Analysis of Alternatives (AoA) Handbook

A Practical Guide to Analyses of Alternatives

July 2008

Office of Aerospace Studies
Air Force Materiel Command (AFMC) OAS/A9
1655 1st Street SE
Kirtland AFB, NM 87117-5522
(505)-846-8322, DSN 246-8322
www.oas.kirtland.af.mil

AoA Handbook Contents

Preface

The Analysis of Alternatives (AoA) Handbook is produced by the Air Force Materiel Command's Office of Aerospace Studies (OAS). OAS is designated the Air Force Center of Expertise (CoE) for AoAs. This handbook embodies the Air Force's current guidance for planning and executing Air Force and Air Force-led AoAs within the Department of Defense (DOD) acquisition process. This handbook is revised frequently to reflect any major evolution in the frequently changing acquisition and capabilities/requirements processes. As changes occur, the individual chapters are updated to reflect the latest analysis techniques and regulatory requirements required to support acquisition efforts. We'd like to hear what you think about the AoA Handbook, especially if you have suggestions for improvements in organization, accuracy, and/or content. **Note:** At the most recent printing of this handbook (June 2008), the DoD 5000 series documents and JCIDS documents were undergoing updates. When these updates are complete, this handbook will be revised again to reflect changes. Even though we do not know what the changes will be, there are some expectations we want to address here.

(1) The actual terms Functional Area Analysis (FAA), Functional Needs Analysis (FNA), and Functional Solutions Analysis (FSA) may go away or be subsumed in the term Capabilities Based Analysis (CBA). There may also be some shifting of the Capabilities/Requirements/Acquisition timeline and exactly where the analyses fall on that timeline. As these new terms are formalized we will change the terminology we use and update ***Figure 2-2 JCIDS-CBA Flow and Resulting Documents*** as needed.

(2) The division between examining material and non-material solutions might shift and/or refocus a little. Some of the early OSD decision points may be modified in time and/or scope, and an additional early decision point added to affirm the need for a material development.

(3) In section ***5.3 Scenarios and Threats*** the term ***Defense Planning Guidance*** is no longer the correct term, however checking with the scenario community there is no replacement term agreed to yet. We will search/replace the new term once it is decided upon.

In all three of these cases the names and timing may change but the underlying issues of what makes good decision support analysis remains the same. As you read this handbook, focus on what issues need to be addressed, how to decompose the tasks, and the fundamental flow of the work as a whole. You will still need to show the relative military utility of the options, you will still need to develop cost estimates, you will still need to manage a diverse team of people with different issues and concerns, and you will still need to consider the resultant consequences of the different alternatives on the logistics, C4, and ISR infrastructures. Focus on those difficult analysis issues and the nomenclature and timing will be easy.

About OAS

OAS provides guidance, technical, analytical, and costing support to the operational commands, Air Force Materiel Command (AFMC), and the Air Staff in planning, conducting, and reviewing AoAs and related studies supporting acquisition decisions. In addition, OAS supports the major commands (MAJCOMs) and AFMC product centers with analytical investigations and evaluations of systems and related issues. For additional information, visit the OAS web site at (http://www.oas.kirtland.af.mil).

1 – Introduction

There are three processes in the DOD that work in concert to deliver the capabilities required by the warfighters: the requirements process, the acquisition process, and the Planning, Programming Budgeting and Execution (PPBE) process.

During the requirements process, the Joint Capabilities Integration and Development System (JCIDS) is initiated and executed through a capabilities based assessment (CBA). The CBA utilizes a Functional Area Analysis (FAA) to determine necessary warfighting capabilities, a Functional Needs Analysis (FNA) to determine the capability gaps, and a Functional Solution Analysis (FSA) to determine the best approaches at achieving the capabilities and closing the gaps. In some cases where there are known or identified shortfalls or gaps in operational capabilities, the acquisition community will look to new acquisitions that can eliminate the shortfalls at the earliest possible date. The JCIDS CBA efforts should be completed prior to the beginning of the AoA.

Within the DOD systems acquisition process, there are multiple milestones and decision points. At any acquisition milestone or decision point, a new system can be initiated, continued, revised, or cancelled. The acquisition process involves a number of acquisition phases following the milestones and/or decision points in which the development of the program proceeds.

The PPBE system is an integrated DOD system developed for the establishment, maintenance, execution, and revision of the DOD budget system. DOD budget issues are heavily impacted by the AoA process.

AoAs are essential elements of these three systems. AoAs are an important element of the defense requirements and acquisition processes and as such, the Office of the Secretary of Defense (OSD) is demonstrating increased involvement and oversight in AoA activities. In the Air Force, the AoA has taken on an increasingly important role in determining whether or not a system should be procured and if so, what would be the nature of the technologies and capabilities available for acquisition. Air Force AoAs must not only make a case for having identified the most cost-effective alternative(s), they must also make a compelling statement about the capabilities and military worth that acquiring those alternative(s) will provide. In short, the AoA has become an important vehicle to provide information that can be used by senior Air Force leaders to debate and assess a potential program's operational capability and affordability. Consequently, AoA data has a great impact on the DOD PPBE process.

An AoA is an analytical comparison of the operational effectiveness, cost, and risks of proposed materiel solutions to gaps and shortfalls in operational capability. AoAs document the rationale for identifying and recommending a preferred solution or solutions to the identified shortfall(s). Threat changes, deficiencies, advances in technology or the obsolescence of existing systems can trigger an AoA. This handbook deals with Air Force-specific AoAs and those Joint AoAs where the Air Force is designated as the lead service.

The current DOD Acquisition process identifies the Office of Secretary of Defense Program Analysis and Evaluation's (OSD/PA&E's) role in the AoA process. Their role will be addressed further in the next chapter. Likewise, the Joint Staff has a defined role through the Functional Control Board (FCB) review of Initial Capabilities Documents (ICDs).

Other services have their own processes for executing AoAs. When the Air Force is directed to support an AoA led by another service, the Air Force will follow the lead service's procedures and guidance. The Air Force's direct involvement in the lead service's process will ensure that Air Force interests are considered and addressed in the AoA. Likewise, for AoAs

where the Air Force is identified as the lead service, it is imperative that the Air Force openly support and defend the supporting service's issues and concerns.

When directed, AoAs are normally required and tasked as part of the acquisition process for identified programs. For other programs, AoAs may be downward directed because they are Joint, Service, or Command special interest or have congressional visibility.

1.1. Purpose of the AoA

AoAs help justify the need for starting, stopping, or continuing an acquisition program. They are done because decision makers need reliable, objective assessments of the options for providing required capabilities. AoAs identify potentially viable solutions and provide comparative cost, effectiveness, and risk assessments of each solution to a baseline; this baseline is typically the current operating system.

AoAs are a big factor in selecting a final solution, but they aren't the only factor. The final decision must consider not only cost-effectiveness, risk, and military worth, but also domestic policy, foreign policy, technological maturity of the solution, the environment, the budget, treaties, and a host of additional factors. AoAs also provide a foundation for developing operational requirements, concepts of operational employment, a test and evaluation strategy for the preferred alternative(s), and additional information for the program office when and if one is formed.

1.2. Who Looks at AoAs?

AoAs influence the investment of very large sums of defense funds. As a result, they receive multi-layered direction and oversight from start to finish. This direction and oversight is necessary to achieve a credible AoA and subsequent buy-in of the results and findings. AoA results are usually briefed at high levels in the Air Force and the OSD, and are used in the decision making process to support acquisition of new capabilities and systems for the warfighters. The nature of an AoA will also reveal understanding and insights into the needed operational capabilities in order to accomplish the desired military effects.

1.3. The AoA Study Team

A study director leads the study team performing the AoA. The director is normally appointed from the Air Force command (operational user) that is designated as the lead for the AoA. The study director forms the study team—as appropriate—from members of the Command, other Air Force commands, Air Force Agencies, the Army, Navy and Marines, DOD, civilian government agencies, and contractors.

Not all study teams will be identical, either in size or makeup of members. Each team should be tailored based on the inherent nature of the AoA to be accomplished, along with the time and money available to complete the AoA. The study team is organized along functional lines to consider identification of alternatives, threats and scenarios, effectiveness, risk, and cost. Small AoA teams with dedicated full-time members, working at a common location, are often better able to react to the timeline demands of the AoA tasking, and may be more productive.

The Air Force Materiel Command's (AFMC's) Office of Aerospace Studies (OAS) helps by supplying an assistant to the study director. This assistant provides help in planning, administering, executing, and facilitating the accomplishment of the AoA and required reviews. OAS has been designated Air Force AoA Center of Expertise (CoE) and is focused on ensuring quality, consistency, and value in Air Force AoAs.

1.4. AoA Products

Most AoAs produce four major products:

- A study plan which defines the background, goals, methodology, tools, schedule, etc. of the AoA
- A midterm progress briefing to summarize early work and future plans
- A final report to document the AoA in detail
- A final briefing to summarize the final results of the AoA

The study plan is important because it defines what will be accomplished during the AoA and how it will be done. Consequently, the study plan is critical to the AoA process.

The midterm briefing is designed to provide an interim progress report of the study results and to permit redirection of the AoA by senior reviewers, if necessary.

The Final Report is the repository for AoA information describing what and how the AoA was accomplished and the results or findings from the analysis process. It will require significant time and effort to produce. The Final Report should include detailed descriptions of the alternatives, threats, cost documentation, final analysis results, and so forth. It is important to remember that soon after the study is concluded, team members start to disburse; therefore it is important to document what is learned throughout the process. This should reflect changes when they occur during the study in areas like threat, computer models, measures of effectiveness (MoEs), methodology, and criteria for selection, as well as the analysis results. If the final report is not accomplished soon after the analysis is accomplished, there may be little to show for what was accomplished during the AoA. "**A study not documented is just as good as a study not done."**

The final briefing carries the most impact, and hence generates the most interest, because it addresses what was found and the implication of the findings to the decision maker(s).

2 – Support to Decision Making

2.1. The Defense Acquisition Management Framework

The Defense Acquisition System is structured to manage the nation's investments in technologies, programs, and product support which allows the achievement of National Security Strategy and support for the United States Armed Forces. This investment strategy is structured to support today's force and forces of the future.

The main purpose of the DOD acquisition system is to acquire quality products that satisfy the user's needs with measurable improvements to mission capability and operational support in a timely manner and at a fair and reasonable price. AoAs are critical analyses that support the DOD acquisition process. DOD acquisition guidance is outlined in DODD 5000.1 and DODI 5000.2. The DOD acquisition system is built on policies that provide for "Flexibility, Responsiveness, Innovation, Discipline, and Streamlined and Effective Management"; other more detailed policy can be found in DODD 5000.1, at https://akss.dau.mil/dapc/index.aspx.

The Acquisition Management Framework for DOD consists of three activities as shown on Figure 2-1. These include: Pre-Systems Acquisition, Systems Acquisition, and Sustainment. In addition, these activities consist of a total of five phases and have three milestones. The milestones (A, B, and C) are positioned at the end of each of the first three phases. In addition, there is a Concept Decision made at the start of the first phase (Concept Refinement); a Design Readiness Review made in the third phase (System Development & Demonstration); and a Full Rate Production Decision Review made in the fourth phase (Production & Deployment).

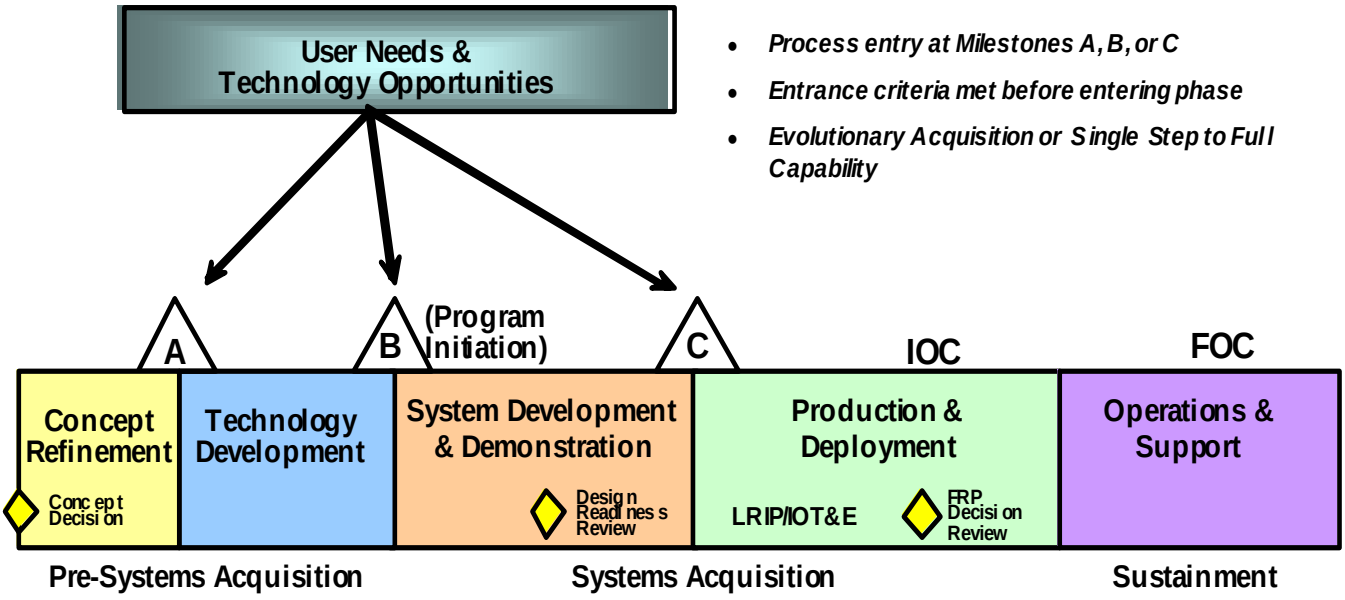


Figure 2-1. The Defense Acquisition Management Framework

Proceeding through the acquisition process depends on obtaining sufficient knowledge to continue to the next stage of acquisition. This is where AoAs contribute significantly to the

Milestone Decision Authority's (MDA's) decision process, providing critical information needed by the MDA to help support his/her decisions. For additional insight on the acquisition process, visit the guidebook at https://akss.dau.mil/dapc/index.aspx.

The above framework allows the Program Manager (PM) and the MDA to exercise discretion and prudent business judgment in order to structure a tailored, responsive, and innovative program. In executing the acquisition system, the MDA may authorize entry into the process at any point consistent with phase specific entrance criteria and statutory requirements.

It is not the intent or goal of this handbook to repeat the details of DOD 5000 guidance. Should the reader require additional information related to the Defense Acquisition Management Framework, the DOD 5000 series documents are available. The objective of this handbook is to demonstrate how the Air Force AoA process contributes and supports the Defense Acquisition Management Framework.

2.2. Acquisition Categories (ACATs)

Weapons system programs along with Command, Control, Communications, Computers and Intelligence (C4I) or Information Technology (IT) programs are placed in ACATs based on the dollar value and required level of decision authority. These categories were established to facilitate decentralized decision making while complying with Congressional mandates for appropriate oversight.

2.2.1. ACAT I

ACAT ID and ACAT IC programs are known as Major Defense Acquisition Programs (MDAPs). ACAT ID and IC programs must meet one of two cost thresholds: more than $365 million in Research, Development, Test, and Evaluation (RDT&E) or more than $2.190 billion in procurement (both in constant FY00 dollars). The level of decision authority further differentiates these programs. The Undersecretary of Defense for Acquisition, Technology and Logistics (USD (AT&L), also called the Defense Acquisition Executive (DAE), approves ACAT ID programs at the DOD level. ACAT IC programs are approved at the service level. This approval comes from either the Head of the DOD Component or, more likely for the Air Force, the Assistant Secretary for Acquisition (SAF/AQ) who is the Air Force Component Acquisition Executive (CAE). The CAE and DAE can elevate the ACAT level of any program to reflect its visibility and/or importance. Thus, a program that does not meet the dollar thresholds but has high Congressional interest may be established as an ACAT ID or IC program by the decision authority.

ACAT IA (IAM and IAC) programs are called Major Automated Information System Acquisition Programs (MAISAP). They must have a total life cycle cost exceeding $378 million, or a total program cost exceeding $126 million or cost more than $32 million (constant FY00 dollars) in a given year. The MDA for ACAT IAM programs is the DOD Chief Information Officer (CIO) who is ASD (C4I). The MDA for ACAT IAC programs is the CAE, as delegated by the DOD Component CIO.

2.2.2. ACAT II

ACAT II programs fall below ACAT I dollar thresholds but require more than $140 million in RDT&E or $660 million in procurement funds (both in constant FY00 dollars). The decision authority is at the DOD CAE, normally SAF/AQ, or an individual designated by the CAE.

2.2.3. ACAT III

ACAT III programs fall below ACAT II dollar thresholds and are approved at the lowest appropriate level. This decision authority would normally be delegated by the DOD CAE to the lowest level appropriate.

2.3. Joint Capabilities Integration and Development System (JCIDS) Analysis and AoAs

The JCIDS analysis process, Figure 2-2, includes three analyses: the FAA, the FNA, and the FSA. The intent of these studies is to define and provide understanding of future warfighter capability requirements, the existing capability shortfalls and gaps, and to determine a general approach for addressing the gaps and shortfalls.

Based on national defense policy and centered on a common joint warfighting construct, the analyses initiate the development of integrated, joint capabilities from a common understanding of existing joint force operations and doctrine, organization, training, materiel, leadership and education, personnel and facilities (DOTMLPF) capabilities and deficiencies. While a JCIDS analysis may be initiated by any number of organizations, to include Combatant Commands (COCOMs) and FCB working groups, this analysis needs to be teamed as early as possible with a user/sponsor. The term "user/sponsor," as applied in this document, describes a collaborative effort between the analytical author of the analysis and the organization/user that will eventually lead the funding of any resulting materiel and/or non-materiel solutions. The assistance and advice of appropriate FCB working groups should be sought out as early as possible during analysis to facilitate the collaborative effort across many stakeholder organizations. The sponsor initiated JCIDS analysis provides the necessary information for the development of the ICD.

The JCIDS process is governed by the Chairman, Joint Chiefs of Staff Instruction (CJCSI) 3170.01, available at https://akss.dau.mil/dapc/index.aspx. OAS has developed a practical guide (FSA Handbook) regarding the FAA, FNA and FSA in particular, which is available on our website at http://www.oas.kirtland.af.mil/. When the JCIDS process results in a validated ICD, an AoA is usually directed to examine alternatives to addressing the capability gaps and shortfalls identified in the ICD.

The DOD 5000 series documents state that AoAs are required for all ACAT I programs and may be directed for ACAT II and III programs. AFI 10-601, *Capabilities-Based Requirements Development*, outlines the AoA process and responsibilities.

The MDA makes all final acquisition program decisions. When the MDA determines that an AoA is required to support the next milestone, he/she issues an Acquisition Decision Memorandum (ADM) requiring an AoA. The ADM typically provides guidance on the required scope and level of detail in the AoA. This guidance is often provided by OSD/PA&E, who plays a major role in AoAs. In addition to providing direction and guidance, OSD/PA&E also reviews the AoA Study Plan and Final Results and advises the MDA on quality and comprehensiveness of the analysis.

The AoA is subject to tailoring and streamlining based on the purpose and magnitude of the effort, maturity of the system concepts, and other considerations as determined by the MDA. An AoA should be sized and scoped for the MDA in light of the issues he/she needs answered. Not all AoAs are the same. Some are more focused and will be smaller in scope while others may address complex overarching issues and will be much larger studies.

The processes outlined in this handbook apply to all AoAs regardless of ACAT level. They ensure that the recommendations from the AoA represent credible, defensible results. The only difference between ACAT I and ACAT II/III AoAs is the level of oversight and approval levels. These differences will be noted within each applicable section of this handbook.

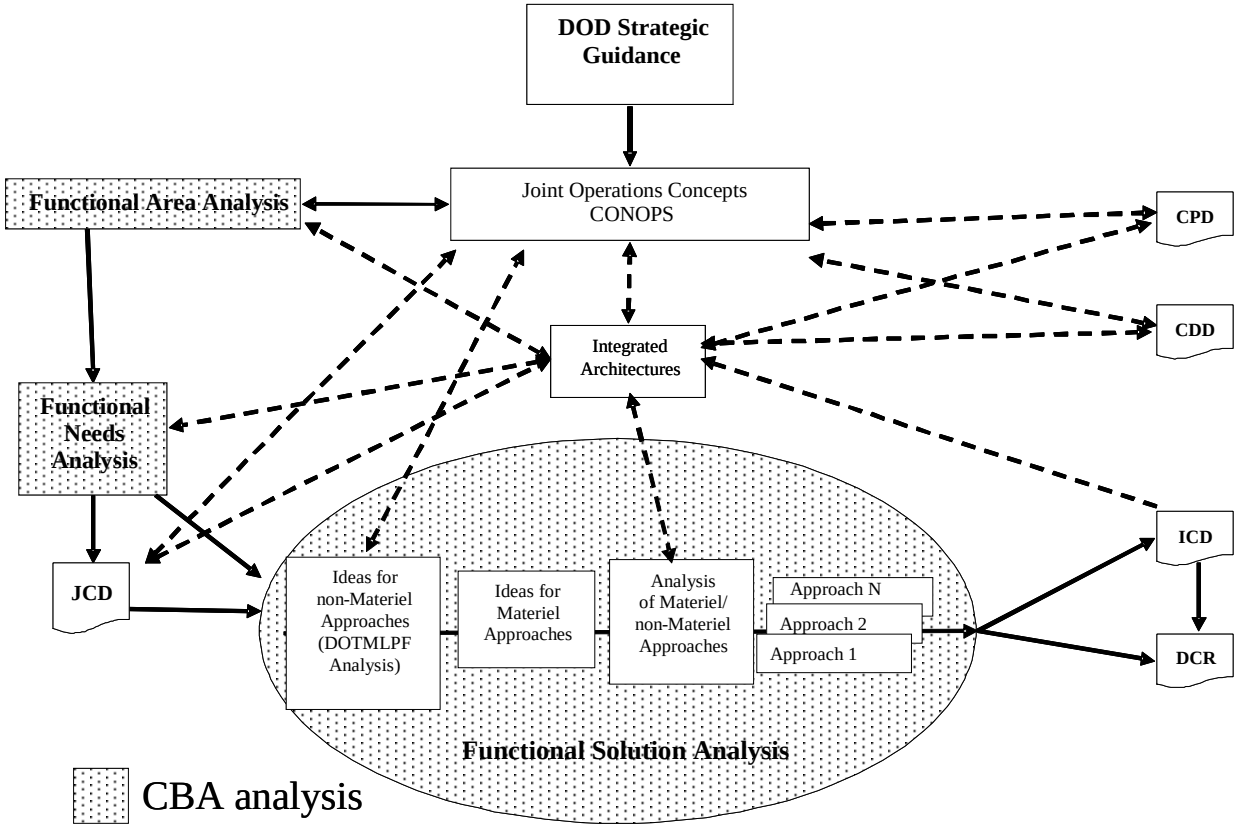


Figure 2-2. JCIDS - CBA Flow and Resulting Documents

The Air Force AoA process will be discussed in the following paragraphs, along with insights on how operational capabilities and requirements are developed and how they relate to acquisition.

3 – AoA Structure

An AoA is conducted by a Working-level Integrated Product Team (WIPT), staffed by a diverse group of government and contractor personnel and led by a study director. This working group is referred to as the AoA study team. Throughout the AoA, the study team will interact with individuals and groups that provide assistance and direction. This chapter discusses typical study team composition, responsible parties, and the names and roles of companion players.

3.1. Study Team Structure

3.1.1. Study Team Director

The lead operating command responsible for the AoA appoints an AoA study team director to lead the AoA. The AoA directorship is a full-time job benefiting from mature leadership skills and continuity of service. Ideally, the study director is a major or lieutenant colonel (or civilian equivalent) from the lead command. Typically, a deputy from the same command supports the director, along with experienced analysts to lead the effectiveness, risk, and cost analysis processes. OAS provides an assistant to the director. The assistant's responsibilities are to provide procedural guidance for AoAs and to serve the director in whatever capacity required ensuring a quality AoA.

3.1.2. Study Team

The study director establishes the study team to plan and execute the AoA. Study team membership is determined by the needs of the AoA; members with appropriate skills are usually drawn from many organizations. Members often include contractors who provide critical skills and resources. The team focuses on defining alternatives, then assessing and comparing their operational effectiveness, life cycle costs and risks. Organizations who typically contribute members to an AoA study team include:

Operating Command (OC)

- Financial Management/Comptroller (FM)
- Manpower and Personnel (A1)
- Intelligence, Surveillance, and Reconnaissance (A2)
- Air and Space Operations (A3)
- Maintenance and Logistics (A4)
- Plans and Programs (A5)
- Communications and Information (A6)
- Installations and Mission Support (A7)
- Requirements (A5/A8)
- Analysis, Assessments, and Lessons Learned (A9)
- Security (A3)
- Weather (A3/5)
- Engineering (A7)

Implementing Command (IC)

- AFMC/A3/FM
- OAS (AFMC/A9)
- Product Centers
- Laboratories
- Air Logistics Centers (ALCs)
- System Program Offices (SPOs)

Other AF Organizations

- AF/A2
- AF/A5XW
- SAF/AQ/FM
- AF Cost Analysis Agency (AFCAA)
- MAJCOMs
- AF Operational Test & Evaluation Center (AFOTEC)
- AF/A9
- AF Flight Standards Agency (AFFSA)
- Global Cyberspace Integration Center (GCIC)
- Air Force Intelligence, Surveillance, Reconaissance Agency (AFISRA)
- AF Global Weather Center (AFGWC)

Other DOD Organizations

- USA, USN, USMC
- Combatant Commanders (COCOMs)
- Defense Intelligence Angency (DIA)
- Defense Threat Reduction Agency (DTRA)
- Defense Logistics Agency (DLA)
- National Geospatial Intelligence Agency (NGA)

Non-DoD Organizations

- Department of Homeland Security (DHS)
- Department of State (DoS)
- Department of Energy (DoE)
- Department of Interior (DoI)
- National Aeronautics and Space Administration (NASA)
- Contractors (KTRs)
- Federal Aeronautics Administration (FAA)
- Department of Transportation (DoT)
- National Imagery Mapping Agency (NIMA)

Oversight/Advisory Organizations

- OSD-level integrated product teams (IPTs)
- AF Council (AFC)

- AF Requirements and Operational Capabilities Council (AFROCC)
- Technical Review Group (TRG)
- OAS (AF CoE)
- OSD/PA&E

The study team is generally organized along functional lines into working groups with a chair for each working group. See Figure 3-1 below. Typical functional areas for the working groups are threats and scenarios, technology and alternatives (responsible for defining the alternatives), operations concepts (of the alternatives), effectiveness analysis, risk analysis, and cost analysis. Typically, management and integration of the products from each work group is undertaken by a "core" group usually composed of the study director and deputy along with the lead and deputy from each of the study team's panels, and the OAS representative.

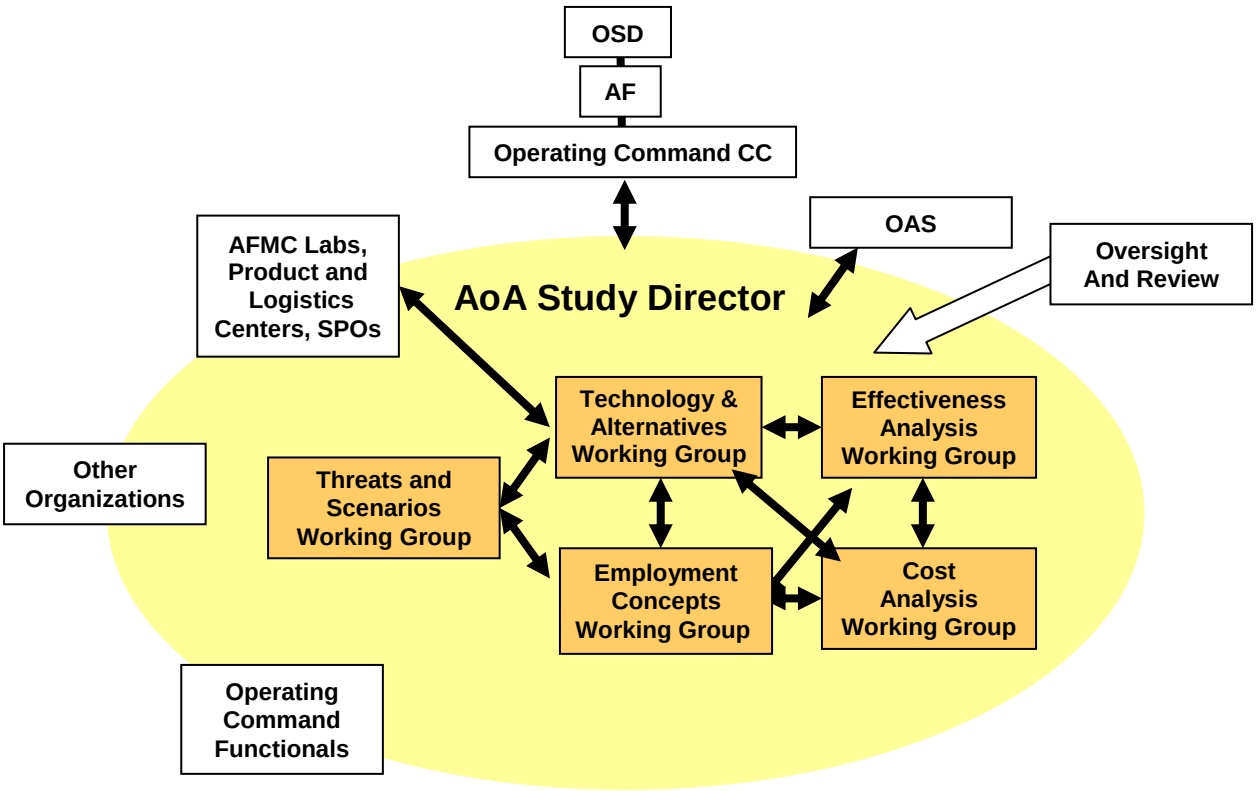


Figure 3-1. Typical Study Team Structure

The structure of a typical study team showing panels and various players is shown in Figure 3-1. While other panel structures may be more appropriate to a particular AoA, the use of functionally oriented panels has been used successfully for years to perform large, complex studies.

The panels meet separately to address their fundamental issues. They also meet in conjunction with other panels or the study team as a whole to exchange information.

Frequent and open exchanges of ideas and data are keys to a successful AoA. The importance of this is greatest when the team is geographically dispersed— a common happenstance. Documenting questions, answers, and decisions made in the various panels enhances open communication. This can be done through taking and distributing minutes of study group meetings. Frequent interaction via telephone and e-mail at all levels should also take place. Another key to success is keeping the AoA study team intact throughout the AoA. A changing membership diminishes the corporate memory and creates delays as new personnel are integrated into the effort.

3.2. Contractor Support for AoAs

Assistance from technical support contractors to conduct substantial parts of the effectiveness and/or cost analysis is frequently necessary. All too often, a contractual arrangement is entered into *before* it is clear what course the AoA will follow. This increases the likelihood that the chosen contractor is not well suited to the tasks at hand. The general rule is: *know your needs and then contract.* In the final analysis, the responsibility for the AoA rests with the MAJCOM and this responsibility should not be delegated to the contractor.

Principal considerations for deciding on contractor support are:

- Is there adequate capability already available within the government?
- Which support areas do I need to contract?
- Are sources of funding available?
- Which contractors are qualified?
- What are the available contract vehicles?
- How will the contract be administered?

AoAs are not usually budgeted items. Funding sources include the Air Staff, the operating commands, and existing program offices.

AFMC can provide advice on experienced and qualified contractors through the product centers and program offices. For most product centers, access to technical support contractors is available through scientific, engineering, technical, and analytical (SETA) contracts. Also, Federally Funded Research & Development Centers (FFRDCs) are available to some product centers. Use of an existing contract for the best-qualified contractor can reduce the AoA initiation and development time considerably.

4 – AoA Study Plan

A major step leading to a successful AoA is the creation of a well-considered study plan. The study plan establishes a roadmap of how the analysis must proceed, who is responsible for doing what, and why they are doing it. Time and effort spent on the study plan before beginning the analysis helps to ensure a high quality AoA, on schedule and within budget. By design, the study plan is structured so that it can be used in the development of the AoA Final Report. The study plan must be updated—it's a "living document"—throughout the AoA effort to reflect new information and changing study perceptions and direction.

4.1. Study Plan Preparation and Review

Preparation of the study plan is the responsibility of the using command, and the study director has the ultimate responsibility. The study team writes the plan, often with substantial contractor participation. OAS can also provide experienced help in preparation of study plans. An intense effort early on by the study director, OAS, and a small group of the core Air Force study team members should be dedicated to drafting an initial study plan. This has proven to be a valuable step in expediting the AoA process and also defines the focus and schedule for the AoA study. This also provides an opportunity for the Air Force members to understand the complexity and focus of the study in order to define 1) if contractor support is needed and 2) what the contractor could contribute to the AoA study. Appendix A of this handbook lists criteria for assessing the adequacy of a study plan and Appendix D contains a study plan template.

A widespread review of the plan is useful in improving the plan and ensuring support for its execution. Review should start within the originating command.

Outside review can be solicited from a variety of agencies, including OAS, AF/A5X, AF/A5R, AFMC/A3, AFOTEC/A8 (when appropriate), and OSD/PA&E (for ACAT ID and IC programs). Appendix C contains a matrix of agencies that review and approve AoAs for different ACAT levels.

5 – Preparing for Analysis

In this section we discuss some of the major inputs to the analysis: the scenarios and threats, the physical environment, the alternatives, and the concepts of operations and employment for the alternatives. The decisions made in each of these areas shape the analysis methodology and the execution of that plan. These inputs will come from the ICD and the FAA, FNA, and FSA that were accomplished to set the stage for the AoA. However, the inputs and the methodology are often developed in parallel, leading to a convergence of the scope of the analysis and methodology to its final form over time.

5.1. Scoping the Analysis

The intent of the JCIDS analyses and AoAs are to provide information for our decision makers. The scope of analysis at each phase of the process should be driven by the information decision makers need as well as the resources and time constraints of the study teams involved.

The following are examples of key overarching questions that most decision makers need answered from an AoA:

- What alternatives provide validated capabilities?
- Are the alternatives operationally effective and suitable?
- Can the alternatives be supported?
- What are the risks (technical, operational, programmatic) for each alternative?
- What are the life-cycle costs for each alternative?
- How do the alternatives compare to one another?

Understanding what information the MDA needs for making a "good decision" is key to appropriately scoping an AoA. Therefore, it is essential that the study director have interaction with the MDA (or the MDA staff). If the study team is given an ADM or other AoA guidance, these documents should identify the issues/objectives and interest levels for the AoA. If the team has not been given an ADM or other AoA guidance, the study director should establish a collaborative effort with the MDA staff to clarify expectations between the MDA and the study team.

The study team should ensure that all scoping decisions are coordinated with the decision makers and that the level of effort and resources required are well understood. The results of any discussions with leadership should be documented so that everyone both inside and outside of the AoA understands what is within the scope of the study and what is not.

Many of the items that define the scope of the AoA will come from the JCIDS analysis that preceded the AoA. Items that are typically used to bind the scope of the AoA are:

- Required capabilities
- Capability gaps
- Mission areas
- Threats and scenarios
- Approaches used to develop alternatives
- Time Frames

5.2. Constraints and Assumptions

Constraints and assumptions are some of the scoping decisions that must be carefully documented and coordinated with the MDA staff. These are boundary conditions, they define the limits of the "box" in which the AoA is enclosed.

- Constraints are actual imposed limitations that can be physical or programmatic. Specifying an operating frequency range for a required communication capability is an example of a physical constraint. Specifying the latest acceptable initial operational capability (IOC) date illustrates a programmatic constraint
- Assumptions specify conditions that apply to the analysis. Examples are; inclusion of a target type that will proliferate in the future, forcing consideration of a specific threat system, or that certain infrastructure or architectures will be provided by another program

Constraints and assumptions arise from many sources. IOC time constraints, for example, may be imposed by an estimated fielding date of a new threat or by the need to replace an aging system. Net-centricity or interoperability with the Global Information Grid (GIG), for example, may be dictated in the ADM. Regardless of the source, each constraint and assumption must be explicitly identified, checked for consistency with other constraints and assumptions, and then

accounted for in the scope of the AoA. Later they will need to be accounted for in the analysis methodologies.

Constraints and assumptions are the one area of the AoA that will come under special scrutiny especially if not discussed up front with the MDA. Every AoA is going to have its allies/supporters and its detractors, and this is one likely point of attack. It is critical that the team thoroughly document each constraint and assumption. The study will begin with an initial set of assumptions but this may grow as the study progresses. The initial set is documented in the study plan which is used to ensure that everyone understands the scope of the AoA.

5.3. Scenarios and Threats

AoA alternatives must be studied in realistic operational settings to provide reasonable comparisons of their relative performances. The AoA does this by developing one or more appropriate military scenarios. Scenarios define operational locations, the enemy order of battle, and the corresponding enemy strategy and tactics ("the threat"). Scenarios are chosen with consideration of AoA mission need, constraints and assumptions, and the physical environments expected.

The threat is most often developed and defined by the AoA study team working in conjunction with the intelligence community. MAJCOM intelligence organizations, DIA, and other intelligence organizations support the AoA and provide detailed threat and target information. Involvement with the intelligence community should be sought early in the AoA. When System Threat Assessment Reports (STARs or STAs) are available they should serve as the basis for the AoA threat description.

The Defense Planning Guidance/Illustrative Planning Scenario (DPG/IPS) provides broad context for a limited number of scenarios and should be used as a starting point for scenario development. The DPG contains a strategic framework and general description of potential military operations in several areas of the world and for various contingencies. Variance from the DPG/IPS must be identified and explained. The details of these excursions must be approved by DIA after OC/A2 review.

The Multi-Service Force Deployment (MSFD) or other digital force projections are resources providing details on enemy, friendly, and non-aligned forces in these areas. In joint AoAs, Army, Navy, and Marine forces must be considered, as well as the Air Force. The order of battle and roles of allied and non-aligned forces must also be considered. Environmental factors that impact operations (e.g., climate, atmospherics, vegetation and terrain) are important as well.

Typical threat elements addressed in an AoA are:

- The enemy order of battle
- Limitations on threat effectiveness, such as logistics, command and control, operational capabilities, strategy or tactics, and technology
- Countermeasures and changes in enemy strategy and tactics in response to the new system's capabilities (i.e., reactive threats)
- A range of threats to account for uncertainties in the estimates
- A target set representing a cross section of all possible targets
- Threat laydown showing potential threat systems and their location

In summary, scenarios must portray realistic operational environments. A range of scenarios may be needed to investigate the full potential of the alternatives and their sensitivities to variations in constraints and assumptions, particularly with regard to threats.

5.4. Physical Environment

Threats and scenarios determine the nature of the physical environment in which the alternatives operate. However, there is often a need to operate in a range of physical environments— this can drive the selection of scenarios.

These environments reflect both human and natural conditions. Natural conditions include weather, climate, terrain, vegetation, geology, etc. Depending on the alternative, these conditions can impact the target selection process, the aircraft and munitions selection process, aircraft sortie rate, aircraft survivability, navigation and communications capabilities, logistics, etc. Conditions caused by humans—jamming and chemical/biological warfare are a few examples—have their own impacts. Chemical and/or biological warfare, for example, may impact the working environment for operational crews and logistics support personnel. This can impact the results of the war or how it is executed. Such real or potential threats may in turn affect aircraft basing decisions and sortie rates.

5.5. Selection and Development of Alternatives

There can be no analysis of alternatives unless there are alternatives to consider. Typically, the FSA and ICD will identify approaches that should be used to develop the alternatives. The ADM or other AoA guidance may also identify a minimum set of alternatives. The study team can augment this set with other appropriate existing systems, modifications to existing systems, systems in development, and conceptual systems. Additional direction during various AoA reviews may insert yet other alternatives.

Practically, the range of alternatives must be manageable. If there are too many alternatives, there will be inadequate resources to perform the analysis. If not enough alternatives are considered; the AoA may not be credible or may not identify the most promising alternative(s). Selecting too few or too many are both possibilities, but experience has shown that selecting too many is the greater danger. The goal is to consider a comprehensive set of alternatives representing all reasonable solutions.

The number of alternatives can be controlled by avoiding similar but slightly different alternatives (avoiding variations on a theme) and by early elimination of non-viable alternatives. Some of the criteria used as a basis for eliminating non-viable alternatives are listed below.

- Non-compliance with AoA guidance
- Non-compliance with treaties or other national policy
- Unacceptable high cost
- Unacceptable performance
- Inability to meet IOC or full operational capability (FOC) requirements

Evidence for the last three criteria may come from previous studies, expert judgment, or early results from the AoA. Since these criteria are subject to interpretation, a disciplined approach for selecting the set of alternatives should be developed and followed to forestall second-guessing. This includes documenting the rationale for selecting the viable alternatives and eliminating the nonviable alternatives.

The Technical Description Document (TDD) is developed as a repository for information that completely describes each alternative. Although the TDD is not required, it has proven to be a valuable method for documenting the technical description of each alternative and maintaining the information current as changes in the alternative definition occur. Documenting the alternatives is required. The AoA team will populate the document with information throughout the AoA process. This is a living document and changes as each alternative becomes more clearly defined. The format for the TDD can be found in Appendix G. To ensure accuracy of alternative definitions and capabilities, all descriptions should be made available to all system advocates for peer review.

A base case is always the first alternative, called Alternative 1. The base case represents the existing, currently programmed system funded and operated according to current plans. The base case offers a yardstick against which to measure the potential improvements provided by the other alternatives.

A second frequently included alternative, called Alternative 2, is based on potential yet unfunded improvements to the base case.

All the alternatives after this are numbered in sequence so they may be tracked and compared in an unbiased manner. New or revised alternatives may need to be included after the analysis is under way; these latecomers are generally conceptual solutions based on immature technology and are still being tuned.

5.6. Operations and Employment Concepts

Evaluating the effectiveness, cost and risks of an alternative requires a significant level of understanding of the operations of the alternative. For each alternative, an operations concept must describe the details of the employment of the alternative as it will function within established military organizations. The concept of employment (CONEMP) for each alternative should be described in the TDD.

The complexity of the CONEMP will vary with the nature of the alternative and the scope of the tasks. An aircraft will have a more complex operations concept than a munition it carries, and the same munition will have a more complex operations concept than an attack-warning sensor protecting the aircraft.

The following list details many of the potentially appropriate issues an operations concept may discuss:

- Deployment plans, including how the system will be deployed and its deployment schedule
- When and how the system will be employed, including tactics
- Logistics concepts for peacetime and wartime
- Interoperability with other Air Force, sister service, and allied systems
- Incorporation into existing organizational structures, including manpower impacts
- The relationship of the CONEMP to relevant AF or Joint Concepts of Operation (CONOPS)
- Peacetime and wartime operations concept

It is difficult to produce operations concepts for developmental and conceptual systems. Typically, system developers are more concerned with the system technology than its employment. The operations concepts for these systems must often be developed from scratch. The operational community must work closely with the technical experts to develop reasonable and realistic CONEMPs. It is best to define the requirements for the operations concepts early in the AoA to maximize the available development time.

6 – Effectiveness Analysis

Effectiveness analysis is normally the most complex element of the AoA and consumes a significant fraction of AoA resources. The goal of the effectiveness analysis is to determine the military worth of the alternatives in performing mission tasks (MTs). The MTs are derived from the capabilities identified in the ICD or the Capabilities Development Document (CDD). The ability to satisfy the MTs is determined from estimates of alternatives' performance with respect to MoEs and their supporting measures of performance (MoPs).

The effectiveness methodology is the sum of the processes used to conduct the effectiveness analysis. The development of the effectiveness methodology is almost always iterative: a methodology will be suggested, evaluated against the resources and data available to support it, and then modified to correspond to what is both possible and adequate. As the AoA progresses, this development sequence may be repeated as more is understood about the nature of the alternatives, the models or analysis tools, and what is necessary to support the AoA decision. Figure 6-1 shows the flow of analysis tasks discussed in this chapter.

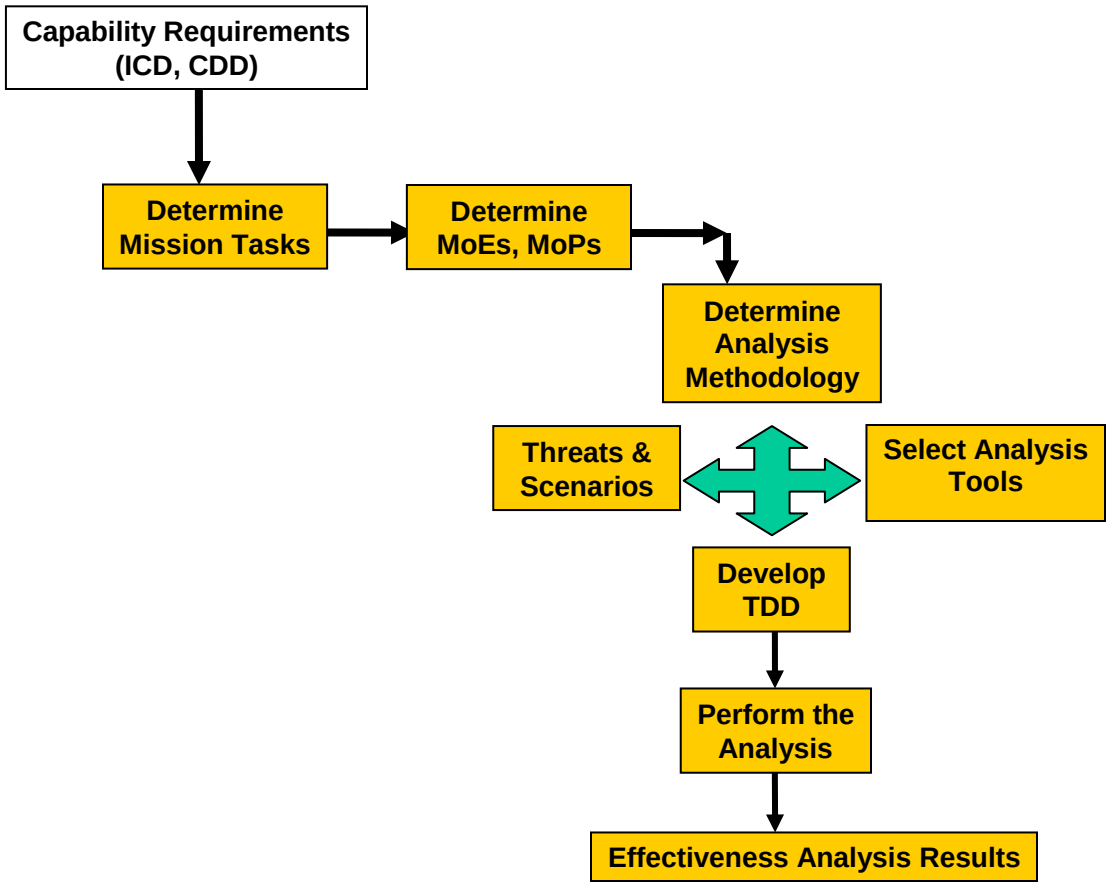


Figure 6-1. General Approach for Effectiveness Analysis

6.1. Measuring the Effectiveness of Alternatives

6.1.1. Mission Tasks (MTs)

MTs are derived directly from the capability requirements identified in the ICD or CDD (Figure 6-1). They are usually expressed in terms of general tasks to be performed or effects to be achieved (e.g., hold targets at risk, provide countermeasures against surface-to-air missiles, or communicate in a jamming environment). The MoEs are then developed to measure "how well" each alternative performs the tasks or achieves the desired effects. Because MTs are tasks, cost is never an MT or MoE, and cost is never considered in the effectiveness analysis. All capabilities discussed in the ICD or CDD should be addressed in the MTs and MoEs for the AoA (barring direction from the ADM or arising from later insight of the AoA).

Because the AoA tries to identify the most promising solution(s), MTs must not be stated in solution-specific language. Neither should MoEs call for optimizing aspects of a task or effect, because this often has unintended impacts on cost or other aspects of the alternatives' performance. For example, one solution to minimizing aircraft attrition could be not flying

missions; this solution would hardly be conducive to placing targets at risk. Similarly, maximizing targets destroyed may result in unacceptable attrition.

6.1.2. Measures of Effectiveness (MoEs)

MoEs are a qualitative or quantitative measure of a system's performance or characteristic that indicates the degree to which it performs the task or meets a requirement under specified conditions. They are a measure of operational success that must be closely related to the objective of the mission or operation being evaluated. There will be at least one MoE to support each MT. Each alternative is evaluated against each MoE, and the results are used for comparison among the alternatives.

MoEs are developed by the study team. If possible, MoEs should be chosen to provide suitable assessment criteria for use during later developmental and operational testing. This "linking" of the AoA to testing is valuable to the test community and the decision maker.

MoEs should be reviewed by OSD/PA&E during development of the AoA study plan. Suitable selection of MoEs helps later independent review and evaluation of the AoA study plan and results.

In general:

- MoEs should be quantitative when feasible (e.g., "How many targets are held at risk?" or "The number of targets by type that you can hold at risk in daytime and nighttime conditions?")
- MoEs may be qualitative or subjective, calling on the opinion of a knowledgeable person or group, (e.g., "In your opinion does the solution provide a day-night capability?")
- Each MoE supports at least one MT and each MT will have at least one MoE supporting it
- MoEs must be independent of the alternatives, as all alternatives are evaluated using all MoEs
- MoEs should not be strongly correlated with one another (to avoid overemphasizing particular aspects of the alternatives)
- MoEs are relative to the MT they support (no quantity is inherently an MoE)
- MoEs may be supported by one or more MoPs

MoEs should normally represent raw quantities like numbers of something or frequencies of occurrence. Attempts to disguise these quantities through a mathematical transformation (for example, through normalization), no matter how well meaning, reduce the information content and may be regarded as "tampering with the data." This same reasoning applies to the use of MoEs defined as ratios; a ratio essentially "hides" both quantities.

Results from MoEs not only make it possible to compare alternatives, they also can be used to investigate performance sensitivities to variations of key assumptions and MoP values. Such analyses help define input to follow-on requirements documents (e.g. CDD, Capabilities Production Document (CPD)). These results can also be used to investigate the robustness (stability of performance) of alternatives whose defining parameters are subject to significant uncertainty.

6.1.3. Measures of Performance (MoPs)

MoPs are typically a quantitative measure of a system characteristic (e.g., range, velocity, mass, scan rate, weapon load-out, etc.) chosen to enable calculation of one or more MoEs. MoPs may apply universally to all alternatives or, unlike MoEs; they may be system specific in some instances. In order to determine how well an alternative performs, each MoP should have a threshold value. This value might come from a requirement document, or can be determined by subject matter experts (SMEs). Each MoP might also have an objective value which is more demanding than the threshold value. The threshold and objective values and the rationale for their selection should be well documented. The MoPs and their threshold and objective values may be directly or indirectly reflected in system performance parameters in the ICD/CDD/CPD. MoPs and the methodology for evaluating their impact on MoEs frequently help determine CDD/CPD inputs. As with MoEs, MoPs should be linked, where possible, to future testing of the alternatives.

6.1.4. Example of deriving measures

Figure 6-2 shows the MTs and MoEs that can be derived from the following Mission statement in the ICD**:**

Theater commanders need a means to obtain *responsive intelligence, surveillance, targeting and BDA information*. The system should be *usable against all theater targets* with a *short tasking time* and be reliable over the mission with limited risk to personnel. It should provide *reasonable coverage* and *have multi-spectral capability* with *near real-time information supplied to the Joint Force Air Component Commander (JFACC)* and allow for *automation* of critical mission elements *to increase capability*.

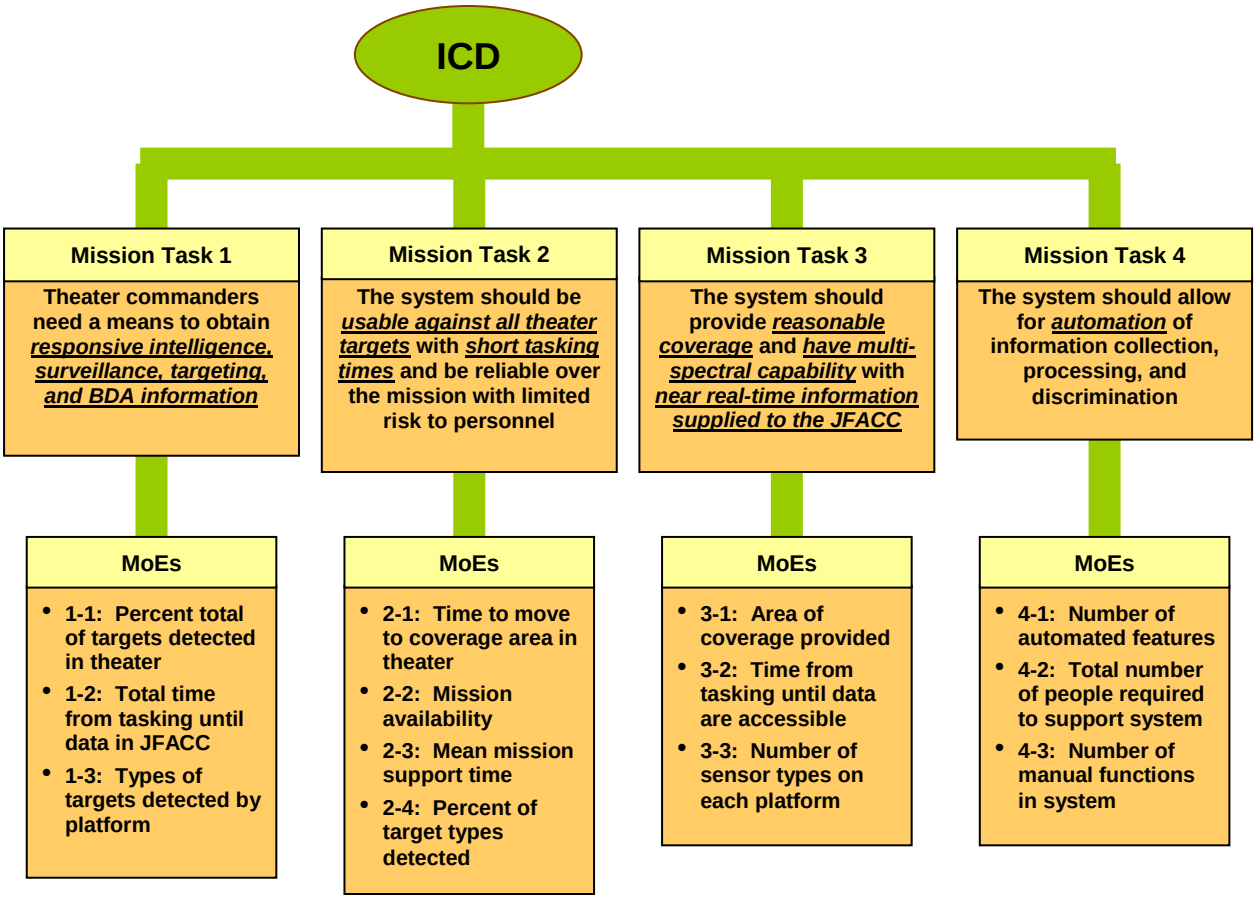


Figure 6-2. Notional MTs/MoEs

6.2. Military Worth

The goal of all defense acquisitions is to assist the warfighter. Success can be measured relative to the immediate goals of the system (attack, communicate, detect, etc.) or relative to high-level goals related to "winning the war." Some examples of measures demonstrating military worth are:

- Time to accomplish high level objectives
- Targets placed at risk
- Targets negated
- Level of collateral damage
- Friendly survivors
- Quantity (and types) of resources consumed
- Number of Operating Locations Needed
- Impact on C4ISR network

6.3. Effectiveness Analysis Methodology

The effectiveness analysis methodology is designed to compare the effectiveness of the alternatives based on military worth. It encompasses and is influenced by the MTs, MoEs, MoPs, alternatives, threats, scenarios, operations concept, study schedule, and available analysis resources. The methodology must be systematic and logical. It must be executable, and it must not be biased for or against any alternative. It must also be able to separate the wheat from the chaff (i.e., allow informed decisions).

Discussion of the analysis methodology begins very early in the AoA, perhaps even before the AoA officially begins. Because of its dependence on many factors, it can approach its final form only after these other factors are defined. In other words, you have to know what you are doing before you can decide how to do it— and that includes selecting modeling and simulation (M&S) software or other analysis tools to support the AoA. In fact, final analysis tool selection must await development of the MTs, MoEs, and selection of the alternatives.

The basic issues shaping the effectiveness analysis methodology are:

- Selection of MTs, MoEs, and MoPs
- Selection of the threats and scenarios
- Description of alternatives
- Determination of the appropriate level of detail required in the analysis
- Identification of suitable analysis tools and input data sources

6.4. Levels of Analysis

In the world of military operations analysis, levels of effectiveness analysis are characterized by the number and types of alternatives and threat elements to be studied. A typical four-level classification is shown in Figure 6-3.

At the base of the triangle is the engineering analysis performed on individual components of an alternative or threat system. One level up, engagement analysis can model the interaction between a single element of the alternative and a single threat. An example of this analysis is weapon versus target, or aircraft versus aircraft. Engagement analysis also looks at interactions of larger quantities of the same elements, or few-on-few.

At the top two levels, mission/battle and theater/campaign (many on many), the analysis becomes very complex involving the modeling of most or all of the forces in a specific, complex scenario. At these higher levels the focus of the analysis changes. The applicable M&S will also change, as does the complexity of the analysis. Analysis at higher levels may require supporting analysis at lower levels.

While the supporting analysis may come from sources outside the AoA, it will often be performed by the AoA team. MoP values tend to be produced from engineering and one-on-one analyses. MoE values tend to come from higher levels of analyses. There are no hard and fast rules, though, because of the range of issues considered in AoAs.

Given the increasing complexity of the analysis encountered in moving up the pyramid, every effort must be made to use the lowest level needed to answer the AoA's questions. Most ACAT I AoAs would require a minimum of mission/battle level modeling.

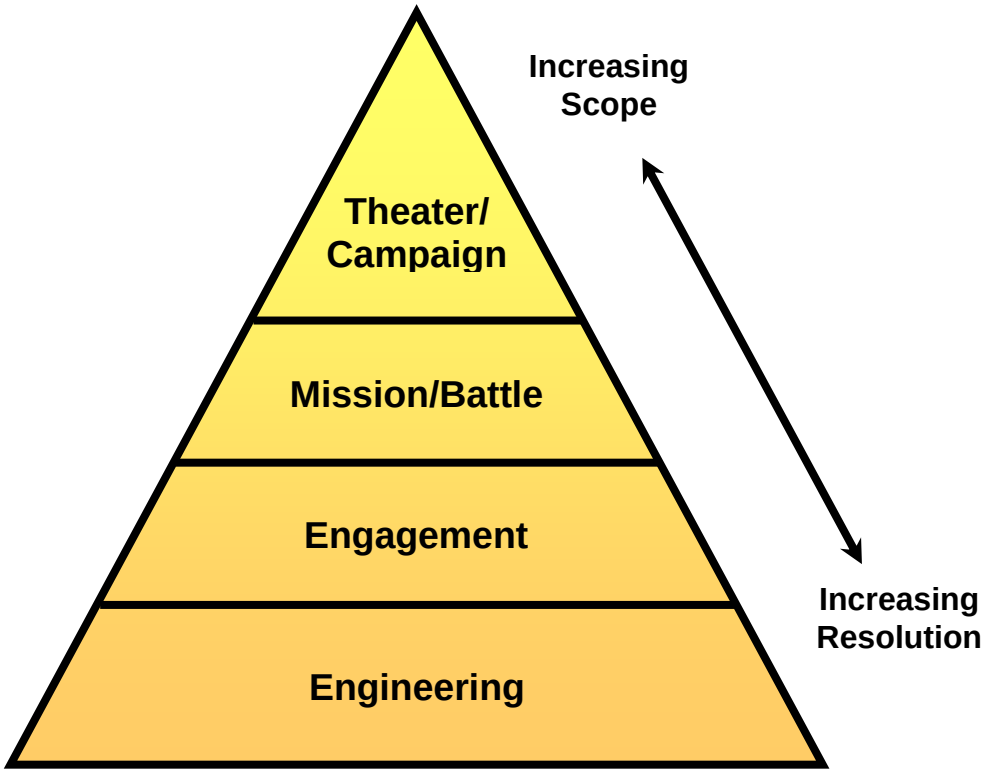


Figure 6-3. Hierarchy of Analysis

6.5. Selection of Effectiveness Analysis Tools and Data Sources

Once MOEs and MOPs have been identified and the methodologies to be used for each analytical effort determined, it is time to determine what "tools" will be used to develop MoE and MoP data. The term "tools" is defined as spreadsheets, SMEs, methods, processes, and M&S. The analysis tools are the heart and soul of analysis and can consist of everything from hand-written steps executed with a "stubby pencil" to elegant mathematical formulations represented by thousands of lines of computer code. In some cases, they may include person-in-the-loop simulations or the informed judgment of SMEs. Whatever their complexity or form, there comes a point when the AoA team must decide which tools to use to generate MoE/MoP data for comparisons of the alternatives.

The MoEs/MoPs developed for the analysis should dictate which tools are needed vice developing MoEs/MoPs based on a particular analysis tool. Doing the latter (for example, because of easy accessibility to a particular M&S) may result in the wrong issues being investigated and the wrong alternatives being identified as promising. Once the MoEs/MoPs are known, the necessary level(s) of analysis can be identified and a search conducted for tools suitable for MoE/MoP calculations.

When selecting analysis tools consider the following:

- Information or input data requirements and the quality of the data sources
- Credibility and acceptance of the tool output or process results (e.g. SME assessments)

- Who is available to run the M&S, develop/manipulate the spreadsheets or participate in SME assessments
- Whether or not the tool can be applied to support the analysis within time and funding constraints
- Cost of running M&S

Tool inputs come from all aspects of the AoA: threats and scenarios, alternative definitions, employment concepts, constraints and assumptions, etc. These may also be derived from the outputs of other tools. Before selecting a tool, the sources of all inputs should be identifiable and credible. Commonly accepted models from the AFSAT Toolkit include:

- AMOS
- BRAWLER
- CFAM
- ESAMS
- EADSIM
- GTSIMS
- GIANT
- JTEAM
- JIMM
- JSEM
- LCOM
- MIL-AASPEM II
- MOSAIC
- RADGUNS
- SCOPES
- SPAAT
- SHAZAM
- SUPPRESSOR
- SEAS
- THUNDER

Before settling on a final integrated set of tools, it is useful to check that the toolset is adequate for evaluating all measures in the AoA. Constructing a linkage diagram as illustrated in Figure 6-4 may be useful for this. As shown, this diagram depicts the source of MoP and MoE values and is a system level diagram of how the selected analysis tools are expected to work together. It should also show what information is expected to flow from one tool (or process) to another. A review of the linkage diagram should also ensure that a common set of assumptions is made across all the tools. Including a linkage diagram in the study plan should also enhance the understanding of those reading or reviewing the plan.

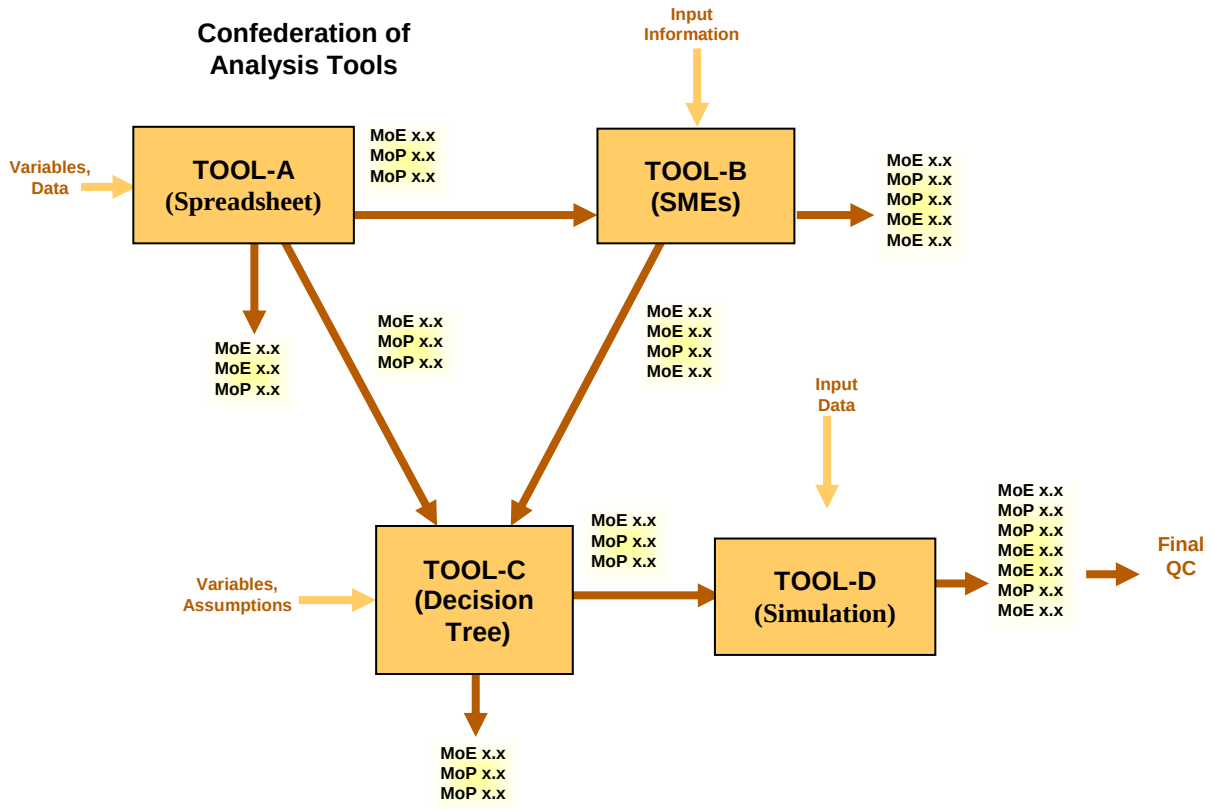


Figure 6-4. Analysis Tools to Measure Linkage

6.5.1. M&S Accreditation

The DoDI 5000 series requires that digital M&S used in support of acquisition decisions be formally accredited for use by an Accreditation Authority. Accreditation involves reviewing the application of M&S tools within an analysis, such as an AoA for appropriateness and credibility. The study team should allow time for the M&S accreditation process within the AoA schedule; this process should be discussed in the study plan. OAS can help tailor an appropriate accreditation plan. Appendix I provides additional accreditation information.

6.5.2. Sensitivity Analysis

Alternatives whose effectiveness is stable over a range of conditions are more adaptable than those lacking such stability. Alternatives in an AoA are typically defined with certain appropriate assumptions made about their performance parameters: weight, volume, power consumption, speed, accuracy, impact angle, etc. These "monolithic" alternatives are then assessed against AoA-defined threats and scenarios under a set of AoA-defined assumptions. This provides very specific cost and performance estimates, but does little to assess the stability of alternative performance to changes in system parameters or AoA threats, scenarios and assumptions.

Stability can only be investigated through sensitivity analyses in which the most likely critical parameters are varied: reduced speed or increased weight or greater or less accuracy, or when overarching assumptions are changed. This form of parametric analysis can often reveal

strengths and flaws in alternative performance that are valuable in making decisions to keep or eliminate alternatives from further consideration. Sensitivity analyses should be performed whenever time and resources allow, with an emphasis on alternatives that survived early screening processes. Sensitivity analysis can also add credibility to the information developed during the effectiveness analysis. Of course, it is always necessary to balance the amount of sensitivity analysis against its potential value and the available resources.

6.6. Effectiveness Analysis (EA) Results Presentation

Once the EA has been completed, the values for the measures of each alternative need to be presented in a comprehensive manner. Figure 6-5 shows a method for presenting each alternative using a color scheme indicating how well each MoE was accomplished. A methodology should be developed to map measured values to the colors displayed, but they should be based on the measured value in relation to the threshold value and associated changes in military utility. This requires a structured process to roll the MoP values up to MoE representation. Weighted averaging of MOPs is almost always a misleading way to do this.

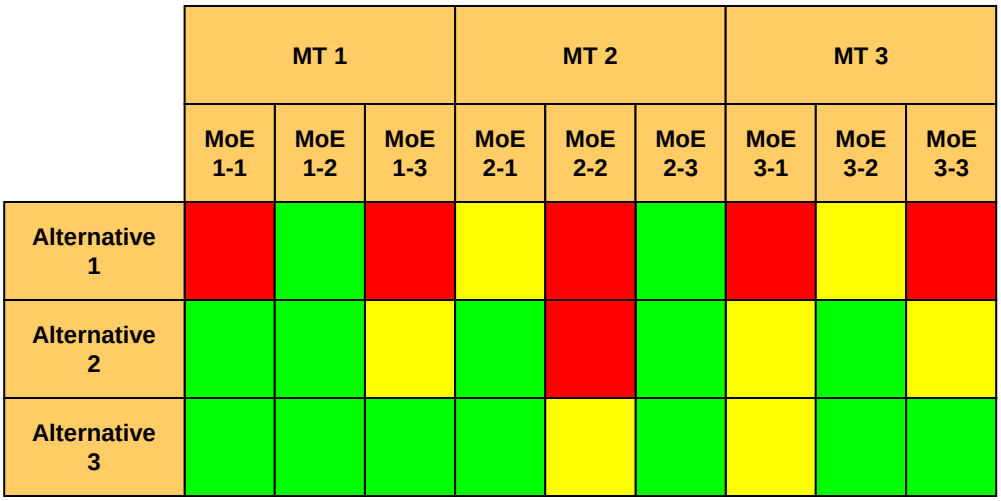


Figure 6-5. Effectiveness Analysis Results Presentation

7 – Cost Analysis

A cost analysis is performed in parallel with the operational effectiveness analysis. It is equal in importance in the overall AoA decision process. The cost analysis estimates the total life cycle cost (LCC) of each alternative and these results are combined with the effectiveness analysis results to identify the alternative(s) that represent the best Air Force or joint value. The LCC approach captures the total cost of each alternative over its entire life cycle and includes costs incurred for the following LCC elements: research and development (R&D), investment, operations and support (O&S), and disposal at the end of the system(s) life. Sunk costs (money already spent or obligated) are not included in the LCC estimates; however, they may be of interest to decision makers and should be identified separately. The AoA LCC analysis is based on peacetime operations and does not include any war-related costs such as replacement of expended or destroyed assets. The impact of consumed assets is reflected as diminished effectiveness in the operational effectiveness analysis. The four LCC elements are defined below. Those alternatives failing to meet minimum effectiveness analysis criteria (non-viable alternatives) are normally not costed.

7.1. LCC Elements

7.1.1. Research and Development Cost

The costs of all R&D phases—concept and technology development, system development and demonstration—are included in this cost element. There are many types of R&D costs: prototypes, engineering development, equipment, test hardware, contractor system test and evaluation, and government support to the test program. Engineering costs for environmental safety, supportability, reliability, and maintainability efforts are also included, as are support equipment, training, and data supporting R&D efforts.

7.1.2. Investment Cost

The cost of investment (low rate initial production, production, and deployment) includes the cost of procuring the prime mission equipment and its support. This includes training, data, initial spares, war reserve spares, pre-planned product improvement (P3I) program items, and military construction (MILCON). MILCON cost is the cost of acquisition, construction, or modification of facilities necessary to accommodate an alternative. The cost of all related procurement, such as modifications to existing equipment, is also included.

7.1.3. Operating and Support Cost

O&S costs are those program costs necessary to operate, maintain, and support system capability. This cost element includes all direct and indirect elements of a defense program and encompasses costs for personnel, consumable and repairable materiel, and all appropriate levels of maintenance, facilities, and sustaining investment. Manpower estimates should be consistent with the Manpower Estimate Report (MER), which is produced by the operating command’s manpower office. For more information, refer to the OSD Cost Analysis Improvement Group's *Operations and Support Cost Estimating Guide*.

7.1.4. Disposal Cost

Disposal cost is the cost of getting rid of excess or surplus property or materiel from the inventory. It may include costs of demilitarization, detoxification, redistribution, transfer, donation, sales, salvage, or destruction. It may also reflect the costs of hazardous waste disposition (including long-term storage) and environmental cleanup. Disposal costs may occur during any phase of the acquisition cycle.

7.2. Cost Analysis Responsibility

The operating command financial management office is typically responsible for conducting the AoA cost analysis and they will normally chair the Cost Analysis Working Group (CAWG). The CAWG should include representatives from specific operating and implementing command organizations with expertise in cost analysis and knowledge of the system alternatives. A logistics analyst on the CAWG can assess the cost implications of logistics support approaches. OAS will serve as advisor to the CAWG Lead and assist the cost team throughout the AoA process. The CAWG shall request cost support from the AF Cost Analysis Agency (AFCAA). In response to this request, AFCAA will provide a representative to support the cost team throughout the AoA process. AFCAA will also provide regulatory guidance, review and approve proposed cost analysis methodology, and perform a sufficiency review for ACAT I and ACAT II AoAs if they are high profile. The CAWG will be responsible for the following cost analysis tasks:

- Develop appropriate cost ground rules and assumptions and ensure they are consistent with effectiveness ground rules and assumptions
- Develop the Work Breakdown Structure (WBS) to be used in the cost analysis; the WBS is a hierarchical organization of the items to be costed
- Determine suitability and availability of cost models and data required
- Define the logistics elements necessary for the cost analysis
- Prepare LCC estimates for the baseline system and each alternative
- Document the cost analysis so that a qualified cost analyst can reconstruct the estimate using only the documentation and references provided in the Final Report
- Review the estimates to ensure the methodology and the ground rules and assumptions are consistent and the LCC estimate is complete
- Bound LCC point estimates with uncertainty ranges
- Include programmatic data in the LCC analyses, such as quantities and delivery schedules (when known)
- Identify cost drivers (those elements to which LCC is most sensitive) and perform sensitivity analyses on significant cost drivers
- Provide funding and affordability constraints and specify schedule limitations
- Provide necessary cost data to implement Cost As An Independent Variable (CAIV) strategy to arrive at an affordable balance among cost, performance, and schedule
- Present all costs in base year dollars (BY$)—normally the year in which the decision will be made—and also in then year dollars (TY$) if a production schedule is known
- Identify the appropriate inflation indices used (the most current OSD indices are published on the SAF/FMC web page)
- Separately identify sunk costs for each alternative

- Address manpower implications for each alternative in the O&S costing, including contractor support where applicable
- Address appropriate environmental regulations, treaties, in determining disposal costs
- Address sources that are driving cost risk and uncertainty for each alternative
- Consult with OAS on the latest guidance related to the AoA report format for cost

Figure 7-1 shows a notional "cost responsibility matrix" that is used to assign and track CAWG tasks.

	OC/FM	OAS	AFCAA	SPO 1, Product Center	SPO 2, Product Center	Logistics Center
Develop ground rules and assumptions	X	X				
Develop WBS	X		X	X	X	X
Develop/review cost methodology	X	X	X	X	X	X
Identify cost models and data sources	X	X	X	X	X	X
Write cost section of study plan	X	X				
Provide data requirements to other working groups	X			X	X	X
Develop, amend, and document LCC				X	X	X
Identify cost drivers				X	X	X
Identify phase-in and steady state periods and quantities				X	X	X
Assess AoA milestone schedules	X	X	X	X	X	X
Perform cost and schedule risk analysis				X	X	X
Perform sensitivity analysis				X	X	X
Time phase estimates, convert to TY$				X	X	X
Analyze cost results	X	X		X	X	X
Write cost section of AoA report	X	X				
Prepare cost briefings for reviews	X	X				
Provide guidance, conduct sufficiency reviews		X	X			

Figure 7-1. Cost Responsibility Matrix

7.3. LCC Methodology

LCC analysis allows alternatives to be compared to the baseline system based on their relative estimated costs. The LCC methodology is initially outlined in the study plan and updated as the AoA proceeds. While the LCC analysis of all alternatives must be based on the same WBS, the level of alternative description available to the cost analyst—and thus the fidelity of the estimate—will vary depending on the detail of system definition and its technological maturity. The system definition of each alternative in the TDD will serve as the foundation for the cost analysis. As part of the cost methodology, the AoA study plan should identify general ground rules and assumptions underlying the analysis as well as those specific to particular cost elements or life cycle phases (e.g., an assumption that no additional manpower is required to employ any alternative). At a minimum, the preliminary list of ground rules and assumptions should address the following:

- Cost basis of the estimate (specified in base year dollars (BY$)
- Specific inflation indices used
- Definition of sunk costs (date separating costs expended or contractually committed from those to be included in the LCC estimate)
- Schedule issues, including major milestones and significant events (IOC and FOC dates, production schedules and quantities)
- Basing, logistics, and maintenance concepts
- MILCON
- Intelligence support requirements
- Environmental cost considerations
- Personnel requirements and constraints
- Affordability constraints

7.3.1. Work Breakdown Structure (WBS)

The LCC methodology is generally based on a WBS. A WBS is a product-oriented (as opposed to functionally-oriented) tree composed of hardware, software, services, data, and facilities that define the product to be developed and produced. The following is a notional WBS for an aircraft system; it illustrates the typical elements found at the first three WBS levels (succeeding levels contain greater detail).

- **Aircraft System**
    - Air Vehicle
        - Airframe
        - Propulsion
        - Air Vehicle Software
        - Armament
        - Weapons Delivery
        - etc.
    - Systems Engineering & program Management
        - *(no Level 3 breakdown)*
    - System Test & Evaluation (T&E)
        - Development T&E

        - Operational T&E
        - T&E Support
        - Test Facilities
    - Training
        - Equipment
        - Services
        - Facilities
    - Data
        - Technical Publications
        - Engineering Data
        - Management Data
        - Support Data
    - Peculiar Support Equipment
        - Test & Measurement Equipment
        - Support & Handling Equipment
    - Common Support Equipment
        - Test & Measurement Equipment
        - Support & Handling Equipment
    - Operational/Site Activation
        - System Assembly, Installation & Checkout
        - Contractor Technical Support
        - Site Construction
    - Industrial Facilities
        - Construction, Conversion or Expansion
        - Equipment Acquisition or Modernization
        - Maintenance (industrial facilities)
    - Initial Spares & Repair Parts *(no Level 3 breakdown)*

Once the WBS has been created, costs are collected for the WBS elements and the LCC estimates are then developed for each alternative. AoA alternatives are not normally estimated below WBS Level 3. For a complete WBS, consult MIL-HDBK 881B.

7.3.2. Cost Estimating Methodologies

There are several cost estimating methodologies available to the analyst. The three formal approaches include the engineering build-up (or bottom-up technique), the parametric estimating technique, and the analogy technique. Informal approaches like expert opinion can also be used when the formal techniques are not practical.

The engineering build-up approach is performed at a detailed level of the WBS. Cost can be estimated for basic tasks like engineering design, tooling, fabrication of parts, manufacturing engineering, and quality control. The cost of materials may also be estimated. The disadvantages of this approach are its time-consuming nature—the modeled processes must be well understood—and the need for detailed, actual cost data.

The parametric method is normally appropriate at the early stages of a program when there is limited program and technical definition (e.g. pre MS-A). It involves collecting relevant historical data at an aggregated level of detail and relating it to the area to be estimated through generally simple mathematical equations—known as cost estimating relationships (CERs).

CERs relate cost to one or more variables (e.g., volume, weight, or power). Usually less detail is required for this approach than for other methods. Since CERs are based on actual program cost history, they reflect the impacts of system growth, schedule changes, and engineering changes. When costs are captured at a very high level however, visibility into more detailed levels is lost. The use of a factor or ratio relating the cost of one entity to another is also considered a form of parametric estimating (e.g., training costs might be estimated as 20 percent of production costs). Factors and ratios allow the estimator to capture a large part of an estimate with limited descriptions of both the historical database used to develop the factor and the program to be estimated. This method is often used for training, data, peculiar support equipment, and systems engineering and program management.

The analogy method uses actual costs from a similar program and adjusts for the new program's complexity and technical or physical differences to derive the estimate. This method is normally used early in a program cycle when there is insufficient actual cost data to use as a basis for a detailed approach. Engineering assessments are necessary to ensure the best analogy has been selected and proper adjustments are made. These engineering judgments are the mainstay of the approach and can also be a limiting factor.

7.3.3. Cost Models and Data

Cost models incorporating the three methodologies are available to assist the cost analyst in developing the LCC estimates. The models and data intended for use in the AoA should be identified and described in the study plan. Cost models and data generally accepted by the Air Force cost analysis community will be used. AFCAA and the OSD CAIG can provide a comprehensive list of acceptable cost models and databases. Cost models frequently used include:

- ACEIT (integrated)
- SEER-SEM/H (software/hardware)
- PRICE-H (hardware)
- PRICE-S (software)
- COCOMO (software)
- LOGISTICS SUPPORT COST (logistics)
- CRYSTAL BALL (risk)

7.3.4. Cost Risk and Uncertainty

Because a cost estimate is a prediction of the future, there is a significant concern that actual costs may differ from the costs developed in the estimate; risk and uncertainty analyses address this concern. Most cost estimates are a composite of both risk (known-unknowns) and uncertainty (unknown-unknowns). However, "risk" is often used generically to address both types of "unknowns." Risk stems from three primary sources: configuration changes, technical and schedule problems, and cost estimating error. Technical and schedule risk and cost estimating error can be accounted for in the risk analysis, but major configuration changes may require a new estimate rather than trying to compensate by applying a risk approach. Several approaches are available to treat risk in an estimate; they range from very subjective to those with complex statistics. Whatever risk methodology the cost analyst decides to employ, it should be adequately described in the study plan. The results of the risk analysis will be included in the final cost estimates.

7.4. Cost Results Presentation

The format illustrated in Figure 7-2 is used to display the AoA cost analysis results; it allows the costs for each alternative and LCC element to be directly compared. This format should be used to present both BY$ and TY$.

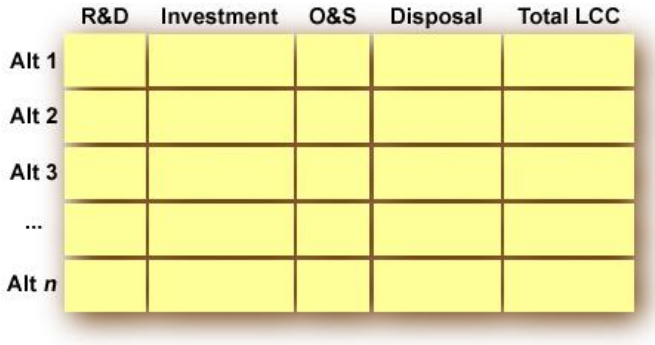


Figure 7-2. General LCC Summary (All Alternatives)

Figure 7-3 presents each alternative's cost in terms of fiscal year spread and appropriation. Again, this format can be used for both BY$ and TY$. The results should also be analyzed graphically in a presentation. Sunk costs are excluded from the estimates in all tables.

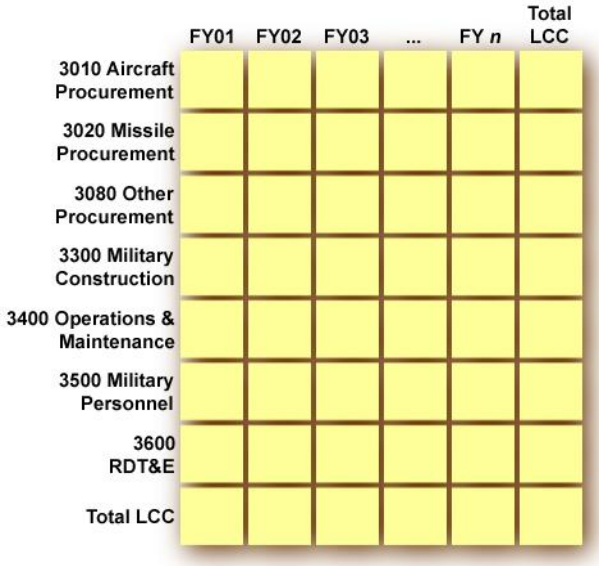


Figure 7-3. General LCC Summary (By Alternative)

7.4.1. Cost Documentation

A complete set of cost documentation is an essential part of the AoA cost analysis. Without an explanation of the data sources and methodology used for each element of the estimates, the costs cannot be replicated and therefore may lack credibility. Chapter 3 of AFI 65-508, *Cost Analysis Guidance and Procedures,* provides guidance on the level of documentation

required. Attachment 5 to the same instruction contains a cost documentation checklist useful in determining the completeness of the cost documentation.

7.4.2 Cost Reviews

The CAWG and AoA study team review the cost estimates for consistency and completeness. OAS also reviews the cost section of the study plan and the final results as part of the overall AoA assessment provided to the AFROCC. For ACAT I AoAs, the AFCAA will perform a cost sufficiency review for all viable alternatives. Sufficiency reviews may also be performed for high profile ACAT II AoAs. Sufficiency reviews assess the completeness, reasonableness, and consistency of the estimates and provide a confidence rating for the estimate; they also highlight any problem areas. It is strongly recommended that the study director request AFCAA cost support early in the AoA process and to conduct a sufficiency review of the cost estimates for the viable alternatives.

8 – Risk Analysis

There are three categories of risks that should be assessed for each alternative in the AoA beyond the work done by the CAWG in assessing cost risk. Risk is defined as the likelihood of an adverse event and the severity of the consequences should that event occur. The first step in risk analysis process is to determine what factors, under each risk category, are relevant to each alternative.

The following shows the three risk categories and potential factors that may be appropriate to assess under each category:

- **Technological Risks**
  - Technology maturity
  - Modularity
  - Open architecture
  - Extensibility
- **Programmatic Risks**
  - Efficacy of doctrine, organization, training, materiel, leadership and education, personnel and facilities (DOTLMPF) characteristics
  - Cost and schedule drivers
  - Overarching dependencies
  - Identify political issues
- **Operational Risks**
  - Special basing requirements or fly-over issues
  - Unique maintenance requirements
  - Technology sensitivities (e.g., keeping info from some of our allies)

Risk analysis may be accomplished by a separate working group, but is often done by the Operations Concepts WG, EAWG or TAWG. Each risk identified should be documented in the TDD.

Once all risks factors associated with each alternative have been identified, the team will need to develop a methodology (e.g., standards or rules) for assigning a level of "likelihood" (e.g., high, medium or low) to the occurrence of each adverse event. The team must then

determine the severity of the "impact" (high, medium or low). At this point the study team or work group responsible for the risk assessment can apply the methodology to each alternative. Spreadsheets or "risk" graphs are the most convenient tools to use to capture these assessments for each alternative. Figure 8-1, shows what the assessment may look like.

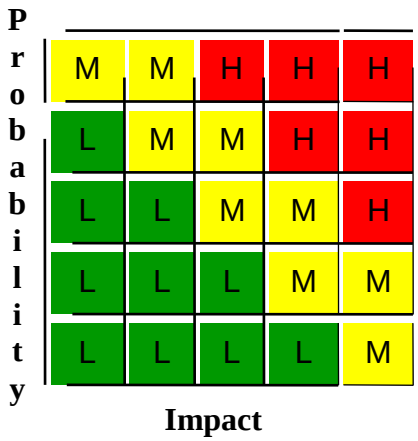


Figure 8-1. Notional Risk Assessment Matrix

One of the key things to remember in this process is that risk assessments are looking at the uncertainty associated with acquiring a particular alternative. For example, an alternative that has a large net-centric architecture will be more dependent upon the GIG providing the required information than an alternative that has enhancements to existing communication and information systems. The first alternative may be more effective but has a greater risk associated with it.

The final step in assessing the overall risks associated with each alternative is to identify risks that cannot be managed or mitigated. This is particularly useful information for the high to moderate risk factors and is excellent information for the decision makers (and program office). The overall risk assessment for each alternative will feed into the alternative comparisons (addressed in the next chapter) along with the effectiveness analysis results and the LCCEs.

9 – Alternative Comparisons

Once the effectiveness results, cost estimates, and overall risk information has been generated and the sensitivities and tradeoffs studied, it is time to bring all of the information together and interpret its meaning through comparative analysis.

Comparing the alternatives means the simultaneous consideration of alternatives' cost, effectiveness, and associated risks and interpreting what it means for making a decision. As consumers, we are all familiar with the concept of comparing alternatives. Whether buying laundry detergent, a new car, or a home, as a consumer, we collect data on costs and make assessments on how well the alternatives will meet our needs (how "effective" they are) and any potential risks associated with bringing a particular product home. With data in hand, we make our comparisons and select a winner. In an AoA, the process is essentially the same, but there is rarely a clear-cut winner.

9.1. The Art of Eliminating Alternatives

Figure 9-1 shows how an original set of alternatives is reduced to a small number of serious contenders. There is no formula for doing this; it is an art whose practice benefits from experience. Each AoA must adapt its methods to circumstances peculiar to that AoA. However, in general, it is prudent to continuously screen the alternatives throughout the AoA process. This has the advantage of eliminating non-viable alternatives before a lot of scarce AoA resources are expended on analyzing them. It is imperative to document the basis for eliminating each alternative from further consideration at the time it becomes clear that it is non-viable. This documentation will need to be included in the final AoA report and provides an audit trail which may be very important in the event the AoA results are questioned.

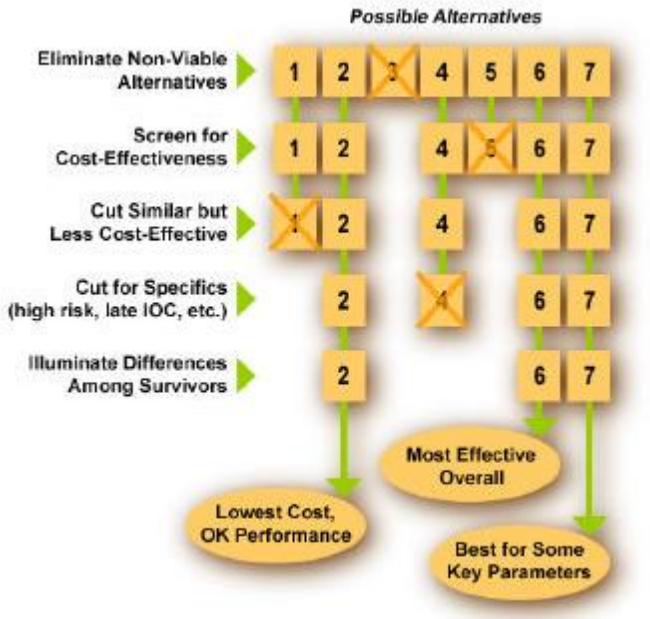


Figure 9-1. Eliminating Alternatives in an AoA

In all AoAs, the study team's understanding of the issues and the techniques to deal with them increases as the study progresses. The same is true for understanding the alternatives. As the AoA progresses, these concepts are often re-engineered to reflect better understanding of requirements, technologies, threats, and scenarios. Improved performance and lower cost usually accompany these changes—thus alternative cost and effectiveness are moving targets. The uncertainty can be limited by setting a cutoff date for concept redefinition, but remember that the charter of the AoA is to find the most cost-effective alternatives, not the most cost-effective alternatives defined up to an arbitrary time. Thus, the AoA should revisit discarded alternatives from time to time when new information promises significantly increased attractiveness. This is most important when a large number of concepts have been screened early in the AoA.

9.1.1. Non-Viable Alternatives

The first screening eliminates non-viable alternatives, i.e. alternatives that have a critical flaw. An alternative should ***not*** be considered "non-viable" because it fails to close 100 percent of the shortfall. For many AoAs, the non-viability criteria are defined in the AoA guidance and often reflect political considerations (environment, world opinion, treaty compliance, etc.) or IOC and FOC requirements due to technology maturity. Non-viable alternatives should be identified in the study plan and the reasons for eliminating these alternatives should be documented.

9.1.2. Preliminary Screening

When a preliminary screening is necessary, it is usually done with limited data derived for alternatives whose definitions are still in transition. This suggests erring on the conservative side by giving alternatives the benefit of any doubt. The exact screening criteria will depend on available analysis resources, the number of alternatives to be carried forward, the perceived uncertainty in cost, risk, and effectiveness estimates, and a host of other factors such as similarity of alternatives, advocacy for alternatives, and technology maturity. Other factors that might be considered are sensitivity of system performance to key assumptions, vulnerability to countermeasures, flexibility in future scenarios, contributions to longer-term goals, reliability and maintainability, and time phasing of resource requirements. The best selection criteria may not be obvious, but they can usually be deduced from the ICD, high level AoA direction, and the experience and expectations of the warfighters. This is a step that is very beneficial to the AoA when there is a premium on rational, creative thinking.

9.1.3. Later Screening

As the AoA progresses and more reliable cost, effectiveness, and risk data become available, there will be opportunities to do additional ad hoc screening. This is typically done on a case-by-case basis using any appropriate criteria. For example, one of the alternatives may be demonstrated to be more costly or less effective than the others; if it has no redeeming qualities it can be removed. Another alternative may be very sensitive to a key parameter, indicating excessive risk in performance; it may then be determined as non-viable.

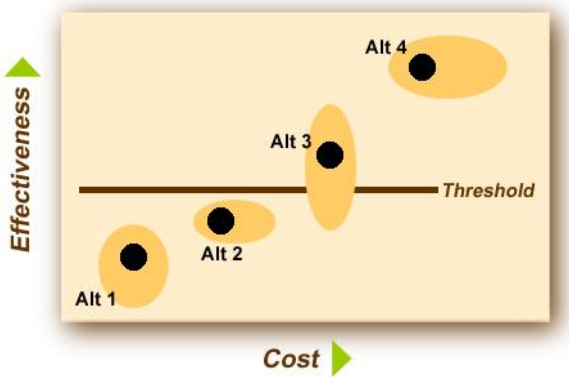
9.1.4. Final Selection

There comes a time in the AoA when the remaining alternatives all have positive attributes that make them attractive in some way (think of a scatter plot similar to that in Figure 9-2: Dilemma 1); they are all true contenders. The next step is to find a way to clearly state for

the decision makers the advantages and disadvantages of each, especially how the alternatives address the ICD/CDD requirements and satisfy high-level guidance. In doing this, the final selection may also consider the impact of risk to help or support the final selection of the preferred alternative(s). Another approach for the final selection is to use the minimum acceptable threshold for critical MoEs, choosing the preferred alternative(s) based on whether or not the alternative meets or exceeds the threshold for all critical MoEs. Any process should present a clear, unbiased picture of the analysis results, findings, and recommendations. The more straightforward and clearly the story is told, the easier it becomes to understand the differences among the alternatives. Even with all results in hand; it is not unusual for this final story to take several weeks or more of intense effort to develop. Again, rational thinking plays an indispensable role. In some cases this final assessment may point to a single "recommended winner." In other cases, no such clear-cut conclusion emerges. In either event, the decision maker will have the best available information and understanding of the alternatives that the AoA can provide.

9.2. Alternative Comparison Dilemmas

As the team conducts the alternative comparisons, the need to determine if additional effectiveness is worth additional cost and the need to assess the relative values of different measures of effectiveness will arise. Figure 9-2 illustrates a common AoA dilemma. From this diagram, we can safely conclude that we would not select Alternatives 1 or 2, but the issue is not clear for Alternative 3 and Alternative 4. Alternative 4 will be chosen if the increase in effectiveness is judged to be worth the cost.



Dilemma 1: Is the Increase in Effectiveness Worth the Increase in Cost?

The decision may be somewhat easier if the AoA guidance has identified the minimum acceptable effectiveness threshold. This would allow us to focus on alternatives that meet or exceed that threshold. This is rarely, if ever, seen for an AoA. Figure 9-2 also illustrates that the analysis results will have ranges representing the uncertainty of the estimates for cost and effectiveness. When the team develops its conclusions, it needs to ensure that the presentation explains what those error bands represent and identify the drivers behind the uncertainties.

Figure 9-3 shows the second type of dilemma. In this illustration, if the MoEs are all critical, there is little to differentiate among the choices. Thus costs and/or risks could be the

more significant discriminating factors. If the MoEs are not all critical, then the three alternatives may differ substantially in overall effectiveness.

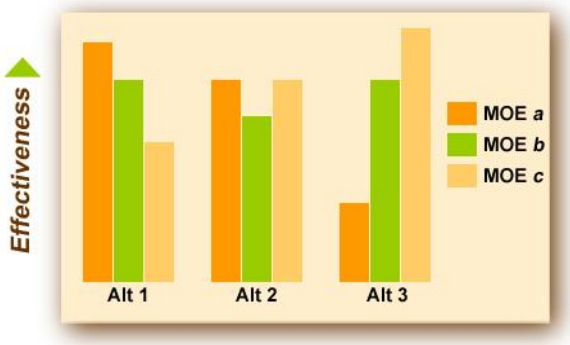


Figure 9-3. Dilemma 2: Do These Three Alternatives Really Have Significant Differences in Overall Effectiveness?

As the comparative analysis is conducted, the team must remember that the goal of the screening process is to identify the most promising candidates for consideration by decision makers. In some cases this may mean a single alternative. In other cases, there will be several alternatives, each with different cost, effectiveness, and/or risk pluses and minuses. Remember: ***there is generally no requirement for an AoA to identify a SINGLE solution***.

The next step in this process is to find a way to clearly identify for the decision makers the advantages and disadvantages of each alternative, especially how the alternatives address the required capabilities and answer the high-level issues/questions in the AoA guidance. In doing this, address the impact of the overall risk of each alternative to help or support the final selection of the preferred alternative(s).

Ensure that the information presented is clear and unbiased, and that it depicts the analysis results, understandable interpretations, and defensible recommendations. The more straightforward and clearly told the story, the easier it becomes to understand the differences among the alternatives. The study team's job is to help the decision makers understand the differences among the alternatives.

The study director should ensure that there is sufficient time in the AoA schedule set aside to conduct sensitivity analysis on the final alternative comparisons. This will allow the results of the final analysis to be vetted with stakeholders before the results are written into the AoA report.

9.3. Alternative Comparison Dos and Don'ts

9.3.1. Provide the Basic Cost, Effectiveness and Risk Data

The completed AoA should provide basic life cycle cost, MoE, and risk assessment data for all candidate alternatives that have been analyzed. By their nature, these data are fundamental to understanding the logic of any additional winnowing of alternatives.

9.3.2. Avoid Using Ratios for Comparisons

Ratios—cost/kill, kills/sortie, etc.—are frequently proposed for comparing alternatives. Unfortunately, ratios can be misleading because they frequently hide necessary information. As an example, suppose that one alternative kills 0.01 targets per sortie and a second alternative kills 0.1 targets per sortie. The second alternative is ten times better than the first, right? That sounds significant, but is it?

The truth is, we can't tell from the ratio alone. If there are 10 targets to be killed, the answer is likely to be a resounding yes—100 sorties may be acceptable, but probably not 1,000. However, if there are 1,000 targets to be killed, the answer is almost certainly no, for we are looking at very large numbers of sorties even for the better alternative.

By using the ratio instead of the numbers of sorties required, there has been a loss of understanding without a corresponding gain of any sort.

9.3.3. Alternative Comparison Matrix

Once all of the analysis has been presented in the report or briefings, it is useful to present a summary of the key discriminators for each alternative side-by-side before presenting the conclusions and recommendations drawn from all of the analysis. Figure 9-4 shows an example of this sort of presentation. This kind of depiction ensures that the report reader or briefing audience has a summary picture of the results in mind (and for reference) as the conclusions and recommendations are made.

	Critical						Non-Critical			Risk	Total LCC $(M)
	Mission Task 1			Mission Task 2			Mission Task 3				
	MoE 1-1	MoE 1-2	MoE 1-3	MoE 2-1	MoE 2-2	MoE 2-3	MoE 3-1	MoE 3-2	MoE 3-3		
Alt 1 (baseline)	G	Y	R	G	G	Y/G	G	R	G	R	$1,200
Alt 2	R	Y/G	G	R/Y	R	G	G	Y/G	Y	G	$1,450
Alt 3	Y/G	G	R	G	Y	Y/G	Y	G	G	R	$1,457
Alt 4	G	R	G	R/Y	G	Y	R/Y	G	R	G	$1,786

Figure 9-4. Notional Matrix of Alternative Comparison Results

9.3.4. Flexibility in Analysis

The need to scale back the planned analysis in an AoA is common; reasons range from delays in obtaining data to mismatches between available resources and desired outputs. This makes it important to design an analysis that is flexible in scope. Without flexibility, often the only choice is to slip the AoA schedule. While at times this can be tolerated, often it cannot.

10 – Final Results

The final results of an AoA are presented initially in a series of briefings. For an ACAT I program, the briefings are typically given to the AFROCC, AFC, Integrating Integrated Product Team (IIPT), and the Overarching Integrated Product Team (OIPT) chaired by the MDA.

The purpose of these briefings is to logically present the case for selection of the best alternative(s) in meeting the capability requirements outlined in the ICD or CDD. The quality of the presentations—and perhaps more so, the quality of the underlying AoA work—is critical to the initiation or continuation of the program.

In addition to the final briefings, the entire AoA process and results must also be documented in a written Final Report. This report, approved by the MAJCOM, and fully coordinated at AF and joint (if appropriate) levels is due at the time of presentation of the final results to the AFROCC. The Final Report is extremely important; it is the principal supporting documentation for any decisions made as a result of the AoA. It also may be the basis for any subsequent AoAs at later milestones and different (but similar) AoAs in the future. We recommend that the Final Report be written as soon as possible after the analysis is complete. Delaying finalization of this document will only make it more difficult to produce as team members will begin to disband and critical information will begin to dissipate once the analysis is completed.

The Final Report should follow the same format as the study plan template (Appendix D) with the addition of these sections:

- Executive Summary
- 5.4 Effectiveness Results
- 6.4 Life Cycle Cost Results
- 7.4 Risk Analysis Results
- 8.3 Alternative Comparison Results
- 8.4 AoA Conclusions and Recommendations

This format corresponds closely to that of the study plan so as to help adapt material from the study plan to the Final Report.

For ACAT I AoAs, OAS is required to provide an independent assessment of the Final Report and briefing prior to the study director's required briefing to the AFROCC. Appendix B describes the criteria OAS uses for this assessment. OAS members, those analysts not directly supporting the AoA, are called upon to read and assess the report, review its contents, and evaluate its credibility and completeness in light of the AoA guidance given and accepted analysis principles. The study director should plan to present the briefing to OAS at least a month before the scheduled AFROCC and after OAS has had sufficient time to review and assess the report (5-6 weeks before the AFROCC briefing).

A – Study Plan Assessment

This appendix contains the AoA study plan assessment criteria used by OAS in their independent assessment of study plans presented to the AFROCC and OSD/PA&E.

In general, the initial study plan must be reasonably complete; however, in some cases complete study plan details may not be finalized or are not yet available. In any case, a believable approach for obtaining the missing details should be in the study plan. The study plan must be organized and concise, be grammatically correct to avoid ambiguity, and contain accurate, easy to interpret figures and tables. It must represent an understandable and logical approach for the analysis that will be executed by the study team. OAS uses a three-color "stop light" assessment for each criterion: "green" means no limitations or risks, "yellow" means some limitations or risks, and "red" means significant limitations or risks. The assessment is based on the supporting statements found in each category and how well the individual parts contribute to overall category. In some cases for a specific AoA, a single item about the AoA may become overarching and critical to the ability of the analysis to be executed.

The following assessment criteria are currently used in evaluating study plans:

1. Measures Based on Relevant Capability Documents.

- Derives mission tasks from the ICD/CDD and other relevant guidance on requirements or capabilities
- Mission Task should reflect the military worth of the alternatives (capability provided to the warfighter)
- Derives MoEs from the mission tasks
- MoEs are independent of the alternatives (all MoEs are used for all alternatives)
- Derives MoPs from the MoEs
- Addresses MoE and MoP threshold requirements (if any)
- Links MTs/MoEs/MoPs to Capability Review and Risk Assessment (CRRA) or FCB stated shortfalls

2. All Relevant Issues and Constraints Are Addressed.

- The AoA study has been responsibly tasked or directed by the MDA, Chief of Staff of the AF (CSAF), SAF, and/or OSD
- Addresses all Issues in the ADM and any other guidance providing insight from the decision makers and impact on the scope of AoA
- Discusses previous related studies that might have provided answers, defined relevant constraints or have addressed important related issues
- Discusses key MDA or other issues that will not be considered or addressed in the analysis
- Discusses key milestones for the AoA and their impact on the analysis
- Make differences in IOC/FOC clear and identify their impact on the alternative solutions

3. Range of Alternatives is Comprehensive.

- Defines the baseline alternative
- Considers a reasonable range of alternatives
- Considers reasonable technologies that can be available
- Discusses the screening criteria for selecting and excluding alternative solutions

- Describes each alternative solution in a reasonable level of detail
- If used, describes categories of alternatives and how a single alternative may be used to represent a category

4. Operational Concepts Are Reasonable.

- Outlines alternative(s) employment concepts (basing, deployment, tactics, infrastructures, interoperability, other limitations, etc.)
- Considers logistics concepts (maintenance, supply, personnel, etc.)
- Identifies interdependencies with existing operational support systems (navigation, communications, weather, etc.) and key support systems (defense suppression, escort, etc.)
- Addresses the impact on the analysis of operational, system, and technical architectures
- Addresses the impact on the analysis from Joint and AF CONOPS perspectives
- Addresses doctrine, organization, training, leadership/education, personnel and facilities (DOTLPF) requirements

5. Threats and Scenarios Are Realistic.

- Discusses nature and sources of threats and scenarios
- Discusses threat and scenario validation
- Discusses threat variations with time
- Discusses integration of threats into scenarios
- Identifies threat and scenario aspects most influential to outcome of the analysis
- Discusses possible reactive countermeasures to each alternative
- Considers contributions of other services and our allies
- Considers the impact of architectures and Joint and AF CONOPS
- Considers a broad range of environmental and hostile operating environments

6. AoA Measures Will Support Capabilities Documents and Other Milestone Documents.

- Ensures key MoEs and MoPs are measurable/testable and that they support development of the ICD, CDD, CPD and Test & Evaluation Strategy (TES) or Test & Evaluation Master Plan (TEMP) documents.

7. Effectiveness Analysis Approach Is Acceptable.

- Discusses effectiveness assumptions/constraints
- Describe potential Designs of Experiments to identify critical areas of the study
- Discusses the suitability of the "level of analysis" (mission, campaign, etc.)
- Defines effectiveness methodology to be used
- Identifies AoA resources required to execute the methodology
- Discusses the ability of the effectiveness analysis to differentiate among alternatives
- Outlines methodology and decision criteria for making the final selection
- Discusses sensitivity analyses addressing threats, alternative performance, etc.
- Identifies effectiveness methodology shortcomings and possible fallbacks

8. Cost Analysis Approach Is Acceptable

- Describes LCC effort to be accomplished during the AoA
- Discusses costing assumptions/constraints

- Defines cost methodology to be used
- Describes the cost WBS for the alternatives
- Discusses the cost risk methodology
- Outline the cost review process
- Describes the appropriate CAIV methodology for the AoA
- Contacted AFCAA to ensure they approve/support the CA approach

9. Use Acceptable Tools and Methodologies, M&S Accreditation Plan is Appropriate.

- Identifies existing effectiveness and cost analysis tools needed
- Identifies analysis tool functions and reasons for selection
- Identifies how each analysis tool is to be used
- Identifies major inputs and outputs of each tool/process
- Identifies tool limitations, if applicable
- Discusses needed tool modifications
- Identifies new M&S needed for the analysis, if applicable
- Identifies data sources and availability
- Discusses interrelationships of tool/process linkages
- Illustrate interrelationships among tools, MTs, MoEs and MoPs
- Discusses M&S and data accreditation procedures (see AFI 16-1001), if appropriate
- Identifies the appropriate M&S Accreditation Authority, if appropriate

10. Alternative Comparison Methodology Approach Is Sound.

- Discusses integration of effectiveness, cost, and cost-effectiveness methodologies
- Discusses the ability of cost-effectiveness comparison methodology to differentiate among alternatives
- Discusses how final results will be presented
- Identifies how the preferred alternative(s) will be selected

11. Overall Risk and Schedule Is Reasonable.

- Includes a schedule for AoA activities
- Addresses potential milestones that are driving the AoA
- Identifies available resources (money, manpower, tools, data, expertise, etc.)
- Assesses the ability of the AoA study team to execute the study plan
- Identifies potential areas of risk pertinent to the study
- Discusses potential roadblocks (new model or methodology development, data availability, lack of stakeholder participants, etc.)

Once the study plan is reviewed and assessed by OAS, the AoA team will prepare a study plan briefing for OAS review and presentation to the AFROCC. Table A-1 describes the actions and timeframe leading to the presentation of the study plan to the AFROCC for approval. OAS members are available to assist the study team to develop the AoA plan and to review the plan before formal coordination begins.

TIMEFRAME	ACTION
5 weeks prior to AFROCC	Study Director sends final study plan and draft AFROCC briefing to OAS.
4 weeks prior to AFROCC	Study Director presents AFROCC briefing to OAS.
	OAS and study team discuss/address any identified issues.
3 weeks prior to AFROCC	Study Director sends coordinated plan/briefing to AFROCC. OAS sends assessment chart and point paper to AFROCC and Study Director.
Week of the AFROCC	OAS attends DC area pre-briefs to support MAJCOM briefer.

Table A-1. Recommended Timeframe to Brief the AoA Plan to the AFROCC

B – Final Results Assessment

This appendix contains the AoA assessment criteria used by OAS for the AoA final results in their independent assessment of final reports and briefings being presented to the AFROCC. The three-color "stop light" assessment for each criterion is also used to assess the final AoA results. It is recommended that the study team review these criteria prior to final report/final briefing coordination. The current assessment criteria are listed below:

1. Important Aspects of the Study Plan Followed.

- Deviations from the planned effectiveness, cost and risk analyses are understood and documented to conform to AoA study plan standards
- Addresses how oversight guidance and all appropriate issues were addressed
- Purpose and tasking were appropriate for the study

2. Threats and Scenarios Appropriate and Approved.

- Addresses threat and scenario validation and DIA approval
- Threats and scenarios were appropriate, providing reasonable results
- AF and Joint architectures have been considered for impact

3. Analysis Tools and Methodologies are Reasonable; M&S Were Appropriately Accredited.

- Tools and methodologies were applied appropriately
- Results are credible and defensible
- Accreditation report covering models and data certification signed
- M&S worked as intended
- Identifies M&S shortfalls; includes workarounds

4. Final Operational Concepts Are Reasonable.

- The appropriate warfighter community and stakeholders vetted the employment concepts (basing, deployment, tactics, treaties and other limitations, etc.)
- The viability of logistics concepts has been validated (maintenance, supply, personnel, etc.)
- Interdependencies with existing operational support systems have been accounted for (navigation, communications, weather, etc.) and key support systems (defense suppression, escort, etc.)
- DOTLPF characteristics have been addressed and documented

5. Effectiveness Methodology Successfully Executed.

- Determines the military worth of alternatives for warfighters
- Discusses effectiveness assumptions
- Follows a logical and reasonable analysis approach
- Evaluates a range of independent alternatives for the final analysis
- Gives a convincing rationale for elimination of alternatives

6. Cost Analysis Methodology Successfully Executed.

- Discusses costing assumptions

- Identifies sources for cost inputs
- Summarizes the cost review process
- Presents cost results by alternative
- Discusses CAIV implications
- AFCAA has approved the methodologies and cost estimating models/methods; Sufficiency Review is underway

7. Presentation of Final Results Support the AoA Findings.

- Discusses the alternative comparison methodology
- Outlines decision criteria and its impact in making the final selection
- Presents alternative comparison results as appropriate
- Presents clear and reasonable results
- Presents and interprets sensitivity analyses addressing the threats, alternative performance, etc.
- Identifies and interprets methodology shortcomings relative to each alternative
- All AoA conclusions are supported with analysis results
- Results, conclusions and recommendations are credible and defensible
- Final AoA Report has been fully coordinated with appropriate AF and stakeholder agencies

The AoA team shall document the final results of the AoA in a Final Report and complete coordination of the report prior to the AFROCC. OAS shall review the Final Report and prepare a documented assessment to be included in the final results briefing that will be presented to the AFROCC. The AoA team will present their AFROCC briefing to OAS for review and recommendations. Both the Final Report and final results briefing shall be submitted to the AFROCC prior to their scheduled presentation. The timeframe and taskings to be completed prior to the AFROCC are described in Table B-1.

TIMEFRAME	**ACTION**
5 weeks prior to AFROCC	Study Director sends final report and draft AFROCC briefing to OAS.
4 weeks prior to AFROCC	Study Director presents AFROCC briefing to OAS.
	OAS and study team discuss/address any identified issues.
3 weeks prior to AFROCC	Study Director sends coordinated report/briefing to AFROCC. OAS sends assessment chart and point paper to AFROCC and Study Director.
Week of the AFROCC	OAS attends DC area pre-briefs to support MAJCOM briefer.

Table B-1. Recommended Timeframe to Brief Results to the AFROCC

C – Review and Approval of AoAs

This appendix contains information related to the review and approval of AoA documentation.

The AFROCC and the AFC, if necessary, reviews and validates AoA study plans, midterm status reports, and draft final results. Also, the AFROCC may direct AoA products be presented to a specific Air Force Group or Board. This action would normally be accomplished to promote advocacy or enhance corporate understanding of the particular program supported by the AoA.

The information presented in Table C-1 should help in determining what reviews are needed for a particular AoA. It should be noted that AoA documents must be approved by AF/CV prior to submission to OSD. It is expected that work at the Action Officer level would be an ongoing process and the sharing of information would have started as early as possible. This would also be true of sharing information with all stakeholders who have an interest in the study.

	MAJCOM	AFROCC	AF/A5R	AF/A5	AF/CV	JROC	PA&E	MDA
ACAT I Study Plan	Reviews All	Reviews All	Coord on package	Coord on package	Approve to go to OSD	Not normally req'd*****	Review prior to AoA initiation******	Approve
ACAT II/III Study Plan	Reviews All	Reviews All	ACAT III Air Staff validation	ACAT II Air Staff validation	Not normally req'd*****	Not normally req'd*****	Not normally req'd******	Approve
ACAT I Midterm Status	Reviews All	Reviews All	Reviews ALL	Reviews ALL	As Required	As Required	As Required	As Required
ACAT II/III Midterm Status	Reviews All	Reviews All	Reviews ALL	Reviews ACAT II	Not normally req'd	Not normally req'd*****	Not normally req'd	Not normally req'd
ACAT I Final Results	Reviews All	Reviews All	Coord on package	Coord on package	Approve to go to OSD	Not normally req'd*****	Review at least 60 days prior to M/S	Approve
ACAT II/III Final Results	Reviews All	Reviews All	ACAT III Air Staff validation	ACAT II Air Staff validation	Not normally req'd*****	Not normally req'd*****	Not normally req'd	Approve

Table C-1: The AoA Review and Approval Process

***** JROC Special Interest Programs may require JROC presentation; Joint Impact Programs may require an FCB presentation.

****** PA&E shall informally review the AoA Study Plan prior to taking it to the AFROCC. This will ensure that the analysis planned addresses issues important to PA&E and the MDA, and represent an executable analysis approach.

- The document sponsor must ensure that PA&E is included as early as possible in AoA development

- The document sponsor is responsible for ensuring AoA "documents" are staffed in a timely manner to meet DODD5000.1 and DODI 5000.02 requirements
- The Air Staff SME should assist in staffing the package through appropriate channels to A5R/A5/VCSAF as appropriate. Some AoAs may require a presentation to either the AFC, and the VCSAF, or both, prior to approval for release to OSD.
    - Staffing of ACAT II/III AoA "documents" beyond A5R/A5 is determined on a case-by-case basis

If the AoA is extremely technical or politically sensitive, either the MAJCOM or the AFROCC may request a formal technical assessment by the TRG. OAS and AF/A9 will help the AoA Study Director schedule reviews with the TRG followed by the AFROCC and AFC if necessary.

If an AoA midterm status briefing is not required outside of Air Force channels and the AoA study is proceeding as originally intended; the study team may request the AFROCC waive the requirement to present the midterm status update.

All ACAT I and selected special interest ACAT II study plans, midterm reviews and final results for Air Force or Joint AoAs which the Air Force is the lead service must have AF/CV approval before being "formally" briefed or presented to OSD. On approval by AF/CV, information will be forwarded to working level IPTs, the OIPT, the Defense Acquisition Board (DAB) and/or equivalent higher bodies. The AF/CV through AF/CVA is the approval authority for modifications to this AF review process (e.g., for special access programs). If the AoA results are being forwarded to OSD/PA&E, the final results/Final Report must be submitted 60 days before the scheduled Milestone Decision briefing.

The AoA schedule should be structured to accommodate the timeline needed to get the AoA final results/Final Report to OSD.

Technical Review Group (TRG)

If a TRG is requested by the MAJCOM study team or the AFROCC, the TRG will assess ACAT I and selected ACAT II or ACAT III AoAs for technical adequacy and completeness of the analytical approach and results. The Director, AF/A9, will chair the TRG. AFOTEC is responsible for reviewing the linkage between the TES/TEMP and ICD/CDD (as outlined in the AoA Final Report) and for presenting a linkage assessment to the TRG. A formal TRG is a very rare occurrence. In the absence of the TRG, OAS will perform technical assessments.

AFROCC and AFC

On occasion, the AFROCC may determine if it is appropriate for the AFC to review the AoA study plan, midterm or the final results. To ensure proper representation on specific issues, the AFROCC through AFSAA may provide attendance recommendations to AF/CVA.

The AFROCC may recommend that AF/CV approve the AoA study plan, midterm or final results without going to the AFC. AF/CV will make the final decision. The senior Air Force members of the OIPT should be invited to the AFROCC and AFC reviews of AoAs.

If the Air Force is identified as the lead service for a Joint Program, AoA members from the other services and OSD/PA&E may be invited to the AFROCC and AFC reviews to ensure their interests and perspectives are addressed when AoA information is presented.

OSD-level Integrated Product Teams and AoAs

DODD 5000.1/DODI 5000.2 and associated interim guidance refer to three levels of

IPTs. The OIPT provides top-level oversight and review, adjudicates issues, and advises the MDA on acquisition issues. The IIPT integrates critical aspects of the program. A specific WIPT, usually the Cost Performance IPT (CPIPT), works AoA issues. The WIPTs may establish WGs to perform specific tasks such as oversight of the study team formed to conduct the AoA.

Air Force AoA CoE

AFMC's OAS is the Air Force CoE for AoAs. The AoA CoE supports the MAJCOM study director in helping administer, plan, execute, and facilitate AoAs and their reviews.

OAS is also responsible for the Air Force AoA training courses and the AoA Handbook providing detailed guidance on how to accomplish an AoA. In cases where the MAJCOM elects not to use a TRG, OAS will provide the AFROCC with an assessment of the AoA products.

To support the AoA planning process, OAS will work with the MAJCOMs to document and track AoA costs, including M&S costs occurring during the study, the number of resources expended, cost of contractor support, and cost of travel and administrative support used during the study.

Joint Service AoAs

For Joint Service AoAs, the central concept is that the AoA process of the lead service will apply, but will be augmented with participation of the other services.

D – Study Plan/Final Report Template

This appendix contains the AoA Study Plan and Final Report template required for the AoA.

----------Cover Page ----------

<Name of Project Here>

Analysis of Alternatives (AoA)
Study Plan/Final Report

<Lead MAJCOM>
<Date>

Distribution Statement
Refer to these sources for more information:
1. Department of Defense Directive (DODD) 5230.24, "Distribution Statements on Technical Documents"
2. Air Force Pamphlet (AFP) 80-30, "Marking Documents with Export-Control and Distribution-Limitation Statements" (to be reissued as Air Force Instruction (AFI) 61-204)
Ask your Scientific & Technical Information (STINFO) Officer for help in choosing which of the available statements best fits your AoA

REMEMBER -- AoA information may be PROPRIETARY, SOURCE SELECTION SENSITIVE, OR CLASSIFIED

----------Table of Contents----------

Table of Contents

Appendices
A. Acronyms
B. References
C. Lessons Learned
D. Technical Description Document
E. Accreditation Plan/Final Report
F. Other appendices as necessary

Note: Additional sections highlighted/underlined in red above to be added to the Final Report (Executive Summary, 5.4, 6.4, 7.3, 8.3, 8.4).

----------Plan/Report Contents----------

Study Plan/Final Report Section Content

Executive Summary

- **Describe the purpose of the study**
- **Identify key organizations associated with the study**
- **Summarize the results of the study**

1. Introduction

1.1. Background

- Describe the history of developments that provide the necessity for the AoA
- Summarize relevant analyses that precede this study
- Paraphrase, quote, and refer to Initial Capabilities Document (ICD), Acquisition Decision Memorandum (ADM), and Program Management Directive (PMD) that required the AoA
- Identifies intended results in general terms
- Identifies any applicable Joint Concept Technology Demonstrations (JCTDs) or Advanced Concept Technology Demonstrations (ACTDs)

1.2. Purpose

- Identifies major acquisition issues to be studied
- Identifies the Milestone to be supported

1.3. Scope

- Identifies the level (engineering, one-on-one, few-on-few, mission, or campaign) and scope of the analysis planned
- Identifies the "tailoring" and "streamlining" used to focus the study
- Describe broadly the nature of possible alternative solutions to be considered

2. Acquisition Issues

2.1. Capability Gaps

- Describe deficiency in system capabilities and refer to ICD or CDD as appropriate
- Identify the timeframe for the mission need
- Describe any applicable ACTDs

2.2. Scenarios

- Describe scenarios and rationale for selection
- Discuss how alternatives are evaluated and compared using scenarios
- Discuss how scenarios are traceable back to DPG/IPS (Defense Planning Guidance/

Integrated Program Summary)

2.3. Threats

- Describe briefly enemy tactics (include potential countermeasures)
- Paraphrase, quote, and reference the System Threat Assessment Report (STAR) or System
- Threat Assessment (STA), if it exists
- Identifies other sources of projections
- Plan to approve or validate the threat through the Defense Intelligence Agency (DIA)
- Identifies areas of uncertainty, if possible

2.4. Environment

- Describe expected operating environment, including terrain, weather, location, and altitude
- Paraphrase, quote, and reference applicable sections in the ICD, CDD or AoA guidance documentation
- Consider the environmental impacts of alternative solutions with the environment

2.5. Constraints & Assumptions for the AoA

- Describe AoA constraints and assumptions, including Initial Operating Capability, Full Operating Capability, and Life Cycle Cost
- Describe the implications of the constraints and assumptions
- Reference applicable sections in the ICD, CDD or AoA guidance
- Identifies the AoA resources available (people, funds and time) and how they affect the scope of the AoA

3. Alternatives

3.1. Description of Alternatives

- Identify the baseline case (this is usually the system in use today)
- Categorize alternatives based on technology, delivery platform, kill mechanism, etc., if productive
- Summarize each alternative
- Use figures to show system functions or interfaces
- Discuss operational concepts variations for individual alternatives
- Describe how alternatives perform their function
- Describe the steps taken to ensure an adequate range of alternatives
- Consider whether the alternative systems are reasonable and feasible
- Discuss the availability of the alternatives within the assumed timeframe
- Describe the economic operating life of each alternative, both expected and required

3.2. Nonviable Alternatives

- Delineate major alternatives that were not included in this analysis
- Describe the rationale for non-selection
- If nonviable alternatives have not yet been identified state so

3.3. Operations Concepts

- Identify organizational functions and operations performed during mission
- Reference applicable sections in ICD or CDD
- Describe how maintenance will be accomplished
- Discuss specific tactics and doctrine used
- Discuss deployment issues
- Discuss interfaces with other systems

- Address needs for inter-operation of the services
- Identifies "day-to-day" and "contingency" operation implications
- Consider any recent field or test experiences that might be relevant
- Describe how the Concepts of Operations and Concepts of Employment fit each alternative

4. Determination of Effectiveness Measures

4.1. Mission Tasks (MTs)

- Identifies what task or tasks need to be achieved to satisfy the ICD
- Endeavor to keep MTs independent of one another
- Try to avoid MTs that use words such as "minimize," "maximize," and "optimize"

4.2. Measures of Effectiveness (MoEs)

- Derives MoEs from MTs
- Make military worth a prime consideration in the selection of MoEs
- Strive to form MoEs that measure and compare the most meaningful quantities that affect performance of MTs
- Support each MT with at least one MoE
- Consider that an MoE may support more than one MT, and may even support other MoEs
- Form 'unbiased' MoEs that are comparable across all alternatives
- Give preference to quantitative versus qualitative MoEs

4.3. Measures of Performance (MoPs)

- Derives MoPs from MoEs
- Support each MoE with at least one MoP
- Consider that an MoP may support more than one MoE, and may even support other MoPs
- Make sure MoPs are "knowable" either analytically or through testing
- Defines MoPs by system performance characteristics, if possible

5. Effectiveness Analysis

5.1. Methodology

- Outline the approach and scope of the analysis, including the proper level of modeling military operations (e.g. campaign, mission, engineering, etc.)
- Plan to carry the baseline alternative through the final effectiveness analysis
- Plan to use MT and, as appropriate, MoE values in the cost-effectiveness analysis
- Consider the influence of threshold performance criteria, if any, in the methodology
- Describe the methodology, including models and simulations to be used
- Assign organizational responsibility for each step
- Describe the mechanisms to be used to obtain the buy-in to the methodology by the appropriate communities
- Plan to perform sensitivity tradeoff analysis, as appropriate
- Discuss how measures used in the AoA are measurable (or testable) and will support the development of the post-AoA documents (e.g., CDD, CPD, TES, TEMP)
- Add details as the plan matures

5.2. Effectiveness Analysis Tool Selection and Data

- Describe briefly the analysis tools and processes that are planned, and the reasons for selection, the input data to be used, and the corresponding sources of the input data
- Give evidence that data for the scenarios, threats, and each of the alternatives will be current, accurate, and unbiased (technically sound and doctrinally correct)

- Describe how models interface and how they are used to calculate MoEs and MoPs (use figures for clarity)
- If M&S are to be used:
    - Discuss who will be running the models
    - Discuss any potential model biases, such as "man-in-the-loop" biases
    - Describe the planned Accreditation process to be used for the models

5.3. Effectiveness Sensitivity Analysis

- Discuss planned methodologies

5.4. Effectiveness Results

- Describe the results of the effectiveness analysis

6. Cost Analysis

6.1. Life Cycle Cost Estimating Methodology

- Outline the approach and scope of the analysis
- Plan to carry the baseline alternative through the final cost analysis
- Consider the influence of threshold performance criteria, if any, in the methodology
- Use the same operational concepts for cost and effectiveness analyses
- Describe the methodology, including the models used
- Assign organizational responsibility for each step
- Describe the mechanisms to be used to obtain the buy-in to the methodology by the appropriate communities
- Plan to perform risk and sensitivity tradeoff analysis, as appropriate
- Identifies the economic operating life of the alternatives (i.e., 10 yr., 20 yr., 25 yr. sustained Operations and Support cost)
- Discuss the methodology for costing Research, Development, Testing, and Evaluation (RDT&E), Investment, Operations and Support (O&S), Disposal, and Total LCC for each alternative
- Identifies "sunk costs" for information purposes only
- Discuss the application of Cost as an Independent Variable to LCC
- Add details as the plan matures

6.2. Cost Analysis Tools and Data

- Describe briefly the models used, their reason for selection, the input data to be used, and the corresponding sources of the input data
- Discuss any potential model shortfalls
- Request sufficiency review from AFCAA

6.3. Cost Risk Sensitivity Analysis

- Plan to identify cost drivers (usually not the most expensive items – see handbook)
- Describe the methodology for determining the level of uncertainty for each element of LCC, as applicable

6.4. Life Cycle Cost Results

- **Describe the results of the cost analysis**

7. Risk Assessment

7.1. Methodology

- Describe the planned methodology for conducting risk analysis and who will be responsible for conducting the analysis

7.2. Risk Assessment Tools

- Discuss risk assessment tools or models which may be used in the analysis

7.3. Risk Analysis Results

- **Describe the results of the Risk analysis**

8. Alternative Comparisons

8.1. Methodology

- Outline the approach and scope of the analysis, including the proper level of analyzing military operations (e.g., campaign, mission, engineering, etc.)
- Consider cost, effectiveness and risk as equal players in the analysis
- Plan to carry the baseline alternative through to the final analysis
- Plan to combine the cost, effectiveness and risk analyses
- Describe the comparison rank ordering methodology
- Describe the methodology, including the analysis tools used
- Assign which organization is responsible for each step
- Describe the mechanisms to be used to obtain the buy-in to the methodology by the appropriate communities
- Plan to perform sensitivity tradeoff analysis, as appropriate
- Plan to use figures and graphics for clarity

8.2. Alternative Comparison Presentation Methodology

8.2.1. Ranking and Decision Criteria

- Discuss criteria for selecting among alternatives
- Describe possible cost and performance thresholds

8.3. Alternative Comparison Results

- **Compare the alternatives using effectiveness, cost and risk**

8.4. AoA Conclusions and Recommendations

- **Provide conclusions and recommendations based on the analysis**

9. Organizational Responsibilities

9.1. Study Team/Organization

- Identify who is doing what
- Include a phone number list for all organization points-of-contact
- Study Advisory Group (SAG) (if used)
- Technical Review Group (if used)

9.2. AoA Review Process

- Describe the review process for this particular AoA (use pictorial if appropriate)
- Working Level Integrated Product Team
- Overarching Integrated Process Team
- Milestone Decision Authority

9.3. Schedule

- Study Plan Preparation 1-4 Months
- Oversight: Review of Study Plan 1-2 Months
- Analysis 3-5 Months
- Oversight: Mid-term Review of Results 1-2 Months
- Any Further Analysis 3-5 Months
- Evaluate Results 1-2 Months
- Study Report Preparation 1-2 Months
- Oversight: Review of Study Report 1-2 Months
- Total 13-24 Months

Appendices
Appendix A: Acronyms
Appendix B: References
Appendix C: Lessons Learned
Appendix D: Technical Description Document (TDD)
Appendix E: Accreditation Plan/Final Report
Appendix F: Other Appendices as Necessary

E – Sources of Information

This appendix provides sources of information applicable to AoA development.

Joint Capabilities Integration and Development System (JCIDS)
JCIDS Overview Briefing
CJCSI 3170.01 – Operation of the JCIDS
CJCSI 3170.01C - JCIDS

DOD Acquisition Process
DODD 5000.1 – The Defense Acquisition System
DODI 5000.2 – Operation of the Defense Acquisition System
Interim Defense Acquisition Guidebook (formerly DOD 5000.2-R)
DODD 5101.2 – DOD Executive Agent for Space
National Security Space Acquisition (NSSA) Policy
DOD 5000.4-M – Cost Analysis Guidance & Procedures

Air Force Specific Implementation
AFPD 63-1 – Capability-Based Acquisition System
AFI 10-601 – Capabilities-Based Requirements Development
AFI 10-604 –Capabilities-Based Planning
FSA Guide
AoA Handbook

Information Technology (IT) Related Policies
Clinger-Cohen Act 1996
CJCSI 6212.01C - Interoperability and Supportability of IT and NSS
DODD 4630.5 – Interoperability and Supportability of IT and NSS
DODI 4630.8 – Procedures for Interoperability and Supportability of IT and NSS
DODD 8100.1 – Global Information Grid (GIG) Overarching Policy
Joint Pub 6-0 – Doctrine for C4 Systems Support to Joint Operations

F – Acronyms

ACAT - Acquisition Category
ACTD - Advanced Concept Technology Demonstration
ADM - Acquisition Decision Memorandum
AF - Air Force
AF/A2 – AF Assistant Chief of Staff for Intelligence
AF/A5R – AF Director of Requirements
AF/A9 – AF Studies and Analysis Agency
AFC - Air Force Council
AFCAA - Air Force Cost Analysis Agency
AFFSA – AF Flight Standards Agency
AFGWC – AF Global Weather Center
AFI - Air Force Instruction
AFMC – AF Materiel Command
AFOTEC – AF Operational Test & Evaluation Center
AFP – AF Pamphlet
AFROCC - Air Force Requirements Operational Capability Council
AFSAA - Air Force Studies and Analyses Agency
ALC - Air Logistics Center
AMA – Analysis of Materiel Approaches
AoA - Analysis of Alternatives
ASD (C4I) - Assistant Secretary of Defense for Command, Control, Communications, Computers and Intelligence
BY$ - Base Year Dollars
C3I – Command, Control, Communications and Intelligence
C4I - Command, Control, Communications, Computers, and Information
C4ISR - Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance
CAE - Component Acquisition Executive
CAIV - Cost As An Independent Variable
CBA – Capabilities Based Analysis
CDD - Capability Development Documents
CER - Cost Estimating Relationship
CINC – Commander in Chief
CIO - Chief Information Officer
CJCSI - Chairman Joint Chiefs of Staff Instruction
CJCSM- Chairman Joint Chiefs of Staff Manual
CoE - Center of Expertise
COEA - Cost and Operational Effectiveness Analysis
COCOM – Combatant Command
CONOPS - Concept of Operations
CPD - Capability Production Documents
CPIPT - Cost Performance Integrated Product Team
CRRA - Capability Review and Risk Assessment
CSAF - Chief of Staff Air Force

CAWG - Cost Analysis Working Group
DAB - Defense Acquisition Board
DAE - Defense Acquisition Executive
DCR –– Doctrine Change Request
DIA - Defense Intelligence Agency
DLA – Defense Logistics Agency
DoE – Department of Energy
DOD - Department of Defense
DODD – Department of Defense Directive
DODI – Department of Defense Instruction
DoI – Department of the Interior
DoT – Department of Transportation
DOTLPF – Doctrine, Operations, Training, Leadership/Education, Personnel, and Facilities
DOTMLPF – Doctrine, Operations, Training, Material, Leadership/Education, Personnel, and Facilities
DPG/IPS - Defense Planning Guidance/Illustrative Planning Scenario
DTRA – Defense Threat Reduction Agency
EAWG – Effectiveness Analysis Working Group
FAA – Functional Area Analysis
FAA – Federal Aeronautical Administration
FCB – Functional Control Board
FFRDC - Federally Funded R&D Center
FM – Financial Management
FNA - Functional Needs Analysis
FoS – Family of Systems
FOC - Full Operational Capability
FSA - Functional Solution Analysis
GEO – Geosynchronous Earth Orbit
GIG – Global Information Grid
IC – Implementing Command
ICD - Initial Capabilities Document
IIPT - Integrating Integrated Product Team
IOC - Initial Operational Capability
IPT - Integrated Product Team
IT – Information Technology
JCIDS – Joint Capabilities Integration and Development System
JCD – Joint Capabilities Document
JCTD - Joint Concept Technology Demonstration
JFACC – Joint Forces Component Commander
JROC - Joint Requirements Oversight Council
KTR – Contractor
LEO – Low Earth Orbit
LCC - Life Cycle Cost
LCCE – Life Cycle Cost Estimate
M&S - Models & Simulations
MAISAP - Major Automated Information Systems Acquisition Programs

MAJCOM - Major Command
MDA - Milestone Decision Authority
MDAP - Major Defense Acquisition Program
MER - Manpower Estimate Report
MILCON - Military Construction
MoA - Memorandum of Agreement
MoE - Measure of Effectiveness
MoP - Measure of Performance
MoU - Memorandum of Understanding
MS - Milestone
MSFD - Multi-Service Force Deployment
MT - Mission Task
NASA – National Aeronautics and Space Administration
NGA – National Geospatial Intelligence Agency
NIMA – National Imagery Mapping Agency
NSSA – National Security Space Acquisition
O&S - Operations and Support
OAS - Office of Aerospace Studies
OC - Operating Command
OC/FM - Operating Command Financial Management
OIPT - Overarching Integrated Product Team
OSD - Office of the Secretary of Defense
OSD/PA&E - OSD/Program Analysis and Evaluation
P3I - Pre-Planned Product Improvement
PM – Program Manager
PMD - Program Management Directive
PPBE – Planning, Programming, Budgeting, and Execution
R&D - Research and Development
RDT&E - Research, Development, Test & Evaluation
SAF – Secretary of the AF
SAF/AQ – Secretary of the AF for AQ
SAG – Study Advisory Group
SETA - Scientific, Engineering, Technical, and Analytical
SME – Subject Matter Expert
SoS – System of Systems
SPO - System Program Office
STA - System Threat Assessment
STAR - System Threat Assessment Report
STINFO – Scientific & Technical Information
T&E – Test and Evaluation
TAWG – Technology & Alternatives Working Group
TDD – Technical Description Document
TEMP - Test and Evaluation Master Plan
TES – Test and Evaluation Strategy
TRG - Technical Review Group
TY($) – Then-year (dollars)

USD (AT&L) - Undersecretary of Defense for Acquisition, Technology and Logistics
VCSAF - Vice Chief of Staff Air Force
WG - Working Group
WIPT - Working-Level Integrated Product Team

G - Technical Description Document (TDD) Template

This appendix provides a general format for TDD development.

General Section – Pertains to all alternatives

1. **Preface**

2. **Overarching Assumptions**
    - Apply to all alternatives or representatives within a category

- **Overarching CONOPS/CONEMPS**
- Represents how the required capabilities fit into the "big picture" mission/functional area
- Should match what is in the JCD and FSA Study Plan
- Independent of the individual alternatives

- **Overarching Operational Considerations**
- Applies equally to all alternatives

- **Overall DOTLPF Implications**
- Implications of required capabilities that apply regardless of which alternative is recommended

- **Framework for Alternative Description Discussion**
- Defines how each alternative will be described in the document
- Stage setter for other sections

Alternative definition – Define each alternative giving particulars

Alternative 1 (repeat for each new alternative)

1. **Definition of Alternative**
    - Title and brief description, one paragraph

- **Assumptions**
- Key assumptions specific to that alternative
- Which capability gap is being addressed

- **Concept of Operations and/or Employments**
- Details how this alternative will be employed
- Details any unique information about how this alternative will operate

- **Alternative Description (Characteristics/Attributes)**
- Describes detailed information specific to this alternative
    - Size, weight

    - Speed, range
    - Power, db
- This section should contain enough detail to develop a cost WBS

- **Risks**
- Technical Risk Assessment (Include TRL level)
- Risk Summary

- **Program Management**
- Identifies special considerations required to manage the development of this alternative
- Identifies special considerations required for fielding this alternative

- **Integration/Development**
- Identifies any integration/interoperability considerations – especially for an SoS or FoS

5. Non-materiel Considerations (DOTLPF Implications)

6. Sample Configuration (if SoS or FoS)

7. Other Issues

H - Lessons Learned

This appendix provides rationale and guidance for capturing and documenting lessons learned. Lessons learned provide current and future AoA study teams with valuable knowledge derived from past and present AoA efforts. This knowledge includes information about the strengths and weaknesses of initiating, planning, and executing an AoA. Lessons learned from the beginning of the AoA to completion of the AoA process should be thoroughly documented. By capturing and documenting lessons learned, each AoA team can add to and benefit from the collective wisdom and best practices related to the AoA process.

Some of the most commonly recurring Study Team lessons learned include:

1. Meet regularly either in person or virtually
2. Team composition of both Air Force and contractor personnel provides good complementary technical support
3. Study Advisory Groups can provide guidance, support and sanity checks
4. The Study Director and his core team must lead the entire effort
5. Small numbers of people meeting are more productive
6. Buy-in of the senior leaders at all levels is critical
7. Things will change – documentation and communication is critical
8. Utilization of High Performance Teams can increase efficiency and has the potential to shorten timelines. They are especially useful when a team is faced with a very aggressive schedule

I –Accreditation Plan/Report Template

This appendix provides guidance for selecting and evaluating individual models for the accreditation process. As AoAs expand the use of M&S to reduce risk and resources expended in the acquisition process, there is an increasing need to ensure the credibility of models and simulations, including input data. As a result, DOD and Air Force regulations now require that software and data be accredited for each major acquisition. Model verification is the process of determining that a model accurately represents the model developer's conceptual description and specification. Model validation is the process of determining the extent to which the model is an accurate representation of the real world with respect to its intended uses. For certain AoAs and similar studies, model accreditation is required.

Accreditation is an official determination that a model is acceptable for a specific purpose. Model accreditation begins with development of the accreditation plan. The plan contains criteria for model assessment based on the ability of the model to accept the required input data and to provide appropriate output information to resolve the MOEs. All data used for model input and scenario configuration should also be validated to ensure credibility of the output. Once the model assessment is complete, a final accreditation report is prepared. Table I-1 provides a method for evaluation for M&S used in AoAs.

OAS has prepared a pamphlet for M&S selection and accreditation. The pamphlet contains criteria for accreditation as well as templates that can be used for summarizing model adequacy for AoA analysis. The purpose of the pamphlet is to help expedite and standardize the AoA M&S accreditation process. Please contact your OAS representative for a copy of this pamphlet.

	Criteria	Rating Scale
Risk	Assess the analysis for 1) timely and accurate representation of the natural environment, 2) authoritative representation of human behavior, and 3) authoritative representation of the subject(s)	**RED:** Model not appropriate for intended purpose; do not use for this study **YELLOW:** Relevant model of environment, behavior, or system **GREEN:** Demonstrated adequacy for intended purpose
Input Data	Assess the input data used to describe the three representations above	**RED:** Data are arbitrary or best guess; data not reviewed **YELLOW:** Most data are traceable to certified sources; data reviewed **GREEN:** All data are valid or certified or pedigreed
Critical Elements Modeled	Compare the M&S capability to the application criteria...can the model address the inherent issues associated with the MOEs?	**RED:** MOE functionality not modeled **YELLOW:** Functionality indirectly contributes to the MOE, or offline analysis required **GREEN:** MOE functionality directly modeled
User Experience	Assess the experience, credibility, and capabilities of the AoA analysis team	**RED:** User has no modeling experience, nor prior expertise with this model **YELLOW:** User has limited expertise with this model **GREEN:** User has expertise with this model, or is the developer
History	Review the M&S development history, summarize past application(s), and define the application domain based on a description of the capabilities by the M&S developer (AFI16-1001)	**RED:** No history; new model **YELLOW:** Some history, primarily undocumented; well documented lineage **GREEN:** Lineage completely documented
Configuration Management	Review the adequacy of the model's configuration version control; complete an acceptable face validation examination, if appropriate (AFI16-1001)	**RED:** No formal configuration management process **YELLOW:** Some configuration management process for all major upgrade/code changes **GREEN:** CCB process for all changes
Documentation	Ensure model documentation exists and is current/sufficient for the intended use (normally includes M&S conceptual model, user's guide, and programmer's and analyst's manuals) (AFI16-1001)	**RED:** No published documentation **YELLOW:** Published documentation for previous version; change documentation developed but not published **GREEN:** Complete set of documentation exists for version used
User Community	Compare the analysis with known US and international analysis standards and techniques	**RED:** Limited user community for specialized applications not related to current use **YELLOW:** Small user community; no formal users group **GREEN:** Formal users group representing wide range of application
Prior V&V	Ensure data sources have been identified and that both producer and user data VV&C were accomplished (AFI16-1001)	**RED:** No prior V&V **YELLOW:** Some V&V on previous version; face validation for current use **GREEN:** Well documented V&V including live test results and/or model comparisons; prior accreditation reports

Table I-1: A Structure for Evaluating Individual Models