MEASUREMENT FOR DOD PROJECTS

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CHAPTER 1 - MEASUREMENT IN THE ACQUISITION PROCESS

Acquisition reform has streamlined the Department of Defense (DoD) and other government agencies' methods for systems acquisition, development, and maintenance. The government has a fiduciary responsibility to ensure that funds are adequately managed. Measurement has become recognized as a cost-effective tool for the acquisition and technical management of software-intensive systems. This chapter explains how measurement and the Practical Software and Systems Measurement (PSM) process fits into the overall DoD acquisition process. PSM describes how to define and implement a measurement program to support the information needs of the software and system acquirer and supplier organizations. Detailed information is provided in the *Practical Software Measurement* Book (reference a) and the *Practical Software and Systems Measurement* Guidebook (reference b).

The DoD has used the 5000 policy series since the 1970s to outline its process for acquiring new systems. A major revision of the 5000 policy series, which began in 1996, presents a new, streamlined acquisition model with an unprecedented focus on software acquisition and systems engineering management and evolutionary acquisition strategies.

1.1 Pre-Acquisition Activities

Technical and mission needs evolve rapidly. As such, a better understanding of the capabilities of technology and user requirements often must be obtained before the formal acquisition process can begin. The DoD relies on several strategies to develop, demonstrate, and evaluate emerging technologies prior to the start of an acquisition. These include Advanced Technology Demonstrations, Joint Warfighting Experiments, Advanced Concept and Technology Demonstrations, and Concept Exploration. Although these demonstrations precede the formal acquisition process, they still require measurement to provide an objective baseline for evaluation of the technology.

These pre-ACAT technology projects evaluate the feasibility and maturity of an emerging technology. They provide a relatively low-cost approach to assess technical risks and uncertainties of critical technologies prior to incorporating these technologies into an acquisition project. A successful technology project often leads to the start of an acquisition project, or its results may be integrated into a larger acquisition effort.

Pre-ACAT technology projects help to respond quickly to urgent military needs. In these projects, a system is designed, fabricated, and then demonstrated in realistic exercises. This builds an understanding of the utility of the system, supports development of a concept of operations, and elicits requirements by placing a limited, demonstrable capability into the hands of the user.

Pre-ACAT technology projects need to be managed correctly. The PSM process can be applied to these efforts, just as it can to any other project. However, the range of information needs may be narrower, since the objectives of these demonstrations are limited. Moreover, the ideal technology project should not only demonstrate that something can be done, but should also provide quantitative information about the likely cost and resulting quality of a product from the demonstrated technology. Measurement can support this requirement.

Measurement results from pre-ACAT technology projects can be useful in the early stages of the acquisition life cycle, as explained below.

1.2 Measurement in the Acquisition Process

The acquisition life cycle contains two major activities related to a contract: acquisition planning and acquisition management. A separate contract may be established to support each phase.

During each phase of the acquisition life cycle, a measurement process as illustrated in Figure 1-1 can be applied to support contract requirements.

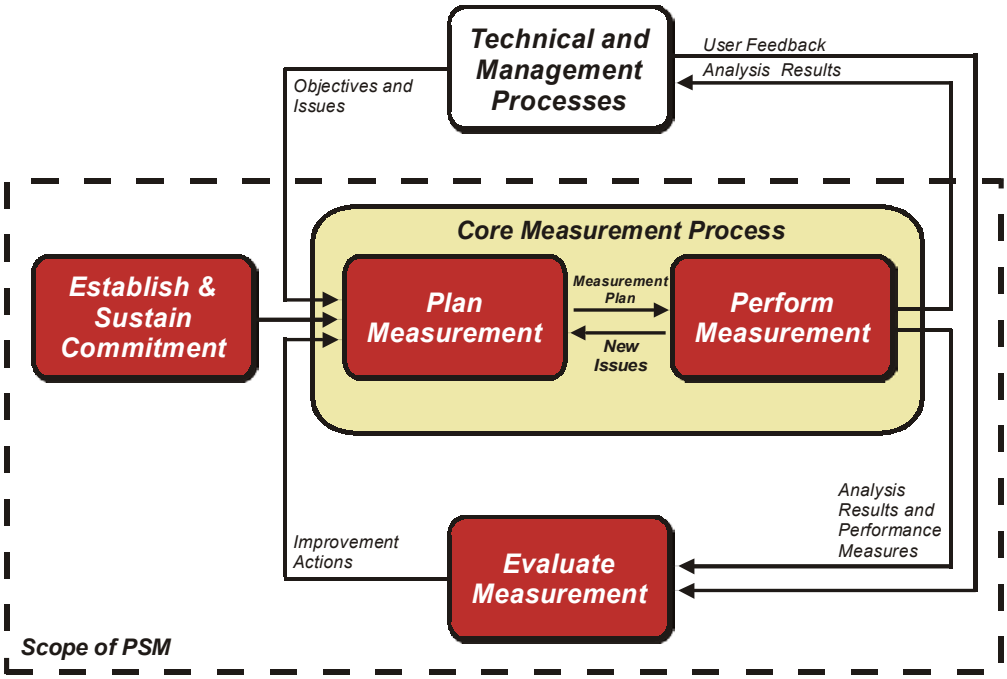

Figure 1-1. Software and Systems Measurement Activities

Figure 1-1 depicts the PSM Measurement Process. The PSM Measurement Process describes measurement activities and tasks and provides an application framework to implement measurement on a given project.

The process is built around a typical "Plan - Do - Check - Act" management sequence, adapted to support measurement specific activities and tasks. The PSM Measurement Process includes four primary activities, each of which is essential to successful measurement implementation. These activities include:

- Plan Measurement
- Perform Measurement
- Evaluate Measurement
- Establish and Sustain Commitment

The **Plan Measurement** activity encompasses the identification of project information needs and the selection of appropriate measures to address these needs. Plan Measurement also includes tasks related to the definition of data collection, analysis, and reporting procedures; tasks related to planning for evaluating the measurement results in the form of various information products; and tasks for assessing the measurement process itself. Most significantly, the Plan Measurement activity provides for the integration of the measures into existing project technical and management processes. Rather than force a project to implement a pre-defined measure, PSM, through this integration task, ensures that the selected measures will be effective within the context of the project. The Plan Measurement activity also addresses the resources and technologies required to implement a project measurement project. The output of the Plan Measurement activity is a well-defined measurement approach that directly supports the project's information needs.

The **Perform Measurement** activity, along with Plan Measurement, is considered one of the core activities that directly addresses the requirements of the measurement user. Perform Measurement encompasses the collecting and processing of measurement data; using the data to analyze both individual information needs and how the information needs and associated issues inter-relate; and the generation of information products to present the analysis results, alternative courses of action, and recommendations to the project decision makers. Perform Measurement implements the measurement plan and produces the information products necessary for effective measurement-based decision-making.

The **Evaluate Measurement** activity applies measurement and analysis techniques to the measurement process itself. It encompasses the assessment of both the applied measures and the capability of the measurement process, and it helps to identify associated

improvement actions. The Evaluate Measurement activity ensures that the project measurement approach is continually updated to address current information needs, and it promotes an increasing maturity of the project and organizational measurement process.

The **Establish and Sustain Commitment** activity ensures that measurement is supported both at the project and organizational levels. It provides the resources and organizational infrastructure required to implement a viable measurement project.

A fifth activity, **Technical and Management Processes**, is also depicted in the PSM Measurement Process. Although technically not a measurement-specific activity, Technical and Management Processes interface directly with the measurement process. The project decision makers operate within these processes, defining information needs and using the measurement information products to make decisions.

The PSM Measurement Process is iterative by design. It is defined to be tailored to the characteristics and context of a particular project, and to be adaptable to changing project information and decision requirements.

During acquisition planning, the contract is established and the mechanisms necessary to effectively manage the contract are put in place, including:

- The Integrated Product Team (IPT) is established as a cooperative forum for making decisions. (See Chapter 2 of this Guide.)

- The Work Breakdown Structure (WBS) is defined to itemize the products to be delivered and the tasks to be performed. (See Chapter 4 of this Guide.)

- The Earned Value (EV) Plan is drafted to assign budget and schedule to each of the products and tasks defined in the WBS. (See Chapter 5 of this Guide.)

- The Risk Management Plan is drafted to identify potential obstacles to project success and contingencies for dealing with them.

- The Measurement Plan is drafted to define the information needs, the data to be collected, and the analysis to be performed to determine whether the project is progressing according to plan.

Measurement does not replace other management skills and techniques. Moreover, measurement is not as effective if it is implemented as a standalone process. Measurement is a supporting discipline that helps a project manager gain the insight necessary to make technical and management decisions, and shows how important software and systems information needs are related. Measurement works best when integrated with other project management disciplines, such as risk management and financial performance management. Together, these quantitative management disciplines enable the project manager to identify and prioritize key concerns, track their resolution,

and manage the allocation of resources to optimize project cost, schedule, and technical performance.

Figure 1-2 shows that the three disciplines of risk management, measurement, and financial performance have parallel activities that define expectations and concerns, establish associated project plans, and provide appropriate information and feedback. While these disciplines can be implemented independently, an integrated approach yields the greatest value. Risk analysis helps to identify and prioritize the software and systems engineering concerns that the measurement process should track. The measurement process helps quantify the likelihood and impact of risks. The measurement process also provides an objective basis for reporting financial performance, using techniques such as Earned Value or activity-based cost accounting. The project manager must consider risks, measurement results, and financial performance when making decisions. Together, these three quantitative management disciplines complement traditional management skills and techniques.

While detailed treatments of risk management and financial performance management are beyond the scope the PSM Guidebook, some understanding of these topics is necessary to gain the full benefit of measurement. The Guidebook describes the interface between these disciplines and the measurement process.

As shown in Figure 1-2, measurement results feed into the Earned Value reporting and risk management processes. Risk, measurement, and Earned Value information are all used by the IPT to track project status and to make decisions.

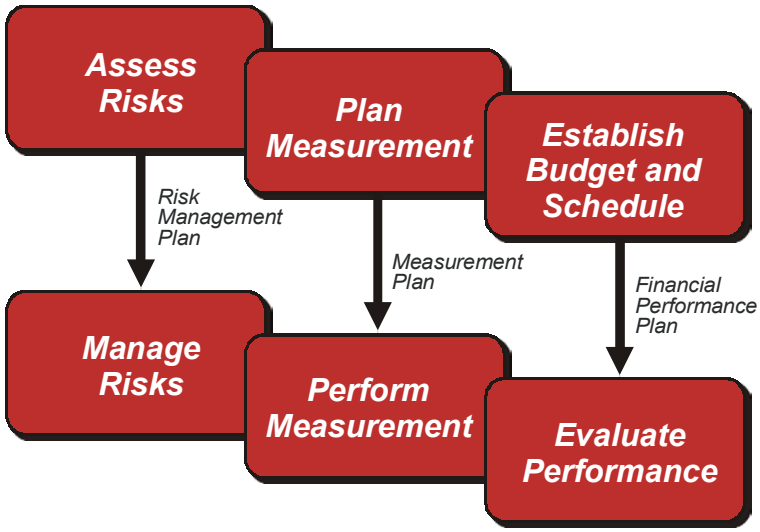

Figure 1-2. Quantitative Management

Section 2.6.6.3 of the Interim Defense Acquisition Guidebook (reference c), Applying Best Practices, recommends several best practices that should be considered in

acquisition planning. Several of these practices require the support of measurement, including:

"management goals; reporting and incentives; an open systems approach that emphasizes commercially supported practices, products, performance specifications, and performance-based standards; ... realistic cost estimates and cost objectives; … the use of past performance in source selection; results of capability evaluations; … and the use of pilot projects to explore innovative practices. The MDA [Milestone Decision Authority] shall review best practices at each decision point."

Chapter 5 of the Interim Defense Acquisition Guidebook, Software Management, also requires measurement in a software acquisition project: "The PM shall base software systems design and development on systems engineering principles, to include the following:

"Use a software measurement process in planning and tracking the software program, and to assess and improve the software development process and the associated software product. Provide those measures to the appropriate OSD oversight office. For example, MAIS PMs shall follow the process described in the *Practical Software and System Measurement Guidebook*…."

The most significant feature in the most recent updates of the DoD 5000 policy series is the opportunity for managers to customize the acquisition process. The DoD Memorandum 5000.1 of 30 October 2002 states:

"Evolutionary acquisition strategies shall be the preferred approach to satisfying operational needs. Spiral development shall be the preferred process."

Although certain baseline procedures will continue to be mandated, tailoring is encouraged for numerous aspects of the process, including project documentation, acquisition phases, the timing and scope of decision reviews, and decision levels. DoD managers are instructed to tailor their acquisition strategies to fit the particular conditions of an individual project, "consistent with common sense and sound business practices."

Evolutionary strategies also help to address another long-existing challenge: weak descriptions of what the user really wants to do with the system. Evolutionary acquisition is a strategy that supports the requirements-definition process by allowing a small initial set of requirements to be refined over time to meet changes in technology and user needs and capabilities.

1.3 Measurement to Support Systems Engineering

Section 5.2.3 of the Interim Defense Acquisition Guidebook states that the following key systems engineering activities shall occur, including:

a. Requirements Analysis - provide traceability among user requirements and design requirements.

b. Functional Analysis/Allocation - support the integrated system design.

c. Design Synthesis and Verification - perform a cost-effective combination of design analysis, design modeling and simulation, and demonstration and testing.

d. System Analysis and Control - provide the basis for evaluating and selecting alternatives, measuring progress, documenting design decisions, and enabling and managing block deliveries under an evolutionary acquisition strategy. They shall include:

   (1) trade-off studies,

   (2) planning technology transition and establishing transition criteria,

   (3) a risk management process - including but not limited to cost, performance, and schedule risks,

   (4) maximum use of performance requirements for items identified as high pay-off for technology insertion,

   (5) configuration management process to provide a complete audit trail of decisions and design modifications,

   (6) an integrated data management system to serve as a ready reference for the systems engineering effort,

   (7) performance metrics to measure meeting system requirements in terms of performance, cost, schedule, and progress in implementing risk handling. Performance metrics shall be traceable to performance parameters identified by the operational user,

   (8) a verification (including test and measurement) effectiveness review process to demonstrate and confirm verification adequacy and compliance with specified requirements,

   (9) interface controls to ensure all internal and external interface requirements changes are properly recorded and communicated to all affected configuration items, and

   (10) a structured review process to demonstrate and confirm completion of required accomplishments and their exit criteria as defined in project planning.

In addition to performance metrics, measurement supports many of these system analysis tasks; especially performing trade-off studies, implementing a risk management process, and defining project exit criteria.

1.3.1 Measurement to Support Definition of Systems Engineering Requirements

DoD Memorandum 5000.1, subject "The Defense Acquisition System" of 30 October 2002 (references d and e), Section 3.15, Systems Engineering, states "Acquisition programs shall be managed through the application of a systems engineering approach that optimizes total system performance and minimizes total ownership costs."

The Interim Defense Acquisition Guidebook, Chapter 5, Program Design, Systems Engineering, states: "The PM shall implement a sound systems engineering approach to translate approved operational needs and requirements into operationally suitable blocks of systems. The approach shall consist of a top-down, iterative process of requirements analysis, functional analysis and allocation, design synthesis and verification, and system analysis and control. Systems engineering shall permeate design, manufacturing, T&E, and support of the product. Systems engineering principles shall influence the balance between performance, risk, cost, and schedule."

Measurement is required to achieve these objectives of the systems engineering process:

a. Transform approved operational needs and requirements into an integrated system design solution.

b. Ensure the interoperability and integration of all operational, functional, and physical interfaces.

c. Characterize and manage technical risks.

d. Minimize or contain information assurance and force protection risks.

1.4 Measurement During System Development

Chapter 5 of the Interim Defense Acquisition Guidebook, Software Management, states: "The PM shall manage and engineer software-intensive systems using best processes and practices known to reduce cost, schedule, and performance risks. … The PM shall base software systems design and development on systems engineering principles, to include the following:

a. Develop architectural based software systems that support open system concepts; exploit COTS computer systems products; and allow incremental improvements based on modular, reusable, extensible software.

b. Use DoD standard data and policies in DoD Directive 8320.1.

c. Select contractors with domain experience in developing comparable software systems; with successful past performance; and with a mature software development capability and process. ACAT [Acquisition Category] I or ACAT IA programs shall undergo an evaluation. …At a minimum, full compliance with SEI Capability

Maturity Model Level 3, or its equivalent in an approved evaluation tool, is the Department's goal. However, if the prospective contractor does not meet full compliance, risk mitigation planning shall describe, in detail, the schedule and actions that will be taken to remove deficiencies uncovered in the evaluation process. Risk mitigation planning shall require PM approval.

d. Use a software measurement process in planning and tracking. Provide those measures to the appropriate OSD oversight office. For example, MAIS PMs shall follow the process described in the *Practical Software and Systems Measurement Guidebook*….

e. Assess information operations risks (DoD Directive S-3600.1) using techniques such as independent expert reviews."

1.4.1 Spiral Software Development

The Interim Defense Acquisition Guidebook [5.2.3.5.6.2] requires the use of spiral development for all software development projects: "When acquiring software for a system, the PM shall plan a spiral development process for both evolutionary and single-step-to-full-capability acquisition strategies."

Spiral development is defined as a cyclical, iterative "build-test-fix-test-deploy process" that yields continuous improvements in software. The spiral development process is expected to provide many benefits to the DoD software acquisition process, including:

a. Facilitating changes to software requirements that are defined by operational mission needs, technology opportunities, experimentation results, and technology obsolescence.

b. Supporting a continuous process of realistic T&E to measure the operational effectiveness, suitability, and supportability of each increment of the software-intensive system.

c. Improving the visibility of the configuration control board (CCB) to allow input from the systems user and software maintenance organizations.

The spiral development process may also have an impact on the measurement process by changing the priorities of the information needs of a project. Spiral development usually increases the number of changes that will be made to the requirements and systems design baselines, expanding the need for configuration control and related measures.

1.5 Independent Expert Reviews

The Interim Defense Acquisition Guidebook, section 5.2.3.5.6.3, "Review of Software-Intensive Programs," states: "All ACAT ID and IC programs that require software

development to achieve the required mission capability shall require an independent expert program review. An independent expert review team shall conduct the review after Milestone B and prior to the system Critical Design Review. The PM or other acquisition official in the program chain of command, up to the SAE, shall also consider independent expert program reviews for ACAT IA, II, and III programs, as well as any other system determined to merit such a review. The independent expert review team shall report review findings directly to the PM."

An independent expert review team will review projects and report on technology and development risk, cost, schedule, design, development, project management processes, and the application of systems and software engineering best practices. The review team may report their finding through any number of measures that are tailored to the project and the objective of the review. The team will report their findings directly to the PM and the PEO or equivalent management official. DUSD (AT&L) shall manage the team, composed of a small group of software systems engineering and technology experts.

1.6 Measurement During Test and Evalution

Because the new policy defines evolutionary acquisition strategies as the preferred approach to satisfy operational needs, the test and evaluation (T&E) process must be tailored to this approach. The Interim Defense Acquisition Guidebook directly addresses this need with regard to software-intensive systems:

"A cyclical, iterative build-test-fix-test-deploy process characterizes spiral development and yields continuous improvements in software. Each software release draws upon the experience and lessons of previous releases."

The new policies do not define a specific T&E approach; they only specify what the end result should be: Software shall have proven its maturity level prior to deploying it to the operational environment."

The DoD 5000 policy series does not define a specific process or measures to evaluate software or system maturity. The measurement approach and quantitative units that are selected to monitor maturity should be selected to meet the information needs of each project.

1.7 Management of Computer Off The Shelf (COTS) Products

The Interim Defense Acquisition Guidebook states: "The PM shall … Develop architectural based software systems that support open system concepts; exploit COTS computer systems products; and allow incremental improvements based on modular, reusable, extensible software." The remainder of this section provides advice for managing COTS software in a development effort:

No matter how much of a system is provided by commercial items, the PM shall engineer, develop, integrate, test, evaluate, deliver, sustain, and manage the overall system. The keys to success involve thinking and acting as an informed consumer, planning for continuous evolution of the system, and maintaining a flexible posture throughout the life of the project.

The use of commercial items often requires changes in the way systems are conceived, acquired, and sustained, to include:

a. The PM shall plan for robust evaluations to assist in fully identifying commercial capabilities to choose between alternate architectures and designs. … Evaluating commercial items requires a focus on mission accomplishment and matching the commercial item to system requirements.

b. The PM shall engineer the system architecture and establish a rigorous change-management process for life-cycle support. … Failure to address changes in commercial items and the marketplace will potentially result in a system that cannot be maintained as vendors drop support for obsolete commercial items.

c. The PM shall develop an appropriate T&E strategy for commercial items, to include evaluating potential commercial items in a system test bed, when practical; focusing test beds on high-risk items; and testing commercial-item upgrades for unanticipated side effects in areas such as security, safety, reliability, and performance.

The changes in the acquisition process that are needed to manage COTS products will also change the information needs of the project. For example, functional performance and not design criteria will be monitored during development, and test cases may not address internal functions of the COTS product.

1.8 Information Technology-Specific Considerations

DoD Memorandum 5000.2 of 30 October 2002, "IT System Procedures," states "The MDA shall not approve program initiation or entry into any phase that requires milestone approval (to include full-rate production) for an acquisition program (at any level) for a mission-critical or mission-essential IT system until the Component CIO confirms that the system is being developed in accordance with the CCA [Clinger-Cohen Act]."

Compliance with the Clinger-Cohen Act requires the PM to verify that these criteria have been achieved:

a. Mission-related, outcome-based performance measures have been established and linked to strategic goals.

b. The processes that the system supports have been redesigned to reduce costs, improve effectiveness, and maximize the use of COTS technology.

c. An analysis of alternatives has been conducted.

d. For AIS [Automated Information Systems], an economic analysis has been conducted that includes a calculation of the return on investment, or, for non-AIS projects, an LCCE [Life Cycle Cost Estimate] has been conducted.

e. There are clearly established measures and accountability for project progress.

f. The acquisition is consistent with the Global Information Grid policies and architecture, to include relevant standards.

g. To the maximum extent practicable, (1) modular contracting is being used, and (2) the project is being implemented in phased, successive blocks, each of which meets part of the mission need and delivers a measurable benefit, independent of future blocks.

1.9 Measurement to Support Security

Chapter 5, of the Interim Defense Acquisition Guidebook, "Software Security Considerations," states: "The following security considerations apply to managing changes to existing DoD software:

a. A documented impact analysis statement, which addresses software reliability, shall accompany modifications to existing DoD software.

b. The PM shall establish formal software change control processes.

c. Software quality assurance personnel shall monitor the software change process.

d. An independent verification and validation team shall provide additional review.

e. The change control process shall indicate whether foreign nationals, in any way, participated in software development, modification, or remediation.

f. DoD contractors, subcontractors, and COTS suppliers that employ foreign nationals must meet additional requirements for personnel security clearances, facility security clearances, development environment, and software quality assurance."

CHAPTER 2 - MEASUREMENT FOR INTEGRATED PRODUCT TEAMS

Implementing many of the streamlining initiatives established by DoD acquisition reform policy requires a close working relationship between the supplier and the acquiring organization. The Integrated Product Team (IPT) provides a mechanism for implementing this relationship. IPTs may be the primary users of measurement results in many projects. This chapter explains how measurement is implemented through an IPT.

In May of 1995, the use of IPTs became policy for all DoD projects. The use of IPTS has been incorporated into the DoD 5000 policy series, and defines different levels of IPTs, such as the Overarching IPTs (OIPTs), the Working-Level IPTs (WIPTs), and the Project IPTs.

The IPT concept is based on the approach of all parties working together to ensure successful implementation of individual projects. IPTs can be formally chartered or they can be informal working groups. They can function at levels that range from one team for multiple projects in an organization to small teams addressing one aspect of a single project. Implementation of the IPTs concept does not mean that an organization needs to restructure. The team is not the end goal, but rather the means through which much of the work is accomplished, including measurement. Figure 2-1, extracted from "A Guide for Leading Successful Integrated Product Teams," describes how the government participates in various IPTs. It is easy to see that measurement plays an important role in almost every aspect of "Focus" and "Participant Responsibilities."

A typical industry IPT would consist of two tiers. The first-tier team provides strategic direction, corporate oversight, and review. The measurement input to this team is at a high "management" level to provide summary information and trend analysis. This team should be a cross-functional team to optimize the chances for success.

The second tier of a typical industry IPT is made up of multiple sub-teams. These sub-tier teams should also be multi-disciplinary, rather than functionally oriented. Each team should have a broad perspective of the product, process, and organization, rather than a centralized viewpoint. Each team should also have a specific charter that identifies expectations and responsibilities for project support. Sub-tier team leaders should also be members of the next higher tier team. The measurement requirements for sub-tier teams are determined by their domain. The teams are responsible for aggregation of their measures for the first-tier team.

Organization	Teams	Focus	Participant Responsibilities	Measurement Relationship
OSD and Components	OIPT	• Strategic Guidance • Tailoring • Project Assessment • Resolve Issues Elevated by WIPTs	• Project Success • Functional Area Leadership • Independent Assessment • Issue Resolution	• Milestone Estimates • Feasibility Studies • Earned Value • Estimates to Complete
	WIPTs	• Planning for Project Success • Opportunities for Acquisition Reform (innovation, streamlining) • Identify/ Resolve Project Issues • Project Status	• Functional Knowledge & Experience • Empowered Contribution • Recommendations for Project Success • Communicate Status & Unresolved Issues	• Milestone Estimates • Feasibility Studies • Estimates to Complete • Earned Value
Project Teams & System Suppliers	Project IPTs	• Project Operation • Identify & Implement Acquisition Reform	• Manage Complete Scope of Project, Resources & Risk • Integrate government & Supplier Efforts for Project Success • Report Project Status & Issues	• Design, Implementation, and Testing measures for all identified issues

Figure 2-1. DoD IPT Types, Focus, and Responsibilities

The IPT concept differs from the traditional project organization concept, which usually focuses on single-function disciplines. IPTs are responsible for designing the product and its associated processes, and also for planning, tracking, and managing their own work and the processes by which they do their work. Successful application of IPPD rests heavily on the ability to form, align, empower, and lead cross-functional teams.

The team's focus is on achieving set goals and objectives. Measurement is a means for creating and maintaining that focus. When measures provide meaningful indicators, IPTs can clearly understand their progress and better allocate resources for identified risks and the remaining tasks. Identification and management of risks are key responsibilities of each IPT.

CHAPTER 3 - PUTTING MEASUREMENT ON CONTRACT

When a DoD activity plans to acquire a system from an external organization, the government's requirements for measurement (including analysis and reporting) during the acquisition project need to be formally defined. Contracts to perform maintenance on a software-intensive system should also address measurement. This chapter explains how measurement may be implemented in a contract between a government organization and a private supplier. These concepts also apply in varying degrees when products are acquired from another government organization via a Memorandum of Agreement (MOA) or Inter-Service Support Agreement (ISSA). This chapter provides an overview of the contracting process, as well as sample contract wording (see Section 3.7).

3.1 Overview of the Contracting Process

The PSM measurement-tailoring process often supports a formal acquisition in which proposals are solicited and an offeror is selected. Measurement must be coordinated within each of the five activities of the contracting process, and the following subsections describe each of these activities in more detail:

a. planning (Section 3.2)

b. solicitation preparation (Section 3.3)

c. proposal evaluation (Section 3.4)

d. negotiation (Section 3.5)

e. contract monitoring and modifications (Section 3.6)

Section 3.7 provides sample wording that may be inserted into a Request For Proposal (RFP) or a contract, along with the rationale for each contract requirement.

Through the contracting process, the project management team ensures that the necessary measurement mechanisms are in place to support the acquisition and/or maintenance objectives and the information needs for the project's current phase. This contracting process applies to both the development and maintenance phases, although the information needs and measures may differ. When adding measures to an existing contract, the acquisition planning and proposal evaluation activities are generally not implemented.

Contracts that are issued for maintenance support after system deployment should require a measurement process to be implemented. If possible, it is best to first define the

maintenance measurement process in the initial development contract. The development contract should require the offeror to describe how the quality of the products will be measured during both the development and maintenance processes of the system life cycle. The maintenance contract should also require the offerors to describe changes from development to maintenance in the information needs, prospective measures, and procedures.

3.2 Planning

The most important consideration to ensure that an adequate measurement process will be implemented is to make measurement a factor throughout the planning process.

The first step in planning a system acquisition project is to document the Acquisition Strategy. The Federal Acquisition Regulation (FAR) mandates that the project manager (PM) shall develop an acquisition strategy that is tailored to the particular major system acquisition project. This strategy is the PM's overall plan to acquire a system that will satisfy the mission need in the most effective, economical, and timely manner. The Acquisition Plan (AP) should specify "information needs" that support project decision-making, and, if possible, the AP should address the expected measurement reporting, for instance, SRDR Manual 5000.4M-2. The FAR defines specific requirements for writing the strategy that becomes the AP for the system. The FAR also states that at key dates specified in the AP, or whenever significant changes occur, and no less often than annually, the planner shall review the AP and revise it, if appropriate.

The FAR also requires that, in developing the AP, the PM shall form a team consisting of all those who will be responsible for significant aspects of the acquisition, such as contracting, fiscal, legal, and technical personnel. Each of these has distinct information needs that can be supported with measurement. The personnel and panels that manage the acquisition process are the Source Selection Authority (SSA), Source Selection Advisory Council (SSAC), and Source Selection Evaluation Board (SSEB). The SSA is the government official in charge of selecting the source, usually the local contracting officer. The SSAC consists of senior personnel from various functional areas involved in the procurement who act as advisors to the SSA throughout the source selection process. The SSEB consists of a chairperson, usually the PM, and other experienced government contracting, technical, and administrative/management personnel. Personnel on the SSEB should have previous experience in similar or related projects in order to provide mature judgment and expertise in the evaluation process; as such, the members of the SSEB will often be the best sources for identifying and specifying the information needs of the project. The information needs should help to prioritize the measurement requirements of the project.

3.3 Solicitation Preparation

The solicitation and source selection process must satisfy procurement statutes and acquisition regulations, including the FAR, the Defense FAR Supplement (DFARS), and the Acquisition Procedures Supplement that each service has established for their acquisition projects. To ensure compliance, a Source Selection Plan (SSP) should be used to control the entire source selection process. The SSP and the solicitation must adhere to the acquisition strategy and contract methodology documented in the approved AP.

The PM has the overall responsibility for preparing the SSP, which must be approved by the SSA prior to issuing the formal solicitation. The SSP should include those evaluation factors that will ensure an offeror can implement an adequate measurement project, based on the information needs associated with managing the acquisition project. The SSP should define:

a. The factors that will be used in the evaluation listed in relative order of importance, along with any additional language necessary to fully describe the relative importance of the factors, including weights, if applied.

b. Evaluation factors that may be used to determine an offeror's measurement capability include process maturity and past measurement experience.

c. Methods for rating/scoring each evaluation factor in the offerors' proposals should be included.

d. When applicable, guidelines for making trade-off decisions among and within the various factors.

Evaluation factors must coordinate with the solicitation's statement of work and must be consistent with the FAR. Evaluation factors must be limited to those areas that will reveal substantive differences or risk levels among competing proposals. There are no restrictions on the kinds of evaluation factors that may be used, as long as they are reasonably related to the government's requirement and tailored to each contract. Only those factors that will have an impact on the source selection decision should be included in the solicitation. Measurement reporting should be one of the evaluation factors, because information derived from the measurement activities is vital to making project decisions. As with all evaluation factors, measurement reporting must include cost to the government and may also define criteria such as technical, management and business, past performance, and schedule. However, the factors should be designed to permit evaluators to distinguish among offerors. Sample tasks, such as submitting a draft measurement plan, may be used to better demonstrate the offeror's capability to perform the required measurement tasks.

The SSP should also define the rating system that will be used by the evaluators to assess each proposal's merit with respect to the evaluation factors in the solicitation. As a general rule, the higher the technical or performance risk, the greater the emphasis on non-cost factors. Cost or price is generally not scored or rated as an evaluation factor during the proposal technical evaluation. But, like all the other factors, the importance of cost or price relative to the other evaluation factors and the overall evaluation must be disclosed. The circumstances of the particular acquisition will indicate how important cost or price is to the source selection.

The FAR requires that price or cost to the government shall be evaluated in every source selection. The FAR requires that the relative importance between all non-cost factors and cost or price must be described in the solicitation. Each evaluation factor is defined as significantly more important, approximately equal, or significantly less than cost or price. Unfortunately, the extra cost to a project for not having an adequate measurement project (resulting in decisions made without adequate information) is not a determining factor.

The final step in preparing the solicitation is to build the RFP. The RFP should include the government's requirements for the contracted effort and contain the information necessary to prepare an adequate proposal, including the statement of work, specifications, data requirements, general provisions, special contract requirements, and the evaluation factors for award and their relative importance.

Section L of the RFP is entitled "Instructions, Conditions, and Notices to Offerors." This section includes the provisions and other information and instructions not required elsewhere in the solicitation to guide offerors in preparing their proposals. It specifies information such as the form and content of the proposals, proposal page limitations, number of copies required, number of volumes, use of electronic commerce, facsimile proposals, and oral presentations. The purpose of this section is to request information from the offerors that can be used to evaluate their proposals in accordance with Section M.

Section M of the RFP is entitled "Evaluation Factors for Award." It notifies offerors of the evaluation factors against which all proposals will be evaluated. All factors that will affect contract award and their relative importance shall be stated clearly in the solicitation. These factors should be carefully structured to ensure that they represent the key areas of importance and emphasis to be considered in the source selection decision. The rating method need not be disclosed in the solicitation. The general approach for evaluating past performance information shall be described.

The RFP may require a draft software and systems engineering measurement plan to be submitted for evaluation in the source selection decision. The draft plan will describe each offerors' measurement process that will be followed after contract award. The draft plan may also become a contractual requirement after award.

The RFP instructions for the draft measurement plan may also require a measurement specification for the offerors' proposed measure. Details on the measurement specification are provided in Section 3.7.1 below.

Sections L and M of the solicitation are developed from input provided in the SSP. The evaluation factors set out in Section M shall be identical to the evaluation factors set out in the SSP.

The evaluation factors may also include the past performance of each offeror. The Government may use past performance to identify the offeror with the best track record in providing quality deliverables, controlling costs, and minimizing the need for Government oversight. The RFP may require each offeror to submit historical data for at least three past projects that are similar to the proposed contract. Specific data may include size, effort, cost, schedule performance, or defects.

More information on considerations of software measurement in the contracting process may be found in the US Air Force, Software Technology Support Center document: "Guidelines for Successful Acquisition and Management of Software-Intensive Systems [GSAM]," Version 3.0, May 2000 (reference f). Relevant topics that are addressed in the GSAM include:

a. the Contractual Data Requirements List,

b. special software RFP considerations,

c. source selection factors,

d. source selection,

e. proposal evaluation and contract award,

f. handling protests.

3.3.1 Evaluation Factors for a Measurement Process

The two most significant factors that can be used to determine an offerors' capability for measurement are past performance and process maturity.

Past Performance

The quality of a supplier's performance on previous contracts is a good indicator of how they will perform in the future. Therefore, past performance should be an evaluation factor on most competitively negotiated contracts. To maximize the benefits associated with using past performance information, the SSA should not be constrained by the

references suppliers provide in their proposals, but should evaluate any other source of past performance data.

An offeror's relevant, current experience (as of the date of the proposal), prior experience, and performance record should be considered as a part of every award decision in the DoD. There is a difference between a supplier's experience and past performance. Experience reflects whether the supplier has performed similar work before. Past performance, on the other hand, describes how well the supplier performed the work. In other words, it describes how well the supplier executed what was promised in the proposal/contract. Both of these areas are considered when making a responsibility determination. Either area can be considered as a source selection criterion, where they can either standalone or be considered under "performance risk."

Several sources of supplier past performance data are available. The Contractor Performance Assessment Reporting System (CPARS) is an electronic database that provides detailed information and an assessment of the ongoing performance of suppliers. Each report in the CPARS consists of a narrative assessment by the project manager, the supplier's comments, if any, relative to the assessment, and the overall past performance assessment (exceptional, very good, satisfactory, marginal, or unsatisfactory) assigned by the CPARS approving official. The primary purpose of the CPARS is to provide a database of supplier performance information that is current and available for use in source selections. The CPARS can be used to effectively convey the strengths and weaknesses of supplier performance on past projects. Past performance information may also be collected by talking to previous project offices to obtain a history of completed projects for estimation analysis.

Sometimes, the only way to find out past performance information is to generate a list of potentially similar contracts using the DD Form 350 database, which is normally used to report contract information or request that the offeror identify similar contracts and respective points of contact for work they have performed or are performing. The cognizant contracting office is identified by a code on the form. The list of contracting offices' addresses and their codes is located in Appendix G of the DFARS.

Process Maturity

It is generally accepted that a supplier has institutionalized a measurement process if their organizational unit proposing to do the work has received a Level 3 rating in a Software Capability Evaluation (SCE) in accordance with Software Engineering Institute's Capability Maturity Model (SEI's CMM) criteria. Although measurement and analysis is not a separate process area in this model, it is implied through many of the other process areas, such as configuration management and quality assurance. The maturity of measurement and analysis becomes a specific finding for an offeror who has been evaluated in accordance with the Capability Maturity Model Integrated (CMMI), using

the Standard CMMI Appraisal Method for Process Improvement, which is discussed below. The results of a CMMI evaluation directly address an organization's Measurement and Analysis (M&A) process. Therefore, an evaluation factor for the maturity of an offeror's measurement process may be defined as achieving a specific level in a capability assessment or by evaluating the capability of the supplier's M&A process.

The current DoD 5000 policy series requires ACAT I and IA project managers to select suppliers with domain experience in developing comparable systems, with proven successful past performance, and with a mature development capability and process. It is the Department's goal that suppliers who are performing development or upgrade(s) for use in an ACAT I or ACAT IA project be compliant with the SEI's CMM Level 3 or its equivalent in an approved evaluation tool. The Department has also determined that the CMMI Level 3 criteria, in addition to the Software Development Capability Evaluation (SDCE), is an acceptable alternative for use in satisfying the referenced policy. The fact that the DoD 5000 series is being updated does not change the Department's goals for selecting suppliers with mature processes.

Although it is necessary for a supplier to have a mature development process, the evaluation factor should address the process that the particular division or component within the organization proposes to use on the project being bid. The parent organization, as a whole, might have a mature process; however, certain divisions or components within the organization proposing to do the work might not be as experienced in or as knowledgeable of that process.

Section 3.7 of this document contains sample wording that may be inserted into an RFP to define the evaluation factors. During acquisition planning, measurement requirements are identified and documented. In the RFP, the project management team may also request historical data to substantiate the offeror's proposal and to conduct an independent feasibility analysis of the proposed system or software development plans. Section 3.7 also provides wording to request this data. In parallel with RFP development, the project management team usually develops independent estimates of size, schedule, effort, and cost to evaluate the suppliers' proposals.

Evaluating Process Capabilities and Organizational Maturity for Supplier Source Selection

Evaluating the process capabilities of potential suppliers is an important measurement activity performed early in an acquisition.

The Standard CMMI Appraisal Method for Process Improvement (SCAMPI) V1.1 is designed to provide benchmarks relative to Capability Maturity Model Integration (CMMI) models. SCAMPI typically will be used in two different acquisition

environments: source selection and contract process monitoring. SCAMPI is also applicable to a wide range of appraisal applications, including support for both internal process improvement assessment and external capability evaluation or determination; as such, SCAMPI replaces the original appraisal process that was developed for supplier source selection, the Software Capability Evaluation (SCE). The SCE was based on the Capability Maturity Model for Software (SW-CMM). Software Development Capability Evaluations (SDCEs) core criteria are another alternative. The SCE has been in routine use since the original publication of the CMM concepts. The commercial community has been applying SCEs in the selection of subcontractors and teaming partners. It is expected that the demand for support of supplier source selection will continue, but these demands will be more routinely satisfied by the application of SCAMPI instead of SCEs.

The SCAMPI V1.1 Method Definition Document (reference g) describes the SCAMPI processes and provides additional implementation guidance related to supplier selection and contract process monitoring applications of this appraisal method.

CMMI and SCAMPI are slated to replace the SW-CMM and its associated appraisal methodologies: CMM Based Appraisal for Internal Process Improvement (CBA-IPI), V1.2, and Software Capability Evaluation, V3.0. This transition is expected to be complete by the end of 2005. SCAMPI is expected to be the single appraisal methodology to be appropriately tailored for use in with CMMI models.

SCAMPI fulfills the Appraisal Requirements for CMMI (ARC) V1.1 document that required an appraisal methodology capable of benchmarking process improvement efforts internal to supplier organizations as well as to government and commercial supplier-selection and contract-monitoring applications. As a benchmarking appraisal method, SCAMPI is classified as an A method. Class B and C methods have less stringent appraisal requirements.

With the advent of SCAMPI V1.1, the historical use of the terms “assessment” and “evaluation” are replaced with the term “appraisal,” because what were previously internal assessments and external evaluations will instead use the same core appraisal methodology with tailoring guidance appropriate to the circumstances of internal process improvement, supplier selection, or contract process monitoring. Independently led, registered appraisals should be considered for use.

3.4 Proposal Evaluation

As part of a supplier’s proposal in response to the RFP that is described in Section 3.3, the bidding organizations could be expected to explain how their measurement process will meet the project manager’s information needs. Each measurement process proposed by the prospective suppliers must be evaluated. This includes assessing the offeror’s understanding of the information needs specified in the RFP, the potential effectiveness

of their process, and the measures that they plan to use to address the information needs. The evaluation should also assess the adequacy of the proposed measurement data specifications. An on-site evaluation at each offeror's facility may be performed to validate the proposed measurement process.

The proposal evaluation team also needs to assess the feasibility of each proposal's estimates of size, schedule, effort, and cost. The team may use cost and schedule estimation models to compute performance parameters and to look for inconsistencies that need to be reconciled. In addition, the offeror's estimates should be compared to the independent estimates developed by the project office. Feasibility of the proposed plan is also evaluated by using historical data provided by the supplier, such as productivity.

The AP, SSP, and RFP must establish firm criteria to ensure that the contract award will be made to an offeror who can provide an adequate measurement process, not just the offeror with the lowest cost bid. The FAR specifically addresses situations in which the contract may be awarded to the offeror with the best value, rather than the lowest cost. In this situation, the source selection authority is responsible for a cost/technical trade-off to independently determine if non-cost advantages are worth the cost/price that might be associated with a higher-rated proposal. The decisive element is not the difference in ratings, but the SSA's rational judgment of the significance of that difference, based on an integrated comparative assessment of proposals.

To determine which proposal provides the best value, the SSA must analyze the differences between competing proposals. This analysis must be based on the facts and circumstances of each acquisition and must be consistent with the solicitation. This analysis ensures a disciplined and documented process for an integrated comparison of proposals and a rational basis for the SSA's ultimate decision. There is no standard formula for making the cost/technical trade-off.

Measurement capability should not justify a significantly higher cost proposal for an offeror. An offeror who has a well-established measurement process may or may not incur higher costs during a development contract. However, a well-established measurement process should be reflected in a superior record of past performance and a higher level of process maturity.

The cost/technical trade-off and the source selection decision, which must be consistent with the solicitation, require that the SSA exercise reasonable business judgment in selecting the offeror for contract award. The SSA must consider the significance of the differences in the non-cost ratings as indicated by each proposal's strengths, weaknesses, risks, and deficiencies. The strengths, weaknesses, risks, and deficiencies for each factor must be considered in light of the relative importance of each factor stated in the solicitation. Any price increase to select an offeror who is superior in non-cost ratings must be justified, regardless of the superiority of the rating. Bidding organizations using superior measurement processes that promise to deliver timely, relevant information in

support of project management decision-making should be able to justify some increased overhead, since the output of their measurement process should help to better manage project risks.

3.5 Negotiation

Once an offeror has been selected according to the procedures described in Section 3.4, negotiation helps to define the measurement requirements in the contract. In the proposal, the offeror should have identified any concerns with the project office's specified information needs and measures, and proposed appropriate alternatives. Alternate measures must adequately address the project office information needs and must be used within the offeror's process to manage the development.

The offeror's proposal should also identify any problems associated with the project office's measurement guidance, including the data items to be collected, the collection and reporting levels, the method for counting actual data, and how the measurement process will be evaluated. The offeror should describe the proposed implementation of the measures, including definitions, estimation techniques, actual measurement methods, and data reporting mechanisms. All of these items must be agreed upon during negotiations. The results of the negotiations, including the measurement project and process offered in the bid that were satisfactory to the government, should be documented in the contract or in an approved measurement plan.

3.6 Contract Monitoring and Modifications

It is important to understand that the information needs will change during the project. The measurement and contracting process has to be flexible to accommodate these changes. Different measures may be required to address new or modified information needs, and changes may be required for data definitions, data elements, or reporting mechanisms. Evaluation of the measurement process may also lead to changes.

Contract modifications may also be necessary to implement measurement on existing projects that did not originally require measurement. Even in these situations, the project management team should define information needs and measurement requirements. The team should work with the existing supplier to determine if any measures are already available to address these information needs.

3.7 Sample Request For Proposal Wording

This section contains sample wording that may be inserted into a RFP, contract, or other agreement between the project manager and offeror. The sample wording may be used to

request measurement data, address questions about that data, and develop a project measurement plan.

Each of the following sections contains a description of the rationale for each request, followed by sample wording (in quotes in the shaded area) that may be directly inserted into an agreement.

3.7.1 Requirements for Project Measurement

3.7.1.1 Offerors' Definition of Measurement Requirements Prior to Contract Award

Contract wording to require collection of measurement data should be specified. In the RFP, the project management team may either require the offeror to propose a measurement process or identify the minimum, initial set of project information needs and the prospective measures that will be required to address them.

If the project management team requires the offeror to propose a measurement process, the following text is provided as an example for the RFP.

"The offeror shall provide a draft Measurement Plan that defines the proposed measurement process and products, including:

a. anticipated information needs and the process for revising these information needs;

b. proposed measures, including:

- *base measures,*
- *derived measures,*
- *indicators, and*
- *other details from the offeror's measurement specifications;*

c. measurement process to be used."

If the project management team has already specified the information needs and prospective measures, the RFP should define the characteristics of each required measure, including the data to be collected (such as those derived from following the guidance in SRDR Manual 5000.4M-2), the collection and reporting levels, and the method for counting actual data as complete. The following paragraph specifies monthly reporting, but this may be adjusted as appropriate for each project.

"The offeror shall provide the project measures specified in Paragraph XXX on a monthly basis. For each measure, data shall be provided at the specified collection level. The supplier shall provide a detailed measurement specification for each measurement to be provided. This specification shall include:

a. project information needs,
b. indicators,
c. derived measures, and
d. base measures."

3.7.1.2 Offerors' Definition of Measurement Requirements After Contract Award

After contract award, the offeror should be required to update the pre-award draft plan or develop a new measurement plan if a pre-award version was not required. The measurement plan will provide details on the project information needs and associated measures; the proposed measurement process; and how the supplier will use and report the measurement information. The following paragraph may be used in a contract to specify the requirements for a measurement plan to be delivered after contract award.

"The supplier shall submit a draft measurement plan that specifies the information needs to be addressed, the measures to be used, and measurement specifications. This plan shall identify the measurement approach to be used, including:
a. a description of the current information needs and how measurement information will be used and reported in the supplier's internal management of this project;
b. proposed measures, including:
- *base measures,*
- *derived measures,*
- *indicators, and*
- *other details from the offeror's measurement specifications;*

c. how data will be collected;
d. points of contact, responsibilities, organization communications, and interfaces;
e. external reporting mechanisms, processes, and frequency."

A measurement plan should be concise, but must ensure that the required information has been identified and a definitive process is established. Figure 2.4-2 in Part 2 of the PSM Guidebook contains a sample outline of a Measurement Plan. This plan should be modified as needed to accommodate different project information needs and offeror processes. It may be included as part of a higher-level plan, such as the Project Plan, Software Development Plan, Systems Engineering Management Plan, or similar planning document.

Requirements for most prospective project measures should include both planned and actual performance data. Any changes to the planning data should be identified, quantified, and provided to the project manager. A few measures may not be accompanied by planning data (such as defect and requirements stability data).

"For all of the measures specified in Paragraph XXX, the offeror shall provide an initial plan and submit periodic actual data. Any time that the planning data for any of the detailed measurement parameters changes, the offeror shall provide an updated plan within 30 days of the change."

For each measure, the offeror should propose measurement definitions, methodologies, and data reporting mechanisms.

"For each measure specified in Paragraph XXX, the offeror shall provide an estimation methodology, measurement functions for derived measures, the measurement method to derive base measures, and the analysis model that is used to derive indicators. This information shall include a description of any tools used.

Planned and actual data shall be based on the same measurement methodology. Any changes in definitions, estimation methodologies, or actual measurement methods or functions shall be documented within 30 days of the change and shall require approval of the project manager."

The data should be provided as soon as possible after data collection occurs. The sample wording in this section recommends that data should be reported within 30 days, but this time period may be modified. The lag time between data collection and reporting should be minimized to provide early warning indicators.

"The required measures shall be delivered within 30 days after the data is collected. Decision criteria should be established for appropriate measurement reporting requirements. Decision criteria will identify quantitative thresholds, limits, and targets that will be used to notify management that action or further investigation should be taken in response to the data results. Measurement activities that generate data and internal reports more frequently than contractual deliverable requirements should be considered for candidate 'out of cycle' exception reporting. Measurement in support of project information needs shall provide early warning indicators. Any breach of the decision criteria shall be reported with an explanation to the project manager within five days of the data collection."

3.7.2 Supplier Access

Throughout the development, the project management team should periodically review the measurement process. In addition, there will be questions about some of the data. The project office needs to have access to the supplier to answer questions and to gather the subjective data required for interpretation of the quantitative data.

"The supplier shall provide direct access to the project team to facilitate open communications with respect to the measurement process. The supplier shall also

provide a rationale for changes, answer questions, and provide clarifications regarding the measurement process and measures."

3.7.3 Data Alternatives

The measures specified in the RFP represent an initial set based on the information needs of the project manager. The supplier may request substitution of an alternate measure if the alternative measure provides similar insight into the same information need. The alternative measure should be readily available and used internally in the supplier's process.

"In the event that a specified measure is unavailable, the supplier shall submit a request for substitution. This request shall identify an alternative measure with a complete measurement specification, a rationale for the change, a description of how this measure addresses the identified information need, and a description of how this measure and associated indicators will be used internally. The alternative measure must be readily available from the development process."

3.7.4 Proposal Evaluation Data

Proposal evaluation should include an assessment of the feasibility of the project plan, based on information provided in the proposal, historical data on the offeror's performance, and independent estimates prepared by the project management team. Information used for this assessment includes:

Required Productivity - The offeror should provide an assessment of the productivity required to successfully complete the project, based on the planning parameters provided in the proposal. The offeror should also include a definition of any tools or methodologies used.

Product Size, Effort, and Milestone Dates - The offeror should submit estimated data for each of these measures to allow the proposal evaluation team to do an independent feasibility assessment on each bidder. The data should describe the data definitions and estimation methodology.

Historical Data - The offeror may also submit actual data (product size, effort, milestone dates, cost, and productivity) from project completed by the organizational unit proposing to do the work. Data should be provided from projects that are similar in domain, size, and complexity to the proposed project.

These items are usually required parts of a proposal, whether or not the measurement approach described in this Guidebook is applied. The following sample RFP wording is

suggested to collect historical data to substantiate the potential offeror's proposal and to conduct the feasibility analysis:

"To support the proposal, the offeror shall provide historical data from at least three projects completed by the organizational unit proposing to do the work. The technical characteristics of the historical projects shall be similar to the proposed system with respect to domain, size, and complexity. If the offeror does not have experience within these criteria, data from other completed projects shall be provided. The data shall include measures of size, schedule, effort, cost, and productivity by WBS element. Any models and methodologies used shall be documented for each historical project to a sufficient level of detail to allow replication by the evaluation team."

3.8 Sample Wording for Performance Evaluation

Measurement Experience and Performance Evaluation Data - As an acquisition best practice, the government project manager should consider the offeror's process and past performance as significant criteria. Therefore, managers and engineers participating in source selection must evaluate the supplier's processes and experience to select the best offeror with the lowest development risks. It is critical that offerors have a successful past performance record, experience in the domain or product-line, a mature development process, and evidence of use and adequate training in project-required methodologies, tools, and environments.

The following is an example of RFP language in Section L to request information on past measurement experience and performance.

"The offeror shall submit a description of its previous government or commercial contracts (all prime and major subcontracts received, or in performance, during the past ____ years) that are in any way relevant to the measurement effort required by this solicitation.

New organizations may submit data on prior contracts involving its officers and employees. However, in addition to the other requirements in this section, the offeror shall discuss in detail the role in the measurement process that was performed by such persons in the prior contracts cited.

Offerors shall provide an outline of how the measurement effort required by the solicitation will be assigned for performance within the offeror's organization entity and among proposed subcontractors. Information required in the above paragraphs shall be provided for each proposed subcontractor who will perform a significant portion of the effort. "Significant" is defined for these purposes in terms of estimated dollar amount of the subcontract (e.g., $_____ or _____% of the contract value, whichever is greater) and/or in terms of criticality of the subcontracted work to the overall project.

Offerors shall include in their proposal the written consent of their proposed significant subcontractors to allow the government to discuss the subcontractor's past performance assessment with the offeror during negotiations."

The following is an example of RFP language in Section M to define how the data on past measurement experience and performance will be used in an evaluation.

"Offers will be assessed on the basis of price, quality of the technical proposal, and the offeror's past performance and experience in a measurement process that is similar to the proposed effort. Each of these factors are of equal importance. Past performance and experience in measurement on similar projects will be assessed as follows:

a. *The assessment of the offeror's past measurement performance will be used as one means of evaluating the relative capability of the offeror and other competitors to meet the measurement requirements of the proposed contract. Thus, an offeror with an exceptional record of performance that indicates a mature measurement process may receive a more favorable assessment than another whose record is acceptable, even though both may have otherwise equally acceptable proposals.*

b. *In reviewing an offeror's past measurement performance, information in the offeror's proposal will be considered along with information obtained from other sources; such as past and present customers, cognizant contract administration offices, other government agencies (including state and local governments), consumer protection organizations, better business bureaus, and others who may have useful information.*

c. *Assessment of past performance in using and reporting measurement in support of information needs will be a subjective assessment based on consideration of all relevant facts and circumstances. It will not be based on absolute standards of acceptable performance. The government is seeking to determine whether the offeror has consistently demonstrated a commitment to customer satisfaction and timely delivery of quality goods and services at fair and reasonable prices. This is a matter of judgment."*

The following is an example of RFP language in Section L to define process maturity as an evaluation factor:

"Offerors shall provide documentation relative to ratings from previous independently led, model-based appraisals. These appraisals had to include the Level 3 criteria for either the Software Engineering Institute's (SEI's) Software Capability Maturity Model (SW CMM) or Capability Maturity Model Integrated (CMMI) Systems Engineering and Software Engineering (CMMI-SE/SW). An acceptable alternative model and criteria to satisfy this evaluation factor is the Software Development Capability Evaluation (SDCE) Core."

The following is an example of RFP language in Section M to define how the data on process maturity will be used in an evaluation.

"The maturity and capability of an offeror's measurement process will be assessed on the basis of the maturity level that is achieved on a formal, independently led evaluation in accordance with the Software Engineering Institute's (SEI's) Software Capability Maturity Model (SW CMM), the Capability Maturity Model Integration (CMMI) Systems Engineering and Software Engineering (CMMI-SE/SW), models or the Software Development Capability Evaluation (SDCE) core."

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CHAPTER 4 - USING WORK BREAKDOWN STRUCTURES

This section contains examples of Work Breakdown Structures (WBS) for information, communication, and weapons systems. These examples can be used as a basis for a contract WBS and as a tool for collecting some measures, such as work unit progress. This material describes how to use the WBS with the development organization.

A WBS is an important management tool used to identify all accountable areas in the development, operations, or maintenance. In a commercial environment, the WBS must be directly linked to the cost accounting system. This linkage would be at the same level of the WBS as the work packages that are managed and reported. In a government environment, a time card system can be implemented that would be directly tied to the WBS. By applying measures at these WBS levels, a manager can quickly focus on areas that directly address their information needs. A WBS is normally first developed to define products at three or four levels in the system structure. The WBS can be expanded to include the process information that is directly related to the product.

Figure 4-1 shows an example of a simple project with two CIs and a two-activity process model. Each of the activities applies to each of the CIs. In addition the management activity applies across the system. The intersections between the process and product structures define five work packages. Usually a budget and schedule are assigned for each work package. These elements of a WBS are commonly organized into a hierarchy diagram as shown in Figure 4-1.

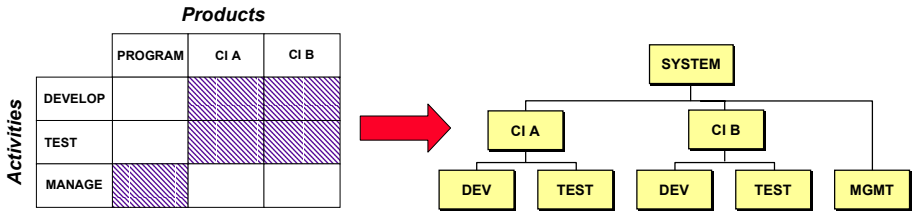

Figure 4-1. Mapping Project Products and Activities

A work package could correspond to something as large as developing an entire Configuration Item (CI) over a period of years or as small as testing a single unit within one week. Most projects define work packages for each major activity, such as requirements analysis, design, implementation, integration and test, and rework, for each CI. However, to adequately address specific project information needs it may be necessary to collect one or more types of data at a more detailed level.

Figure 4-2 shows the final task in defining the WBS structure, mapping responsibility for work packages to organizational elements.

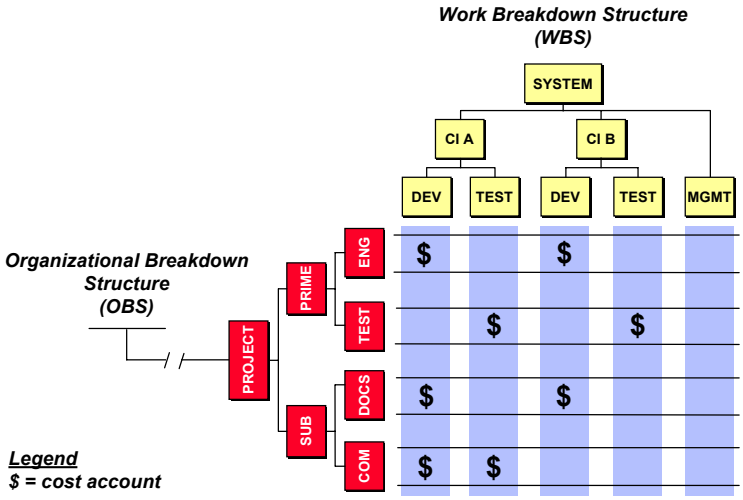

Figure 4-2. Cost Accounts

Figure 4-2 shows that WBS and organizational elements intersect. These intersections usually correspond to the cost accounts that track budgets and expenditures in most financial systems. These cost accounts define the interface between the measurement and financial reporting processes. Planning the measurement process appropriately enables it to support the analysis of a project's financial situation.

Figure 4-3 contains a high-level WBS that can be used as a starting point for development and support of a weapons system. This level may be the minimum level required for contracts that require no insight for reporting purposes.

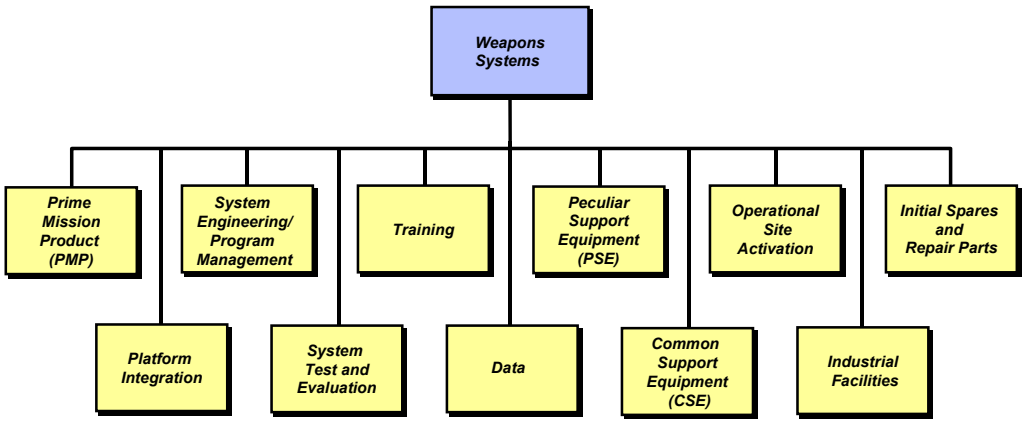

Figure 4-3. Weapon System WBS

Most likely, at least one level lower is reported in a WBS, as described in Figure 4-4. The challenge is to use the WBS to assist in reporting specifics related to information needs. This is accomplished by expanding those areas of concern in the WBS to allow

data to be collected on the identified and expected information needs. A WBS also needs to accommodate the constraints of the cost accounting or data collection system. A good guide to help develop a WBS is Military Handbook 881-B. Figure 4-4 shows a Weapon System WBS that was developed using this handbook. It is important to remember that every data element collected should be linked to a WBS element, either directly or indirectly, and the link should be documented. Once the links are established, the automated collection mechanisms can be put into place.

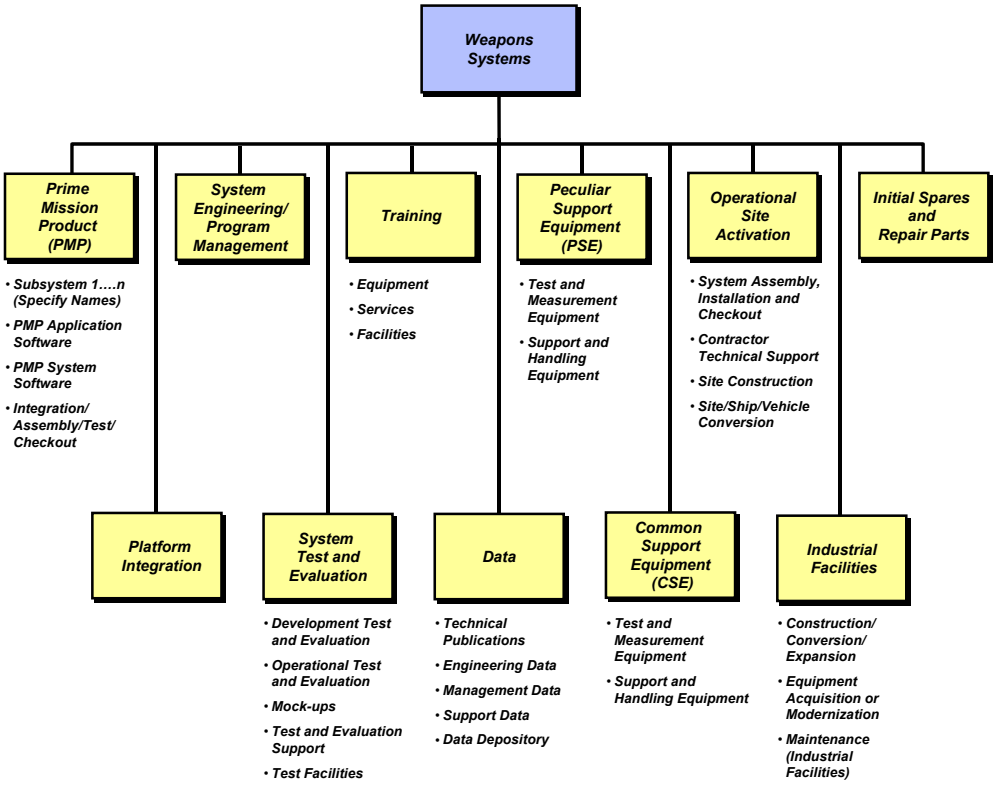

Figure 4-4. Weapon System WBS (reference MIL HDBK 881B)

In a commercial environment, those measures that include cost or effort data require the cost accounting system to have the work unit codes tied directly to the desired WBS reporting level. For time card systems, an audit check is normally conducted on the time cards before they go into the accounting system. This may result in a delay in the period of time when the actions are completed and information can be reported. Some companies have upgraded their systems to daily reporting and have periodic audits to ensure accuracy. For an in-house or government operation, it would be more difficult to implement a time card system in which the reported effort is tied to a specific WBS element. A time card system with work unit codes tied to a WBS would normally be developed and maintained within the organization.

For those measures requiring other data, such as defects, similar mechanisms must be implemented at the appropriate WBS levels. The critical link back to the WBS is often left out of a data collection effort. For example, defects could be linked to rework in a specific CI. Therefore, a WBS element for rework on the CI must be included, and a work unit code must be identified for the cost accounting system.

Figure 4-5 contains an expanded sample WBS that may be a subset of Figure 4-4, or could describe a stand-alone management effort. This sample WBS could also be used within an organization to identify the lower-level elements that are targeted for data collection.

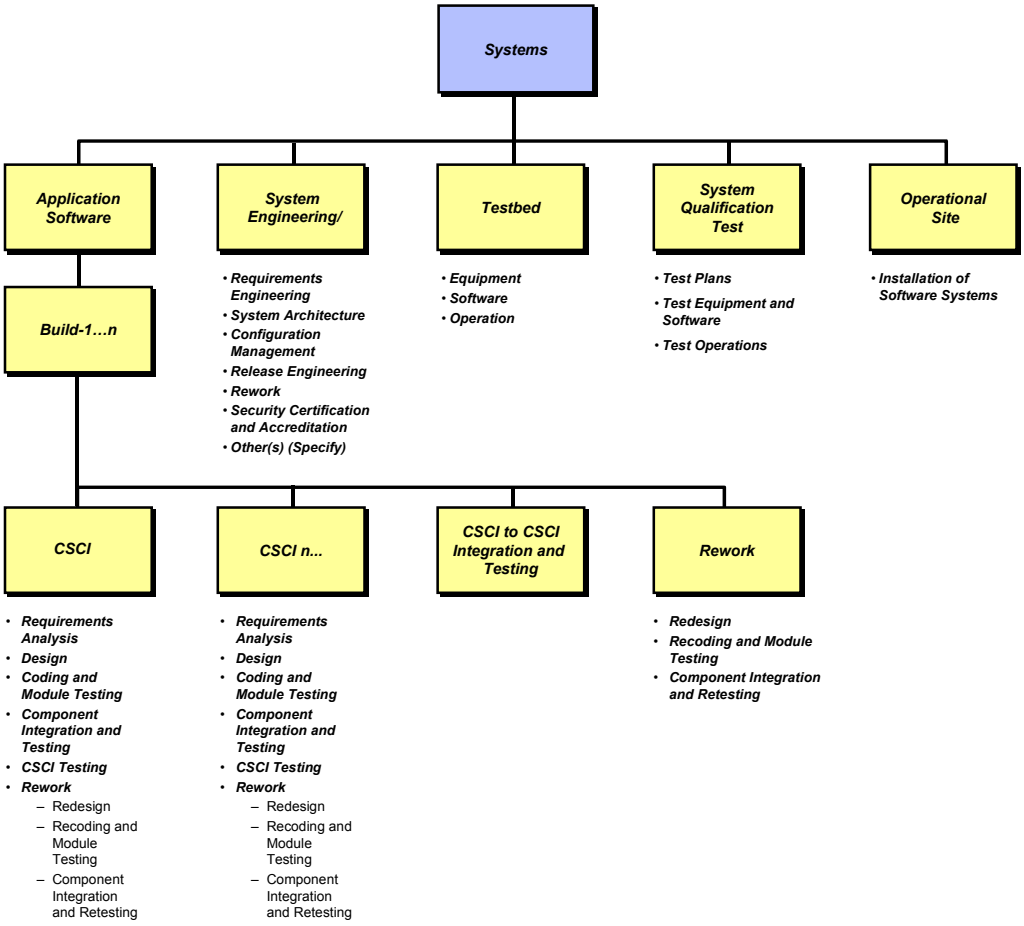

Figure 4-5. Expanded Sample WBS

Figure 4-6 contains an example of an expanded WBS that can be used in information system development and maintenance. This example contains many elements that appear to be outside the normal activities in a technical or management effort, such as security certification and accreditation**.** A WBS should identify all areas that may affect the total cost and schedule.

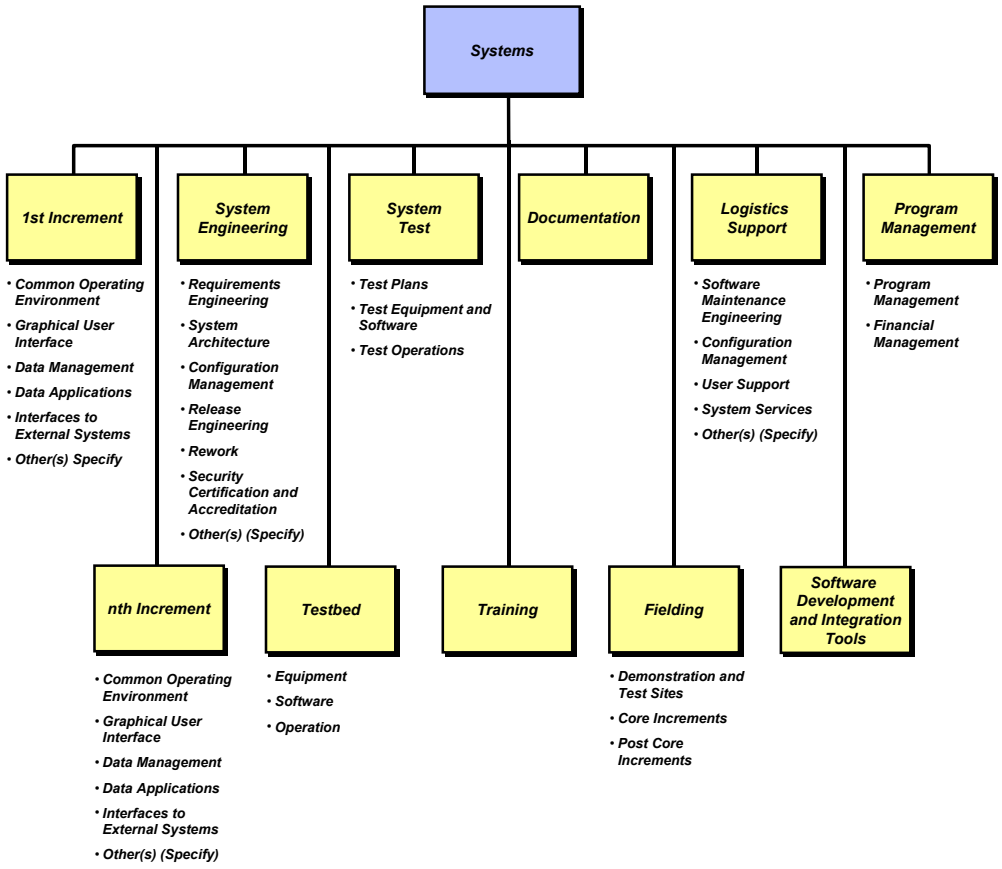

Figure 4-6. Expanded Sample Information System WBS

After contract award, it is important to modify the WBS used during the selection process and to map to the selected supplier's negotiated WBS. The revised WBS ties the estimated measures of the government to the actual measures collected by the supplier. The revision also ensures that the cost account elements map to the same WBS that is used for data collection.

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CHAPTER 5 - INTEGRATING MEASUREMENT WITH EARNED VALUE

This chapter describes how Earned Value can be used as part of the measurement process.

Earned Value is a performance management approach that some organizations use to assess the cost and schedule against the amount of work being performed. Earned Value requires cost and schedule estimates to be identified with specific work packages that have their own cost account. An example of this is illustrated below for a work unit package in the detailed design, code and unit test phase of a system development.

Earned Value is a management technique that relates resource planning to technical, cost, and schedule requirements. All work is planned, budgeted, and scheduled in time-phased "Planned Value" increments that constitute a cost and schedule measurement baseline. An Earned Value Measurement System (EVMS) uses Budgeted Cost of Work Performed (BCWP) as a basic Earned Value indicator. The Budgeted Cost of Work Scheduled (BCWS) is used as the Planed Value indicator to determine the Schedule Variance. The BCWP is compared with the Actual Cost of Work Performed (ACWP) as the Actual Cost indicator to determine the Cost Variance. The two major objectives of an Earned Value system are to encourage suppliers to use effective internal cost and schedule management control systems, and to permit the customer to evaluate the status of deliverable products. The following example was modified from the OUSD(A&T) web site (www.acq.osd.mil) to illustrate the ease of use of Earned Value on a work unit package during detailed design, code and unit test.

The example baseline plan in Figure 5-1 shows that six work units (A to F) should be completed at an estimated cost of $100 for the period covered by this report. A and B are associated with the detailed design of a component. A credit of $10 to A would be given when a component is released to the team/individual responsible for the detailed design of the component. An additional $15 credit is given to B when the component design completes a successful peer design walkthrough. A credit of $10 to C is given when the team begins coding of the component, and a credit of $25 to D when the component has completed a successful peer code walkthrough. Finally, when a component enters unit test, it is given a credit of $20 to E. A credit of another $20 is given to F when it has successfully completed unit test. In some situations a percentage of the allocated effort can be given credit if it is partially completed. This depends on how the Earned Value system is established and how credit is allocated for the work.

	Unit Design		Unit Code		Unit Test		
	A	B	C	D	E	F	Total
Planned Value ($)	10	15	10	25	20	20	100

Figure 5-1. Baseline Plan Work Units

As work is performed, it is "earned" on the same basis as it was planned, in dollars or other quantifiable units such as labor hours. Planned Value compared with Earned Value measures the dollar volume of work planned vs. the equivalent dollar volume of work accomplished. Any difference is called a schedule variance. In contrast to what was planned, Figure 5-2 shows that the code walkthrough D was not completed. Work unit test E began, but nothing had been completed as shown by F. Therefore, $35 of the planned work was not accomplished. As a result, the schedule variance shows that 35 percent of the work planned for this period was not done.

	Unit Design		Unit Code		Unit Test		
	A	B	C	D	E	F	Total
Planned Value ($)	10	15	10	25	20	20	100
Earned Value ($)	10	15	10	10	20	0	65
Schedule Variance	0	0	0	-15	0	-20	-35=-35%

Figure 5-2. Schedule Variance Work Units

Earned Value compared with the actual cost incurred (from supplier accounting systems) for the work performed provides an objective measure of planned and actual cost. Any difference is called a cost variance. A negative variance means more money was spent for the work accomplished than was planned. Figure 5-3 shows the calculation of cost variance. The work performed was planned to cost $65 and actually cost $91. The cost variance is 40 percent.

	Unit Design		Unit Code		Unit Test		
	A	B	C	D	E	F	Total
Earned Value ($)	10	15	10	10	20	0	65
Actual Cost ($)	9	22	8	30	22	0	91
Cost Variance	1	-7	2	-20	-2	0	-26=-40%

Figure 5-3. Cost Variance Work Units

The organization can graphically represent Earned Value as a single chart for any part of the development or work package, or for the entire project, as depicted in Figure 5-4.

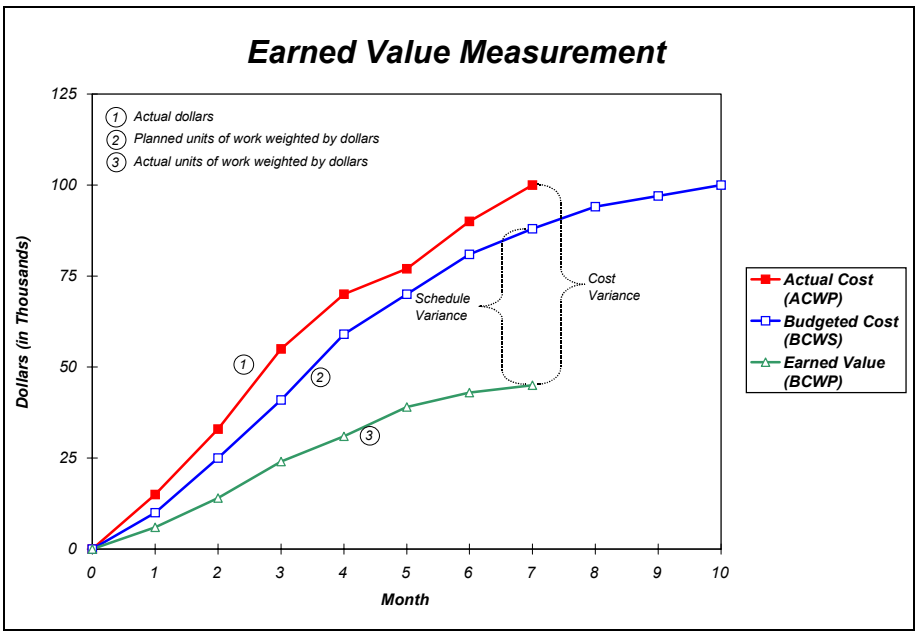

Figure 5-4. Earned Value Measurement

Earned Value can be used as an indicator for any identified unit of work that is associated with estimated and actual cost/effort and schedule. Other measures can be used as technical indicators for variance analysis, including requirements stability, design stability, project size, and computer resource utilization. The Earned Value approach benefits project management by requiring disciplined planning. The availability of the Earned Value measures show the real variances from plans to identify necessary corrective actions.

References:

(a) *Practical Software Measurement: Objective Information for Decision Makers*, McGarry J., Card, D., Jones, C., Layman, B., Clark, E., Dean, J., Hall, F., Addison-Wesley, 17 October 2001 (www.psmsc.com).
(b) *Practical Software and Systems Measurement: A Foundation for Objective Project Management*, Version 4.0b, October 2000 (www.psmsc.com).
(c) Interim Defense Acquisition Guidebook [formerly the DoD 5000.2-R, dated 5 April 2002], 30 October 2002.
(d) Secretary of Defense Memorandum, *Defense Acquisition*, Attachment 1, *The Defense Acquisition System,* 30 October 2002.
(e) Secretary of Defense Memorandum, *Defense Acquisition*, Attachment 2, *Operation of the Defense Acquisition System,* 30 October 2002.
(f) Department of the Air Force, Software Technology Support Center, *Guidelines for Successful Acquisition and Management of Software-Intensive Systems* [GSAM], Version 3.0, May 2000.
(g) *SCAMPI V1.1 Use in Supplier Selection and Contract Process Monitoring*, CMMU/SEI-2002-TN-008, dated April 2002.