generally the SRR assesses the prototyping results with respect to the system requirements captured in the system specification and support strategy to ensure they are consistent with the system and support solution as well as available technologies.

The SRR is important in understanding the performance requirements, cost, and scheduling impacts on the system and its support concept. During the SRR, the systems requirements are evaluated to determine whether they are fully defined and consistent with a demonstrated mature technology solution. A successful review is predicated on determining the system and support element requirements are based on available technology, a sustainable support concept, and program resources (e.g., funding, staffing, processes and schedule). Logistics and product support subject matter experts should participate to ensure the critical sustainment system and support elements enabler technologies required to implement the support strategy and achieve the needed materiel availability are included in the planning and performance specifications. Understanding and accepting the program risk inherent in the system specification, Systems Engineering Plan and Life-Cycle Sustainment Plan is key to a successful review. The SRR should provide:

- An approved system performance specification with achievable system, supportability, human systems integration, and sustainment enabler requirements which satisfy and are traceable to the ICD or draft CDD and support concept.
- A preliminary allocation of system requirements to hardware, human, and software subsystems. The system sustainment requirements should be sufficiently detailed and understood to enable system functional definition and functional decomposition.
- Demonstration that critical sustainment system and support element enabler technologies required to implement the support strategy and achieve the needed materiel availability are sufficiently mature to enable low risk entry into development.
- Approved support and sustainment concepts with the corresponding metrics.
- A preliminary Cost Analysis Requirements Description consistent with the approved system performance specification and sustainment concept.

5.4.2.2.3.2. Sustainment Considerations in the System Functional Review (SFR)

The SFR ensures the system functional baseline has a reasonable expectation of satisfying the CDD requirements within the allocated budget and schedule. A critical SFR aspect is the development of representative operational and product support use cases for the system. System performance and the anticipated functional requirements for operations, maintenance and sustainment are assigned to sub-systems and support systems hardware and support systems hardware & software after analysis of the operational and support environments. The SFR determines whether the systems functional definition is fully decomposed to its lowest level forming the functional baseline, and that IPTs are prepared to start preliminary design.

Additional information for this review can be found in section 4.2.11 .

Product support IPT members as well as independent supportability and sustainment subject matter experts should participate in the review to ensure the system functionality is consistent with the supportability requirements and the support strategy contained in the evolving Life-Cycle Sustainment Plan (LCSP). This involves:

- Addressing the supportability requirements to support the CDD and the supportability functionality as defined in the functional baseline ensuring adequate processes for achieving the sustainment metrics are in place.
- Defining the detailed support concept functionality requirements for system and subsystem elements to ensure system functional requirements are sufficiently detailed and understood to enable system design supportability analyses to proceed.
- Ensuring program sustainment development efforts (including system and software critical path drivers), with corresponding schedules, are included in LCSP updates.
- Ensuring the updated Cost Analysis Requirements Description (CARD) (or a CARD-like document) based on the system functional baseline, captures the key program sustainment cost drivers, development costs, production costs, and operation & support costs for all aspects of sustainment and human system integration.

5.4.2.2.3.3. Sustainment Considerations in the Preliminary Design Review (PDR)

The PDR helps ensure the systems allocated baseline and its associated support system have a reasonable expectation of satisfying the CDD requirements within the allocated budget, staffing, and schedule and have an acceptable risk level. Details can be found in section 4.2.12 but in summary the PDR assesses the preliminary design captured in the preliminary subsystem product specifications for each configuration item (hardware and software) and ensures each function, in the functional baseline, has been allocated to one or more system configuration items. The PDR evaluates the subsystem requirements to determine whether they correctly implement all system requirements allocated to the subsystem. The Integrated Product Team (IPT) should review the results of peer reviews of requirements, preliminary design documentation (including Interface Control Documents) along with the plans for development and testing for both system performance and supportability aspects to ensure the system is ready to proceed into detailed design and test procedure development.

Product support IPT members, as well as independent supportability and sustainment subject matter experts, should participate in the review to ensure the supportability requirements and the support strategy contained in the Life-Cycle Sustainment Plan (LCSP) are consistent with the evolving design. This involves:

- Addressing the supportability requirements to support the CDD and ensuring the supportability functionality are allocated to each system or subsystem and they can be achieved within the budgets and schedule. This includes ensuring the Failure Mode Effects and Criticality Analysis, Maintainability Analysis, and Reliability Centered Maintenance Analysis results have been factored into the allocated requirements, preliminary design, and risk assessment. In addition to ensuring adequate processes for

achieving the sustainment metrics are in place, this includes ensuring the HSI design factors have been reviewed and included in the overall system design.

- Setting the allocated baseline for any system and/or major subsystem product support package elements. This includes defining the detailed support concept functionality requirements for subsystem product support package elements to ensure system functional requirements are sufficiently detailed and understood to enable more detailed supportability analyses to proceed.
- Defining the test success criteria for development testing and operational testing (for both operationally effective and suitable) requirements and the general test approach for key sustainment enablers or drivers.
- Ensuring program sustainment development efforts (including system and software critical path drivers with corresponding schedules) are included in LCSP updates.
- Ensuring the updated Cost Analysis Requirements Description (CARD) (or a CARD-like document) based on the system allocated baseline, captures the key program sustainment cost drivers, development costs, production costs, and operation & support costs for all aspects of sustainment and Human Systems Integration (HSI.)

5.4.2.2.3.4. Sustainment Considerations in the Technology Readiness Assessment (TRA)

The TRA is a metrics based process that assesses the maturity of critical technology elements, including sustainment drivers, conducted concurrently with technical reviews. From a sustainment perspective, the process should be used for assessing risk and the adequacy of technology maturation planning when the support concept or sustainment drivers depend on specific new or novel technologies to meet system threshold requirements in development, production, or operation. If a key enabler or sustainment driver (e.g., reliability, turnaround time) does not meet required performance levels or significant performance advances is required over what is currently achieved with existing technology, then a plan for maturing the critical technology should be developed, explaining in detail how the performance level will be reached within the programs schedule and resources. See section 10.5.2 for additional information.

5.4.2.2.3.5. Sustainment Considerations in the Integrated Baseline Reviews (IBR)

IBRs are used throughout the program whenever earned value management is used. IBRs establish a mutual understanding of the project performance measurement baseline. While they have a business focus, IBRs can also be useful in ensuring sustainment is considered in the acquisition process when the efforts required to achieve the Sustainment KPP, KSAs and any other key sustainment enabler metrics are included in the reviews. These reviews and resultant understanding also provide for a plan of action to evaluate the risks inherent in the program measurement baseline and the management processes during project execution. Additional information can be found in section 11.3.1.3 .

5.4.2.3. Technology Development Phase Results/Exit Criteria

The focus of this phase is on reducing risk and defining achievable performance and sustainment requirements. This begins with the analysis of alternatives that include examining alternative operating and system support concepts, with specific consideration of performance-based

requirements. Success is demonstrated by identifying key performance and related sustainment metrics (with their basis) as design requirements that affect the overall capability of the system to perform and endure in the required mission environment. (In addition to the Sustainment KPP/KSAs, the metrics can include other supportability, maintainability, interoperability, manpower or footprint measures.) Implementing the process contained in figure 5.4.2.2.F1 produces the refined supportability objectives and, in some cases, anticipated constraints based on the technology assessments. The conclusion of this phase results in the contractual documents required to continue (including the related sustainment requirements and actions) and updated system baseline support & maintenance concepts, LCC, and manpower estimates.

Table 5.4.2.3.T1 identifies the most critical documents that should incorporate or address sustainment/logistics considerations. The key sustainment elements to be addressed in the next phase should be included in the Acquisition Strategy and the materiel availability enabler requirements should be included in the Engineering and Manufacturing System Development RFP as well as the Source Selection Plan. The exit documents from this phase should focus on the materiel availability driver metrics (including drivers for the enablers) and the baseline support strategy. They should also contain the following sustainment related information:

Table 5.4.2.3.T1. Sustainment Considerations in Technology Development

Entry Documents:
Analysis of Alternatives
Technology Development Strategy Draft Capability Development Document (including sustainment technology issues)
Test and Evaluation Strategy
Life-Cycle Sustainment Plan
Exit Documents:
Analysis of Alternatives (including Market Research results)
System Performance Specification
Capability Development Document
Preliminary Design Review Results
Test and Evaluation Master Plan (TEMP)
Information Support Plan
Acquisition Strategy
Cooperative Opportunities
Technical Data Rights Strategy
Core Logistics Analysis/Source of Repair Analysis
Industrial Capabilities
Life-Cycle Sustainment Plan
Life-Cycle Cost Estimate and Manpower Estimate
Preliminary Maintenance Plans

Acquisition Program Baseline (APB)
Affordability Assessment (including DoD Component Cost Analysis & ICE)

- **AoA** - the sustainment driver metrics and product support strategies for each alternative considered along with any gaps and major assumptions
- **System Performance Specification** - objectives and thresholds for the sustainment driver metrics including the corresponding enabler drivers
- **CDD** - the information necessary to deliver an affordable and supportable capability using mature technology. The following sustainment drivers information should be included:
    - System maintenance/support profiles and use case scenarios
    - The corresponding support and maintenance effectiveness measures
    - Description of the specific capabilities required to achieve the support concept and/or to reduce risks in achieving the values required to meet the operational requirements. It should include metrics for each of the key enabling technologies (e.g., reliability/ maintenance rates, diagnostics/prognostics effectiveness measures)
- **Preliminary Design Review Results** the description and status of the sustainment driver design features
- **Technology Readiness Assessment** - approach for achieving the required enabling sustainment technologies (including design criteria for each of the drivers in the preliminary system design specification) (see section 10.5.2)
- **Test and Evaluation Master Plan (TEMP)** identification of the metrics and enabling/driver technologies to be evaluated in subsequent phases, the approach for evaluating them, and test points (see section 9.5.5)
- **Data Management Strategy** the long term strategy integrating data requirements across all functional disciplines.
- **Information Support Plan** for acquiring and managing the data required to execute the support concept in the operational environment (see section 7.3.6)
- **Acquisition Strategy** containing the LCSP executive summary
- **Life-Cycle Sustainment Plan (LCSP)** summary of the maintenance & sustainment concepts including the support locations and duration. It should focus on the support strategy including the contracting strategy to acquire the major elements of the support concept and the specific incentives being used to help achieve the sustainment drivers and enablers
- **Life-Cycle Cost Estimate and Manpower Estimate** the major assumptions and values being used for the sustainment drivers and enablers (see Chapters 3 and 6) It should also include the confidence level of the values being achieved
- **Acquisition Program Baseline (APB)** description of the sustainment metrics, criteria, and logistics funding requirements (see section 10.9)
- **Affordability Assessment** an assessment based on the likelihood of the key sustainment metrics being achieved (also see section 3.2.2)

5.4.2.4. Sustainment Considerations in the Technology Development Phase

During this phase, the focus should be on refining the threshold and objective range value estimate for each sustainment metric based on more detailed analysis identifying the technical capabilities, risks, and limitations of the alternative concepts and design options. Analysis should also be performed to identify the impacts the sustainment metrics will have on mission success and materiel availability. The key enabling requirements to achieve the sustainment metrics should be allocated to the major system level and included in the system specification. Even this early it is important to establish the reliability requirements and assess the extent to which the system will likely meet the requirements. Consequently, the reliability of the technology or system should be included in the technology readiness assessments.

Detailed plans for monitoring, collecting and validating key metrics should be established to provide empirical data to evaluate technical performance, system maturity, and the projected logistics burden. Detailed test criteria should be developed for each metric (including any key dependent enabling technologies) to provide information about risk and risk mitigation as the development and testing continue. The test strategy/requirements to provide data and analysis support to the decision process should be documented in the TEMP.

5.4.2.5. Best Practices during the Technology Development Phase

M&S combined with LCC analysis are important best practices to help assess the success in reducing program risk. In addition, both should be used in the Engineering & Manufacturing Development Phase source selection process and to define the sustainment objectives and thresholds to be placed on contract. The data used for the assessments and analysis (including the projected sustainment demand) should be complied and saved for analyses in subsequent phases.

5.4.2.5.1. Supportability Analysis

During this phase, supportability analysis focuses on the technology trade-offs. As indicated in figure 5.4.2.5.1.F1, the analysis process is iterative. They are re-run as required as the design is refined. Trade-off impacts are identified and evaluated to ensure the selection of a system concept that not only delivers system performance, but also achieves supportability, interoperability and system affordability objectives. The supportability analysis goal within this phase is to establish affordable and obtainable thresholds and objectives to achieve the user requirements in the projected environment within the Concept of Operations.

The analyses are iterative, evolving and expanding as more specific design and other technical information on the actual equipment is identified. While the focus is high level for the system at the beginning of this phase, it should also consider requirements for key enablers in terms of "what is required" vice "how it is accomplished". As the phase progresses, the analysis should determine the relative cost vs. benefits of different support strategies (including potential source of support decisions). The impact and value of performance/cost/schedule/sustainment trade-offs based on the preliminary design should continue expanding to the lowest level of the work break down structure as the design evolves across this and subsequent life-cycle phases.

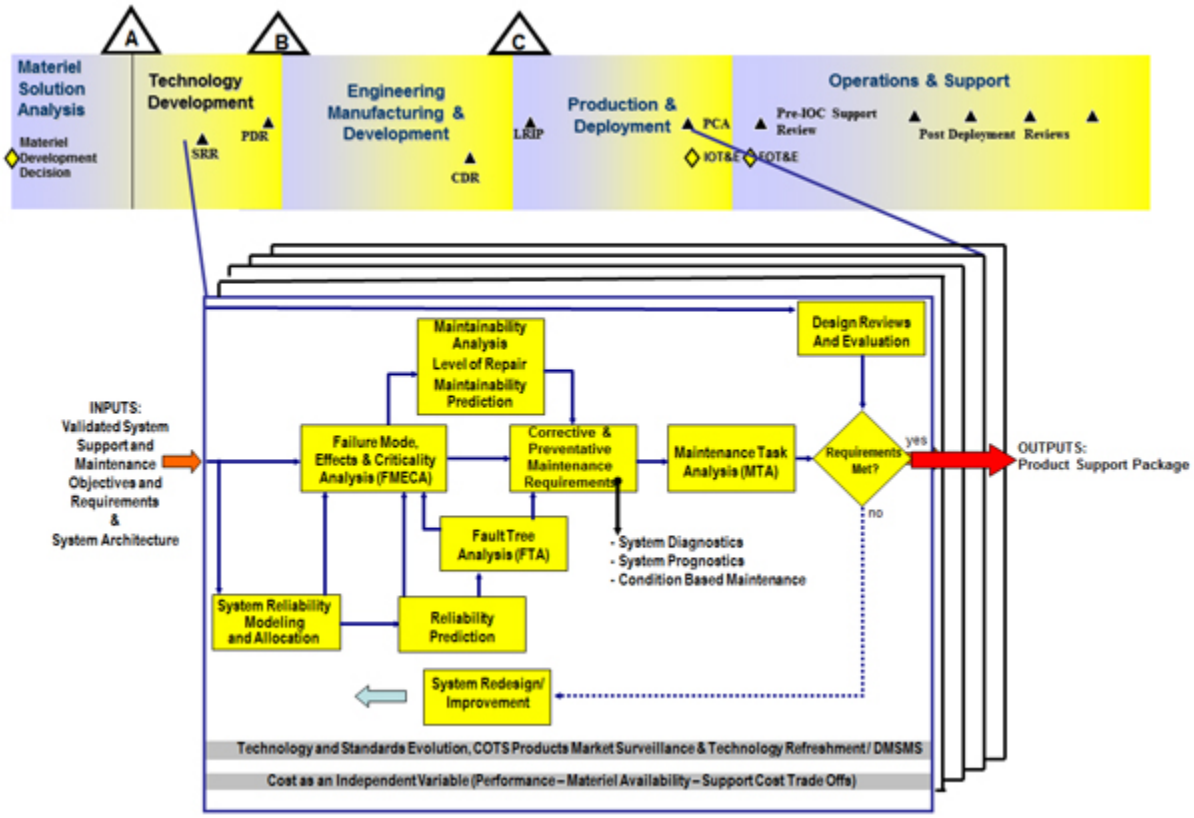
A complete supportability analysis should be performed for any parts of the system for which the government is going to provide the product support package vice using a contracted approach with materiel availability as the performance measure. Figure 5.4.2.5.1.F1 shows the key system reliability, maintainability and supportability system engineering processes. The affordable system operationally effectiveness analysis process coupled, with available tools and opportunities - such as modeling and simulation, performance testing, supportability testing/demonstration, technical data validation, and maintenance assessments - should be proactively applied and integrated with the systems engineering process. For example, system requirements can be used to develop a system reliability/availability block diagram as a basis for modeling and analysis. This approach can identify opportunities for targeted system redundancy, ease of reconfiguration, and derating, etc., and can thereby enhance system level reliability and availability. In addition, reliability, maintainability (BIT/prognostics), and supportability/ logistics demonstrations can provide the data to assess achievement of RAM requirements.

The level of detail performed by the government team will vary by the extent to which performance-based product support contract is used but that will not impact the general process, including the program major events. As a result, the supportability analysis process should take advantage and be an integral part of the major engineering events and processes, including but not limited to the System Requirements Review (SRR) and Preliminary Design Review (PDR).

As illustrated in Figure 5.4.2.5.1.F1, a FMECA helps identify the ways in which systems can fail, performance consequences, and serve as basis in the identification of Critical Safety Items as well as potential areas for preventative maintenance for the system. When conducted in a timely fashion, the FMECA can be used to support trade-offs between performance and life-cycle costs to drive design improvements. A Fault Tree Analysis (FTA) assesses the safety-critical functions within the systems architecture and design. A Maintainability Analysis and Prediction (MAP) assesses the maintenance aspects of the systems architecture, including maintenance times and resources. This analysis identifies strategic opportunities for focused diagnostics, prognostics, and performance monitoring/fault localization, leading to reduced system maintenance times and cost drivers. A level of repair analysis optimally allocates maintenance functions for maximum affordability and materiel availability.

Once FMECA, FTA, and MAP are completed and system design has been established, RCM analysis develops a focused, cost-effective system preventive maintenance program. RCM uses a system based methodical approach to determine causes of failure, failure consequences, and a logic tree analysis to identify the most applicable and effective maintenance task(s) to prevent failure, if possible. RCM also provides rules for determining evidence of need for condition based maintenance to perform maintenance only upon evidence of need. (DoDI 4151.22, Enclosure 3)

Figure 5.4.2.5.1.F1. Supportability Analysis During Design



A maintenance task analysis identifies detailed logistics and support resource requirements to sustain system readiness. Appropriate use of proactive maintenance technologies embodied in diagnostics and prognostics pays system dividends. Integrating on-board and off-board monitoring, testing, data collection, and analysis capabilities can significantly enhance system maintainability and overall supportability. Typically, practices here include enhanced prognosis/diagnosis techniques, failure trend analysis, electronic portable or point-of-maintenance aids, corrosion mitigation, serial item management, automatic identification technology, and data driven interactive maintenance training. Ultimately, these practices can increase materiel availability and readiness at a reduced cost throughout the life cycle.

The activities shown in figure 5.4.2.5.1.F1 are not necessarily carried out in a linear progression. Design increments and the continuous assessment of test results and in-service system performance will identify needs for system improvements to enhance reliability, maintainability, overcome obsolescence, corrosion, or other sustainment needs.

Risk Assessments. Risk assessments should be performed to identify and develop design trade-off that mitigates risk. Technology risk considerations should receive intensive consideration as the system concept is developed. Maximum use of low-to-medium risk technology, as indicated in Table 5.4.2.5.1.F2, provides the greatest opportunity to hold to program cost, schedule and performance requirements. Medium-to-high risk technologies should be thoroughly justified and risk mitigation efforts resourced. Use of high-risk technologies should be avoided and be a

critical factor in choosing an incremental acquisition strategy.

Once the preferred system, system support concepts and enabling technologies are selected, case scenarios reflecting system support, maintenance, and logistics are refined. These scenarios identify significant system support, maintenance, and logistic requirements and objectives. These are compared to the Sustainment KPP/KSA threshold and objective and expanded in depth as the hardware design matures and the process is iterated until an affordable systems operational effective solution is achieved.

Table 5.4.2.5.1.T1. Technology Risk Considerations

Technology Maturity	Technology Description
Low Risk	Existing Mature Technologies
Medium Risk	Maturing Technologies; New Applications of Mature Technologies
High Risk	Immature Technologies; New Combinations of Maturing Technologies

5.4.2.5.2. Modeling and Simulation

M&S should be used to refine sustainment objectives (this includes the Sustainment KPP and KSAs as well as any other LCC or readiness driver metrics) and identify any constraints based on technology assessments. The technology demonstration results should be modeled to project likely capabilities and the associated confidence levels that enabling technologies will be achievable in the operational environment. It should also be used to develop initial/notional system level product sustainment strategy and maintenance concepts for major sub systems. All of these elements will be used to project the mature Sustainment KPP/KSA values and their associated confidence levels they will be met within the CONOPS.

As the design evolves, modeling and simulation can be used to help keep the product support elements in balance between and within system hardware elements. This is done by allocating the sustainment, LCC or readiness driver metrics to specific subsystems and equipment's. These requirements are then used to develop the specific system level support strategies and maintenance plans along with their design-to requirements for both the system and it's logistic support system. Modeling at this level of detail provides more creditability especially relative to the following efforts important in this phase:

- Analyzing the impact of proposed budget alternatives on the Sustainment KPP/KSAs (as well as mission effectiveness).
- Assessing the alternatives affecting the design and deployment of both the end item and it's support system to ensure all metrics and their drivers are considered in parallel and not at the expense of the others.
- Anticipating and resolving potential problems by taking use data and user feedback for

similar equipment's and/or sustainment strategies.

5.4.3. Sustainment in the Engineering and Manufacturing Development (EMD) Phase

5.4.3.1. Overview

5.4.3.2. Activities/Processes

5.4.3.2.1. Life-Cycle Sustainment Plan

5.4.3.2.2. Technical Reviews in Engineering and Manufacturing Development

5.4.3.2.2.1. Sustainment Considerations in the Critical Design Review (CDR)

5.4.3.2.2.2. Sustainment Considerations in the Test Readiness Review (TRR)

5.4.3.2.2.3. Sustainment Considerations in the System Verification Review (SVR)

5.4.3.2.2.4. Sustainment Considerations in the Functional Configuration Audit (FCA)

5.4.3.2.2.5. Sustainment Considerations in the Production Readiness Review (PRR)

5.4.3.3. Engineering & Manufacturing Development Phase Results/Exit Criteria

5.4.3.4. Sustainment Considerations in the Engineering and Manufacturing Development Phase

5.4.3.4.1. Sustainment Metrics

5.4.3.4.2. Technology Refreshment and Obsolescence Management

5.4.3.4.3. Sources of Support

5.4.3.4.3.1. Maintenance

5.4.3.4.3.2. Supply

5.4.3.4.3.3. Transportation

5.4.3.4.4. Other Considerations

5.4.3.5. Best Practices during the System Engineering and Manufacturing Development Phase

5.4.3.1. Overview

The purpose of this phase is to develop a detailed integrated design and ensure producibility and operational supportability. The focus is on producing detailed manufacturing designs, not solving a myriad of technical issues. Prototyping and analysis should have been applied prior to this phase to discover and resolve issues to ensure the design is based on a mature technology and is achievable within cost, schedule and sustainment constraints. From a sustainment perspective this means paying particular attention to reducing the logistics footprint; implementing human systems integration; designing for supportability; and ensuring affordability, integration with the supply chain, interoperability, and safety. All of these factors are used to refine the performance-based support concept and strategy, with the associated requirements, and to identify potential support providers.

5.4.3.2. Activities/Processes

During this phase, the focus is on developing the requirements for the long-term performance-based support concept and the initial product support package. In accomplishing this, life-cycle management documents and analyses are refined as a result of the detailed design process, iterative systems engineering analyses and developmental test results. During this phase, the critical sustainment metrics are also refined and incentives developed for eventual performance-based support contracts and/or performance-based agreements. Stakeholders (including potential support providers) are identified and included in Integrated Product/Process Team (IPT) processes to build an early understanding of and buy-in for sustainment requirements and objectives. Also during this phase, the support concept is refined and potential support providers are identified. Incentives to design for support and to design a cost-effective support concept can, and should, be linked to the support strategy. Identification and involvement of the potential support providers and integrator early during these efforts is essential for program success.

Supportability Analysis. Supportability analysis, modeling and simulation, and life-cycle costing should be applied and integrated with the systems engineering process in increasing levels of detail to determine the relative cost vs. benefits of different support and maintenance strategies; the impact and value of performance/cost/schedule/sustainment trade-offs; and to create the data required to support and justify the support strategy. During this phase, data will be compiled, refined, and analyzed consistent with acquisition policy and Defense Acquisition Board (DAB) requirements to develop and document a best value long term support strategy. The assessment process determines the right mix between organic and commercial performance-based support and should consider all requirements (including statutory) when determining the best value long term sustainment approach to optimize readiness while minimizing cost. The programs should use accepted decision making tools and processes, such as Business Case Analysis, Economic Analysis, DSOR Analysis, Decision Tree Analysis, and/or other appropriate best value assessments. At this point, no firm source of support decisions should be made until sufficient data is collected and the risks are determined. (Determination of core capability workload requirements should be made after the system passes Critical Design Review (CDR).) As a result, the analysis results should be used and expanded throughout the program life cycle to:

- Assess alternative contracting approaches based on cost, benefit, and performance outcomes
- Establish a strong foundation for budgetary requirements
- Provide the definitive cost and performance base to be used for contract negotiation
- Provide the cost/performance baseline to be used to measure effectiveness
- Quantify the benefit's to be realized

Almost all of the values used during this phase should be based on engineering estimates and actuals or test results. The level of detail performed by the government team will vary by the extent to which industry is used to achieve the materiel availability in a performance-based logistics contract product support package. (The government's detailed supportability analysis requirements decrease in depth as a direct function of the level the performance standards are set in the contract requirements, the portion of the system covered, and the sustainment functions for which the contractor is responsible.)

Regardless of the contracting approach taken, Supportability Analysis will have to be performed even if only to determine the specific metrics and their respective values that will motivate the right behavior, be aligned with the user requirements and to determine a fair and affordable price. Analysis is also needed to ensure any contracted metrics are aligned with portions of the public infrastructure/supply chain that will support the user. See section 5.4.3.5 for a further description of the best practices that should be used in performing a detailed supportability analysis for any parts of the system in which the government will provide the product support package, vice using a contract with materiel availability as the performance measure.

Reliability Growth. A reliability development/growth effort should be undertaken if the assessed reliability of the system or technology is not above threshold with a safe margin to account for the typical drop experienced when a system transitions from a paper design to fielded conditions. Emphasis should be placed on discovering and mitigating failure modes throughout the system design and development process, since relying solely on testing as a means of improving reliability has been shown to be risky and costly. Consideration should be given to using such practices as physics of failure reviews, environmental stress screening, and highly accelerated life testing. A test analysis and fix program should be implemented to increase reliability and it should be expanded as more of the hardware (including prototypes) is tested and operated by the users. Using this process, failure modes may be found through analysis and testing are then eliminated or reduced by design or process changes as appropriate. Shortchanging this effort early in development, particularly at the subsystem and component level, is a frequent cause of later program delays and cost increases as the flaws inevitably show up in system level performance.

Maintainability Growth. Efforts to improve maintainability and/or validate maintainability metrics are being achieved in the development process should also be considered along with traditional Reliability Growth management efforts. Typically this includes new diagnostics and prognostics technologies, but, the same principles can be applied to other maintainability drivers such as extensive time consuming repair techniques. The specific maintainability growth management efforts are unique to the program but should be considered for maintainability

drivers upon which the sustainment KPP/KSA depend.

5.4.3.2.1. Life-Cycle Sustainment Plan

In this phase and in preparing for MS-C, the LCSP focuses on the efforts to manage the sustainment related risk focusing on the implementation of the product support package. This includes the approach for developing and fielding the product support package describing who is doing what, where, and when with the associated budgets. In addition to refining and expanding on the sustainment management approach, schedule and costs aspects, specific attention should be paid to the:

- Product Support Strategy details (including the depot maintenance requirements and the implications of core requirements) and what is expected from each of the stakeholders
- Performance verification methods used in production, fielding and operations. This includes the design characteristics included in the contract, how they will be demonstrated and performance to date
- Outcome based contracts, including the level that will be covered by performance-based incentives tied to metrics
- Assessment results to date and the product support risks
- How major actions/events for the product support package elements fit with the overall program master schedule including the interfaces and dependences between the elements
- Processes to establish the requirements for product support package elements and keep them aligned/balanced as the design and supply chain evolve

5.4.3.2.2. Technical Reviews in Engineering and Manufacturing Development

Regardless of the acquisition strategy chosen relative to PDR timing and prototyping, any remaining initial systems design activities and reviews not finished during the Technology Development phase (i.e., System Requirements Review (SRR), System Functional Review (SFR), or Preliminary Design Review (PDR)) are completed early in the EMD phase. Section 5.4.2.2.3 provides a description of the sustainment aspects that should be considered for each review and is not repeated in this section. If the PDR was not conducted prior to Milestone B, the PM should include the results of the sustainment assessment in the PDR report and Post-PDR Assessment.

5.4.3.2.2.1. Sustainment Considerations in the Critical Design Review (CDR)

The CDR helps to ensure the system can satisfy the CDD requirements within the allocated budget, staffing and schedule. Details can be found in section 4.2.13 , but in summary the CDR results in an initial product baseline for the system, hardware, software, maintainability, supportability, and the product support elements, including support equipment, training systems, and technical data. Subsystem detailed designs and product support elements are evaluated during the review to determine whether they correctly implement system requirements and if the system is mature enough to proceed into fabrication, demonstration, and test.

Product support IPT members, as well as independent sustainment subject matter experts, should

participate to ensure the design includes the supportability requirements and the support strategy contained in the Life-Cycle Sustainment Plan (LCSP) are consistent with the product baseline and the projected sustainment metrics (e.g., reliability, maintainability) and other supportability features. The PM should include the results of the CDR sustainment assessment in the Post-CDR report and Post-PDR Assessment. For the system and key product support elements as appropriate, this involves ensuring the:

- Supportability requirement enablers, such as Human Systems Integration (HSI) design features, inclusive of the environment, safety and occupational health risk reduction features, are included in the design.
- Failure Mode Effects and Criticality Analysis have been completed and any remaining subsystem requirements for the product support package elements design are complete.
- Key sustainment characteristic drivers (including critical manufacturing processes to achieve them) have been identified, and an estimate of system reliability based on demonstrated reliability rates and other sustainment drivers are being used in developing the product support package.
- Development testing results are used to update the sustainment metric projection estimates and any planned corrective actions to hardware/software deficiencies have been identified.
- Test success criteria for any remaining development testing and operational testing plans (for testing both operationally effective and suitable) for key sustainment enablers or drivers requirements are complete. If the test results to date do not indicate the operational test success is likely or risk has increased, new developmental and operational testing criteria and plans should be considered, along with fallback plans.
- Program sustainment development efforts with corresponding schedules, including system fabrication, test, and software critical path drivers, are included in LCSP updates.
- Updated Cost Analysis Requirements Description (CARD) (or a CARD-like document) based on the initial product baseline, captures the key program sustainment cost drivers, development costs, production costs, operation and support costs for all aspects of sustainment and HSI.

5.4.3.2.2.2. Sustainment Considerations in the Test Readiness Review (TRR)

The TRR helps to ensure the subsystem or system is ready to proceed into a formal test. Details can be found in chapter 9 , but in summary it assesses test objectives, test methods and procedures, test scope, and safety confirming test resources have been properly identified and coordinated. Consequently, there are two primary logistics roles in the TRR. One is to help ensure the test is properly planned and resourced (e.g., people, facilities, data systems, support equipment, and any other product support elements) to achieve the test objectives. The second role is to ensure the tests will identify and help control risk by verifying and validating key sustainment drivers are in place to achieve the Sustainment KPP and KSAs. This can be accomplished by building off the system performance tests as well as structuring specific tests and demonstrations focused on sustainment drivers including maintainability. Regardless of stage of development or the level of testing (component, subsystem, or system), the basic tenets contained in section 4.3.3.4.3 apply. This includes, but is not limited to, identifying the:

- Test purpose and exit criteria.
- Expected result, test success criteria, and how the test results will affect the program.
- Risks that will be mitigated by the test and which will remain.
- Fall-back plan should a technical issue or showstopper arise during testing.

5.4.3.2.2.3. Sustainment Considerations in the System Verification Review (SVR)

The SVR is a product and process assessment to ensure the system can proceed into production within cost, staffing, schedule, and other system constraints with an acceptable risk level. Details can be found in section 4.2.14 but in summary the SVR assesses the system functionality, determining if it meets the functional requirements, and verifies final product performance. The SVR is often conducted concurrently with the Production Readiness Review (section 4.2.15) and Functional Configuration Audit (section 4.2.14). Product support IPT members as well as independent sustainment subject matter experts should participate to:

- Address system supportability and, based on developmental testing or analysis whether the sustainment features will satisfy the Capability Development Document/draft Capability Production Document and Sustainment KPP/KSAs.
- Adequate processes are in place so the sustainment performance metrics can be used to help the program to succeed in meeting user needs.
- Ascertain if the system is supportable within the procurement, operations, and support budgets.

5.4.3.2.2.4. Sustainment Considerations in the Functional Configuration Audit (FCA)

FCA is essentially a review of an item's test/analysis data to validate the intended function or performance stated in its specification is met. See section 4.2.14 for additional details. From a sustainment perspective, the FCA should include auditing the testing and analysis performed to date to ensure the results indicate system compliance with the applicable Sustainment KPPs, KSAs, and derived supportability requirements as reflected in the functional baseline. In addition, to help ensure a system will be sustainable, key elements of the product support system should also undergo a FCA.

5.4.3.2.2.5. Sustainment Considerations in the Production Readiness Review (PRR)

The PRR determines whether the design is ready for production and if the producer has accomplished adequate production and product support planning. Details can be found in section 4.2.15 , but in summary it determines if production or production preparations incur unacceptable risks that might breach schedule, performance, cost, or other established criteria thresholds. The review evaluates the full, production configured system to determine if it correctly implements all system requirements, including embedded sustainment enablers. Product support IPT members, as well as independent sustainment subject matter experts, should participate to ascertain that the product support baseline has been established, documented and the:

- Supportability design features are mature enough to be incorporated into the design

within the budget, schedule or other design constraints (e.g., weight, size, bandwidth).
- Product support is properly planned and implementation will meet sustainment objectives and requirements.
- System is supportable within the procurement, operations, and support budgets and fielded infrastructure.
- Initial product support package and supply chain are ready to support production output.
- Processes in place are adequate for sustainment performance metrics to help the program succeed in meeting user needs.

5.4.3.3. Engineering & Manufacturing Development Phase Results/Exit Criteria

The focus of this phase is to ensure the system design incorporates the critical supportability/ logistics requirements, develops the product support element capabilities, and demonstrates the key support and sustainment capabilities are mature. Implementing the process contained in figure 5.4.3.2.F1 produces the detailed supportability/logistics requirements and the initial designs. The conclusion of this phase results in the contractual documents required to continue into the Production and Deployment Phase as well as the system prototype logistics equipment and processes. The program should be able to demonstrate acceptable performance in the development, test & evaluation, and operational assessments, to include:

- Demonstrated reliability, availability, maintainability, and sustainment features
- Established and verified product support baselines
- Mature software design
- Acceptable interoperability

Table 5.4.3.3.T1 identifies the most critical documents that should incorporate or address supportability/ logistics considerations. The logistics related data in program deliverables should be updated prior to milestone decisions and to support the various major design reviews (e.g., CDR, and FCA). The key sustainment elements required for low rate initial production systems and initial operational test and evaluation (IOT&E) should be addressed in the LCSP which is summarized in the Acquisition Strategy. Materiel availability enabler driver initiatives should be included in the RFP as well as the Source Selection Plan.

From a logistics perspective, the exit documents should focus on the results of the maintenance planning process, the materiel availability driver initiatives, and their associated metrics. In addition to updating the support strategy, sustainment funding requirements, key logistics parameter and logistics testing criteria, the annual determination of the distribution of maintenance workloads required by statute, an auditable depot level maintenance core capability and workload assessment should be completed bi-annually.

Table 5.4.3.3.T1. Sustainment Considerations in EMD

Entry Documents:
Initial Capabilities Document and Capability Development Document
Acquisition Strategy

Acquisition Program Baseline
Preliminary Design Review Results
Developmental Test and Evaluation Report
Operational Test Plan and Test & Evaluation Master Plan (TEMP)
Life-Cycle Sustainment Plan
Exit Documents:
Update documents from MS B
Capability Production Document
Technical Data Rights Strategy
Approved Maintenance Plans
Life-Cycle Sustainment Plan

5.4.3.4. Sustainment Considerations in the Engineering and Manufacturing Development Phase

5.4.3.4.1. Sustainment Metrics

During this phase, the focus should be on achieving the objective range value estimate for each of the Sustainment KPP/KSAs, along with their supporting driver metrics, and on further analysis (including analysis of the results of any demonstrations that have been performed). The analysis should be performed to:

- Ensure the various metric performance values are consistent with each other as each is refined
- Ensure the design/production process does not degrade the system's ability to meet the sustainment metrics
- Identify the operation impacts the sustainment metrics enablers will have on mission success and materiel availability

The models for establishing and tracking projecting expected values should be refined and the requirements for the metrics should be further allocated to the equipment level. Key metrics data should be collecting and used to validate the models, evaluate technical performance, evaluate system maturity and determine the logistics footprint. The key enabling requirements to achieve the sustainment metrics should be included in the system specification and PBAs. Detailed test criteria should be developed for each metric (including any key dependent enabling technologies) to provide information about risk and risk mitigation as the development and testing continue. The sustainment test strategy/requirements should be documented in the TEMP.

5.4.3.4.2. Technology Refreshment and Obsolescence Management

The extensive life of our systems and rapid technology change has heightened the importance of technology refreshment and obsolescence management. Consequently, successful parts management necessitates the need to address diminishing manufacturing sources and material

shortages in the proposal, design, and sustainment phases of a product (to include the systems and support elements). The PM should develop a proactive approach to effectively resolve obsolescence problems before they have an adverse impact on the LCC and system availability. The following are potential approaches the PM should consider:

- Design features that facilitate change/insertion of new technology.
- Establishing a rigorous change management process for life-cycle support.
- Using performance-based logistics contracts that provide significant latitude to manage technology refreshment. This includes ensuring they are incentivized to maintain currency with state-of-the-art technology and use readily available items to avoid the high cost of diminishing manufacturing sources and materiel shortages over the systems life.

5.4.3.4.3. Sources of Support

DoD Components should operate an integrated, synchronized, total system supply chain to meet user requirements for information and materiel. Competition throughout the life cycle, including during sustainment, is integral to providing best value logistics processes. Consequently, per Public Law 111-23, major weapon systems shall, to the maximum extent practicable and consistent with statutory requirements, ensure maintenance and sustainment contracts are competitively awarded and given full consideration to all sources (including sources that partner or subcontract with public or private sector repair activities).

The Sustainment KPP/KSAs allow the acquisition and sustainment communities to focus their efforts from the users perspective, rather than focusing on any segment of the chain in isolation. This consistent focus on a common outcome (affordable materiel availability) across the supply chain reduces the potential for disconnects during the multiple hand offs across the various links in the supply chain. Consequently, in satisfying the user's needs under the total life-cycle system management approach, the PM is responsible for:

- Determining the appropriate set of metrics to align the various supply chain segments to achieve materiel availability. The specific metrics and their values should be determined regardless of who is executing the action to meet the user needs in the operational environment and be based on the system characteristics.
- Selecting the sources of support to sustain the system. Working with the maintenance community, the PM should use the most effective sources of support that optimize the balance of performance and life-cycle cost, consistent with statutory requirements and required military capability. The sources may be organic or commercial, but the focus should be on optimizing customer support and achieving maximum system availability at the lowest LCC. In making the determination, the PM shall (DoD Instruction 5000.02, Enclosure 8, paragraph 2.d.) work with the manpower community to determine the most efficient and cost effective mix of DoD manpower and contract support.
- Providing the mechanisms and product support elements (including technical data) to implement the source of support decisions. In doing so, the strategy and resources required to implement the strategy should foster and ensure competition throughout the life of the system.
- Monitoring execution against the metrics to ensure the respective stakeholders are

engaged in providing the system support to the user. Effective supply chain management requires data collection and data sharing within and between all elements of the supply chain (public and private). There should be a process to collect data throughout the manufacturing process and operations period so the data may be mined for product and process improvements using trend analysis to effectively communicate/collaborate with a shared understanding of the environment.

User and Provider Collaboration. Implementation of the life-cycle management approach places a premium on collaboration to promote user confidence in the logistics process in building a responsive, cost-effective capacity to ensure users get the materiel they need, when they need it, with complete status information. Supply chain management in particular requires PMs to collaborate with users (e.g., the force providers, the Combatant Commands, and the DoD Components of those commands) to determine optimal logistics strategies tailored to meet the users' needs and expectations and should produce a performance-based agreement codifying the negotiated user requirements and performance expectations (DoD Directive 5000.01). The PM should ensure user support is based on collaborative planning, resulting in realistic performance expectations established through performance-based agreements. These agreements should be negotiated in conjunction with the product support integrator, support providers, and the service providers (e.g., maintenance, supply, distribution centers, transportation providers).

Program managers can contract for performance-based sustainment as part of or as the total sustainment strategy. Contracts can be very powerful tools when support is focused on the customer and entire supply chain thereby mitigating or eliminating conflicting commodity priorities. Any sustainment contracts used should be focused to exploit supply chain processes and systems as well as to provide flexible and timely materiel support response during crises and joint operations. Regardless of the strategy taken, the PM must provide for long-term access to the data required for competitive sourcing of systems support and maintenance throughout its life cycle (see DoD Directive 4151.18 for additional information and guidance). The following major elements of the supply chain should be considered.

5.4.3.4.3.1. Maintenance

Program managers should determine the most effective levels of maintenance and sources based on materiel availability and cost factors. In early deployments the best value may be to use existing contractor capabilities for interim support. However core sustaining workload must be accomplished in Government owned facilities with Government owned equipment and personnel. If it has not already been completed, the PM should perform the analysis discussed in sections 5.2.1.2 and 5.4.2.2.2 to determine the maintenance source that complies with statutory requirements, operational readiness and best value for non-core workloads.

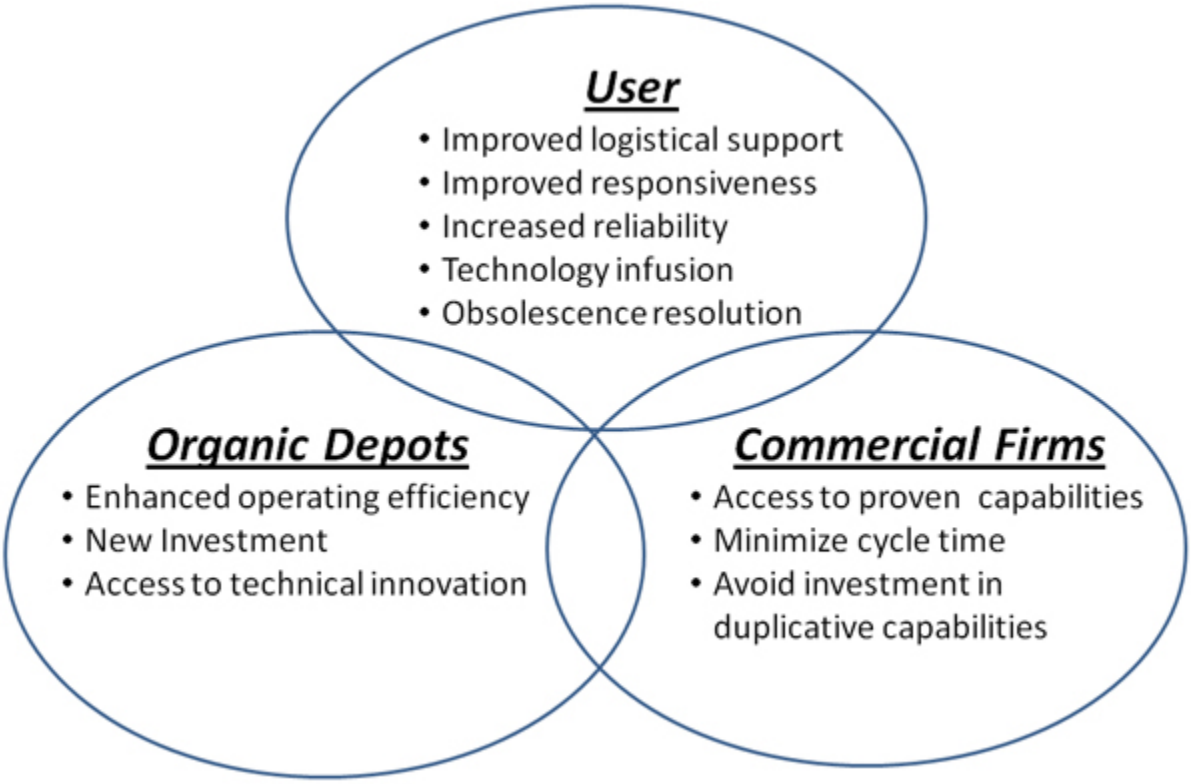
Government and Industry Support Partnerships. In meeting the sustainment requirements, maintenance public private partnerships are the preferred arrangements for maintaining and repairing DoD weapon systems, hardware, equipment, and software. Public Private Partnerships can contribute to more effective DoD sustainment operations, can introduce innovative processes or technology, and enable the economical sustainment of organic capabilities. Delineating specific performance objectives in the mutual interests of both sectors, providing financial

incentives for attaining the objectives, ensuring responsibilities are clearly assigned across the widest possible segment of maintenance workload requirements can result in:

- Improving DoD depot maintenance operations by combining the best of commercial processes and practices within the Department's own extensive maintenance capabilities
- Industry leveraging the depot's skilled artisans along with best commercial best practices
- Increasing availability at reduced life-cycle costs and increased reliability for new and legacy systems

Figure 5.4.3.4.3.1.F1 depicts some of the key benefits of well-designed public private partnerships. However, care is needed when third parties are involved. For example for information technology/software support some level of organic support needs to be resident and none of the support can be sent to non-approved third party countries (i.e. India, China etc.) without thorough analysis and State Department approval. Further examples and discussion of public private partnerships can be found in DoDI 4151.21 and on the Acquisition Community Connection web site .

Figure 5.4.3.4.3.1.F1. Public Private Partnership Opportunities



5.4.3.4.3.2. Supply

Supply requirements are determined as a part of the maintenance planning process. However, DoD policy gives the program manager latitude in selecting a source of supply support,

including support management functions, that maximizes service to the user while minimizing cost. A framework for developing, improving, and conducting supply chain management activities to satisfy support element requirements is a vital link in systems sustainment because skilled labor and advanced technology repair equipment mean little without the right part in the right place at the right time. Consequently, the PM should select a source of supply support that gives sufficient control over financial and support functions to effectively make trade-off decisions that affect materiel availability and cost.

Competitive Process. Supply support may be included as part of the overall system procurement or as a separate competition. The competitive selection process should result in a contract with a commercial source and/or an agreement with an organic source that prescribes a level of performance in terms of materiel availability and cost. The PM may use a competitive process to select the best value supply support provider or include supply support in an overarching performance-based logistics support arrangement. While access to multiple sources of supply may be encouraged to reduce the risks associated with a single source, it is imperative that a single entity be established as a focal point of responsibility. Particular attention should be given to prime vendor contracts for specific commodities and virtual prime vendor contracts for a wide range of parts support for specific subsystems. Additional guidance appears in DoD Directive 4140.1 and DoD 4140.1-R .

Organic Supply Source of Support. The PM should select organic supply sources of support when they offer the best value. (DoD Directive 5000.01, E1.1.17) When changing the support strategy for fielded equipment from organic to contractor support or from contractor to organic support, DoD owned inventory that is unique to that system should be addressed in the source of support decision.

5.4.3.4.3.3. Transportation

The PM is encouraged to determine the best overall support strategy for the customer to include the use of all available transportation alternatives, including those provided by original equipment manufacturers (OEMs), third party logistics providers, or commercial transportation providers. These alternatives may include the use of commercial transportation services and facilities to the maximum extent practicable; the use of organic transportation consistent with military needs; or the combination of both commercial and organic transportation to support customer requirements. As in supply support, the PM should strive to structure a support arrangement, such as performance-based logistics contracts, that will consolidate the responsibility for transportation in a single entity. Regardless of the approach taken, when making the transportation source decision the PM needs to ensure the entire end-to-end chain is considered including the "last mile" aspects along with any required implementing technology (e.g., IUID).

In considering transportation options, the PM should also plan for transition of the supply and distribution chain from normal operations to expeditionary operations in austere locations that are not served, at least initially, by commercial transportation services and facilities. Transportation alternatives in contractual arrangements must require the contractor to comply with established business rules, when the DoD organic distribution system is used in lieu of or

with the commercial transportation service. All contractual arrangements requiring that deliveries be made using door-to-door commercial transportation must include a provision that requires vendors to notify the contracting officer or the contracting officer's designee when they are unable to use door-to-door commercial transportation and to request alternate shipping instructions. The contracting officer or contracting officer's designee must expeditiously provide alternate shipping instructions and make the appropriate contract price adjustments. For additional information, see the on-line Defense Transportation Policy Library .

Arms, Ammunition, and Explosives . PMs should refer to DoD 4500.9-R, Defense Transportation Regulation, Part 2 , and DoD Manual 5100.76-M , Physical Security of Sensitive Conventional Arms, Ammunition and Explosives (AA&E), for transportation and security criteria regarding the movement of arms, ammunition, and explosives. Contract provisions should apply to the prime contractor and all subcontractors.

5.4.3.4.4. Other Considerations

Design Impact . Design alternatives should continue to be considered to help mitigate sustainment risks and reduce LCC and logistics footprint as the design is refined.

Support Strategy . In refining and determining the detailed supportability requirements developed in the earlier phases, the PM should take into consideration the various alternatives that can be cost effectively implemented to achieve the Sustainment KPP and KSAs and to reduce program risks. The following are also aspects that should continue to be considered during this phase in designing and implementing the support strategy:

- **Interservice servicing agreements** to take advantage of joint capabilities by drawing support from other DoD Components and Allies. In developing the support strategy, the long term potential of Acquisition and Cross Servicing Agreements (ACSAs) to help reduce the logistics infrastructure and footprint should be considered. For further discussion including information on the legal authority for the acquisition and reciprocal transfer of logistic support, supplies, and services from eligible countries and international organizations, see section 11.2.3 and DoDD 2010.9 .
- **Adopting DoD Enterprise initiatives** to reduce LCC. For example adopting DoD's enterprise architecture for the information infrastructure, processes, data, data standards, business rules, operating requirements, and information exchanges can facilitate interoperability and LCC.

5.4.3.5. Best Practices during the System Engineering and Manufacturing Development Phase

Modeling and simulation combined with supportability analysis are important best practices to design and develop the individual product support elements required to implement the support strategy. During this phase they are applied to lower and lower levels of detail as the design matures. The supportability analysis should continue to be used to determine the relative cost vs. benefits of different support strategies (including the source of support decisions). The data should be refined and the results included in the LCSP and used to support contract negotiations.

Use of Open Source Architecture (OSA) practices is another effective methodology to increase affordability and supportability. Code reuse is a force enabler that provides for more efficient software development programs that can cut across multiple program areas.

Once product support elements are developed and prototyped, modeling and simulation can also be used to provide confidence the sustainment metrics will mature to sufficient levels when the system and supply chain are deployed. This is accomplished with the use of models that take test results and predict likely capabilities. The same concepts are applied to provide confidence levels of what the enabling technologies will be able to achieve in the operational environment and identify any anticipated constraints. All of these factors are then used to project the mature sustainment metric values and their associated confidence levels for the projected Concept of Operations.

5.4.4. Sustainment in the Production and Deployment Phase

5.4.4.1. Overview

5.4.4.2. Activities/Processes

5.4.4.2.1. Managing Product Support Package Fielding

5.4.4.2.2. Maintenance Supportability Considerations

5.4.4.2.3. Life-Cycle Sustainment Plan

5.4.4.2.4. Measuring Sustainment Effectiveness

5.4.4.2.5. Pre-Initial Operational Capability Supportability Review

5.4.4.2.6. Technical Reviews in Production and Deployment

5.4.4.2.6.1. Sustainment Considerations in the Operational Test Readiness Review (OTRR)

5.4.4.2.6.2. Sustainment Considerations in the Physical Configuration Audit (PCA)

5.4.4.3. Production and Deployment Phase Results/Exit Criteria

5.4.4.4. Sustainment Considerations in the Production & Deployment Phase

5.4.4.4.1. Sustainment Metrics

5.4.4.4.2. Configuration Management

5.4.4.4.3. Contractor Logistics Support/Contractors on the Battlefield (CLS/COTB) Integration, In-Theater

5.4.4.5. Best Practices during the Production and Deployment Phase

5.4.4.5.1. Supportability Analysis

5.4.4.5.2. Modeling and Simulation

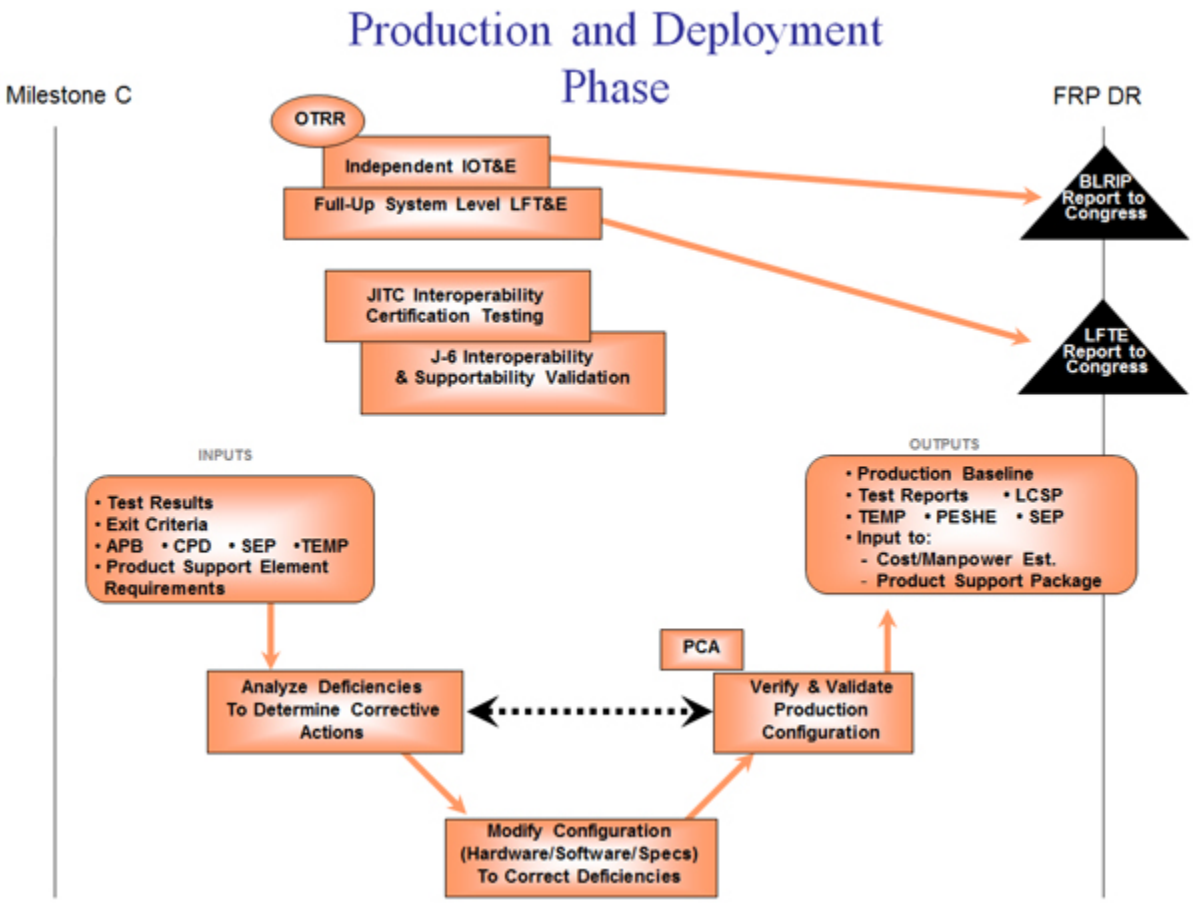
5.4.4.1. Overview

The logistics purpose in this phase is to achieve a materiel availability capability that satisfies mission needs. Milestone C authorizes entry into Low Rate Initial Production, at which time the design should be mature. The supportability design feature requirements should have been verified and validated as operationally suitable and effective at an affordable cost. At this point, the support requirements should be fully defined and performance-based product support agreements and funding expectations documented and signed. Funding should also be identified and available for testing and implementation of the performance-based strategy. Once operational test and evaluations have determined the effectiveness, suitability, and supportability of the system, the full rate production and deployment decision is made.

5.4.4.2. Activities/Processes

During this phase, the emphasis is on finalizing equipment product support packages/ maintenance plans, managing and deploying the initial sustainment capabilities, and demonstrating the product support capabilities and effectiveness. Once they have been demonstrated, the emphasis is on fully fielding and implementing the sustainment capabilities to provide the users the capabilities identified in their requirements documents. Measuring the product sustainment package's effectiveness (including the associated supply chain) is an important aspect of the management responsibilities in this phase. Figure 5.4.4.2.F1 highlights the key phase activities.

Figure 5.4.4.2.F1. System Support Implications in the Production and Deployment Phase



5.4.4.2.1. Managing Product Support Package Fielding

The following are key program manager responsibilities in this phase:

- Ensuring actions are taken to provide the user support required to sustain the system within the budget provided, including highlighting to senior management the consequences and impacts on the Sustainment KPP/KSAs of budget constraints.
- Coordinating with the contractors, supply chain and operators to ensure each understands and is implementing responsibilities in accordance with the LCSP in an integrated fashion.
- Monitoring any changes to the design, operational environment and supply chain and adjusting the product support elements within the product support package accordingly.
- Looking for improvements to reduce the product support package cost.

During this phase, the reliability of contractor cost and performance data should be verified by monitoring contracts. Increased use of Defense Contract Management Agency and Defense Contract Audit Agency in overseeing contracts should be considered.

5.4.4.2.2. Maintenance Supportability Considerations

10 USC 2464 requires the establishment of the capabilities necessary to maintain and repair systems and other military equipment required to support military contingencies (i.e., core capabilities) at Government-owned, Government-operated facilities not later than four years after achieving initial operating capability. During the production and deployment phase, it is imperative for the PMs and Program Executive Officers to ensure the prior planning for maintenance support is executed to meet the supportability requirements of the system and/or subsystems. If organic depot maintenance is a portion of the selected supportability strategy, it will require the activation of the requisite organic depot maintenance capabilities.

5.4.4.2.3. Life-Cycle Sustainment Plan

The LCSP should be used to help manage the program's fielding efforts. It should focus on the product support implementation plan and schedule, with emphasis on putting into place the continuous process improvement management structure to review processes and remove bottlenecks or constraints encountered by the user. The following aspects should be emphasized along with the projected sustainment metric values by fiscal year over the FYDP:

- The fielding plan details including any actions to adjust the product support package, ensure competition, and control costs.
- The analytical and management processes for how the sustainment performance will be measured, managed, assessed and reported as well as and achieve and maintain the sustainment requirements.
- The stakeholder roles in executing the sustainment strategy describing the relationships and responsibilities with key players, especially relative to the product support arrangements.

5.4.4.2.4. Measuring Sustainment Effectiveness

Under the total life-cycle systems management concept, the PM is responsible for the timely fielding of an effective product support package, measuring its effectiveness, and taking corrective actions when shortfalls are uncovered. The most effective time to catch problems is before the system is deployed, so including reliability, maintainability and supportability test requirements in the TEMP should be as important as other performance measures. Sustainment KPP/KSA driver metrics should be monitored thought out the test and deployment process to help provide confidence the system will achieve the sustainment objectives in an operational environment.

5.4.4.2.5. Pre-Initial Operational Capability Supportability Review

This review and its associated analysis should be performed at the DoD Component level in conjunction with the OTRR to:

- Confirm design maturity and configuration of the system
- Determine status of correction of any deficiencies identified

- Confirm configuration control
- Certify product support integrator/providers plan to meet user requirements
- Verify product support integrator/provider agreements/contracts and funding are in place

5.4.4.2.6. Technical Reviews in Production and Deployment

Many of the actions and subsequent results in this phase are reviewed during technical reviews and should be accomplished even if the specific referenced reviews do not occur. The actions and results are tied to the reviews to reflect the relative timeframe in which they should be accomplished.

5.4.4.2.6.1. Sustainment Considerations in the Operational Test Readiness Review (OTRR)

The OTRR is a product and process assessment to ensure the system can proceed into Initial Operational Test and Evaluation with a high probability of successfully completing operational testing. (See chapter 9 for additional information.) Many of the same actions used to prepare for the Test Readiness Review (TRR) should be used in preparation for this review. This test is critical because it provides the users the first real hands-on indication as to whether the system is operationally effective and suitable. Consequently, it is important the product support IPT members as well as independent sustainment subject matter experts participate in the review to ensure the test:

- Is properly planned and resourced (e.g., people, facilities, data systems, support equipment, and any other product support elements) to achieve the test objectives. The Pre-Initial Operational Capability Supportability Review should be used to support this process.
- Will verify and validate the key sustainment drivers to achieve the Sustainment KPP and KSAs are included. This should include ensuring system reliability, maintainability, and support performance features are included and demonstrated.
- Is structured to include as much of the product support package that will be used in the operational environment. Where this is not possible, prototypes should be used to gain early user feedback on the product support package.

5.4.4.2.6.2. Sustainment Considerations in the Physical Configuration Audit (PCA)

The PCA examines the end-item actual configuration as defined by the Technical Data Package and sets the final production baseline under government control. Details can be found in section 4.2.16 , but in summary the audit verifies that design documentation matches the item specified in the contract. In addition to the standard practice of assuring product verification, the PCA confirms that manufacturing processes, quality control system, measurement and test equipment, product support, and training are adequately planned, tracked, and controlled. As such, this review should be used to ensure the "as-produced" system is compliant with sustainment requirements and objectives. To the extent lead times will allow, ordering the product support package elements should be delayed until this review to ensure they are being bought for the right configuration.

5.4.4.3. Production and Deployment Phase Results/Exit Criteria

The focus of this phase is to deploy the initial sustainment capabilities and once the system (both the system and its product support package) are demonstrated to be operationally suitable and effective to then fully deploy the system. This should be demonstrated by:

- The satisfactory achievement of the sustainment criteria in the Initial Operational Test and Evaluation (IOT&E) and other tests.
- Performance-based product support agreements being in place.
- A fully funded sustainment program in the budget.

Implementing the process depicted in figure 5.4.4.2.F1 provides the materiel required to gain full rate production/deployment approval and produce the product support elements to sustain the system. The conclusion of this phase results in a fully fielded and supported system. Table 5.4.4.3.T1 identifies the most critical documents that should address sustainment considerations. Key logistics information complied during this phase should be used to update the acquisition documents, along with the latest sustainment strategy based on the actual technology development progress and/or follow-on increments if an incremental acquisition strategy is used. Also, the sustainment related data and performance-based requirements should continue to be included in product and sustainment contracts and agreements to ensure the system is effectively supported.

Table 5.4.4.3.T1 Sustainment Considerations in Production and Deployment

Entry Documents:
Test and Evaluation Reports
Acquisition Program Baseline
Operational Test Plan and Test & Evaluation Master Plan (TEMP)
Life-Cycle Sustainment Plan
Exit Documents:
Update documents from MS C as appropriate
Physical Configuration Audit Report
Life-Cycle Sustainment Plan
Information Supportability Certification

5.4.4.4. Sustainment Considerations in the Production & Deployment Phase

All the product support elements should be considered and focus should be on refining and fielding them based on their demonstrated success and on confidence that the requirements will be achieved.

5.4.4.4.1. Sustainment Metrics

The results and experience demonstrated in all the tests (including follow-on operational test & evaluation (FOT&E)) and early operations should be considered in refining the metric estimates. This, along with key supply chain performance and effectiveness measures for similar fielded systems, should be used to increase the confidence levels for the PM's estimates. Supply chain performance, Sustainment KPP/KSAs, and key driver metrics should also be considered in the analysis. Special emphasis should be placed on tracking the metrics for the drivers of key enabler technologies that have been developed for the system or are critical for achieving the required materiel availability. Consideration should be given to revising the product support package and it's agreements if major performance shortfalls are found.

5.4.4.4.2. Configuration Management

Special attention should be placed on configuration and data management, as design changes are made to ensure the product support package is developed and fielded to the same configuration(s) the user will be operating and supporting. Ensuring logistics and sustainment implications are considered and addressed during the Physical Configuration Audit (PCA), Physical Configuration Review, and Operational Test Readiness Review (OTRR) can increase the probability both the system and its support package are deployed in a coordinated fashion.

When multiple production baselines are deployed or if the full product support package is not deployed to support test or operations, the program manager should consider the most effective support method. The alternatives considered can include employing mixes of contractor and organic support over varied performance periods for each configuration. This may result in the consideration of multiple performance agreements and/or support strategies. In determining the best mix, the results from the Production Readiness Review (PRR) and System Verification Review (SVR) should be considered to ensure the product support elements are developed for all configuration / block increments.

5.4.4.4.3. Contractor Logistics Support/Contractors on the Battlefield (CLS/COTB) Integration, In-Theater

Contractors can provide logistics support over a wide range of options, from interim contractor support covering the initial fielding while the product support package is being deployed, to supporting specific limited operations, to full contractor support. When support strategies employ contractors in a battlefield environment, PMs should, in accordance with Joint Publication 4-0 Chapter 5 and DoD Component implementing guidance, coordinate with affected Combatant Commanders. This coordination must be carried out through the lead DoD Component and ensure functions performed by contractors, together with functions performed by military personnel, and government civilians, are integrated in operations plans (OPLANs) and orders (OPORDs). During this process the Combatant Commanders will:

- Identify operational specific contractor policies and requirements, to include restrictions imposed by international agreements;
- Include contractor related deployment, management, force protection, medical, and other

support requirements, in the OPORD or a separate annex; and
- Provide this information to the DoD Components to incorporate into applicable contracts.

The intent of the coordinated planning is to ensure the continuation of essential services in the event the contractor provider is unable (or unwilling) to provide services during a contingency operation. Contingency plans are required for those tasks that have been identified as essential contractor services to provide reasonable assurance of continuation during crisis conditions. PMs should also coordinate with the DoD Component manpower authority in advance of contracting for support services to ensure tasks and duties that are designated as inherently governmental or exempt are not contracted.

5.4.4.5. Best Practices during the Production and Deployment Phase

5.4.4.5.1. Supportability Analysis

Supportability Analysis should continue to be expanded in depth and adjusted as necessary based on test results and operational experience. In examining additional information, a conscious decision has to be made as to whether or not the new data warrants a re-examination of previous analyses. Even if the change is not sufficient enough to warrant an adjustment to the support package, an analysis should be performed to assess the risk associated with the new information so key stakeholders can take risk mitigation steps.

Configuration control over the analysis and resulting data becomes important as the design changes. The program should take steps to ensure that as the system changes, the product support package is adjusted to take into account the various configurations the user will encounter and the product support elements stay in sync.

Even well into operations, programs should evaluate opportunities for transitioning, in whole or part, to performance-based logistics contracts by examining opportunities to leverage public private partnerships. Experience has shown that, even with existing capitalized infrastructure in place, legacy programs can transition to outcome based contracts across the spectrum of subsystem or functional process support segments.

5.4.4.5.2. Modeling and Simulation

M&S continues to support the program improvement efforts by analyzing the impact of proposed design refinement, maintenance processes, and budget alternatives on the sustainment metrics/mission effectiveness. M&S should be used in assessing the alternatives of both the system and its support system (especially the enabling technologies), ensuring all critical metrics are considered in parallel and not at the expense of others. In addition, taking early operational results and predicting likely trends (with confidence levels) can be used to proactively anticipate problems so corrective actions can be taken as the system is fielded to minimize adverse impacts on the users. This also helps to provide confidence the critical sustainment metrics will mature to sufficient levels when the system and supply chain are fully deployed and to identify any anticipated constraints or limitations.

5.4.5. Sustainment in the Operations and Support Phase

5.4.5.1. Overview

5.4.5.2. Activities/Processes

5.4.5.2.1. Adjusting to meet User Needs

5.4.5.2.2. In-Service Reviews (ISR)

5.4.5.2.3. Formal DoD Component Post Deployment Reviews

5.4.5.2.4. Life-Cycle Sustainment Plan

5.4.5.3. Operations and Support Phase Results/Exit Criteria

5.4.5.4. Sustainment Considerations in the Operations and Support Phase

5.4.5.4.1. Sustainment Metrics

5.4.5.5. Best Practices during Operations and Support

5.4.5.5.1. Continuous Process Improvement (CPI)

5.4.5.5.2. Supportability Analysis

5.4.5.5.3. Modeling and Simulation

5.4.5.1. Overview

In the total life-cycle systems management concept, providing user support and managing the demilitarization/disposal of old systems are the PM's responsibilities. During this phase, the PM is the system focal point to the user and should continually assess the sustainability effectiveness of the fielded systems, adjusting the program as required to support the user.

Users require readiness and operational effectiveness (i.e., systems accomplishing their missions) in accordance with their design parameters in an operational environment. Systems, regardless of the application of design for supportability, suffer varying stresses during actual deployment and use. Consequently, the PM should apply the systems engineering processes used in acquisition throughout the entire life cycle. The difference is that during this phase actual use data including user feedback, failure reports, and discrepancy reports rather than engineering estimates are used.

While acquisition phase activities are important to designing and implementing a successful and affordable sustainment strategy, the ultimate measure of success is supporting the user after the system has been deployed for use. Accordingly, the PM and DoD Components should conduct periodic assessments of system support outcomes comparing actual vs. expected levels of

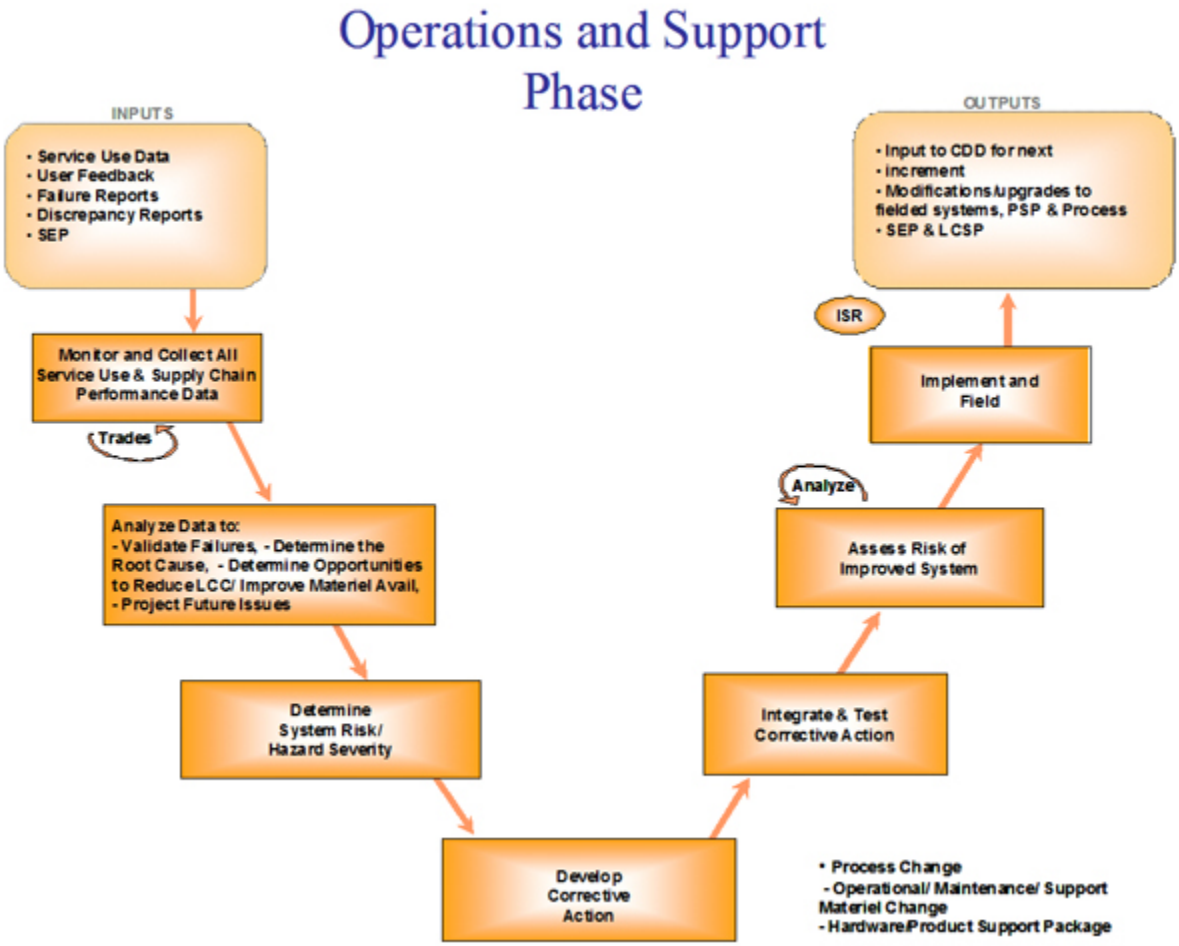
performance and support. The assessments require close coordination with the user, support providers and appropriate systems engineering IPTs. They should be structured to:

- Monitor system usage and supply chain against design baseline criteria and assumptions.
- Review and triage all use data and supplier data to determine operational hazards/safety risks, as well as readiness degraders.
- Develop alternatives to resolve critical safety and readiness degrading issues.
- Identify sub-optimal performers in the fielded product support system, and correct them through rebalanced product support elements or changes to the maintenance program.
- Enhance the performance and cost-effectiveness of the end-to-end supply chain to ensure materiel readiness continues to meet user needs.
- Identify redesign opportunities to enhance system effectiveness.

5.4.5.2. Activities/Processes

During this phase, the focus is on supporting the user by executing the sustainment program and on making adjustments based on effectiveness and operating conditions using systems engineering principles. However, the PM should not undertake depot maintenance source of support decisions without consultation with accountable military department logistics officials to ensure the DoD Component depot maintenance 50 percent limitation statutory requirement is being met. Figure 5.4.5.2.F1 highlights the key sustainability and product support activities.

Figure 5.4.5.2.F1. System support implications in the Operations and Support Phase



5.4.5.2.1. Adjusting to meet User Needs

Under the total life-cycle systems management concept, the program manager continually assesses the system performance from the users perspective. The PM should use existing reporting systems and user feedback to evaluate the fielded system, focusing on performance outcomes meaningful to the user. (If existing reporting systems do not provide sufficient information, the PM should augment existing reporting systems by collecting critical data required to assess performance and, where necessary, work with the DoD Components to add the capabilities to the existing reporting systems.) The data should be analyzed, comparing performance expectations against actual performance, root causes of problems identified, and corrective actions developed.

Potential corrective actions can be implemented through maintenance plan/requirement changes, process changes, modification of performance-based product support agreements, and/or design changes. The final decision for the corrective action selected will be determined by a balance between many factors, including but not limited to risk/safety, costs, schedule, user requirements and probability of success. (During this phase, the solution selected has a higher probability of

success because more of the supportability analysis/RCM processes have the benefit of actuals, vice expectations, thereby reducing the amount of unknowns and eliminating many of the unknown-unknowns.) Regardless of the reason for the change (e.g., a required characteristic short fall, obsolescence, safety, changing user requirements or system design changes), the implementation/ fielding process will follow a tailored version of the Defense Acquisition Management System Framework.

5.4.5.2.2. In-Service Reviews (ISR)

The PM should conduct regularly scheduled In-Service Reviews (also known as Post IOC Reviews) with the users, assessing the current status, operational health and corrective actions to satisfy user operational needs based on user feedback and performance metrics. (See section 4.2.17 for additional information.) The ISR is a multi-disciplined product and process assessment to ensure the system is employed with well-understood and managed risk, so timely corrective actions can be taken. Leading into and during the reviews engineering, sustainment stakeholders (e.g., suppliers, representatives from primary supply chain providers, and the comptroller communities) and product support IPT members, as well as independent sustainment subject matter experts, should apply sound programmatic, systems engineering, and logistics management processes to:

- Assess product support performance against requirements and objectives. The focus should be on reliability, maintainability, and support problems (hardware and software) and their impact on safety and operational readiness. It should include an assessment of risk, readiness, and trends in a measurable form.
- Access the status of current system problems, solutions, and performance metrics. The metrics should include material reliability, material availability, mean down time, materiel ownership cost, and any additional useful sustainment metrics to substantiate in-service problems and budget priorities.
- Group system problems, safety, product support, and readiness issues by priority to form an integrated picture of in-service health, operational risk, system readiness, and future sustainment requirements. This information should be used to prioritize budget requirements (execution and out year) and future sustainment planning.
- Quantify and project system operational risk and system readiness levels based on current levels and current procurement, operations, and support budgets.
- Access the status of current initiatives and the program's responsiveness to meeting customer needs, including problem (discrepancy) report inflow, resolution rate, and trends.

The reviews should be conducted at defined intervals to identify needed revisions and corrections, and to allow for timely improvements in the strategies to meet performance requirements for materiel readiness. At least initially, the In-Service Reviews will focus on the product support package fielding including the product support providers performance against the PBAs and other requirements. Consequently, the reviews with the users and product support service providers should be on a semi-annual basis as the support plans are executed (including transition from organic to contract support and vice versa, if applicable). After the system has been fully deployed, the frequency of these reviews should then be based on system performance

(including trends), the pace of technology, obsolescence issues, and safety. The program's In-Service Reviews should be used to prepare for the DoD Component level assessments or reviews.

5.4.5.2.3. Formal DoD Component Post Deployment Reviews

Program assessments encompass and evaluate supportability, logistics, readiness, and sustainment planning and are conducted by each DoD Component to help ensure a solid life-cycle product support program. Assessments independent of the program office are management practices that have proved to be useful in managing product support risks by providing an impartial evaluation of a program's product support and sustainment implementation. The DoD Components have independently established formal assessment processes in DoD Component specific policies and instructions. The process names vary, but all are intended to assist the PM in the successful execution of his/her total life-cycle management responsibilities.

The DoD Components conduct Post Deployment Reviews beginning at Initial Operational Capability (IOC) and then nominally every three to five years or when precipitated by changes in requirements/design or performance problems. These periodic assessments verify whether the fielded system continues to meet or exceed thresholds and objectives for cost, performance, and support parameters approved at the full rate production decision. In addition to comparing actual versus expected levels of performance and support, the reviews should at minimum include:

- Product Support Integrator/ Product Support Provider's performance, including effectiveness of sustained materiel readiness implementation
- Product improvements incorporated
- Configuration control

5.4.5.2.4. Life-Cycle Sustainment Plan

Following the Full Rate Production Decision, the LCSP is the principle program document governing the systems management and execution. It describes the actions to be taken to meet the total system availability requirements based on measured performance in the operational environment. The plan documents the results of the stakeholder actions and projects outcomes expected based on the budget and real world conditions emphasizing the:

- Sustaining Engineering processes for refining Product Support Package elements based on operation experience to maintain the systems sustainment metrics and control or reduce sustainment costs.
- Results of logistics assessments on how the system and supply chain are performing.
- Adjustments to the product support strategy including any changes to the Program Office or Product Support Arrangements.
- Projected sustainment metric values over the FYDP reflecting the expected results of corrective actions under way.
- Required and anticipated funding levels over the FYDP necessary to ensure acceptable affordability and availability rates to maintain mission capability against the relevant

threats.

Once a program has been designated a "replaced system", a Replaced System Sustainment Plan will be generated which will require the program to work closely with the defense acquisition authority and the replacement system program manager. (See section 5.1.2.3)

5.4.5.3. Operations and Support Phase Results/Exit Criteria

Implementing the process depicted in figure 5.4.5.2.F1 results in proactive support to the user focusing optimized resources to meet operational needs. It can also result in new system requirements which would begin the **Life-Cycle Management System** process again.

The conclusion of this phase results in the disposal of the system following statutory regulations and policy. The PM should coordinate with DoD Component logistics activities and DLA, as appropriate, to identify and apply applicable demilitarization requirements necessary to eliminate the functional or military capabilities of assets (DoD 4140.1-R and DoD 4160.21-M-1). The PM should coordinate with DLA to determine property disposal requirements for system equipment, support assets, and by-products (DoD 4160.21-M).

5.4.5.4. Sustainment Considerations in the Operations and Support Phase

DoD Instruction 5000.02, Enclosure 2, paragraph 8 , includes "supply; maintenance; transportation; sustaining engineering; data management; configuration management; HSI; environment; safety (including explosives safety), and occupational health; protection of critical program information and anti-tamper provisions; supportability; and interoperability" within life-cycle sustainment. While not all of these elements are traditional product support elements, all are important considerations for the PM to take into account in supporting the user. Key is ensuring the entire program is assessed and adjustments are made as needed, based on changing user requirements/needs or system design changes.

When assessing performance and revising agreements or support strategies, the process should encompass all configuration/block increments, and potential redesigns/ECPs to address changes required to address problems encountered in the operational environment. Emphasis should not only be on newly added support requirements, but also on addressing the support strategy in total across the entire platform and range of deployed configurations using the same analytical processes used in earlier phases.

The total life-cycle systems management and performance-based product support concept required by DoD 5000.01 necessitates that managing performance be focused on outcomes vs. segmented functional support organizational outputs. The PM is the focal point for ensuring that all program elements are considered and the respective stakeholders are engaged to support the user.

5.4.5.4.1. Sustainment Metrics

During this phase, the PM should measure, track and report the supply chain performance and its

effectiveness, along with the sustainment metric drivers and the root cause of any performance shortfalls. Special emphasis should be placed on tracking the metrics for the drivers for the key enabler technologies that were developed for the system or are critical for achieving the required materiel availability.

5.4.5.5. Best Practices during Operations and Support

The following are important, but not the only, best practices to be used in this phase since the concepts previously spelled out still apply. In each case, the best practices involve Sustaining Engineering where the PM continually comparing performance against expectations using actual equipment and support performance data, to revise, correct and improve product support strategies to meet the users' requirements.

5.4.5.5.1. Continuous Process Improvement (CPI)

Often, due to revisions in funding, mission requirements, or other fact-of-life changes, logistics resources become out of balance or poorly synchronized. Therefore, PM efforts to achieve system availability while reducing costs should include periodic assessments and, where necessary, improvements of the support strategy and processes. While some system deficiencies can be addressed through system design, many can be more effectively resolved by adjusting the support strategy or processes. The continual application of supportability analysis, including condition based maintenance plus concepts, is an effective means of meeting evolving conditions and providing improved materiel availability.

Adjusting the maintenance requirements using RCM and CBM+ principles can be a very effective in optimizing the sustainment KPP and KSAs during the Operating and Support Phase. Additional approaches useful to the PM in balancing logistics resources, decreasing repair cycle times, and/or improving readiness/availability include:

- Application of Lean, Six Sigma and Theory of Constraints Concepts.
- Updating the supply chain processes based on actuals. This can help balance logistics support through thorough review of readiness degraders, maintenance data, maintenance and support process implementation.
- Implementing properly incentivized performance-based agreements with support providers that encourage product support assessments and improvements based on comparisons between performance expectations against actual performance data.

5.4.5.5.2. Supportability Analysis

During this phase, the supportability analysis continues to focus on design changes regardless of the need for the change (e.g., reliability shortfall, obsolescence issue, safety concern) and adjusting the support package to accommodate the changes. In this process, care should be given to ensure the analysis encompasses all previous configuration/block increments across the entire platform and range of deployed configurations. In doing this, the entire support strategy should be addressed to look for opportunities to reduce the costs and logistics footprint.

Supportability analysis should also be used to adjust the support package based on how it is performing. A wide range of changes (including moving between overhaul and repair, improving off equipment diagnostic capabilities, transitioning to a commercial supply chain management system, etc.) should be considered in determining the best solution. The ability to continually compare performance against expectations using actual equipment and support performance data to drive data analyses and a RCM decision analysis is more efficient and reduces risks.

In both cases, use data is monitored/collected and analyzed using FMECA. Any failure, maintenance or operational issues are verified and root causes, risk and severity are determined. An analysis should then be performed to determine if the most cost effective solution is a:

- Maintenance change (either a preventative maintenance task (including scheduled inspections) or, if it is a non-critical failure, a corrective maintenance task. A Maintenance Plan analysis can help balance logistics support through thorough review of readiness degraders, maintenance data, maintenance procedures and commercial opportunities.
- Supply chain change.
- Product support element change.
- Change in the operations or use of the system (including the timeframe and conditions under which the limitations will be have to remain in effect).
- Design change.

In any proposed solution, the PM should work with the users to determine if the change and the timeframe are acceptable. Once the agreements have been reached, supportability analysis is used to adjust the appropriate product support package elements.

5.4.5.5.3. Modeling and Simulation

During this phase M&S supports the program improvement efforts by analyzing the impact of proposed continuous process improvements, ECPs, and budget alternatives on the sustainment metrics as well as mission effectiveness. M&S can be used in assessing the alternatives affecting the design and deployment of both the end item and it's support system. In addition, it can be used in a proactive mode to anticipate problems by taking use data and user feedback to:

- Project trends (with confidence levels) so actions are taken as conditions deteriorate to minimize adverse impacts on the users.
- Identify areas in the supply chain where performance is adversely affecting materiel availability, increasing LCC, or where there are opportunities for savings/improvements.
- Identify specific risk areas and ways to address/resolve root causes and reduce risk.

5.5. References

5.5.1. Handbooks and Guides

5.5.2. Other References

5.5.1. Handbooks and Guides

Product Support Manager Guidebook . This guide provides the PSM easy reference in addressing key requirements for managing product support across the entire life cycle of the weapon system. It serves as an operating guide to assist the PSM and the Acquisition Community with the implementation of product support strategies in aligning the acquisition and life cycle product support processes.

DoD Product Support Business Case Analysis (BCA) Guidebook. This guide provides overall guidance for conducting a Product Support BCA. It provides a standardized process and methodology for writing, aiding decision making, and providing analytical decision support for a Product Support BCA. The guide should be used in conjunction with other analytical tools and guidance in making product support decisions across the life-cycle.

Performance-Based Agreement Guidance. This guide and the Performance-Based Logistics section of Logistics Community of Practice (LOG CoP) provide guidance, explanations of Performance-Based Agreements, and related concepts for both Commercial and Organic PBAs. It includes sample Performance-Based Agreements, templates, contractual incentives, a Performance-Based Agreement Toolkit and other resources. It also includes An End to End Customer Support PBA template that provides a common framework and a checklist to consider when undertaking a performance-based type agreement that may involve one or more supply chain support services as well as PBA terms and definitions. (**Note:** This guide is in the update process.)

Operating and Support Cost-Estimating Guide. This guide and DoD Manual 5000.4 , DoD Cost Analysis Guidance and Procedures provide procedures for life-cycle cost estimates. They explain the policies and procedures, focusing on the preparation, documentation, and presentation of cost estimates, and include and Operating and Support Cost element structure.

Diminishing Manufacturing Sources and Material Shortages (DMSMS) Guidebook . This guide consists of a compilation of the best practices for managing the risk of obsolescence. It identifies assorted measurement tools that may useful in analyzing and tracking the effectiveness of DMSMS programs.

CBM+ DoD Guidebook . This guide is an information reference as well as a tool to assist program and logistics managers with CBM+ project development, implementation, and execution. As a supplement to the CBM+ DoD Instruction, the Guidebook illustrates various complementary components of successful CBM+ implementation and describes management actions necessary to integrate technologies in order to increase reliability, availability, operational effectiveness, and maintenance efficiency.

Logistics Assessment Guidebook . This guide provides a structure for conducting Logistics Assessments and helps the DoD Components establish baseline assessment criteria specific to their weapon systems. It serves as an operating guide to put into place assessments that will help ensure there is adequate supportability planning, management, resource identification, and risk mitigation for each program at different life-cycle phases. (**Note:** Statute now requires Logistics

Assessments to be independent. How ILAs are conducted is left to the DoD Components, however, pending formal policy, as general guidance, independent can be considered as individuals or organizations outside the line authority of the Program Manager or PMO staff for the program being evaluated.)

5.5.2. Other References

The Acquisition Community Connection (ACC) and the Logistics Community of Practice (LOG CoP) . The Acquisition Community Connection , sponsored by the Defense Acquisition University (DAU), is a tool to facilitate collaboration, sharing, and the transfer of knowledge across the DoD AT&L workforce. ACC is a collection of communities of practice centered on different functional disciplines within the acquisition community. The Logistics Community of Practice , is one of the communities currently residing within the ACC framework. LOG CoP provides a number of resources for implementing life-cycle logistics. The community space also allows members to share (post to the website) their knowledge, lessons learned, and business case related material, so that the entire logistics community has access and can benefit.

Environment, Safety, and Occupational Health (ESOH) . DoD ESOH Guidance for systems acquisition programs can be found in Chapter 4 Systems Engineering and in the ESOH Special Interest Area on the Acquisition Community.

The DoD Guide For Achieving Reliability, Availability, Maintainability (RAM) . This document helps project managers and engineers to plan for and design RAM into systems. The guide focuses on what can be done in the systems engineering process to achieve effective levels of RAM, successfully demonstrate them during operational test and evaluation, and sustain them through the systems life cycle. It can be used to help capability document requirements writers and engineering organizations think through the top-level sustainment requirements for RAM early in the life cycle to ensure the system is sustainable and affordable throughout its life cycle.

The DoD Reliability, Availability, Maintainability & Cost (RAM-C) Rationale Report Manual . This manual describes the development of the RAM-C Rationale Report. It provides guidance in how to develop and document realistic sustainment Key Performance Parameter (KPP)/Key System Attribute (KSA) requirements and related supporting rationale. It addresses how the requirements must be measured and tested throughout the system life cycle as well as the processes that should be followed when developing the sustainment requirements.

DoD Instruction 4151.20 , Depot Maintenance Core Capabilities Determination Process . This instruction describes the policy, assigns responsibilities, and prescribes procedures to implement 10 USC 2464 and DoD Directive 4151.18 . It identifies the methodology to be used in determining the required core capabilities for depot maintenance and the associated workloads needed to sustain those capabilities.

DoD Instruction 5000.67 , Prevention and Mitigation of Corrosion on DoD Military Equipment and Infrastructure . This instruction establishes policy, assigns responsibilities, prescribes procedures and provides guidance for the establishment and management of programs

to prevent or mitigate corrosion of DoD military equipment and infrastructure.

CBM+ Continuous Learning Module (CLL029) . The Condition Based Maintenance Plus (CBM+) module provides the learner with an overview and introduction to Depot Maintenance Management and Operations needed in DoD legacy systems. The module will cover DoD maintenance, CBM+ information and background, essential elements, CBM+ implementation, as well as managing initiatives and measuring success.