IMD COST METHODOLOGY GUIDEBOOK

Required by Department of Defense Directive (DoDD) 5250.01, the Costing Methodology Guidebook provides guidance to Intelligence Mission Data (IMD) producers in developing cost estimates for IMD requirements as part of the Lifecycle Mission Data Planning (LMDP) process.

Version 1.0

IMD COST METHODOLOGY GUIDEBOOK

DEPARTMENT OF DEFENSE

February 2013

PREFACE

(U) The speed of technical innovation and the complexity of modern weapons systems are creating ever-increasing demand for specialized intelligence mission data (IMD) to feed sensors and automated processes supporting the Warfighter. Concurrently, the Department of Defense (DoD) is reforming its acquisition processes and refining policies and procedures to achieve cost savings and efficiencies in acquisitions. The confluence of these trends has created recognition of the need to collaborate more effectively across the defense acquisition and intelligence communities to ensure that defense acquisition programs provide optimal mission capability at affordable costs. Dialogue about IMD requirements and provision of cost estimates throughout the acquisition lifecycle are important components of that collaboration.

(U) The ability to generate reliable cost estimates for IMD requirements is critical to supporting the DoD's acquisition and intelligence programming processes. Without this ability, programs risk experiencing cost overruns, missed deadlines, and performance shortfalls – jeopardizing the Department's ability to meet critical Warfighter needs. Intelligence producers must consider and communicate clearly to acquisition customers what capabilities are technically feasible and at what cost to avoid creating unrealistic expectations that affect mission capability. As resources become scarcer, competition for them will increase. Defense acquisition programs and the intelligence community must be able to deliver as promised, not only because of the critical warfighting capability needs they fill, but also because of increased scrutiny on stewardship of public funds and awareness of opportunity costs.

(U) The IMD Cost Methodology Guidebook (IMD CMGB) is one tool to facilitate cost and capability decision-making based on reliable, transparent, and consistent data. This manual provides a consistent methodology that is based upon best practices that can be used across the IMD production community to develop, manage, and evaluate IMD cost estimates. Adoption of consistent cost estimating methodologies and techniques across the IMD producer community increases customer and decision-maker confidence in estimates and also enables comparability and analysis to identify efficiencies and cost-saving opportunities across the enterprise. Deeper understanding of the full costs of intelligence support to acquisition will improve both communities' ability to validate their budgetary requirements and manage resources more effectively.

ACKNOWLEDGEMENTS

(U) In September 2012, an Integrated Project Team (IPT) with representation from OUSD(I), OSD(AT&L), ODNI(CAIG), DIA, Service Intelligence Production Centers, DoD Acquisition and Intelligence Community organizations, Service Cost Centers, GAO, and IMD producer organizations stood up to sponsor the development of the IMD CMGB. IPT membership included more than 75 participants from over 25 government organizations who were empowered to review, validate, and scope IMD costing methodology approaches for the IMD CMGB.

(U) IPT members met virtually over several months to review and discuss materials and approaches; this guidebook reflects the invaluable inputs and insights IPT members offered over the course of these sessions. The Cost Methodology Guidebook drafting team also gained important understanding through individual consultations with several IPT members to discuss specific issues and existing costing processes. Our many thanks go to all participants; this guidebook is a more complete and higher quality product thanks to their contributions.

APPROVALS

(U) This product has been approved as the official Cost Methodology Guidebook for IMD. The approving bodies for this document include the Office of the Under Secretary of Defense for Intelligence OUSD(I) and the Defense Intelligence Agency (DIA), Intelligence Mission Data Center (IMDC).

(U) Version 1.0 is valid 15 February 2013, and will be effective upon the official date of publication until a revision is issued. This document will evolve through updates, be expanded, and adjusted over time at the direction of OUSD(I) as cost estimating for IMD matures. This document should be considered "living" guidance and will ensure that the most credible and timely support is available to inform the IMD community of cost estimating and analysis best practices. The approving bodies listed above endorse the guidance provided, and convey the expectation that these practices will be followed in the production of all IMD cost estimates.

TABLE OF CONTENTS

1.0 INTRODUCTION

1.1 Overview

(U) Department of Defense Directive (DoDD) 5250.01, "*Management of Intelligence Mission Data in DoD Acquisitions,*" requires that DoD acquisition efforts include the cost of acquiring Intelligence Mission Data (IMD) from the DoD intelligence enterprise as part of the DoD Acquisition System approval process. IMD is defined in DoDD 5250.01 as: "the DoD intelligence used for programming platform mission systems in development, testing, operations, and sustainment including, but not limited to, the functional areas of:

- Signatures
- Electronic Warfare Integrated Reprogramming (EWIR)
- Order of Battle (OOB)
- Characteristics and Performance (C&P)
- Geospatial Intelligence (GEOINT)."

(U) An acquisition effort must identify and provide cost estimates for IMD requirements from any of the functional areas if the platform relies on IMD in order to successfully carry out its mission capabilities. Programs may require IMD for such activities as combat identification, Intelligence, Surveillance, and Reconnaissance (ISR), and targeting. IMD-dependent programs must submit a Lifecycle Mission Data Plan (LMDP) that details IMD requirements, provides cost estimates for the IMD, and assesses mission capability and affordability tradeoffs related to IMD. Costing requirements apply to potentially available IMD, or IMD that is not currently available but can be produced or appropriately modified given current technical capabilities and legal authorizations (e.g. collection on Allied systems) if the necessary technical and financial resources are made available. Costing requirements do not apply to "available IMD" that has already been produced, or "unobtainable IMD" which would require either technical competencies or legal authorities that exceed current capabilities. In cases where unobtainable IMD is identified, it should be clearly documented in the LMDP so that decision makers understand the limitations that may result.

(U) DoDD 5250.01 also requires that all IMD producers use standardized and transparent costing methodologies for each functional area in developing and communicating IMD production cost estimates. IMD producers must also coordinate effectively to develop an agreed upon approach that ensures cost estimates meet Office of the Secretary of Defense Cost Assessment and Program Evaluation (OSD CAPE) standards. (U) To assist IMD producers in meeting this requirement, the Defense Intelligence Agency (DIA), Intelligence Mission Data Center (IMDC), and IMD functional area stakeholders have developed the IMD CMGB.

(U) The IMD CMGB communicates guidelines, repeatable methods, and best practices for IMD producers to adopt in creating cost estimates, and for acquisition efforts to use in evaluating them. The table below details the definitions for available, potentially available, and unobtainable IMD.

Intelligence Mission Data Categorizations
Available IMD - IMD that has already been produced or that the DoD Intelligence Community (IC) can provide with no extra level of effort needed
Potentially Available IMD - IMD that is not currently available, but the DoD IC can provide, given one or more of the following: 1. Additional funding and/or manpower for IMD production 2. A sufficient collection operation. The IMD needed does not currently exist, but can be collected given current capabilities and operations. 3. The development of an additional collection capability. The needed IMD can be produced given the time and resources to develop an additional collection capability that does not currently exist. 4. Re-prioritization relative to all IMD production, if the production of the IMD is too low of a priority for it to be produced in accordance with the program's schedule.
Unobtainable IMD - IMD that the IC cannot provide for technical/scientific/legal reasons, or due to political sensitivities.

1.1.1 Purpose and Scope

(U) The CMGB defines the cost estimating methodologies and processes needed to develop credible, high-quality cost estimates for potentially available IMD. This product was modeled after the 2009 GAO Cost Estimating and Assessment Guide, as well as applicable DoD, Intelligence Community (IC), and Service Component cost estimating artifacts and source material. All cost procedures explained in the IMD CMGB are consistent with OSD CAPE cost standards. The IMD CMGB is intended to be a "ready-reference" for staff across the intelligence and acquisition communities.

(U) The purpose of the guidebook is threefold:

1. To adopt generally accepted best practices consistently across the IMD producer community to ensure program cost estimates are credible;

2. To establish processes and standards that integrate cost estimates for IMD into the Defense Acquisition Life Cycle Management System;
3. To serve as a primer for future intelligence cost reporting.

(U) To these ends, this guidebook provides consistent and validated approaches to costing potentially available IMD. The IMD CMGB explains commonly used costing methodologies (such as analogy, parametric, engineering, expert-opinion and extrapolation from actual costs); describes how to conduct sensitivity, risk, and uncertainty analysis; and identifies common cost factors, drivers, and considerations within the IMD development process. It includes best practices to improve estimating methodologies and data management strategies as well as examples, resources, and tools to assist producers in the development of cost estimates.

(U) In addition, the guidebook describes how IMD cost estimates inform the Lifecycle Mission Data Planning process and the overall Integrated Defense Acquisition, Logistics, and Technology Lifecycle Management System. The guidebook includes documentation and reporting templates that will create consistency and comparability of cost estimates across IMD functional areas, IMD producers, acquisition programs, and over time.

(U) The proposed DoDI 5250.01 states that: "IMD producers will collaborate with each other and the IMDC to adopt costing methodologies for each IMD functional area. Each functional area methodology will meet the guidelines and standards outlined in the IMD Costing Guidebook, while reflecting unique elements of each IMD discipline." As each functional area develops standards around specific costing processes and procedures, this guidebook provides the overarching costing principles and methodologies to serve as the foundation for further guidance.

(U) This guidebook is intended to provide guidelines and references for creating high-quality IMD cost estimates; it is not intended to be a step-by-step instruction manual. Each individual IMD cost estimate will be unique, and the intent of this guidebook is to create enough uniformity and comparability across estimates to enable cross-program analysis while still allowing for adaptability and creativity to meet individual program needs. Consistent communication among the acquisition effort sponsors, the IMD producers creating the cost estimates, the IMDC, IMD functional area Enterprise Management Offices (EMOs) and relevant cost analysis organizations is critical to ensuring that each individual estimate is valid and compliant with all relevant costing standards. Establishing open lines of communication during estimate development will also facilitate the ability for programs and producers to track costs throughout the program's lifecycle and identify potential efficiencies as IMD production progresses.

1.1.2 Guidebook Case Study and Vignette Approach

System Overview: EK-38 Merganser

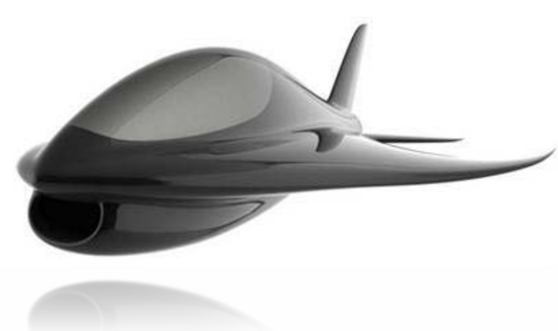
Acquisition Sponsor:	Joint Program Office Merganser
SYSCOM:	NAVAIR, NAVSEA, AFMC, AMC, MARCORSYSCOM
IMD Dependency:	Signatures, EWIR, C&P, OOB, GEOINT
Milestones:	A – 2014; B-2017; C-2020

(U) This guidebook includes four case studies which are intended to highlight specific examples of how costs analysis for IMD is currently being conducted at Intelligence Production Centers and Program Offices. These case studies explain the process and rationale associated with each case, and where applicable, offer lessons learned and opportunities for improvement. The CMBG team engaged with key IMD stakeholders over a four-month time span to gather data and construct analysis for each case study. In addition, all case studies include additional source material and documentation. The CMBG team is grateful to the stakeholder group for their willingness to share their experiences, and improve the capability of the entire IMD community.

(U) In addition to real-life case studies, this guidebook contains several exemplar vignettes intended to illustrate key principles and costing methodologies. The vignettes center around a fictitious platform conceived to encompass a wide variety of IMD-related issues, while providing a consistent and relatively simple frame of reference. The fictitious platform - the EK-38 Unmanned Amphibious Surveillance System (UASS) "Merganser" - is intended to be realistic enough to provide cost estimators with examples of the types of challenges they are likely to face, but is not intended to reflect a true-to-life acquisition scenario. For each cost methodology, the guidebook will provide a "snapshot" example of one functional area cost estimate provided for the LMDP at one particular milestone. The underlying assumption is that a cost estimate will be produced for each functional area at each milestone, and that the estimates prepared at Milestones B and C are updates.

EK-38 Merganser

(U) **Overview:** The Unmanned Amphibious Surveillance System (UASS) Merganser supports United States Navy, Air Force, Army, and Marine Corps military operation capabilities. The craft is fully configured with an array of sensors to include day/night Full Motion Video (FMV), Signals Intelligence (SIGINT), and Synthetic Aperture Radar (SAR) sensor payloads, avionics, and data links; a ground control segment consisting of a Launch and Recovery Element (LRE), and a



EK-38 UASS-Merganser

Mission Control Element (MCE) with embedded Line-of-Sight (LOS) and Beyond-Line-of-Sight (BLOS) communications equipment; a support element; and trained personnel. Merganser can also be equipped with weapon payloads depending on its mission.

(U) **Mission:** The EK-38 Merganser is a single-engine, remotely piloted armed reconnaissance aircraft designed to operate over-the-horizon, under sea as well as at low or medium altitude for long range endurance. The primary mission is reconnaissance with an embedded strike capability against critical, perishable targets. Its configuration can be supported to hold 8 hellfire missiles. The United States Air Force MQ-9 Reaper has similar mission capabilities, though the Merganser's undersea and very low altitude capabilities provide additional mission functionality.

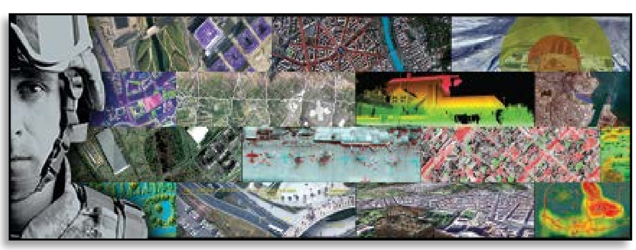
1.1.3 Intended Audience and Availability

(U) The IMD producer community is the primary audience for this guide. Specifically, individuals who are qualified and tasked to prepare cost estimates for IMD can apply the principles and templates in this guide directly. Many IMD producer organizations do not have dedicated cost estimating capabilities available, and will benefit from having a standardized methodology resource that is DoD policy compliant. Additionally, acquisition program offices, service component cost agencies, and OSD CAPE can reference this guide to understand the methodology, process, and criteria that are used to develop and update IMD cost estimates and associated LMDPs.

(U) All documents referenced herein are located on the Joint Worldwide Intelligence Communications System (JWICS), Secret Internet Protocol Router Network (SIPRNet), or Non-secure Internet Protocol Router Network (NIPRNet). The IMD CMGB and all related templates are available through the Defense Acquisition University portal (http://www.dau.mil/default.aspx) and the Intelligence Mission Data Center websites on JWICS, SIPRNet, and NIPRNet. The IMD CMGB is designed to be an electronic resource; it has been developed and tagged to facilitate search capability, extraction of specific pages or templates, and electronic dissemination.

1.2 INTELLIGENCE MISSION DATA COSTING IN CONTEXT

(U) The rise and complexity of modern weapons systems, informational technology (IT), ISR, and other sensor platforms are creating ever-increasing demand for IMD to feed automated and interrelated processes supporting the Warfighter. A growing amount of surveillance, communications, and intelligence work is being performed by unmanned aircraft and satellites. Concurrently, DoD is reforming its acquisition processes, using lessons learned to refine policies and procedures to achieve cost savings and efficiencies in acquisitions. The following sections will detail the various DoD policies and



Intelligence Mission Data

initiatives that have led to the development of a cost estimating methodology for IMD requirements. They will further explain how this guidebook supports and complements the defense acquisition lifecycle and other cost and affordability related activities across the Department.

1.2.1 Policy Imperatives

(U) Title 10 and Title 50 of the U.S. Code contain a number of requirements for cost estimates for defense and intelligence community acquisition programs. The following sections detail the public laws, DoD Directives, Instructions, and initiatives that are most relevant to the IMD cost estimating problem set and explain how implementation of the IMD cost estimating processes in this guidebook support their objectives.

Weapon System Acquisition Reform Act (WSARA)

(U) The passage of the Weapon System Acquisition Reform Act (WSARA) of 2009 instituted significant reforms to the defense acquisition process. WSARA's intent is to improve DoD's requirements and acquisition management practices to deliver needed capability at acceptable performance levels and rates, and to improve stewardship of public funds.

(U) WSARA places particular emphasis on strengthening critical cost growth reporting requirements (commonly referred to as "Nunn-McCurdy") and requires DoD to re-establish systems engineering organizations and developmental testing capabilities. WSARA also emphasizes the importance of managing weapons system acquisition effectively and efficiently from the earliest possible stages of the acquisition lifecycle. The legislation requires consultation between the budget, requirements and acquisition communities as well as the joint requirements process to ensure trade-offs between cost, schedule, and performance are considered early in the process of developing major weapon systems – specifically during the Analysis of Alternatives phase.

(U) Developing high-quality cost estimates for IMD requirements directly supports the intent and initiatives of the WSARA. Identifying programs with IMD dependencies and initiating dialogue among the acquisition effort's sponsoring office, IMDC, relevant EMOs, and IMD producers at submission of the Initial Capabilities Document (ICD) will ensure that acquisition efforts consider and plan for IMD requirements as early in the process as possible. High-quality cost estimates will enable effort managers to make informed cost-risk based decisions throughout the program's lifecycle.

USA: Joint Light Tactical Vehicle (JLTV)

(U) Cross-program analysis of cost estimates will enable identification of outcome-based partnering strategies to effectively optimize existing assets, identify gaps, and provide cost-effective solutions in an environment of increasing budgetary pressure.

Department of Defense Directive 5000.01/Department of Defense Instruction 5000.02

(U) DoDD 5000.01, *The Defense Acquisition System,* and DoDI 5000.02, *Operation of the Defense Acquisition System,* provide DoD policy on the overall defense acquisition lifecycle process. These policies construct DoD acquisition as an iterative and event-driven process; programs and efforts are held accountable for their accomplishments and performance in order to pass through various milestones or investment reviews.

(U) Cost estimates are essential sources of information as decision-makers determine whether programs will be able to meet their capability objectives within reasonable and affordable cost. At each milestone decision point beginning with program initiation, as many as three cost estimates are prepared to support the acquisition decision process for a new system. These estimates identify all the costs of an acquisition program, from time of initiation through disposal.

(U)DoDD 5000.01 and DoDI 5000.02 specify that cost must be treated as an independent variable and require all acquisition programs to prepare and document life cycle cost estimates (LCCE) at each milestone. A LCCE attempts to identify all the costs of an acquisition program, from initiation through disposal of the resulting system and to properly phase, or spread, the costs for inclusion in budget submission documents. LCCEs for DoD systems serve two primary purposes. First, they are used at acquisition program milestone and decision reviews to assess whether the system's cost is affordable, or consistent with the DoD Component's and DoD's overall long-range investment and force structure plans. Second, LCCEs form the basis for budget requests to Congress. In most cases, LCCEs are prepared by the program office (referred to as a Program Office Estimate (POE)), or in some cases the responsible service component may also request preparation of a Component Cost Estimate (CCE) by the component's cost analysis agency.

(U) Major Defense Acquisition Programs (MDAPs) and Major Automated Information Systems (MAISs) have additional cost estimating requirements associated with them. Acquisition Category (ACAT) 1 and ACAT 1A programs must prepare Cost Analysis Requirements Descriptions (CARDs) and ACAT 1 programs must have Independent Cost Estimates (ICEs) conducted prior to each milestone. The CARD is a complete description of the system whose costs are to be estimated; it provides the common description of the technical and programmatic features of the program. The CARD is intended to define the program to a sufficient level of detail such that no confusion exists between the many parties who may be concerned with estimating the program's cost. OSD CAPE prepares ICEs for ACAT I programs.

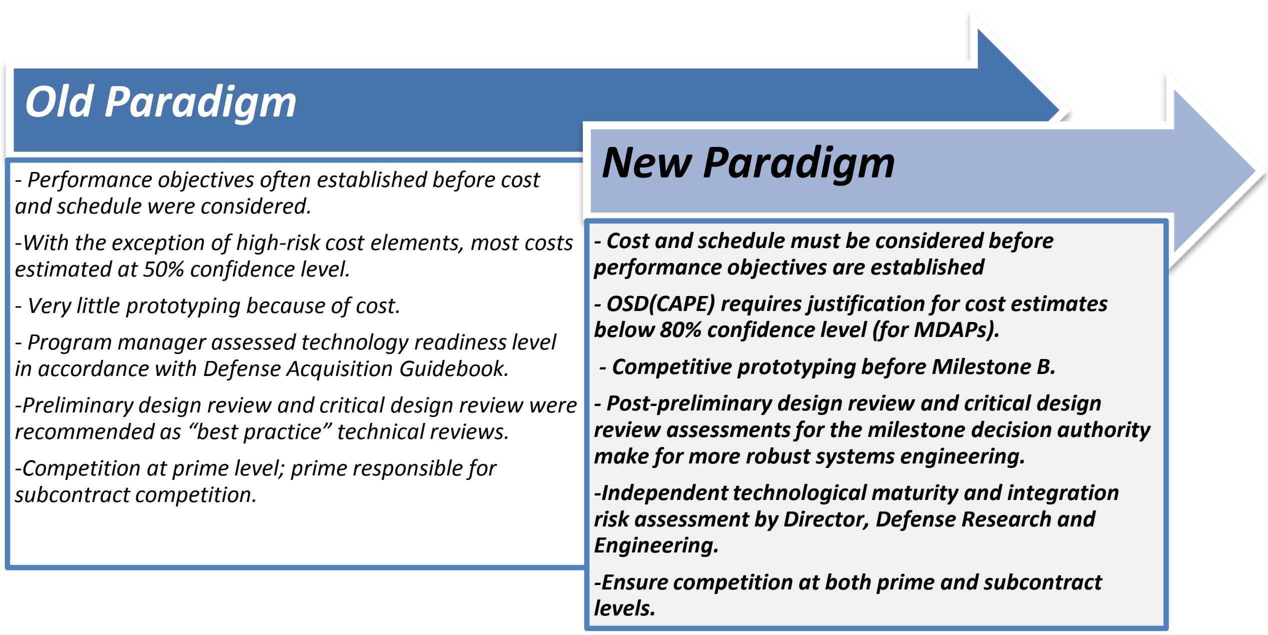
USN: F/A-18 E/F Super Hornet

(U) An ICE is a statutory requirement for ACAT 1D and 1C programs and required for Milestones B and C. OSD CAPE prepares the ICE for ACAT 1D programs and is based on the CARD and ground rules/assumptions. Further, ACAT 1D and ACAT 1C programs require an Analysis of Alternatives (AoA) at Milestone A, B and C (DoD Instruction 5000.02). An AoA is an analytical comparison of the operational effectiveness, suitability, and life-cycle cost of alternatives that satisfy established capability needs. The AoA process explores numerous conceptual solutions with the goal of identifying options used to justify the rationale for formal initiation of the acquisition program. Beyond Milestone A, an AoA may be used to evaluate a more focused or narrow range of options, or to take stock of any major changes to the program or circumstances.

(U) The Lifecycle Mission Data Plan (LMDP) and the IMD cost estimate are not stand-alone requirements; rather, they are an integral part of the Integrated Defense Acquisition, Technology, and Logistics Lifecycle Management System. The LMDP process has been designed to plan and manage the IMD requirements of a program or effort within the context of the existing framework, not solely to satisfy reporting requirements. The LMDP and IMD cost estimates offer value added to decision-makers throughout the lifecycle acquisition process by providing credible cost estimates and analysis of viable capability alternatives.

(U) Cost estimates for IMD prepared as part of the LMDP process will serve as important inputs to and components of LCCEs, CARDs, and ICEs. IMD cost estimates must be prepared in accordance with overarching DoD cost estimating standards and procedures in order to ensure that they are compatible with and complementary to these products.

Figure 1.2.1.1: Paradigm Shifts Under WSARA 2009 and DoDI 5000.02



Pre-Milestone A

(U) Though a completed LMDP is not required until 90 days before the Milestone A decision, the LMDP process will begin with IMD requirements identification upon recognition of an acquisition program or effort as IMD dependent. Once IMD requirements have been documented and submitted to the IMDC, the IMD providers will develop cost estimates for potentially available IMD, to the greatest extent possible based on the specificity of the requirements. In some cases, an acquisition program or effort could submit multiple IMD requirements packages, as they seek to identify the most mission capable and affordable option in the Analysis of Alternatives process. Before a program reaches Milestone A, the IMD requirements may be general or non-specific, and cost estimates may also be imprecise.

(U) Even early, imprecise estimates allow the acquisition effort to assess and incorporate the costs associated with IMD requirements, facilitate development of an IMD production plan, and enable all interested parties to develop a funding and programming strategy. IMD cost estimates developed pre-Milestone A will inform the AoA process, the Technology Development Strategy (TDS), and when required, the CARD.

Key Considerations: Pre-Milestone A and Milestone A
✓ Have all the viable alternatives been considered?
✓ To what extent are there identified IMD gaps or shortfalls?
✓ Can the proposed improvements be measured and verified?
✓ Have all material solution considerations been identified?
✓ Is the cost analysis methodology sound?
✓ Are any benchmarks available?
✓ Does the analysis support the solution?

Milestone Progression

(U) The LMDP and the IMD cost estimate will be important inputs to the analysis and documentation supporting the progression of an acquisition program through the milestone process – including Joint Capabilities Integration and Development System (JCIDS) documents, TDS, Acquisition Strategies, CARDs, ICEs, and Affordability Analysis. As the acquisition effort or program matures, the LMDP and the IMD cost estimates will evolve to become more precise.

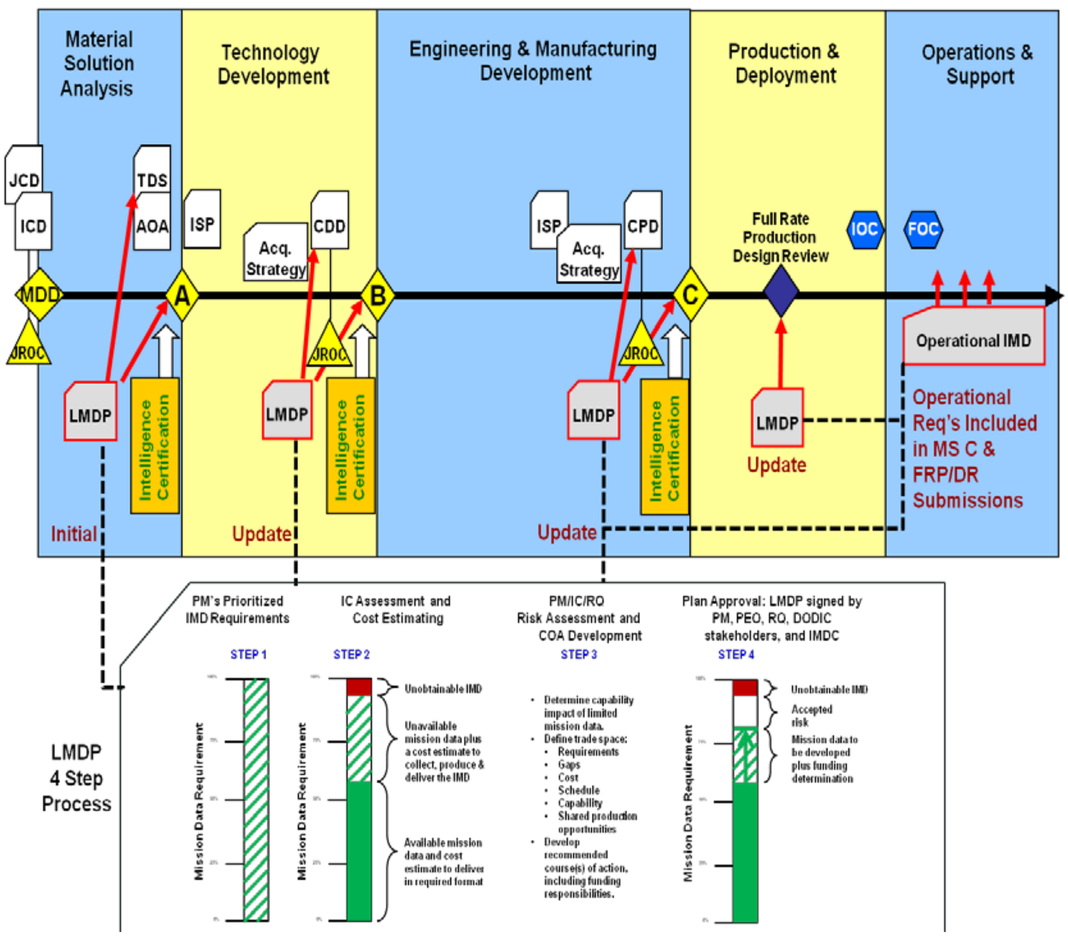
Acquisition Milestone Decision Reviews
➢ Milestone A: Decision to proceed with concept exploration
➢ Milestone B: Decision to proceed with system development and demonstration
➢ Milestone C: Decision to proceed with low-rate initial production/MAIS production
➢ FRP Review: Decision to proceed with full-rate production (FRP)

(U) Communication among the Program Office, the IMDC, EMOs, and IMD producers throughout the acquisition lifecycle is a critical element to ensuring that all processes are synchronized and that all parties have the same information. Programs should be able to refine and clarify their IMD requirements as they progress through the acquisition lifecycle; IMD producers should remain in contact with program offices throughout the progression to assist with IMD requirements development and to agree upon the bases for cost estimates. Using standard, consistent IMD terms and WBS items throughout the lifecycle will facilitate visibility across platforms for more valuable cost reduction actions with higher confidence levels.

Key Considerations: Milestone B and C
✓ Does the benefit justify the costs and can they be measured?
✓ Have technology development calculations been cross-checked?
✓ Do the AOA, BCA, and economic analysis evaluate all alternatives consistently?
✓ Have program costs been cross-checked with the independent cost estimate?
✓ Have cost-effectiveness trade-offs been considered and have costs been updated in the LMDP?

(U) Especially for MDAPs, IMD producers should also expect to collaborate with service costing agencies and OSD CAPE to provide information on the methodology used for development of IMD cost estimates.

Figure 1.2.1.2: Acquisition Lifecycle and LMDP Integration



Department of Defense Directive 5250.01 and Department of Defense Instruction 5250.01

(U) The requirement for specific IMD life-cycle cost estimates in DoDD 5250.01 developed out of recognition that the complexity and capability of 5th Generation weapons systems require increasing quantity and quality of IMD support. These increasing demands represent a new, unique, and significant factor in overall program costs and affordability.

(U) The IMD CMGB responds to the requirement in DoDD 5250.01 that "a standardized and transparent data costing methodology for each functional area shall be used by all IMD producers." The proposed DoDI 5250.01 further states that "IMD producers shall develop and use a standardized data costing methodology for each functional area; maintain accessible data; provide data availability information; and provide IMD production cost estimates" and that "this costing methodology shall be compliant with OSD CAPE cost accounting procedures and shall be documented in the IMD CMGB."

(U) One of the primary objectives of DoDD 5250.01 is to improve understanding across the Department of the full costs of providing IMD to meet mission capability requirements for acquisition efforts. LMDPs will include cost estimates for all potentially available IMD in order to document and analyze IMD cost data over time. The requirement that all producers use a common cost estimating methodology will ensure the estimates provided in the LMDPs are reliable, compliant with DoD costing policies, and comparable across IMD producers and over time. High quality cost estimates and actual cost data will enable decision-makers to identify and quantify IMD gaps, and to implement cost-effective IMD investment strategies that meet critical mission needs.

Chairman of the Joint Chiefs of Staff Instruction 3312.01B

(U) Chairman of the Joint Chiefs of Staff Instruction 3312.01B (CJCSI 3312.01B), *Joint Military Intelligence Requirements Certification*, establishes the policies and procedures for Joint Military Intelligence Requirements Certification of capabilities being reviewed under the JCIDS. CJCSI 3312.01B supports the Joint Staff Director for Intelligence (J-2) and the Intelligence Review and Certification Office (J282/IRCO or IRCO) in identifying, assessing, and certifying capabilities reviewed pursuant to the JCIDS process.

(U) The intelligence review process is based upon a collaborative, analytical process that evaluates what proposed capabilities will require from, or contribute to, the intelligence enterprise throughout their acquisition life cycle. The intelligence certification is a statement of adequacy based on previously completed reviews and assesses whether the projected intelligence architecture will be available, suitable, and sufficient to support those needs.

(U) Though the IRCO certification and review processes are currently under revision, "IMD Support" is one of the Intelligence Supportability categories in the IRCO process. IMD cost estimates will support and enhance the IRCO certification process by providing programs and joint staff with a clear understanding of the IMD requirements of each program, and identifying various courses of action and associated costs for the intelligence community to meet these requirements.

Department of Defense "Better Buying Power" Initiative

(U) The OSD Better Buying Power 2.0 (BBP 2.0) initiative, launched in 2010 and revised in 2012 (version 2.0), is the implementation of best practices used to strengthen the Defense Department's buying power, improve industry productivity, and provide an affordable, value-added military capability to the Warfighter. BBP 2.0 encompasses a set of fundamental acquisition principles to achieve greater efficiencies through affordability, cost control, elimination of unproductive processes and bureaucracy, and promotion of competition. BBP 2.0's thirty-six specific initiatives against seven focus areas also incentivize productivity and innovation in industry and Government, to improve tradecraft in the acquisition of services. The basic goal of BBP 2.0 is to deliver better value to the taxpayer and Warfighter by improving the way the Department does business.

(U) Providing credible cost estimates for required IMD supports two of the seven BBP 2.0 focus areas: "Achieve Affordable Programs" and "Control Costs throughout the Product Lifecycle." To help the Department "achieve affordable programs," the LMDP process and IMD cost estimates will allow acquisition programs to evaluate the mission impacts of IMD against its cost, and to make informed decisions about affordability early in the acquisition lifecycle. Further, cross-program analysis will enable Department-level policymakers to examine IMD requirements and costs across the entire acquisition portfolio and "institute a system of investment planning to derive affordability caps" – a BBP initiative.

(U) IMD cost estimates will "control costs throughout the product lifecycle" by supporting three related initiatives:

1. Eliminate redundancy within Warfighter portfolios;
2. Institute a system to measure cost performance of programs and institutions to assess the effectiveness of acquisition policies; and
3. Build stronger partnerships with the requirements community to control costs.

(U) Cross-program analysis of IMD estimated costs will identify common and redundant capabilities or activities and opportunities for efficiency. Compilation and analysis of both IMD cost estimates and actual costs will enable evaluation of IMD production costs and processes to identify potential improvements. Consistent communication between the requirements community and IMD producers throughout the LMDP development process will refine requirements and identify alternative courses of action earlier in the acquisition lifecycle, limiting unnecessary efforts and reducing costs.

FY13 Defense Budget Request

(U) The Fiscal Year (FY) 2013 President's Budget request develops a defense strategy to transition from emphasis on today's wars to preparing for future challenges; protects the broad range of U.S. national security interests; advances the Department's efforts to rebalance and reform; and supports the national security imperative of deficit reduction through reduced defense spending. The FY 2013 Base Budget provides $525.4 billion, a reduction of $5.2 billion from the FY 2012 enacted level ($530.6 billion) and is consistent with Administration-wide efforts to make tough cuts and create cost savings.

(U) The budget adjusts programs that develop and procure military equipment, begins to re-size ground forces, slows the growth of compensation and benefit programs, continues to make better use of Defense resources by reducing lower priority programs, and restructures for more efficient approaches to doing business. The incremental costs of Overseas Contingency Operations (OCO), including ongoing efforts in Afghanistan and support for the Office of Security Cooperation in Iraq, are funded separately in the FY 2013 budget request at $88.5 billion, a decrease of $26.6 billion from the FY 2012 enacted level.

Figure 1.2.1.3: FY13 Department of Defense Budget Request

In Billions	FY13	FY14	FY15	FY16	FY17	FY13-17
FY 2012 PB	570.7	586.4	598.2	610.6	621.6	2,987.5
FY 2013 PB	525.4	533.6	545.9	555.9	567.3	2,728.1
Delta	-45.3	-52.8	-52.3	-54.7	-54.3	-259.4
Real Growth	**-2.5%**	**0.0%**	**+0.8%**	**+0.2%**	**+0.2%**	**-0.3%**

Source: OSD Comptroller FY13 Budget Request --Real growth calculated from the FY 2012 appropriation ($530.6 billion).

(U) The Department is learning from prior drawdowns that it is impossible to generate all the needed savings just through efficiencies. The DoD prioritizes by eliminating missions and programs that, while useful, are not valuable enough to be retained in the FY 2013 budget. Major themes of the Defense Budget include:

- More Disciplined Use of Resources
- Strategy-Driven Changes in Force
- Structure and Modernization
- Supporting the All-Volunteer Force
- Overseas Contingency Operations

(U) The DoD continues to substantially restructure the Acquisition programs, taking positive actions that should lead to more achievable and predictable outcomes. Restructuring has consequences—higher up-front development costs, fewer systems in the near term, training delays, and extended times for testing and delivering capabilities to warfighters. The table below details various systems that the Department has terminated, restructured, or retired in FY 13 in order to balance costs.

Figure 1.2.1.4: FY13 DoD Acquisition Programs Reductions and Savings

Termination	Program Restructuring	Retirements
Global Hawk Block 30	F-35 Joint Strike Fighter	KC-135 Tanker
Defense Weather Satellite System	SSBN(X) Ohio-class Replacement	C-130J Super Hercules
C-27J Joint Cargo Aircraft	Littoral Combat Ship	C-27 Spartan
HMMWV Recapitalization	V-22 Osprey	C-5A Galaxy
C-130 AMP	P-8A Poseidon	RC-26 Metroliner
Cruiser Modernization Program	CVN-79 Ford-class Aircraft Carrier	Landing Ship, Dock (LSD)
Sea-Based X-Band Radar	JLENS (Cruise missile defense sensor)	CG Cruisers
Joint Air-to-Ground Missile	Ground Combat Vehicle	
Light Attack and Armed Reconnaissance Aircraft	Family of Medium Tactical Vehicles	
Joint High Speed Vessel		

Source: Office of Management and Budget, *FY 2013 Budget of the U.S. Government: Cuts, Consolidations and Savings.*

(U) This budget continues the reform agenda advanced in the previous three budgets, but with more emphasis now on enhancing how DoD does business. The Department must continue to reduce the "cost of doing business", before taking further risk in meeting the demands of the strategy.

Quantifiable Benefits of IMD Cost Estimates
➢ Cost reduction in the number of dollars needed to meet customer-established IMD requirements by improving processes. ➢ Cost savings that permits removal of dollars from the program or budget. ➢ Cost avoidance which is a cost reduction that is not savings. ➢ Productivity improvements in personnel time and effort requirements associated with IMD functions. ➢ In most cases, a productivity improvement will result in a savings or cost avoidance.

1.2.2 Significance and Impact of Cost Estimates

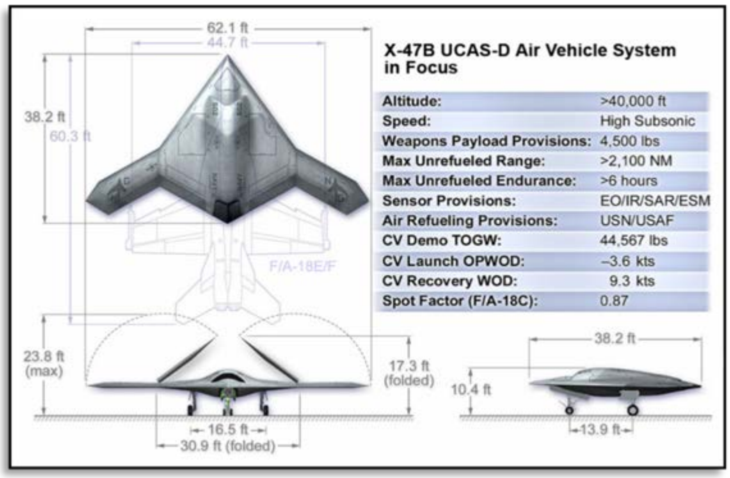
(U) Development and analysis of cost estimates for IMD requirements will enable improved leadership decision-making and program management both for individual programs, and across acquisition portfolios. High-quality, comparable cost estimates will help to identify potential cost-savings, capability shortfalls or bottlenecks, and improve the ability to budget and program effectively for IMD requirements.

Individual Programs

(U) The development of cost estimates reveals important steps necessary for budgeting individual program cost baselines for IMD. The establishment of realistic cost estimates for IMD will enable more advanced decision making at the program level ensuring that:

- Data used to inform cost-capability risk assessments are transparent and reliable;
- Program offices can identify potential efficiencies, realistic cost savings opportunities and viable courses of action;
- Full costs of developing necessary IMD are understood and programmed for early in a project's lifecycle.

(U) IMD cost estimates will play a critical role during milestone or investment decisions. Cost estimates will help programs make informed cost-capability trade-off decisions, and ensure that costs for IMD are fully understood and appropriately budgeted, including identifying opportunities for cost sharing across programs. Once an initial IMD cost estimate is accepted and approved, it will serve as the baseline and point of reference for both the program and IMD producers as the program matures or requirements change.



USN: X-47B Drone (Characteristics and Performance)

Defense Enterprise

(U) At the defense enterprise level, development and analysis of cost estimates across programs and IMD functional areas will identify common cost drivers and limiting factors in IMD production. Requiring all acquisition efforts to identify and report the costs associated with IMD development and production using a consistent methodology will help to identify the total effort and expense across the DoD. Department decision-makers and IMD governance bodies can use this increased understanding of IMD production and costs to identify potential capability investments that will provide optimal return on investment. Further, understanding the magnitude and impact of IMD costs across advanced weapons platforms will enable identification of efficiencies and cost savings across acquisition portfolios.

(U) The defense acquisition and intelligence communities are facing fiscal pressures to do more with less. Since 2009, the Department has undertaken a series of management efficiency and acquisition reform efforts (e.g. WSARA, BBP) that are projected to produce significant cost savings from FY13 through FY17. These improvements focus on creating a more streamlined, agile and effective organization, freeing up resources currently tied up in activities that are low priorities. The key to successful acquisition reform relies on implementation of effective cost management techniques by acquisition programs and efforts. These reform efforts require greater and earlier insight into systems engineering, cost-estimating, and developmental testing in the program cycle.

Affordability

(U) As defined by GAO, affordability is the degree to which an acquisition program's funding requirements fit within the agency's overall portfolio plan. Affordability considers not only development and investment costs, but also operations and sustainment costs. Affordability assessments evaluate whether a program's projected funding and manpower requirements are realistic and achievable, in the context of agency mission priorities. The determination of whether a program is affordable depends greatly on the quality of the cost estimate produced.

> The FY13 Department of Defense base budget accounts for cost savings of $525.4 billion. These reductions include cuts to initiatives that will reduce planned spending by $259 billion over five years and $487 billion over ten years under the Budget Control Act.

(U) DoD Directive 5000.1 provides the fundamental acquisition policies for cost and affordability, as well as program stability. For MDAPs, affordability assessments are required at Milestones B and C. Also, affordability analysis is part of the standard Defense Acquisition Board (DAB) planning process to facilitate investment decisions. The military services are implementing Should-Cost estimates as standard practice, and competitive incentive contracts, services acquisitions, and small business opportunities are receiving greater attention and focus.

(U) Providing IMD cost estimates will support several of these initiatives including:

- Reforming programs that develop and procure military equipment;
- Continuing to make better use of defense resources by reducing lower-priority programs;
- Restructuring the defense organization to achieve more efficient approaches to doing business.

2.0 COST ANALYSIS OVERVIEW

(U) This section provides an overview of how to produce high-quality, defensible, and credible IMD cost estimates. Materials in this section describe high quality lifecycle cost estimating, and review of applicable USG guidance. The procedures explained in this guidebook were modeled after the best practice framework established in the 2009 GAO Cost Estimating and Assessment Guide.

USAF: MQ-9 Reaper

(U) Lifecycle cost estimates, including those required for LMDPs, contain all costs from the program or initiative's start through implementation, operation, and disposal. The purpose of a cost estimate is determined by its intended use and scope of detail. Cost estimates serve two general purposes:

1. Help evaluate affordability and performance against plans;
2. Support the budget process by providing estimates of the funding required to execute a program efficiently.

(U) Generally, cost estimates are required for government acquisition programs, as they are used to support decisions about funding one program over another. Developing a quality cost estimate requires stable program requirements, access to detailed documentation and historical data, and well-trained, experienced cost analysts. Cost estimating combines concepts from such disciplines as accounting, budgeting, economics, engineering, mathematics, and statistics. Establishing realistic estimates for projected costs supports effective resource allocation and increases the probability of a program's success. In addition, cost estimates are used to develop annual budget requests, evaluate resource requirements at key decision points, and to develop performance measurement baselines.

(U) Cost estimating is defined as the process of collecting and analyzing historical data and applying quantitative models, techniques, and tools to predict the future cost of an item, product, program, or task. Cost estimating is integral during the selection of alternatives and is used as a management tool to support decision-making during the acquisition process.

(U) When performed correctly, cost estimating can be used to support any of the following activities:

- Evaluating program or sponsor viability, structure, and/or resource requirements;
- Supporting a program's or sponsor's planning, programming, budgeting, and execution process (PPBE);
- Meeting the OUSD(AT&L) requirement for PMs to manage and report "should-cost" to include IMD, with their performance parameters

- Predicting future costs based on known historical technology and manpower requirements;
- Evaluating alternative courses of action;
- Supporting milestone decisions and reviews; and
- Forming the basis for budget requests to Congress.

(U) Expecting that a cost estimate will be 100 percent correct is unreasonable. The estimating process for IMD should focus on determining a sufficiently accurate estimate based on defined assumptions for a reasonable expenditure of effort. Further, IMD estimates should be supported by appropriate risk management strategies and management reserves based on an appreciation for the likely levels of variability and uncertainty inherent in the estimate. During this process all assumptions, cost factors, and sources for development of IMD cost estimates should be documented accordingly.

(U) Accurate cost estimates require careful attention to detail and a comprehensive look at all expenses. However, there are many factors which can undermine the accuracy or validity of a cost estimate. Careful explanation and documentation of the underlying assumptions and estimating process are critical to establishing credibility with decision makers, especially those who have a say over program funds. When program managers or other decision makers view an estimate as not credible all involved parties, including design engineers, managers, budget planners are affected. The table below lists common pitfalls which can negatively impact cost estimates:

Common Cost Estimating Pitfalls
1. The scope of work is poorly defined; individual elements are not broken down appropriately and become misinterpreted. 2. Adjustments to raw data have been made several times without documentation or explanation. 3. Documentation of cost data and omissions are inadequate. 4. Ground rules and assumptions have not been appropriately applied. 5. Cost estimators fall prey to "padding syndrome," and provide a "cushion" or "fudge factor" to meet desired costs. 6. Cost estimators fail to assess, neglect, or ignore risk and uncertainty, result in unrealistic estimates. 7. Targets for cost and performance are set or phased inconsistently or incorrectly between various lifecycle phases – this is referred to as the "Cost Fantasy." 8. PMs apply external pressure to meet specific, but unrealistic cost, schedule, quality, or performance targets.

2.1 U.S. Government Cost Estimating Best Practices

(U) In the federal government, cost estimating involves collecting and analyzing historical data and applying quantitative models, techniques, tools, and databases to predict a program's future cost. For government agencies and program offices, centralizing cost estimating procedures is a best practice because doing so facilitates the use of consistent cost processes, identifies and leverages experts, and enables sharing of program resources.

USMC: V-22 Osprey

(U) Acquisition effort cost estimates are used for scenario planning, budget development, comparison of alternatives, source selection, affordability comparisons, and milestone decisions. Obtaining accurate cost estimates can be difficult at first as projects usually involve new technologies and require multi-year efforts to complete. Inaccurate estimates can result from an inability to predict and/or define requirements, technological advancements, task complexity, economic conditions, schedule requirements, or system environment concepts. Additionally, managers often feel pressured to provide optimistic estimates in order to obtain project approval. As a result, a poorly developed cost estimate can lead to creation of an unrealistic and impossible plan.

(U) From the intelligence and acquisition perspective, cost estimating has taken on a greater importance due to legislation and guidance directing agencies to be more accountable and responsible with costs. The ability to compare costs with capabilities and risks is essential for decision makers as they prepare the necessary project documentation to receive funding. Government agencies have used LCCEs to enhance decision making, especially in the early planning and concept formulation phases of an acquisition. As standard practice, LCCEs provide structured accounting of all resources and associated cost elements required to develop, produce, deploy, and sustain a particular program. LCCEs are a "cradle to grave" approach to managing a program throughout its useful life. This entails identifying all cost elements that pertain to the program from initial concept all the way through operations, support, and disposal. LCCEs are usually phased through three primary phases of a program's lifecycle which correspond to differentiated funding appropriations or "colors of money" — Research, Development, Test and Evaluation (RDT&E), Procurement, and Operations and Sustainment (O&S).

- **RDT&E:** Includes government and contractor costs to research, develop and test equipment, material, and computer application software necessary to bring a system from concept to production. It includes efforts associated with material solutions analysis, technology development and engineering manufacturing development (EMD). For IMD production, RDT&E may include collections activities or development of modeling and simulation tools.

- **Procurement:** Includes all costs for the prime mission equipment (PME) and its support. Procurement costs cover production through introduction (fielding) of the materiel system into operational inventory. "Procurement" activities for IMD would include tasks such as data production, conditioning, and dissemination.
- **O&S:** Includes all direct and indirect costs of a system; manpower, fuel, maintenance and support that starts after fielding and ends when the materiel system leaves the service inventory. O&S activities for IMD include all tasks necessary to update IMD after initial production. Lifecycle O&S costs would include any additional collection, development, dissemination or validation activities performed according to an agreed upon refresh rate.

Operations and Sustainment (O&S)

(U) O&S activities for IMD include all costs incurred from the initial system deployment through the end of system operations, which entail all costs of operating, maintaining, and supporting a fielded system or program. These associated costs include (organic and contractor) personnel, equipment, supplies, software, and services associated with operating, modifying, maintaining, supplying, training, and supporting a system in the DoD inventory. For IMD these costs will carry great significance when identifying O&S requirements. Each producer must communicate and develop clear and common assumptions regarding O&S requirements as costs will vary based on program complexity and factors such as periodicity of updates.

(U) O&S requirements include the necessity of updates to sensor suites as well as the identification of future threats, and the undefined IMD requirements related to those threats. Areas with considerable uncertainty will need to be accounted for appropriately in all IMD cost estimates. The importance of including reasonable O&S costs in the cost estimate cannot be understated; O&S costs can range from 25-85% of a program's total lifecycle costs, and remain an area of cost concern for the Department. However, O&S requirements for IMD will likely involve a significant degree of uncertainty for factors such as the fielding rates of updates or modifications to identified threat systems, the development and capabilities of future threat systems, changes in the geographic regions in which U.S. weapons systems will be deployed, and the intelligence community's ability to collect and analyze the IMD associated with these changes. Careful, consistent communication with the acquisition effort and clear documentation of all assumptions about and limitations of O&S cost estimates is critical to ensuring the credibility of IMD lifecycle cost estimates.

Case Study 1: Joint Strike Fighter F-35 IMD, Operations and Sustainment

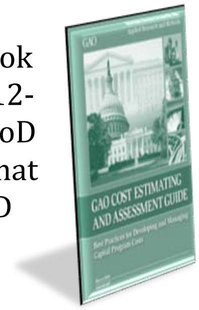
(U) Procurement of F-35 Joint Strike Fighters (JSFs) began in FY 2007. Current DoD plans call for acquiring a total of 2,456 JSFs for the Air Force, Marine Corps, and Navy at an estimated total acquisition cost (as of December 31, 2007) of $246 billion in constant (i.e., inflation adjusted) FY2009 dollars. O&S requirements include the necessity of updates to sensor suites as well as the identification of future threats and as yet undefined IMD requirements related to those threats – areas with considerable uncertainty that will need to be accounted for appropriately in IMD cost estimates.

(U) The F-35 has a large number of design features that aim to simplify maintenance and keep life cycle costs down. Since operations and maintenance are usually about 65% or more of a fighter's lifetime cost, this is one of the most important and overlooked aspects of fighter selection. Stealth aircraft have always had much higher maintenance costs, but the F-35′s designers have hoped that new measures can reverse this trend. March 2012 operations and maintenance projections have the F-35 at 142% O&M cost, relative to any F-16s they will replace.

(U) Whether the advantages of F-35 innovations in practice manage to fulfill their promise, or projections that these innovations will be outweighed in the end by increased internal complexity and the proliferation of electronics remains to be seen. This has been the general trend over the last 30 years of fighter development, with a very few notable exceptions like the F-16, A-10, and JAS-39. Further, the JSF F-35 program serves as an instructive example of the importance of including O&S in cost estimates:

- The FY13 budget request for the program included $302M for O&S. This request attributes to 66% of produced aircraft. (Senate Report 112-196 DoD Appropriations Bill)
- NASIC's JSF IMD cost estimate projected that O&S costs would be approximately 60% of the costs associated with initial IMD shortfall costs (approximately 40% of total costs) at Block 3.

2.2 CHARACTERISTICS OF CREDIBLE COST ESTIMATES



(U) GAO reaffirmed in the 2009 Cost Estimating and Assessment Guidebook that credible cost estimates share nine fundamental characteristics. The 12-step approach defined in the GAO guidebook and adapted here to meet DoD standards and the IMD cost estimating challenge is designed to ensure that resulting cost estimates have all nine of these key characteristics. As IMD producers are developing cost estimates, they should be mindful of whether estimates meet these standards.

- **Clear Identification of the Task:** The estimator must have the system description, ground rules and assumptions, and technical and performance characteristics of the system. The estimate's constraints and conditions must be clearly identified to ensure the preparation of a well-documented estimate. In the case of IMD costing, this includes having as clear a definition of the IMD requirements as possible, understanding the acquisition effort's mission objectives in the use of the required IMD, and identifying any barriers to successful completion of the requirements (e.g. collections, technical capability).
- **Broad Participation in Preparing Estimates:** All stakeholders should be involved in deciding mission need and requirements and in defining system parameters and other characteristics. Data should be independently verified for accuracy, completeness and reliability. Production of high-quality IMD estimates will require inputs from a wide stakeholder community, including the acquisition effort team to provide requirements and timelines, multiple IMD producers responsible for meeting different elements of the requirements, EMOs, the IMDC, service costing elements, and various DoD oversight organizations.
- **Availability of Valid Data:** Whenever possible, cost estimates should be based on numerous sources of suitable, relevant, and available data. This data should be from similar systems, and should be directly related to the new system's performance. This characteristic may present a challenge to the IMD producer community over the short-term, as historically the specific costs associated with producing IMD have not been individually documented. The development of IMD cost estimates and more specific cost tracking over time will improve the availability of historical data and improve the quality of cost estimates. In any case where the data supporting a cost estimate may not be directly related to the estimating task, or where the validity of the data is in question, cost estimators must document and explain these limitations clearly.
- **Standardized Structure for the Estimate:** Cost estimates should be derived from a standard work breakdown structure that identifies all key elements of the work to be performed. The work breakdown structure should be updated as the program matures and the requirements become more defined. Clearly defined and standardized work breakdown structures will also facilitate comparison of IMD development processes over time.
- **Provision for Program Uncertainties:** Uncertainties should be defined, and an allowance developed to cover the potential cost effect. Known costs should be

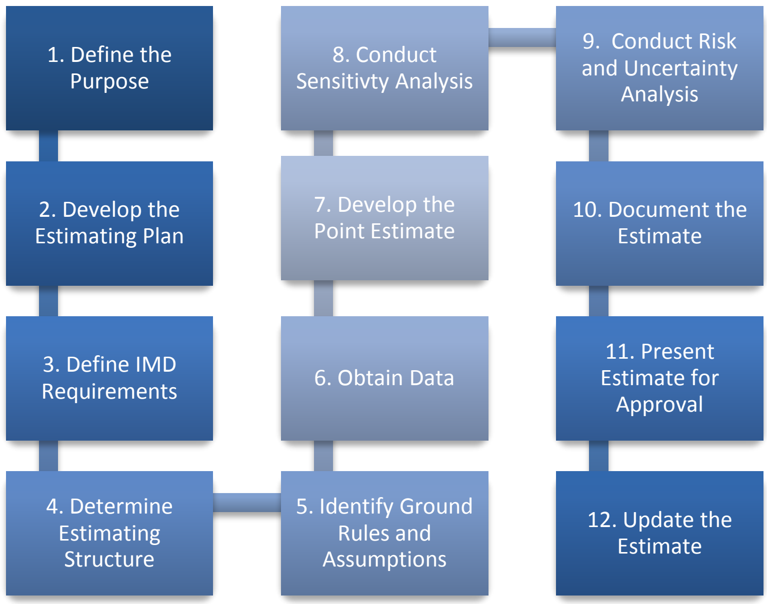
included, and any unknown costs should be allowed for. Common uncertainties in IMD cost estimating may include the availability of collections or technical capabilities.

- **Recognition of Inflation:** High quality cost estimates will ensure that economic changes, such as inflation, are properly and realistically reflected in the life-cycle estimate. Standards for DoD cost estimating, and IMD cost estimating, call for all cost estimates to be calculated and presented in "then-year" base dollars to properly account for inflation. DoD issues extensive inflation guidance and indices; producers of IMD cost estimates should ensure that they are using the most recent inflation guidance applicable to the program in question.
- **Recognition of Excluded Costs:** All costs associated with a system should be included; any excluded costs should be disclosed and given a rationale. Excluded costs in an IMD cost estimate could include items such as collections costs that are outside of the control of the IMD producer or additional data conditioning that will be performed by the program once sensor suites are finalized.
- **Independent Review of Estimates:** An independent review of a cost estimate that verifies, modifies, and corrects a cost estimate to ensure realism, completeness and consistency helps to establish confidence in the estimate. The functional area EMOs will validate the methodologies and processes used to create all IMD cost estimates. Additionally, OSD CAPE will conduct independent reviews of cost estimates for all MDAPs.
- **Revision of Estimates for Significant Program Changes:** Estimates should be updated to reflect changes in a system's requirements in order to ensure that any changes that affect cost are properly accounted for in program decision processes. IMD cost estimates will be submitted in preparation for each milestone review and will identify any major changes from the previous version.

3.0 TWELVE STEPS TO HIGH QUALITY COST ESTIMATES

(U) The GAO guidebook presents a 12-step process composed of best practices used to create and establish repeatable methods for developing high-quality cost estimates, which can easily be traced, replicated, and updated. This process represents the most basic framework for creating cost estimates and is intended to be flexible enough to accommodate a wide variety of cost estimating requirements.

Figure 3.0.1: 12 Step Cost Estimating Process Flow Chart



(U) The following sections provide the basic principles documented in the GAO guidebook, and additional guidance on applying these steps to the IMD mission set. Some elements of the GAO processes have been modified slightly to conform to specific DoD requirements; some have been modified to meet better the needs of IMD cost estimating. Overall however, following the 12-step process detailed below will help ensure that IMD cost estimates are defensible, consistent, and trustworthy in order to facilitate better decision-making by DoD stakeholders.

3.1 Define Purpose

(U) Defining the purpose of the cost estimate includes determining three key components: the required level of detail, the overall scope of the estimate, and who will receive the estimate. For IMD cost estimating within the LMDP, the required level of detail and overall scope will vary based on the maturity of the acquisition effort and its phase in the acquisition lifecycle. The audience for the cost estimates at any phase in the acquisition lifecycle will be the program's or effort's management and key decision-makers.

(U) All IMD cost estimates developed as part of the LMDP process will serve three common purposes:

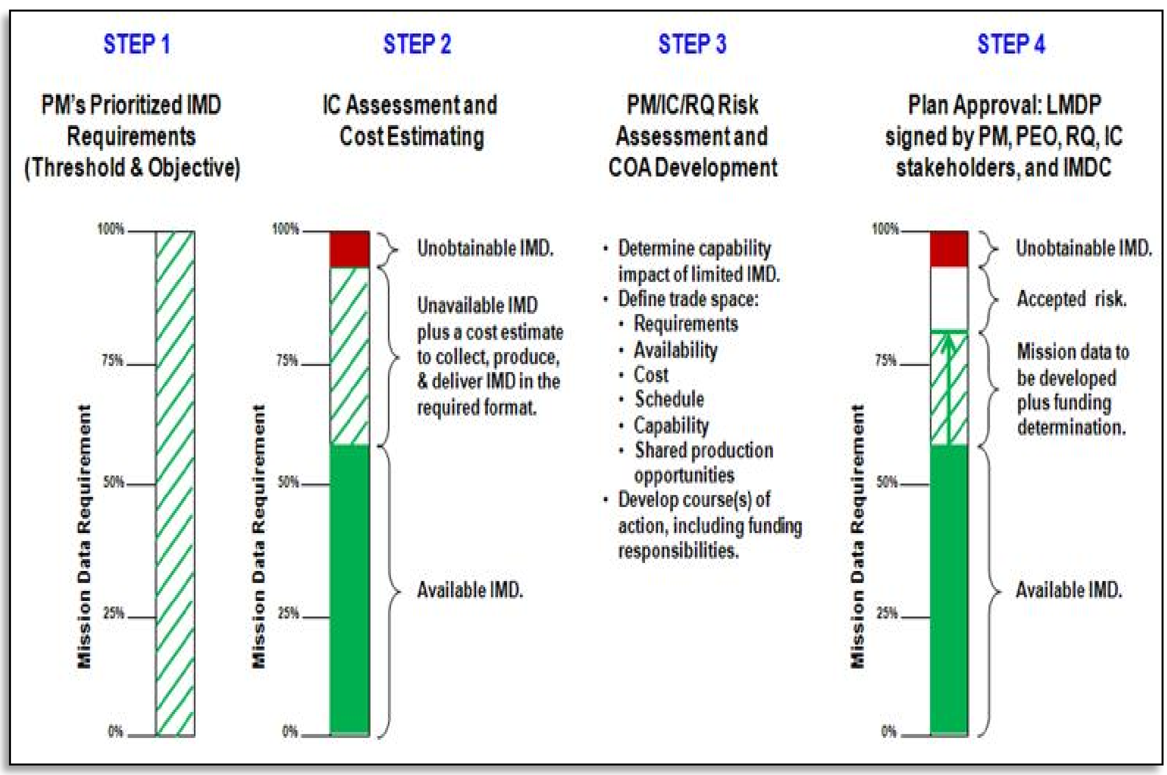
1. Identify IMD that is currently unavailable but technically feasible to produce;

2. Inform affordability analysis of acquisition intelligence requirements and capabilities against costs; and
3. Reveal opportunities for cost savings and cost sharing in IMD production and acquisition efforts.

(U) The cost estimate will fulfill all of these purposes to varying degrees as an acquisition effort progresses through its lifecycle. Early in an effort's lifecycle, program managers may only be able to identify that a desired mission capability will require a specific type of IMD. In these cases, the estimate will still meet all of the identified purposes by providing information on existing data, establishing a range - even a wide one - of potential costs for the program managers to consider, and identifying potential common needs with other programs. A program that is advanced in the development cycle should be able to identify specific intelligence requirements. Cost estimates should provide detailed accountings of the production and efforts necessary to meet these requirements, a relatively narrow range of costs associated with those efforts, and identification of specific overlap areas with other programs or opportunities for efficiency.

(U) The LMDP is designed to facilitate a four-step mission data risk analysis and management process, illustrated in Figure 3.1.1.

Figure 3.1.1: IMD 4 Step Risk Management Process



- **Step 1:** The process begins with the acquisition effort's identification of all IMD required, for both threshold and objective performance parameters, for desired mission capability.
- **Step 2:** Based on this submission, the IMDC, EMOs, and intelligence community will identify which of these requirements have already been fulfilled through existing production (available IMD), which are technically possible but have not yet been produced (potentially available IMD), and which requirements are unobtainable due to a lack of collections, technical capabilities, or other limiting factors (unobtainable IMD). In accordance with DoDD 5250.01, the IMD producers responsible for meeting the potentially available IMD requirements will develop a cost estimate for the potentially available IMD and submit it to the IMDC and the acquisition effort.
- **Step 3:** The acquisition effort leadership, requirements community, IMDC, EMOs, and IMD producers will then assess risk to the program's desired capability based on the assessment of available/potentially available/unobtainable IMD and the cost estimate.
- **Step 4:** Based on the risk analysis, the stakeholders will determine and agree to an acceptable course of action that balances mission capability, cost, and timeliness. The final course of action should incorporate opportunities to share IMD across multiple programs, and determine how responsibility for funding IMD development will be shared between the acquisition efforts and the intelligence community.

Key Considerations: Define the Purpose
✓ The estimate's purpose and scope are clearly defined. ✓ The level of detail the estimate is to be conducted at is consistent with the level of detail of the requirements available for the program.

3.2 Develop Estimating Plan

(U) Developing the cost estimating plan includes identifying the cost estimating team, outlining the cost estimating approach, and developing a timeline for the estimate. The participants in the cost estimating team will be determined by the IMD requirements, based on what functional areas and IMD producers must be involved. Once the participants have been identified, they should all convene to develop a cost estimating approach together. The timeline for the cost estimates should be developed based on the acquisition effort's required use of the IMD and its identified milestone schedule.

Joint Services: Small Diameter Bomb II

- At a minimum, LMDPs are due 90 days before a milestone, and cost estimates should be submitted sufficiently before that date to enable the risk assessment and course of action determination described above.
- Where possible, however, programs should keep in mind that CARDs are due in draft form 180 days prior to milestone review and in final form 45 days before review.
- Acquisition efforts and IMD producers should coordinate to ensure that IMD requirements are available to support CARD development. Even if final cost estimates and LMDPs are not available within the 180 day window, maintaining dialogue with the CARD team to inform development will be helpful.

Roles and Responsibilities

(U) The IMDC will analyze an acquisition effort's IMD requirements to determine what IMD functional areas the program requires, and what organizations should produce the necessary IMD. Based on this analysis, the functional area EMOs (e.g. GEOINT, Signatures, OOB, C&P, EWIR) will lead cost estimate development for each functional area.

(U) The EMOs will compile the cost estimate for their respective functional areas, using inputs from all producers who will be providing IMD in that functional area. The EMO will convene all participating organizations to develop, agree upon, and document a common estimating approach to and structure for the cost estimate (detailed further in section 3.4). The approach should include common ground rules, assumptions, and estimating factors (detailed further in Section 3.5), a data collection and validation strategy (detailed further in Section 3.6), common definitions of key terms and principles, a schedule with deadlines, and clear roles and responsibilities for all participants. The approach should comply with all standards and guidelines included in functional area costing guidance as appropriate.

(U) All participating organizations will identify responsible points of contact who will be compiling their inputs to the cost estimate. As the EMO and participating organizations determine who will be on the cost estimating team, they should consider that development of quality cost estimates requires a broad array of skill sets. The team should include:

- A variety of technical experts with a deep understanding of the entire scope of work and all specific tasks;
- Program managers who understand how the work will need to be phased, the resources available to complete the work, and how best to incorporate the work stream into existing priorities;

- Budgeting and programming experts who ensure the manpower and financial requirements presented by the program managers are conveyed appropriately to facilitate resource requests; and
- Experienced cost estimators who can help overcome cost estimating challenges in line with accepted cost estimating best practices.

(U) Though various participants may play a role only in certain phases of the cost estimate's development, identifying them up front in the process and determining their specific responsibilities will help ensure that the cost estimating process runs smoothly and that no important elements are overlooked. Additionally, EMO cost estimating staff will be available to provide technical assistance to all relevant IMD producers in development of their elements of the cost estimate.

Key Considerations: Develop Estimating Plan
The estimating team's composition and project plan are commensurate with the assignment: ✓ The team has the proper number and mix of resources. ✓ Team members are from a centralized cost estimating organization. ✓ The team includes experienced and trained cost analysts. ✓ The team includes, or has direct access to, analysts experienced in the program's major areas. ✓ Team members' responsibilities are clearly defined. ✓ Team members' experience, qualifications, certifications, and training are identified. ✓ A master schedule with a written study plan has been developed. ✓ The team has access to the necessary subject matter experts.

3.3 DEFINE IMD REQUIREMENTS

(U) Acquisition efforts will initiate the LMDP process by submitting to the IMDC prioritized IMD requirements for threshold and objective performance parameters using standard LMDP requirements inputs templates. These templates itemize individual IMD requirements according to IMD functional area and type of IMD. Input fields will include all elements necessary to produce each mission data element, and each requirement will also have an associated timeline or "need by" date. The templates for IMD requirements inputs are included in the LMDP Guidebook and Templates document, available through DAU. https://acc.dau.mil/CommunityBrowser.aspx?id=289687&lang=en-US

USAF: F-22 Raptor

(U) Requirements early in an effort's acquisition lifecycle are likely to be imprecise or incomplete and will evolve towards specific intelligence requirements as more information becomes known. However, at each phase, acquisition efforts, the IMDC, EMOs, and IMD producers should collaborate to ensure that the requirements provide the best available information at any given point in a program's lifecycle.

(U) The IMDC and EMOs will review the requirements to determine which IMD is already available, and which IMD producers are responsible for producing against the other requirements. The IMDC will distribute the requirements to the EMOs, who will determine which requirements are potentially available and which are unobtainable.

(U) The unobtainable requirements will be catalogued by the IMDC for future reference, and the potentially available requirements will form the baseline technical requirement for the cost estimate. Where possible, IMD producers should work with the acquisition effort and requirements community to refine the requirements and understand the mission need and capability driving the requirement.

Key Considerations: Define IMD Requirements
✓ The IMD requirements are as specific as possible for the program or effort's level of maturity/development. ✓ The program has included IMD requirements for both threshold and objective performance where possible. ✓ IMD producers can identify available, potentially available, and unobtainable IMD requirements. ✓ IMD producers, the IMDC, EMOs, and acquisition effort sponsors have agreed on the potentially available IMD requirements and the scope of the cost estimate.

3.4 Determine Estimating Structure

(U) The objective for determining the estimating structure is to establish a common technical mission data baseline that thoroughly describes the process to be used by the cost estimating team. There are several activities associated with developing an estimating baseline:

- Describe the lower-level system characteristics, configuration, quality factors, operational concept, and the risks associated with the system or effort
- Define a work breakdown structure (WBS) and describe each element in a WBS dictionary
- Choose the best estimating method for each WBS element
- Identify potential cross-checks for likely cost and schedule drivers
- Develop a cost estimating checklist.

(U) Program technical descriptions provide quantitative and qualitative descriptions of the project characteristics from which cost estimates are derived. As such, the project technical description ensures that cost projections jointly developed by the Program Offices and the independent review organizations are based on a common definition of the system and project. The project technical description should identify any area or issue that could have a major cost impact (e.g., risks) and, therefore, must be addressed by the cost estimator. For IMD cost estimates, the program technical description is the IMD requirements.

(U) Determining the estimating structure is initiated by identifying inputs to cost processes and elements which can be either one-time or iterative occurrences. One-time inputs include project/program requirements, the mission need statement, and the acquisition strategy or acquisition plan. Iterative inputs include the technical/scope development, the schedule development, and the risk management plan with associated risk identification and mitigation strategies.

(U) Cost estimates that are developed early in a project's lifecycle may not be derived from detailed IMD requirements. However, they should be sufficiently developed to support budget requests for the remainder of the project definition phase. Over the life of the project, cost estimates become increasingly more definitive, and reflect the scope and schedule of work packages and planning packages defined for the project.

Key Considerations: Determine Estimating Structure
✓ Describe the level lower system characteristics, configuration, quality factors, operational concept, and the risks associated with the system. ✓ Define a work breakdown structure (WBS) and describe each element in a WBS dictionary. ✓ Select the best estimating method for each WBS element. ✓ Identify potential cross-checks for likely cost and schedule drivers. ✓ Develop an IMD cost estimating checklist.

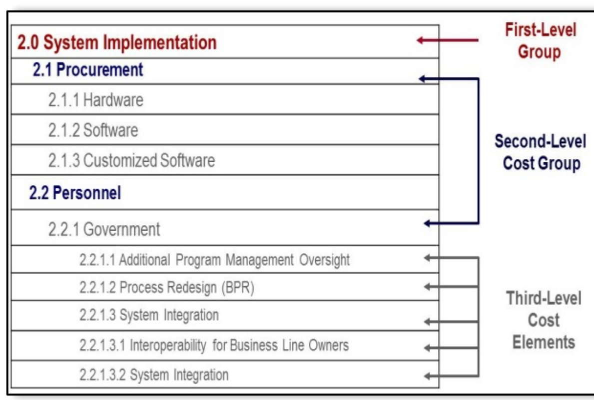
3.4.1 Work Breakdown Structures

(U) A well-defined WBS is a necessary program management tool for costing IMD because it provides a basic framework for estimating costs, developing schedules, identifying resources, determining where risks may occur, and providing the means for evaluating program status. Creation of a well-structured WBS will help retain accountability by identifying work products that are independent of one another. Further, this estimating structure provides the framework to develop a schedule and cost plan that can easily track technical accomplishments in terms of resources spent in relation to the plan as well as completion of activities and tasks—enabling quick identification of cost and schedule variances. By breaking work down into smaller elements, management can more easily plan and schedule the program's activities and assign responsibility for the work.

The 100 Percent Rule

(U) A WBS breaks down product-oriented elements into a hierarchical structure that shows how elements relate to one another as well as to the overall end product. A properly structured WBS follows the "100 percent rule:" the next level of decomposition of a WBS element (child level) must represent 100 percent of the work applicable to the next higher (parent) element. Its hierarchical nature allows the WBS to logically sum the lower-level elements that support the measuring of cost, schedule, and technical analysis for an IMD development effort.

Figure 3.4.1.1: WBS Example



(U) The number of levels for a WBS will vary between programs or efforts and is dependent upon complexity and risk. A WBS needs to be expanded to a level of detail that is sufficient for planning and successfully managing the full scope of work. However, each WBS should, at the very least, include three levels.

- **The first level** represents the program or effort as a whole and therefore contains only one element— the program or effort name
- **The second level** contains the major program or effort segments

- **The third level** contains the lower-level components, subsystems, or activities for each segment

WBS Dictionary

(U) When following the product-oriented best practice, there should not be WBS elements for various functional activities like design engineering, logistics, risk, or quality control, because these efforts should be embedded in each activity. A WBS should be developed early to provide for a conceptual idea of program size and scope. As the program matures, so should the WBS.

(U) Therefore, as the technical baseline becomes further defined with time, the WBS will also reflect more detail. It is important that each WBS be accompanied by a dictionary of the various elements. A WBS dictionary describes in brief narrative form what work is to be performed in each WBS element. Each element is presented in an outline to show how it relates to the next higher element and what is included to ensure clear relationships.

Standardizing WBS

(U) Standardizing the WBS to the greatest extent possible is considered a best practice because it enables an organization to collect and share data among programs. Standardizing work breakdown structures results in more consistent cost estimates, allows data to be shared across organizations, and leads to more efficient program execution. A standardized, product-oriented WBS can help define high-level milestones and cost driver relationships that can be repeated in future applications. In addition to helping the cost community, programs reporting to a standard WBS enable leadership to make better decisions about where to apply contingency reserves and where systemic problems are occurring, like integration and test. DoD Military Standard Practice 881C (MIL-STD 881C) provides guidance on developing a standardized WBS. Though this standard does not address IMD specifically, IMD cost estimators should review this document to understand how acquisition efforts will need to integrate IMD cost estimates into their other cost reporting requirements. MIL-STD 881C can be found at: https://acc.dau.mil/adl/en-US/482538/file/61223/MIL-STD%20881C%203%20Oct%2011.pdf. Additionally, the Air Force uses the Acquisition Intelligence Lifecycle Cost Estimating Structure (AILCES), which is a standardized WBS relating to all intelligence support to an acquisition effort, not just IMD. Case Study 2 in this guidebook provides additional information on AILCES.

(U) Not using a standardized WBS causes difficulty in comparing costs from one contractor or program to another, resulting in substantial expense to government estimating agencies when collecting and reconciling cost and technical data provided in inconsistent formats. As the primary repository for all IMD cost estimates, the IMDC will retain all WBSs submitted as part of the LMDP, and will identify opportunities to standardize WBSs within and across IMD functional areas. To the extent possible, each IMD functional area should strive to develop and use consistent WBS elements that apply to activities common within the functional area.

WBS and System Maturation

(U) As program or system mission data requirements mature, engineering efforts should focus on system-level performance in order to validate critical technologies needed to meet top-level specifications. As the specifications become further defined, and the system concepts have been determined, major subsystems can be identified. During this process lower-level system elements can be defined, eventually completing the total system definition.

(U) Elements of a WBS may vary by phase, and different activities are required for development, production, operations, and support. A master WBS must be established as soon as possible for the program's life cycle, as it will provide many program benefits:

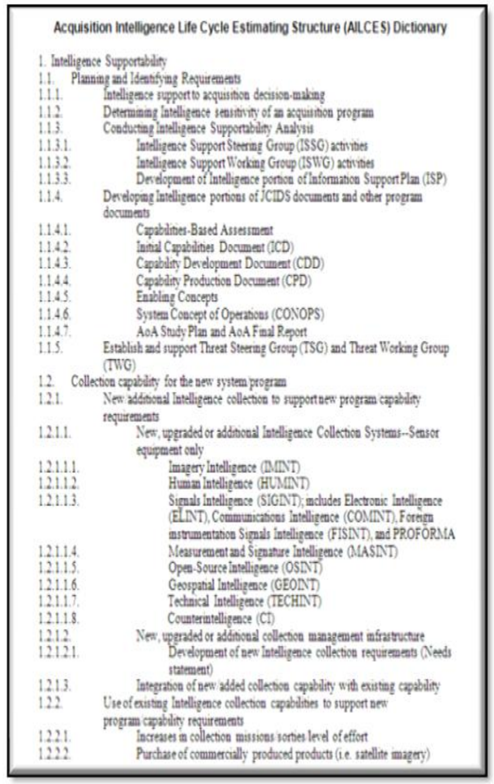
- Isolate work elements into their component parts;
- Clarify relationships between the parts, the end product, and the tasks to be completed;
- Facilitate effective planning and assignment of management and technical responsibilities;
- Help track the status of technical efforts, risks, resource allocations, expenditures, and the cost and schedule of technical performance within the appropriate phases.

(U) In summary, a well-developed WBS is essential to the success of costing IMD for acquisition programs and efforts. The WBS is a key communication tool among the cost estimators, the IMD producers, and the acquisition effort. The WBS provides clear documentation for all anticipated work, identifies potential dependencies, and provides a common framework from which all parties can collaborate. The development of a comprehensive WBS provides a consistent and observable framework that:

- Improves communication streams;
- Helps in the planning and assignment of management and technical responsibilities; and
- Facilitates tracking of engineering efforts, resource allocations, cost estimates, expenditures, and cost and technical performance.

Case Study 2: Acquisition Intelligence Lifecycle Cost Estimating Structure (AILCES)

(U) At the Air Force Materiel Command (AFMC), cost analysts use the Acquisition Intelligence Lifecycle Cost Estimating Structure (AILCES) tool to determine and document the costs associated with identified Defense Intelligence Requirements (DIRs). The AILCES was developed by the AF Intelligence Cost Working Group to identify systematically and consistently intelligence cost requirements throughout the lifecycle of an acquisition effort (to include capabilities development, research and development, testing, fielding, operations and support). It is a standardized work breakdown structure for intelligence activities that are required to support an effort. Each element of the WBS has associated cost consideration categories and factors such as manpower, travel, IT resources, etc. Proper application of AILCES, or a similar WBS early in the lifecycle of an acquisition program will help avoid program delays and additional costs caused by failure to consider all activities related to DIRs supporting testing, fielding, and sustainment of the effort.



Acquisition Intelligence Life Cycle Estimating Structure (AILCES) Dictionary

1. Intelligence Supportability
1.1. Planning and Identifying Requirements
1.1.1. Intelligence support to acquisition decision-making
1.1.2. Determining Intelligence sensitivity of an acquisition program
1.1.3. Conducting Intelligence Supportability Analysis
1.1.3.1. Intelligence Support Steering Group (ISSG) activities
1.1.3.2. Intelligence Support Working Group (ISWG) activities
1.1.3.3. Development of Intelligence portion of Information Support Plan (ISP)
1.1.4. Developing Intelligence portions of JCIDS documents and other program documents
1.1.4.1. Capabilities-Based Assessment
1.1.4.2. Initial Capabilities Document (ICD)
1.1.4.3. Capability Development Document (CDD)
1.1.4.4. Capability Production Document (CPD)
1.1.4.5. Enabling Concepts
1.1.4.6. System Concept of Operations (CONOPS)
1.1.4.7. AoA Study Plan and AoA Final Report
1.1.5. Establish and support Threat Steering Group (TSG) and Threat Working Group (TWG)
1.2. Collection capability for the new system/program
1.2.1. New/additional Intelligence collection to support new program/capability requirements
1.2.1.1. New, upgraded or additional Intelligence Collection Systems--Sensor equipment only
1.2.1.1.1. Imagery Intelligence (IMINT)
1.2.1.1.2. Human Intelligence (HUMINT)
1.2.1.1.3. Signals Intelligence (SIGINT); includes Electronic Intelligence (ELINT), Communications Intelligence (COMINT), Foreign instrumentation Signals Intelligence (FISINT), and PROFORMA
1.2.1.1.4. Measurement and Signature Intelligence (MASINT)
1.2.1.1.5. Open-Source Intelligence (OSINT)
1.2.1.1.6. Geospatial Intelligence (GEOINT)
1.2.1.1.7. Technical Intelligence (TECHINT)
1.2.1.1.8. Counterintelligence (CI)
1.2.1.2. New, upgraded or additional collection management infrastructure
1.2.1.2.1. Development of new Intelligence collection requirements (Needs statement)
1.2.1.3. Integration of new/added collection capability with existing capability
1.2.2. Use of existing Intelligence collection capabilities to support new program/capability requirements
1.2.2.1. Increases in collection missions/sorties level of effort
1.2.2.2. Purchase of commercially produced products (i.e. satellite imagery)

(U) The AILCES includes a WBS dictionary that helps identify intelligence-related cost requirements throughout a program's lifecycle including capabilities development, R&D, testing, fielding, and O&S activities. Though AF specific, the WBS dictionary includes entries for each WBS component that briefly defines the scope or statement of the work, defines deliverables, contains a list of associated activities, and provides a list of recognized milestones to gauge progress. The WBS dictionary helps to ensure that each element is applied uniformly each time a cost estimate is conducted.

(U) Cost analysts at AFMC value the AILCES framework both as a cost estimating tool and as a communications tool. Working with the program offices to complete the AILCES and map individual DIRs to specific activities enables them to refine the requirements and ensure that they capture all of the associated activities and costs. The common WBS structure ensures that conversations among the program, cost estimators, and intelligence producers/analysts are all based off of the same assumptions and understanding of the work to be completed. The consistency of the WBS across efforts also assists in and streamlines the process of identifying valid and applicable historical data.

(U) AILCES is available with approved access on both NIPRNet and SIPRNet. For further information on AILCES and its application or to request access, please contact the Air Force Lifecycle Management Center (LCMC), 21st Intelligence Squadron.

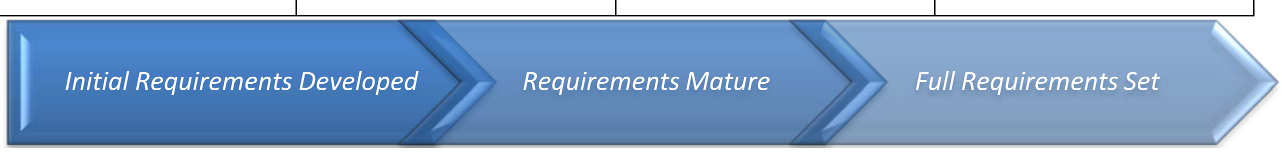
Source: Air Force Lifecycle Management Center (LCMC), 21st Intelligence Squadron

3.4.2 Cost Estimating Methodologies

(U) Once the cost estimating team has developed the WBS, the next step is to determine how to develop cost estimates for each element of the WBS. These individual estimates will form the basis of the overall point estimate (explained further in Section 3.7). Multiple cost estimating methods are available which span across the Acquisition Lifecycle, and facilitate the cost estimating process. Figure 3.4.2.1 provides an overview of the four most common and accepted costing methodologies.

Figure 3.4.2.1: Cost Estimating Methodologies and Lifecycle Applicability

Analogy	Parametric	Engineering	Extrap. From Actuals
• Compares a new or proposed system with one homogeneous (i.e., similar) system in which the form, fit, and function are alike • Analogous system should be acquired in the recent past, include accurate cost /technical data • Must be reasonable and logical correlation between the proposed and "historical" systems identified by the cost estimator • This method is typically performed early in the cost estimating process, such as the pre-Milestone A and Milestone A stages of program lifecycle • Uses of additive or multiplicative factors	• Uses statistical regression analysis of a database of two or more similar systems • Develops cost estimating relationships (CERs) which estimate cost based on one or more system performance or design characteristics (e.g., speed, range, weight, thrust) • Performed in the initial phases of product description, such as after Milestone B when the program is in EMD phase • CERs used evaluate the cost effects of changes in design, performance, and program characteristics • Based on statistical inferences about the relationship between cost and schedule	• Reflects a detailed build-up of labor, material and overhead costs • The "bottom-up" method, most detailed of all the techniques and the most costly to implement • Typically performed after Milestone C (i.e., Low Rate Initial Production (LRIP) approval) when the design is firm, minimal design changes are expected to occur • Data is available to populate the Work Breakdown Structure (WBS) • Estimate is based on standards, either company-specific or industry-wide	• Uses the actual (past or current) costs of an item to estimate future costs • Best suited for estimating follow-on units of the same item when there are actual data from current or past IMD production efforts • Essential to have accurate data at the appropriate level of detail, and the cost estimator must ensure that the data have been validated and properly normalized • Reliance on IMD historical costs to predict future costs



(U) Depending on project scope, estimate purpose, project maturity, and availability of cost estimating resources, the estimator may use one, or a combination, of these techniques. Generally speaking, the estimating team should identify an overarching methodology that will frame the entire estimating effort, and also identify the methodology that is most appropriate for estimating each individual WBS element. As the level of project definition increases, the estimating methodology tends to progress from conceptual techniques to deterministic and definitive techniques. The following sub-sections include techniques that may be employed in developing cost estimates.

(U) Typically, best practice states the cost estimator must choose the appropriate methodology which applies to where the program or effort is in its lifecycle. Early in the program, definitions maybe somewhat limited and actual costs may not have been accrued. Once a program is in production, cost and technical data from the development phase can be used to estimate the remainder of the program. DoD 5000.4-M, identifies five analytical cost estimating methods and techniques commonly used to develop cost estimates for DoD acquisition systems:

1. Analogy
2. Parametric
3. Engineering Build-Up
4. Extrapolation from Actual Costs
5. Expert Opinion

(U) Each of these methodologies is explained in depth in the following sections.

3.4.2.1 Analogy

USAF: Analogous Fighter Systems (F-16, F-35, F-22)

(U) Analogy-based cost estimates rely on comparison to similar programs or efforts and use this comparison to estimate new components, subsystems, or total programs. If a comparable system is available as a reference, this methodology is most appropriate to use early in the program life cycle when the system is not yet well defined. This guidebook recommends identifying cost data from a past IMD development effort which is technically representative of the effort to be estimated as the basis of estimate (BOE) for an analogy based cost estimate.

(U) The analogy methodology is typically applied early in the cost estimating process at pre-Milestone A or Milestone A stages of a program. Adjustments should be made as objectively as possible, using factors or scaling parameters that represent differences in technology or complexity between the effort being estimated and its analogy. During adjustments, cost data can be subjectively adjusted upward or downward, depending upon whether the subject system or effort is felt to be more or less complex than the analogous effort. However, clearly subjective adjustments compromise the validity and defensibility of the estimate and should be avoided; adjustments should be substantiated with data whenever possible and clearly explained. This estimating approach is best used when an adequate amount of program and technical definition is available to allow proper selection and adjustment of comparable program costs.

(U) One drawback of this methodology is that without detailed data it is difficult to determine what parameters are the true drivers of cost. When using the analogy method, it is important that the estimator research and discuss with program experts the reasonableness of technical program drivers to determine whether they are significant cost drivers. Also, the analogy approach places heavy emphasis on the opinions of experts to modify the comparable system data to approximate the new system and becomes increasingly untenable as greater adjustments are made.

Key Considerations: Analogy Methodology
✓ The estimator must make an informed, but ultimately subjective evaluation of the differences between the new system of interest and the historical system. ✓ Historical data points may be limited – has the estimator identified limitations and adjustments effectively and clearly? ✓ Best to use early in the cost estimating process; Pre Milestone A or Milestone A Stage. ✓ All cost adjustments should be as objective as possible, using clearly identified and substantiated factors or scaling parameters.

(U) With so many emerging technologies and ideas, an analogy is often the only method available. Estimating by analogy may be the best technique for estimating the cost of state-of-the-art IMD dependent systems such as a space vehicle, next-generation submarine, or a future fighter.

VIGNETTE #1: ANALOGY METHODOLOGY

IMD Scenario: GEOINT Cost Estimate at Milestone A

Specific GEOINT requirements for EK-38 Merganser have not yet been identified. However the EK-38 Merganser will operate globally within a 50 mile range either inland or offshore from all coastlines and major littoral zones. The EK-38 Merganser will need terrain/topography data to support operational awareness during low altitude flight, with geolocation capability to within 10 meters for strike operations. The Merganser JPO anticipates needing the full complement of GEOINT data within 3 years for Milestone B related operational test & evaluation.

Source ... uct the
navigat ...
require ... sed on
military ...
this dat ...
though ... ited for
cost da ...
funding ... se and
... etween
Gaps/S ... ict and
MQ-9 ... t team
from t ... tors to
instead ... areas,
... m then
... ed the

Cost

1. Identify Analogies & Data Collection
2. Determine Key Differences
3. Develop WBS
4. Develop Adjustment Factors
5. Apply Adjustment Factors
6. Develop Cost Estimate

Estimate Limitations & Iterative Processes

Limitations & Uncertainties	Next Steps
• The estimate relies on a single prior effort. • Adjustment factors are inherently subjective, even when using historical data. • Differences between MQ-9 & Merganser platforms may not be fully understood at this stage of development.	• Engage with JPO Merganser to develop more specific GEOINT requirements. • Continue to collect additional data on costs associated with bathymetric and maritime data development. • Refine cost model based on newly acquired data.

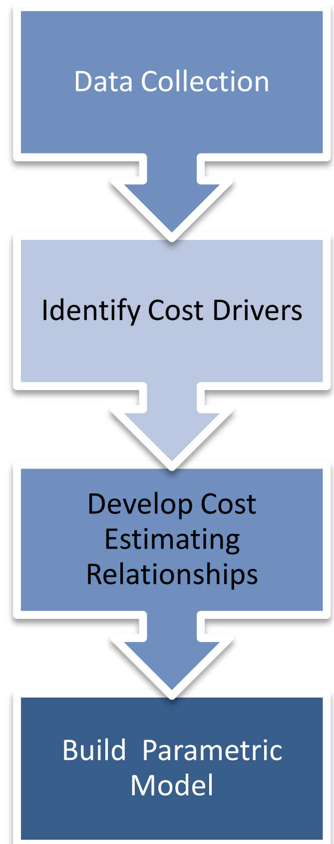
UNCLASSIFIED

UNCLASSIFIED

3.4.2.2 Parametric

(U) The parametric method (sometimes called statistical) makes statistical inferences about the relationship between cost and one or more system parameters. This methodology uses regression analysis of a database of two or more similar systems to develop cost estimating relationships (CERs) which estimate cost based on one or more system performance or design characteristics that are key cost drivers. The assumption driving the parametric approach is that the same factors that affected cost in the past will continue to affect future costs. This methodology is also sometimes referred to as the "top-down" approach.

Figure 3.4.2.2.1: Parametric Cost Estimating Process



(U) As with the other methodologies, the availability and reliability of valid historical data is critical to successful implementation. A good parametric estimate must be timely and accurate, containing the latest available data reflecting technologies similar to that of the system or effort of interest. The cost estimator must have access to historical data from a sufficient number of similar systems or efforts to create a statistically valid CER that can then be used to estimate the cost of the new effort by entering its specific characteristics into the parametric model. Estimates created using a parametric approach are based on historical data and mathematical expressions relating cost as the dependent variable to selected, independent, cost-driving variables through regression analysis.

(U) Normalization of data is particularly important when using a parametric approach in order to ensure commonality of terms across multiple data sources and development of valid CERs. A data element entry for one system must be consistent with the same data element entry from another database. Therefore, the database is not directly related and CERs developed from the database need to be made homogeneous or not used. Additional information on data normalization can be found in Section 3.6.

(U) The more simplified CERs include rates, factors, and ratios. A rate uses a parameter to predict cost, using a multiplicative relationship. Since rate is defined to be cost as a function of a parameter, the units for a rate are always dollars per something. The rate most commonly used in cost estimating is the labor rate, expressed in dollars per hour or dollars per man-year. A factor uses the cost of another element to estimate a new cost using a multiplier. Since a factor is defined to be cost as a function of another cost, it is often expressed as a percentage. For example, travel costs may be estimated as five percent of program management costs. A ratio is a function of another parameter and is often used to estimate effort. For example, the cost to develop a component could be based on an industry standard of 20 hours per subcomponent.

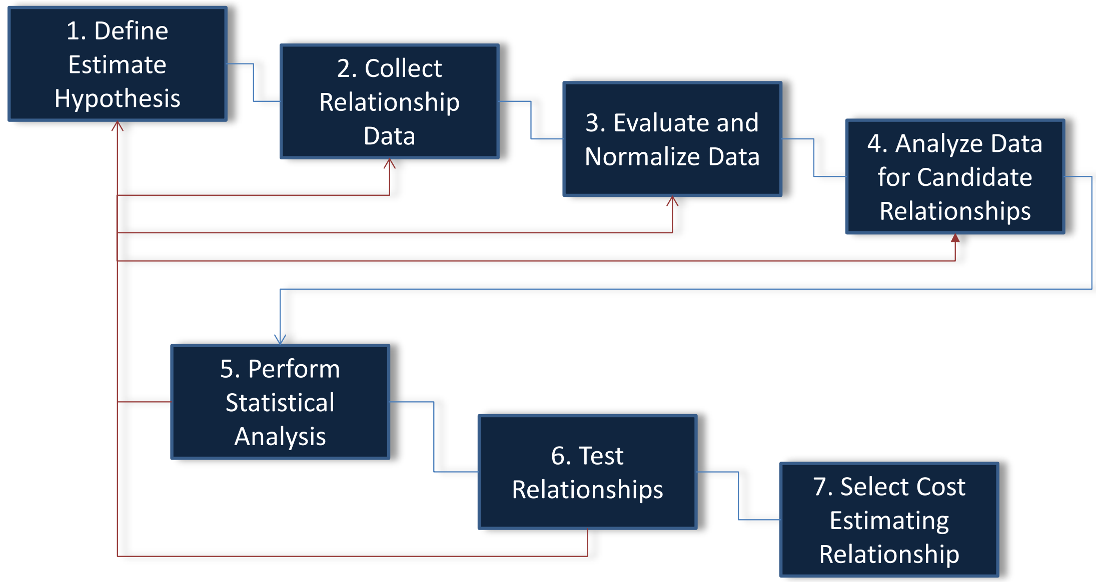
(U) The validity of a CER is usually judged by its regression statistics and the data used in its creation. The regression statistics measure the accuracy of the fit of the CER to the sample data points used in developing the CER. Confidence in a parametric estimate's results depends on how valid the relationships are between cost and the performance characteristics. Data used to create the CER must be current, representative of the entire universe of representative systems, and contain enough data points to allow for valid statistical inference. While there is no hard rule on the size of the sample data set used in CER creation, it is incumbent upon the cost analyst to ensure the data set is both fully representative and contains adequate data points to allow for statistical manipulation. The actual data set size will vary depending on the amount of available data. When using this method, the cost estimator must always clearly document and present the related statistics, assumptions, and sources of the data.

(U) The parametric method is very different from drawing analogies to multiple systems. Parametric estimating relies on data from many programs, and covers a broader range. The parametric methodology relies on statistical models, whereas analogy applies and adjusts direct comparisons.

Key Considerations: Parametric Methodology
✓ The parametric, or statistical, method uses regression analysis of a database of a sufficient number of similar systems to develop statistically reliable and valid CERs. ✓ CERs developed using the parametric method can easily be used to evaluate the cost effects and changes in program characteristics. ✓ Estimating by the parametric method is appropriate relatively early in the program life cycle when a detailed design specification is not available, but a database of like systems and a performance specification are available.

(U) Generally, an estimator selects parametric cost estimating when only a few key pieces of data are known. The parametric method is also useful as a cross-check against an estimate made using another method. The major advantage of using a parametric methodology is that the estimate can usually be conducted quickly and be easily replicated. The parametric method is most commonly performed in the initial phases of production, such as after Milestone B when the program is in the engineering, manufacturing, and development phase, but can be applied as early as pre-milestone A or up through Milestone C, depending on the availability of relevant data. Parametric estimating is used widely in government and industry because it can yield a multitude of quantifiable measures of merit and quality (e.g. probability of success). The figure below details the process steps needed to develop a parametric CER.

Figure 3.4.2.2.2: Parametric CER Development Process Steps



(U) The largest downside of parametric estimating is that the technique is constrained by the amount and quality of the data. Many times an analyst unknowingly incorporates flawed data into the database, in effect producing inaccurate CERs. Thus, the resulting statistics can be misleading. By providing a much more detailed view of what is being estimated, estimating by engineering circumvents the necessity for statistical analysis.

(U) Additional information on how to perform a parametric cost estimate can be found in the GAO Cost Estimating and Assessment Guidebook and the Parametric Estimating Handbook published by the International Cost Estimating and Analysis Association, available under "Products" at: https://www.iceaaonline.org.

VIGNETTE #2: PARAMETRIC METHODOLOGY

IMD Scenario: Signatures Cost Estimate at Milestone B

Initial signature requirements have been identified for EK-38 Merganser. The Merganser will need a variety of spectral, hydro-acoustic, EO/IR, and RF signatures for target identification purposes, using multiple sensor platforms (e.g. SAR, HRR, Fire Control). The RF and EO/IR signatures can be synthetic, while hydro acoustic and spectral signatures must be derived from operational testing. Required levels of fidelity for each signature type have been defined. Specific targets to be identified have not yet been defined but will include maritime, ground, and aerial combat systems across the Merganser's anticipated battlespace.

Data Availability	*Cost Estimate Development*
Source and co NASIC, produc proces **Gaps/S** genera and coı	ı broad levelop ociated cost of ametric oped a RF and pectral, al data, gies for sources well as eated a

Cost

Estimate Limitations & Iterative Processes

Limitations & Uncertainties	*Next Steps*
• Requirements are derived only from assumptions. • Some of the data in the dataset underlying the CERs is likely outdated and may not represent current capabilities.	• Work with JPO Merganser to develop more specific IMD requirements. • Continue to collect additional data on costs; seek out additional data sources. • Refine and update cost model and CERs based on additional data.

UNCLASSIFIED

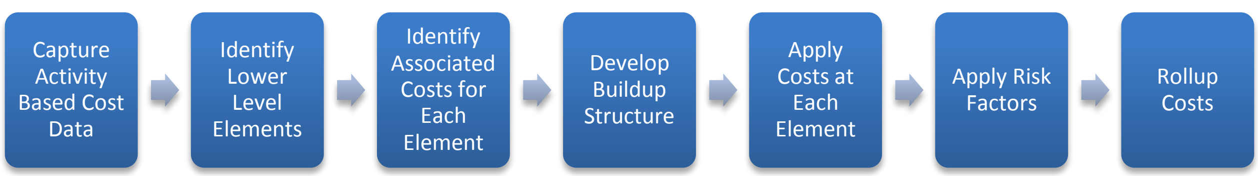
3.4.2.3 Engineering Build-Up

(U) The engineering build-up or "bottom-up" method of cost analysis is the most detailed of all the techniques and the most costly to implement. This methodology requires the detailed build-up of labor, material and overhead costs. Estimating by engineering is typically performed after Milestone C (e.g. Low Rate Initial Production (LRIP) approval) when the design or requirements are firm and minimal changes are expected to occur. When this occurs, cost data is available to populate the WBS, specifications are complete, and IMD production operations are well-defined in terms of labor and material.

(U) The engineering cost estimating method builds the overall cost estimate by summing or "rolling up" detailed estimates done at lower levels of the WBS. An engineering build-up estimate should be done at the lowest level of detail and consists of labor and materials costs that have overhead and fee added to them. In addition to labor hours, a detailed parts list is required.

(U) When using this method, cost estimators should work with engineers or SMEs to develop the detailed estimates. The cost estimator's focus is to get detailed information from the engineer or SME in a way that is reasonable, complete, and consistent with the program's ground rules and assumptions. The cost estimator must find additional data to validate the engineer's or SME's estimates.

Figure 3.4.2.3.1: Engineering Buildup Process Steps



Key Considerations: Engineering Build-Up Methodology

- ✓ The engineering method is the most detailed of all the techniques and the most costly to implement.
- ✓ These estimates make use of insight into the specific resources and processes used in performing the work.
- ✓ The engineering cost estimating method builds the overall cost estimate by summing or "rolling up" detailed IMD estimates done at lower levels of the WBS.

Case Study 3: NGIC's Development of Metrics for TECHELINT and EWIRDB Production

(U) The TECHELINT Branch of the U.S. Army National Ground Intelligence Center (NGIC) has developed common methodologies and terminologies by which the missions, roles, and tasks for TECHELINT production can be defined and manpower requirements for TECHELINT producers can be estimated. ELINT is comprised of the detection, characterization, interpretation and reverse engineering exploitation of signals emitted by non-communication based systems.

(U) Over the past decade, the ever-increasing demand for the number of radars and the exponential growth of customer demands for more detailed signal weapon system descriptions has overwhelmed production capacity. In order for TECHELINT resources to be applied for maximum mission impact, NGIC developed metrics for production so that it could substantiate and justify resource requests and prioritization. This included development of a robust WBS, baseline level of effort calculations, identifying key characteristics of signals and assigning varying degrees of difficulty to possible values of these characteristics, and definition of varying phases of ELINT support.

(U) To derive metrics for ELINT production activities, multiple costing techniques were used to extrapolate costs. This included a combination of analogy, engineering build-up, parametric, and expert-opinion costing methodologies. During this process, comparisons were identified among systems (expert opinion, analogy) and the results of analyzed ELINT activities, gathered organizational inputs, and costs were brought together to produce totals for each manpower requirement (engineering buildup). This enabled the creation of a WBS aligned to major functional tasks, as production rates were established to determine the levels of effort (e.g per hour or day). This led to a method of calculating functional tasks for a new a requirement, multiplying the percent of time expended by an organizational unit on each functional task to establish a full duration cycle (e.g lifetime/annual). For identifying degree of difficulty attributes for signal complexity, weighted factors (parametric) were used with low- high range (.1-1.0) thresholds; this was largely dependent on specific or unique attributes. The primary purpose of developing and instituting a common process for TECHELINT requirement baselines was threefold:

1. Enable TECHELINT resource allocation decisions to be made and determine trade-offs among competing production demands;
2. Provide meaningful TECHELINT accountability; and
3. Establish credible mechanisms for justifying requests for additional TECHELINT resources.

(U) It is important to note that the methodology was not intended to develop specific cost estimates, but did include elements that could be expanded to create a cost estimating methodology. This work was undertaken to develop a common approach and define mission tasks as combinations of analytical elements so that a reasonable estimation for TECHELINT production could be achieved. This included:

- Define ELINT Functional tasks (29) – Work Breakdown Structure
    - Identify New Radar Variants, Provide Emitter Targeting Data
- Baseline manpower requirements for a simple signal – Define Characteristics
    - Derive Parametric Signature Definitions (8hrs/set, 4 data sets, @4hrs/set)
    - Tasks and Duration—Lifetime/Annual

- Define degrees of difficulty (DDL) attributes for signal complexity and assign weighting factors for each DDL attribute—specific and unique element incorporated in analysis – ID Ground Rules, Assumptions
    - Unstable Timing Source (.1), Complex Stagger (.3)
    - Band together radars which have similar DDL weighting factors for analogous comparisons
- Define ELINT support/missions
- Extrapolate total manpower requirements

(U) While the estimation techniques address the manning requirements for TECHELINT production, this methodology could also be used to construct models and WBSs for ELINT collections, ELINT reporters, and collection managers. This type of methodical approach can be used to identify manpower required for any type of production effort. This approach derives valid estimates that will:

- Enable flexibility to permit each producer to represent manpower usage in terms of its own capabilities and mission requirements;
- Provide a useful management tool for prioritizing requirements, tasking available resources, and identifying shortfalls; and
- Represent the need for new resources through mission based formulation.

(U) For additional information on the TECHELINT WBS and program analogy structure, please contact NGIC's Signatures Division, TECHELINT Branch.

Strengths	Drawbacks
• Requirements were well defined, ground rules and assumptions were clearly stated. • Used historical data to develop and document a common methodology process. • Cost drivers seemed reasonable, and data was traceable. • The use of multiple cost estimating methodologies was appropriate for the subject matter. • All data sources and adjustments were normalized and clearly presented.	• Process does not incorporate elements for identification of risk and uncertainty. • Documentation to support the weighting factors is lacking.

Source: TECHELINT Branch of the U.S. Army National Ground Intelligence Center (NGIC)

VIGNETTE #3: ENGINEERING METHODOLOGY

IMD Scenario: EWIR Cost Estimate at Milestone C

JPO Merganser has submitted detailed EWIR requirements against specific threat systems at varying degrees of complexity. The JPO has also provided specific formats and standards in which they will require the IMD. The JPO has indicated that they need all of the EWIR data to support Full-Rate Production.

Data Availability	*Cost Estimate Development*
Sources: Since initiation of the Merganser IMD production effort, IPCs (e.g. NASIC, ONI, NGIC) … develo… comple… labor … ongoin… associa… to disse… **Gaps/S…** simulat… require…	**Rationale:** An engineering build-up approach was most appropriate in this case because: …e IMD … nt was …mming …roduce …, and …ed with …ch that …d those …oduced …d work …d with …o each …stimate …te may …duction

Cost…

1. Capture Activity Based Data
2. Identify Lower Level Elements & Associated Costs
3. Develop Buildup Structure
4. Apply Costs to Each Element
5. Examine Sensitivities, & Apply Risks
6. Rollup Cost Elements

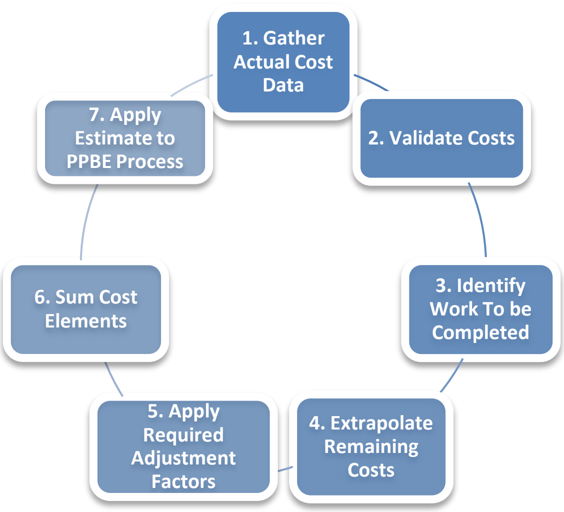
Estimate Limitations & Iterative Processes:

Limitations & Uncertainties	*Next Steps*
• Small errors or faulty assumptions may grow into larger errors during summation. • Any elements omitted by accident could cause misrepresentation of costs.	• Identify potential cross-checks for cost drivers, and validate estimate; look for errors like double counting and omitted costs. • Update the cost model as more data become available or as changes occur and compare results against previous estimates.

3.4.2.4 Extrapolation from Actuals

(U) The extrapolation from actuals method is best suited when estimating follow-on units of the same item when there are actual data from current or past production lots. This method is valid when IMD requirements have changed little. If major changes have occurred, careful adjustments will have to be made or another method will have to be used. Estimating by actual costs is, essentially, an extrapolation of current program cost. The cost data is internal to the current system being constructed, which is not the same as "actual" historical data. There are several conditions that must be present to enable actual cost estimation.

Figure 3.4.2.4.1: Extrapolation from Actuals Process



(U) First and foremost, a program must be in a phase where the process of prototype development, low rate initial production, or full rate production has at least started – otherwise there is nothing "actual" from which to base actual costs. Second, there must be a reporting process in-place that enables the DoD agency to review accumulated actual costs as the prototype or system is being constructed. Although such a reporting process can vary significantly from program to program, the reporting process typically (a) occurs monthly or quarterly, (b) requires the contractor or data provider to provide percent-of-work completed to date and (c) requires the contractor or data provider to provide the cumulative cost it has expended for the completed work-to-date.

Figure 3.4.2.4.2: FY12 DoD Acquisition Systems Costs

Program	Total Cost ($ million)	N° of units
ARMY:		
ARH-70	3,602.0	368
Black Hawk Upgrade	23,769.6	1,235
CH-47F	12,797.7	512
Longbow Apache	9,405.2	613
NAVY:		
E-2 Adv Hawkeye	15,721.5	75
EA-18G Prowler	9,045.0	90
F-18E/F	44,030.5	462
H-1 Upgrades	8,015.3	284
MH-60R	11,319.3	254
MH-60S	7,725.6	271
MMA (P-8A)	32,134.1	114
V-22 Osprey	50,497.1	458
VH-71 (EH-101)	6,547.3	23
HLR (CH-53K)	18,876.0	161
AIR FORCE:		
C-130 AMP	4,933.2	434
C-130J	7,612.3	79
C-17A	59,552.7	180
C-5 RERP	11,054.1	112
F-22 Raptor	62,600.0	185
Global Hawk (UAV)	7,815.7	54
JPATS (T-6A)	5,251.7	782
INTER-SERVICE:		
F-35 JSF	276,458.9	2,458

(U) When using extrapolation techniques, accurate data at the appropriate level of detail are essential, and the cost estimator must ensure that the data have been validated and properly normalized. When such data exist, they form the best basis for cost estimates. Estimates for decision reviews are to be based at least in part on actual production cost data for the IMD requirements under review.

(U) OSD CAPE prefers this method since it uses actual or near actual data for the system of interest. The uncertainty associated with this method is based, as with the analogy method, on the technical assessment of the difference between an earlier version of the system, such as a prototype, and the current model under consideration.

Obviously, the more the two versions are alike, and the further along the system is in the acquisition process, the more easily an accurate estimate can be made.

Key Considerations: Extrapolation from Actuals
✓ Estimating by actual costs is, essentially, an extrapolation of current program cost. ✓ This method uses the actual cost of the previous production lot adjusted for inflation, labor saving, material cost, technology changes and other factors. ✓ This is the most accurate cost estimating method when the data is available.

VIGNETTE #4: EXTRAPOLATION METHODOLOGY

IMD Scenario: OOB Cost Estimate at Milestone C

JPO Merganser has submitted a fully defined OOB requirements deck at the Full Rate Production Phase. For intelligence purposes this includes the listing of equipment, units, facilities, and geolocation of enemy forces that will operate within the Merganser's range. The JPO has specified a required refresh rate every 3 years.

Data Availability	*Cost Estimate Development*
Sources: Since initiation of the Merganser IMD production effort, IPCs (e.g. DIA, NASIC, ONI, NGIC) have tracked and maintained records of the labor and resources required to develop O surge effo during the this effort The contr updated a work com **Gaps/Shor** necessary	**Rationale:** An extrapolation from actuals methodology was most appropriate in this situation because: eam

Cost Es

Gather Actual Costs → Validate Costs → Identify Work To Be Completed → Apply Adjustment Factors → Sum Cost Elements → Apply Estimate to PPBE Process

Estimate Limitations & Iterative Processes:

Limitations & Uncertainties	*Next Steps*
• If the work remaining is not sufficiently similar to the work completed, the cost estimate could be flawed.	• Continue to monitor actual costs and work completed; update the cost model as required. • Incorporate cost estimate into future budget requests.

UNCLASSIFIED

3.4.2.5 Expert Opinion

(U) Expert opinion is generally considered too subjective but can be useful in the absence of data. Valid cost estimates should not be based solely on expert opinion, but rather may be used to bridge gaps in available data. In all cases, cost estimators should delve deeply into the experts' opinions to determine if real data back them up.

(U) If data support the expert's opinion, the cost estimator should obtain this data for review and document its source. Also, cost estimators should identify multiple experts for the scope of the cost estimate and develop a "consensus" opinion after interviewing all experts. Expert opinion analysis can be performed using a variety of techniques, each of which has advantages and disadvantages.

- **Individual one-on-one interviews:** Cost estimators interview a variety of experts independently. Estimators should use a common questionnaire for all interviews to ensure that they capture and document the same information from all experts on a given topic. Cost estimators must craft the questionnaire so that it reveals and documents the source of the expert's opinion and identifies any underlying data sources. They must also craft the questionnaire so that it approaches the issue from many angles and ensures the expert's opinion remains consistent. This approach can be time consuming because it requires conducting multiple interviews, but can be relatively easy from a logistical perspective. This approach also requires the cost estimator to develop a consensus opinion that must then be re-circulated to the experts for validation/confirmation – which may be difficult to achieve.
- **Round-table discussion:** Multiple experts convene to discuss and present all sides of an issue. All experts remain in the discussion until they reach a consensus position. The experts document all areas of risk or uncertainty within their estimate, and describe in detail any concerns or disagreements. This approach may be difficult to manage logistically depending on the number of experts required. Additionally, the opinions or personality of one expert may overly influence the group; the cost estimators facilitating the discussion should be watchful for this behavior, and mitigate it if possible. The facilitators must also ensure that the group stays on task and does not become mired in tangential discussions or disagreements. Finally, the facilitators should take careful note of any disagreements among the group that lead to a "watering down" of the consensus position, and consider these elements carefully during the sensitivity and risk analysis phases of the estimating process.
- **Delphi Technique:** The Delphi technique aims to minimize the influence of any one particular opinion or expert in a group environment. In a Delphi session, a group of experts submit their responses to a questionnaire anonymously through multiple rounds. Between rounds, facilitators summarize the results as well as the reasons provided for the judgments and send them back out to the group for coordination. Experts are thus encouraged to revise their previous answers based on the replies of the other members of the panel. This approach generates a range of opinions and generally results in convergence around a single number or a tighter range. The process ends after a pre-defined stop criterion (e.g. number of rounds, achievement

of consensus, stability of results) and the mean or median scores of the final rounds determine the results. A Delphi session can be conducted either virtually or in person, and requires careful and intensive management of the process by the facilitators.

(U) In all of these techniques, the cost estimator's interviewing skills are important for ensuring that the experts provide the right information consistently, and for capturing the experts' knowledge effectively so that the information can be used properly. In all cases, cost estimators should never ask experts to estimate the costs for anything outside the bounds of their expertise, and they should always validate experts' credentials before relying on their opinions. Expert opinion relies upon imperfect human participants, who tend to understate both variance (spread) and randomness (lack of uniformity).

(U) Additionally, expert opinion is vulnerable to faulty recollection and human tendency to be either excessively optimistic or conservative without basis. Because of its subjectivity and lack of supporting documentation, expert opinion should be used sparingly and only as a sanity check.

Key Considerations: Expert Opinion
✓ Carefully validate the qualifications of the experts, and understand the boundaries of their expertise. ✓ Understand and document wherever possible the sources and qualifications underpinning the experts' judgments and rationalizations. ✓ Maintain consistency in the engagement with and questioning of experts to the greatest extent possible. ✓ Do not use this approach when time permits for more thorough analysis or as a convenient substitute when more scientific methods are available.

VIGNETTE #5: EXPERT OPINION METHODOLOGY

IMD Scenario: C&P Cost Estimate at Milestone A

The Merganser JPO has indicated that it will require C&P data for likely threat systems in the operational environment over a 30-year anticipated employment lifecycle.

Data Availability	Cost Estimate Development
Sources: Historical data on C&P production costs and technology development rates. SMEs on C&P production, technology development, and relevant country military strategies and objectives. **Gaps/Shortfalls:** The In order to accurately capture full lifecycle IMD costs, the cost	**Rationale:** Given the high level of uncertainty, the cost estimating team decided to use an expert opinion approach to refine the problem set. • High degree of uncertainty with little available data • Expert knowledge can help fill the data gaps

estimating team
threat platforms
many important

- Ability to
  of techno
- In order t
  costs, th
  questions
- What are
  systems
  operation
- What mil
  employ th
- What im
  productio

Cost Estima

- Identify Uncertainties & Gaps
- Data Collection
- Identify Expertise
- Consult with SMEs
- Cross-Check and Validate Expert Inputs
- Develop Cost Estimate

Cost Limitations & Iterative Processes

Limitations & Uncertainties	Next Steps
• This method is completely subjective if employed without data and use of other techniques. • Difficult to determine risk around an expert opinion method.	• Refine cost data and develop cost model. • Continue engagement with SMEs over time to identify changes in costs. • Seek out data to validate or refute expert conclusions.

Case Study 4: NASIC Joint Strike Fighter F-35 IMD Cost Estimate

(U) The release of the initial IMD requirement associated with the Joint Strike Fighter (JSF/F-35) in 2008 represented a unique scale and scope of intelligence requirement for the intelligence community, and the Intelligence Production Centers (IPCs) specifically. The National Air and Space Intelligence Center (NASIC) determined that it would need a new approach to intelligence requirements management and cost estimating even to begin to respond to the requirement.

(U) NASIC began with a detailed analysis of the requirements. The office responsible for coordinating the requirements response, the Threat Representation and Validation Flight, surveyed subject matter experts in order to scope the existing knowledge posture and determine exactly what IMD would need to be produced. From this analysis, they developed a comprehensive list of all unmet requirements, and derived a rough work breakdown structure from this list. Next, they defined assumptions about the level of effort (LOE) that NASIC was likely to have available to meet these requirements, and developed costing factors and associated formulas to derive costs to meet each individual requirement. The assumptions, LOE, and costing factors were all based on historical data; the cost model employed a combination of analogy and engineering build-up techniques to arrive at a point estimate.

(U) This initial point estimate spurred the JSF Program Office and other interested stakeholders to address the need for further refinement. AFMC convened a “Tiger Team” to refine the requirements that included representatives from the Joint Program Office, the JSF prime contractor, and the Intelligence Production Centers. Through a series of intensive meetings, the Tiger Team was able to address approximately 80% of the requirements, and provide the IPCs with greater clarity on the application of IMD within the platform, acceptable levels of risk, likely surrogates/analogies, and required operations and maintenance refresh rates. These refinements allowed the cost estimating team to adjust the calculations and cost model to reflect the new data, and to provide a more precise and defensible point estimate, based on mutual understanding of the requirements and required effort.

(U) With this defensible point estimate in hand, NASIC and the JPO were able to begin a discussion about funding and cost sharing for IMD production. NASIC involved its budget and programming staff in order to develop a program build specific to meeting the JSF requirements. This program build incorporated some elements that the initial point estimate had not, such as the costs associated with developing single source intelligence, and overhead and support resources. Based on the program build and continued communication, the JPO agreed to provide NASIC with funding dedicated to producing unique IMD requirements. The JPO continues to revise and refine its IMD requirements based on continuing dialogue with the IPCs.

(U) For additional information on NASIC’s initial approach to costing JSF’s IMD requirements, please contact the Threat Representation and Validation Flight (NASIC/ANCR).

Strengths	Drawbacks
• Developed and documented deliberate data collection methodology. • Used historical data to develop, document assumptions and to estimate future costs. • Estimated costs for individual IMD requirements (rough WBS elements), and summed to develop point estimate. • Collaborated, communicated closely with program office and other stakeholders. • Refined estimate as additional data became available. • Documented and communicated cost estimating process, cost model clearly. • Translated cost estimate into budget program build.	• Estimating process did not originally include budget and program staff or all costs associated with IMD production. • Estimate did not include sensitivity, risk and uncertainty analysis or recommended contingency adjustments.

Source: NASIC Threat Representation and Validation Flight (NASIC/ACNR)

3.4.2.6 Advantages and Disadvantages

(U) The appropriate cost methodology to select depends on where the program is in its lifecycle, how well defined the program requirements are, and the availability of data. Once a program is in production, cost and technical data from the development phase can be used to estimate the remainder of the program. Figure 3.4.2.6.1 provides an overview of the strengths and weaknesses of these five methods.

Figure 3.4.2.6.1: Advantages and Disadvantages of Cost Estimating Methodologies

Methods	Advantages	Disadvantages
Analogy	+ Method can be used before detailed program requirements are known. + If the analogy is strong, the estimate will be defensible. + Estimates can be developed quickly and at minimum cost. + The tie to historical data is simple enough to be readily understood.	- An analogy relies on a single data point. - It is often difficult to find the detailed cost, technical, or program data required for analogies. - There is a tendency to be too subjective about the technical parameter adjustment factors – SME teams must document rationale carefully.
Parametric	+ Parametric relationships can be derived at any level. + As elements change, CERs can be quickly modified and used to answer what-if questions about alternatives. + Simply varying input parameters and recording the resulting changes in cost can produce a sensitivity analysis. + CERs rely on historical data that provide objective results, increasing the estimate's defensibility.	- CERs must represent the state of the art; that is, they must be updated to capture the most current cost, technical, and program data. - Using data outside the CER range may cause errors, because the CER loses its predictive ability and credibility for data outside the development range. - Complicated CERs (such as nonlinear CERs) may make it difficult for others to readily understand the relationship between cost and its independent variables.
Engineering	+ The estimator has the ability to determine exactly what the estimate includes and whether anything was overlooked. + The method gives good insight into major cost contributors, and can transfer results to other programs.	- The method can be expensive to implement and is time consuming. - The method is not flexible enough to answer what-if questions. - New estimates must be built for each alternative. - Small errors can grow into larger errors during summation. - Some elements can be omitted by accident.
Extrapolation From Actuals	+ This is typically the most accurate cost estimating method when the data is available. + The OSD CAPE prefers this method since it uses actual or near actual data for the system of interest.	- The method can only be implemented relatively late in the program's lifecycle - usually too late to adjust or build a budget. - It should not be used for items outside the actual cost data range.
Expert Opinion	+ The method can be used when no historical data are available. + The method takes minimal time and is easy to implement, once experts are assembled.	- The method lacks objectivity. - Expert opinion is not very accurate or valid as a primary estimating method.

3.5 IDENTIFY GROUND RULES AND ASSUMPTIONS

USN: Littoral Combat Ship

(U) Cost estimates are typically based on limited information and therefore need to be bound by constraints that make the estimating process possible. These constraints usually take the form of assumptions that bind the estimate's scope, establishing baseline conditions on which the estimate will be built. Because of the many unknowns, a cost analyst must create a series of statements that define the conditions the estimate is to be based on. IMD cost estimates typically will be based on incomplete or imperfect information and therefore need to be bound by agreed-upon constraints which include ground rules and assumptions.

- **Ground rules:** Represent a common set of agreed on estimating standards that provide guidance and minimize conflicts in definitions. When conditions are directed, they become the ground rules by which the team will conduct the estimate.
- **Assumptions:** Represent a set of judgments about past, present, or future conditions postulated as true in the absence of positive proof.

(U) Management or decision makers relying on the study should be briefed on and provide concurrence or approval for all IMD cost estimating assumptions. This communication ensures management fully understands the conditions according to which the estimate was structured. By reviewing the technical baseline in the cost estimating process, analysts will be able to flush out potential misunderstandings. Further, GR&As enable cost analysts to:

- Remove critical unknowns from costing inputs by providing an assumed answer;
- Simplify estimating efforts by limiting potential variables (threat, environment, operational tempo, etc.);
- Satisfy IMD requirements for key program decision points;
- Answer detailed and probing questions from oversight groups;
- Present a convincing picture to people who might be skeptical;
- Provide useful IMD estimating data and techniques to other cost estimators; and
- Provide for reconstruction of the estimate when the original estimators are no longer available, and provide a basis for the cost estimate.

(U) GR&As can be classified as global or element specific.

- **Global GR&As:** Apply to the entire IMD cost estimate, study, or program (e.g. 5-Year Design Phase, FY12 OSD inflation indices are used to calculate inflation)
- **Element-specific GR&As:** Are driven by each WBS element's detailed requirements, and may vary between alternatives being costed.

(U) GR&As will be more pronounced for IMD cost estimates in the development phase, where there are more unknowns. They should become less prominent as the program moves through development into production and a program can articulate specific intelligence requirements. While each program has a unique set of GR&As, some are general enough that each estimate should address them. One of the most important GR&As to define is a realistic schedule. Performing an in-depth schedule assessment early to uncover the frequent optimism in initial program schedules may be difficult.

(U) In addition to establishing firm ground rules, cost analysts will be responsible for making assumptions that allow the estimate to proceed. Certain assumptions can influence cost, and the subsequent rejection of even a single assumption by management could invalidate many aspects of the estimate, making sensitivity analysis of assumptions critical. The estimators must evaluate the effects of their assumptions on the overall estimate. Should any assumptions prove to be overly sensitive to changes, the validity of that assumption should be challenged and verified with appropriate experts. For example, if the production rate is assumed to be five per year and changing the quantity to four or six has significant impact on the IOC, FOC, or cost the assumption of five should be evaluated closely to ensure it is valid and representative of industry capabilities. Section 3.8 provides a detailed discussion of sensitivity analysis.

(U) For IMD, one important global ground rule is to define the base year dollars that the estimate will be presented in and the inflation index that will be used to convert the base year costs into then-year dollars that include inflation. At a minimum, the inflation index, source, and approval authority should be clearly explained in the estimate documentation.

(U) IMD estimates should remain phased because program costs will usually span many years. Time phasing spreads a program's expected costs over the years in which they are anticipated in order to aid in developing a proper budget. Depending on the activities in the schedule for each year, some years may have higher costs than others. The base year is used as a constant dollar reference point to track program cost growth. Expressing an estimate in base year dollars removes the effects of economic inflation and allows for comparing separate estimates "apples to apples."

(U) Escalation rates should be standardized across similar programs, since they are all conducted in the same economic environment, and priority choices between them should not hinge on different assumptions about what is essentially an economic scenario common to all programs. In addition to global GR&As, estimate-specific GR&As should be tailored for each alternative or program, including, but not limited to:

- Life-cycle phases and operations and maintenance concepts;
- Acquisition strategy, including competition, single or dual sourcing, and contract or incentive type;
- Savings for new ways of doing business;
- Commonality or design inheritance assumptions; and
- Mission data or technology assumptions and new technology to be developed, including refresh cycles.

(U) The cost estimator should work with members from the technical and operational communities to tailor these specific IMD GR&As to the program or effort. Information from the technical baseline and WBS dictionary help determine some of these GR&As, like quantities and technology assumptions. Element-specific GR&As carry the most risk and therefore should be checked for realism and should be well-documented in order for the estimate to be considered credible.

(U) Assumptions should be realistic and valid. This means that historical data should back them up to minimize uncertainty and risk. Understanding the level of certainty around an estimate is imperative to knowing whether to keep or discard an assumption. Assumptions tend to be less certain earlier in a program, and become more reliable as more information is known about them. Documenting all assumptions is a best practice, so that risk and sensitivity analysis can be performed efficiently and quickly.

(U) Cost estimators should document all explicit assumptions clearly, and must also be aware of and document any implicit assumptions as well. Well-supported assumptions should include documentation of an assumption's source and should discuss any weaknesses or risks. Documenting assumptions, understanding their implications, and identifying alternatives will ensure the sensitivity analysis addresses all relevant issues.

Key Considerations: Ground Rules and Assumptions

- ✓ Identify global GR&As that apply to the entire estimate (scheduling, budget, etc.), as well as element specific GR&As.
- ✓ Element specific GR&As carry the most risk – check for realism, and document clearly to increase estimate credibility.
- ✓ Coordinate closely with sponsor offices to develop GR&As – this will ensure that the sensitivity analysis provides actionable information on the influence of various factors on overall cost and schedule.
- ✓ Identify assumptions related to O&S (e.g. periodicity, level of effort) for both available and potentially available IMD.
- ✓ Use historical data to develop assumptions wherever possible – minimize uncertainty and risk.
- ✓ Collaborate with IMDC and EMOs to identify existing data or processes to be leveraged during GR&A development.

3.6 Obtain Data

(U) Data are the foundation of every cost estimate, and the overall quality of the data affects the estimate's overall credibility. Thus, collecting valid and useful historical data is a key step in developing a sound IMD cost estimate. The challenge in doing this is obtaining the most applicable historical data and placing it in the correct context for the current problem to ensure that the new estimate is as accurate as possible.

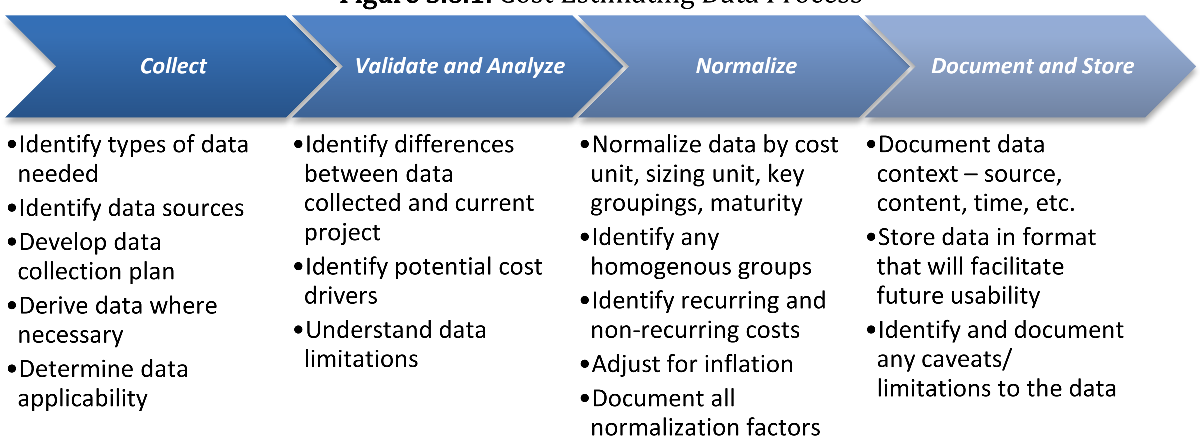
Overview of Cost Estimating Data

USA: Ground Combat Vehicle

(U) Data collection will be the most time-consuming aspect of cost estimate development, and should continue throughout development and IMD production itself. Development of cost estimates requires many types of data—technical, schedule, program, functional area, and cost data. The LMDP requirements submission and operational use and concept narrative will be the primary sources for technical, schedule, and program data for IMD cost estimates. Estimators should also work closely with the acquisition sponsor to determine if there is any relevant data produced by contractors or research laboratories and to identify a strategy for obtaining that data, especially for efforts that are pre-Milestone A.

(U) Any other data required can be collected in a variety of ways, such as from databases of past projects, engineering build-up estimating analysis, interviews, surveys, data collection instruments, and focus groups. Once collected, data need to be normalized to ensure that the data set is consistent and all data is comparable. After the estimate is complete, the data need to be well-documented, protected, and stored for future use in retrievable databases.

Figure 3.6.1: Cost Estimating Data Process



Collect Data

(U) Understanding the factors which influence a program's cost is essential for capturing the right data. To properly identify potential cost drivers, cost estimators must meet with the acquisition effort sponsors and technical experts. In addition, by studying historical data, cost estimators can determine through statistical analysis the factors that tend to influence overall cost.

(U) Another challenge is that data availability for IMD may be an issue. Some agencies may not have IMD costs documented in databases. Data may be accessible at higher levels but information may not be sufficient to break down to the lower levels needed to estimate various WBS elements. Also, data may be incomplete. Similarly, data that are in the wrong format may be very difficult to use. For example, if the data are only in dollars and not hours, they may not be as useful if the labor and overhead rates are available.

Types of Data

In general, the three main types of data are:

- Cost data
- Schedule or program data
- Technical data.

USN: Fire Scout MQ-8B

(U) **Cost data**: Cost data include labor dollars (with supporting labor hours and direct costs and overhead rates), material and its overhead dollars, and facilities capital cost of money. Program cost estimators often do not know about specific dollars, so they tend to focus mostly on hours of resources needed by skill level. These estimates of hours are often input to specialized databases or cost models to convert them to cost estimates in dollars. Cost data must often be derived from program and technical data. Moreover, program and technical data provide context for cost data, which by themselves may be meaningless.

(U) **Schedule/Programmatic data:** Schedule and programmatic data provide parameters that directly affect the overall cost and will be provided by the acquisition effort in the LMDP. For example, lead-time schedules, start and duration of effort, delivery dates, testing, initial operational capability dates, operating profiles, and multiyear development must all be considered in developing a cost estimate. Cost estimates must be based on realistic schedule information. The man-hours required to develop IMD may not be flexible; how quickly the acquisition effort needs the IMD may affect whether an IMD producer must hire or contract for additional manpower to meet the deadlines, potentially impacting costs. Cost estimators must stay in synch with any changes in schedule, since schedule changes can lead to cost changes. Furthermore, seeking input from schedule analysts can provide valuable knowledge about how aggressive a program's schedule may be.

(U) **Technical data:** Technical data define the requirements for the IMD production being estimated, based on technical attributes, such as data fidelity, data format, data parameters, etc. The LMDP requirements submission will be the primary source of the technical data for the IMD cost estimate. When technical data are collected, care must be taken to relate the types of technologies and development or production methodologies to be used. These change over time and require adjustments when estimating relationships are being developed.

Figure 3.6.2: Data Types and Cost Estimate Application

Type of Data	Examples	Usability in the Cost Estimate
Cost Data	• Labor rates • Contract costs • Historical costs • Actual costs • Direct and indirect costs • Unit costs • Materiel costs • Overhead costs • R&D costs • Procurement costs • O&S costs	• Support calculations for incurred IMD costs • Identification of significant cost drivers or actual costs • Apply costs to the program or system being estimated • Document the data used to estimate each WBS element • Validate and input collected data into the cost estimate
Schedule/Program Data	• Key milestone activities and deadlines • Monthly, quarterly, yearly assessments of IMD • IMD delivery and "need-by" dates • IMD mission application	• Provide parameters that directly affect the overall costs • Scope summaries which provide a detailed description of the work included in the estimate • Present the basis for estimating activity durations used to construct the schedule • Indicate key milestones, deliverables, and relationships
Technical Data	• Required level of fidelity • Degrees of difficulty • Specific IMD requirements per functional area • Data formats and standards • Technology dependencies	• Determine specific costs for IMD and assist in the development of WBS • Determine and transcribe the cost estimating methodology • Define functional tasks and baselines (e.g. NGIC TECHELINT) • Establish levels of confidence around estimate • Calculate scenarios and events of collected data

Sources of Data

(U) Since all cost estimating methods are data-driven, analysts must know the best data sources. Figure 3.6.3 lists some basic sources. Cost estimators should use primary data sources whenever possible. Primary data are obtained from the original source, can usually be traced to an audited document, are considered the best in quality, and are ultimately the most useful. Primary data sources for IMD costing will include agency budgeting and resource management tools, organizational spend plans, and performance management records. Secondary data are derived rather than obtained directly from a primary source. Since they were derived, and thus changed, from the original data, their overall quality can be lower and less useful. However, in cases where cost data may not have been identified and maintained, cost estimators may be able to derive cost data by analyzing multiple sources of data to identify required costs.

Figure 3.6.3: Data Sources

Data Sources	Primary	Secondary
Basic Accounting Records	●	
Data Collection Input Forms	●	
Cost Reports	●	●
Historical Databases	●	●
Interviews	●	●
Program Briefs	●	●
Subject Matter Experts	●	●
Technical Databases	●	●
Other Organizations	●	●
Contracts or Contractor Estimates		●
Cost Proposals		●
Cost Studies		●
Focus Groups		●
Research Papers		●
Surveys		●

Data Applicability

(U) Because cost estimates are usually developed with historical data, examining whether the historical data apply to the effort being estimated is important. Time, or changes in requirements, may make the historical effort less similar to the new effort. For example, a previous effort may have been able to rely on an existing model, but the current effort will require development of new modeling and simulation capabilities. Having good descriptive requirements of the data is imperative in determining whether the data available apply to what is being estimated or how they must be modified to make them applicable. To determine the applicability of data to a given estimating task, the analyst must scrutinize them against the following issues:

- Do the data require normalization to account for differences in base years, inflation rates, or calendar year rather than fiscal year accounting systems?
- Is the work content of the current cost element consistent with the historical cost element (e.g. contractor compared to government)?
- Do the data reflect actual costs, proposal values, or negotiated prices?

Validate and Analyze Data

(U) The cost analyst must consider the limitations of IMD cost data before using them in an estimate. According to GAO, historical cost data have two predominant limitations:

1. The data represent specific circumstances that must be known if they are to have future value, and

2. Current cost data eventually become dated.

(U) The first limitation is routinely handled by recording these circumstances as part of the data collection task. To accommodate the second limitation, a cost estimator can either adjust the data (if applicable) or decide to collect new data. A cost analyst must attempt to address data limitations by:

- Ensuring that the most recent data are collected;
- Evaluating cost and performance data together to identify correlation; and
- Ensuring a thorough knowledge of the data's background, and holding discussions with the data provider.

(U) Thus, it is best practice to continuously collect new data so they can be used for making comparisons and determining and quantifying trends. This cannot be done without background knowledge of the data. This contextual knowledge allows the estimator to confidently use the data directly, modify them to be more useful, or simply reject them.

Data Normalization

(U) The purpose of data normalization (or cleansing) is to make a given data set consistent with and comparable to other data used in the estimate. One of the most challenging and perennial problems confronting a cost analyst is the identification and normalization of cost data. The adjustment of actual cost to a uniform basis has two objectives:

- Reduces the dispersion of the data points, creating consistency;
- Expands the number of comparable data points .

(U) Since data can be gathered from a variety of sources (e.g. multiple program offices, contractors), they are often in many different forms and need to be adjusted before being used for comparison analysis or as a basis for projecting future costs. Cost data are adjusted in a process called normalization, stripping out the effect of certain external influences. Normalization provides consistent cost data by neutralizing the impacts of external influences. As stated above the main objective of data normalization is to improve data consistency, so that comparisons and projections are more valid and multiple sources of data can be used to increase the number of data points.

(U) Documenting the steps taken to normalize multiple data sets into one cohesive data set is important so that independent analysts or future estimators understand the conversions already inherent in the data and can recreate the steps if necessary. Data are normalized in several ways.

Cost Units

(U) Normalization by cost units primarily adjusts for inflation. Because the cost of an item has a time value, knowing the year in which funds were spent is important. In addition to inflation, the cost estimator needs to understand what the cost represents. For example, does it represent only direct labor or does it include overhead? Finally, cost data have to be converted to equivalent units before being used in a data set. That is, costs expressed in thousands, millions, or billions of dollars must be converted to one format—for example, all costs expressed in millions of dollars.

Sizing Units

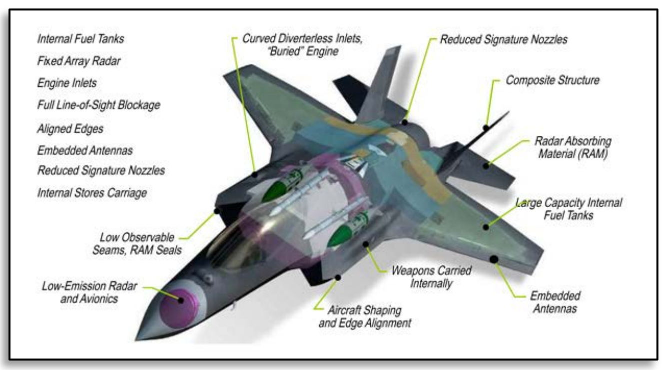
(U) Sizing units normalize data to common units—for example, cost per foot, cost per pound, dollars per software line of code. When normalizing data for unit size, it is very important to define exactly what the unit represents: What constitutes a software line of code? Does it include carriage returns or comments? The main point is to clearly define what the sizing metric is so that the data can be converted to a common standard before being used in the estimate.

Key Groupings

(U) Key groupings normalize data by similar missions, characteristics, or operating environments by cost type or work content. Products with similar mission applications have similar characteristics and traits, as do products with similar operating environments. For example, producers may be able to categorize and compare various IMD requirements by similar degrees of difficulty to produce, or geographic areas with similar profiles, or by systems with similar characteristics. Costs should also be grouped by type. For example, costs should be broken out between recurring and nonrecurring or fixed and variable costs.

Technology Maturity

(U) Technology maturity normalizes data for where a program is in its life cycle; it also considers learning and rate effects. The first unit of something would be expected to cost more than the 1,000th unit, just as a system procured at one unit per year would be expected to cost more per unit than the same system procured at 1,000 units per year. Technology normalization is the process of adjusting cost data for productivity improvements resulting from technological advancements that occur over time.



USAF: F-35 Joint Strike Fighter Technology Components

(U) In effect, technology normalization is the recognition that technology continually improves, so a cost estimator must make a subjective attempt to measure the effect of this improvement on historical program costs. For instance, an item developed 10 years ago may have been considered state of the art and the costs would be higher than normal. Today, that item may be available off the shelf and therefore the costs would be considerably less. Therefore, technology normalization is the ability to forecast technology by predicting the timing and degree of change of technological parameters associated with the design, production, and use of devices. When considering data for use in a cost estimate, producers should consider whether any significant technological advances have been made since the data was created that influence the IMD production process and associated costs.

(U) Technology Readiness Level (TRL) is a measure used to assess the maturity of evolving technologies (i.e. devices, materials, components, software, work processes, etc.) during its development and in some cases during early operations. Generally speaking, when a new technology is first conceptualized, it is not suitable for immediate application. Instead, new technologies are usually subjected to experimentation, refinement, and increasingly realistic testing. Once the technology is sufficiently proven, it can be incorporated into a system/subsystem. TRLs consist of nine graded definitions for stages of technology maturity. They were originated by the National Aeronautics and Space Administration (NASA) and later adapted by the DoD for use in its acquisition system. The table below summarizes each of the nine levels.

Technology Readiness Level	Description and Supporting Information
1. Basic principles observed and reported.	Lowest level of technology readiness. Scientific research begins to be translated into applied research and development (R&D). Examples might include paper studies of a technology's basic properties.
2. Technology concept & application formulated	Invention begins. Once basic principles are observed, practical applications can be invented. Applications are speculative, and there may be no proof or detailed analysis to support the assumptions. Examples are limited to analytic studies.
3. Analytical and experimental critical function & characteristic proof of concept	Active R&D is initiated. This includes analytical studies and laboratory studies to physically validate the analytical predictions of separate elements of the technology. Examples include components that are not yet integrated or representative.
4. Component and/or breadboard validation in laboratory environment	Basic technological components are integrated to establish that they will work together. Generally this is relatively "low fidelity" compared with the eventual system. Examples include integration of "ad hoc" hardware in the laboratory.
5. Component and/or breadboard validation in relevant environment	Fidelity of breadboard technology increases significantly. The basic technological components are integrated with reasonably realistic supporting elements so they can be tested in a simulated environment. Examples include "high-fidelity" laboratory integration of components
6. System/subsystem model or prototype demonstration in a relevant environment	Representative model or prototype system, which is well beyond that of TRL 5, is tested in a relevant environment. Represents a major step up in a technology's demonstrated readiness. Examples include testing a prototype in a high-fidelity laboratory environment or in a simulated operational environment.

7. Prototype demonstration in an operational environment.	Prototype near or at planned operational system. Represents a major step up from TRL 6 by requiring demonstration of an actual system prototype in an operational environment (e.g., in an air-craft, in a vehicle, or in space).
8. Actual system completed and qualified through test & demonstration.	Technology has been proven to work in its final form and under expected conditions. In almost all cases, this TRL represents the end of true system development. Examples include developmental test and evaluation (DT&E) of the system in its intended weapon system to determine if it meets design specifications.
9. Actual system proven through successful mission operations.	Actual application of the technology in its final form and under mission conditions, such as those encountered in operational test and evaluation (OT&E). Examples include using the system under operational mission conditions.

Like-to-Like Activities

(U) Identifying like activities normalizes for differences between historical and new program WBS elements in order to achieve content consistency. To do this type of normalization, a cost estimator needs to gather cost data that can be formatted to match the desired WBS element definition in the current cost estimate. This may require adding and deleting certain items to get an apples-to-apples comparison. A properly defined WBS dictionary is necessary to avoid inconsistencies.

Recurring and Non-Recurring Costs

(U) Embedded within cost data are recurring and nonrecurring costs. These are usually estimated separately to keep one-time nonrecurring costs from skewing the costs for recurring production units. For this reason, it is important to segregate cost data into nonrecurring and recurring categories.

(U) The International Cost Estimating and Analysis Association (ICEAA) defines nonrecurring costs as the elements of development and investment costs that generally occur only once in a product's life cycle. They include all the effort required to develop and qualify an item, such as defining its requirements and its allocation, design, analysis, development, qualification, and verification. For IMD development, examples of non-recurring costs might include:

- Collections;
- Development of any necessary modeling and simulation tools;
- Data conditioning.

(U) As defined by ICEAA, recurring costs are incurred for each item produced or each service performed. Recurring integration and testing, including the integration and acceptance testing at all WBS levels, also represent recurring costs. In addition, refurbishing hardware for operational or spare units is a recurring cost, as is maintaining test equipment and production support software. In contrast, maintaining system operational software, although recurring in nature, is often considered part of operating and support costs, which might also have nonrecurring components.

(U) Similar to nonrecurring and recurring costs are fixed and variable costs.

- **Fixed costs:** Are static, regardless of the number of quantities to be produced. An example of a fixed cost is the cost to rent a facility.
- **Variable costs:** Are directly affected by the number of units produced and includes such things as the cost of electricity or overtime pay. Knowing what the data represent is important for understanding anomalies that can occur as the result of production unit cuts.

(U) The most important reason for differentiating recurring from nonrecurring costs is in their application to learning curves. The learning curve theory applies only to recurring costs. Cost improvement or learning is generally associated with repetitive actions or processes, such as those directly tied to producing an item again and again. Categorizing as recurring or variable costs that are affected by the quantity of units being produced adds more clarity to the data. An analyst who knows only the total cost of something does not know how much of that cost is affected by learning.

Inflation Adjustments

(U) In the development of an estimate, cost data must be expressed in like terms. This is usually accomplished by inflating or deflating cost data to express them in a base year that will serve as a point of reference for a fixed price level. Applying inflation is an important step in cost estimating when more than 4 years are being reflected in the IMD estimate. If a mistake is made or the inflation amount is not correct, cost overruns can result.

(U) Applying inflation correctly is necessary if the cost estimate is to be credible. Cost estimators must adjust the historical data they are using to a common base-year to ensure comparability and relevance to the cost estimate. Inflation rates are used to convert a cost from its current year into a constant base year so that the effects of inflation are removed. When cost estimates are stated in base-year dollars, the implicit assumption is that the purchasing power of the dollar has remained unchanged over the period of the program being estimated. Cost estimates are normally prepared in constant dollars to eliminate the distortion that would otherwise be caused by price-level changes. This requires the transformation of historical or actual cost data into constant dollars. The DoD and individual services offer guidance and standards for inflation indices; cost estimators should consult these guidelines when preparing estimates for IMD and clearly document which guidance and approach they apply.

(U) OMB Circular 94, Section 7 instructs all federal agencies to avoid the necessity of using inflation forecasts as much as possible for cost estimates, as they introduce additional risk into the estimate. OSD guidance reflects the OMB language, which is further mirrored in instructions published by each service branch to its analysts. However, as stated throughout this guidebook, it is frequently impossible to avoid using inflation forecasts due to the multi-year nature of many defense programs. When it is necessary to use an inflation forecast, OMB instructs agencies to use the GDP deflator forecast in the President's economic assumptions for the year in question. Since publication of OMB Circular 94, the Bureau of Economic Analysis has substituted the GDP Price Index for the GDP deflator.

(U) Instructions for applying inflation in cost estimates generally incorporate the same procedures described throughout this handbook for the budget process and for budget analysis. Individual agencies have established their own policies and procedures which may differ from those established by OSD. Each service publishes its own inflation rates by type of money (i.e. O&M, RDT&E, Manpower, etc.); cost information sources for the services can be found in Sections 4.4-4.6.

Data Normalization Example: EWIR EK-38 Merganser

(U) The cost estimating team preparing the EWIR estimate for the Merganser has compiled a number of relevant, validated data sources to inform development of their estimate. They now must normalize these different data sets to develop a consistent data set and a comprehensive and defensible cost model and estimate. Their data sources include:

- **IMD requirements from the LMDP submission** – provides all threat systems for which the program requires EWIR data. Includes required data fidelity, technical parameters, and schedule requirements. The required threat systems largely represent emerging technologies in denied or semi-denied areas.
- **Contract data from 2009** – provides cost information from a 12-month contract executed by an IMD producer to clear a backlog of EWIR requirements. Tasks performed included updates to existing systems, identification of new systems, development of new signals, and database maintenance. Contract labor rates are fully burdened and effort is reported in hours; the contractor also purchased hardware to execute database upgrades. Data is reported in monthly invoices and expenditure reports.
- **Actual cost data from ongoing EWIR data development** – provides cost information related to development of similar EWIR requirements for another acquisition effort. The development has been ongoing for two years. The threat systems for this effort are primarily existing technologies being proliferated in differing variants across neutral or potentially hostile nations. The acquisition effort agreed to provide funding to the IMD producer based on the IMD cost estimate and a four-year timeline. The IMD producer has created a dedicated budget line item (BLI) for this funding and provides semi-annual expenditure reports along with data delivery. The IMD producer is using a mix of government and contract staff to execute this requirement, and labor is reported in FTEs.
- **"Actual" cost data from a denied area radar signature development effort** – provides cost information from a 2010 effort to develop radar signatures for a denied area target. An IMD producer responded to a requirement from a service research laboratory to provide the radar signature of a denied area platform. After the fact, the team developed an estimate of the time and resources the development of the signature had required in order to prepare for the next year's budget request. They created a work breakdown structure of the tasks required, and estimated the total man-hours dedicated to the tasks. They consulted their budget office to identify a generic labor rate. The estimate also applied an estimated 10% management and overhead factor to account for the project management, communications, and general resources involved in the effort, based on guidance from the budget office.

(U) The cost estimating team must undertake several kinds of normalization to make these various data sets comparable in their cost model. In order to normalize the data accurately, they will likely need to go back to the data owners for clarification on how certain data is reported or categorized. Some suggestions for how they may be able to normalize the data sets can be found below. Again, documentation of all characteristics of and modifications made to the data set are critical, so that those validating the estimate, auditors, milestone decision authorities, and future cost estimators have a full understanding of the data and assumptions underlying the estimate.

- *Cost units/Inflation adjustments:* The cost estimating team must ensure that all costs are expressed in constant terms – dollars, thousands of dollars, etc. They must also apply inflation adjustments to all of the cost data, based on when it was gathered. The cost estimate should be provided in current year dollars, so all data must be adjusted to current year figures. The team should document and provide a rationale for the inflation adjustment factors that they use.

- *Key groupings:* The cost estimating team may have enough data to be able to categorize the various efforts. They may be able to normalize the cost data by identifying degrees of difficulty associated with various types of threat systems or data requirements, similar to the schema that NGIC used in Case Study #3, and applying adjustment factors to associated costs. They should carefully justify and document any such adjustment factors in the final cost estimate.
- *Cost types:* The cost estimating team must be careful to identify and properly include in their cost model recurring vs. non-recurring and fixed vs. variable costs. Within the data sets for this estimate, fixed costs might include any required hardware, costs associated with the procurement process (i.e. contract review and selection), or overhead or management costs.
- *Activity Types:* The team will need to do a careful review of the data sources to ensure they are comparing like-to-like activities. In cases where they have a WBS, they can compare it to their own WBS to identify analogous activities. In cases where they do not have a WBS, they may be able to derive one from a contract statement of work. They may need to request additional information from the data owners to ensure they understand completely what the costs identified in each data set do and do not include.

Document and Store Data

(U) After the data have been collected, analyzed, and normalized, they must be documented and stored for future use. One way to keep a large amount of historical data viable is to continually supplement them with every new system's actual return costs. IMD producers should maintain records of their actual costs as they produce IMD in order to improve the quality of data available for future estimates. The IMDC will also maintain records of cost estimates for all programs, and actual IMD production costs where available.

(U) All data collection activities should document source, work product content, time, units, and assessment of accuracy and reliability. Comprehensive documentation during data collection greatly improves quality and reduces subsequent effort in developing and documenting the estimate. The data collection format should serve two purposes:

- Provide for the full documentation and capture of information to support the analysis; and
- Provide standards that will aid in mapping other forms of cost data.

(U) Further, the cost estimate templates for the LMDPs have been designed to facilitate high-quality data collection for future use and analysis. Previously documented cost estimates may provide useful data for a current estimate. Relying on previous estimates can save the cost estimator valuable time by eliminating the need to research and conduct statistical analyses that have already been conducted. For example, a documented program estimate may provide the results of research on contractor data, identification of significant cost drivers, or actual costs, all of which are valuable to the cost estimator.

(U) Properly documented estimates describe the data used to estimate each WBS element, and this information can be used as a good starting point for the new estimate. Moreover, relying on other program estimates can be valuable in understanding various contractors and providing cross-checks for reasonableness.

(U) Because many cost documents are secondary sources of information, the cost estimator must fully understand the data. Previous estimates can provide the cost estimator with valuable data and can also save time, since they provide a structure from which to develop the new cost estimate.

(U) Cost estimating for IMD will require a continual influx of current and relevant cost data to remain credible. This guidebook recommends that all cost data should be managed by estimating professionals who understand what the historical data are based on, can determine whether the data have value in future projections, and can make the data part of the corporate history.

Key Considerations: Obtain Data
✓ Identifying the factors that will influence an effort's cost is essential for capturing the right data.
✓ Use primary data sources whenever possible; consider potential outside sources and identify any barriers to obtaining data.
✓ Best practice dictates continuously collecting new data in order to make comparisons, as well as to determine and quantify trends.
✓ Cross-checking of various data sources helps to identify outliers and validate the applicability of data to the current problem set.
✓ Maintaining historical cost data as well as their context is critical for validation and normalization of data over time.

3.7 Develop Point Estimate

(U) High-quality IMD cost estimates will express a range of possible costs, with the point estimate being between the best and worst case extremes. The point estimate is the "best guess" at the cost estimate, given the available data. The point estimate serves as the starting point for the overall cost estimate that sensitivity and risk analyses will help to refine. The IMD point estimate is the sum of individual WBS element estimates created using a variety of costing methodologies. As explained in Section 3.4, the cost estimator should select a methodology for each WBS element based on the unique characteristics associated with each element, and provide a rationale for why the chosen methodology is the most appropriate.

(U) When developing an IMD point estimate, the cost estimator must perform several key activities:

- Develop the cost model by estimating each WBS element, using the best methodology, from the data collected;
- Include all estimating assumptions in the cost model;
- Express all IMD costs in current year dollars;
- Time-phase the results by spreading costs in the years they are expected to occur, based on the program schedule; and
- Add the WBS elements to develop the overall point estimate.

Auditor's Checklist: Point Estimate

- ✓ Is the cost estimate type clearly defined?
- ✓ Have all applicable costs been estimated?
- ✓ Have program costs been estimated independently of funding source and appropriation?
- ✓ Was the cost estimate developed by a proven process?
- ✓ Have program costs been cross-checked with an independent cost estimate? If no ICE is available, has the estimate been vetted by an outside entity such as an EMO or service cost agency?

(U) After each WBS element has been estimated with one of the common methodology approaches, the elements should be added together to arrive at the total point estimate. Once the overall point estimate is complete, the cost estimating team must validate the estimate by looking for errors like double counting and omitted costs and ensuring that estimates are comprehensive, accurate, well-documented, and credible. The cost estimator should compare the estimate against an independent cost estimate if available, and examine where and why there are differences.

(U) This validation can also be accomplished by performing cross-checks on cost drivers to see if results are similar. If no ICE is available, the cost estimating team should ensure that a third party, such as a functional area EMO or service cost agency, reviews the estimate to provide feedback and suggestions for alternative approaches or considerations. Also, the estimator should update the model and the point estimate as more data become available or as changes occur and compare the results against previous estimates.

USN: USS Albuquerque

(U) As a best practice, all IMD point estimates should be prepared in terms of base-year dollars (e.g Constant Year Dollars), the year of program initiation or last major milestone review. For budgeting purposes all IMD estimates should be escalated to then-year dollars (e.g current year dollars) to reflect inflation input for programming plans.

Key Considerations: Developing a Point Estimate
The cost estimator considered and appropriately selected various cost estimating methods: ✓ Expert opinion - very early in the life cycle, if an estimate could be derived no other way; ✓ Analogy - early in the life cycle, when little was known about the system being developed; ✓ Parametric - if a database of sufficient size, quality, and homogeneity was available for developing valid CERs and the data were normalized correctly; ✓ Engineering build-up - in acquisition, when the scope of work was well defined and a complete WBS could be determined; ✓ Extrapolating from actual cost data - after the start of IMD production. Cost estimating relationships were appropriately developed in a parametric approach: ✓ Used statistical techniques to develop CERs; ✓ Examined the underlying data set to understand anomalies; ✓ Checked equations to ensure logical relationships; ✓ Normalized the data; ✓ Ensured that CER inputs were within the valid dataset range; ✓ Checked modeling assumptions to ensure they applied to the estimated program. The point estimate was developed by aggregating the WBS element cost estimates ✓ Results were checked for accuracy, double-counting, and omissions; ✓ Results were validated with cross-checks and independent cost estimates.

3.8 Conduct Sensitivity Analysis

(U) Sensitivity analysis helps decision makers choose the most effective alternative. For example, it could allow a program manager to determine how sensitive IMD costs are to the level of fidelity at which the data is required, and determine whether the desired level is affordable. By using information from a sensitivity analysis, a program manager can take certain risk mitigation steps to limit the impact of potential cost drivers.

(U) For a sensitivity analysis to be useful in making informed decisions, however, it must be based on valid assessments of the underlying risks and supported by data. The ranges applied to the cost drivers in the sensitivity analysis should be based on historical data or previous experience where possible, and clearly documented and traceable. Simply varying the cost drivers by applying a subjective plus or minus percentage is not useful and does not constitute a valid sensitivity analysis.

(U) Sensitivity analysis reveals how the cost estimate is affected by a change in a single assumption by changing one assumption or cost driver at a time while holding all other variables constant. This approach helps the customer understand which variables most affect the cost estimate. In some cases, a sensitivity analysis can be conducted to examine the effect of multiple assumptions changing in relation to a specific scenario. (U)

Regardless of whether the analysis is performed on only one cost driver or several within a single scenario, the difference between sensitivity analysis and risk or uncertainty analysis is that sensitivity analysis tries to isolate the effects of changing one variable at a time, while risk or uncertainty analysis examines the effects of many variables changing all at once.

Auditor's Checklist: Sensitivity

- ✓ Was a sensitivity analysis performed?
- ✓ Were cost drivers identified?
- ✓ Were their inputs varied?
- ✓ Were all assumptions and results documented?
- ✓ Were the results presented to decision-makers along with the baseline estimates?

(U) Sensitivity analysis involves recalculating the cost estimate with different quantitative values for selected input values, or parameters, in order to compare the results with the original point estimate. This process can be time consuming, but the ability to identify cost drivers and their impacts on the IMD production effort will enable decision-makers to understand fully the implications of cost, performance, and schedule tradeoffs during the risk assessment phase of the LMDP process. If a small change in the value of a cost element's parameter or assumption yields a large change in the overall cost estimate, the results are considered sensitive to that parameter or assumption. Therefore, a sensitivity analysis can provide helpful information because it highlights elements that are cost sensitive. This type of analysis is typically called a what-if analysis and is often used for optimizing cost estimate parameters.

Sensitivity Factors

(U) Uncertainty about some, if not most, of the IMD requirements is likely to be common early in a program's acquisition lifecycle. Many assumptions made at the start of a program will likely turn out to be inaccurate. Therefore, especially for early cost estimates, once the point estimate has been developed, it is important to determine how sensitive the total cost estimate is to changes in the cost drivers.

(U) Some IMD relevant factors that may be varied in a sensitivity analysis could be:

- A shorter or longer timeline in which to develop the IMD;
- Geographic areas of coverage;
- Required level of fidelity of the data;
- Availability of collection assets;
- Required confidence level in the data;
- Periodicity of required updates.

(U) These are just some examples of potential cost drivers. Many factors that should be tested are determined by the assumptions and requirements parameters outlined in the technical baseline description and GR&As. In addition, the cost estimator should always include in a sensitivity analysis the assumptions that are most likely to change, such as an assumption that was made for lack of knowledge or one that is outside the control of the program office.

Steps in Performing a Sensitivity Analysis

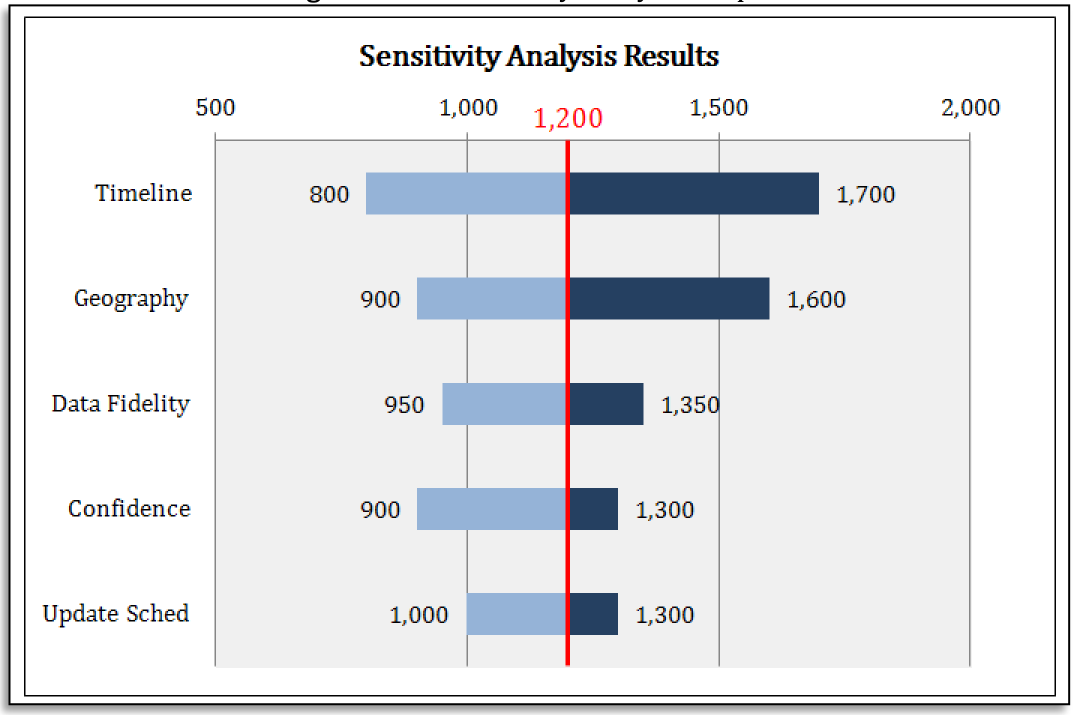
(U) A sensitivity analysis addresses some of the estimating uncertainty by testing discrete assumptions and other factors that could change. By examining each assumption or factor independently, while holding all others constant, the cost estimator can evaluate the results to discover which assumptions or factors most influence the estimate. A sensitivity analysis also requires estimating the high and low uncertainty ranges for significant cost driver input factors.

(U) In order to determine what the key cost drivers are, a cost estimator needs to determine the percentage of total cost that each cost element represents. The major contributing variables within the highest percentage cost elements are the key cost drivers that should be varied in a sensitivity analysis. A credible sensitivity analysis typically has five steps, shown below.

5 Steps for Performing Credible Sensitivity Analysis
1. Identify key cost drivers, ground rules, and assumptions for sensitivity testing.
2. Re-estimate the total cost by choosing one of these cost drivers to vary between two set amounts based on historical data or experience — for example, maximum and minimum or performance thresholds.
3. Document the results.
4. Repeat 2 and 3 until all factors identified in step 1 have been tested independently.
5. Evaluate the results to determine which drivers affect the cost estimate most.

(U) Assumptions and cost drivers that have the most effect on the cost estimate warrant further study to ensure that the best possible value is used for that parameter. If the cost estimate is found to be sensitive to several parameters, all the GR&As should be reviewed, to assure decision makers that sensitive parameters have been carefully investigated and the best possible values have been used in the final point estimate. Figure 3.8.1 is an example of a "tornado chart," one effective way to demonstrate the findings of a sensitivity analysis graphically to facilitate decision-making. A tornado chart demonstrates the high and low variance from the point estimate that could result from each individual cost driver.

Figure 3.8.1: Sensitivity Analysis Graphic



Sensitivity Analysis Benefits

(U) A sensitivity analysis provides a range of costs that span a "best-case" and "worst-case" spread. In general, it is better for decision makers to know the range of potential costs that surround a point estimate and the reasons behind what drives that range than to have just a point estimate from which to make a decision. Sensitivity analysis can provide a clear picture of both the high and low costs that can be expected, with discrete reasons for what drives them.

(U) A sensitivity analysis also reveals critical assumptions and program cost drivers that most affect the results and can sometimes yield surprises. Therefore, the value of sensitivity analysis to decision makers lies in the additional information and understanding it brings to the final decision. Sensitivity analysis can also make for a more traceable estimate by providing ranges around the point estimate, accompanied by specific reasons for why the estimate could vary.

(U) This insight allows the cost estimator and program manager to further examine potential sources of risk and develop ways to mitigate them early. Sensitivity analysis also provides important information for the trade-space analysis that can end in the choice of a different alternative from the original requirements submission.

Key Considerations: Sensitivity Analysis

- ✓ Ensure consistency of tested elements with key ground rules and assumptions.
- ✓ Maintain all other factors constant while testing sensitivity against one element at a time.
- ✓ Sensitivity analysis provides a range of costs that span a "best-case/worst-case" spread.
- ✓ Sensitivity analysis permits decisions that influence design, production, and operation to focus on the elements that have the greatest effects on cost.
- ✓ Outputs of sensitivity analysis should include:
  - ✓ Documented re-estimates for each parameter that is a key cost driver;
  - ✓ Identification of parameters most sensitive to change;
  - ✓ Range of possible costs, point estimate, and method for "what-if" analysis.

3.9 Conduct Risk and Uncertainty Analysis

(U) The purpose of cost risk and uncertainty analysis is to estimate the impact of unknown or potential events and identify what additional resources may be required to meet specified requirements and performance objectives should those events occur. Without risk analysis, a cost estimate would just be a single value, the point estimate, which does not account for the uncertainties inherent in the effort. There are two points to keep in mind when analyzing risk:

- Where is the risk?
- How significant is the risk?

(U) Cost risk and uncertainty analysis identifies the cost, in terms of dollars, time, and materials that should be added to a point estimate to increase the probability of meeting the desired outcome. Risk and uncertainty analysis communicates to decision makers how specific uncertainties contribute to overall cost and schedule risk. Without this analysis, costs and schedules tend to be understated. Ignoring potential uncertainties can cause a program to require additional funds to meet its objectives, or to have to decrease its scope or performance objectives to stay within available funding.

(U) The cost analyst must inform the decision maker about cost and schedule risk. The analyst should present the decision maker with a cost and schedule estimate that has an acceptable confidence level for success when considering the risks. In the end, the decision makers can decide to accept risk; but analysts must ensure decision makers understand the risk they are accepting.

(U) Cost risk and uncertainty refer to the fact that there is always a chance that the actual cost will

Auditor's Checklist: Cost/Risk Uncertainty

- ✓ Was a cost risk/uncertainty analysis performed?
- ✓ Was a confidence interval derived around the point estimate?
- ✓ Did the analysis address requirements uncertainty, including; baseline realism, first time integration, and requirements creep?

differ from the estimate, because a cost estimate is a forecast. Moreover, lack of knowledge about the future is only one possible reason for the difference. Other reasons include the error inherent in using historical data, inconsistencies, faulty assumptions, cost estimating equations, and factors typically used to develop an estimate.

(U) The following resources contain some of the information needed to identify the risks and uncertainties associated with the future of a program.

Cost Risk Identification Resources
✓ Cost Analysis Requirements Description (CARD) ✓ Initial Capabilities Document (ICD) / Capability Development Document (CDD) / Capability Production Document (CPD) ✓ Program's Risk Assessment ✓ Technology Development Strategy ✓ Acquisition Strategy ✓ Analysis of Alternatives ✓ Test and Evaluation Master Plan ✓ Engineers and Subject Matter Experts (SMEs) ✓ Cost and Performance Reports from analogous systems

(U) Recognizing the potential for error and deciding how best to quantify it is the purpose of risk and uncertainty analysis. Adding up the individual most likely WBS elements to derive a program cost estimate (the point estimate) is insufficient, since their sum is not usually the most likely estimate for the total program, even if they are estimated without bias. However, the summing of costs estimated at the detailed level to derive a point estimate is the most common approach to estimating a total program.

(U) Quantifying risk and uncertainty is a cost estimating best practice addressed in many guides and references. DoD specifically directs that uncertainty be identified and quantified. While risk and uncertainty are often used interchangeably, in statistics their definitions are distinct:

- **Risk:** The chance of loss or injury. In a situation that includes favorable and unfavorable events, risk is the probability that an unfavorable event will occur.
- **Uncertainty:** The indefiniteness about the outcome of a situation. It is assessed in cost estimate models to estimate the risk (or probability) that a specific funding level will be exceeded.

(U) While both risk and uncertainty can affect a program's cost estimate, enough data will never be available in most situations to develop a known frequency distribution. In a program's early phases, knowledge about how well technology will perform, whether the estimates are unbiased, and how external events may affect the program is imperfect. For management to make good decisions, the program estimate must reflect the degree of uncertainty, so that decision makers can understand the level of confidence in the estimate and make decisions accordingly.

(U) Establishing quantitative risk and uncertainty analysis for IMD production provides a way to assess the variability in the point estimate. Using this type of analysis, a cost estimator can model such effects as schedules slipping, missions changing, and proposed solutions not meeting user needs, allowing for a known range of potential costs. Establishing a range of costs around a point estimate will be more useful to decision making bodies, because it conveys the level of confidence in achieving the estimated cost and also informs them on cost, schedule, and technical risks.

Addressing Uncertainty in Cost Estimates

(U) The estimating methodology determines which particular elements are subject to risk analysis. For example, if part of Prototype Manufacturing is estimated using a CER to produce a cost estimates for a hardware component, the characteristics of the CER determine how the risk analysis should be done. Any CER will have some variance between predicted costs, and the actual costs in the data from which the CER was generated. This is one element of uncertainty.

(U) Another element of variance (which is much harder to assess), is the applicability of the CER. The data behind the CER will not usually precisely represent the item being estimated. Any difference between the new item, and the items in the data set, creates a source of variance between the CER's prediction, and the actual result. Ideally, this variance should be considered in any risk analysis.

(U) The various parameters in the CER may also be sources of risk or uncertainty. When the duration of a future schedule is used, the possibility of a schedule shift will introduce variance in the CER result; the situation will determine whether it is feasible to estimate the probability distribution of the actual schedule.

Categorizing Uncertainty

(U) The aforementioned examples are only possibilities and the factors which will actually introduce risk and uncertainty depend on the methodology used and on the particular situation. As uncertainties are identified, they can be categorized as either *internal* or *external* to the program.

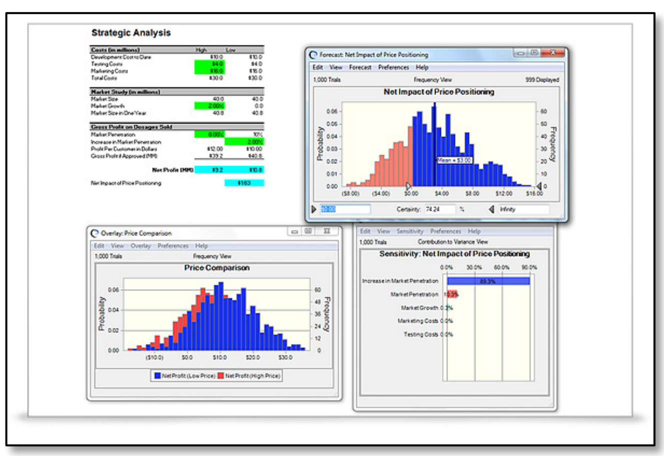
- **Internal elements of uncertainty:** can be represented within an estimate by defining distributions for the estimate's underlying variables.

1. *Technical Variance* is the variation of costs due to the evolution of a new design or approach, which provide a greater level of performance or capability than has previously been demonstrated. This includes all development and implementation of changes, which increase the capabilities of the produced system.
2. *Schedule Variance* is cost variance due to changes in the schedule, derived from technical challenges and issues with whether the program has the correct personnel in place to complete specific tasks on schedule. This variation is especially an issue when a program schedules many interrelated activities concurrently.
3. *Cost Estimating Variance* is the variation of costs from the level predicted by the data and methodologies used. This may be due to variance within the estimate's adjustment factors, cost estimating relationships (CERs), learning curve slopes, estimates done by experts, etc.

- **External elements of uncertainty:** tend to be more difficult to represent by probability distributions. Their impacts are generally examined, using sensitivity analysis.
    1. *Programmatic Variance* relates to issues and events outside of the program's control that can still impact the program's future. Such variance may be caused by program decisions made at higher levels of authority, indirect events affecting the program, or other unforeseen events that are largely unpredictable.
    2. *Requirements Variance* is the variance related to potential changes in system requirements. Some critical parameters of IMD that may fall in this category include anticipated threat systems, geographic areas of coverage, data fidelity, and reprogramming requirements.
    3. *Budget and Economic Variance* is the variance related to future funding and key business assumptions made by the program. Some specific uncertainties in this category are based on changes to future funding levels, supplier viability, inflation indices, and market conditions.

Quantifying Risk

(U) Quantifying risk can be a complex and mathematical process. The following software packages are commonly applied across DoD, and allow the user to input risk distributions and then produce a cost risk and uncertainty analysis.



- **Automated Cost Estimating Integrated Tools – ACEIT** (www.aceit.com): Directly integrated within ACEIT is a simulation-based risk analysis capability (RI$K) that allows the analyst to perform cost, schedule, and technical risk and uncertainty analysis. After running the simulations, the analyst can select the appropriate confidence level and time-phase the risk-adjusted result.

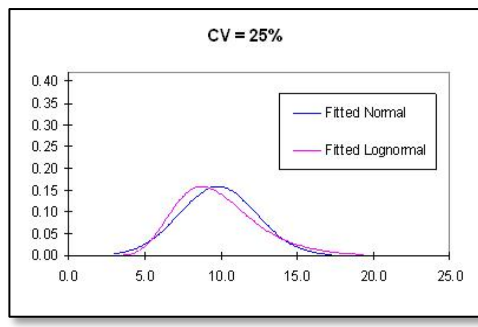
- **@RISK** (www.hearne.com.au): @Risk interfaces with Excel and allows insight into the possible outcomes of an estimate and the likelihood of each particular outcome.
- **Crystal Ball**: Oracle Crystal Ball is the leading spreadsheet-based application for predictive modeling, forecasting, simulation, and optimization. This application gives the analyst insight into the critical factors affecting risk.

(U) Quantifying risk begins with the application of well-defined probability distributions to an estimate. These distributions are used to quantify the range of possible outcomes caused by variance or error in the estimate's variables and CERs. Also, quantifying risk means putting a price on risk, to determine whether a risk is worth taking. To that effect, each software package described in the previous section offers an array of distributions for modeling such risk. Some of the most commonly used distributions are:

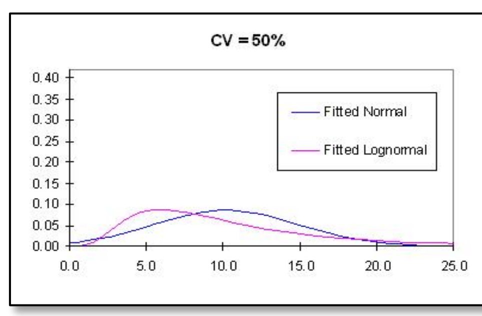
Example: Quantifying Risk

Suppose there is a 25% chance of running over schedule, costing you a $100 out of your own pocket that might be a risk you are willing to take. But if you have a 5% chance of running over schedule, knowing that there is a $10,000 penalty, you might be less willing to take that risk.

- **Uniform Distributions:** Are used when low and high estimates are available, but there is no indication that any point between them is more probable than any other.
- **Triangular Distributions:** Are frequently used in applying risk, since they require only three inputs but are more descriptive than the uniform distribution. A triangular distribution can be skewed or symmetrical, and has its peak at the most likely value (point estimate), with a linear taper on either side to the low and high values.
- **Normal Distributions:** Are characterized by a symmetric single-peak bell curve and are determined by two parameters. The sample mean (point estimate) serves as the center of the curve and the sample standard deviation indicates the spread. As the standard deviation increases, the spread increases. This distribution is more descriptive than the previous two and is most often used to describe the error term around linear CERs. It may also be used when data exhibits sufficient mathematical characteristics of a normal distribution or when such an assumption is otherwise appropriate.
- **Lognormal distributions**: Are used to describe risk for power functions or log-linear CERs. This type of distribution represents data that follows a normal distribution after



Example Normal Distribution



Example Lognormal Distribution

logarithmic transformation. The scaling/sizing parameters of the lognormal distribution are the logarithm of the same parameters of the underlying normal distribution. This distribution is always skewed right; as the standard deviation increases, the skewness increases as well.

Level of Confidence

(U) The level of confidence in the point estimate is the probability that the point estimate will not be exceeded. This guidebook recommends that the cost estimator identify the confidence level (e.g. 80 percent) needed to establish a successful planning process. In addition the estimator must identify uncertainties and develop an allowance to ensure the effects of the uncertainties do not exceed the estimate.

(U) Stemming from the 2009 WSARA, the OSD CAPE requires the disclosure of the confidence levels for baseline estimates for MDAP and MAIS programs. Cost estimates calculated at a confidence level less than 80 percent must provide a justification. By definition, a program estimated at the 80 percent confidence level has an 80 percent probability of coming in at that amount (or less) and a corresponding 20 percent probability of a cost overrun. However, if that same program is estimated at the 50 percent confidence level, it has only a 50 percent probability of coming in at that amount (or less) and may experience cost growth over time. The required confidence level in the estimate represents another paradigm shift in the way the military departments and defense agencies estimate the cost of programs, as setting confidence levels to 80 percent and budgeting to those amounts will drive up acquisition budgets, making cost overruns less likely but also making development programs less affordable. The confidence level statement shall be included in the ADM approving the APB, and in any other cost estimates for MDAPs or MAIS programs prepared in association with the estimates.

Key Considerations: Risk and Uncertainty
✓ Point estimates alone are insufficient for good decisions. ✓ Use uncertainty analysis to model effects such as schedule slippage, mission change, proposed solutions not meeting user needs, and to create a known range of potential costs. ✓ Consider risks early in the process and identify opportunities to collect, quantify, and bound risk-related data throughout the cost estimating process. ✓ Uncertainty should decrease as a program matures – however, more refined requirements often do translate into additional costs – meaning later estimates are generally higher, but bounded within a smaller range of potential costs. ✓ Based on risk/uncertainty analysis, allocate, phase and convert a risk-adjusted cost estimate to then-year dollars and identify high-risk elements. ✓ The recommendations from risk/uncertainty analysis will inform the 4-Step IMD Risk Management Process.

3.10 DOCUMENT THE ESTIMATE

(U) The IMD Cost Estimate Reporting Template (Appendix 5.4) must be used to document all IMD cost estimates for the LMDP. This template has been designed to demonstrate that the estimate was developed using recommended best practices, and to provide all information necessary for decision-makers to have high confidence in the quality and reliability of the estimate. The template format also allows the IMDC to ingest the data efficiently and effectively to perform cross program analysis and identify trends or gaps over time.

(U) When completed properly, the template should describe the cost estimating process, data sources, and methods and should be detailed enough to allow the IMDC, EMOs, or other independent cost estimators to easily understand the process and reconstruct the estimate. The documentation should scope the requirements around which the estimate is built, clearly explain and justify all ground rules and assumptions, provide a detailed WBS, trace all conclusions back to underlying data or calculations, and identify any changes from previous estimates and the reasons for them if applicable. A well-executed IMD cost estimate should convince program officials and decision-makers that the estimate is logical and credible. EMOs will review and validate their respective functional area inputs to each cost estimate.

Key Considerations: Document the Estimate
Does the documentation of the estimate: ✓ Adhere to and fulfill the prescribed template? ✓ Clearly identify and justify all ground rules and assumptions? ✓ Indicate and describe all data sources? ✓ Provide the WBS? ✓ Convince program management that the estimate is logical and credible? ✓ Define the scope of the requirements and analysis? ✓ Provide enough information to facilitate replication by an outside estimator? ✓ Clearly identify risks and uncertainties, and outline a strategy to mitigate them? ✓ Anticipate and answer likely questions about the approach or data used in the estimate? ✓ Provide supporting data that can be used for future estimates or compared across programs?

3.11 PRESENT ESTIMATE FOR APPROVAL

(U) An IMD cost estimate and associated LMDP will not be considered valid until the IMDC, PEO, and involved IMD producers have approved it. The estimate should be presented in the LMDP and Cost Estimate Reporting Template. Since cost estimates are developed to support a budget request or make a decision between competing alternatives, program management must be briefed on how the estimate was developed, including risks associated with the underlying data and methods.

(U) This guidebook suggests that the cost estimator prepare briefing materials with sufficient detail to easily defend the IMD estimate by showing how it is accurate, complete, and high in quality. The briefing should present the documented estimate with an explanation of the program's technical and program baseline.

(U) This approach provides a consistent format to facilitate management understanding of the completeness of the cost estimate, as well as its quality. The cost estimate briefing should succinctly illustrate key points that center on the main cost drivers and the final cost estimate's outcome. The results must be communicated clearly so management has confidence in the ground rules, methods, and results and in the process that was followed to develop the estimate.

3.12 Update Estimate to Reflect Actual Costs

(U) IMD cost estimates must be updated as a program progresses through the acquisition lifecycle milestone process. Program decision-makers will expect that cost estimates will become increasingly precise and accurate as the program and its IMD requirements mature. To facilitate updates and ensure that cost estimates reflect the most recent and accurate data, IMD producers should track and record actual costs as they work through a program's requirements. Actual cost data should reflect and clearly explain any changes from the estimate, such as deviations from the anticipated WBS, different labor or contract rates, increased or decreased time to complete tasks, etc. Where applicable and possible, costs that relate to multiple efforts should be distributed across those efforts as accurately as possible and documented clearly.

(U) In order to update records and develop more accurate and data-based cost estimates, IMD producers should monitor and record costs associated with IMD production, such as, but not limited to:

- Labor rates and hours required to develop IMD;
- Travel and communications;
- Hardware and software; and
- Contractual expertise.

(U) IMD producers should work closely with their budgeting offices to develop effective resource tracking processes, and ensure that they are compliant with acceptable cost accounting procedures. The WBS should serve as a useful starting point for identifying the activities and associated costs that need to be tracked. Use of such tools will increase program confidence in IMD producer accountability for results and resources, and facilitate dialogue about cost-sharing strategies. Additionally, consistent and comparable tracking of costs associated with IMD production over time will increase the quality and defensibility of cost estimates.

(U) In between milestones and LMDPs, IMD producers may also be asked to provide cost estimates for various IMD requirements scenarios. While these estimates may not be prepared as rigorously as those required for LMDPs, having well-documented prior estimates and reliable actual cost data will provide a strong basis for preparing these alternative scenarios quickly while maintaining the credibility of the estimate.

(U) As an effort progresses through acquisition milestones, IMD producers should be able to rely more heavily on actual costs in preparing cost estimates, as they will have completed some of the required IMD production. The USD (AT&L) implementation of "should cost" and Earned Value Management (EVM) provides a data resource of actual costs for MDAPs/MAISs. If IMD Requirements are included, there could be a WBS item to correlate to the IMD LMDP cost updates. Additionally, the Performance Assessment and Root Cause Analyses (PARCA) Group in OUSD(AT&L) has published the Integrated Program Management Report (IPMR) Implementation Guide as of January 28, 2013 to implement the new ACAT program cost report. The Contract Performance Report (CPR) Data Item Description (DID) (81466A) and the IMS DID (81650) have been replaced and consolidated into DID 81861. The EVM and IPMR guides are provided in the Reference section of this document, to help walk users through what is expected to be shown in each format of the new reports. Reliable and auditable actual data will increase the fidelity of later stage cost estimates, both by reflecting expenditures to date and by providing an updated basis for remaining costs.

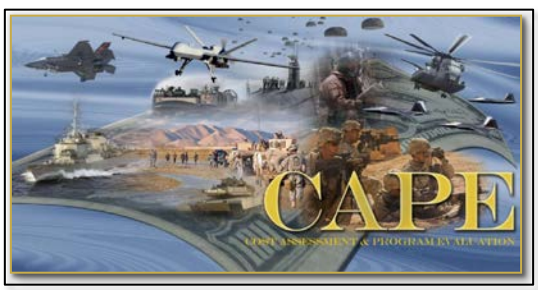
4.0 AGENCY & SERVICE COST ESTIMATING GUIDANCE

(U) Several offices, agencies, and organizations promulgate cost estimating guidance across DoD and the services. Department-wide organizations such as OSD CAPE and ODNI CAIG issue overarching standards and guidance, often derived from specific legislative requirements. Each military service also has an agency or office responsible for cost estimating and analysis that issues specific guidance based on the needs and concerns of the service. Personnel developing cost estimates for IMD should be aware of the unique focus areas or requirements for each service, and be sure to address or incorporate service specific guidance as appropriate in IMD cost estimates. The following sections provide a brief overview of the guidance issued by each organization, as well as resources for further reference.

4.1 DIRECTOR, COST ASSESSMENT AND PROGRAM EVALUATION

Primary Responsibilities

(U) The Director, CAPE (DCAPE) is the principal staff assistant to the Secretary of Defense for cost assessment and program evaluation. The Director's principal responsibilities include analyzing and evaluating plans, programs, and budgets in relation to U.S. defense objectives, projected threats, allied contributions, estimated costs, and resource constraints. OSD CAPE reviews, analyzes and evaluates programs, including classified programs, for executing approved policies. Also, the OSD CAPE provides leadership in developing and promoting improved analytical tools and methods for analyzing national security planning and the allocation of resources and ensures that the costs of DoD programs, including classified programs, are presented accurately and completely. Lastly, the OSD CAPE assesses effects of DoD spending on the U.S. economy, and evaluates alternative policies to ensure that DoD programs can be implemented efficiently.



IMD Cost Estimating Related Roles and Responsibilities

(U) The OSD CAPE is the principal official for independent cost estimation and cost analysis, ensuring that the cost estimation and analysis processes of the DoD provide accurate information and realistic estimates for acquisition programs. Also, the OSD CAPE reviews all cost estimates and cost analyses conducted in connection with MDAPs and MAIS programs. Under DoDD 5250.01, OSD CAPE shall assign appropriate representation to the IMDSSG and IMDOB to provide independent advice to Service Intelligence Centers and Program Offices on IMD costing methodologies.

Costing Guidance and Resources

(U) The OSD CAPE has published two key cost guidance documents:

1. DoD 5000.04-M, Cost Analysis Guidance and Procedures, December 11, 1992

2. Operating and Support Cost Estimating Guide, 2007 (currently under revision)

DoD 5000.04-M, Cost Analysis Guidance and Procedures, 1992

(U) This manual provides guidance on the scope of cost analysis, the analytical methods to be used in preparing cost estimates and the procedures and presentations of the estimates to the OSD CAPE. It provides definitions for seven cost terms and provides an understanding as to how they relate to lifecycle cost categories, work breakdown structure elements and appropriations. This manual applies to OSD, Military Departments, Joint Chiefs of Staff, and Defense Agencies.

Operating and Support Cost Estimating Guide, 2007

(U) The primary purpose of this guide is to review and explain the policies and procedures contained in these documents, focused on the preparation, documentation, and presentation of system O&S cost estimates that are reviewed by the OSD CAPE. A secondary purpose of this guide is to identify and define a set of standard categories of O&S cost elements known as a cost element structure that the military departments may use in making presentations to the OSD CAPE.

Data Sources

(U) OSD CAPE also maintains several data sources and cost estimating tools to assist in preparation of cost estimates. Available through CAPE's website are several tools of potential use:

- **Select and Native Programming Data Input System (SNaP):** SNaP is a mature, web-based application used to collect non-standard program and budget data requirements. OSD CAPE hosts parallel web sites on the SIPRNet and NIPRNet. SNaP runs as an umbrella system that manages data calls for analysts who need data beyond what is contained in the FYDP and the Budget. The SNaP web sites are open for submissions during the POM/BES and President's Budget preparation.
- **Defense Cost and Resource Center (DCARC):** DCARC's primary role is to collect current and historical MDAP and MAIS cost and software resource data in a joint service environment, and make that data available for use by authorized government analysts to estimate the costs of ongoing and future government programs. The DCARC's Defense Automated Cost Information Management System (DACIMS) provides the cost community with instant access to current and historical cost and software resource data needed to develop independent, substantiated estimates. DACIMS is a secure website that allows DoD government cost estimators and analysts to browse through almost 30,000 Contractor Cost Data Reports (CCDR), Software Resources Data Reports (SRDR) and associated documents. It is the largest central repository of DoD cost information available to the cost community. DCARC access is limited to government personnel, and requires an account.
- **Joint Data Support (JDS):** JDS is a library of Department-level data, models, tools, scenarios and analytical baselines (common starting points for analyses in planning, programming, and acquisition)as well as an information exchange with high speed links to Component (Service, Agency, COCOM, Joint Staff, OSD) holdings. JDS

includes links to and descriptions of various modeling and simulation tools used across the cost analysis community.

- **Cost Guidance Portal:** The Cost Guidance Portal provides resources, guidance, and calculators to assist in developing cost estimates. Access to the Cost Guidance Portal requires CAC certificates or PKI.

Points of Contact

(U) The OSD CAPE is comprised of 155 staff which includes a combination of government civilians and military officers and is augmented by contractor support. Questions can be addressed to OSD CAPE at 1800 Defense Pentagon Washington, DC 20301-1800; Phone: 703-695-7945; FAX 703-614-2981. Additional information can be found at http://www.cape.osd.mil/

4.2 Director of National Intelligence, Cost Analysis Improvement Group

Primary Responsibilities

(U) ODNI CAIG leads the IC in independent cost analysis providing consistent and defensible cost estimates supported by in-depth innovative methods that raise the level of cost awareness across the community. ODNI CAIG develops best practices, policies, methods and tools for cost and resource analyses across the intelligence community. ODNI CAIG provides support to development of Independent Cost Estimates (ICE) when IC program development and/or procurement cost is projected to exceed $500 million (current FY dollars). ODNI CAIG conducts cross-program and intra-program resource affordability analyses to assess current and projected funding and issues. Following the completion of an ICE, CAIG provides the results, budget, and explanations of impacts/differences (if required) through Congressional Budget Justification Book (CBJB) submissions.

IMD Cost Estimating Related Roles and Responsibilities

(U) ODNI CAIG ensures that IC program costs are presented accurately and completely. The Associate Director for Systems and Resource Analyses (ADNI/SRA) Office was established to evaluate objectively the effectiveness of multi-year, cross-program investments and to integrate an efficient intelligence planning, programming, and budgeting system that enables effective decisions across programs and missions. SRA provides an adaptive capability to provide independent, credible and pragmatic systems analyses that inform future decisions through balanced, feasible alternatives considered in the context of broad, reasoned requirements. In addition, this group provides cost analyses and trade option assessments for long-range systems analyses and program alternatives. Lastly, SRA conducts ICEs of Agency Cost Positions (ACP) developed by other IC organizations for major acquisition reviews.

Points of Contact

(U) ADNI/SRA assists the ODNI in shaping intelligence capabilities by enabling proactive, balanced, and effective resource decisions on issues of national importance. For direct questions and further information, please contact:

- Phone: 703-725-2500
- Website:http://www.dni.gov/index.php/about/organization/systems-and-resource-analyses-what-we-do

4.3 United States Air Force Cost Analysis Agency

Primary Responsibilities

(U) The Air Force Cost Analysis Agency (AFCAA) performs independent component cost analyses for major space, aircraft, and information system programs. AFCAA assists the Secretary of Air Force and Financial Management Comptroller SAF/FMC in the assessment and review of cost estimates for MDAPs, MAISs and pre-MDAP/MAIS. AFCAA is responsible for providing guidance, analytical support, and quantitative cost-risk analyses to 11 major commands in the Air Force. AFCAA develops Non-Advocate Cost Assessments (NACAs) which are an analysis of program cost/price, schedule, and technical risk, prepared by an organization not directly responsible for the development, acquisition, or support of the program. NACAs are primarily designed to support both the Air Force Corporate Structure (AFCS) and acquisition milestone decision processes, and can range from a simple sufficiency review of an existing estimate to a full ICE.

IMD Cost Estimating Related Roles and Responsibilities

(U) AFCAA performs special studies supporting long-range planning, force structure, Analysis of Alternatives, and life-cycle cost analyses. This support would include the ability to generate cost estimates for IMD requirements to support the DoD's acquisition and intelligence programming processes. Where applicable, AFCAA will provide guidance and policy for Air Force IMD costing, and assist with the cost development process as the independent cost agency.

Costing Guidance and Resources

(U) AFCAA has published two key cost guidance documents:

1. Air Force Cost Risk and Uncertainty Handbook, 2007
2. Air Force Instruction 65-508: Cost Analysis Guidance and Procedures, 2010

Air Force Cost Risk and Uncertainty Handbook, 2007

(U) The CRUH serves as a reference for approved methods, practices, and reporting requirements needed to produce a realistic, defendable cost risk and uncertainty analysis. It provides detailed guidance and definitions useful for cost analysts. The intended audience of the CRUH begins with the junior analyst and extends to seasoned experts. The cost uncertainty analysis process is alternatively viewed as too complicated, mysterious, unreliable or irrelevant. The goal of the CRUH is to define and clearly present straightforward, well-defined processes that are repeatable, defendable, acceptable, and easily understood. The CRUH aims to create a more common understanding of this critical cost estimating activity. The guidance in this handbook should be treated as the core instruction and common frame of reference rather than an absolute treatment of the discipline. Though the primary audience for this document is the Air Force, its approach to cost risk and uncertainty analysis is certainly applicable to cost estimates for other services, and the guidebook is instructive for anyone looking to perform uncertainty analysis.

Air Force Instruction 65-508: Cost Analysis Guidance and Procedures, 2010
(U) This publication is a reissue of Air Force Instruction (AFI) 65-508, dated 1 October 1997. It updates the policy, responsibilities, functions, and relationships associated with Air Force cost estimating. It incorporates major revisions resulting from the reissue of AFPD 65-5 Cost and Economics (5 August 2008) and DoDI 5000.02 (2 Dec 2008), and the issue of the Weapon Systems Acquisition Reform Act (WSARA) (Public Law 111-23).

(U) This instruction implements Air Force cost estimating requirements. The primary change moves the Air Force from focusing on developing cost estimates at acquisition milestones into a comprehensive structure requiring annual cost estimates for all Acquisition Category (ACAT) I, II, and III programs. This ensures that credible and timely estimates are available to inform a broader spectrum of Air Force decision making, in particular, improving and integrating day to day program management decisions, DoD Acquisition processes for MDAPs, and the Planning, Programming, Budgeting, and Execution (PPBE) system. This instruction describes the different types of Air Force cost estimates, the process used to develop cost estimates, and the content and documentation requirements associated with cost estimates, emphasizing collaboration between program office, product/logistics center FMC, and AFCAA cost estimators.

Air Force Manual 65-506: Economic Analysis, SAF/FMC, 2011
(U) This instruction provides information on conducting economic analysis (EA) to support Air Force Management decisions. EA is a method of making a rational decision among competing alternatives.

Points of Contact
(U) For additional information on AFCAA please visit, http://www.saffm.hq.af.mil/

Additional Field Level Cost Organizations
Air Force Lifecycle Management Center, 21st Intelligence Squadron
(U) One of five centers under Air Force Materiel Command, the Air Force Life Cycle Management Center is the single center responsible for total life cycle management of Air Force weapon systems.

Electronic Systems Center
(U) The Acquisition Cost Division supports the Electronic Systems Center by providing independent analysis and verification of electronic systems' cost to the Center's leadership, with a focus on improving the overall quality, objectivity, and credibility of cost estimates. The Cost Division leads the Center's modern, quick-reaction cost tools program and spearheads comprehensive cost training essential to cost analysts and program managers throughout the Center.

Air Force Space Command, Space and Missile Center (SMC)
(U) The Acquisition Cost Division supports cost estimates and cost analyses associated with Air Force Space Command and the Space and Missile Center's mission of satellite acquisition, launch, and control.

Aeronautical Systems Center (ASC)
(U) The ASC Cost and Economics Division is responsible for training, organizing, and equipping the cost analysis workforce at the ASC. This support is accomplished by leading estimates for program milestone decisions, managing the annual cost estimate process, supporting pre-award activities and source selections, and participating in policy discussions resulting in high-quality cost estimates and analysis across the Center

National Reconnaissance Office (NRO) Cost Analysis Improvement Group
(U) The NRO Cost Analysis Improvement Group provides independent cost estimating support to NRO. This support covers milestone decisions; budget submissions, Earned Value Management, ad hoc program support, data collection, methods development, and model/tool development.

4.4 United States Army Deputy Assistant Secretary for Cost and Economics

Primary Responsibilities
(U) The Deputy Assistant Secretary of the Army for Cost and Economics (DASA-CE) is the principal advisor to the Assistant Secretary of the Army (Financial Management and Comptroller) (ASA (FM&C)) on all Army cost and economic analysis activities. Specific duties of the DASA-CE include developing, implementing and directing the U.S. Army Cost and Economic Analysis Program as it relates to all financial management activities, to include establishing cost and economic analysis policies, methods, and procedures. DASA-CE develops statutory ICEs and CCAs of weapon and information systems as well as independent reviews and validation of Business Case Analyses, Economic Analyses, and Special Cost Studies of major weapon and information systems, Force Structure, and Operating and Support costs. DASA-CE also chairs and oversees the Army Cost Review Board, and develops and approves the Army Cost Position for all major Acquisition programs. Additionally, DASA-CE conducts in-depth cost risk analyses of major Army programs, develops policy, and approves all Army cost research efforts and cost model development.

IMD Cost Estimating Related Roles and Responsibilities

(U) The office of the DASA-CE is organized into the Programs and Strategy Directorate, the Acquisition Costing Directorate, and the Cost Review Board Office. The Acquisition Cost Directorate is likely to be the most relevant directorate during the preparation of IMD cost estimates, as it is responsible for developing LCCEs for major Army acquisitions, developing the Army Cost Position, coordinating with OSD CAPE and the PM prior to milestone decisions, and reviewing cost related documents for validity and reasonableness in support of the PPBE process. Within the Acquisition Costing Directorate are the Weapons Systems Costing Division, the C4ISR Division, and the Cost Policy and Research Division. The Weapons System Division is responsible for costing and reviews related to weapons systems, while the C4ISR division is responsible for MAISs and Communications-Electronics Systems. The Cost Policy and Research Division can serve as a valuable resource for Army costing information, as it is responsible for developing, distributing, and providing training on cost analysis models and tools; collecting and configuring cost data, cost factors, and CERs as inputs to databases for use with cost analysis tools; developing policy; and providing guidance and oversight of cost research efforts and cost model development.

Costing Guidance and Resources

(U) DASA-CE has published three key cost guidance documents:

1. U.S. Army Cost Analysis Handbook (CAH), 2010
2. U.S. Army Economic Analysis Manual (EAM), 2010
3. U.S. Army Cost Benefit Analysis Guide (CBAG), v2.01, 2011

U.S. Army Cost Analysis Handbook

(U) The CAH was prepared by the Cost Policy and Research Division of the Acquisition Costing Directorate. The Army CAH provides methods, techniques and procedures for preparing Army cost estimates. The Army CAH contains current and relevant subject matter, such as: fully-detailed information regarding the cost analysis process; procedures for preparing an Analysis of Alternatives (AoA); information in order to prepare estimates for Pre-Milestone A and Capability Costing; a thorough explanation of the software cost estimating process; cost risk analysis as applied to Army cost estimates; and applications of business case analysis and cost management.

(U) The CAH contains specific guidance on costing for Analysis of Alternatives (Section 5), Operations and Support (O&S) Costing (Section 6), Lean Six Sigma application (Section 7), Pre-Milestone A and Capabilities Costing (Section 9), Cost Risk Analysis (Section 12), CARD Guidance (Section 13), and Business Case Analysis (Section 15). This specific guidance should be applied for all IMD cost estimates for Army programs, to ensure that IMD estimates are compatible with and complementary to other program costing.

(U) Additionally, the CAH includes information on cost estimating tools licensed by the Army, which may be available to those conducting IMD cost estimates for Army programs. DASA-CE has also developed a web-based cost estimating system, the Joint Integrated

Analysis Tool (JIAT). JIAT facilitates seamless linkages between cost estimating tools, engineering design models, capability/performance data, modeling and simulation tools and operations and support databases. In its current phase, JIAT has integrated commercial cost estimating tools and all of DASA-CE's databases, which include Automated Cost Databases (ACDBs) for Aircraft and Unmanned Aerial Systems, Communication Electronics, Wheeled and Track Vehicles, and Missiles and Munitions. Additional information regarding JIAT and other Army cost estimating tools are located in the CAH or at : http://asafm.army.mil/offices/CE/Jiat.aspx?OfficeCode=1400.

U.S. Army Economic Analysis Manual

(U) The Economic Analysis (EA) manual provides guidance to analysts who prepare or review EA's in support of the decision making process. The manual provides a basic framework for implementing the policies of EA concepts, methods and procedures, and applies to all Army proponents preparing EA's. The manual describes the EA process, provides information on identifying and quantifying program benefits, identifies methods of comparing alternatives, and gives examples of quantitative techniques. Information for handing sensitivity, risk and uncertainty is also provided.

U.S. Army Cost Benefit Analysis Guide

(U) The purpose of the *Cost Benefit Analysis* (CBA) *Guide* is to assist Army analysts and agencies in preparing CBAs to support Army decision makers. Based on a structured process, the guide assists analysts in identifying, quantifying, and evaluating the future costs and benefits of alternative solutions. It also assists in identifying the optimum course of action for decision-making purposes. The CBA Guide outlines an eight-step process to conduct a cost-benefit analysis, applicable to a wide range of requirements, issues, tasks, and problems that require a deliberate analysis to arrive at the optimum course of action. Understanding the Army's cost-benefit analysis requirements and decision-making framework will help IMD cost estimators prepare estimates that facilitate this process during the risk assessment and COA development phase of the LMDP.

Cost and Performance Portal

(U) The Cost and Performance Portal (CPP) program is run by DASA-CE and helps Army organizations with cost estimating, modeling, metric development, performance tracking and process automation. Its mission is to support effective cost and performance management in the Army, to promote visibility and transparency into Army spending and operations, and to promote an organizational culture that maximizes cost effectiveness. The CPP consolidates data from disparate data sources, configures reporting and analytical tools, creates data models and automates processes for users throughout the Army. The CPP is Common Access Card (CAC) enabled and is accessible with an AKO account at:
https://cpp.army.mil/portal/page/portal/Cost_Performance_Portal/CPP_Home_Page.

Points of Contact

(U) As the proponent for the Army's Cost and Economic Analysis Program, DASA-CE is available to provide advice and aid. Questions may be addressed to Director, Acquisition Costing Directorate, ODASA-CE, ATTN: SAFM-CEA, 1421 Jefferson Davis Highway, Suite

9000, Arlington, VA 22202-3259, phone (703) 601-4200 or DSN 329-4200. Additional information is available on the ASA(FM&C) home page (http://asafm.army.mil).

Additional Field Level Cost Organizations

TACOM Life Cycle Management Command (LCMC)

(U) The TACOM LCMC cost organization is responsible for preparation of program office estimates; lifecycle cost estimates, economic analyses, and combat effectiveness modeling that support the development of combat and tactical vehicles.

Aviation and Missile Life Cycle Management Command (AMCOM)

(U) The AMCOM cost organization provides cost estimation and analysis support to Aviation, Missiles and Space Program Executive Offices and their Program/Project Offices. It manages the AMCOM Cost Analysis Program and develops, updates, or obtains Cost Estimating Relationships, cost factors, and mathematical and computerized cost models for estimating purposes. It develops cost estimates to support AoAs, tradeoff studies, and force structure cost estimates. It develops and prepares life-cycle cost estimates, and it conducts other related studies in support of weapon systems cost analysis. It performs cost risk analyses and cost risk assessments to support weapon systems program decisions. It also provides validation and review of cost estimates, economic analyses, and business case analyses.

4.5 UNITED STATES NAVY NAVAL CENTER FOR COST ANALYSIS

Primary Responsibilities

(U) The Naval Center for Cost Analysis (NCCA) advises the Secretary of the Navy, Chief of Naval Operations, and Commandant of the Marine Corps on cost and economic issues. The Deputy Assistant Secretary of the Navy for Cost and Economics (DASN-CE), within the Assistant Secretary of the Navy for Financial Management and Comptroller, is dual-hatted as the Director of NCCA. NCCA is the lead cost center for the Navy and provides support to cost community issues relating to policy and implementation. Its mission is: to guide, direct and strengthen cost analysis within the Department of the Navy; to ensure the preparation of credible cost estimates of the resources required to develop, procure and operate military systems and forces in support of planning, programming, budgeting and acquisition management; and to perform such other functions and tasks as may be directed by higher authority. Specific functions include developing independent cost estimates and assessments for Acquisition Category I and IA programs and preparing Service Cost Positions to inform the Milestone Decision Authority.

IMD Cost Estimating Related Roles and Responsibilities

(U) NCAA is organized into six divisions, most of which may be relevant to the development of IMD cost estimates. Three divisions are responsible for conducting independent cost estimates and assessments for ACAT IA, IC, and ID programs – the IT Estimating Division (MAISs and C4ISR programs), the Aviation and USMC Division (aircraft, aviation weapons, and USMC), and the Ships and Weapons Division (combatant ships, submarines, and auxiliary weapons systems). Personnel conducting IMD cost estimates for Navy ACAT IA, IC, and ID programs should coordinate with the appropriate offices to ensure open communication and common understanding of the IMD requirements and mission set.

(U) Additionally, the Economics and Special Analysis Division provides direction for economic and business case analyses at the enterprise level for the Department of the Navy. This division advises Department of the Navy leadership on critical issues related to the allocation of scarce resources required to satisfy a broad and dynamic spectrum of military requirements. As IMD producers, EMOs, and the IMDC identify common, cross-program IMD requirements, this office may be helpful in determining IMD development and cost-sharing strategies that maximize investment dollars across the Navy portfolio.

(U) Finally, the Cost Research and Tools Division conducts cost research that addresses the needs of the Navy cost community. This division is responsible for improving costing capability through development and enhancement of databases, costing models, and costing methodologies. It also liaises with other Navy activities, OSD, and other services to promote joint cost research efforts and foster transfer of knowledge resulting from cost research. This division can serve as a valuable resource for IMD cost estimators as they seek relevant data and cost models to assist in developing IMD estimates.

Costing Guidance and Resources

(U) NCCA has produced two key cost guidance documents:

1. Department of the Navy Cost Estimating Guide, 2010
2. Cost Analysis Requirements Description Outline and Instructions

Department of the Navy Cost Estimating Guide

(U)This document provides overarching guidance for developing Navy cost estimates. This guide presents a six step process that aligns with other cost guidance, including the GAO Cost Estimating and Assessment Guide. The guidebook contains useful information on key stakeholders in Navy costing, data sources, approval processes, and tools and resources. It is available at:
https://www.ncca.navy.mil/references/DON_Cost_Estimating_Guide.pdf.

Cost Analysis Requirements Description (CARD) Outline and Instructions

(U) This guide provides best practices for developing and submitting a high-quality CARD that will be compliant with DoDD 5000.4. This guide can be a useful resource in preparing IMD cost estimates as it provides context for how the IMD cost estimate will be incorporated into the CARD.

Tools and Data Sources

(U) Additionally, NCCA makes several useful cost estimating tools and resources available on its website at: https://www.ncca.navy.mil/tools/tools.cfm. Tools include an Excel-based S-Curve tool to assist in risk and uncertainty analysis, a discount rate calculator, and Navy approved inflation indices. Also available on the NCCA website with appropriate credentials are the:

- Joint Cost Analysis and Research Database (JCARD);
- Collaborative Cost Research Library System (CCRLS);
- Navy and Marine Corps Visibility and Management of Operating and Support Costs (VAMOSC);
- Operating and Support Cost Analysis Model; and
- Manpower Cost Estimating Tool for Enhanced Online Reporting (METEOR).

(U) JCARD is a web information system that aids in improving efficiency, credibility and capability of cost analysis within the DoD community through the use of shared resources, data, knowledge and expertise. JCARD is a joint effort among NCCA, NAVAIR, and AFCAA that intends to create a single information bridge between cost analysts and the DoD authoritative sources for Unclassified//For Official Use Only cost, technical and programmatic data. NCCA maintains the CCRLS, which contains a variety of cost analysis related publications and resources. The Navy and Marine Corps VAMOSC is the management information system that collects and reports Navy and USMC historical O&S costs. The Operating and Support Cost Analysis Model is a family of models for various platform types (e.g. Ship, Air, Land) designed to estimate O&S costs based on historical data. Finally, METEOR provides life cycle cost analysis of active duty personnel attached to Navy platforms. Though some of these resources may not be directly applicable to IMD cost estimate development, they can provide sources of data and useful examples of cost models that may be adapted to the IMD problem set.

Points of Contact

(U) The NCCA can be reached at: Naval Center for Cost Analysis, 1000 Navy Pentagon, Room 4C449 (NCCA), Washington, DC 20350-1000; Phone: (703) 692-4899 (DSN): 222-4899.

Additional Field Level Cost Organizations

Naval Air Systems Command (NAVAIR)

(U) The Cost Department of the Naval Air Systems Command provides a wide variety of cost analysis products and services. Its primary focus is to provide a clear and comprehensive understanding of lifecycle cost and attendant uncertainties to be used in developing, acquiring, and supporting affordable naval aviation systems. Besides life-cycle cost estimates, the Cost Department provides source selection cost evaluation support, earned value management analysis, cost research, databases, and various cost/benefit studies.

Naval Sea Systems Command (NAVSEA)

(U) The Cost Engineering and Industrial Analysis Division of NAVSEA provides cost engineering and industrial base analysis for ships, ship-related combat systems, and weapons. It provides cost estimates in support of the Defense Acquisition Board review process, including AoA studies. It also participates in contract proposal evaluations and the source selection process for builders and suppliers of ships and weapon systems, and it conducts analysis and forecasting of labor, industrial, and technical trends as they affect the overall acquisition of ships, combat systems, weapons, and other equipment. The focus of the cost research program within NAVSEA is O&S cost estimating; Total Ownership Cost estimating; commonality and standardization of ship design and construction processes, as well as ship components or subassemblies (impact on acquisition and O&S costs); how build strategy affects ship costs; ship design trade-off analysis tools; and ship and weapon system cost modeling.

Naval Surface Warfare Center (NSWC)

(U) The Cost Analysis Group resides within the Warfare Analysis Branch of the Requirements Analysis and Advanced Concepts Division of the Warfare Systems Department at the Naval Surface Warfare Center, Dahlgren Division. The Cost Analysis Group produces cost estimates, cost-risk assessments, and affordability analyses for Combat Systems. The Group also develops cost-estimating methodology in support of systems development and production, AoAs, and strategic planning. Particular areas of expertise include model development and maintenance, cost-research databases, technology assessments, life-cycle cost estimates, budget and force-level analyses, performance-based cost models, product oriented cost models, proposal evaluation, and source selection reviews.

5.0 APPENDICES

5.1 GLOSSARY/TERMS

Acquisition: A term used within the DoD to denote the aggregation of efforts to develop, produce and provide a weapon or other system to the user. The acquisition process includes the conceptualization, initiation, design, development, test, contracting, production, deployment, and logistic support, modification, and disposal of weapon and other systems, supplies, or services (including construction) required to satisfy DoD needs, and intended for use in or in support of military missions.

Actual Cost Method: Uses actual cost data from earlier/previous units, prototypes, or production lots of a system (not a similar system, as in the analogy method) to estimate future costs of the same system.

Analogy Method: Estimates the cost of a new item by starting with the cost of one or more similar existing items, then modifying this cost to take into account the differences between the old item and the new item.

Assumption: A supposition on the current situation or a presupposition on the future course of events, either or both assumed to be true in the absence of positive proof. Assumptions are necessary in the process of planning, scheduling, estimating, and budgeting

Characteristics and Performance: All-source derived assessments of foreign military system capabilities and physical attributes.

Constant Year Dollars: This phase is always associated with a base year and reflects the dollar "purchasing power" for that year. An estimate is in constant dollars when prior-year costs are adjusted to reflect the level of prices of the base year, and future costs are estimated without inflation. A cost estimate is expressed in "constant dollars" when the effect of changes in the purchasing power of the dollar (inflation) has been removed.

Cost Element: An identifiable function, or a common group of functions, which have been established as a separate entity for the purpose of estimating, collecting, controlling, and reporting contract costs. Cost elements often include functional area groupings (i.e., Engineering, manufacturing, test, etc.), Acquisition Phase categories (i.e., development, production, operating and support, etc.), or types of cost (i.e., labor, material, overhead, etc.).

Cost Element Structure: A unit of costs to perform a task or to acquire an item. The cost estimated may be a single value or a range of values.

Development Cost: is the cost of all research and development-related activities, contract and in-house, necessary to design and test the system. It includes a number of WBS elements, including Prime Mission Equipment, Support Equipment, Training, etc. Prototypes and test articles are included in this cost category. Development costs are funded with only the RDT&E appropriation and are included only in the R&D cost category.

Discount Rate: The interest rate used to discount future costs and benefits, in order to arrive at present values based on the time value of money. The time value of money adjusts cash flow to reflect the increased value of money when invested. The time value of money also reflects that benefits and costs are worth more if they are realized earlier.

Element-specific GR&As: Are driven by each WBS element's detailed requirements.

Engineering Method: Builds an estimate from the "bottom up" by analyzing the individual elements of the WBS for the direct costs of accomplishing the work then adding appropriate amounts for indirect costs (for example, plant overhead, company overhead, etc.).

EWIR Data: All-source derived data describing observed and assessed radio frequency parametric data. The EWIR database includes threat, neutral military, and friendly and commercial system mission data.

Geospatial Intelligence (GEOINT): The exploitation and analysis of imagery and geospatial information to describe, assess, and visually depict physical features and geographically referenced activities on the Earth. GEOINT consists of imagery, imagery intelligence, and geospatial information (section 467 of Title 10, USC). GEOINT collection encompasses all aspects of: literal, infrared (IR), and synthetic aperture radar (SAR) imagery; overhead persistent infrared capabilities; and geospatial information and services. The terms imagery intelligence and advanced geospatial intelligence are encompassed within this definition of GEOINT. GEOINT includes the exploitation and analysis of electro-optical, IR, and radar imagery; and of geospatial, spectral, laser, IR, radiometric, SAR phase history, polarimetric, spatial, and temporal data. It employs all ancillary data, signature information, and fused data products, as necessary. Integrated GEOINT products may also include data and information from collateral sources.

Global GR&As: Apply to the entire IMD cost estimate (e.g. 5-Year Design Phase, FY12 OSD inflation indices are used to calculate inflation)

Ground rules: Represent a common set of agreed on estimating standards that provide guidance and minimize conflicts in definitions. When conditions are directed, they become the ground rules by which the team will conduct the estimate.

Inflation: The proportionate rate of change in the general price level, as opposed to the proportionate increase in a specific price. (Source OMB A94 Appendix A)

Intelligence Mission Data: DoD intelligence used for programming platform mission systems in development, testing, operations, and sustainment including, but not limited to, the functional areas of signatures, EWIR, OOB, C&P, and GEOINT.

IMD-dependent programs: Any acquisition programs that will require IMD (e.g., programs that carry out combat identification, ISR, and targeting using, but not limited to, signatures, EWIR, OOB, C&P and GEOINT.)

IMD Management: The management of mission data production and costing, storage, maintenance, and dissemination processes to achieve the highest degree of efficiency and effectiveness in response to validated DoD requirements.

Life-Cycle Cost: includes all WBS elements, all appropriations, and all cost categories. It is the sum of Program Acquisition Cost, Operating and Support Cost, and Disposal Cost for a system.

Lifecycle Mission Data Plan: A statement of program needs that is applied throughout the life of an IMD-dependent acquisition program and potentially influences programmatic decisions based on the availability of IMD over the life of the program.

Order of Battle: The identification, command structure, strength, and disposition of personnel, equipment, and units of an armed force.

Operating and Support Costs: Are funded primarily with the O&M and Military Personnel appropriations. However, RDT&E, Procurement, and/or MILCON appropriations may also be used, as appropriate, based on the nature of the effort, after the weapon system has been deployed. This category includes all costs for personnel, equipment, and supplies associated with operating, modifying, maintaining and supporting a weapon system in the DoD inventory. This includes all direct and indirect costs. These costs do not include any of the development costs, procurement costs or any other part of the program acquisition costs for the weapon system, nor do they include any disposal costs for the weapon system.

Parametric Method: Uses regression analysis of a database of several similar systems to develop a line or curve described by a mathematical equation that fits as closely as possible to the data.

Risk: The chance of loss or injury. In a situation that includes favorable and unfavorable events, risk is the probability that an unfavorable event will occur.

Risk Management: The process that identifies, analyzes, and mitigates risks to capabilities due to gaps in IMD availability.

Schedule: A time-frame for the work to assist in understanding how escalation was applied. The schedule should reflect the same technical scope and cost as the estimate.

Sensitivity Analysis: describes the effect of changing key cost drivers and assumptions independently.

Signature: A distinctive characteristic or set of characteristics that consistently recurs and identifies a piece of equipment, material, activity, individual, or event such as a radio frequency or acoustic characteristics.

Then-Year Dollars: Dollars that are escalated into the time period of performance of a contract. This is sometimes referred to as escalated costs, inflated costs, or real-year dollars.

Uncertainty: The indefiniteness about the outcome of a situation. It is assessed in cost estimate models to estimate the risk (or probability) that a specific funding level will be exceeded.

Weapon System Cost: is funded completely from the Procurement appropriations. It is the procurement counterpart of Development Cost in that it contains the same WBS elements as Development Cost. Weapon System Cost consists of the Flyaway Cost plus the additional WBS elements

5.2 REFERENCES AND RESOURCES

(U) Below lists key sources of information and resources which were either used to generate content material for the IMD Cost Methodology Guidebook include or provide additional resource instruction.

National Level Guidance

- GAO Cost Estimating and Assessment Guide," 2009
- Intelligence Community Directive 105,"Acquisition," 2006
- Intelligence Community Directive 109, "Independent Cost Estimates," 2010
- The Defense Acquisition System, May 12, 2003 (DoDD 5000.01)
- Operation of the Defense Acquisition System, December 8, 2008 (DoDI 5000.02)
- Cost Analysis Guidance and Procedures, December 11, 1992 (DoD 5000.4-M)
- Cost and Software Data Reporting (CSDR) Manual, April 18, 2007 (DoD 5000.04-M-1)
- DoD Standard: Work Breakdown Structures for Defense Material Items, October 3, 2011 (MIL-STD-881C)
- Defense Acquisition Guidebook 2012
- Economic Analysis (Major Automated Information System (MAIS))
- Joint Memorandum on Savings Related to "Should Cost", April 22, 2011 (USD(AT&L) and USD(C/CFO))
- Improving Milestone Process Effectiveness Memo, June 23, 2011
- DoD CAIG O & S Cost Estimating Guide, October 2007
- DoD Directive 5105.05.84, Director of Cost Assessment and Program Evaluation (DCAPE), May 2012
- Sections 139a, 181, 2306b, 2334, 2366a, 2366b, 2433a, 2434, and 2445c of title 10, United States Code
- Public Law 111-23, "Weapon Systems Acquisition Reform Act of 2009," May 22, 2009
- DoD Instruction 5025.01, "DoD Directives Program," October 28, 2007 Section 415a-1 of title 50, United States Code
- DoD Directive 8260.05, "Support for Strategic Analysis (SSA)," July 7, 2011
- (U) DoD Directive 5205.07, "Special Access Program (SAP) Policy," July 1, 2010
- DoD Instruction 8910.01, "Information Collection and Reporting," March 6, 2007
- DoD Instruction 5545.02, "DoD Policy for Congressional Authorization and Appropriations Reporting Requirements," December 19, 2008
- DoD 5000.4-M, Cost Analysis Guidance and Procedures, December 1992
- National Defense Budget Estimates FY 2012
- Geospatial Intelligence in Joint Operations, 2012
- Better Buying Power Fact Sheet, 2012
- Cost Estimating Guidance, Department of Energy 2011
- Memorandum Better Buying Power: Guidance for Obtaining Greater Efficiency and Productivity in Defense Spending, 2010
- Defense Acquisition University, Teaching Note Cost Estimating Methods, 2011

Service Level

- Department of the Navy Cost Analysis, December 03, 2012 (SECNAVINST 5223.2A)
- Establishment and Review of Department of the Navy Independent Cost Estimates for Acquisition Category's IC and IA Programs, December 03, 2012 (SECNAVINST 5420.196A)
- Department of the Navy Cost Estimating Guide
- Department of the Navy Service Cost Positions Memo, January 7, 2010 ((ASN(RD&A) and ASN(FM&C))
- Department of the Navy Implementation and Operation of the Defense Acquisition System and the Joint Capabilities Integration and Development System, September 1, 2011 (SECNAVINST 5000.2E)
- Implementation of Should Cost Management Memo, July 19, 2011 (ASN(RD&A))
- Required Signed and Documented Component-level Cost Position for Milestone Reviews Memo, March 12, 2009
- Department of the Navy Cost Analysis, December 03, 2012 (SECNAVINST 5223.2A)
- Establishment and Review of Department of the Navy Independent Cost Estimates for Acquisition Category's IC and IA Programs, December 03, 2012 (SECNAVINST 5420.196A)
- Department of the Navy Cost Estimating Guide 2005
- Department of the Navy Service Cost Positions Memo, January 7, 2010 ((ASN(RD&A) and ASN(FM&C))
- Department of the Navy Implementation and Operation of the Defense Acquisition System and the Joint Capabilities Integration and Development System, September 1, 2011 (SECNAVINST 5000.2E)
- Air Force Instruction (AFI) 10-601, Operational Capability Requirements Development
- Air Force Acquisition Intelligence Guidance, Version 2.0, August 2012
- Air Force Cost/Risk and Uncertainty Handbook, July 2007
- US Army Cost Analysis Handbook, February, 2010
- US Army Cost Benefit Analysis Guide, 2010
- Navy inflation rates: https://www.ncca.navy.mil/services/inflation.cfm
- Army inflation rates: http://cost.tacom.army.mil/inflation_disc.htm
- Air Force inflation rates: SAF/FMC on the Air Force portal

DAU and Industry Cost Analysis Training and Resources

ACQ 101 Fundamentals of Systems Acquisition Management: This course provides a broad overview of the DoD systems acquisition process, covering all phases of acquisition. It introduces the Joint Capabilities Integration and Development System; the planning, programming, budgeting, and execution process; DoD 5000-series policy documents; and current issues in systems acquisition management. Designed for individuals who have little or no experience in DoD acquisition management, this course has proven very useful to personnel in headquarters, program management, and functional or support offices.

ACQ 201 Intermediate Systems Acquisition Management: Intermediate Systems Acquisition, Part A, uses computer-based training to prepare mid-level acquisition professionals to work in integrated product teams by providing an overview of systems acquisition principles and processes. Both ACQ 201A and ACQ 201B are required for DAWIA certification.

BCF 103 Fundamentals of Business Financial Management: Using interactive, computer-based training, professionals will develop the skills necessary for formulating and executing a program office budget. Topics covered in this course include cost analysis; funding policies; the DoD planning, programming, budgeting, and execution process; the congressional enactment process; and the budget execution process.

BCF 106 Fundamentals of Cost Analysis: Professionals are introduced to policies and techniques that are used for the preparation of system cost estimates, including DoD estimating requirements and guidance, estimate use and structure, analogy estimates, parametric estimating, improvement curves, inflation, risk, economic analysis, and software cost estimating. Through practical exercises, professionals gain the opportunity to apply the policies and techniques to real-world examples.

ICEAA Cost Estimating Body of Knowledge Modules

1. Cost Estimating Basics
2. Costing Techniques
3. Parametric Estimating
4. Data Collection & Normalization
5. Inflation & Index Numbers
6. Basic Data Analysis
7. Learning Curve Analysis
8. Regression Analysis
9. Cost & Schedule Risk Analysis
10. Probability & Statistics
11. Manufacturing Cost Estimating
12. Software Cost Estimating
13. Economic Analysis
14. Contract Pricing
15. Earned Value Management
16. Cost Management (TOC/CAIV/Tgt. Cost/ABC)

DoD Cost Analysis Sites and Systems

- Select & Native Programming Data Input System (SNaP)
- Defense Cost and Resource Center (DCARC)
- Defense Employment and Purchases Projection System (DEEPS)
- FSM (FYDP Structure Management System)
- Joint Data Support (JDS)
- Defense Economics Large Internet File Transfer (LIFT)
- DoD Cost Guidance Portal

5.3 IPT Charter, Abstract, and Participants

(U) Integrated Project Team Charter: Cost Methodology Guidebook

Descriptions and Charter Summary	
ACTION	As directed by the Office of the Undersecretary of Defense (Intelligence) (OUSD(I)), and required by Department of Defense Instruction (DODI) 5250.01X, the Intelligence Mission Data Center (IMDC) and Intelligence Mission Data (IMD) functional area stakeholders will develop an Intelligence Mission Data (IMD) Cost Guidebook to guide IMD producers in developing cost estimates for IMD requirements.
PROBLEM STATEMENT	Department of Defense Directive (DoDD) 5250.01x requires that "a standardized and transparent data costing methodology for each functional area shall be used by all IMD producers," yet no such methodology exists. The IMD producer and consumer communities must develop agreed upon and DoD standard-compliant cost estimating methodologies to enable effective and transparent IMD cost estimates.
DESCRIPTION	The DIA Signature Support Program (DIA/SSP), acting on behalf of the Intelligence Mission Data Center (IMDC), will lead an Integrated Project Team (IPT) including representatives from USD(I), the Service Intelligence Centers, Service Acquisition Community, DIA, and IMD Producer Community to develop an IMD Cost Guidebook. The IPT will develop and draft a guide that delineates approved, common approaches and transparent methodologies for estimating the costs of developing and maintaining IMD, in accordance with OSD Cost Assessment Program Evaluation (CAPE) and ODNI Cost Analysis Improvement Group (CAIG) approved standards and processes. The IPT will support current DODI 5250 Working Group efforts to codify standards, identifying requirements for cost estimation techniques related to the collection, processing, exploitation, or dissemination of available and potentially available IMD as required by DoDD 5250.01x. The IPT will research and identify cost estimating difficulties and best practices within the IMD producer and consumer communities; examine and leverage existing DoD costing material sources; engage with OSD CAPE for guidance and support on costing methodologies; and raise identified issues and potential solutions outside the scope of the IPT to the appropriately empowered sponsors. The IPT will meet (generally via teleconference or video-teleconference) bi-weekly to review materials and discuss issues. Membership of the IPT will consist of sufficiently empowered individuals at the GS-13/14/15 level, military officers, or contractors where appropriate.
SCOPE & BENEFITS	The scope of the IPT is to review, validate, document, and approve guidelines for costing methodologies and incorporate them into an IMD Costing Guidebook. The scope of the IPT also includes coordinating with other elements of the DODI 5250 Working Group as required to ensure a consistent and integrated approach to cost estimating issues. At a minimum, the resulting IMD Costing Guidebook will: • Facilitate and support development of costing methodologies for each IMD functional area identified in DoDD 5250.01x by providing clear standards

<table>
<tr><td></td><td colspan="3">and guidelines;
• Serve as a reference for consistent and validated approaches to costing techniques and data management;
• Provide guidance and best practices to improve estimating methodologies, data management strategies, and estimation management processes.
• Provide guidance on how to integrate cost estimates into Lifecycle Mission Data Plans (LMDPs)
• Maintain a “living and flexible” format which can be evolved over time
• Recommend cost training and education for cost estimators (e.g. Defense Acquisition University).
Benefits of creating a viable, stakeholder validated IMD Costing Guidebook include:
• Compliance with DoDD 5250.01x requirements;
• Development of consistent, transparent, best-practice-based, and repeatable methods for creating high-quality, credible IMD cost estimates;
• Improvement of information exchange between IMD producers, consumers, policymakers;
• Improvement of quality of cost estimates, leading to higher cost standards and improved long-term planning;
• Ability to compare and analyze cost estimates over time to identify best practices, areas of improvement.</td></tr>
<tr><td>RISK & CONSTRAINTS</td><td colspan="3">Documented risk and constraints which will be mitigated include:
• Required level of participation by IPT membership and commitment to schedule.
• Consistent support from OSD CAPE throughout guidebook development.
• Ability to synchronize DOD cost policy with evolving IMD requirements.</td></tr>
<tr><td rowspan="2">ACTIVITIES, TIMELINE, & DELIVERABLES</td><th>Key Activities</th><th>Task Duration</th><th>Deliverable</th></tr>
<tr><td>1. Development
• Identify IPT members; establish IPT weekly meeting agendas
• Identify data and source materials; determine consistent terminology
• Formulate structure/outline of document
2. Analysis and Production
• Identify, define, and document cost methodologies, best practices from CAPE, IMD Producers, industry standards
• Analyze and define advantages, limitations, trade-offs of methodologies
• Data gathering, analysis, and</td><td>August-September 2012
(weekly IPT)

September-October 2012

October-</td><td>IMD Cost Guidebook Outline

IMD Cost Guidebook Draft V1</td></tr>
</table>

	reporting strategies are identified • Draft Cost Guidebook 3. Implementation • Coordinate draft Cost Guidebook with DoDI 5250.01x stakeholders; secure appropriate approval • Review/refresh cost methodologies annually • Document lessons learned	November2012	IMD Cost Guidebook Final

(U) **OVERVIEW:** Directed by Office of the Undersecretary of Defense (Intelligence) (OUSD(I)), and required by Department of Defense Instruction (DODI) 5250.01, the DIA Signature Support Program (SSP) to author the IMD Cost Guidebook in order to aid IMD producers in developing cost estimates for IMD requirements. The guidebook is a supplemental reference to the "Cost Methodology Section", per Department of Defense Instruction (DODI) 5250.01, and supports DoDIC costing initiatives/requirements to be followed by IMD stakeholders. Also, it will support continual updates, considered a" living document, "distribution available upon request.

(U) **INTEGRATED PROJECT TEAM (IPT):** In September, an IPT was formed with representation from OUSD(I), Service Intelligence Centers, DoD Acquisition and Intel Community, Cost Service Centers, GAO and IMD Producer Community to facilitate the development of a drafted guidebook. The scope is to review, validate, document, and approve guidelines for costing methodologies and incorporate them into the guidebook. Meetings will occur throughout the year, delineating common costing approaches and transparent methodologies for costing IMD requirements. All efforts are in accordance with OSD Cost Assessment Program Evaluation (CAPE) and ODNI Cost Analysis Improvement Group (CAIG) approved standards and processes.

(U) **BACKGROUND:** Department of Defense Directive (DoDD) 5250.01" Management of IMD in DoD Acquisitions" governs IMD oversight requirements through the Defense Intelligence Enterprise. IMD is defined through the Directive, as the intelligence used for programming mission systems in development, testing, operations, and sustainment phases but not limited to, the following functional areas: Signatures, EWIR, OB, Characteristics and Performance, and GEOINT. Currently, costs associated with acquiring IMD are not included in existing acquisition program cost estimates. The capture of IMD requirements must occur early in system development lifecycles, through directive guidance IMD dependent programs will now include the cost of technical IMD in the overall program costs, and further the guidebook is the first step to enable this process. Further, the guidebook is intended for individuals who are qualified to prepare a cost estimate and will serve as a primer for future Intel cost reporting. Furthermore, the guide will:

Stakeholders and Participants
OUSD(I), OSD AT&L, DIA, NGA, NASIC, NGIC, MSIC, NMIC, AFMC/IS, AFMC/ OAS, AFMC A2, GAO, AFCCA, NAVSEA, J28, Army G2

- Establishing a costing methodology process for identified IMD functional areas through applicable DoD-wide acquisition/intelligence policy and guidance
  - Provide common cost factors and reference to consistent approaches for costing techniques and data management, LMDP integration
- Identify DoD Acquisition lifecycle phases and costing requirements for IMD Dependent Systems
  - Determine cost/risk trade space levels, used for senior decision making purposes (i.e. JROC/DAB)

- Facilitate engagement/collaboration channels with IMD community stakeholders
    - Identify data sources and availability, risks, cost drivers, and capability impacts across programs
    - Centralize cost methods, cross-program analysis, and realistic cost savings/efficiency opportunities
    - Provide shortfall and costing gaps, present findings to Intelligence Mission Data Oversight Board (IMDOB) and Intelligence Mission Data Senior Steering Group (IMDSSG) for action across Defense Intelligence Enterprise

5.4 Overview of Cost Estimating Steps

(U) The GAO Cost Estimating Process consists of 12 steps, with each step building upon each other to develop and complete the cost estimate. Each of the 12 steps is important for ensuring that high-quality cost estimates are delivered in time to support important decisions.

Step 1: Define Estimate Purpose and Scope	**Step 2: Develop Estimating Plan**
• Identify IMD that is currently potentially available but technically feasible to produce. • Inform affordability analysis of acquisition intelligence requirements and capabilities against costs. • Reveal opportunities for cost savings and cost sharing in IMD production and acquisition efforts.	• Assemble a multidisciplinary team with functional skills. • Develop the master schedule. • Determine who or which EMO will conduct the independent cost estimate. • Outline the cost estimating approach and develop the estimate timeline.
Step 3: Define the IMD Requirements	**Step 4: Determine the Estimating Structure**
• Determine the appropriate specificity of IMD requirements for the program or effort's level of maturity and development. • IMD producers will identify available, potentially available, and unobtainable requirements. • IMD producers, the IMDC, EMOs, and acquisition effort sponsors should agree on the potentially available IMD requirements and the scope of the cost estimate.	• Describe the level lower system characteristics, configuration, quality factors, operational concept, and the risks associated with the system. • Select estimating method for each WBS element. • Define a WBS and describe each element in a WBS dictionary. • Identify potential cross-checks for likely cost and schedule drivers. • Develop an IMD cost estimating checklist.
Step 5: Identify Ground Rules and Assumptions	**Step 6: Obtain Data**
• Identify global GR&As that apply to the entire estimate and determine which ones carry most risk. • Identify assumptions related to O&S (e.g. periodicity, level of effort) for both available and potentially available IMD. • Collaborate with the IMDC and EMOs to identify existing data or processes to be leveraged during GR&A development. • Identify any schedule or budget constraints, inflation assumptions, and miscellaneous costs. • Understand technology refresh cycles, technology assumptions, and be development. • Define commonality with legacy systems and presumed cost savings.	• Create a data collection plan with emphasis on collecting current and relevant technical, programmatic, cost, and risk data. • Collect data and normalize them for cost accounting, inflation, learning, and quantity adjustments. • Analyze the data for cost drivers, trends, and outliers. • Compare results against rules of thumb and standard factors derived from historical data. • Interview data sources and document all pertinent information. • Maintain historical cost data.

Step 7: Develop the Point Estimate	Step 8: Sensitivity Analysis
• Develop the cost model by estimating each Work Breakdown Structure (WBS) element, using the best methodology, from the data collected. • Include all estimating assumptions in the cost model. • Add WBS elements to develop the point estimate. • Validate the estimate by looking for errors like double counting and omitted costs. • Perform cross-checks on cost drivers to see if results are similar. • Update the model as more data become available or as changes occur and compare results against previous estimates.	• Test the sensitivity of cost elements to changes in estimating input values and key assumptions. • Identify effects on the overall estimate of changing the program schedule or quantities. • Determine which assumptions are key cost drivers and which cost elements are affected most by changes. • Ensure consistency of tested elements with key ground rules and assumptions. • Sensitivity analysis provides a range of costs that span a "best-case/worst-case" spread and reveals the range of possible costs, point estimate, and method for "what-if" analysis. • Sensitivity analysis permits decisions that influence design, production, and operation to focus on the elements that have the greatest effects on cost.
Step 9: Conduct Risk & Uncertainty Analysis	**Step 10: Document the Estimate**
• Determine and discuss with technical experts the level of cost, schedule, and technical risk associated with each WBS element. • Analyze each risk for its severity and probability. • Develop minimum, most likely, and maximum ranges for each risk element. • Determine type of risk distributions and reason for their use. • Ensure that risks are correlated. • Use an acceptable statistical analysis method (e.g., Monte Carlo simulation) to develop a confidence interval around the point estimate. • Identify the amount of contingency funding and add this to the point estimate to determine the risk-adjusted cost estimate. • Recommend that the project or program office develop a risk management plan to track and mitigate risks.	• Document all steps used to develop the IMD cost estimate. • Document the purpose of the estimate, the team that prepared it, and who approved the estimate and on what date. • Document ground rules/assumptions. • Include auditable and traceable data sources for each cost element and document for all data sources how the data were normalized. • Describe in detail the estimating methodology and rationale used to derive each WBS element cost. • Describe the results of the risk, uncertainty, and sensitivity analyses and whether any contingency funds were identified. • Track how this estimate compares to any previous estimates.
Step 11: Present the Estimate for Approval	**Step 12: Update the Estimate to Reflect Actual Cost**
• Develop a briefing that presents the documented life-cycle cost estimate. • Focus on the largest cost elements and drivers. • Make the content clear and complete so that those who are unfamiliar with it can easily comprehend the competence that underlies the estimate results. • Act on and document feedback from management. • Request acceptance of the estimate.	• Update the estimate to reflect changes in technical or program assumptions or keep it current as the program passes through new phases or milestones. • Report progress on meeting cost and schedule estimates. • Document lessons learned for elements whose actual costs or schedules differ from the estimate. • Document all changes to the program and how they affect the cost estimate.

5.5 Cost Estimating Reporting Templates

(U) The IMD cost estimate reporting templates to be included with the LMDP are attached to this document.

IMD COST ESTIMATE TEMPLATE AND INSTRUCTIONS

IMD COST ESTIMATE [PROGRAM NAME]

Submitted in accordance with Department of Defense Instruction (DODI) 5250.01, and the IMD Cost Estimating Methodology Guidebook.

IMD Cost Estimate Releasability: This IMD Cost Estimate is releasable to other DoD entities and may be posted on appropriate IMD-related sites to promote sharing of IMD, and to facilitate cross-program analysis for potential efficiencies and cost savings.

TABLE OF CONTENTS

1.0 EXECUTIVE SUMMARY

(U) The executive summary should provide a concise overview of the cost estimate results, including information about the key identified cost drivers and risk areas. The summary should also present a time phased display of the total estimate in constant and current year dollars. Identify any recommended contingency adjustments in order to reach the desired confidence level, and explain how the contingency adjustment should be applied to the point estimate. If this estimate is an update from a previous version, the breakout should also identify any actual costs incurred to date, changes from the prior estimate and provide an explanation and any lessons learned.

[Program Name] IMD Requirements Cost Estimate							[$Total]
	FYXX	FYXX	FYXX	FYXX	FYXX	FYXX-XX	Total
[Signatures]							[$Risk Adjusted Estimate]
[EWIR]							[$Risk Adjusted Estimate]
[Order of Battle]							[Etc.]
[Characteristics and Performance]							
[GEOINT]							

(U) The executive summary should also include a brief discussion of the key ground rules and assumptions underpinning the estimate and identify the data sources used in compiling the estimate.

(U) The executive summary should also include a brief discussion of the results of the sensitivity analysis and the factors that will have the greatest impact on the overall costs. This paragraph should also indicate the level of uncertainty of the estimate, and identify any recommended contingency adjustments.

2.0 INTRODUCTION

(U) The introduction should include:

- The name, service, milestone, and POCs of the program for which the estimate is being provided;
- The agencies and specific organizations that prepared/contributed to the cost estimate;
- The timeframe over which the estimate was prepared;
- Whether the estimate is the first for this program, or an update;
- A description of the estimate's scope, including what the estimate includes and does not include, with reasons
- A description of the ground rules and assumptions, such as timelines, inflation rates, availability of technical resources, etc.
- Identification of the sources of data used in the estimate, along with any limitations of or concerns about the data so

3.0 POTENTIALLY AVAILABLE IMD REQUIREMENTS

(U) This paragraph should include an overview of the IMD requirements included in the cost estimate – identifying all IMD functional areas with requirements. Provide a characterization of the IMD requirements – consider the following questions:

- What percentage/proportion of total requested IMD is potentially available?
- Is there a particular functional area with the preponderance of requirements?
- Are there particular mission capabilities or threats driving the IMD requirements?
- Are there technical factors, such as the level of data fidelity required, that are driving the requirements?

In the following sections, include only those sections/functional areas for which the cost estimate includes requirements.

3.1 SIGNATURES

(U) This section should include a narrative overview of the potentially available IMD that is included in the estimate. This section should include general descriptions of the requirements (e.g. "spectral signatures for X, Y, Z threat systems") and the estimated timelines to produce the various elements. Use language and tables from the LMDP where possible or appropriate. The full IMD requirements submission for this functional area from the LMDP, with identification of the potentially available requirements, should be included as an Appendix and referenced here.

3.2 ELECTRONIC WARFARE INTEGRATED REPROGRAMMING (EWIR)

(U) This section should include a narrative overview of the potentially available IMD that is included in the estimate. This section should include general descriptions of the requirements (e.g. "radar cross sections of ground targets") and the estimated timelines to produce the various elements. Use language and tables from the LMDP where possible or appropriate. The full IMD requirements submission for this functional area from the LMDP, with identification of the potentially available requirements, should be included as an Appendix and referenced here.

3.3 ORDER OF BATTLE (OOB)

(U) This section should include a narrative overview of the potentially available IMD that is included in the estimate. This section should include general descriptions of the requirements and the estimated timelines to produce the various elements. Use language and tables from the LMDP where possible or appropriate. The full IMD requirements submission for this functional area from the LMDP, with identification of the potentially available requirements, should be included as an Appendix and referenced here.

3.4 CHARACTERISTICS AND PERFORMANCE (C&P)

(U) This section should include a narrative overview of the potentially available IMD that is included in the estimate. This section should include general descriptions of the requirements (e.g. "key parameters of X, Y, Z threat systems") and the estimated timelines to produce the various elements. Use language and tables from the LMDP where possible or appropriate. The full IMD requirements submission for this functional area from the LMDP, with identification of the potentially available requirements, should be included as an Appendix and referenced here.

3.5 GEOINT

(U) This section should include a narrative overview of the potentially available IMD that is included in the estimate. This section should include general descriptions of the requirements (e.g. “elevation data for X region”) and the estimated timelines to produce the various elements. Use language and tables from the LMDP where possible or appropriate. The full IMD requirements submission for this functional area from the LMDP, with identification of the potentially available requirements, should be included as an Appendix and referenced here.

4.0 WBS ELEMENTS AND POINT ESTIMATE

(U) This section provides the bulk of the documentation for the cost estimate. The opening paragraph should provide a narrative explanation of how the overall point estimate was developed, identifying the major WBS elements and all data sources and estimating methodologies used. In the below table, provide individual fiscal year costs throughout the development phase, and one total cost estimate for O&S costs in the second-to-last column.

[Program Name] IMD Requirements Cost Estimate							[$Total]
	FYXX	FYXX	FYXX	FYXX	FYXX	FYXX-XX	Total
[Signatures]							[$Point Estimate]
[EWIR]							[$Point Estimate]
[Order of Battle]							[Etc.]
[Characteristics and Performance]							
[GEOINT]							

4.1 SIGNATURES POINT ESTIMATE:

SIGNATURES POINT ESTIMATE							[$Total]
	FYXX	FYXX	FYXX	FYXX	FYXX	FYXX-XX	Total
WBS Element #1							[$Point Estimate]
WBS Element #2							[$Point Estimate]
[Etc.]							[Etc.]

(U) This section should identify which IMD producer is responsible for producing and preparing the cost estimate for each major WBS element.

(U) Provide any global ground rules and assumptions, with justification, for items such as:

- direct and indirect labor rates,
- labor hours,
- material and subcontractor costs,
- overhead rates,
- learning curves,
- inflation indexes and factors.

Again, use tables or charts where appropriate or illustrative.

(U) Identify and discuss any identified cost drivers for the overall estimate. Describe any cross-checks performed to validate the estimate.

4.1.2 [WBS Element #1]

[WBS Element #1]							[$Total]
	FYXX	FYXX	FYXX	FYXX	FYXX	FYXX-XX	Total
[Sub-element #1]							[$Point Estimate]
[Sub-element #1]							[$Point Estimate]
[Etc.]							[Etc.]

(U) This section should provide a brief Description of WBS Element #1 including an overview of the task/requirement and associated subtasks/elements, down to the lowest level at which individual cost estimates were produced. It should provide an overview of the various data sources and costing methodologies used to derive the total cost estimate for the element. Detailed information on the sub-element calculations should be provided in the sub-sections, with the most detail provided on the lowest level at which individual cost estimates were produced. In the above table, provide individual fiscal year costs throughout the development phase, and one total cost estimate for O&S costs.

4.1.2.1 [Sub-Element #1]

(U) For each of these sections, repeat and expand as necessary to encompass all elements of the WBS.

(U) This section should provide a detailed description of the data and methodology used to derive the cost estimate for the sub-element. Include all assumptions used to develop estimates for this sub-element, including O&S costs, and provide the rationale for the assumptions. Identify all data sources used and describe the data in sufficient detail to create confidence in its validity and relevance. Describe in detail and with justification any modifications or adjustments made to the data to normalize it or to account for differences between the historical data and the current problem set. Identify and describe any models used in preparation of the cost estimate. Fully document any identified cost estimating relationships, including the rationale for the relationship between cost and the independent variable and any analysis or statistics supporting the relationship. Where necessary, include detailed documentation and calculations (e.g. MSExcel spreadsheets) as additional data in the appendices.

(U) For the cost estimating methodology used, provide sufficient information to justify use of the methodology and explain how it was applied in developing the cost estimate. For example, if the estimate relies upon an analogy, describe the characteristics of the other project that make it a viable analogy, and describe any adjustments or factors applied. For a parametric approach, describe judgments about the parametric variables and how they were determined. For an engineering based estimate, describe the engineering approach and associated costs in sufficient detail to create understanding. For an actuals based assumption, provide the source of the data.

4.2 EWIR Point Estimate:

EWIR POINT ESTIMATE							[$Total]
	FYXX	FYXX	FYXX	FYXX	FYXX	FYXX-XX	Total
WBS Element #1							[$Point Estimate]
WBS Element #2							[$Point Estimate]
[Etc.]							[Etc.]

(U) For each functional area, repeat the introduction/WBS element/WBS sub-element structure outlined above as required to capture all activities for which cost estimates were developed.

4.3 OOB Point Estimate:

OOB POINT ESTIMATE							[$Total]
	FYXX	FYXX	FYXX	FYXX	FYXX	FYXX-XX	Total
WBS Element #1							[$Point Estimate]
WBS Element #2							[$Point Estimate]
[Etc.]							[Etc.]

(U) For each functional area, repeat the introduction/WBS element/WBS sub-element structure outlined above as required to capture all activities for which cost estimates were developed.

4.4 C&P Point Estimate:

C&P POINT ESTIMATE							[$Total]
	FYXX	FYXX	FYXX	FYXX	FYXX	FYXX-	Total

						XX	
WBS Element #1							[$Point Estimate]
WBS Element #2							[$Point Estimate]
[Etc.]							[Etc.]

(U) For each functional area, repeat the introduction/WBS element/WBS sub-element structure outlined above as required to capture all activities for which cost estimates were developed.

4.5 GEOINT POINT ESTIMATE:

GEOINT POINT ESTIMATE							**[$Total]**
	FYXX	FYXX	FYXX	FYXX	FYXX	FYXX-XX	Total
WBS Element #1							[$Point Estimate]
WBS Element #2							[$Point Estimate]
[Etc.]							[Etc.]

(U) For each functional area, repeat the introduction/WBS element/WBS sub-element structure outlined above as required to capture all activities for which cost estimates were developed.

5.0 SENSITIVITY ANALYSIS

(U) In this section, identify key factors and assumptions that will have a significant impact on the cost estimate should they prove to be incorrect. Provide a summary of the findings in the introductory paragraph, and then provide more details in the subsections for each factor.

5.1 Key Cost Driver #1

(U) Provide the range of input values considered for this factor, and the rationale behind the range. Indicate the upper and lower bounds of the cost estimate when this value is changed, demonstrating the impact graphically if possible. Provide a monitoring and risk management strategy to mitigate potential cost increases resulting from this factor.

5.2 Key Cost Driver #2

(U) Repeat this section as necessary.

6.0 RISK AND UNCERTAINTY ANALYSIS

(U) The introduction to the risk and uncertainty analysis should identify the factors that present the greatest risk to the cost estimate, and provide an overview of the mitigation strategies. Provide a brief discussion of the analytic approaches used to assess and quantify risk. Identify any significant dependencies between factors that compound risk. Identify the confidence level in the point estimate, and provide any recommended adjustment or contingency factors that would increase the confidence level. If this cost estimate is an update, identify whether any new risks have been identified and why. Also indicate performance against previously identified risk factors, and identify any risk factors that have come to pass.

6.1 RISK FACTORS AND PROBABILITY DISTRIBUTIONS

6.1.1 [Risk Factor #1]

(U) Describe the risk factor and the WBS elements it will affect. Provide the range of cost estimates for the best, worst, and most likely scenarios. Describe the assumptions, data, and analytic processes used to arrive at these estimates. Identify whether there are dependencies associated with the WBS elements affected by this risk factor, and describe the dependency and anticipated cost impact on all elements if so. Identify any strategies to mitigate negative cost impacts that could result from this risk.

(U) Include any relevant or illustrative charts, such as probability distributions. If available, provide any background data or calculations (such as SME interviews, results of any Delphi sessions, analytic hierarchy modeling, risk scoring, etc.) as appendices to the cost estimate.

6.1.2 [Risk Factor #2]

(U) Repeat the above as required to document all risk factors and associated WBS element cost probabilities.

6.2 UNCERTAINTY ANALYSIS AND CONFIDENCE FACTOR

(U) Describe the process and all supporting data used to determine the probability range for the cost estimate. Identify the confidence level in the point estimate, based on the probability analysis, as well as the maximum and minimum ranges. If available, provide the S-curve associated with the probability distribution, and demonstrate where the point estimate falls, as well as the values associated with any desired confidence levels.

6.3 RECOMMENDED CONTINGENCY ADJUSTMENTS

(U) Based on the uncertainty analysis, identify any recommended contingency adjustments to ensure that the cost estimate falls within a certain confidence level. Provide the basis for the contingency factor and any calculations that were used to derive it.

7.0 CONCLUSIONS & RECOMMENDATIONS

(U) In this section, provide the overall adjusted IMD cost estimate, based on the point estimate, sensitivity analysis, and risk and uncertainty analysis. Present the time phased display of the cost estimate, in current and then-year dollars.

[Program Name] IMD Requirements Cost Estimate							[$Total]
	FYXX	FYXX	FYXX	FYXX	FYXX	FYXX-XX	Total
[Signatures]							[$Risk Adjusted Estimate]
[EWIR]							[$Risk Adjusted Estimate]
[Order of Battle]							[Etc.]
[Characteristics and Performance]							
[GEOINT]							

(U) If over the course of the analysis, IMD providers have identified any alternative courses of action or alternative IMD production strategies that would affect the cost estimate, present those courses of action here, with their own cost estimates, supported by the data and analysis in the previous sections. Identify the advantages and disadvantages of any of these alternatives, and provide a recommendation if appropriate.

8.0 IMDC COMMENTS

(U) In this section, the IMDC will provide its comments on the cost estimate, and certify that it has been conducted in accordance with the IMD Cost Estimating Methodology Guidebook procedures, and functional area costing guidebooks as appropriate.

(U) The IMDC will also provide any recommendations related to IMD production and costs, based on cross-program analysis. If applicable, the IMDC will identify any other acquisition efforts with the same or similar IMD requirements and opportunities for cost-sharing.

APPENDICES

Suggested Appendices include:

- Data Sources – links to data sources, explanation of how data was used in the cost estimate.
- Full results of sensitivity and risk and uncertainty analysis – explanation of how factors and ranges were determined, inclusion of results that proved to be insignificant.