
# Analysis of Alternatives (AoA) Handbook

## *A Practical Guide to the Analysis of Alternatives*

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Office of Aerospace Studies

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# Preface

The purpose of this handbook is to guide study teams in planning and conducting Analysis of Alternatives (AoA) studies. The handbook provides guidance on forming the Working Integrated Product Team (WIPT), developing the AoA study guidance and study plan, forming the AoA study team, conducting the study, and developing the final report. The handbook was not designed to be a stand-alone source of information about planning and conducting an AoA and reporting AoA results, but instead provides references to relevant supplemental, and in some cases, more detailed information contained in other OAS, Air Force, and Department of Defense (DoD) documents.

This handbook is grounded in over twenty years of providing analytic advice on Air Force and DoD AoAs. It has been shaped by best practices we have gathered from well over two hundred AoAs, and by what we have observed to be the expectations of Air Force and DoD senior decision makers. As these expectations keep evolving, so will this handbook. We encourage you to contact us to ask questions about any parts of the handbook that appear unclear, how the guidance in the handbook applies to your particular situation, or any other study issues or concerns you may have. We always appreciate feedback and welcome any suggestions to improve this handbook. Please contact OAS with any questions or suggestions at (OAS.DIR@us.af.mil) or 505-846-8322 (DSN 246).

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Director, Office of Aerospace Studies

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# 1 Introduction

This chapter describes the Analysis of Alternatives (AoA) study and how it fits in the capability development and acquisition processes. It defines the purpose of the AoA and discusses how and when AoAs are initiated. The OAS role in supporting the planning and conduct of the AoA is discussed at the end of the chapter.

## 1.1 About this Handbook

The activities and processes outlined in this handbook apply to all AoA studies regardless of Acquisition Category (ACAT) or Joint Staffing Designator (JSD). With the AoA being an important element of both the capability development process and the acquisition process, a basic understanding of these processes is essential. To help facilitate an understanding of the material presented in this handbook, OAS recommends that, as a minimum, the reader reviews the following documents, focusing especially on the sections that pertain to the AoA. Due to frequent changes, the directives contained in the documents below supersede this handbook:

- AF/A5R Capability Development Guidebook, Volume 1 - Air Force Implementation of the JCIDS Deliberate Process.[1] This guidebook outlines the AF execution of the Chairman of the Joint Chiefs of Staff Instruction (CJCSI) 3170.01, *Joint Capabilities Integration and Development System* (JCIDS) and the accompanying Joint Staff (JS)/J8 JCIDS Manual, *Manual for the Operation of the Joint Capabilities Integration and Development System*. It implements Air Force Policy Directive (AFPD) 10-6, *Capabilities Requirements Development*. It also implements JCIDS for the Air Force and establishes the guidelines, policies, and procedures for defining, developing, documenting, validating, approving, and managing Air Force operational capability requirements.
- JCIDS Manual, *Manual for the Operation of the Joint Capabilities Integration and Development System.* This manual provides procedural guidance for the overall JCIDS process. It outlines the various processes to identify capability requirements, associated capability gaps, document formats (e.g., ICD, CDD, CPD), and proposed materiel and non-materiel capability solutions for submission into the JCIDS process for review and validation.
- Department of Defense Instruction (DoDI) 5000.02, *Operation of the Defense Acquisition System*. This instruction provides detailed procedures that guide the operation of the defense acquisition system in accordance with the overarching management principles and mandatory policies described in the Department of Defense Directive (DoDD) 5000.01, *The Defense Acquisition System*.
- *Defense Acquisition Guidebook*. This guidebook is designed to complement DoDD 5000.01 and DoDI 5000.02 by providing discretionary best practices that can be tailored to the needs of each program. It is designed to improve understanding of the acquisition process and ensure

[1] The AF/A5R Capability Development Guidebook, Volume 1 - Air Force Implementation of the JCIDS Deliberate Process is hereafter referred to as the A5R Guidebook throughout this handbook.

adequate knowledge of the statutory and regulatory requirements associated with the process. Be advised, updates to this document lag DoDD 5000.01 and DoDI 5000.02.

- AFI 63-101, Integrated Life Cycle Management. This instruction is a supplement to DoDI 5000.02. It provides detailed instructions that guide Air Force operation of the defense acquisition system.

## 1.2 What is an AoA?

As defined in the A5R Guidebook, the AoA is an analytical comparison of the operational effectiveness, suitability, risk, and life cycle cost of alternatives under consideration to satisfy validated capability needs (usually stipulated in an approved ICD). Other definitions of an AoA can be found in various official documents. The following are examples from DoDI 5000.02 and the *Defense Acquisition Guidebook*:

- The AoA assesses potential materiel solutions that could satisfy validated capability requirement(s) documented in the Initial Capabilities Document, and supports a decision on the most cost effective solution to meeting the validated capability requirement(s). In developing feasible alternatives, the AoA will identify a wide range of solutions that have a reasonable likelihood of providing the needed capability.
- An AoA is an analytical comparison of the operational effectiveness, suitability, and life cycle cost (or total ownership cost, if applicable) of alternatives that satisfy established capability needs.

Though the definitions vary slightly, they all generally describe the AoA as a study that is used to assess alternatives that have the ***potential*** to address capability needs or requirements that are documented in a validated or approved capability requirements document. The information provided in an AoA helps decision makers select courses of action to satisfy an operational capability need.

## 1.3 What is the Purpose of the AoA?

According to the A5R Guidebook, the purpose of the AoA is to help decision-makers understand the tradespace for new materiel solutions to satisfy an operational capability need, while providing the analytic basis for performance attributes documented in follow-on JCIDS documents. The AoA provides decision-quality analysis and results to inform the Milestone Decision Authority (MDA) and other stakeholders at the next milestone or decision point. In short, the AoA must provide compelling evidence of the capabilities and military worth of the alternatives. The results should enable decision makers to discuss the appropriate cost, schedule, performance, and risk tradeoffs and assess the operational capabilities and affordability of the alternatives assessed in the study. The AoA results help decision makers shape and scope the courses of action for new materiel solutions to satisfy operational capability needs and the Request for Proposal (RFP) for the next acquisition phase. Furthermore, AoAs provide the foundation for the development of documents required later in the acquisition cycle such as the Acquisition Strategy, Test and Evaluation Master Plan (TEMP), and Systems Engineering Plan (SEP).

The AoA should also provide recommended changes, as needed, to validated capability requirements that appear unachievable or undesirable from a cost, schedule, performance, or risk point of view. It is

important to note that the AoA provides the analytic basis for performance parameters documented in the appropriate requirements documents (e.g., AF Form 1067, Joint DOTmLPF-P[2] Change Request (DCR), AF-only DCR, Draft Capability Development Document (CDD), Final CDD, or Capability Production Document (CPD)).

## 1.4 When is the AoA Conducted?

As noted earlier, the AoA is an important element of both the capability development and acquisition processes. As presented in the A5R Guidebook, Figure 1-1 highlights where AoA is conducted in these processes. The capability development phases are shown across the top of the figure[3] while the lower right of the figure illustrates the acquisition phases, decision points, and milestones. In accordance with the Weapon Systems Acquisition Reform Act (WSARA) of 2009, DoDI 5000.02, and the A5R Guidebook, for all ACAT initiatives, the AoA is typically conducted during the Materiel Solution Analysis (MSA) phase. Follow-on AoAs, however; may be conducted later during the Technology Maturation & Risk Reduction and the Engineering & Manufacturing Development phases.

[2] DOTmLPF-P is the acronym for Doctrine, Organization, Training, materiel, Leadership and Education, Personnel, Facilities, and Policy.

[3] The basis for the capability development process used by the Military Services is the Joint Capabilities Integration and Development System (JCIDS). For more information about JCIDS, see the *JCIDS Manual.*

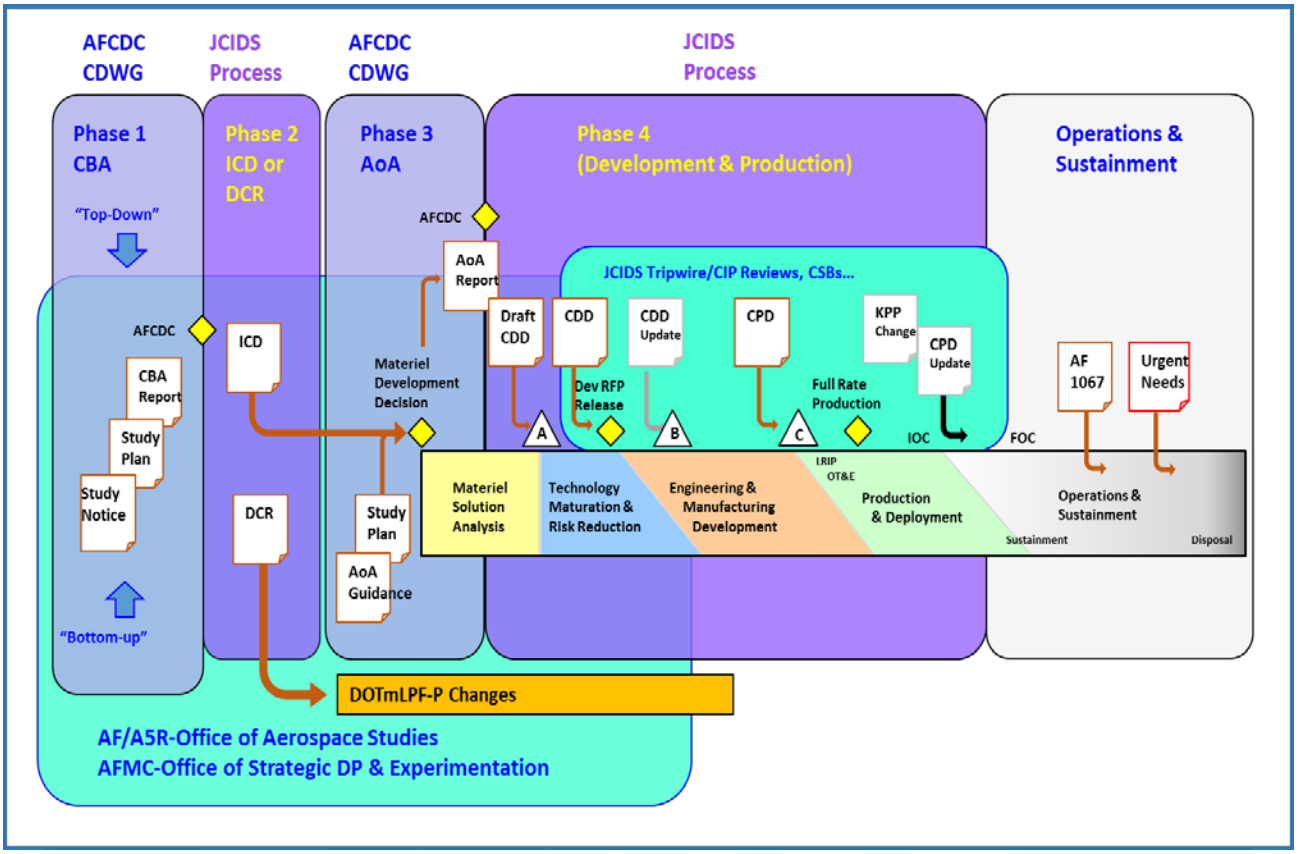


**Figure 1-1: The AF Requirements Processes Overview**

## 1.5 What drives the requirement to conduct AoAs?

All potential acquisition programs have either a statutory (i.e. law-based) or regulatory requirement for the conduct of an AoA. Beginning with the statutory requirements, Title 40, Subtitle III of the U.S. Code (40 USC, Subtitle III: aka the Clinger-Cohen Act) drives the requirement for AoAs to be conducted in support of all Information System acquisitions to include National Security Systems (NSS) regardless of their potential or designated ACAT level. However, it is important to note that the actual language of 40 USC, Subtitle III does not specifically mention AoAs; rather, AoAs are the means by which the DoD has chosen to satisfy the analytical requirements specified in the law. In addition to the statutory requirement for AoAs levied against Information Systems, Title 10 USC Sections 2366a and 2366b (10 USC § 2366a & § 2366b: aka Milestone A and B certifications to Congress, respectively) do the same for all potential or designated ACAT I programs.

Readers should note that Congress occasionally tweaks the statutory requirements for AoAs via the annual National Defense Authorization Acts (NDAA) or other public laws such as the Weapon System Acquisition Reform Act (WSARA) of 2009.

As for regulatory requirements, if an effort is neither an Information System nor a potential or designated ACAT I program, then DoDI 5000.02 still requires the conduct of an AoA.

## 1.6 What are the primary AoA-related products?

There are three primary AoA-related products: the AoA study guidance, the AoA study plan, and the AoA final report. As shown in the Figure 1-1, the AoA study guidance and study plan are developed prior to the Materiel Development Decision (MDD). In the Air Force, the decision to proceed with developing the study guidance and plan is made by AF/A5R.[4] If approved, the AoA study sponsor convenes Working Integrated Product Teams (WIPTs) to develop the study guidance and plan (generally, two separate events). See paragraph 2.5 for more information regarding WIPTS. The AoA study guidance is usually drafted by the Sponsor and broadly describes the AoA scope, goals, and timeline. Similarly, the AoA study plan is developed by the study team and describes the specific methodologies and processes to be employed during the AoA as the means of complying with the AoA guidance. Prior to MDD, there are usually several Air Force, and in some cases depending on the program, Joint Staff (JS) and Office of the Secretary of Defense (OSD) reviews that are required as part of the study guidance and study plan approval processes. At MDD, the MDA uses the AoA study guidance, study plan, and other relevant information to determine whether to proceed with entering the MSA phase and conducting an AoA.

After MDD, the AoA study team conducts the AoA and produces an AoA final report. It contains a summary of the study plan's methodologies and processes, describes any significant deviations thereof, and, finally, documents the results, findings, conclusions, and recommendations of the study. Similar to the study guidance and plan, the final report may undergo a number of Air Force, Joint Staff, and OSD reviews as part of the approval and validation processes. Results from the AoA (and other sources) provide information that allows the MDA to make an informed decision as to whether an acquisition program is appropriate and at which milestone the program should enter. The MDA may authorize entry into the acquisition process at any point consistent with phase-specific entrance criteria and statutory requirements. The AoA final report results are also used to help develop the draft Capability Development Document (CDD). DoDI 5000.02 and the A5R Guidebook provide details regarding the staffing, assessment, and approval guidelines for the AoA final report.

The AoA study plan and final report may be updated as needed later in the capability development and acquisition processes. At Milestone B, AoA updates are used to refine the proposed materiel solution and reaffirm the rationale for proceeding into the formal systems acquisition process. The update is initiated at the start of the Technology Maturation and Risk Reduction Phase and is reviewed at Milestone B (which usually represents the first major funding commitment to the acquisition program). At Milestone C, updates to the AoA are usually not needed unless significant changes to threats, costs, or technology have occurred, or additional analysis is otherwise deemed necessary by the MDA.

There is one important exception to the above scenarios; specifically, when some or all of the requirements have a JSD of JROC Interest and yet the potential or designated ACAT is something less than ACAT ID/IAM. In this case, the Defense Acquisition Executive (DAE) (i.e., AT&L) typically delegates MDA to the Component-level or below. If that occurs, the Office of the Secretary of Defense, Cost

[4] A more complete explanation of the process is described in Section 1.7. Additional information regarding the AoA entry criteria can be found in the A5R Guidebook.

Analysis and Program Evaluation OSD(CAPE) will typically likewise delegate AoA study guidance approval authority as well; however, one cannot assume that the initial delegation implies the latter. AoA study leads should obtain documentation which explicitly captures the OSD(CAPE) delegation decision even if that entails nothing more than emails between the related action officers. Even when OSD(CAPE) delegates this authority, it does not relieve them of their related statutory responsibilities, thus you can expect them to maintain some level of oversight or situational awareness during the AoA.

## 1.7 How is the AoA Initiated?

Generally, AoA activity is initiated by a lead command/sponsor in response to one or more validated capability gaps identified in an ICD or multiple ICDs and following the determination (via early systems engineering and development planning or similar activity) that there are candidate solutions that have the potential to effectively and affordably address the gaps.[5]

Approval to proceed with AoA activity is dependent on several criteria including the status of the validation review of the associated ICD or AF/A5R approval to use a previously validated non-AF ICD. Validation of an ICD and concurrence with the need for an AF-sponsored materiel approach (as indicated in the ICD validation) generally represents the approval to convene an AoA study team to begin developing the associated AoA documentation, beginning with AoA study guidance. (Note: As prescribed in the JCIDS manual, at a minimum, a study initiation notice must be submitted to the study repository. See JCIDS for specific information regarding study initiation notice requirements).

After the sponsor/study team develops the draft AoA study guidance, the MAJCOM/sponsor POC submits the document and any supporting materials (via Information and Resource Support System (IRSS)) for CDWG review followed by Air Force Capability Development Council (AFCDC) (or higher) approval and release to OSD(CAPE), if required.

The Director of Cost Assessment and Program Evaluation (DCAPE) is the approval authority for all AoA documents associated with ACAT I/JROC Interest programs. For those AoAs where DCAPE elects not to provide oversight, the AFCDC Chair (i.e. AF/A5/8) serves as the approval authority.

With AFCDC approval of the study guidance (and/or approval from OSD(CAPE), when required), the sponsor may then proceed with development of the AoA study plan.

Following development and coordination of the AoA study guidance and plan, the team's next step will be briefing the MDA at the Materiel Development Decision (MDD). The MDA officially directs execution of the AoA and authorizes the designated lead DoD Component to do so during the Materiel Solution Analysis Phase. Note that all efforts must go through an MDD as the entry point into the acquisition process (regardless of their potential or designated ACAT level); however, DoDI 5000.02 emphasizes that an "acquisition program" is not formally initiated until at least Milestone B. At the MDD, the MDA is

[5] The Sponsor is typically a lead MAJCOM, but other types of organizations may also be designated as the lead for an AoA. The term "lead command/sponsor" or "study lead/sponsor" is used to refer to lead command, or other organization leading the AoA and development of the associated documentation.

presented with a synopsis of the AoA study guidance, the AoA study plan, the affordability goal, and the plan to staff and fund the actions that will precede the next decision point. If the MDD is approved, the MDA will designate the AoA lead Component/MAJCOM (as appropriate); determine the acquisition phase of entry; and identify the initial review milestone. An Acquisition Decision Memorandum (ADM) will be generated to document these decisions. The approved AoA study guidance and study plan will be attached to the ADM.

Another way an AoA can be initiated is by the MDA. The AoA study plan and final report may also be updated as needed by the MDA later in the capability development and acquisition processes. If deemed necessary by the MDA, AoA updates can occur at Milestones B and C.

Finally, an AoA may be initiated through higher-level guidance or direction. Organizations such as the AFCDC, the Office of the Under Secretary of Defense for Acquisition, Technology, and Logistics (OUSD(AT&L)), the OSD(CAPE), and the United States Congress can provide guidance as to whether an AoA should be initiated.

## 1.8 What are the typical inputs (i.e., prerequisites) to an AoA?

Because every AoA is different, there is no typical starting point. Optimally, the inputs to an AoA include the following, though all may not be available at the start of the AoA:

- A clear definition and understanding of the required capability, including high-level mission tasks (MTs) and supporting sub-tasks, quantitative and qualitative measures (e.g., measures of effectiveness (MOE), measures of performance (MOP), and measures of suitability (MOS)), initial threshold and objective standards or criteria associated with the tasks, and the expected conditions and operating environment under which the tasks must perform,[6]
- An overarching operating concept and operational context[7] for the required capability and associated employment concepts,
- A comprehensive description of the baseline capability (if one exists) which includes the identification of all contributing systems planned and programmed within the current POM/FYDP,
- The identification of the specific capability gaps of the baseline to be addressed by the AoA and an assessment of the related operational risks as endorsed by the JSD validation authority,

[6] For more information about developing measures, see *The Measures Handbook,* OAS, and the ICD section of the JCIDS Manual.

[7] The operational context includes the timeframe under consideration, applicable threats, relevant Service and joint concepts, CONOPS, objectives, related effects to be achieved, and associated operational tasks. Examples of CONOPS include the AF Future Operating Concept (AFFOC), the Joint Operational Access Concept (JOAC), and the Capstone Concept for Joint Operations (CCJO).

- The JCIDS required DoDAF views for the CBA and ICD. If the JCIDS required DoDAF views do not already exist, recommend developing them before beginning execution of the AoA,
- Service-level requirement authority and JSD validation authority (Functional Capability Board (FCB), AFCDC, and potentially JROC) concurrence that the related operational risks warrant an assessment of potential Materiel and materiel solutions available to mitigate those risks,[8]
- A collection of potential Materiel and materiel approaches to fill the gaps/shortfalls as defined by Concept Characterization & Technical Descriptions (CCTD) generated via the Development Planning (DP) process,
- An affordability analysis completed for the ICD in accordance with JCIDS along with an affordability goal as defined at MDD and coordinated with HAF A8,
- An assessment of intelligence support required for the potential materiel solutions,
- AoA study guidance and an AoA study plan approved in accordance with the ACAT and JSD level,
- The identification and commitment of program funding to reach the next anticipated/planned acquisition milestone decision.

Assuming the standard JCIDS process has been followed up to this point, the related Capabilities Based Assessments (CBA) and subsequent development/approval of the respective Initial Capability Documents (ICD) should have already addressed the first five major bullets above to some degree. However, additional work is usually required (either during AoA planning or execution) to bring this data up to the level of fidelity required of an AoA. The amount of additional work required is a direct reflection on the quality, depth, or rigor of any preceding CBAs and/or ICDs. But, as implied by the sixth bullet, the existence of validated requirement documents does not guarantee they will be followed by an AoA. On the other hand, their absence doesn't necessarily preclude Higher Headquarters (HHQ) support for an AoA either. To facilitate the proper prioritization of today's scarce resources, both the Service requirements authority and JSD validation authority must agree on proceeding with an AoA before the Sponsor expends any effort in anticipation of one. Obtaining such an agreement marks the informal start of an AoA and it is between this point and the official beginning of the AoA that the Sponsor either produces or coordinates on those products required by the decision authority.

Excluding the first five CBA and ICD-related bullets, the longest lead-time item from the list above is, by far, the CCTDs. The DP effort for capability gaps with a high likelihood of proceeding directly to an AoA should be started as soon as possible after the draft ICD is placed into Joint coordination. This

[8] Throughout this document, the words "materiel" and "Materiel" will be used. The lower case "m" in materiel signifies a solution that is limited to modifications of existing systems and/or procurement of more existing systems. Although called "materiel", these solutions are classified as non-materiel solutions. The upper case "M" in Materiel signifies a solution that is procured through a new acquisition program.

recommendation assumes the standard JCIDS process up to this point. If the CCTDs were not completed prior to AoA start, the study team is responsible for developing them during study plan development.

The bottom line for all of the items listed above is that it is far better to have these tasks completed before the AoA begins rather than expending resources to complete them during AoA execution.

## 1.9 When does an AoA end; what are the expected close-out activities?

The AoA study guidance will typically assign oversight of AoA execution to a forum called the Study Advisory Group (SAG) comprised of senior representatives from the key stakeholder organizations. When OSD(CAPE) retains AoA study guidance approval authority, a senior representative from that office will either chair the SAG or share that duty with a senior representative from the DAE. When AFCDC has AoA study guidance approval authority, a senior HAF/A5R representative will typically chair the SAG. Either way, the SAG usually has the authority to alter the study guidance during AoA execution. Thus, regardless of what the original AoA study guidance directed in terms of content and/or schedule, an AoA typically does not end until the SAG is satisfied. If the AF had additional concerns identified in an AF guidance supplement, these must also be satisfied.

Once the SAG has given their approval to begin AoA close-out activities, the study team begins compiling the AoA final report. When ready, a draft of the final report typically goes through two rounds of coordination (i.e., 3-letter and 2-letter) with AoA stakeholder organizations. After all critical comments have been addressed to stakeholder satisfaction and other comments properly adjudicated, the Sponsor can then begin the briefing trail for the AoA final report. The briefing trail usually begins with a sponsor corporate review process (e.g., Requirements Group, Board, Council, etc.); however, where it ends depends on the ACAT and JSDs levels. See DoDI 5000.02 and the A5R Guidebook, and work with HAF/A5R-P and HAF/A5R-OAS representatives for appropriate staffing paths as well as details regarding review, validation, assessment, and approval processes.

## 1.10 What Role does OAS Play?

The Office of Aerospace Studies (OAS) has over 20 years of experience in supporting organizations across the Department of Defense and Federal government with AoA training, planning, and execution. OAS provides a full spectrum of analytical assistance in planning and conducting AoAs. As described in the A5R Guidebook, OAS is responsible for:

- Assisting HAF/A5R, lead commands and field agencies with the development of CCTDs, Air Force study guidance, study plans, study organizing, and study execution for CBAs, Pre-MDD analyses, and AoAs.
- Training analysis leads, teams, and stakeholders. Training is based upon regulations, policy, best practices, and lessons learned. It is tailored to the specific analytic effort and addresses the planning, scoping, execution, and out-brief of the analysis.
- Advising the Air Staff, AFCDC, CDWG, Air Force Gatekeeper (AFGK), lead commands, teams, and stakeholders during the planning, execution, and review of the analysis.
- Facilitating Working Integrated Product Teams (WIPTs) for developing AoA study guidance, and AoA study plans,

- Assessing the study guidance, study plan, and study final report/briefing. The assessment is advisory and given to the team, lead command, AFGK, CDWG, and AFCDC.

To fulfill these responsibilities, OAS appoints an advisor to help the study director during the initial planning stages of the AoA.[9] Preferably this is done before initiation of the AoA. The advisor assists the study director in identifying stakeholders, AoA study team members, and WIPT members. Once the WIPT or AoA study team is formed, the advisor provides AoA training as needed and assists in facilitating the AoA planning activities to include development of the study guidance and plan. The advisor assists the study director and team in preparing for the AFGK, CDWG, AFCDC, and other reviews that may be required. As part of the AoA staffing process, the OAS Leadership conducts a risk assessment of the study plan for the AFGK, CDWG, and AFCDC principals. This assessment assists the Air Force in determining the quality of the study plan and the extent of the risks associated with conducting the AoA.

During the conduct of the AoA, the OAS advisor provides guidance as necessary to help facilitate the data collection and analysis activities of the working groups. The advisor provides an unbiased perspective to the analysis and can assist the team in identifying analysis resources and data. The advisor assists the study director and team in developing presentations for in-process reviews for any special groups that are involved in the AoA.

During the development of the final report, the advisor assists the study director and team in ensuring the analysis results are presented in a clear and comprehensive manner. This includes ensuring that the study questions are fully addressed as well as compliance with the study guidance. The advisor assists the team in developing the final report and any associated presentations. The advisor helps facilitate the staffing of the AoA final report and assists the study director and team in preparing for the AFGK, CDWG, AFCDC, and other reviews that may be required. As part of the AoA staffing process, the OAS Leadership conducts an assessment of the final report for the AFGK, CDWG, and AFCDC principals. This assessment assists the Air Force in determining the overall quality of the analysis and the risks associated with any recommended courses of action.

[9] The level of assistance from OAS is determined by the scope of the AoA, where the AoA fits in the overall Air Force priority, and the availability of OAS staff.

# 2 Forming the AoA Study Team

This chapter describes how the study team is formed and provides information that will help facilitate the planning and conduct of the AoA. It describes the roles and responsibilities of the stakeholders and study team members and the structure of the study team. Ideally, the AoA study team evolves from the ICD HPT membership as well as the CBA and pre-MDD analysis study teams.

## 2.1 When is the AoA Study Team Formed?

As described in Chapter 1, there are several ways that an AoA can be initiated. The Core Function Lead (CFL) or lead command may begin initial planning in preparation for a potential AoA well before the official decision to proceed with an AoA is made. The initial planning may include designating a preliminary study director and identifying potential team members and stakeholders.

Given that there are several ways that an AoA may be initiated there may be situations where the CFL or lead command has conducted little or no initial AoA planning. This may be the case when the AoA is initiated through higher-level guidance or by the MDA. In these cases, the study team is formed after higher headquarters direction to initiate an AoA.

## 2.2 Determining the Level of Effort

Regardless of how the AoA may be initiated, one of the first actions taken by the study director is determining the level of effort that will be required to plan and conduct the AoA. Understanding the level of effort is important because it can affect various aspects of the study including the size and composition (i.e., level of expertise and experience that is needed, number of members, government and contract personnel mix) of the study team as well as the length and cost of the study. [10]

The level of effort will depend on various factors such as the study scope, study questions, complexity of the problem, analysis requirements (i.e., extent of data collection, sophistication of analysis methods), and time and resource (e.g., funding, manpower, and expertise) constraints. Most of this should be described in the study guidance. However, during the early stages of AoA planning, much of this information may not be known. Though not all inclusive, answers to the following questions can help the study director determine the level of effort that will be required:

- What is the anticipated ACAT level and JSD of the resulting acquisition program?
- How many alternatives will be evaluated? Are they part of a complex system of systems? Are there dependencies to be addressed?
- What relevant analysis has been accomplished to date? How well do we understand the problem space?

[10] See Appendix N for an historical perspective of average cost and length of an AoA.

- How recent, complete, and well-documented are the AoA prerequisites? How much development planning has been or will be completed prior to AoA execution? Are all of the concepts sufficiently documented in CCTDs?
- Will this AoA require special security considerations?
- What remaining information needs to be learned from the AoA?
- Are significant DOTmLPF-P changes anticipated?
- Who in the stakeholder community is available to participate in the effort? How broad and diverse is the stakeholder community?
- Are the right experts available and can they participate?
- How much government and contractor support is available?
- What data, models, tools, and scenarios are needed to execute the AoA?
- How much time and funding is available to execute the AoA?
- What level of analytic rigor is required?
- Where and what amount of analytic risk is acceptable to the decision makers?

As part of determining the level of effort, the study director should consider the level of contract support that is available. It is not uncommon for technical support contractors to accomplish much of the work in an AoA. Before making contract support arrangements, the study director must first understand the study objectives. This will increase the likelihood that the chosen contractor is well suited to perform the required tasks in the study. Answers to the following questions can help the study director to determine whether contract support is required and to what level:

- Is there adequate expertise available within the government?
- Are sources of funding available?
- For which study areas is contract support needed?
- Which contractors are qualified?
- What are the available contracts?
- How will the contract be administered?

Experienced and qualified contractors are often obtained through the Air Force 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 and 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.

## 2.3 Identifying Study Risks

When determining the level of effort, it is important to identify areas of study risk associated with any time or resource constraints in the study. Study risks and how they are mitigated can affect the size and composition of the study team and overall conduct of the study. Study risks are associated with the planning and conduct of the study and are different from the risks that will be assessed for the baseline

and alternative capabilities in the risk assessment part of the AoA.[11] These risks must be identified to the AoA Study Guidance approval authority so that the appropriate AoA scope, time, and resources are defined. (Note: If new risks are identified after the study guidance is issued, the AoA Study Plan WIPT must identify these for discussion with the appropriate stakeholders and oversight communities prior to approval of the study plan.)

Time and resource constraints are typically major root causes of study risk. For example, a study conducted with limited time and resources may reach different conclusions (or conclusions based on less rigor) compared to the same study conducted with less constrained time and resources. In this example, the less constrained study could utilize more suitable, though time and resource consuming, data collection and analysis methods compared to the more constrained study. Not only may the results be different, but the level of confidence in the results may be different given the different data collection and analysis methods used.

As another example, the cost and performance data for an alternative that is a modification to an existing system may be easy to obtain or estimate, whereas the data for a new technology may be far more difficult to obtain. Therefore, the evaluation of the performance of a future system may not be as robust as the evaluation of a current system.

The decision makers should be kept informed of all study risks and their implications during the course of the study. When risks are identified, the discussion should focus on courses of action that entail possible tradeoffs to mitigate the risk (e.g., providing more resources or reducing scope to meet an aggressive study schedule, or screening out alternatives early so that resources can be focused appropriately.) This discussion will ensure the level of effort and risks are acceptable to all principals involved in the study.

## 2.4 Stakeholders and Study Team Members

Before discussing the structure of the study team, it is important to first discuss the roles and responsibilities of the stakeholders and study team members.

### *2.4.1 Stakeholders*

A stakeholder is defined as any agency, Service, or organization with a vested interest (a stake) in the outcome of the study. A stakeholder may contribute directly or indirectly to study-related activities and is usually affected by decisions made as a result of these activities. Asking the following questions can help identify members of the stakeholder community:

- Who are the end-users (e.g., COCOMs, warfighters) of the capability?
- What enablers (e.g., intelligence, human systems integration, logistics, and communications) and interdependencies within the solution space are being analyzed in the AoA?

[11] For more information about the AoA risk assessment, see Chapter 5.

- How do the other Services, DoD agencies, and government agencies fit into the mission area being explored in the AoA?

The study team should include appropriate members of the stakeholder community (e.g., CFL/lead command, other Air Force commands and agencies, combatant commands, Army, Navy and Marines, DoD, Joint Staff, and other government agencies such as Department of Energy, Department of State, and Department of Homeland Security). With assistance from the lead command staff and the Air Staff, the study director must determine which key stakeholders should have membership in any of the special groups that may be formed for the AoA (the special groups are discussed in the next section). HAF/A5R representatives (including OAS, A5R-P, and/or A5R functional subject matter experts (SMEs)) can also assist the study director in identifying the stakeholder community. The stakeholder community should be involved as early as possible, preferably before development of the study guidance and plan.

There are many benefits to having stakeholders involved in the AoA. Stakeholder involvement can help facilitate buy-in and an understanding of the problem, capability gaps, risks, and potential solutions. The stakeholder community can assist the study team in identifying potential solutions available from other Services or agencies (within or outside DoD). Additionally, allied and partner nations may offer possible solutions. The study director should carefully identify the stakeholders (in accordance with the A5R Guidebook, at a minimum) to participate in the study since they will likely be candidates for membership in the WIPT.

### *2.4.2 Study Team Members*

Team membership normally includes operators, logisticians, intelligence analysts, cost estimators, and other specialists. As noted above, study team membership should include representatives from the stakeholder community such as the appropriate CFLs, lead command, operating commands, implementing commands, combatant commands, Headquarter Air Force (HAF) organizations, and other agencies/Military Services. Participants in previous applicable studies and others with special skills or expertise such as Human Systems Integration (HSI) should be considered for team membership as well.

Most study team members are assigned to one or more working groups and are responsible for completing tasks that are assigned by the working group leads, deputy leads, study director, or deputy study director. It is important that each study team member strive to plan and execute an unbiased and complete study within the time and resource constraints provided.

## 2.5 Study Team Structure

The structure of the AoA study team depends upon the scope of the AoA and the level of effort required. Not all study teams are identical but are instead tailored in size and skill sets to meet the objectives of the AoA. For example, an AoA that is limited in scope (e.g., updating a previous AoA which may entail conducting additional sensitivity analysis of the assumptions, updating cost estimates, or conducting additional analysis for one or more new alternatives) may have a smaller team comprised of members with specific skill sets compared to a team that is conducting the initial AoA for a new program. With overall responsibility for planning and conducting the AoA, the study director must determine the best way to organize the team. It is important to note that the size and focus of the team

may change during the course of the study. For some studies, designating a deputy study director can help alleviate some of the workload on the study director and maintain continuity if the study director is unavailable for periods of time during the course of the study. The lead command, HAF/A5R representatives (including OAS, A5R-P, and/or A5R functional SMEs) and other stakeholders can assist the study director in determining the best way to organize the team to meet the objectives of the study.

Figure 2-1 illustrates an example of a study team structure and various oversight and support organizations. Depending on the scope of the AoA, the team is usually organized along functional lines to conduct the effectiveness, risk, and cost analyses. Working groups are formed along these functional lines to facilitate the planning and conduct of the study. In addition to the working groups, the study director normally form a Working Integrated Product Team (WIPT) to help coordinate and manage the activities of the working groups.[12]

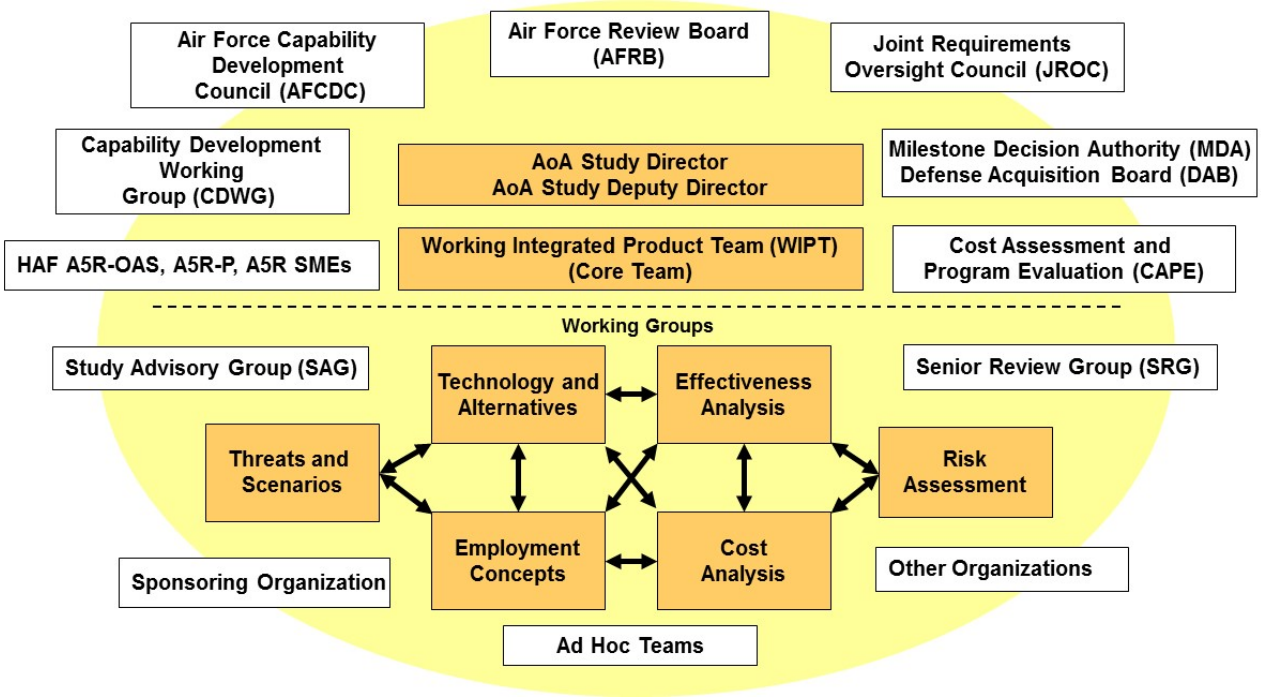


**Figure 2-1: Example Study Team Structure**

### *2.5.1 Study Director*

The study director leads the study team in planning and conducting the AoA.[13] The study director is normally appointed by the CFL or lead command. The study director must be a government employee

[12] The Working Integrated Product Team (WIPT) may also referred to as the Core Team or some other terminology. For the purpose of this handbook, this team will be referred to as a WIPT.

[13] The study director is sometimes referred to as the study lead. For this document, the study director and study lead are used synonymously.

(military or civilian) and is responsible for all aspects of planning and executing the study. OAS recommends that the study director organize the team as quickly as possible and define the responsibilities of the team members early in the AoA planning phase. The study director is responsible for the following:

- Providing funding and other resources necessary to successfully plan and conduct the AoA,
- Facilitating coordination with external organizations and agencies,
- Assisting in acquiring security clearance guidance and special access clearances, and if required, developing a security plan for the study,
- Consolidating inputs and maintaining configuration control of AoA documents (e.g., study plan, final report, briefing),
- Establishing the modeling and simulation (M&S) accreditation team, developing and executing an M&S accreditation plan, and overseeing the staffing of the M&S accreditation report when M&S is used,
- Coordinating approval of required documentation,
- Briefing special groups and stakeholders.

### *2.5.2 Working Groups*

This section describes the working groups that are typically established to plan and conduct the AoA. The study director has much discretion in how the study team is organized. In some cases, a group may not be needed or groups may be combined. In other cases, one or more ad hoc teams may be established to work specific tasks. It is important that the study director select working group leads and deputies who have the relevant subject matter expertise as well as the ability to lead people, manage multiple situations, and facilitate their groups. Each working group should be led by a military or government employee. Ultimately, it is the study director's responsibility to organize the study team in the best way to meet the objectives of the study.

Once the team is established, the working groups meet separately to conduct their work and address any issues or problems. They also meet regularly with other working groups or the entire study team to exchange information. Frequent and open exchanges of ideas and information are essential to a successful AoA. When the team is geographically dispersed, maintaining frequent and open communication is usually more challenging. Documenting questions, answers, and decisions made in the various working groups and oversight groups (to include changes to the study guidance and study plan) facilitates clear and effective communication. This can be accomplished by taking and distributing minutes of study group meetings. Frequent interaction via telephone and e-mail at all levels should also take place. If possible, the study director should keep the study team intact throughout the AoA. A changing membership can adversely impact continuity and may create delays as new personnel are integrated into the effort.

### Technology and Alternatives Working Group (TAWG)

The TAWG is responsible for examining all applicable technologies and materiel concepts and defining the baseline and alternatives to be analyzed in the study. The major tasks of the working group include the following:

- Develop a plan for documenting the baseline (preferably as defined in the CBA and ICD) and developing the alternatives (if not already done in DP),
- Collaborate with the Employment Concepts Working Group (ECWG) to understand the operating environments and employment concepts for which the baseline and alternatives will operate,
- Gather information from all available and appropriate sources to define the baseline and alternatives,
- As necessary, develop criteria for initial screening of non-viable alternatives,
- Refine alternatives and identify those to be analyzed in detail by the working groups,
- Present the baseline and alternatives to the WIPT and other study oversight groups for approval,
- Develop and maintain configuration control of CCTD documents that describe the baseline and alternatives,
- Provide data associated with the baseline and alternatives to support the analysis efforts of the other working groups,
- Assist the Risk Assessment Working Group (RAWG) in identifying risks associated with the baseline and alternatives,
- Write their respective section(s) of the final report.

### Threats and Scenarios Working Group (TSWG)

The TSWG is responsible for identifying the relevant threats to the capabilities being addressed in the study and selecting the appropriate scenarios to be used in the analysis. The major tasks of the working group include the following:

- Develop a stressor matrix to identify the most appropriate scenarios to use in the study and which were proposed in the study guidance,
- Evaluate and select scenarios to be used in the study,
- As necessary, develop detailed vignettes based on the selected scenarios,
- Present the scenarios and vignettes to the WIPT and other study oversight groups for approval,
- As necessary, develop targets sets and associated data,
- Provide data associated with the threats, targets, or scenarios to support the analysis efforts of the other working groups,
- Assist the RAWG in identifying risks associated with the baseline and alternatives,
- Write their respective section(s) of the final report,

### Employment Concepts Working Group (ECWG)

The ECWG[14] is responsible for identifying or developing the overall operational concept, and, as needed, employment concepts associated with individual alternatives in the operational context associated with the capability gaps and requirement. The major tasks of the working group include the following:

- Collaborate with the TAWG to understand the baseline and alternatives in the study and to define the alternatives and their Concepts of Operations (CONOPs), operating environments, employment concepts, and operational context.
- If not already done, document the CONOPs, operating environments, employment concept, and operational context in the CCTDs. The baseline alternative should only consider doctrinal CONOPs; all other alternatives should also consider non-doctrinal approaches.
- Identify any changes to the operational context (and OVs) from that used during the CBA and described in the ICD[15],
- Assist the Effectiveness Analysis Working Group (EAWG) in developing the mission tasks and measures to be used in the effectiveness analysis,
- Assist in developing detailed vignettes based on the selected scenarios as necessary,
- Conduct research of existing employment concepts and logistics approaches that are relevant to the baseline and alternatives,
- Based on the results of the research, identify or develop employment concept(s) for use in the study,
- Identify the environmental factors, enablers, and intelligence and logistics implications associated with the alternative-specific employment concept(s),
- Present the employment concept to the WIPT and other study oversight groups for approval,
- Provide information associated with the operational concept to support the analysis efforts of other working groups,
- Assist the RAWG in identifying risks associated with the baseline and alternatives,
- Write their respective section(s) of the final report.

### Effectiveness Analysis Working Group (EAWG)

The EAWG is responsible for planning and conducting the effectiveness analysis and assisting in the comparison analysis to include the cost-capability analysis. The major tasks of the working group include the following:

- Work with the ECWG to develop the mission tasks and measures to be used in the effectiveness analysis and identify the linkage to the gap(s),

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[14] Another name commonly used for this group is the Operational Concepts Working Group (OCWG).

[15] Because CBAs and ICDs may be several years old at the start of an AoA, the ECWG (and the entire study team) should identify if the context has changed in any significant ways. If it has, the ECWG should document those changes and ensure they are properly addressed in the AoA. At a minimum, the ECWG should examine the threat, top level architectures, and supporting elements from appropriate Core Function Support Plans.

- As necessary , assist in developing detailed vignettes based on the selected scenarios,
- Develop the effectiveness analysis methodology,
- Present the effectiveness analysis methodology to the WIPT and other study oversight groups for approval,
- Conduct the effectiveness analysis and report the results,
- Provide required force structure (buy amounts) to the Cost Analysis Working Group (CAWG),
- Assist the RAWG in identifying risks associated with the baseline and alternatives,
- Collaborate with the CAWG in conducting the cost-capability analysis,
- Write their respective section(s) of the final report.

**Cost Analysis Working Group (CAWG)**

The CAWG is responsible for planning and conducting the cost analysis and assisting in the comparison analysis to include the cost-capability analysis. The major tasks of the working group include the following:

- If necessary, request Air Force Cost Analysis Agency (AFCAA) support,[16]
- Define the enabling (e.g., logistics, intelligence, Human Systems Integration) elements necessary to create the cost estimates,
- Develop the cost analysis methodology,
- Develop the Work Breakdown Structure (WBS) for the baseline and alternatives,
- Present the cost analysis methodology to the WIPT and other study oversight groups for approval,
- Conduct the cost analysis and report the Life Cycle Cost Estimates (LCCEs) for the baseline and alternatives,
- Coordinate with the EAWG to identify and evaluate any possible relationships between cost drivers and aspects of the alternatives that may drive capability,
- Assist the RAWG in identifying risks associated with the baseline and alternatives,
- Participate in the alternative comparison, cost-capability analysis, and risk analysis efforts to ensure LCCE data is appropriately used and interpreted,
- In conjunction with the TAWG, identify which operational requirements are likely to be the primary drivers of cost and schedule,
- Write their respective section(s) of the final report.

[16] AFCAA should respond to the team's request and identify what, if any, involvement they will have in the AoA. Their involvement may include providing regulatory guidance, reviewing and approving proposed cost analysis methodologies, and performing a sufficiency review, which is a form of Non-Advocate Cost Assessment (NACA), per AFPD 65-5, *Cost and Economics*.

#### Risk Assessment Working Group (RAWG)

The RAWG is responsible for planning and conducting the risk assessment of the baseline and alternatives and comparison analysis to include the cost-capability analysis. The major tasks of the working group include the following:

- Develop the risk assessment methodology,
- Present the risk assessment methodology to the WIPT and other study oversight groups for approval,
- Conduct the risk assessment of the baseline and alternatives,
- Write their respective section(s) of the final report.

#### Ad hoc Teams or Groups

Ad hoc teams or groups may be formed during the course of the study to complete specific tasks that are beyond the scope of the other working groups. These teams may be temporary or endure over the full course of the study. For example, the study director may create an ad hoc team comprised of members of the other working groups to conduct the alternative comparison analysis (discussed later in this handbook). The team would be responsible for integrating the effectiveness, cost, and risk results to identify the most viable alternatives.

### *2.5.3 Working Integrated Product Team (WIPT) or Core Team*

The Working Integrated Product Team (WIPT) or core team should include the study director, deputy study director (if designated), lead and deputy lead from each working group, the HAF/A5R representatives (including OAS, A5R-P, and/or A5R functional SMEs), and other important stakeholder representatives. The enduring HPT membership should serve as the foundation of the WIPT membership to maintain continuity of effort. Ideally, this team should include members from previous studies that are relevant to the AoA. The WIPT is primarily responsible for the following major tasks:

- Assisting the study director in leading the study,
- Providing advice to the study director regarding the direction of the study,
- Coordinating and managing the activities of the working groups,
- Sharing and integrating information and products from each of the working groups,
- Identifying and resolving issues or problems that affect the study.

### *2.5.4 Oversight and Review Groups*

There are one or more special groups that are typically involved in an AoA. Special groups are formed to keep the stakeholder community informed and to provide feedback, vetting, and direction on the planning, execution, analysis, and reporting of AoAs. The two most common groups are the Study Advisory Group (SAG), usually mandated by the guidance, and the Senior Review Group (SRG), which is usually optional at the discretion of the Study Director.

### Study Advisory Group (SAG)

The SAG is responsible for overseeing the conduct of the AoA and ensuring that the study complies with the study guidance. During the course of the study, the SAG typically has the authority to change the study guidance as necessary. The SAG provides guidance as appropriate during the planning and execution of the study. The SAG reviews and approves the following:

- Study scope, assumptions, ground rules, and constraints beyond those specified in the initial guidance,
- Baseline and alternative concepts, to include screening concepts out of the study,
- Threats, scenarios, methodologies, and measures,
- Further staffing required of the study plan and final report.

The SAG is led by a chair or co-chairs and is usually comprised of senior stakeholder representatives (i.e., General Officer, Flag Officer, or Senior Executive Service). The type and level of authority of the SAG chair/co-chairs will depend on the nature of the program (e.g., projected or designated ACAT, JSD (e.g., JROC Interest), and other stakeholder interest):

- For potential and designated Major Defense Acquisition Program (MDAP) ACAT ID and Major Automated Information System (MAIS) ACAT IAM programs, the OUSD (AT&L) will participate in the study since the Under Secretary of Defense for Acquisition, Technology, and Logistics (USD(AT&L)) will be the MDA for the program, unless delegated to a DoD Component or other official (see DoDI 5000.02 for more information). For these programs, a representative from OUSD(AT&L) will likely chair or co-chair the AoA SAG.
- The DCAPE approves AoA study guidance, based on inputs from the sponsor, for potential and designated ACAT I and IA (includes IAM) programs and for each joint military or business requirement for which the Chairman of the JROC or the Investment Review Board is the validation authority (see DoDI 5000.02 for more information). In addition, OSD(CAPE) also participates in AoAs that have JROC interest. A major responsibility of OSD(CAPE) is assessing whether the AoA final report is sufficient to inform future acquisition decisions. For these programs, a representative from OSD(CAPE) will likely chair or co-chair the AoA SAG.
- If the Defense Acquisition Executive (DAE) delegates the Milestone Decision Authority for a potential or designated ACAT ID or IAM program to a DoD Component such as the Air Force or other organization, then the SAG chair will likely be a representative from Headquarters Air Force or the designated official's organization.
- For all other potential or designated ACAT I programs, the Head of the DoD component or, if delegated, the Component Acquisition Executive (CAE) will have Milestone Decision Authority. For these programs, the AoA SAG chair will likely be a representative from Headquarters Air Force.
- For potential or designated ACAT II and III programs, the CAE or individual designated by the CAE will have Milestone Decision Authority. For these programs, there may not be a SAG, but rather some other form of advisory group such as an Air Force Steering Group. The chair will

likely be a representative from Headquarters Air Force or the designated individual's organization.

The SAG chair or co-chairs will likely identify some of the organizations that should have membership in the SAG. The following are some organizations to consider in determining SAG membership:

- JROC/Joint Capabilities Board (JCB)/Joint Chiefs of Staff (JCS)/Military Service/Other US Government Agency/Allied Partner Interest. Most programs have some level of joint interest and will involve other military services. Occasionally, a program will involve other US government agencies or have interest from allied partners. It is important to consider including representatives from these interested entities as members of the SAG. The most recent version of CJCSI 3170.01, *Joint Capabilities Integration and Development System (JCIDS)*, reemphasized the increased JCS interest in AoAs. Before going directly to the Joint Staff, discuss JCS participation with the appropriate Air Staff functional and Air Staff FCB representative. Other government membership depends upon the problem being worked. If the AoA results will potentially impact non-AF parts of the government as major customers, enablers, partners, or suppliers, then they should probably be considered for SAG membership. Just as the Navy does not speak for the Air Force on most issues, neither does the Air Force speak for the other military services, nor the DoD for the other Departments.
- Air Force and Secretary of the Air Force (SAF) organizations. The following Air Force and SAF organizations should be considered for SAG membership:
    - HAF/A5R: Headquarters Air Force, Operational Capability Requirements Directorate,
    - SAF/AQ: Office of the Assistant Secretary of the Air Force (Acquisition),
    - AFOTEC: Air Force Operational Test and Evaluation Center,
    - AFCAA: Air Force Cost Analysis Agency,
    - AF/A2/A4/A6 since intelligence, logistics, and communications are critical to almost every program,
    - Other HAF and SAF organizations on a problem by problem basis (e.g., AF/A10 for nuclear-related problems).
- Other DoD-level organizations. Depending on the projected or designated ACAT level, JROC/JCB interest, and focus of the AoA, there are other DoD-level organizations that should be considered for SAG membership. These organizations include the following:
    - ASD(A)/S&ST: Assistant Secretary of Defense for Acquisition/Strategic and Tactical Systems,
    - ASD(R&E)/SE: Assistant Secretary of Defense for Research and Engineering/Systems Engineering,
    - OUSD(C): Office of the Under Secretary of Defense (Comptroller),
    - OUSD(I): Office of the Under Secretary of Defense (Intelligence),
    - OUSD(P): Office of the Under Secretary of Defense (Policy),
    - DOT&E: Director, Operational Test and Evaluation.

Communication between the SAG and study team is vital to the success of the study. The study director is responsible for maintaining a dialogue with the SAG throughout the course of the study. The study

director is responsible for scheduling and providing in-process reviews to the SAG that address the study team's progress and any issues or problems that require SAG assistance or awareness.

**Senior Review Group (SRG)**

The SRG is an O-6/GS-15 level group that is comprised primarily of lead command organizations and other important stakeholders involved in the study. The SRG is usually chaired by an O-6/GS-15 in the lead command.

There are a number of ways the SRG can assist the study director. For example, the study director may seek guidance as needed from the SRG in planning and conducting the study. The study director may request assistance from the SRG in resolving a specific problem or issue. Before meeting with the SAG for in-process reviews or other special meetings, the study director can seek feedback and advice from the SRG on any documents or briefings that the study director plans to present to the SAG. Depending on its charter, the SRG may or may not have directive authority.

### *2.5.5 Other Oversight Groups*

There are several other oversight groups that may be involved in the AoA. Roles and responsibilities for the AFGK, HAF/A5R SME, CDWG, AFCDC, FCB, JCB, and Joint Requirements Oversight Council (JROC) are described in the A5R Guidebook. Other oversight groups include the following:

- Lead Command Oversight Groups. Some lead commands have oversight groups that are involved in reviewing and approving AoA documents and presentations. Air Combat Command (ACC), for example, has an ACC Requirements Board (ACCRB) that reviews and approves AoA documents and presentations before they are released to organizations external to the command.
- Air Force Review Board (AFRB). For ACAT ID and ACAT IAMs, AFRBs are used to develop the AF corporate consensus prior to an OSD Defense Acquisition Board (DAB) (pre-DAB within AF) or Information Technology Acquisition Board (ITAB).

  The AFRB determines whether promising technologies and design concepts have been identified. Presentation of a concept at the AFRB should be taken as evidence of endorsement that the concept described in the CCTD document meets the expectations of the lead command or sponsor in terms of having the potential to fulfill the stated operational capability need. SAF/AQRE makes a technical recommendation about each CCTD to SAF/AQR at the AFRB.

  The AFRB should be conducted prior to an OSD Integrating Integrated Product Team (IIPT) meeting. The SAE, or as delegated, determines if an ACAT ID or ACAT IAM program requires an AFRB. The AFRB process is required for all ACAT IC, ACAT IAC, non-delegated ACAT II programs, and special interest programs. The program executive officer (PEO) may recommend what type of AFRB is necessary: full, mini (tailored attendance), or paper.

- OSD Integrating Integrated Product Team (IIPT): This IPT is a lower level meeting held in preparation for the OIPT described below. Membership is tailored as required to address potential issues.
- OSD Overarching Integrated Product Team (OIPT): An Integrated Product Team (IPT) led by the appropriate Office of the Secretary of Defense (OSD) director, and composed of the Program Manager (PM), PEO, component staff, user/user representative, and OSD and Joint Staff (JS) members involved in the oversight and review of a particular ACAT ID or ACAT IAM program. OSD OIPTs are teams expected to collectively assist the DAE in making sound investment decisions for the Department and to ensure programs are structured and resourced to succeed. Success is defined as affordable, executable programs that provide the most value achievable for the resources invested by the Department.

# 3 Planning the Working Integrated Product Team (WIPT) Event

The AoA study guidance and plan are normally developed during two separate Working Integrated Product Team (WIPT) events comprised of AoA study team members and other stakeholders. This chapter describes the WIPT and offers some recommendations for planning the event.

## 3.1 How does the WIPT relate to HPTs?

In the Air Force, High Performance Teams (HPTs) are used to develop Air Force-sponsored JCIDS documents As much as possible, core members of the various HPTs that are formed to develop JCIDS documents are maintained throughout the process (from ICD to CPD). This concept is referred to as the enduring HPT. The objective of the enduring HPT is to achieve a more efficient and effective connection between the Air Force requirements and acquisition processes; provide the appropriate level of consistent cross-functional involvement in requirements generation from ICD to CPD; and produce executable, risk-based, fiscally informed requirements that deliver affordable capabilities within optimal cycle time to the warfighter. This potentially accelerates the documentation process, improves the quality of requirements documents, and provides an enduring forum for developing, fielding, and sustaining operational systems. Over time, some stakeholders may no longer have a stake in the effort and will end their participation in the HPT, and others may be added, when appropriate.

Ideally, the AoA study team evolves from the ICD HPT membership as well as the CBA and pre-MDD analysis study teams. Core study team members and stakeholders make up the WIPT.

## 3.2 WIPT Roles and Responsibilities

The following sections describe the key roles and responsibilities of the WIPT lead, WIPT facilitator, and WIPT members.

### *3.2.1 WIPT Lead*

As noted in the previous chapter, the CFL/lead command or organization typically designates an AoA study director. The AoA study director is a military member or government civilian (not a contractor). In most cases, the AoA study director also serves as the WIPT lead for developing the AoA study guidance and study plan. The WIPT lead has overall responsibility for planning and conducting the WIPT and has the final decision on the content of the WIPT products.

The WIPT lead is responsible for communicating details of the WIPT event (e.g., dates, meeting location), identifying WIPT participants, ensuring participants have the permission and funding required to attend the event, distributing read-ahead material, writing and sending WIPT invitations to identified participants, leading the execution of the WIPT, and providing support to document WIPT outcomes and actions.

### *3.2.2 Facilitator*

As described in the A5R Guidebook, the Sponsor develops the draft AoA study guidance and plan with direct assistance from HAF/A5R-OAS. If requested by the WIPT lead, OAS will facilitate the WIPTs for

developing the AoA study guidance and plan.[17] The facilitator guides and advises the WIPT to ensure it is productive and worthwhile for all team members and helps enable the WIPT to achieve its objectives. The facilitator's main responsibilities include the following:

- Preparing the WIPT lead for the WIPT event and assisting the WIPT lead in identifying and preparing the other WIPT members,
- Guiding and advising the WIPT during the WIPT event,
- Providing subject matter expertise on the AoA process and expectations (e.g., effectiveness, cost, and risk analysis methodologies, alternative development and screening, scenario and threat identification, measures development) and associated JCIDS processes,
- Ensuring the WIPT understands the content requirements of the study guidance or plan and associated staffing requirements, and
- Enabling the WIPT to achieve its objectives.

The intent of the facilitation is different than that of the traditional facilitation approach in which a subject-agnostic individual maintains administrative control of the process and event timeline. It differs in the sense that the WIPT facilitator must be a subject matter expert in the WIPT process (i.e., AoA study guidance or AoA study plan development) and well-versed in facilitation techniques. Facilitators with these skills will be most effective as every WIPT will require some measure of both skills to be successful. The facilitator guides participants throughout the event to ensure they are aware of the standards of performance required, can provide useful input to the WIPT product(s), and can deliver a quality product(s) in the time available.

To enable the WIPT to meet its objectives, the facilitator must have general knowledge of the mission area, capability gaps, and other key studies pertinent to the mission area of interest. [18] The facilitator prepares for the WIPT event by reviewing and understanding the CBA(s), RSR, ICD(s), lessons learned, and other relevant studies and documents. In some situations, the facilitator may need to conduct a literature search for other studies that may have been completed in the mission area of interest. In all cases, the facilitator must engage the study sponsor, Air Staff, and other key players to understand their perspectives, issues, and concerns.

Ideally, the facilitator should establish a rapport with the WIPT lead well in advance of the WIPT event. Through this rapport, the facilitator will be better able to assess the needs of the WIPT (e.g., how much have they done, what needs to be done, what is the level of experience, how best to guide them forward) which will help the facilitator and WIPT lead plan the WIPT event as well as determine the resources that will be required. This needs assessment will also enable the facilitator to recommend a facilitation approach to the WIPT lead (e.g., number of days for the WIPT event, tasks that will be completed on each day, working groups that will be formed). Working with the WIPT lead prior to the

[17] For HPTs developing JCIDS documents (e.g., ICD), the HAF/A5R SME will normally facilitate the HPT event.

[18] The facilitator will typically not be an expert in the specific area of interest being assessed in the AoA.

event will also allow the facilitator to gain insights into the politics, issues, subject matter, and personalities involved.

### *3.2.3 WIPT Members*

It is the responsibility of study team and most stakeholder organizations involved in operational capabilities capability development to provide WIPT members, as appropriate, to support the development of AoA products. Each member of the WIPT plays a vital role in the success of the WIPT and is selected for a specific reason. Furthermore, each member is expected to contribute to meeting the objectives of the WIPT. For example, the WIPT member(s) who is selected for his or her background in intelligence is expected to address intelligence-related aspects of the study guidance or study plan such as potential scenarios and threats for consideration, scenario and threat selection methodology development, intelligence mission data requirements and costs, and other intelligence support requirements or issues. As another example, members of OSD(CAPE) and OUSD(AT&L), when they participate, are expected to express the interests, expectations, and concerns of their respective organizations as they help guide the WIPT. This is best accomplished when OSD(CAPE) is willing to provide a draft of their guidance for discussion and/or proposed revision at the WIPT. This is also true when HAF/A5R issues the guidance.

The WIPT lead and facilitator must define the expected contributions of each member and establish a WIPT environment that is conducive to open and non-confrontational discussions to enable each member to be as productive as possible. The WIPT lead and facilitator should strive to make the WIPT event a productive and worthwhile experience for all members.

Determining WIPT membership requires significant thought and deliberation on the part of the lead command, WIPT lead, OAS, and HAF/A5R. As described in the A5R Guidebook, the AoA study guidance and study plan WIPTs should be an extension of the enduring HPT that was initiated for developing the ICD. If the AoA study team has formed or is in the process of being formed, it is worthwhile for the WIPT lead to select expected key members of the study team, SAG, SRG, and other special groups to be members of the WIPT (see the A5R Guidebook and Sections 2.5.2, 2.5.4, and 2.5.5 of this handbook for additional guidance regarding WIPT membership). In addition, the WIPT lead should consider the following:

- CBA Study Team Members and ICD HPT Members. The study team members of the CBA(s) and members of the ICD HPT who identified the capability gaps that will be assessed in the AoA should be considered for WIPT membership. These members will be beneficial to the WIPT since they will likely have more insights into the baseline capabilities, potential solutions, risks, and costs associated with the capability gaps.
- Program Enablers/Interdependencies. All programs require enablers (e.g., intelligence, human systems integration, logistics, and communications) and have interdependencies with other systems and programs. These enablers and interdependencies may be managed, controlled, or influenced by organizations in other Services, DoD agencies, the Air Staff, MAJCOMs, or US government agencies. To ensure these enablers and interdependencies are appropriately

addressed, representatives from these organizations should be considered for WIPT membership.

#### *3.2.4 WIPT Support*

Experience has shown that scheduling the WIPT event, consolidating and distributing read-ahead materials, recording information during the WIPT event, and producing and publishing minutes requires assistance from one or more individuals responsible for managing and accomplishing administrative tasks. It is not advisable for the WIPT lead to attempt to simultaneously lead and provide administrative support to the WIPT. Having one or more individuals charged with handling the administrative details will help alleviate the administrative burden on the WIPT lead and enable him or her to focus on the more important task of leading the WIPT.

## 3.3 Initial Communication between the WIPT Lead and Facilitator

The initial communication between the WIPT lead and facilitator is very important since it helps establish rapport and enables the facilitator to determine the level of readiness to conduct the WIPT event. This is a critical step in the process since the facilitator will be working closely with the WIPT lead throughout the WIPT event.

In most cases, the initial communication between the WIPT lead and facilitator will likely be by telephone. Ideally, the facilitator should meet with the WIPT lead in-person, but this is not always possible. In preparing for this initial conversation, the WIPT lead and facilitator will need to coordinate a date and time (most likely, several times) to discuss the upcoming WIPT event. The facilitator will likely have a list of questions beforehand to gain insights into various aspects of the WIPT such as the WIPT members, experience levels, participating stakeholders, tasks accomplished, and projected timeline. Although not an all-inclusive list of questions, Appendix C is a list of commonly-asked questions regarding the WIPT event. Based on the responses received from the WIPT lead, the facilitator can assess WIPT readiness, determine what additional actions must be taken to prepare for the WIPT, and begin formulating an approach to facilitate the WIPT.

## 3.4 Developing the WIPT Objectives

A well thought-out set of objectives is essential to the success of the WIPT. The WIPT lead and facilitator should work collaboratively to ensure that the WIPT objectives are established, documented, and realistic, and that they are clearly articulated to WIPT members prior to their arrival at the meeting location.

A key objective that must be determined by the WIPT lead and facilitator is the level of study guidance or study plan completion that is expected. Is the objective of the WIPT to develop an initial rough draft or a near-final document? The complexity of the problem, amount of previous work that has been accomplished, and the experience and expertise of the team members must be considered in setting expectations. It is vital that the WIPT lead and facilitator share the same understanding of the level of completion that is expected.

## 3.5 Designing the WIPT Event

As shown in Figure 3-1, there are several key planning factors that the WIPT lead and facilitator must consider when designing the WIPT event. As a minimum, the facilitator must assess the level of experience of the team, the complexity of the problem, and the amount of work that has been accomplished when determining the length of the WIPT event and tasks to be accomplished on each day of the event. For instance, a more experienced team that has developed a good quality initial draft of the study guidance or study plan document on a less complex problem will likely require less time to complete tasks, so the length of the WIPT event will tend to be shorter. In contrast, a less experienced team that has developed a very rough and largely incomplete draft of the study guidance or study plan on a complex problem will likely require more time to complete the WIPT tasks, so the length of the WIPT event will tend to be longer.

Appendix D shows examples of short and long versions of the study guidance development WIPT and study plan development WIPT events. Each version shows a set of tasks for the WIPT to complete. The tasks are allocated to specific days and may be assigned to all members of the WIPT or specific working groups within the WIPT. Depending on the planning factors, the WIPT lead and facilitator may select the short or long version to use for the WIPT event, or tailor either version for a particular program.

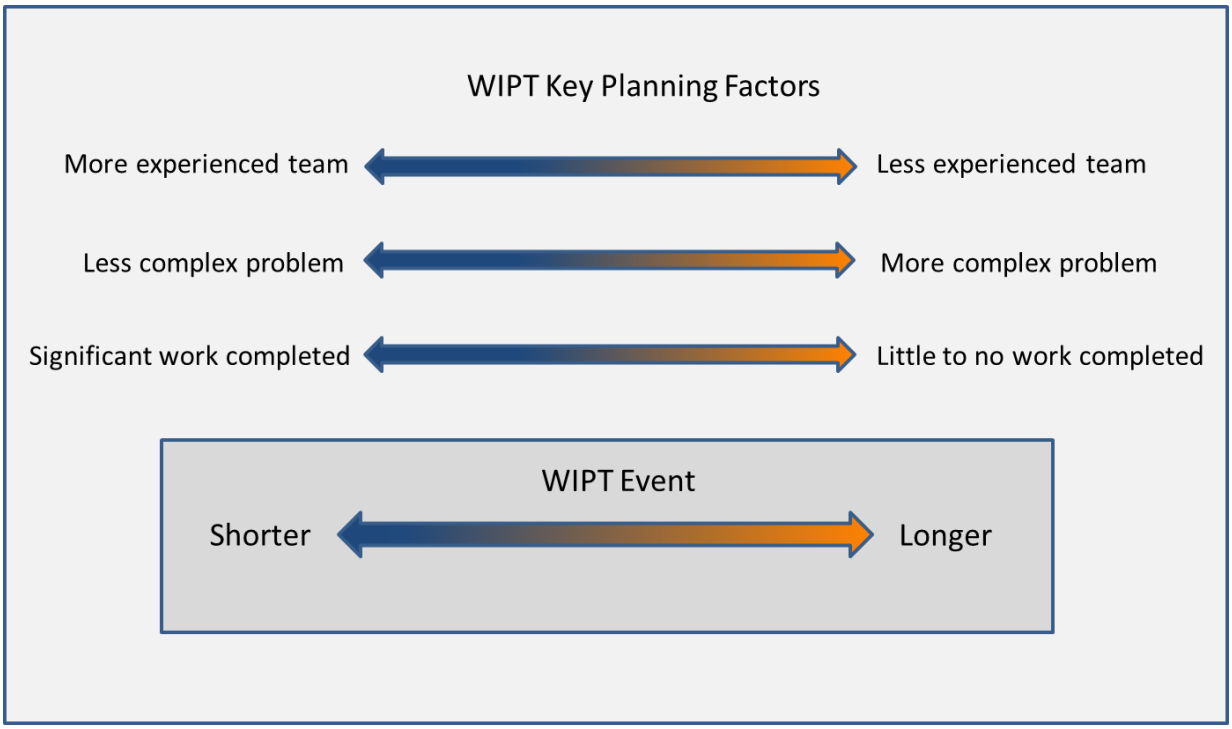


**Figure 3-1: Key Planning Factors and Length of WIPT Event**

### *3.5.1 Study Guidance Development WIPT*

The schedule versions for the study guidance development WIPT (see Appendix D, Tables D-1 and D-2) were designed for developing DCAPE study guidance and follow the OSD(CAPE) study guidance template (Appendix K). Unlike OSD(CAPE), for AF delegated studies, HAF/A5R does not have an official study

guidance template. However, the A5R Guidebook does provide a list of items that are expected to be discussed in the study guidance. Given that the OSD(CAPE) study guidance template addresses most of these items, it is recommended that the WIPT use the OSD(CAPE) template as a starting point and tailor it as necessary to develop the HAF/A5R-issued study guidance.

For some studies, there may be reasons to add, omit, or change parts of the OSD(CAPE) study guidance template. In these situations, it is vital to discuss template modifications with OSD(CAPE) as early as possible. In addition, it is also possible that the Air Force will have concerns and questions that OSD(CAPE) does not view as a priority. These may need to be addressed by the WIPT, documented, and discussed with OSD(CAPE) for inclusion in the OSD(CAPE)-issued guidance. This minimizes the chance that the study team will have multiple, possibly conflicting guidance documents to address (although AF supplemental guidance may still need to be provided by HAF/A5R).

In the examples shown in Appendix D (Tables D-1 and D-2), there are 10 tasks for the WIPT to complete. The short version (Table D-1) requires 16 working hours (2 days), while the long version (Table D-2) requires 32 working hours (4 days). In both versions, the WIPT lead and facilitator can establish breakout sessions, if necessary, designed for various purposes such as resolving problems or issues, finishing work on specific sections, or planning future activities. Select members of the WIPT would participate in these breakout sessions which may occur concurrently with other tasks. At the end of each day, the WIPT lead, facilitator, and other WIPT members as needed, meet to discuss how the day went (e.g., progress made, issues or concerns that must be addressed, answers to questions that must be provided) and plan for the next day and beyond (e.g., adjustments to the schedule, changes in working group membership, additional resources that are required, breakout session timing and purpose).

The steps described in Chapter 4 for drafting the study guidance during the WIPT represent the ideal situation and assume that at least an initial draft of the guidance has been developed by the sponsor and reviewed by the WIPT members prior to convening the WIPT. In many cases, the WIPT will not have enough information during the guidance development stage to fully describe all of the required sections; however, they should at least state in the study guidance that the items and the specific methodologies addressed in those sections will be identified and documented during study plan development (ideally) or during study execution.

### *3.5.2 Study Plan Development WIPT*

The versions of the study plan development WIPT (see Appendix D, Tables D-3 and D-4) were designed for developing a study plan that follows the OAS study plan template (Appendix F). For some programs, there may be reasons to add, omit, or change parts of the OAS study plan template. In these situations, it is vital to discuss template modifications with OAS as early as possible.

In the examples shown in Appendix D (Tables D-3 and D-4), there are 16 tasks for the WIPT to complete. The short version of the study plan development WIPT (Table D-3) requires 32 working hours (4 days), while the long version of the study guidance development WIPT (Table D-4) requires 64 working hours (8 days). In both versions, the WIPT lead and facilitator can establish breakout sessions, if necessary, designed for various purposes such as resolving problems or issues, finishing work in specific sections, or

planning future activities. Select members of the WIPT would participate in these breakout sessions which may occur concurrently with other tasks. At the end of each day, the WIPT lead, facilitator, and other WIPT members as needed, meet to discuss how the day went (e.g., progress made, issues or concerns that must be addressed, answers to questions that must be provided) and plan for the next day and beyond (e.g., adjustments to the schedule, changes in working group membership, additional resources that are required, breakout session timing and purpose).

Like the study guidance WIPT, the steps described in Chapter 5 for drafting the study plan during the WIPT represent the ideal situation and assume that at least an initial draft of the plan has been developed by the sponsor and reviewed by the WIPT members prior to convening the WIPT. In many cases, the WIPT will not have enough information during the plan development stage to fully describe all of the required sections; however, they should at least state in the study plan that the items and the specific methodologies to be used in those sections will be identified and documented during study execution.

## 3.6 Preparing for the WIPT Event

There are many important preparation tasks that must be accomplished in planning and conducting a WIPT event. One important detail is establishing the funding for the event. The level of funding is often a factor that affects how many team members can attend the event in-person. If funding is limited, some members may be required to attend the event virtually (i.e., teleconferencing and video teleconferencing). Given that virtual attendance may not be as effective as in-person attendance, the WIPT lead may need to make some adjustments during the course of the event (e.g., increase the time planned to accomplish more difficult tasks, defer some of the work to a time when members can meet in-person, and reduce expectations of what can be accomplished).

Other important preparation tasks include determining the location, facilities, equipment, security, transportation, and accommodations. The WIPT lead will likely delegate many of these administrative tasks to one or more individuals from the lead command assigned to help support the WIPT. In addition, OAS can provide advice to the WIPT lead concerning any decisions associated with these tasks.

## 3.7 Conduct a Literature Review

During the early phase of conducting the AoA, the study team is usually focused on defining in much greater detail the tasks that need to be accomplished. In defining these tasks, the AoA study team often overlooks the literature review as a source of information. Most capability requirements studies have a lineage or pedigree comprised of related studies, reports, plans, and other documents. The study team gains an understanding of the pedigree and the state of knowledge in the area of interest by reviewing the relevant literature.

The review enables the study team to determine where the study fits in the lineage and how it will build on previous work. The search for related previous work should be broad, erring on the side of being too

inclusive.[19] With a broad view, the study team not only reduces the risk of repeating past mistakes, but also minimizes the chances of missing something that should have been addressed in the study.

In the review, the study team not only evaluates the results of each work, but also draws overall conclusions by comparing and integrating results across all the work. The review enables the study team to evaluate methods, approaches, and findings, and critically discuss the strengths and weaknesses of each work.[20] It can reveal new approaches, ideas, and sources of data and provide insights into how similar analysis problems and issues were addressed. Lastly, the study team can learn the basis for previous decisions and how they shaped the current circumstances.

The study team should consider various sources of information and data such as published and unpublished studies, reports, and papers. There are many resources to draw from when conducting literature reviews. MAJCOMs typically have internal SharePoint sites and other repositories of information that may be relevant to the area of study. The following is a list of frequently used sources of government-sponsored technical documents:

- Contract Studies Registry Program
- Joint Lessons Learned Information System: NIPRNET, https://www.jllis.mil/usaf SIPRNET, http://www.jllis.smil.mil/usaf
- DTIC: www.dtic.mil
- Information and Resource Support System (IRSS): https://www.my.af.smil.mil/IRSS/irss7/pkg_portal.prc_main (requires SIPRNet Air Force Portal account, as well as permission from HAF/A5R)
- Defense Acquisition University (ACQuipedia): https://dap.dau.mil/acquipedia/Pages/ArticleDetails.aspx?aid=d5461b4c-2887-4be8-8cd9-b09920308670 and https://dap.dau.mil/acquipedia/Pages/Search.aspx?q=AoA
- Department of Defense Chief Information Officer Website: http://dodcio.defense.gov/Library/DoDArchitectureFramework.aspx
- Better Buying Power: http://bbp.dau.mil/
- Rand Corp: www.rand.org
- The Knowledge Management/Decision Support system (KM/DS): For instructions go to the JCIDS NIPRNet page: https://intellipedia.intelink.gov/wiki/JCIDS

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[19] Cooper, Harris M. (1989). *Integrating Research: A Guide for Literature Reviews, Second Edition*. Newbury Park CA: Sage Publications, Inc., pp. 57-60.

[20] Leedy, Paul D. (1997). *Practical Research: Planning and Design, Sixth Edition*. Upper Saddle River, NJ: Prentice-Hall, Inc., p. 71-72.

There are other key documents that should be reviewed by the WIPT members in preparation for the WIPT event. OAS recommends developing a collection of documents in a widely accessible central location such as a SharePoint site (at the appropriate security level) for the team to use (distribution of the material through e-mail is also possible, but is more time-consuming and may not be possible due to file size). Providing this information ahead of time will help prepare members for the event and enable them to be more productive at the start. In addition to the documents listed in Section 1.1, the team should review the following key documents:

- Relevant CBAs, AoAs, and capability requirements documents. These documents provide information about relevant capability gaps, potential solutions, capability requirements, analysis methodologies, and measures of effectiveness, suitability, and performance. The Department of Defense Architecture Framework (DoDAF) views that are included in the DCR, ICD, Draft CDD, Final CDD, and CPD are particularly useful for understanding the traceability of requirements. [21]
- Requirements Strategy Review (RSR). Depending on the program, there may be multiple RSRs that should be reviewed. The initial RSR is typically conducted after the CBA to garner approval to proceed with developing an ICD, but follow-on RSRs may have been completed for other JCIDs purposes.
- Concept Characterization and Technical Description (CCTD) documents. Depending on the program, there may be CCTD documents that have been developed in previous Development Planning (DP) efforts or in other studies that describe concepts to will be assessed in the AoA. A CCTD is a description of a concept. This description includes information about the technical, performance, cost, desired operational attributes, and associated dependencies. Typically, the DP team will produce CCTDs for use in the AoA. The AoA study team should review existing CCTDs and determine if they are sufficient for use in the AoA. The team should also ensure there is a range of concepts across the viable tradespace. If existing CCTDs do not cover the tradespace, further refinement may be necessary or additional CCTDs may need to be developed prior to or during the AoA. Developing CCTDs can be time consuming and costly, so it is better to have most of the concept development work completed prior to starting the AoA if possible.[22]
- OAS Handbooks. In addition to this handbook, there are several OAS handbooks that are useful for planning and conducting an AoA:
    - *The Measures Handbook*. The purpose of this handbook is to guide analysts in developing and analyzing measures of effectiveness, suitability, and performance for the AoA and other capability requirements studies. The handbook is designed to supplement the AoA handbook by providing more detailed measure development and analysis guidance.

[21] For more information about DoDAF views, see the US Department of Defense Chief Information Officer website at http://dodcio.defense.gov/Library/DoDArchitectureFramework.aspx

[22] For more information about the CCTD, see the *Concept Characterization and Technical Description (CCTD) Guide*, SAF/AQ.

- *Survey Research Handbook*. This handbook describes the fundamental principles of survey research that are necessary for ensuring questions are both reliable (i.e., provide consistent responses in comparable situations) and valid (i.e., answers correspond to what they are intended to measure). With expert elicitation being a special form of survey research, this handbook also presents an approach to conducting expert elicitation in the AoA and other operational capability requirements studies. The handbook is designed to supplement the AoA and Measures handbook by providing a comprehensive discussion of survey research principles.
- *Models and Simulations Selection and Accreditation Handbook*. This handbook provides guidance for selecting and accrediting models and simulations used in the AoA.

- Government Accountability Office (GAO) Report 09-665, *Many AoAs Have Not Provided a Robust Assessment of Weapon System Options*, Sep 2009. This report (1) examines whether AOAs have been effective in identifying the most promising options and providing a sound rationale for weapon program initiation, (2) determines what factors have affected the scope and quality of AOAs, and (3) assesses whether recent DOD policy changes will enhance the effectiveness of AOAs.

# 4 Developing the AoA Study Guidance Draft

One of the first tasks accomplished in the AoA is developing a draft of the AoA study guidance. As described in the previous chapter, the AoA study guidance is normally developed in a Working Integrated Product (WIPT) comprised of AoA study team members and other stakeholders. This chapter provides guidelines on developing the AoA study guidance draft.

## 4.1 What is AoA Study Guidance?

The purpose of the study guidance is to facilitate high caliber analysis, fair treatment of the options, and decision-quality outcomes to inform the MDA at the next milestone. AoA study guidance is developed to address the critical areas that the decision makers want explored during the AoA. The guidance provides direction to the study team to plan and execute the study. It typically directs the study team to explore the tradespace in performance, schedule, risk, and cost across a full range of options to address validated capability requirements. Additionally, the guidance has specific questions to be answered that are designed to highlight important aspects of the tradespace.

The WIPT is responsible for developing a draft of the study guidance. The study guidance undergoes a formal staffing and review process during which it is further developed before it is approved and issued.[23] The organization that ultimately approves and issues the study guidance will depend on several factors.[24] As described previously, staffing, validation, and approval guidelines for the study guidance and study plan are dependent upon the JSD and anticipated ACAT level for the effort. DoDI 5000.02 and A5R Guidebook provide details regarding these guidelines.

## 4.2 WIPT Tasks

As described in the previous chapter, Tables D-1 and D-2 in Appendix D graphically show examples of short and long versions of the study guidance development WIPT that were designed for developing DCAPE guidance and that follow the OSD(CAPE) study guidance template (Appendix K). Depending on the planning factors discussed in Chapter 3, the WIPT lead and facilitator may select the short or long version to use for the WIPT event, or tailor either version for a particular program. Though the versions are designed for developing DCAPE guidance, the WIPT lead and facilitator can tailor any version to develop HAF/A5R guidance.

Although there is a specific order to the tasks, the WIPT lead and facilitator may make adjustments depending on the situation. In some cases, the WIPT may finish the assigned tasks for the day early. The WIPT lead and facilitator will need to determine whether there is sufficient time remaining in the day to begin the next or another day's tasks or use the time for another purpose. In other cases, the WIPT may take longer to finish the assigned tasks. The WIPT lead and facilitator will need to make adjustments to the schedule and perhaps defer some work until after the WIPT event.

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[23] See the A5R Guidebook for review and staffing guidance.

[24] For all programs, AoA study guidance must be provided prior to the MDD (DoDI 5000.02).

Another option entails working some of the tasks concurrently by forming smaller groups within the WIPT that are focused on developing specific sections of the guidance. In these cases, the WIPT lead and facilitator should ensure the smaller groups are aligned in their efforts by fostering cross-communication and requiring frequent progress updates from each group. Decomposing the work this way will often speed up writing the different sections of the guidance, but it inherently adds importance and time to the integration and consistency check of the pieces. Keeping the group together helps ensure good integration and consistency, but will typically slow down the development of some individual parts. Finding the right mix is an art.

As noted in the previous chapter, there may be reasons to add, omit, or change parts of the OSD(CAPE) study guidance template for some programs. In these situations, it is vital to discuss template modifications with OSD(CAPE) as early as possible.

If DCAPE is the guidance approval authority, WIPT members should be aware that DCAPE may or may not accept AF study guidance inputs into the final version. However, it is possible that the Air Force will have concerns and questions that OSD(CAPE) does not view as a priority. In this case and if needed, HAF/A5R approves any additional AF guidance to supplement the OSD(CAPE) guidance. This AF-specific guidance supplement may need to be addressed by the WIPT and documented, but not necessarily included, in the OSD(CAPE)-issued guidance. Finally, for AF-delegated studies, the AFCDC Chair approves the AoA study guidance.

The remainder of this chapter provides specific guidance for each of the tasks. In completing the tasks, the WIPT will have developed an initial AoA study guidance document.

## 4.3 Task 1: WIPT Introductions and Overview

The WIPT lead and facilitator begin the WIPT event by welcoming the team members and briefly introducing themselves to the team. As part of the introduction, the WIPT lead and facilitator should describe his or her role as well as the roles of the team members. Given that the team is in the forming stage, each team member should be allowed to briefly introduce themselves and identify their area of expertise.

Once the introductions are complete, the WIPT lead or facilitator presents the rules of the WIPT (e.g., active participation, withholding criticism, avoiding attribution) and explains why they are important and must be followed. The rules are necessary to help enable the team to be fully productive and ensure the WIPT experience is worthwhile for all team members. There may be times during the course of the WIPT event that the WIPT lead or facilitator must remind the team of these rules and the need to abide by them.

To help the team understand what to expect, the WIPT lead or facilitator should provide an overview of the purpose of the WIPT and the approach that will be used to develop the AoA study guidance. If OSD(CAPE) AoA study guidance is being developed, the WIPT lead or facilitator should strongly consider providing a review of the OSD(CAPE) AoA guidance template to the WIPT. This decision will depend on the quality and state of completion of the draft study guidance as well as the experience level of the team. For Air Force guidance, the WIPT lead, in collaboration with the facilitator, should coordinate

with the HAF/A5R subject matter expert representative during pre-WIPT planning for specific study guidance content requirements. Again, the decision to review the study guidance content requirements during the WIPT will depend on the quality and state of completion of the draft study guidance template as well as the experience level of the team. Finally, before beginning Task 2, it is important to provide an opportunity for WIPT members to ask questions about their roles, the facilitator's role, the WIPT purpose, the study guidance development approach, or any other issues.

## 4.4 Task 2: AoA Training

The extent of AoA training required will depend on several factors such as the experience level of the WIPT members in developing AoA study guidance and planning and conducting an AoA. As a minimum, the facilitator should present an overview of the capability development process in the context of the program that includes discussion of the key decisions made by the sponsor, CDWG, and AFCDC, as well as the documents that have been produced (e.g., CBA, RSR, ICD) at this point in the process. The facilitator should also describe the decision points, milestones, and documents that will come later in the process (e.g., MDD, AoA, Milestone A, CDD) and how they are linked to previous decisions and documents. The facilitator should highlight how the WIPT is not starting from scratch, but rather leverages information from various sources such as CBAs, RSRs, ICDs, CDWG and AFCDC memorandums, OSD(CAPE) discussions, and existing pre-MDD analyses to develop the AoA study guidance.

## 4.5 Task 3: Defining the Purpose and Scope of the AoA

Identifying and developing the guidance and the purpose and scope of an AoA are arguably the most important aspects of study planning, because the purpose and scope will shape all the planning and execution that is to come.

The first section in the AoA study guidance template describes the purpose of the AoA. The basic purpose of an AoA is to assess the effectiveness, cost, and risks of alternatives that have potential to close or mitigate the capability gaps addressed in the study. The purpose statement should address the three fundamental aspects of the assessment (i.e., effectiveness, cost, and risk) as well as identify the specific gaps that will be addressed. Since the specific capability gaps are described in more detail in the Background section (see Task 4 below), detailed descriptions of the capability gaps are not needed in this section.

The purpose should highlight how the results of the AoA will be used to inform the MDA at the next milestone.[25] The MDA determines the milestone that a future program will enter by considering many factors (e.g., level of technology development, urgency of the program). In most AoAs, Milestone A is the next milestone.

[25] For more information about the MDA, see DoDI 5000.02, *Operation of the Defense Acquisition System*.

The study scope defines the focus of the study by describing what is, and is not, in the study. Ultimately, the scope is driven by the information decision makers need to make a decision; previous analyses; and ground rules, constraints, and assumptions.

When determining the scope of the study, the team should consider several factors, including:

- the decision to be supported,
- the capability gaps to be assessed,
- the nature of the capability needed (e.g., high risk or low risk),
- previous analyses,
- what information is already known and what is not known about the alternatives,
- the end-to-end mission effects chain,
- a clear understanding of the baseline capability,
- DOTmLPF-P implications,
- timeframe for the study,
- limitations on the study including constraints imposed by time and resources,
- guidance from senior leaders.

Additionally, the JCIDS required DoDAF views are a good tool to help scope the AoA. More fully described in the JCIDS Manual, these views address all of the capability requirements in the ICD, which is usually more than will be addressed in a single AoA. The views enable the team to illustrate why the proposed scope is appropriate. This helps the team obtain required agreement among decision makers and stakeholders about which capability gaps and mission tasks will be addressed. DoDAF views can also be used to show traceability of the operational capabilities and mission tasks to the CBA and ICD.

Since the AoA is an assessment of potential materiel solutions, the study must be scoped to provide decision-quality analysis and results to inform the MDA and other stakeholders at the next milestone or decision point. In short, the AoA must provide compelling evidence of the capabilities and military worth of the alternatives. The results should enable decision makers to discuss the appropriate cost, schedule, performance, and risk tradeoffs and assess the operational capabilities and affordability of the alternatives. A clear understanding of the decision to be made will help inform the scope of the AoA.

The scope of an AoA will be different for each study and depends upon many factors, including the nature of the capability need and the type of program being considered–whether it is a new development start, a modification of a commercially available system, or an upgrade to an existing system. In most cases, AoAs should consider a broad range of alternatives. However, it may be appropriate for some AoAs to evaluate only a limited number of alternatives within a single weapon system concept, such as in the case of the modernization of an existing system.

Risk assessment is a major factor to consider when determining AoA scope. AoAs that fail to examine risks could provide overly optimistic assessments of alternatives. Understanding the technology readiness levels of the proposed alternatives can help shape the scope of the AoA. Comparing risks across alternatives is especially critical for new development programs, which rely on breakthrough technologies and assume that technology will be achieved as planned. On the other hand, a less robust

risk assessment may be suitable for evaluating alternatives for a relatively straightforward modernization effort. Assessing risks is also important for alternatives based on commercial products that require significant modifications. Failure to assess the systems engineering and programmatic risks of alternatives can lead to a misunderstanding of the true costs associated with militarizing commercial platforms or integrating military capabilities onto commercial platforms. In addition to alternative risks, the team should consider the study risks as well (described in Section 2.3).

A common mistake made during the study scoping and planning phase is to ignore relevant previous analyses. A careful assessment of previous analyses can help scope the AoA. An AoA can leverage analysis from other AoAs or other analytic efforts. Leveraging previous work can help shorten the duration and reduce the cost of an AoA. The WIPT should identify and build upon previous studies and other analytical products applicable to the area of interest. The intent is to not only avoid unnecessary repetition of prior efforts, but also provide continuity between analyses for reviewers and decision makers. Conversely, another frequent error is to assume all previous analyses with similar title or subject matter is relevant or suitable to be leveraged. In fact, other studies may have used assumptions or planning factors that are no longer appropriate. Therefore, before leveraging prior analytic results, teams should study those products carefully and determine if they are suitable for the AoA at hand. Study teams should work closely with their sponsor and senior leadership to get guidance on how much previous analyses can be leveraged.

Many AoA study teams will evaluate alternatives for solutions to a portion of a mission effects chain. In other words, the alternatives being evaluated are just part of a larger system of systems and sequence of events that must work together to achieve overall mission success. When scoping the AoA, the team should consider the degree to which these other systems and parts of the mission effects chain must be considered. If those other parts are not considered, what assumptions can or should be made? For example, when looking at alternatives for a new smart weapon, does the AoA need to consider systems for gathering the intelligence needed to get information about the potential targets? If so, the study may become much more complex. If the intelligence systems are not included in the study, then the team must address how that information will be provided. Teams should avoid scoping the study so narrowly that a solution looks promising when examining a portion of the mission effects chain, but in reality that solution requires some other capability in another portion of the mission effects chain that will not be available. Teams should also avoid overlooking intelligence, communications, and other support functions because of time or resource constraints. Involving the functional experts in A2, A4, A6, etc. early in AoA planning will help scope the AoA and ensure greater likelihood of stakeholder acceptance of the results.

A part of study scoping that is easy to overlook is a thorough understanding of the baseline capability. The team should understand what baseline capability was used to define the capability gap(s) the AoA is addressing. If the baseline has changed since the gaps were defined, the team should consider updating the gap analysis. Additionally, the overall baseline capability in a mission effects chain will usually consist of many more elements than just the one system or piece of equipment being considered for replacement or augmentation. For example, an AoA examining alternatives for a new radar in a legacy

aircraft may also need to take into consideration the full capabilities and limitations of the baseline aircraft, not just the legacy radar.

Another aspect of study scoping is determining the DOTmLPF-P derived implications of the systems to be analyzed. Understanding how DOTmLPF-P aspects were addressed in the CBA can help scope the AoA.

The study scope should also define the timeframe of interest in the study. This includes the estimated time when solutions will be delivered to close or mitigate the capability gaps. By defining a timeframe of interest, the study team can better determine the operational context that will be used to conduct the assessment.

The WIPT should also identify and explain any limitations to the depth and breadth of analysis and impacts to the study (e.g., what study questions will not be answered, what will not be evaluated, what analyses will not be conducted). As described previously in Section 2.3, time and resource constraints and lack of access to certain data may limit study content or render the study results invalid. While there may be risk mitigation strategies that can be applied, the WIPT should get guidance from sponsors and senior leaders on the merits of conducting the study should there be no viable mitigation strategies.

Because the scope of the study can have such a profound effect on the results, the study lead should interact frequently during this stage of study planning with key stakeholders and senior leaders. Multiple iterations may be needed before an appropriate scope is attained.

## 4.6 Task 4: Identifying the Capability Gaps (Background)

The capability gaps to be addressed in the AoA are described at the end of the Background section of the study guidance. The description of the capability gaps is more than just background information since it establishes the fundamental scope of the AoA. The guidance should make clear that the values of the capability gaps identified in JCIDS documents should be treated as reference points to frame decision space rather than minimum standards to disqualify options.

With an approved ICD, the specific capability gaps to be addressed in the AoA are identified before the WIPT convenes. Unless there is other guidance from the CDWG or AFCDC, the WIPT lead and facilitator should ensure the capability gaps that will be addressed in the AoA align with the capability gaps described in the ICD. Any changes to the capability gaps will require CDWG, AFCDC, or higher-level review and approval. Note: Due to factors such as limited time and resources and the need for a realistic and achievable study scope, it is entirely appropriate and very common for an AoA to address only a sub-set of the capability gaps identified in an ICD.

The remainder of the Background section provides a brief history of the effort and explains why the AoA is being conducted now. The background should include a discussion of related programs and lessons learned from previous programs. This information is discussed in the beginning of the Background section and leads into the capability gap(s) discussion. Ideally, the WIPT lead should work with the facilitator to develop a draft of this part of the study guidance before the WIPT event. If the WIPT is time-constrained, the WIPT lead may defer development of this information until later in the WIPT event, or even after the WIPT event, in order to focus on more important sections of the study guidance.

## 4.7 Task 5: Describing the Baseline Capability and Alternatives

The baseline capability and alternatives are described in the Alternatives section of the study guidance. As noted in the guidance template, the baseline capability includes legacy systems, their approved modifications, and existing and/or planned and programmed systems. The alternatives should be realistic and grounded in industry (normally via requests for information or market research), a national laboratory, or another agency. The WIPT should avoid contriving idealized alternatives that have no basis in industry or government. The WIPT should consider one or more alternatives from the following alternative categories:

- Modified legacy systems,
- As-is or modified commercial, government, or allied off-the-shelf systems,
- Repurposing and/or recombining existing systems with new pieces in a system-of systems approach,
- New development systems.

When considering the scope of the alternatives to be evaluated during the AoA, if the existing baseline currently provides some level of capability, the guidance should direct the study team to examine all potential modifications to the legacy systems including optimizing the existing baseline, adding potential new, yet unfunded improvements, or augmenting the baseline with new systems to provide additional capability.

The baseline and alternatives should be defined with enough detail to avoid misconceptions regarding what will be addressed in the AoA. To do this, the WIPT should use the initial CCTDs as a source of information to describe the baseline and alternatives. If initial CCTDs do not exist, then the WIPT must rely on other sources of information (e.g., Joint Concept Technology Demonstration studies, Advanced Technology Demonstration studies, Science and Technology initiatives, other relevant CCTDs, and subject matter expert opinion) to define the alternatives.

In most cases, there should be other previous analyses that can serve as the basis for defending why certain alternatives will be included or excluded from the AoA scope. If the WIPT knows a specific alternative has political support from one or more stakeholders, but the WIPT believes it is not a viable option, it is best to state why the particular alternative will not be included. This will preclude supporters of the alternative from claiming that the alternative was excluded due to an oversight by the WIPT.

OSD(CAPE) emphasizes the exploration of the full range of viable modifications to baseline systems in the AoA.[26] These alternatives are generally referred to as baseline+ or modified baseline. The WIPT

[26] In AoA studies, the baseline is defined as the existing, currently programmed system funded and operated according to current plans. This includes improvements that are identified in the Future Years Defense Program (FYDP). Improvements may include Service Life Extension Program (SLEP) efforts, additional procurement, additional maintenance, or other efforts to continue to provide the baseline level of capability.

should consider having multiple alternatives with appropriate modifications, rather than one with all potential modifications.

Similar to the capability gaps described in the previous section, the number of alternatives will drive the scope of the AoA. The number of alternatives will depend on the AoA, but is typically ten or less, although it is not uncommon to have more. The WIPT should consider the number of alternatives that will be analyzed and determine whether it is possible to complete the analysis within the time and resource constraints. In some situations, it may be possible to bin similar concepts and conduct an analysis on a single representative from each bin. In all cases, alternatives should be general at this stage, which means not referring to brand names and specific instantiations (except in the baseline).

Alternative screening should begin early and continue throughout the AoA as knowledge increases. During study guidance development, it may be possible to screen out some alternatives considered early on because they are non-viable (e.g., cannot execute the required mission or have very low maturity levels). As shown in Figure 4-1, as the study progresses, additional alternatives may be screened out for a variety of reasons including poor performance, high risk, or higher costs than comparably performing alternatives. In other cases, continued analysis of alternatives that have already demonstrated potential may not provide any additional useful information. In these cases, and with the approval of the SAG/SRG, the team should discontinue further evaluation and apply the study team's time and resources elsewhere.

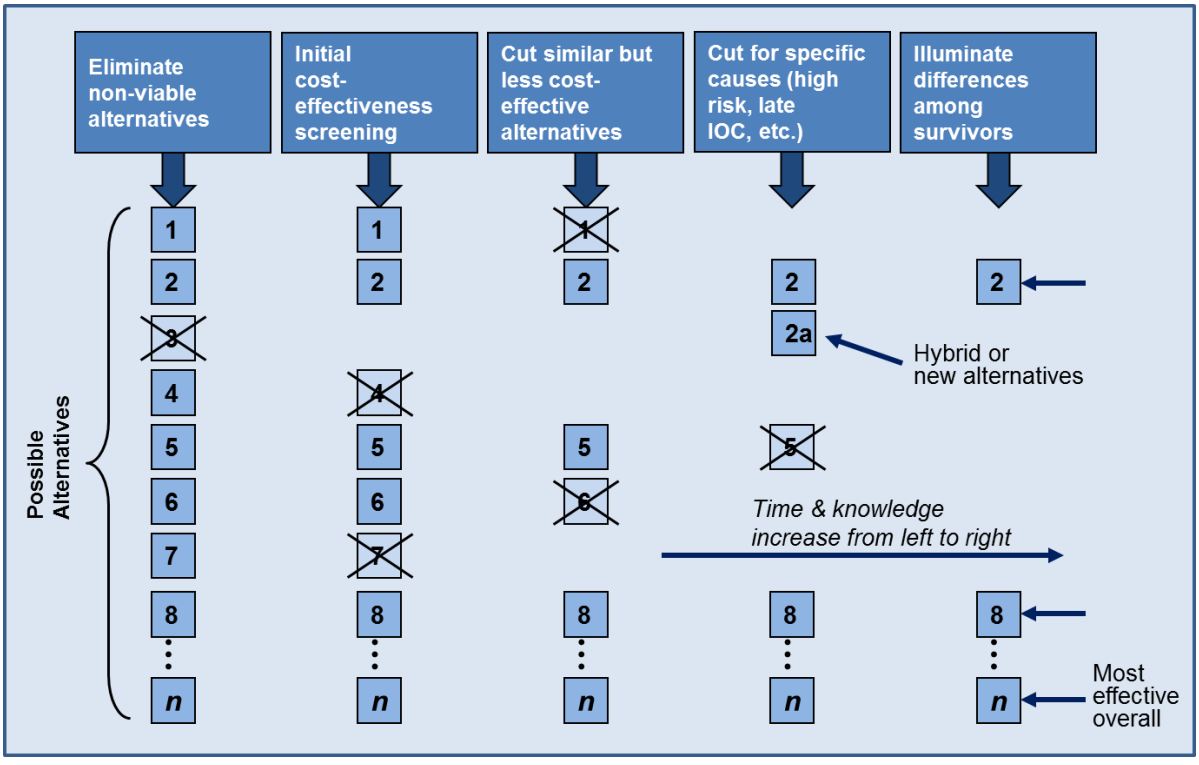


**Figure 4-1: Screening Alternatives**

The WIPT should not eliminate one or more alternatives due to time and resource constraints since such actions could result in an incomplete analysis and adversely impact the credibility of the results. If the alternatives should be addressed in the study, but time and resource limitations are an issue, the WIPT lead should seek assistance from the study sponsor, OSD(CAPE), the SAG, or the senior review group. Sometimes, if schedule and resources are a concern, the guidance can define one set of alternatives that must be analyzed, and another group (or further stratification of the initial group) that should be analyzed as resources allow.

## 4.8 Task 6: Developing Specific Questions to be Answered

Depending upon the JSD and anticipated ACAT level for the effort, AoA study guidance may be written and issued by either OSD(CAPE) or HAF/A5R. If the guidance is issued by OSD(CAPE), the Air Force typically will propose questions to CAPE. The AoA study guidance questions shape the direction, scope, and context of the AoA. This section describes some of the criteria teams should consider when developing proposed study guidance questions.

The questions themselves must be written in a way that fosters study success. Good study questions will be:

- Answerable. There may be valid questions that are simply unanswerable with current analytic methods, or within the available time and resources. If possible, AoA study guidance questions should be written in a way that takes into account the time, data, resources, and methods available to answer the question.
- Not written as a yes/no question. Questions written in a yes/no format are not very informative and may inadvertently limit creativity and exploration of answers during the analysis.
- Written to highlight important aspects of the tradespace. Questions should drive the analysis to identify key inflection points, knees in the curve, critical tradeoffs in cost and capability, important assumptions and sensitivities, limiting factors, etc., to best inform the decision.

This is one of the more difficult sections to develop since it requires some critical thinking and insightful discussion. The OSD(CAPE) AoA Study Guidance Template (Appendix K) is very clear that study questions should not address requirements that are discussed elsewhere in the guidance, but rather probe issues associated with the program. Questions that are inherent in the analysis are redundant to the fundamental purpose of the AoA: to determine the effectiveness, cost, and risk of the alternatives under study and therefore, do not provide additional information or insights. The following are some examples of redundant questions that should not be included in this section:

- How effective are the alternatives?
- What are the life cycle costs of the alternatives?
- How affordable are the alternatives?
- What are the most viable alternatives?
- What are the risks associated with each alternative?
- What are the DOTmLPF-P implications associated with each alternative?
- What is the military utility or worth of each alternative and why is this important?

- What are the operational benefits and risks associated with each alternative?
- What operational environment factors could affect performance?

Questions should be substantive to the specific program and, when answered, will highlight important aspects of the tradespace (e.g., how a program would achieve high reliability; how a program might trade lethality versus survivability if cost (or weight) is a limiting factor). Study questions are used to guide the AoA study team in analyzing aspects important to the stakeholders. Teams should plan to draft questions and then solicit feedback on those questions from senior leaders and from all the stakeholders. Some stakeholders may have a different point of view than others; teams should seek to understand these differences before the study starts, and the study questions are a good way to have that dialogue. Usually, multiple iterations will be required before the set of study questions can be finalized and agreed upon.

Some examples of substantive questions include the following. Typically, these questions will be tailored to capture the context of a specific AoA:

- Of the affordable and viable solutions to mitigate the identified capability gap(s), what parts of the gap does each solution mitigate? Why should they be pursued?
- For Service-unique solutions, what are potential areas of commonality (e.g., shared technology) with other Service solutions?
- Identify if a DoD-specific solution is required; or are there alternative solutions (e.g., commercial, international, partnerships, etc.)?
- To what degree does each alternative depend on mission enablers (e.g., intelligence, logistics, communications, training, etc.), both organic and Joint, to accomplish mission objectives?
- What are the potential reductions in cost, risk, and time that can be obtained by using systems and components that are off-the-shelf or already in advanced development, and how do these non-developmental solutions compare to developmental solutions in terms of performance?
- Given the expected lower cost, risk, and time associated with off-the-shelf systems, how much performance degradation would be acceptable to the Air Force if off-the-shelf systems are chosen?
- What is the export potential of each alternative and how might export sales affect DoD costs?
- What are the potential cost savings that could result from leveraging maintenance and spares support from existing programs, or using alternative maintenance sustainment concepts that differ from the baseline capability?
- How have affordability goals and constraints been included in the program and how will they be achieved?

Many of these key questions should trace back to the CDWG or AFCDC direction the CFL or lead command should have received prior to forming the WIPT. Some questions will reflect issues OSD(CAPE) or other stakeholders have that the CFL or lead command may not have considered.

## 4.9 Task 7: Developing the Key Ground Rules, Constraints, and Assumptions

Defining the key ground rules, constraints, and assumptions (GRC&As) is important in properly scoping the study and limiting bias. Despite their importance, GRC&As are typically misunderstood, resulting in the tendency to misuse the terms. This misunderstanding can cause teams to default to labeling most elements as assumptions, when, in fact, it is not the appropriate term to use. GRC&As are defined as follows:

- Ground rule – broadly stated procedure that governs the general process, conduct, and scope of the study. An example is: the study sponsor will review and approve the description of the baseline capability prior to the study team conducting the analysis.
- Constraint - imposed limitation that can be physical, programmatic, or policy. Human physical or cognitive limitations or a specific operating frequency range are examples of physical constraints. Specifying the latest acceptable initial operational capability (IOC) date illustrates a programmatic constraint. A treaty is an example of a policy constraint.
- Assumption - a supposition that something is true and can address various aspects associated with scoping and supporting the analysis. Examples include specific manpower levels, inclusion of a target type that will proliferate in the future (thus forcing consideration of a specific threat system), or a certain infrastructure or architecture will be provided by another program.

The WIPT should focus on identifying GRC&As that are key and have the potential to drive the results. Key GRC&As address important elements such as force ratios, threat characterizations, and CONOPS that will be used in the study. GRC&As that have no potential to impact the results are less important and should not be identified in the study guidance, although they may be identified in the study plan and report.

This section of the study guidance should describe how the key GRC&As will be validated. The Study Advisory Group (SAG) typically validates the key GRC&As prior to beginning the analysis. However, in some situations, key GRC&As may be identified during study execution, requiring SAG validation as they are developed.

The WIPT should refrain from assuming something away for various reasons such as the data does not exist, it is too difficult to analyze, or there is no time or resources to assess it. GRC&As developed for reasons such as these will likely bias the results and adversely impact the credibility of the study team. GRC&As are not developed for convenience sake, but rather have a purpose in helping to effectively scope and support the study. One of the most egregious errors is to assume away problems in order to bias the results in a certain direction. This can be done by assuming away a certain type of threat, assuming the availability of a critical enabler that might not actually be available, or by excluding a significant cost element because it will make an alternative unaffordable.

## 4.10 Task 8: Developing the Analysis Methodology

At this stage of AoA planning, the WIPT may not have a clear understanding of how the analysis will be conducted. In these cases, the WIPT should at least capture what AoA data collection and analysis methods are being considered and focus on guidance for the study team to follow when developing the

analysis methodologies in the study plan. Regardless of the level of understanding at this point, the following fundamental aspects of the effectiveness, cost, and risk analyses should be addressed in the study guidance:

- Development of mission tasks, measures of effectiveness (MOEs), measures of suitability (MOSs), and measures of performance (MOPs). NOTE: The WIPT may not know what all the measures are at this time, but should acknowledge they must be developed to conduct the analysis.[27] DoDAF views OV-2, OV-5a, CV-2, and CV-6 may be useful in developing measures.[28]
- Specific tools or techniques that the study team plans to use or is considering (e.g., Modeling and Simulation (M&S) applications (e.g., BRAWLER, SUPPRESSOR), parametric analysis, expert elicitation).
- Cost capability analysis and other sensitivity analysis that will be conducted. (NOTE: this is intended to be a minimum set – other tradeoffs and sensitivity analyses will only be identified once the AoA is underway and initial results are produced).
- Scenarios, CONOPS, threats, and targets that will be used or are being considered.
- Cost analysis approach that describes the development of life cycle cost estimates (LCCEs) and what they include (i.e., research, development, test and evaluation (RDT&E), procurement, operations and support, and disposal costs), then-year and base-year estimates, and applicable OSD and Air Force guidance that will be followed.
- Risk assessment methodology the study team will use or is considering (e.g., Air Force Risk Assessment Framework; Department of Defense Risk, Issue, and Opportunity Management Guide for Defense Acquisition Programs; hybrid technique).
- Plan to present analysis methodology (e.g., scenarios, threats, tools, techniques, measures, data) for review and approval by the SAG and other stakeholders.

The following provides more specific OSD(CAPE) guidance the WIPT should consider in developing the analysis methodology section of the study guidance:

- Scenarios. The study team should identify the scenarios and CONOPS that will be used and explain the rationale for their inclusion. If non-standard scenarios will be employed, the study team should plan to fully explain outcomes unique to those scenarios. [29] If one or more vignettes from standard scenarios will be used, the study team should describe them and

[27] For more information about developing measures, see *The Measures Handbook*, OAS.

[28] For more information about DoDAF views, see the US Department of Defense Chief Information Officer website at http://dodcio.defense.gov/Library/DoDArchitectureFramework.aspx

[29] Defense Planning Scenarios (DPSs) and Integrated Security Constructs (ISCs) are commonly referred to as standard scenarios. Non-standard scenarios are generally scenarios constructed by the study team to create an appropriate operational context for the study analysis. Non-standard scenarios are used in cases when the standard scenarios do not apply to the area of interest being assessed in a study.

provide rational for their use.[30] The guidance should direct that a range of less stressing and more stressing scenarios be used, rather than using only highly demanding scenarios. Every scenario identified should be logically linked to the questions and capability gaps (i.e., the team should be able to explain why the scenario is needed in the AoA). The guidance should also direct the study team to explain how variations to CONOPS or attributes of alternatives might mitigate cost drivers or low ratings on assessment metrics. The guidance should instruct the study team to characterize the circumstances in which a given option appears superior and the conditions under which its outcomes degrade (a useful example of this was in the AoA for the replacement of the M113 armored personnel carrier, which showed how casualties varied according to the explosive weight of improvised explosive devises). Additionally, as one alternative may be better suited for one scenario over another or be better suited for a particular scenario than another alternative, identifying these distinctions is an important part of the AoA and should be considered as the study guidance is developed.

- Cost Analysis. The study team should conduct an analysis of life cycle costs that includes estimates of development, production, operations and support, military construction (MILCON), and disposal costs. Life cycle cost estimates provide a relative comparison of the costs of the alternatives and should not be considered the absolute cost of alternatives. These estimates should be of sufficient quality to support acquisition and investment decisions but are not necessarily of budget quality. The guidance should also call out any problem-unique cost considerations that should be addressed in the AoA.
    - Operations and Support cost estimates will cover a common life cycle period for the system under consideration (for most, a 20-30 year period) for all alternatives, consistent with the *Operating and Support Cost-Estimating Guide*, Cost Assessment and Program Evaluation, Office of the Secretary of Defense. The estimates shall include point estimates for the Average Procurement Unit Cost (APUC), as well as total life cycle cost.
    - Life cycle estimates should be calculated as point estimates and also shown at the 50%, 80%, and mean confidence levels.
    - The cost analysis will identify APUC estimates for varying procurement quantities, if applicable. Present-value discounting should be used in comparing the alternatives, in accordance with OSD and Office of Management and Budget guidelines.
    - Costs should be expressed in base-year dollars and, if appropriate in the context of Future Years Defense Program (FYDP) phased funding, in then-year dollars. Costs should be presented at the major appropriation level with defined risk ranges to communicate the uncertainty associated with the estimates.
    - The cost portion of the analysis should include an assessment of how varying the annual procurement rate affects cost and manufacturing risk when appropriate (e.g., procuring items faster to complete the total buy sooner vice procuring at a slower rate over time).

[30] When a standard scenario (i.e., DPS or ISC) is too broad, study teams often use one or more vignettes which are smaller pieces of a standard scenario.

- Sensitivity Analysis. Through the sensitivity analysis, the study team should identify cost, schedule, and performance drivers to illuminate the trade space for decision makers (e.g., identify performance attributes that make the largest changes to mission effectiveness or are likely to most influence development or production cost). The study team will identify GRC&As, variables, and measure thresholds that when altered, may significantly change the relative schedule, performance, and cost-effectiveness of the alternatives. The guidance should make clear that the values of the capability gaps in the Initial Capabilities Document (ICD) and draft Capability Development Document (CDD) should be treated as reference points to frame the decision space rather than minimum standards to disqualify alternatives. For features that appear to provide substantive operational benefit to one or more alternatives, the team should assess whether they apply to all viable alternatives. For example, if a type of sensor is found to provide improved effectiveness for one alternative, the team should explore incorporating the feature in all alternatives.
- Operational, Schedule, Cost, and Technology/Manufacturing Readiness Assessment. The guidance should instruct the study team to give full treatment to both operational and non-operational risks (i.e., technical, schedule, and cost). Within the technical risk area, empirical data should guide the assessment, with particular focus on integration risk. Note that the cost risk assessment is addressed in the cost analysis section of the guidance. As part of the risk assessment methodology, the study team should develop a realistic acquisition strategy for the recommended alternative(s), if one or more is identified. The study team should describe how the estimated schedules for each alternative and Technology Readiness Levels (TRLs) and Manufacturing Readiness Levels (MRLs) for critical technologies will be used to assess the likelihood of completing development, integration, and operational testing activities on schedule and within budget. Where significant risks are identified, the assessment should outline practical mitigation strategies to minimize impact to delivering the operational capability to the warfighter, and if applicable, possible workarounds in the event the risks are realized.
- Other Specified Analysis Identified in the OSD(CAPE) study guidance (as required).
    - All mandatory Key Performance Parameters (KPPs) as noted in the JCIDS manual should be analyzed, as applicable. Additionally, if a value has been specified within the requirements documents for these KPPs, describe the risk incurred for failing to achieve these values.
    - DOTmLPF-P Assessment. The study team will evaluate the implications for Doctrine, Organization, Training, materiel, Leadership and Education, Personnel, Facilities, and Policy (DOTmLPF-P) for each alternative.
    - Operational Energy Assessment. If applicable, the study team will include an examination of demand for fuel or alternative energies under each of the alternatives, using fully burdened costs. The study lead will:
        - Ensure the Fully Burdened Cost of Energy (FBCE) method is used in computing costs for the Life Cycle Cost Estimate (LCCE) and documented in the final report.
        - Brief the SAG as to whether FBCE significantly differentiates between the alternatives being considered.

- In cases where it does not significantly differentiate between alternatives, the Service shall complete the FBCE work external to the AoA.

## 4.11 Task 9: Developing the Administrative Guidance

The administrative guidance describes the oversight and staffing requirements associated with the AoA study plan and final report. The OSD(CAPE) study guidance typically describes a staffing or review process for presenting the AoA study plan and final report for review and approval (see the OSD(CAPE) study guidance template in Appendix K). After CFL or lead command review, the study guidance is submitted through the AFGK to the CDWG for review, and then AFCDC (or higher) for approval to be released to OSD(CAPE), if required. For those AoAs where DCAPE elects not to provide study guidance, AFCDC chair will serve as the approval authority.[31]

Administrative guidance that is specific to the OSD(CAPE) AoA study guidance includes the following:[32]

- Study Advisory Group (SAG). The SAG is responsible for overseeing the AoA and ensuring it complies with the guidance. This section describes the SAG members and their roles. The SAG chair (or co-chairs) and members will depend on the program.[33]
- AoA Study Plan. This section describes the review and staffing process for the study plan. It may also stipulate a page count for the plan and who is responsible for validating or approving the plan. There is also guidance for developing a schedule for briefing the SAG on the AoA team's progress.
- Analysis Timeline. This section describes the expected length of time needed to complete the study. If the AoA analysis is expected to take longer than 6-9 months, the scope of work should be reconsidered to ensure the analysis planned is truly necessary to inform the milestone decision.
- AoA Final Deliverables. This section describes the final deliverables which are typically a final report document and briefing. It may stipulate a page count and guidance regarding the format (e.g., having an Executive Summary and using appendices for additional information). It describes who will review and approve the final report.

## 4.12 Task 10: Wrap-up, Action Item Review, and Adjourning the WIPT

The wrap-up entails finishing up the remaining work before adjourning the WIPT. This does not mean rushing work and settling for a mediocre, or worse, product. If it is not possible to produce a quality product in the remaining time, it is better to defer the work until after the WIPT event.

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[31] See the A5R Guidebook.

[32] For Air Force-issued guidance, the WIPT will need to determine what aspects of the administrative guidance apply. For DCAPE-issued guidance, see Appendix K (OSD(CAPE)) study guidance template) for more information.

[33] See Chapter 2, section 2.5.4, for more information about the organizations that can serve as the SAG chair (or co-chairs) and members.

The WIPT lead, in collaboration with the facilitator, should assign actions items with time deadlines to the appropriate team members. Action items may address various aspects such as issues that must be resolved, questions that must be answered, and study guidance sections or parts of sections that must be completed.

The WIPT lead and facilitator should advise the WIPT members to coordinate the draft study guidance with their respective organizations to avoid possible delays during formal staffing. For representative(s) of organization(s) that were invited but did not attend, the WIPT lead should provide the draft study guidance to these representatives for review and comment prior to the formal staffing.

After CFL or lead command review, the study guidance is submitted through the AFGK for CDWG review, and then AFCDC (or higher) for approval to be released to OSD(CAPE), as required. For those AoAs where DCAPE elects not to provide study guidance, the AFCDC Chair will serve as the approval authority.[34]

Before adjourning the WIPT, the facilitator should elicit feedback from the team members regarding his or her performance as a facilitator, the value of the WIPT approach, and improvements or enhancements that should be considered. In addition, the facilitator should document any lessons learned as well as the successes and shortcomings of the WIPT.

[34] See the A5R Guidebook, for study guidance approval criteria.

# 5 Developing the AoA Study Plan

Similar to the AoA study guidance, the AoA study plan can be developed in a Working Integrated Product Team (WIPT) event or it can be developed over time via other collaborative efforts. Ideally, this WIPT or other collaborative efforts should have the same membership as the ICD and AoA study guidance WIPTs. This chapter provides guidelines on developing the AoA study plan.

## 5.1 What is the AoA Study Plan?

The AoA study plan describes how the analysis will be conducted. The study plan typically describes the purpose and scope of the study as well as the methodologies that will be used to analyze the data. A methodology is generally defined as a process through which the study team attempts to achieve systematically, and with support of the data, the answer to a question. Methodologies are the core that underlies all studies. Through various methodologies, a study team describes the process for collecting, analyzing, and interpreting data. Methodologies enable the study team to interpret data and draw conclusions to answer questions that lead to the expansion of knowledge. The methodologies must adhere to the following:

- They are objective to reduce bias in the interpretation of results,
- They are systematic in that it involves certain standard procedures,
- They involve careful recording, documenting, archiving, and sharing of data to enable others to verify results.

It is important that the study questions drive the methodology, and not the other way around. Though each method has particular strengths and limitations, the choice of which to use requires careful consideration of the specific question and the type, quality, and quantity of data available. In practice, it is not uncommon for analysts to favor particular data collection and analysis methods over others. Familiarity and prior success with using a particular method often reinforces its use, even when it is not the most suitable method for addressing a specific study question.

The study plan includes other important information such as capability gaps, alternatives, scenarios, measures, stakeholders, and study questions. The study plan should clearly describe how the effort will address the AoA study guidance received from the Air Force and, if applicable, OSD(CAPE).

Developing a study plan is a worthwhile endeavor given the many uses of the plan. In addition to describing how the analysis will be conducted, the study plan is useful for getting new team members up to speed more quickly, capturing ongoing changes to the plan, and serving as the basis for the final report.

The study team members are responsible for developing a draft of the study plan during the WIPT event. The study plan undergoes a formal staffing and review process before it is approved or validated. The A5R Guidebook describes the staffing requirements for an AoA study plan.

## 5.2 WIPT Tasks

As described in Appendix D, Tables D-3 and D-4 graphically show examples of short and long schedule versions of the study plan development WIPT that were designed for developing a study plan based on the OAS AoA study plan template (Appendix F). Depending on the planning factors discussed in Chapter 3, the WIPT lead and facilitator may select the short or long version to use for the WIPT event, or tailor either version for a particular program. For some programs, there may be reasons to add, omit, or change parts of the OAS study plan template. In these situations, the WIPT lead should discuss template modifications with OAS as early as possible.

Although there is a specific order to the tasks, the WIPT lead and facilitator may make adjustments depending on the situation. In some cases, the WIPT may finish the assigned tasks for the day early. The WIPT lead and facilitator will need to determine whether there is sufficient time remaining in the day to begin the next or another day's tasks or use the time for another purpose. In other cases, the WIPT may take longer to finish the assigned tasks. The WIPT lead and facilitator will need to make adjustments to the schedule and perhaps defer some work until after the WIPT event.

Another option entails working some of the tasks concurrently by forming smaller groups within the WIPT that are focused on developing specific sections of the plan. In these cases, the WIPT lead and facilitator should ensure the smaller groups are aligned in their efforts by fostering cross-communication and requiring frequent progress updates from each group. Decomposing the work this way will often speed up writing the different sections of the plan, but it inherently adds importance and time to the integration and consistency check of the pieces. Keeping the group together helps insure good integration and consistency, but will typically slow down the development of some individual parts. Finding the right mix is as much an art as a science.

The remainder of this chapter provides specific guidance for each of the tasks. Upon completing the tasks, the WIPT will have developed an initial AoA study plan.

## 5.3 Task 1: WIPT Introductions and Overview

The WIPT lead and facilitator begin the WIPT event by welcoming the team members and briefly introducing themselves to the team. As part of the introduction, the WIPT lead and facilitator should describe his or her role as well as the roles of the team members. Given that the team is in the forming stage, each member should be provided an opportunity to briefly introduce themselves and identify their area of expertise

Once the introductions are complete, the WIPT lead or facilitator presents the rules of the WIPT (e.g., active participation, withholding criticism, avoiding attribution) and explains why they are important and must be followed. The rules are necessary to help enable the team to be fully productive and ensure the WIPT experience is worthwhile for all team members. There may be times during the course of the WIPT event that the WIPT lead or facilitator must remind the team of these rules and the need to abide by them.

To help the team understand what to expect, the WIPT lead or facilitator should provide an overview of the purpose of the WIPT. This should include a review of the AoA study plan template and, if applicable, the study guidance (draft or final document). Finally, before beginning Task 2, it is important to provide an opportunity for the WIPT members to ask questions about their roles, the facilitator's role, the WIPT purpose, the study plan template, or any other issues.

## 5.4 Task 2: AoA Training

The extent of AoA training required will depend on several factors such as the experience level of the WIPT members in developing an AoA study plan and planning and conducting an AoA. As a minimum, the facilitator should present an overview of the capability development process in the context of the program that includes discussion of the key decisions made by the sponsor, CDWG, and AFCDC as well as the documents that have been produced (e.g., CBA, RSR, ICD) at this point in the process. The facilitator should also describe the decision points, milestones, and documents that will come later in the process (e.g., MDD, AoA, Milestone A, CDD) and how they are linked to previous decisions and documents. The facilitator should highlight how the WIPT is not starting from scratch, but rather leverages information from various sources such as the CBA, RSR, ICD, CDWG and AFCDC memorandums, OSD(CAPE) discussions, and existing pre-MDD analyses to develop the AoA study plan.

## 5.5 Task 3: Overview of the Study Plan Development Approach

In this task, the WIPT lead and facilitator provide an overview of the study plan development method to ensure the WIPT members understand how the study plan will be developed. As noted earlier, the WIPT lead may use one of the versions described in Tables D-3 and D-4 (Appendix D), or develop his or her own method.

## 5.6 Task 4: Develop Chapter 1 (Introduction)

In this task, the WIPT lead and facilitator guide the WIPT in the development of Chapter 1 (Introduction) of the study plan. Drafts of Section 1.1 (Background), Section 1.2 (Purpose and Scope), Section 1.3 (Study Guidance), and Section 1.4 (Capability Gaps) should have been developed by the WIPT lead and facilitator prior to the WIPT, since they are a summary of what was provided in the guidance. The following provides specific guidance for each section of the chapter:

### *5.6.1 Section 1.1: Background*

The background section provides a brief history of the effort and explains why the AoA is being conducted now. Ideally, a draft of this section should be completed before the WIPT event. If the WIPT is time-constrained, the WIPT lead may defer development of this section until later in the WIPT event, or even after the WIPT event in order to focus on more important sections of the study plan.

The background should include a discussion of the related programs and lessons learned from previous programs. Previous analyses such as relevant Joint Concept Technology Demonstrations (JCTDs) and Advanced Technology Demonstrations (ATDs) should be discussed a well.

### *5.6.2 Section 1.2: Purpose and Scope*

The basic purpose of an AoA is to assess the effectiveness, cost, and risks of alternatives that have potential to close or mitigate the capability gaps addressed in the study. The purpose statement should address the three fundamental aspects of the assessment (i.e., effectiveness, cost, and risk) as well as identify the specific gaps that will be addressed. Since the specific capability gaps are described in more detail in Section 1.4 (Capability Gaps), detailed descriptions of the capability gaps are not needed in this section. See paragraph 4.5 for additional information regarding defining the purpose and scope.

The purpose should highlight how the results of the AoA will be used to inform the MDA at the next milestone.[35] The MDA determines the milestone that a future program will enter by considering many factors (e.g., level of technology development, urgency of the program). In most AoAs, Milestone A is the next milestone.

The study scope defines the focus of the study. In other words, the study scope defines what is and is not in the study. Scope is primarily driven by three things:

- Information decision makers need (may be expressed in study guidance or other directives),
- Previous analyses,
- Ground rules, constraints (e.g., resources, time), and assumptions.

AoAs are designed to provide decision-quality information to inform decisions. It is therefore important to scope the AoA appropriately to focus on the information required for those decisions. In addition, the WIPT should identify and explain any limitations to the depth and breadth of analysis and impacts on the study (e.g., what study questions will not be answered, what will not be evaluated, what analyses will not be conducted). A clearly and carefully written scope increases the likelihood that the study team will meet the objectives of the study and complete it on time and within budget.

In describing the study scope, the WIPT should identify and build upon previous studies and other analytical products applicable to the area of interest. The intent is to not only avoid unnecessary repetition of prior efforts, but also provide continuity between analyses for reviewers and decision makers. This does not preclude the WIPT from applying different context or different assumptions, as appropriate, to the scope of the study.

The study scope should also define the timeframe of interest in the study. This includes the estimated time when solutions will be delivered to close or mitigate the capability gaps. By defining a timeframe of interest, the study team can better identify the appropriate operational context (described later in Chapter 2 of the study plan) that will be used to conduct the assessment.

For further information regarding identifying and developing the purpose and scope of the AoA, refer to paragraph 4.5 of this handbook.

[35] For more information about the MDA, see DoDI 5000.02.

### *5.6.3 Section 1.3: Study Guidance*

The key aspects of the AoA study guidance from OSD(CAPE) or the Air Force are summarized in this section. In some cases, the study guidance may not be signed before the WIPT event to develop the study plan. In these cases, the WIPT should defer developing this section until the guidance is signed or is in the final stages of staffing. Once the study guidance is signed, it should be attached as an appendix to the study plan.

### *5.6.4 Section 1.4: Capability Gaps*

In this section, the WIPT describes the capability gap(s) that will be addressed in the AoA. The actual wording of the capability gap(s) should be used and the name(s) of the source document(s), typically one or more ICDs, should be provided. The gaps to be addressed in the AoA should have been prioritized during the CBA and in the ICD; if not, the study team should work with the sponsor to prioritize them. The specific capability gaps that will be addressed in the AoA should also have been identified in the ICD and AoA study guidance. Unless there is other guidance from the CDWG or AFCDC, the WIPT lead and facilitator should ensure the capability gaps that will be addressed in the AoA align with those described in the CBA, RSR, and ICD. Any changes to the capability gaps identified in the ICD will require CDWG or higher review and approval.

### *5.6.5 Section 1.5: Stakeholders*

In this section of the study plan, the WIPT identifies the AoA stakeholders and their roles and responsibilities. The WIPT identifies which stakeholders should have membership in the Study Advisory Group (SAG) and any other special group that may be formed for the AoA. In addition, the WIPT describes how the SAG will review and approve key aspects of the study such as the analysis methodologies, alternatives, scenarios, and assessment criteria.

### *5.6.6 Section 1.6: Key Ground Rules, Constraints, and Assumptions*

In this section, the WIPT describes the key AoA ground rules, constraints, and assumptions (GRC&As). An initial set of key GRC&As is identified during the AoA study guidance WIPT. If there was no WIPT event to develop the study guidance, the WIPT lead and facilitator should complete Task 7 (Developing the Key Ground Rules, Constraints, and Assumptions) of the AoA study guidance WIPT to guide the WIPT in developing GRC&As (see Chapter 4, section 4.9).

During the WIPT event, additional GRC&As may be developed. The WIPT should review these additional GRC&As to determine whether they are appropriate and do not conflict with other previously identified GRC&As. Some of these GRC&As may be specific to an analysis methodology (e.g., effectiveness analysis, cost analysis) and should be listed in the appropriate analysis chapter. Others may be overarching and should be designated as key GRC&As and included in this section of the study plan. It is important that the WIPT review the information provided in Task 7 (Developing the Key Ground Rules, Constraints, and Assumptions) of the AoA study guidance WIPT to learn about appropriate and inappropriate GRC&As. This will help the WIPT to ensure the GRC&As are necessary and appropriate for the study.

## 5.7 Task 5: Overview of Baseline Capability and Potential Alternatives

Before beginning development of Chapters 2 - 5 of the study plan, the WIPT lead and facilitator should ensure the WIPT fully understands the baseline and alternatives that are being considered in the AoA. By having a good understanding of the baseline and alternatives, the working groups that are formed are better able to develop their assigned chapters (see next paragraph for more discussion regarding the working groups). The ideal method for achieving this is through a briefing or background paper(s). During pre-WIPT planning, the facilitator coordinates with the WIPT lead to assign responsibility for developing the briefing or background paper(s) to a member of the study team, most likely the individual who has been selected or is being considered for the AoA Technology and Alternatives Working Group (TAWG) lead position. For this task, this member presents the key aspects of the baseline and alternatives to the WIPT and answers any questions that may arise.

Prior to starting Tasks 6 - 9, the WIPT lead and facilitator divide the WIPT into four working groups (Day 2 of the short version and Days 3-4 of the long version ) and assign a chapter to each working group to develop (see Tables D-3 and D-4 in Appendix D). The tasks are completed concurrently by the working groups (note that this means Chapters 2 - 5 in the study plan are developed concurrently). Despite working concurrently, the groups must collaborate to maintain alignment and unity of effort. The WIPT lead and facilitator should meet with the working group leads as necessary during these sessions (2-3 times per day is recommended) to review progress, share information, and foster collaboration.

It is important to note that Tables D-3 and D-4 in Appendix D provide one example of how the WIPT can be formed into working groups. With facilitator assistance, the WIPT lead must determine the best way to structure the WIPT representatives for a particular study. This means the WIPT lead may choose to have multiple groups working on various sections of the plan. If the AoA study team is forming or has formed, the WIPT lead may structure the WIPT groups to align with the AoA study team structure as shown in Figure 2-1 (i.e. effectiveness analysis (EAWG); threats and scenarios (TSWG); technology and alternatives (TAWG); cost analysis (CAWG); employment concepts (ECWG); and risk assessment (RAWG) working groups). However, it is possible that the formal working groups may not have been chartered at this point, in which case, the WIPT lead will assign the WIPT representatives to work on sections of the plan commensurate with their skills and expertise.

## 5.8 Task 6: Develop Chapter 2 (Alternatives)

In this task, the WIPT lead and facilitator guide the WIPT representatives designated to develop the Alternatives, Scenarios, and Employment Concepts in the development of Chapter 2 (Alternatives) of the study plan. The following provides specific guidance for each section of the chapter:

### *5.8.1 Section 2.1: Description of Alternatives*

The baseline capability and alternatives are described in this section of the study plan. The WIPT representatives designated to develop the alternatives should utilize the study guidance since the information it contains can be used to develop this section of the chapter. If there was not a WIPT event to develop the study guidance, the representatives should complete Task 5 of the AoA study guidance WIPT (see Chapter 4, section 4.7).

At this stage of AoA planning, there should be sufficient information about the baseline and alternatives to enable the study team to develop one or more initial CCTD documents that describe the baseline and alternative concepts. As described in Chapter 2, the Technology and Alternatives Working Group (TAWG) develops and maintains the CCTD documents that will be used in the AoA. Though the CCTDs may not fully describe the concepts at this stage, the information should be sufficient to enable the study team to proceed with conducting the AoA upon MDA approval.[36]

The initial CCTDs are included as appendices to the AoA study plan. SAF/AQR makes a technical recommendation of the concepts to SAF/AQ in support of the CDWG and/or AFCDC when the lead command or sponsor presents the AoA study plan for validation. The inclusion of a concept in the AoA study plan should be taken as evidence of endorsement that the concept described in the CCTD(s) meets the expectations of the lead command or sponsor in terms of having the potential to fulfill the stated operational capability need.[37] During the course of the study, the CCTDs are further developed as new data and information requirements are identified by the study team. The final CCTDs are included as appendices to the AoA final report. Additionally, as previously described in section 4.7, alternatives may be further screened from the study with the approval of the SAG or senior review group during development of the plan.

### *5.8.2 Section 2.2: Operational Context, Operational Concept, and Employment Concepts*

In this section of the study plan, the WIPT representatives designated to develop the operational concepts describe the operational concepts and the employment concepts that are relevant to the baseline and alternative capabilities, and the operational context associated with the capability gaps and requirements. The following are some aspects to consider when developing this section of the study plan:

- Missions, tasks, processes, decision points, and business rules,
- Activities, relationships among activities, activity sequence and timing, activity responses to events, activity inputs and outputs, and delivery timing, in accordance with the applicable OV-2s and CV-3s,
- Organizational and human roles and responsibilities in accordance with the applicable OV-4s,
- Manpower requirements and skill-sets,
- Intelligence support, logistics support, and other support services in accordance with the applicable OV-2s and OV-4s,
- Command, control, coordination, and other relationships among organizations in accordance with the applicable OV-2s and OV-4s,
- System of systems (SoS), and family of systems (FoS),

[36] CCTDs are required at the Air Force Review Board (AFRB) that is conducted prior to MDD.

[37] For more information about the CCTD, see the *Concept Characterization and Technical Description (CCTD) Guide*, SAF/AQ.

- Geographic configuration and connectivity,
- Communications systems, links, interfaces, and networks,
- Data requirements, information flows, and types of information exchanges and relevant attributes such as media, quality, quantity, frequency, and the level of interoperability,
- Key tactics, techniques, procedures, and doctrine,
- Peacetime, contingency, and deployment requirement,
- Existing DoDAF views from the CBA and ICD.

### *5.8.3 Section 2.3: Scenarios and Operational Environments*

The WIPT representatives designated to develop the scenarios and operational environments should utilize the study guidance, since the information it contains can be used to develop this section of the chapter. If there was no WIPT event to develop the study guidance, the representatives should refer to Task 8 of the AoA study guidance WIPT to identify the scenarios (i.e., standard, non-standard, or vignettes) and operational environments that will be used in the study (see Chapter 4, section 4.10). The remainder of this section provides additional information that is useful for identifying preliminary scenarios and the associated operational environments.

The scenarios, associated vignettes, and the operational environments describe the realistic operational settings (e.g., locations, conditions, and threats) that apply to the baseline and alternative capabilities that will be assessed in the AoA. Scenarios provide a common frame of reference that covers the full spectrum of relevant operational situations that will help enable the study team to analyze the baseline and alternatives.

The operational environment includes both natural and man-made conditions. Examples of natural conditions include weather, climate, terrain, vegetation, and geology. Depending on the alternative, these conditions can impact the target selection process, aircraft and munitions selection process, aircraft sortie rate, aircraft survivability, navigation and communications capabilities, or logistics. Man-made conditions such as jamming and chemical/biological warfare have their own impacts. Chemical or biological warfare, for example, may impact the working environment for operational crews and logistics support personnel. Such conditions can affect aircraft basing decisions and sortie rates.

In identifying scenarios, the representatives should consider the mission, capability gaps and requirements, constraints and assumptions, and the expected physical environments. This means that the representatives should be able to explain why a particular scenario was included in the AoA. In addition, a range of scenarios may be needed to fully analyze the baseline and alternatives. Scenarios used in previous analyses should be considered as well. If a CONOPS is used to define the operational environment, it must be previously endorsed by the JROC, combatant command, or at a minimum, the sponsoring DoD component.

In most situations, the representatives may not have enough information to select scenarios or fully describe the operational environments in the AoA study plan. The working group should at least describe how the scenarios will be selected, the sources of information that will be used, and the scenarios that are being considered. The following are some sources of information for the working group to consider:

- Support for Strategic Analysis (SSA, formerly known as the Analytical Agenda) products such as Defense Planning Scenarios (DPS's), Multi-Service Force Deployment (MSFD) documents, Analytical Baselines, and Integrated Security Constructs (ISCs),
- Operation Plans (OPLANs), Contingency Plans, and CONOPS and Concepts of Employment (CONEMPs).

Finally, the representatives should describe how the scenarios and associated threats will be reviewed and approved by the study advisory group (SAG).

## 5.9 Task 7: Develop Chapter 3 (Effectiveness Analysis)

In this chapter, the WIPT representatives designated to develop the Effectiveness Analysis section describe the AoA effectiveness analysis methodologies.[38] The representatives should utilize the study guidance, since the information it contains can be useful for developing this section of the plan. It is important to note that the effectiveness analysis methodologies that may have been described in the study guidance are very abbreviated and insufficient for the study plan.

In general, the goal of the effectiveness analysis is to determine the military worth of the alternatives in performing mission tasks and their potential to close or mitigate capability gaps. Mission tasks are typically derived from capability requirements identified in requirements studies such as CBA(s) and requirements documents such as the ICD, CDD, or CPD; DoDAF views; and other sources of information (e.g., Tactics, Techniques, and Procedures (TTPs), CAF standards, JMETLs, UJTLs). Defining this linkage is necessary to determining how well capability gaps can be closed or mitigated by the alternatives, one of the main objectives of the AoA. The ability to satisfy the mission tasks is determined from estimates of an alternative's performance with respect to measures. Additionally, AoAs and other supporting analyses can provide the analytical foundation for determining the appropriate thresholds and objectives for system attributes and aid in determining which of these attributes should be Key Performance Parameters (KPPs) or Key System Attributes (KSAs) for the subsequent acquisition program.

The development of the effectiveness analysis methodologies is almost always iterative: a methodology will be planned, then evaluated against the resources and data available to support it, and potentially 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 alternatives, the models or analysis tools, and the information needed by the decision makers. Analysis continues throughout the conduct of the AoA, and based on what the team learns as it progresses, methodologies may be refined.

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[38] The term “effectiveness analysis” entails more than just analyzing the effectiveness of baseline capabilities and alternatives. If not mentioned explicitly, suitability should be included in the effectiveness analysis. The representatives should address suitability by describing how it will be measured (measures of suitability) and analyzed. The representatives should also address how mandatory KPPs will be measured and analyzed (required by DoDI 5000.02 and JCIDS) and whether or not Intelligence Supportability Analysis (ISA) is required (see paragraph 5.9.4). For more information about suitability, see Appendix E.

Figure 5-1, General Approach for Effectiveness Analysis, shows the flow of analysis tasks required for a typical study.

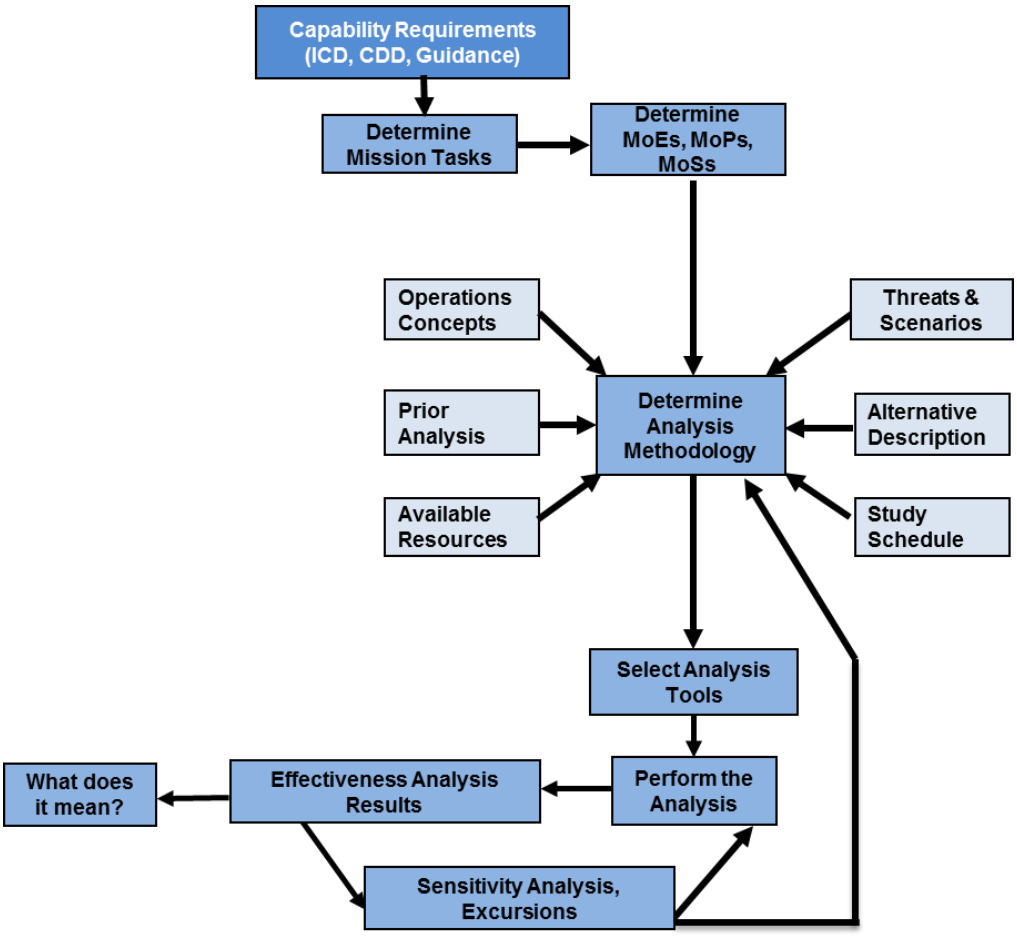


**Figure 5-1: General Approach for Effectiveness Analysis**

At this stage of AoA planning, the WIPT representatives developing the Effectiveness Analysis section may not have a clear understanding of how the effectiveness analysis will be conducted. In these cases, it is important to at least capture what the representatives are considering in its effectiveness analysis planning and development. The following provides specific guidance for each section of the chapter:

### *5.9.1 Section 3.1: Effectiveness Analysis Methodologies*

In this section, the representatives describe the process for collecting, analyzing, and interpreting data. They also describe the scope (i.e., what is or is not included in the analysis), level of analysis (i.e., campaign, mission, engineering), and resources required to conduct the analysis. The methodologies include a discussion of the specific data collection and analysis approaches that are planned or being considered such as Modeling and Simulation (M&S), parametric analysis, and expert elicitation.

The general approach for developing the effectiveness analysis methodologies typically begins with identifying any initial ground rules, constraints, or assumptions underlying the effectiveness analysis that have been identified at this point in the study. Ground rules, constraints, and assumptions (GRC&As) can address various aspects of the analysis. They can help establish the depth and breadth of the analysis, so it is essential that they are necessary and defensible. Any overarching or key GRC&As that have been identified by the WIPT should be assessed as to how they affect the effectiveness analysis. Any issues with these key GRC&As should be discussed by the WIPT. Finally, any GRC&As identified by the working group that have potential to be key GRC&As should be discussed by the WIPT as well.

Once the initial GRC&As have been identified, the representatives, in collaboration with the those working on other sections of the plan, begin identifying the mission tasks, attributes, conditions, and standards that are relevant to the baseline and alternative capabilities being assessed in the study.[39]

The requirement to perform tasks and the context of each task's performance to include the operational conditions and the scenarios/vignettes under which a task must be performed is determined through a mission analysis. The mission analysis provides insights into when and where a task must be performed and how the performance of a task contributes to mission success. The mission analysis entails utilizing the experience and expertise of subject matter experts knowledgeable of the operational concepts relevant to the mission area of interest in the study. Expert elicitation is a particularly useful method for deriving tasks for a mission and gaining insights into attributes, conditions, and measures that should be considered for each task.[40] Although all experts will be knowledgeable of the mission area, they have different experiences and perspectives that will produce insights that may not be possible without their involvement. A literature review is also useful for gathering information for identifying tasks, attributes, conditions, and standards.[41] Other sources of information include the following:

- Joint Capability Areas (JCAs),
- Task lists (e.g., Universal Joint Task List (UJTL), Joint Mission-Essential Task List (JMETL), Mission-Essential Task List (METL), Air Force Task List (AFTL), other Service task lists),
- Support for Strategic Analysis (formerly known as the Analytic Agenda) documents (e.g., Defense Planning Scenarios (DPSs), Integrated Security Constructs (ISCs)),
- Planning and operations-related documents (e.g., OPLANs, Concept Plans (CONPLANs), CONOPS, CONEMPs, and TTPs),

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[39] The mission is a statement of the action to be taken and the reason behind the action (*Universal Joint Task List Manual*). A task describes what is expected to be performed and is commonly expressed as an action or activity (*Universal Joint Task List Manual*). An attribute is a quality or feature of something (e.g., survivability, persistence, availability) (AFOTECMAN 99-101, *Operational Test Process and Procedures*). Conditions describe the environment under which the mission will be performed (*Universal Joint Task List Manual*).

[40] As a form of survey research, expert elicitation is a structured method of gathering expert judgment and answering questions concerning issues or problems of interest in a study. For more information about survey research and expert elicitation, see the *Survey Research Handbook*, OAS.

[41] For more information about identifying tasks, attributes, and conditions, see *The Measures Handbook*, OAS.

- Concept documents (e.g., CCTDs, Joint Concept Technology Demonstration (JCTD) reports), and
- Department of Defense Architecture Framework (DoDAF) products.

Once the tasks, attributes, and conditions have been identified, the methodologies should describe the development of measures and the associated measure criteria (or standards) and metrics. Measures are commonly expressed as measures of effectiveness (MOEs), measures of suitability (MOSs), and measures of performance (MOPs). Measures should address what is most important in accomplishing the tasks to include relevant enabling capabilities such intelligence, communications, logistics, etc. The focus is on the operational effect and the attributes supporting or enabling the operational effect. As is the case for tasks, attributes, and conditions, relevant CBA(s) and capability requirements document(s) can be used as sources of information for developing measures and the associated measure criteria and metrics. Expert elicitation and brainstorming are also useful for gathering information needed to develop measures, measure criteria, and metrics.[42]

If the mission tasks and measures have already been identified, or there are mission tasks and measures that are being strongly considered, it is useful to display them in a table such as the example shown in Table 5-1. Tables such as these can help the reader understand the structure or dendritic of the mission tasks and associated measures.

**Table 5-1: Example Table Displaying Mission Tasks and Associated Measures**

| Mission Task | Measures |
|---|---|
| Defeat Target | MOE 1.1: Probability of Kill |
| | MOE 1.2: Number of Weapons to Defeat Target |
| | MOE 1.3: Range |
| | MOE 1.4: Collateral Damage |
| Survive Threat | MOE 2.1: Time to Launch |
| | MOE 2.2: Probability of Survival |
| | MOE 2.3: Counter Threats |
| Support System | MOS 3.1: Deployability |
| | MOS 3.2: Maintainability |
| | MOS 3.3: Mission Reliability |

[42] For more information about developing measures, measure criteria, and metrics, see *The Measures Handbook*, OAS.

The methodologies should describe the data collection and analysis methods that will be used to analyze the tasks and associated measures for the baseline and alternatives. The measures framework, if possible to create at this stage of AoA planning, is useful for informing the study team, stakeholders, and study oversight groups of the key elements of each measure and data collection and analysis methods that will be used in the study.[43] An example of a measures framework is shown in Table 5-2.

There are many methods that can be used to collect data needed to analyze measures and the performance of the baseline and alternatives. Some examples include Modeling and Simulation (M&S), parametric analysis, and expert elicitation.[44] Understanding the capabilities and limitations of the methods is important in determining the appropriate data collection and analysis methods to use. For each measure, there are various factors that must be considered when selecting the appropriate data collection and analysis method(s). Typically, several different methods are used to address all the measures in a study. The data collection method chosen is important since the data collected will dictate the analysis methods that can be used. For example, data collection methods that produce qualitative data (nominal or ordinal) have limitations on what analytical techniques can be used.[45]

[43] For more information about the measures framework, see *The Measures Handbook*, OAS.

[44] For more information about data collection and analysis methods, see *The Measures Handbook*, OAS, and the *Survey Research Handbook*, OAS.

[45] For more information types of data, see *The Measures Handbook*, OAS.

**Table 5-2: Measures Framework Example**

| Task | Attribute | Measure | Metric | Criteria | Analysis |
|---|---|---|---|---|---|
| Enhance Survivability | Survivability | Probability of survival | Probability | ≥ .85 | M&S (BRAWLER) |
| | Conditions: | Combat range (beyond and within threat detection range); engagement environment (contested, highly contested) | | | |
| Detect and Identify Threats | Completeness | Number of threat detections | Percentage | ≥ 98% of threats | Parametric analysis |
| | Accuracy | Number of threat identifications | Percentage | ≥ 95% unambiguous identification of threats | Parametric analysis |
| | Conditions: | Electronic signal density (high); emitter environment (red, blue, grey, and white); threat classes (low to high priority) | | | |
| Sustain and Maintain | Availability | Operational availability (Ao) | Probability | ≥ .98 | M&S (LCOM) ; Expert elicitation |
| | Reliability | Weapon system reliability | Probability | ≥ .98 | Comparative analysis; Expert elicitation |
| | Conditions: | Operations tempo (peacetime, wartime) | | | |
| Deploy System | Deployability | Operator rating of ability to transport system | Mode | Operators can easily transport system | Statistical analysis of operator responses to questionnaire items |
| | Conditions:: | Austere airfield environment; transport by C-130 aircraft | | | |

A key factor that must be considered is the levels of analysis of interest in the study. The levels of analysis will drive the data collection and analysis methods that may be used. The methodology should describe the levels of analysis that will be used and why they are necessary. The basis for choosing a

particular level of analysis should be linked to key study questions, capability gaps, measures, or specific objectives of the study.

Figure 5-2 shows a hierarchy of the levels of analysis that are commonly used in AoA studies. The analysis scope typically increases moving up the hierarchy, whereas the resolution typically increases moving down the hierarchy. Engineering analysis is at the base of the triangle and is usually performed on individual components of an alternative or system. One level up is engagement analysis which entails analyzing one-versus-one to multiple-versus-multiple engagements. Examples include one weapon versus one target, or multiple aircraft versus multiple aircraft. At the top two levels, mission/battle and theater/campaign, the analysis becomes more complex and involves the analysis of the performance of an alternative or system across multiple dimensions and in complex scenarios. Moving up the hierarchy typically requires more sophisticated data collection and analysis methods such as M&S. In addition, analysis at these higher levels may require inputs from supporting analysis at lower levels.

Other factors that should be considered when selecting data collection and analysis methods include the following:

- Study objectives, questions, constraints, scope, and guidance,
- Availability and quality of the data,
- Input data requirements for other methods being used,
- Credibility and acceptability of the output data from a particular method,
- Availability of resources (e.g., funding, manpower) and expertise to collect the data and conduct the analysis.

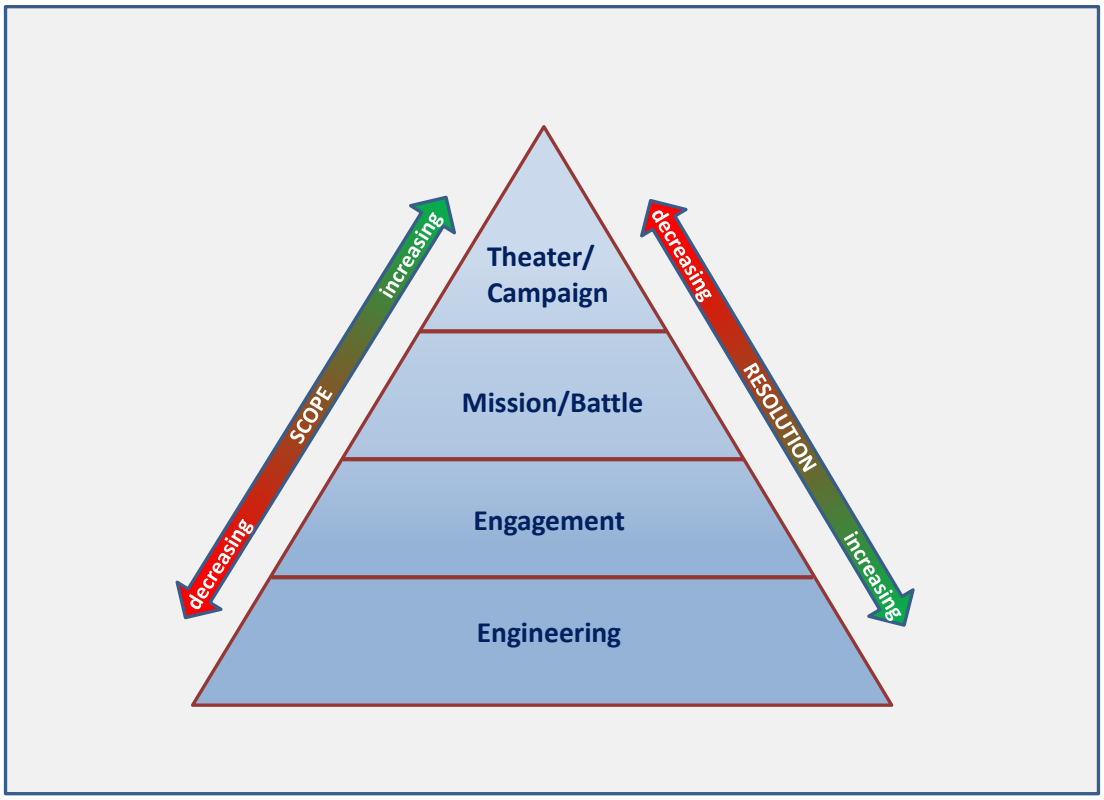


**Figure 5-2: Levels of Analysis Hierarchy**

The methodology should describe the relationship between the data collection and analysis methods and measures. Figure 5-3 shows a notional example of a diagram that depicts the linkages between the data analysis and collection methods and the measures in a study. As shown, data can flow from one method to another. For example, data collected through a literature review may be used to characterize the baseline and alternatives in the study. The data from the alternative characterization (using information gleaned from CCTD documents, Requests for Information (RFIs), Cost Analysis Requirements Description (CARD), and other reports, studies and analyses) may flow to an M&S application or be used directly for rating measures as shown in the figure. Including a linkage diagram in the study plan such as the example shown in the figure can greatly enhance the understanding of the effectiveness analysis methodology. It is also useful to ensure that the toolset is adequate to evaluate all measures in the study.

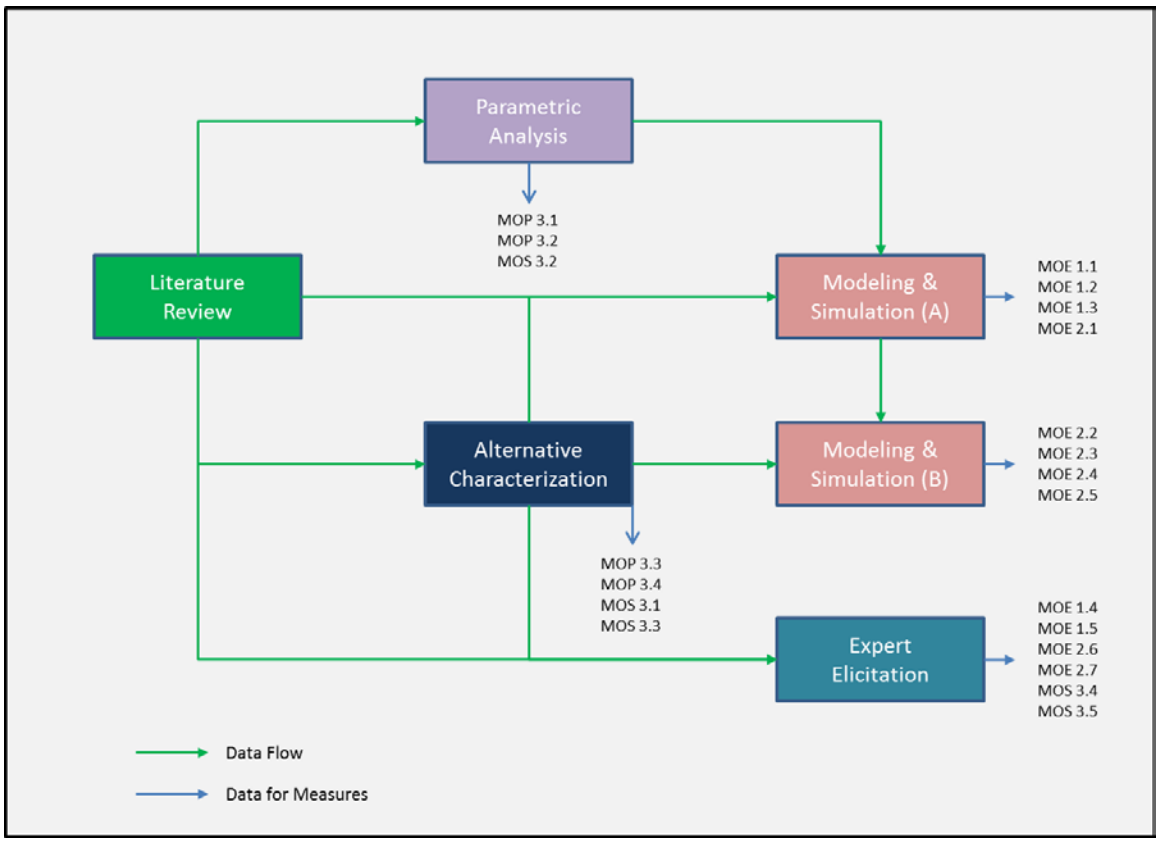


**Figure 5-3: Linkage Diagram of Data Collection and Analysis Methods and Measures**

### *5.9.2 Section 3.2: Sensitivity Analysis Methodology*

In this section, the representatives describe the sensitivity analysis methodology. The sensitivity analysis is used to identify cost, schedule, and performance drivers to illuminate the trade space for decision makers. In a program, a driver is a requirement that, if modified, can trigger a change in the cost, schedule, or performance of the program. The sensitivity analysis can highlight the stability or robustness of a concept, system, or alternative being assessed in a study. The sensitivity analysis can also enhance the credibility of the analysis and help identify potential performance tradeoffs and cost savings.

The general approach to the sensitivity analysis typically entails identifying assumptions, parameters, measures, or other variables that, when altered, significantly change the relative schedule, performance, and/or cost-effectiveness of the alternatives. For example, varying size, weight, and power parameters of an alternative based on new assumptions may not only show significant changes in range and speed performance, but in cost as well. In this example, the sensitivity analysis provides additional insights into the stability of these key measures of performance as well as the cost implications when assumptions are changed. When the sensitivity analysis identifies the drivers that trigger the biggest changes in cost, schedule, or performance, those requirements may be candidates to be KPPs or KSAs in the CDD.

As another example, the sensitivity analysis may involve altering the operational conditions or scenarios to assess capabilities and limitations of systems in different environments. The results of the analysis can be used to determine how robust the systems are in a wider range of operational conditions and scenarios.

As part of the sensitivity analysis, the study team should assess whether features that appear to provide substantive operational benefit to one (or more) alternatives apply to all viable alternatives. For example, if a particular type of sensor is found to provide improved effectiveness for one alternative, the study team should explore incorporating the sensor, if feasible, in all alternatives.

### *5.9.3 Section 3.3: Modeling and Simulation Accreditation*

If M&S will be used in the AoA, the methodology should describe the approach to accredit the M&S for use in the study. Accreditation is an official determination by an accreditation authority that an M&S application is acceptable for a specific purpose. The accreditation methodology must be in accordance with AFI 16-1001, *Verification, Validation and Accreditation (VV&A)*.

The accreditation methodology is typically described in an M&S accreditation plan that is included as an appendix to the AoA study plan. The plan defines how the AoA study team will conduct the M&S accreditation by describing the requirements analysis, resource planning, and information collection processes. The plan also describes the key participants (e.g., accreditation authority, accreditation agent team, developer) and timeline for completing the accreditation process.

In general, the accreditation methodology involves forming an accreditation agent team that conducts an unbiased assessment of the potential risks associated with results produced by the M&S applications.[46] The accreditation authority reviews the assessment and makes an accreditation decision that is documented in an M&S accreditation report.[47] This report is included as an appendix to the AoA final report. There are five possible decisions:

- Full accreditation – the M&S produces results that are sufficiently credible to support accreditation.
- Limited or conditional accreditation – constraints should be placed on how the M&S can be used to support the application of the M&S in the study.

[46] For more information about the M&S accreditation process, see AFI 16-1001, *Verification, Validation and Accreditation (VV&A)*, and the OAS *Models and Simulation Selection and Accreditation Handbook*.

[47] The accreditation authority is typically a senior member of the study sponsor's organization (i.e., GS-15, O-6, or above). To maintain an independent viewpoint, the accreditation authority should not be involved in planning and conducting the effectiveness analysis for the particular AoA. Ideally, the accreditation authority should have knowledge of the M&S applications being used in the AoA. Senior members of analysis directorates or offices within the sponsor's organization are generally suitable accreditation authority candidates.

- Modification of the model or simulation is needed – the M&S capabilities are insufficient to support either full or conditional accreditation; modifications and subsequent V&V are needed to correct deficiencies.
- Additional information is needed – the information obtained about the M&S is insufficient to support either full or conditional accreditation; additional information should be generated or otherwise obtained; supplemental verification, validation, and/or testing should be conducted to provide the necessary information before the accreditation decision is made.
- No accreditation – the results of the assessment show the model or simulation does not adequately support the application of the M&S in the study.

If no accreditation is deemed possible, the AoA study team must select a different M&S application or data collection and analysis method. If additional work or information is needed, the AoA team must develop a new M&S accreditation plan to accomplish the necessary work.

### *5.9.4 Section 3.4: Intelligence Supportability Analysis*

One important action that must be accomplished is the determination of whether an Intelligence Supportability Analysis (ISA) is needed. AoAs that address systems and operations that are intelligence sensitive (i.e., either produce intelligence products or consume intelligence products during development and/or operation) require acquisition intelligence support and an ISA. Intelligence support includes intelligence mission data (IMD) which is commonly needed to enable the operation of various types of systems. Acquisition intelligence is the process of planning for and implementing the intelligence information and infrastructure necessary to successfully acquire and employ future Air Force capabilities.

The WIPT lead should contact the local Air Force Life Cycle Management Center (AFLCMC)/Intelligence (IN) office to determine whether an ISA must be accomplished as part of the AoA.[48] These offices review the study plan to identify any potential intelligence concerns associated with the alternatives or the study plan itself. The results of this review are documented in an Intelligence Health Assessment Memorandum for Record. If an ISA is required, the ISA report is included as an appendix in the AoA final report.

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[48] If there is no local IN office, the HPT lead should contact the AFLCMC/21st Intelligence Squadron, Early Acquisitions Office (INO), at Wright-Patterson Air Force Base. Email: AFLCMC/21IS.INO.EarlyAcquisitions@us.af.mil. For space systems, the ISA is conducted within the Air Force Space Command A2/3/6 YA Branch at the headquarters, and is conducted at the sustainment center within SMC/IN for collateral programs and SMC/SYEI for Special Access Programs.

## 5.10 Task 8: Develop Chapter 4 (Cost Analysis)

In this chapter, the WIPT representatives designated to develop the Cost Analysis section describe the AoA cost analysis methodology.[49] The representatives should utilize the study guidance since the information it contains can be useful for developing this section of the plan. It is important to note that the cost analysis methodology in the study guidance is very abbreviated and insufficient for the study plan.

The AoA cost analysis generally entails collecting and analyzing data and applying analysis methods and tools to estimate the lifecycle costs of the baseline and each alternative. Cost analysis combines concepts from such disciplines as accounting, budgeting, economics, engineering, mathematics, and statistics. Developing a sound life cycle cost estimate (LCCE) requires credible data, trained and experienced cost analysts, and detailed documentation. When developing this section of the plan, the cost representatives need to keep in mind how the cost results will be reported (see Section 7.6).

### *5.10.1 Section 4.1: Life Cycle Cost Methodology*

The general approach to the cost analysis methodology typically begins with identifying any initial ground rules, constraints, or assumptions underlying the analysis that have been identified at this point in the study. Ground rules, constraints, and assumptions can address various aspects of the analysis such as the following:

- Cost basis of the estimate specified in Base Year and Then Year dollars,
- Duration of the life cycle of each alternative,
- Specific inflation indices that will used,
- Definition of sunk costs (i.e., the date separating costs expended or contractually committed from those to be included in the estimate),
- Schedule issues, including major milestones and significant events (e.g., Initial Operational Capability (IOC) and Full Operational Capability (FOC) dates, production schedules and quantities),
- Basing, logistics, and maintenance concepts for each alternative,
- Fully Burdened Cost of Energy (FBCE),
- Military construction (MILCON) requirements,
- Intelligence, Human Systems Integration (HSI), and other enabler support requirements,
- Environmental costs,
- Personnel requirements and constraints,
- Affordability constraints.

[49] For more information about cost analysis and cost estimating, see: (1) *Air Force Cost Analysis Handbook*, Air Force Cost Analysis Agency (AFCAA), (2) AFI 65-508, *Cost Analysis Guidance and Procedures*, (3) Operating and Support Cost-Estimating Guide, Cost Assessment and Program Evaluation, Office of the Secretary of Defense, (4) Cost Estimating and Assessment Guide, GAO, (Document number: GAO-09-3SP), and (5) DoD Instruction 5000.73, Cost Analysis Guidance and Procedures.

Once the initial ground rules, constraints, and assumptions have been identified, the representatives describe the data collection and analysis methods that will be used in the study. The objective is to identify what data is available to estimate the different cost elements of the alternatives as well as the methods and cost tools and models that are best suited for the data. This refers to both the primary methods and data used to make the main estimates and the associated cost risk and uncertainty analysis, and the secondary methods and data used to crosscheck the reasonableness of the primary estimates. As part of this effort, a formal data collection plan should be developed which addresses such data collection tasks as:

- Identifying the types of data needed (e.g., cost, programmatic, mass properties),
- Determining which estimating methods, tools, and models will be used with which data sets (i.e., for the primary and crosscheck estimates and the cost risk and uncertainty analysis),
- Locating sources for the data,
- Determining the sample size of data to be collected for each cost element,
- Developing collection forms and checklists,
- Determining data source points of contact,
- Laying out the collection schedule,
- Collecting cost data and program documentation (e.g., the CCTDS, the Cost Analysis Requirements Description (CARD)),
- Verifying and adjusting (normalizing) the data,
- Collecting any additional information.

The data collection plan provides a way of keeping track of data as it is collected. In addition to the technical and cost data needed for the estimate, programmatic information is collected and used for such tasks as properly phasing the estimate or understanding the work contents of all Work Breakdown Structure (WBS) elements. The identification of data and methods may be an iterative process because the data, once collected, may not be suitable for use with an intended method, requiring the selection of another method and a determination of whether data is available. For example, if an analogy method is initially selected, but the technical or cost data needed is not available, a simpler method may have to be used instead, requiring the collection of different data.

Historical data is typically collected from other programs and used to estimate a given cost element. This involves research to determine the most applicable data to use. For example, when estimating a modification to a missile, it may be appropriate to limit the data collection to only missile modifications rather than including new missiles and modifications to other weapon systems. Such decisions require judgment based on the system being estimated.

Data can also be collected for use in developing new methods or techniques for estimating. For instance, if an appropriate cost estimating relationship (CER) does not exist for making an estimate, an analyst may collect data to develop a new CER and then use it for the estimate. The development of a CER requires a considerable amount of time and effort since the analyst must determine the form of the CER and whether it is statistically sound.

Along with the data for the primary and secondary estimates, the information needed to perform a cost risk and uncertainty analysis of the primary estimate must also be collected. This involves collecting enough information to characterize the uncertainty inherent in the data, and using this to determine the level of confidence in any risk-adjusted estimate based on the data. For example, a commonly-used practice is to collect the lowest, most likely, and highest values that have occurred in the past for a certain type of data, and use that to define a triangular probability data distribution that becomes the basis for the cost risk and uncertainty analysis.

The level(s) of data that will be collected should be discussed in the methodology. Data should be collected at the level(s) required by the planned estimating methods, tools, and models and, if possible, one level lower to allow more flexibility in estimating. The data should be broken out in as much detail as possible and reflect the main factors which affect the estimate's cost elements (e.g., program phase, WBS, functional area, recurring/non-recurring).

In addition to describing the data collection approach, the methodology should describe what methods will be used or, if not known, what methods are being considered. As shown in Table 5-3, there are a range of methods available for estimating the different cost elements associated with an alternative. Each method is suited for specific applications given its strengths and weaknesses. In practice, the ability to use a particular method for a given cost element is constrained by the type and amount of data available, the suitability of the method for the stage of the system or program (i.e., concept, development, production), and the time available for data collection and analysis. In addition, analysts may use special estimating tools (e.g., improvement curves) and link or combine the basic methods when estimating (e.g., use an analogy to develop an input to a parametric equation).

There are several cost tools that can be used with the methods described in Table 5-3.[50] A cost tool is a device used to develop some or all of a cost estimate. A cost tool may be applied to a range of systems or processes. For example, an analyst may employ the regression analysis module in Microsoft Excel as the tool to develop one or more cost estimating relationships (CERs). As another example, an analyst may use the Automated Cost Estimating Integrated Tools (ACEIT) program as a tool to organize and document all the cost methods used in estimating the costs of an alternative. Some examples of cost tools that are commonly-used in AoA studies are shown in Appendix J.[51]

[50] A cost tool is different from a cost model. A model is generally defined as a physical, mathematical, or logical representation of a system, entity, phenomenon, or process. Cost models are built to estimate a specific system or process and are therefore unique to that system or process. An example of a model used to analyze a particular element of cost would be a CER that characterizes the impact of both weight and speed on airframe costs.

[51] For more information about cost tools, see the *Air Force Cost Analysis Handbook*, AFCAA.

**Table 5-3: Cost Estimating Methods**

| Model | Strengths | Weaknesses | Application |
|---|---|---|---|
| **Analogy** | • Requires limited data<br>• Based on actual data<br>• Reasonably quick<br>• Good audit trail | • Subjective adjustments<br>• Accuracy depends on similarity of items<br>• Difficult to assess effect of design change<br>• Blind to cost drivers | • When limited data are available<br>• Rough-order-of-magnitude estimate<br>• Cross-check |
| **Parametric** | • Reasonably quick<br>• Encourages discipline<br>• Good audit trail<br>• Objective, little bias<br>• Cost driver visibility<br>• Incorporates real-world effects (funding, technical, risk) | • Lacks detail<br>• Model investment<br>• Only valid for data in relevant range of CER<br>• Need to understand model's behavior<br>• Complexity may make it difficult to explain relationships | • Budgetary estimates<br>• Design-to-cost trade studies<br>• Cross-check<br>• Baseline estimate<br>• Cost goal allocations |
| **Expert Opinion** | • Quick<br>• Enables iteration<br>• Requires little actual data | • Difficult to audit and document<br>• Sensitive to experts<br>• Easy to critique | • Early analysis<br>• Absence of data<br>• Cross-check |
| **Extrapolation from Actual Data and Learning Curves** | • Requires standard data (format, year, etc.)<br>• Based on historical data<br>• Reasonably quick<br>• Good audit trail/credibility | • Assumes constant pricing/accounting methods<br>• Assumes no design change<br>• Obtaining access to cost data may be difficult | • When data is available<br>• Sub-systems are commercial or government off-the-shelf<br>• Cross-check |
| **Engineering Build-Up** | • Easily audited<br>• Sensitive to labor rates<br>• Tracks vendor quotes<br>• Time honored | • Requires detailed design<br>• Slow and laborious<br>• Cumbersome | • Production estimating<br>• Software development<br>• Negotiations |

A cost tool often contains some combination of previously developed analogy, parametric, engineering build up, expert opinion, and extrapolation from actual data/learning curves estimating methods that the analyst can use to project the costs of an alternative. These previously developed methods may include such things as:

- estimating relationships based on the statistical analysis of historical data (e.g., parametric),
- estimating relationships based on comparison with existing programs (e.g., analogies, factors),
- estimating relationships from the informal/intuitive analysis of previous estimates (e.g., rule of thumb, lessons learned, subject matter experts),

- equations which construct a detailed estimate from a set of inputs and throughputs (e.g., build-up),
- standard estimating techniques (e.g., cost improvement curves, inflation calculators, wrap rate/overhead calculators).

The cost representatives should describe what cost tools will be used or are being considered for the study. Some factors to consider in selecting a specific tool include the following:

- general capabilities,
- limitations and excluded uses,
- estimating methods used,
- types of data required,
- user guides,
- documentation of estimating equations and calculations.

The cost of the baseline and all proposed alternatives must be evaluated for the same life cycle time frame as defined in the study guidance to ensure a fair comparison of the baseline and alternatives. This may require service life extension efforts for the baseline and alternatives which are expected to have shorter useful lives. It may also include the calculation of residual values for alternatives that may continue to provide capability beyond the life cycle time frame. It is important to estimate the costs associated with providing a capability (albeit at different levels for different alternatives) for the same period of time.

Figure 5-4 illustrates the concept of evaluating the baseline and all alternatives across the same life cycle time frame.[52] In this example, the life cycle spans from FY02 to FY38. As shown in the figure, each alternative has a different Initial Operational Capability (IOC) date when it becomes an operational asset. In addition, each alternative requires at least one Service Life Extension Program (SLEP) effort during its life. Alternative 1 has the longest life and ends its useful life (and incurs disposal costs) in FY38. Alternative 2 may have some residual value at the end of its life cycle which should be included in the LCCE. For alternatives 1 and 2, the baseline is shown incurring costs until such time as its capabilities

[52] In AoAs, the baseline is defined as the existing, currently programmed system funded and operated according to current plans. Costs associated with the baseline may include baseline extension costs which are the costs of maintaining the current capabilities (i.e., the baseline) through the life cycle identified in the study. Only improvements that are identified in the Program Objective Memorandum (POM) are included in the baseline cost estimate. Improvements may include Service Life Extension Program (SLEP) efforts, additional procurement, additional maintenance, or other efforts to continue to provide the baseline level of capability. Capabilities that may be provided by other alternatives, but are not provided by the baseline alternative, should be addressed as continued shortfalls in the baseline capability. For other study alternatives, the baseline costs must be continued until such time as an alternative providing that additional capability is fielded and operational (Full Operational Capability (FOC), which will be based upon the study assumptions).

are replaced by the new alternatives.[53] These costs are referred to as pre-fielding costs and are associated with maintaining the baseline capabilities until a new alternative can be fielded. Pre-fielding costs must include the costs of maintaining the current baseline capability until such time as the other alternatives can be fielded. There may be a ramp-up of a new alternative and a corresponding ramp-down of the baseline from IOC to FOC depending on the schedule assumptions. This will result in a ramp-down in baseline costs from IOC to FOC for each new alternative along with a corresponding ramp-up of alternative operational costs.

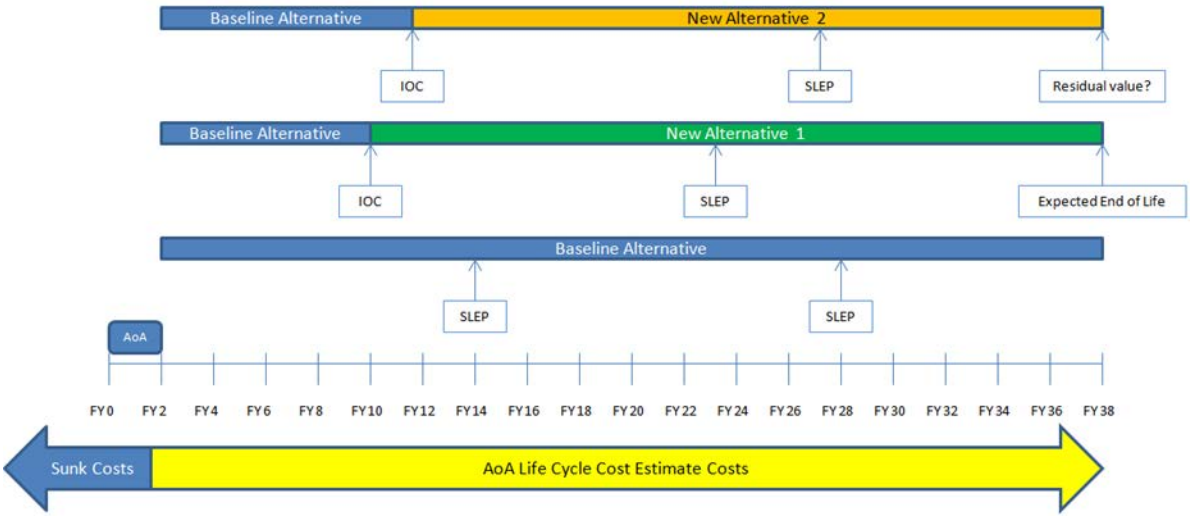


**Figure 5-4: Life Cycle Time Frame Comparisons**

In addition to determining the life cycle time frame, the analyst must also determine the time phasing of the estimate. The phasing (or spreading) of an estimate is the identification of its component costs and their distribution (in part or in whole) among the fiscal years of the alternative or program. Phasing must be consistent with the program schedule. The IOC date is a primary driver in determining the program's development and production schedules. There are many events and activities which must occur within fairly precise time spans before the program can meet the IOC. The program's time phased estimate must be consistent with the schedule events and activities to support the achievement of the IOC. The analyst should also take into account the results of any studies, cost risk and uncertainty analysis, or sensitivity analyses of the program schedule and what they imply about the likelihood of the program meeting the IOC.

[53] The baseline also shows sunk costs. Sunk costs are those costs that either already occurred or will be incurred before the AoA can inform any decisions on their expenditure. The best method of determining the cut off for sunk costs is to use the fiscal year in which the AoA is to be completed. Any costs that are expected to be incurred after that fiscal year should be included in the LCCEs.

Finally, the methodology should describe how the data will be reviewed and normalized before they can be used in an estimate. The review is necessary to ensure that all the information identified in the data collection plan has been gathered and is actually applicable to the estimate. For example, when analyzing contractor cost data, the analyst must understand the peculiarities of each contractor's accounting system, WBS, and labor rate structure, and determine how these factors affect or restrict the use of the data.

In most cases, data are normalized by adjusting and/or deleting specific pieces of data to make the data set homogenous. The purpose of normalization is to provide data that are consistent and, therefore, comparable. Normalization is a way of handling and neutralizing the effects of external influences on the data. There are two objectives of adjusting data to obtain a homogeneous data set:

- Improve data consistency so that any comparison or projection based on the data is valid (i.e., reduce the dispersion of the data points due to the effects of known outside influences),
- Allow the use of all credible data points.

Adjustment for inflation is the most common form of normalization. This form of normalization entails adjusting all dollar/cost data to account for the effects of inflation. The dollar/cost data are adjusted in the same way so that they are comparable.

### *5.10.2 Section 4.2: Structuring the Cost Estimates*

In this section of the study plan, the representatives should describe the approach that will be used to structure the cost estimates for the baseline and each of the alternative. One method of ensuring that the cost representatives capture all costs while avoiding double counting any costs is to develop a Cost Element Structure (CES).[54] This structure is used to define and allocate costs across multiple categories. At a minimum, costs should be defined according to their Work Breakdown Structure (WBS) elements, O&S Cost Element Structure elements, life cycle phases, and appropriation categories. There may be additional ways to categorize costs that the cost representatives may choose to use such as delineating costs by recurring vs non-recurring, direct vs indirect, and functional categories. These groupings of costs are hierarchical in that the cost elements at the lowest levels can be rolled up into elements that represent increasingly larger cost features of the program or system. The total cost for the baseline and each alternative is the sum of all the cost elements over all life cycle phases. When developing the structure of the estimate, it is important to capture all cost elements according to the scope of the AoA while ensuring that the team does not double count any costs.

**Work Breakdown Structure (WBS)**

A WBS is a product-oriented (as opposed to functionally-oriented) hierarchy that defines a system by elements of hardware, software, services, data, and facilities. The WBS lists and defines the product(s) to be developed or produced and relates the elements to each other and to the end product(s). Once the WBS has been created, cost estimates are collected for the WBS elements and then used to develop

[54] For more information about the Cost Element Structure see *Air Force Cost Analysis Handbook*, Air Force Cost Analysis Agency (AFCAA).

an overall point estimate for each alternative. Table 5-4 shows the first three levels of a notional aircraft system WBS.

OAS recommends that the cost representatives use the standard WBS provided in MIL-STD 881C when developing their WBS for the AoA.[55] It is recommended that any WBS used in the AoA is defined to at least level 3. This will provide for consistency in data collection and data comparison across programs or systems. The use of the standard WBS will also make the transition to the acquisition process much smoother if the recommendation from the AoA includes pursuing a materiel solution. As new information is gathered during the course of the study, each WBS may be further defined.

**Table 5-4: WBS Example**

| Level 1 | Level 2 | Level 3 |
|---|---|---|
| Aircraft System | Air Vehicle | Airframe |
| | | Propulsion |
| | | Vehicle Subsystems |
| | | Avionics |
| | | Armament/Weapons Delivery |
| | | Auxiliary Equipment |
| | | Furnishings and Equipment |
| | | Air Vehicle Software Release 1….n |
| | | Air Vehicle Integration, Assembly, Test, and Checkout |
| | Systems Engineering | (no level three breakdown) |
| | Program Management | (no level three breakdown) |
| | System Test and Evaluation | Development Test and Evaluation |
| | | Operational Test and Evaluation |
| | | Mock-ups/System Integration Labs (SILs) |
| | | Test and Evaluation Support |

[55] For more information about the WBS, see MIL-STD-881 Revision C, *Work Breakdown Structures for Defense Materiel Items*.

| Level 1 | Level 2 | Level 3 |
|---|---|---|
| | | Test Facilities |
| | Training | Equipment |
| | | Services |
| | | Facilities |
| | Data | Technical publications |
| | | Engineering data |
| | | Management data |
| | | Support Data |
| | | Data Depository |
| | Peculiar Support Equipment | Test and Measurement Equipment |
| | | Support and Handling Equipment |
| | Common Support Equipment | Test and Measurement Equipment |
| | | Support and Handling Equipment |
| | Operational /Site Activation | System Assembly, Installation and Checkout on Site |
| | | Contractor Technical Support |
| | | Site Construction |
| | | Site/Ship/Vehicle Conversion |
| | | Sustainment/Interim Contractor Support |
| | Industrial Facilities | Construction/Conversion/Expansion |
| | | Equipment Acquisition or Modernization |
| | | Maintenance (Industrial Facilities) |
| | Initial Spares and Repair Parts | (no level three breakdown) |
| Source: MIL-STD-881C, Appendix A | | |

### Operating and Support (O&S) Cost Element Structure

Similar to a WBS, the O&S Cost Element Structure is a hierarchy that categorizes and defines cost elements for defense systems, but this structure is to be used specifically for O&S costs. The OSD standard O&S cost element structure is divided into six major categories (Table 5-5). For more information on each of these categories, see the OSD(CAPE) O&S Cost-Estimating Guide. The cost structure identifies where a specific type of cost should appear in an estimate, if that cost applies to the system for which the estimate is being created. However, some cost elements (such as Training Munitions) refer to expenses that may not apply to every system, in which case the applicable cost element would be omitted. In other cases, available data may prevent estimation at the same level of detail as the cost element structure. In these cases, the applicable cost elements may be combined to the level of detail that can be estimated.

Recent versions of the OSD standard operating and support cost element structure, including the one shown in Figure 5-5, do not use ICS (interim contractor support) or CLS (contractor logistic support) as cost elements. It is intended that any contractor sustainment costs will be distributed to the appropriate functional element such as depot maintenance or DLRs (Depot Level Reparables).

**Table 5-5: OSD Standard Operating and Support Cost Element Structure***

| Cost Element | Description |
|---|---|
| 1.0 Unit-Level Manpower | Cost of operators, maintainers, and other support manpower assigned to operating units. May include military, civilian, and/or contractor manpower. |
| 2.0 Unit Operations | Cost of unit operating material (e.g., fuel and training material), unit support services, and unit travel. Excludes material for maintenance and repair. |
| 3.0 Maintenance | Cost of all system maintenance other than maintenance manpower assigned to operating units. Consists of organic and contractor maintenance. |
| 4.0 Sustaining Support | Cost of system support activities that are provided by organizations other than the system's operating units. |
| 5.0 Continuing System Improvements | Cost of system hardware and software modifications. |
| 6.0 Indirect Support | Cost of support activities that provide general services that lack the visibility of actual support to specific force units or systems. Indirect support is generally provided by centrally managed activities that provide a wide range of support to multiple systems and associated manpower. |

*These definitions come from the OSD(CAPE) O&S Cost-Estimating Guide. See this guide for more detailed information.

### Life Cycle Phases for the Cost Estimate

In AoA studies, a life cycle cost estimate (LCCE) is reported for the baseline and each alternative assessed in the study. These LCCEs are presented in the AoA final report and are broken down into the following life cycle phases:

- Research and Development (R&D). The costs of all R&D phases, including Advanced Technology Demonstration (including Concept Development), Technology Maturation and Risk Reduction (TMRR), and Engineering and Manufacturing Development (EMD), 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 acquisition supporting R&D efforts.
- Investment. Also referred to as production or procurement cost, investment cost includes the cost of procuring the prime mission equipment and its support and spans low rate initial production, full rate production, and fielding. This includes training, data, initial spares, support equipment, integration, pre-planned product improvement (P3I) items, and military construction (MILCON). MILCON cost is the cost of acquisition, construction, or modification of facilities (e.g., barracks, mess halls, maintenance bays, hangers, and training facilities) necessary to support an alternative. The disposal of this infrastructure should be captured in the disposal costs (discussed below). The cost of all related procurement (e.g., transportation, training, and support equipment) is included in the total investment cost.
- Operations and Support (O&S). O&S costs are those program costs necessary to operate, maintain, and support system capability through its operational life. These costs include all direct and indirect elements of a defense program and encompass 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 on estimating O&S costs, refer to the *Operating and Support Cost-Estimating Guide*, Cost Assessment and Program Evaluation, Office of the Secretary of Defense.
- Disposal. Disposal costs represent the cost of removing excess or surplus property (to include MILCON) or materiel from the inventory. It may include costs of demilitarization, detoxification, divestiture, demolition, redistribution, transfer, donation, sales, salvage, destruction, or long term storage. It may also reflect the collection, storage, and disposal of hazardous materiel and waste. Disposal costs may occur during any phase of the acquisition cycle. If, during development or testing, some form of environmentally unsafe materials are created, the costs to dispose of those materials are captured here.

### Budget Appropriations

The life-cycle cost categories correspond not only to phases of the acquisition process, but also to budget appropriation categories. In an AoA, it is important to be able to break out costs by appropriations in order to properly normalize cost data (i.e. inflation) and to allow for subsequent

planning, programming, budgeting, and execution (PPBE) activities as necessary. Research and development costs are funded from Research, Development, Test and Evaluation (RDT&E) appropriations. Investment costs are funded from Procurement, Military Construction (MILCON), and, occasionally, acquisition-related O&M appropriations. O&S costs are primarily funded from Military Personnel (MILPERS) and O&M appropriations. Note that for both MILPERS and O&M, there are distinct appropriations for the Active, Reserve, and Guard Components. In addition, the O&S cost elements for continuing system improvements (system hardware modifications and software maintenance) may be funded by RDT&E and/or Procurement appropriations.

### *5.10.3 Section 4.3: Cost Risk and Uncertainty Analysis*

In this section of the study plan, the cost representatives describe the cost risk and uncertainty analysis.[56] Though the initial focus of the cost analysis is on developing point estimates, the final estimate must incorporate uncertainty. Any point estimate of a total cost of an alternative is likely to be incorrect since it is the sum of the point estimates of individual Work Breakdown Structure (WBS) elements that are themselves approximations because they are predictions based on uncertain program, technical, and schedule information. By performing a cost risk and uncertainty analysis, the analyst gains an understanding of the probabilities associated with the mathematical form and behavior of the cost range of an alternative or system. This information is used to explain how changes in system content and technical and schedule assumptions affect the cost range.

Cost analysts analyze uncertainty for the purpose of measuring risk. While an uncertainty analysis assesses both the positive and negative outcomes of events that can affect an alternative, a cost risk analysis quantifies the likely effect of negative impacts (i.e., a cost overrun given a specific budget). The analysis of risk is complicated by the fact that some risks may also provide opportunities for improving an alternative's performance or achieving its goals, and simultaneously foster both negative and positive outcomes (e.g., a system overcomes a technological risk and attains better than required mission capabilities, but at additional cost). As shown in Table 5-6, there are many sources of uncertainty that may affect cost risk.

There are a number of methods and cost tools that can be used to conduct the cost risk and uncertainty analysis.[57] The most commonly-used methods include the following:

- Inputs-Based Simulation (IBS). Uncertainty is applied to the data and estimating methods used to prepare the cost element estimates of the alternative (data and estimating methods are commonly referred to as inputs). A simulation model such as Crystal Ball or @Risk is then used to build the estimate by randomly sampling the elements' uncertainty distributions and

[56] For more information see the *Cost Risk and Uncertainty Analysis Handbook*, Air Force Cost Analysis Agency (AFCAA).

[57] Crystal Ball, @Risk for Excel, @Risk for Project, and the PRICE and SEER suites are some examples of cost tools that have uncertainty/risk simulation and decision analysis capabilities.

aggregating the results into a cost probability distribution. The IBS method requires substantial data collection and set-up of the simulation model.

- Outputs-Based Simulation (OBS). Unlike the IBS method, the OBS method applies uncertainty to the estimates (outputs) of the cost estimating process. The analyst first assesses the uncertainty of the outputs and then runs the simulation model using this data. The OBS method is appropriate when the data or other resources (e.g., time, personnel) are not available to perform an IBS, or when there are uncertainty issues that affect an element's cost, but are not inputs to the estimating process.
- Scenario-Based Method (SBM). SBM is an analytical approach (i.e., one that does not involve simulation) for quantifying cost risks and calculating the level of reserves needed to protect it from cost overruns. The method is based on an assessment of the possible scenarios under which cost risk can affect an alternative. These scenarios do not have to represent worst cases, but rather reflect the effects that a decision maker would want to consider in the event any of them occur.

**Table 5-6: Potential Sources of Uncertainty**

| Technical | Programmatic |
|---|---|
| How close the technology is to state of the art | Contractor capability to support key requirements |
| Special requirements for manufacturing | Acquisition strategy |
| New support and maintenance requirements | Degree of program oversight |
| Integration and installation requirements | Operational requirements definition |
| Level of specification of software requirements | Multiple contractor teaming arrangements |
| Software development method used | Budgetary changes or other resource constraints |
| Amount of commercial off the shelf software used | Level of WBS definition |
| Potential for requirements evolution or creep | |
| Aggressive performance goals | |
| **Schedule** | **Cost Estimating** |
| Networking of critical path tasks | Ground rules and assumptions |
| Whether all tasks have been specified in detail | Standard errors of parametric equations |
| Optimism concerning task durations | Detail of analogies |
| Analysis of multiple critical paths | Bias/optimism in expert-provided data and inputs |
| Identifying tasks with most effect on outcome | Adequacy of data |
| Specifying ranges of duration for driver tasks | Bias in data |
| Performance of schedule risk assessment | Establishing degree of variability of collected data |
| Schedule constraints | Calibration of cost tools |
| Source: Air Force Cost Analysis Handbook, | |

### *5.10.4 Section 4.4: Cost Sensitivity Analysis*

In this section of the study plan, the cost representatives should also discuss any sensitivity analysis that will be conducted. Through sensitivity analysis, the analyst determines how an estimate varies with changes in cost drivers or key data inputs. The analyst examines the impact on individual estimates (or the total estimate) by calculating them using different values selected over the ranges of the main input variables. For example, if system weight is thought to be a driver of a system's development cost, the analyst may vary the weight input over its relevant range and observe the affect this has on cost. Sensitivity analysis helps identify major sources of uncertainty and provides valuable information to the system designer by highlighting elements that are cost sensitive, areas in which design research is needed to overcome cost obstacles to achieving better performance, areas in which system performance can be upgraded without substantially increasing program cost, and even areas where funds can be saved without altering system performance or reliability.

Sensitivity analysis tends to target requirements uncertainty, as contrasted with the uncertainties associated with the use of specific cost estimation data and methods. For this reason, the analyst uses the uncertainty and sensitivity analyses together to provide decision makers with an overall view of an alternative's cost and requirements uncertainties. Some factors that are often varied in a sensitivity analysis include the following:

- Duration of life cycle,
- Volume, mix, or pattern of workload,
- Threshold and objective criteria,
- Operational requirements,
- Hardware, software, or facilities configurations,
- Assumptions about program operations, fielding strategy, inflation rate, technology heritage savings, and development time,
- Learning curves,
- Performance characteristics,
- Testing requirements,
- Acquisition strategy (e.g., multiyear procurement, dual sourcing),
- Labor rates,
- Software lines of code or amount of software reuse,
- Scope of the program,
- Manpower levels and personnel types,
- Occupational health issues,
- Quantity planned for procurement,
- Purchase schedule.

Cost As an Independent Variable (CAIV) is one of the most common types of sensitivity analysis. CAIV is a technique that involves varying the expected cost of the alternative(s) and determining the impacts to performance and schedule. As shown in the notional example in Table 5-7, the technique entails changing the LCCE by decrements (for example, 0, 10, and 25 percent) and then determining the

performance and schedule impacts.[58] Impacts may include changes to the quantity of systems that can be procured, performance characteristics, and schedules. The results of this analysis can help identify a point at which it is not advisable to proceed with one or more alternatives.

**Table 5-7: Cost As an Independent Variable Example Results**

| Cost as an Independent Variable (CAIV) Analysis Results<br>Narrative Impacts (quantity, timeline, IOC/FOC, # of Sqdrns fielded, etc.) | | | | |
|---|---|---|---|---|
| LCCE ($B) | % Change from Point Estimate | **Performance** (Estimated impact on specific MoPs and MoEs impacted and reasons for impact) | **Schedule** (Estimated impact on IOC/FOC, Production schedule, etc.) | **Effectiveness** (Estimated impact of changes on performance in specific AoA scenario) |
| 18.50 | 0 | MoP 1-4 (Unrefueled Range) is 1220 miles<br>MoP 2-1 (Cargo Capacity) is 53,000 pounds<br>MoP 1-3 (Max Cruise Speed) 550 Knots | Annual Delivery is 12, production schedule complete 2020 | Time to target in scenario is 2.5 hrs<br>Amount of ordinance carried is 48 (SDB) rounds<br>Phase III is achieved in 14 days |
| 16.65 | -10 | MoP 1-4 (Unrefueled Range) reduced 120 Miles<br>MoP 2-1 (Cargo Capacity) reduced by 12,000 pounds | Reduces annual delivery quantity by two, extends production schedule additional year (to 2021) | Time to target in scenario is extended by 15 minutes due to refueling requirement. Mobile targets may relocate and require additional ISR resources to track.<br>Amount of ordinance carried reduced by 14 (SDB) rounds reducing number of targets that can be prosecuted per sortie. Required one additional sortie in scenario delaying achievement of Phase III by two days. |
| 13.88 | -25 | MoP 1-3 (Max Cruise Speed reduced by 100 Knots<br>MoP 2-1 (Cargo Capacity) reduced by 30,000 pounds | IOC slippage two years<br>FOC slippage three years | Unable to prosecute appropriate number of targets to halt enemy approach. Losses increase to the point that blue forces are not combat efficient. |

## 5.11 Task 9: Develop Chapter 5 (Risk Assessment)

In addition to analyzing operational effectiveness and life cycle costs, the study team assesses the risks associated with the baseline and alternatives analyzed in the AoA. The types of risks that should be examined for the alternatives in the AoA include acquisition risks (cost, schedule, and technical performance), as well as operational, force management, and other risks. In the risk assessment section of the study plan, the working group describes the risk assessment methodology to be used to evaluate these different kinds of risks. The study team must use the Air Force Risk Assessment Framework (RAF)

[58] There are no set levels at which the cost should be fluctuated, nor are there any set formats for displaying this information. The analyst should determine the best approach that provides meaningful insights into the cost, performance, and schedule variables associated with each alternative.

to describe the core function, mission, and activity-level risks (which are included in HAF/A5R briefing templates). To assess acquisition and other risks associated with the alternatives in the AoA (i.e., cost, schedule, performance, technology, etc), most teams have used the Department of Defense Risk, Issue, and Opportunity Management Guide for Defense Acquisition Programs (RMG) as the basis for the risk assessment methodology, though the RAF may also be used for this purpose.[59] Both of these methods are briefly described below, with additional details included in Appendices L and M. Other risk assessment methodologies (not described herein) are also allowable, provided the team obtains the approval of their study plan approval authority or Study Advisory Group.

### *5.11.1 Air Force Risk Assessment Framework*

The Air Force Studies, Analyses, and Assessments Directorate (HAF/A9) developed the Risk Assessment Framework (RAF) as a structured way to identify and translate core function, mission, and activity-level risks (from an operational and force management perspective) into a consistent and comparable format.

The RAF is a scalable risk assessment approach that standardizes the use of risk-related terminology within and across the Air Force. The RAF is linked to the Chairman's Risk Assessment definitions and the CJCS Integrated Risk Matrix. Operational risks are associated with the ability of the planned force to execute strategy successfully within acceptable human, materiel, financial, and strategic costs. Force Management risks are associated with the ability of the Service to recruit, train, educate, and retain the force. Additional details about the RAF process can be found in Appendix L and on the HAF/A9 web page.

### *5.11.2 Department of Defense Risk, Issue, and Opportunity Management Guide for Defense Acquisition Programs (RMG)*

As noted earlier, the working group can use the RMG (further described in Appendix M) as the basis for the risk assessment methodology to examine acquisition and other risks. This guide provides basic guidance for executing risk management throughout the entire acquisition process. It defines risk as having three components:

- A future root cause (yet to happen), which, if eliminated or corrected, would prevent a potential consequence from occurring,
- A probability (or likelihood) assessed at the present time of that future root cause occurring, and
- The consequence (or effect) of that future occurrence.

The intent of the RMG risk assessment is to answer the question: How big is the risk? This is accomplished by considering the likelihood of the root cause occurrence, identifying the possible consequences in terms of mission impact, performance, schedule, and cost, and identifying the risk level using a risk reporting matrix. Regardless of whether the RAF, RMG, or another risk assessment approach is used, the working group must describe how the risks will be identified. The intent is to answer the

[59] In this handbook, the term "Risk Management Guide" and corresponding acronym "RMG" refer to the Department of Defense Risk, Issue, and Opportunity Management Guide for Defense Acquisition Programs.

question: What can go wrong? This entails identifying a future root cause which, if eliminated or corrected, would prevent a potential consequence from occurring. Risk can be associated with many different aspects such as operational needs, attributes, constraints, performance parameters, organization, management, personnel qualifications and training, design processes, threat changes, technology maturation, changes in assumptions about enabling capabilities, political changes (US or foreign), Work Breakdown Structure (WBS) elements, etc. The following sources of information can be used to identify root causes of risks (note that this is not intended to be an all-inclusive list, but rather a starting point in the thought process):

- **Threat -** The sensitivity of the alternatives to uncertainty in the threat description, the degree to which the alternative or its employment would have to change if the threat's parameters change, or the vulnerability of the alternative to foreign intelligence collection efforts (sensitivity to threat countermeasures). This also includes reactive threats: i.e., what might an adversary do specifically ***because*** the US acquires a certain type of system.
- **Test and Evaluation -** The adequacy and capability of the test and evaluation process and community to assess attainment of performance parameters and determine whether the alternative is operationally effective, operationally suitable, and interoperable. [Note: this requires T&E membership on the study team.]
- **Modeling and Simulation (M&S) -** The adequacy and capability of M&S to support all life cycle phases of an alternative using verified, validated, and accredited models and simulations. This includes the availability of data to run the M&S.
- **Technology -** The degree to which the technology proposed for the alternative has demonstrated sufficient maturity (Technology Readiness Level) to be realistically capable of providing the required capability.
- **Logistics -** The capability of the alternative's support concepts to achieve the sustainment KPP thresholds based on the alternative technical description, maintenance concept, expected availability of support data and resources, and the capability of the associated maintenance concept to handle the expected workload.
- **Concurrency -** The sensitivity of the alternative to uncertainty resulting from the combining or overlapping of life cycle phases or activities.
- **Industrial Capabilities -** The degree to which the manufacturing/industrial base has demonstrated sufficient maturity (Manufacturing Readiness Level) to be realistically capable of providing the required capability.
- **Schedule -** The sufficiency of the time allocated by the estimated schedule to deliver the required capability by IOC/FOC.
- **Command and Control (C2) -** The capability of the alternative to work within the existing C2 environment as well as the capability of alternatives being evaluated to perform C2 functions in the operational environment, if appropriate.
- **Interoperability -** The capability of alternatives being evaluated to work with existing or planned systems in the operational environment. This may be C2 interoperability, such as the capability to coordinate fires from another weapon system, or the capability of a new component in an existing system to operate with the remaining subsystems.

- **CONOPS -** The impact of various aspects of the operational concept for an alternative on its mission effectiveness. For example, will basing in certain areas impact targets held at risk? What risk does that represent in operational or political terms?
- **Intelligence -** The ability of resources expected to be available at IOC/FOC to provide the intelligence data required by the alternative, in the right format, in a timely fashion to allow the alternative to function as envisioned.

Other sources of information that may be useful for identifying risks include the Core Function Support Plans (CFSPs), CCTD documents, CBAs, capability documents (e.g., ICD), and other studies. For example, the CBA that identified the capability gaps that will be analyzed in the AoA should have identified risks associated with not filling the capability gaps. This information is useful for identifying risks and may also reduce the level of analysis to support the risk assessment.

### *5.11.3 Conducting the Risk Assessment*

Risk identification should be conducted early and continuously in the study. For example, a best practice is to conduct one or more brainstorming sessions to identify potential risks early in the execution phase of the study. During these initial brainstorming sessions, use the time to identify as many risks as possible and not get held up trying to categorize the risk (i.e., determining whether the risk is operational or non-operational). There are opportunities later in the execution of the study to categorize the risks. Other risks may be identified during the course of the AoA, so the study team should have a formal process in place to capture these risks. Risk identification is the responsibility of every member of the AoA study team and should occur throughout the conduct of the study.

In addition to identifying risks, the study team should identify any potential mitigation options associated with any risks. The intent of risk mitigation is to answer the question: "Is it feasible that with modifications to a process, design, tactics, basing, or some other non-materiel aspect of an alternative, a risk could be sufficiently mitigated, thereby rendering an alternative much more viable?" Risk mitigation options should include specific information about what should be done, when it should be accomplished, and the resources required to implement the risk mitigation, as these may well impact the LCCE for some alternatives. If any mitigation options are identified, the study team should describe them and how they were considered in assessing risk for each alternative.

The risk assessment should describe the initial acquisition schedule for each alternative and provide an assessment of existing Technology Readiness Levels (TRLs) and Manufacturing Readiness Levels (MRLs) for critical technologies which may impact the likelihood of completing development, integration, and operational testing on schedule and within budget. This should include an assessment of the likelihood of achieving the proposed schedule of each alternative.

As discussed in Chapter 2 (Forming the AoA Study Team), a Risk Assessment Working Group (RAWG) can be formed to conduct the risk assessment. Certainly, the study director should structure the working groups to best meet the objectives of the study. The RAWG is typically comprised of a working group lead and team members from the other working groups. Throughout the course of the study, the RAWG is responsible for employing a formal process to record risks identified by the RAWG itself or developed from ideas received from other study team members. Working collaboratively with the other working

groups, the RAWG conducts the risk assessment using a methodology based on the RAF, RMG, and/or, possibly, other approved risk methodologies. During the development of the final report, the RAWG plays a key role in helping to combine the results of the risk assessment with the results of the effectiveness and cost analyses to identify the most viable alternatives.[60]

## 5.12 Task 10: Review and Revise Chapters 1–5

The WIPT reconvenes as a group to review and revise, as necessary, the chapters that have been produced. It is important to note that the review includes Chapter 1 which was developed earlier in the WIPT event. Since new GRC&As could have been identified by the working groups, the review provides an opportunity for the WIPT to determine whether any new GRC&As should be included in the set of key GRC&As and whether any GRC&As conflict with each other. Additionally, the working groups could have developed analysis methodologies that will affect the scope of the study, requiring adjustments to either the study scope or analysis methodologies.

In addition to the GRC&A review, the working group leads discuss their data and information requirements and their expectations regarding who or what organization is expected to provide the data and information. This crosstalk is a critical element of the planning effort that is needed to meet all data and information requirements of the study. Effective planning in this area will help minimize data and information disconnects between the AoA study team working groups during AoA execution. For example, the cost analysis working group may require specific details of the alternatives in order to develop accurate cost estimates. By knowing about this information requirement, the technology and alternatives working group can plan to gather this information and ensure it is included in the CCTDs and provided to the CAWG.

## 5.13 Task 11: Develop Chapter 6 (Alternative Comparison and Cost Capability Analysis)

Once the operational effectiveness analysis results, life cycle cost estimates, and risk assessments are completed, it is time to bring this information together and address overall sensitivities and tradeoffs

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[60] For more information about risk and risk assessments, see the following:

(1) *Risk Assessment Framework (RAF)*, AF/A9.

(2) *Department of Defense Risk, Issue, and Opportunity Management Guide for Defense Acquisition Programs*, Office of the Deputy Assistant Secretary of Defense for Systems Engineering, Washington DC.

(3) SAF/AQ Guidance Memorandum: Life Cycle Risk Management.

(4) *DoD Technology Readiness Assessment (TRA) Deskbook*.

(5) AFPAM 63-128, *Integrated Life Cycle Management*.

through the alternative comparison and cost capability analysis (CCA). In this chapter, the WIPT describes the alternative comparison and CCA methodology that will be used in the study.

The outcome of alternative comparison analysis highlights the key factors that influence the tradespace when making a decision among alternatives that have differing costs, capabilities, and risks. CCA is a process that helps define the trade space between cost and warfighting capabilities. Consumers are familiar with the concept of comparing alternatives, whether buying laundry detergent, a new car, or a home. They collect data on costs and make assessments on how well the alternatives will meet their needs (the effectiveness of the alternatives) and any potential risks associated with each option. With data in hand, consumers make comparisons and identify the tradespace to consider before buying the product or service. In an AoA, the process is essentially the same.[61]

The WIPT should develop a methodology that entails a simultaneous comparison of the alternatives with respect to effectiveness (and suitability), cost, and risk. If possible, the WIPT should develop an example of how the results will be presented (e.g., color-coded table, graphic).[62] The specific comparison technique(s) chosen will depend on the study. Regardless of the technique used, the message must be clear and cogent. The plan should address not only comparison of alternatives to each other, but more importantly, comparison of the alternatives in terms of how they close the gap(s).

The results of these comparison analyses can serve as the basis for addressing requirements sufficiency issues such as:

- Identifying the sensitivity of specific assumptions, parameters, measures, or other variables that, when altered, significantly change the relative schedule, performance, and cost-effectiveness of the alternatives—in other words, what are the cost, schedule, and performance drivers?
- Recommending changes to validated capability requirements that appear unachievable, operationally unnecessary, or undesirable from a cost, schedule, risk, or performance point of view.
- Identifying critical or essential parameters and attributes that have the potential to be Key Performance Parameters (KPPs), Key System Attributes (KSAs), Additional Performance Attributes (APAs), or Other System Attributes (OSAs).
- Identifying the point at which further investment provides little additional value for specific alternatives.
- Identifying areas where additional investigation is likely warranted, and why.
- Identifying capability requirement threshold/objective values that require further exploration.

In developing the alternative comparison and cost capability analysis methodologies, the team should ensure the methodology chosen will answer the following cost capability analysis questions:

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[61] See AF CCA Reference Guides, draft version 0.1D, AFLCMC/OZA, 1865 4th St., Bldg 14, WPAFB, OH 45433.

[62] See Chapter 7, section 7.8, for presentation examples.

- What is the military worth of increased (or decreased) operational capability for each gap?
- What are the tradeoffs between cost, schedule, risk, and capability?
- Have affordability goals been identified? If so, how well do each of the alternatives meet the affordability goals?
- Is there a preferred alternative(s)? Is it cost effective?
- If there is a preferred alternative(s), what are the primary drivers of performance, cost, schedule and risk (both operational and programmatic)?

In some cases, the WIPT may not have enough information during the study plan development stage to fully describe the alternative comparison and cost capability analysis methodology. In these cases, an assessment of the initial results is often required before the study team can determine the best approach to conduct and present the analysis. For example, based on early effectiveness or cost analysis during the study, several alternatives might have been screened out, resulting in only a very small number of alternatives to evaluate. This kind of outcome could impact the plans for a comparison analysis, in which case the planned methodology should be adjusted. The WIPT should at least state in the study plan that alternative comparison and cost capability analysis will be conducted. In the end, the "right" alternative comparison presentation is the one that illuminates the critical analytic findings.

## 5.14 Task 12: Develop Chapter 7 (Organization and Management)

This chapter describes the organization of the study team and oversight group(s), study plan review process, and study schedule. Ideally, this chapter should be developed prior to the WIPT event. If there is insufficient time during the WIPT, the WIPT lead, in collaboration with the facilitator, may defer development of this information until after the WIPT event. The following provides specific guidance for each section of the chapter:

### *5.14.1 Section 7.1: Study Team Organization*

In this section, the WIPT describes the organization of the study team, special groups, and oversight group(s). The WIPT should review Chapter 2 (Forming the AoA Study Team) of this handbook for information about stakeholders, special groups (SAG and SRG), study team structure, and team member roles and responsibilities. This information can be useful to the WIPT for organizing the AoA study team.

As a minimum, the WIPT should describe the study team structure to include the AoA study director, deputy director, Working Integrated Product Team (WIPT), working groups (i.e., EAWG, TAWG, OCWG, TSWG, CAWG, and RAWG), special groups, and oversight groups. In addition, the roles and responsibilities of the study director, deputy director, WIPT, working groups, special groups, and oversight groups should be described.

### *5.14.2 Section 7.2: AoA Review Process*

The AoA review process will largely depend on whether the AoA has OSD(CAPE)/OUSD(AT&L) or Air Force oversight. The DCAPE study guidance typically describes a staffing or review process for presenting the AoA study plan and final report for review and approval (see the OSD(CAPE) study guidance template in Appendix K). It is important that the review process described in the study plan aligns with what is described in the study guidance. Any changes to the review process must be

coordinated with the office issuing the guidance. The A5R Guidebook provides more detailed information regarding the review and staffing requirements of AoA study plans.

### *5.14.3 Section 7.3: Schedule*

This section should include a high-level schedule (i.e., includes only the key events and phases) of the timeline from the start of AoA planning to Milestone A. The WIPT should include the following (note that if the AoA has JROC or JCB interest, the JROC/JCB reviews should be included as well):

- Study guidance issuance,
- Study planning phase,
- AFRB approval to proceed to MDD (as applicable),
- CDWG study plan review,
- AFCDC approval,
- If required, OSD(CAPE) approval of study plan,
- MDD,
- Materiel Solution Analysis Phase /Study execution phase,
- SAG reviews during study execution phase,
- Final report staffing phase,
- CDWG final report review,
- AFCDC final report review and validation,
- If required , OSD(CAPE) approval of final report,
- Milestone A.

With the four tasks remaining, the WIPT lead and facilitator must assess whether additional breakout sessions are needed to address issues or complete specific sections or chapters.

## 5.15 Task 13: Review and Revise Chapters (1–7)

As a group, the WIPT reviews and revises, as necessary, the chapters that have been produced. This gives the WIPT one last opportunity as a group to review the document and express any remaining concerns or issues. This also helps the WIPT lead and the facilitator determine whether consensus has been achieved on how the study will be conducted.

## 5.16 Task 14: Create Plan to Develop Appendices

The study team has some discretion in determining what information to place in an appendix. It is customary to place more detailed information about the study methodology in an appendix rather than the body of the study plan. If OSD(CAPE) has oversight of the study, they may direct the study team to limit the length of the plan to no more than 10 pages. In these cases, the study team must place the more detailed information in appendices to meet the 10-page requirement.

The WIPT lead, in collaboration with the facilitator, should develop a plan to develop the appendices. This will entail assigning actions items with time deadlines to the appropriate study team members. Appendices may include the CCTD(s) and, if M&S is used, the M&S Accreditation Plan (see the OAS study

plan template, Appendix F). Responsibility for the CCTD appendix is typically assigned to the TAWG lead. The Study Director is assigned responsibility to ensure the M&S Accreditation Plan appendix is accomplished.

## 5.17 Task 15: Create Technical Editing and Document Staffing Plan

The WIPT lead, in collaboration with the facilitator, should develop a technical editing and staffing plan. The WIPT lead and facilitator should advise the WIPT members to coordinate the draft study plan with their respective organizations to avoid possible delays during formal staffing. For representative(s) of organization(s) that were invited but did not attend, the WIPT lead should provide the draft study plan to these representatives for review and comment prior to formal staffing.

## 5.18 Task 16: Wrap-up, Action Item Review, and Adjourning the WIPT

The wrap-up entails finishing up the remaining work before adjourning the WIPT. This does not mean rushing work and settling for a mediocre, or worse, product. If it is not possible to produce a quality product in the remaining time, it is better to defer the work until after the WIPT event.

The WIPT lead, in collaboration with the facilitator, should assign actions items with time deadlines to the appropriate team members. Action items may address various aspects such as issues that must be resolved, questions that must be answered, and study plan sections or parts of sections that must be completed.

Once the study plan is completed, the study director provides it to OAS for review and assessment. OAS reviews the documents and provides feedback to the study director and team. After the review and feedback, OAS provides an assessment of the study plan to the AFGK, CDWG, and AFCDC that addresses the quality of the study plan and the extent of the risks associated with conducting the AoA.[63] The study plan is reviewed by the CFL or lead command before it is reviewed by the AFGK and CDWG, approved by the AFCDC, and approved by the Chief of Staff of the Air Force (CSAF) or Vice Chief of the Air Force (VCSAF) for release to the DCAPE, if required.[64]

Before adjourning the WIPT, the facilitator should elicit feedback from the team members regarding his or her performance as a facilitator, the value of the WIPT approach, and improvements or enhancements that should be considered. In addition, the facilitator should document any lessons learned as well as the successes and shortcomings of the WIPT.

[63] See Appendix H for the OAS study plan assessment criteria.

[64] See the A5R Guidebook for information about the study plan approval criteria used by the AFGK, CDWG, and AFCDC.

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# 6 Conducting the AoA

When the study plan is approved, the AoA can officially begin. In general, execution of the AoA should follow the plan unless deviations are approved by the SAG or senior review group. All deviations should be recorded and documented in the final report. This chapter describes some fundamental lessons learned (best practices and landmines) for conducting the AoA.

## 6.1 Best Practices for Successful AoA Execution

### *6.1.1 Continue conducting literature reviews*

The team should continue to conduct literature reviews throughout study execution. New material regarding the problem(s) of interest may become available and have an impact on how the study is conducted.

### *6.1.2 Continue screening alternatives*

Screening of alternatives, which began during pre-MDD activities, should continue throughout the AoA with the approval of the SAG or senior review group. See section 4.7 for more information regarding screening.

### *6.1.3 Meet frequently as a team*

During the study, regularly scheduled meetings provide opportunities for the working groups to coordinate their efforts, identify and resolve problems or issues, share information, identify and assign actions items, and provide updates to the study director. The study director can also provide guidance and direction to the team.

The study team should meet at least weekly to ensure all team members are kept informed. Because teams are geographically dispersed, teleconferencing and video teleconferencing are typically used to conduct these weekly meetings. WIPT meetings are usually in-person meetings and should occur as needed. In the early phase of conducting the AoA, the team is usually in the forming and storming stages of group development. During this time, WIPT meetings may need to be held monthly. As the team evolves into the norming and performing stages,[65] the WIPT meetings can usually be held less frequently.

### *6.1.4 Stay focused--Answer the study questions*

One fundamental purpose of the AoA is to answer questions for the study sponsor and stakeholders. Answers to study questions provide insights into specific areas of interest in the study and help inform decision making. A study that fails to address the study questions has limited value, and in some cases, it may require additional analysis or another study.

[65] For more information about team forming, storming, norming, and performing, see the OAS HPT Facilitation Guidebook.

Many times, AoA final reports do not answer the questions in the study guidance. During the study execution, team leads should periodically vet progress against the study questions by asking, are we answering the questions? Likewise, when the final report is being drafted, ask the same question. In the final report, there should be a restatement of the study questions and a concise, straightforward answer to each of the questions, followed by the supporting analysis results.

### *6.1.5 Report back to stakeholders and sponsors frequently*

AoAs can sometimes last more than two years. During this time, sponsor priorities can change, and the sponsors themselves can change. Early and frequent updates to sponsors can help keep the study on track, and they will help the sponsors keep the study high on his or her list of priorities.

Additionally, during the course of the study, the study team should keep the special groups and stakeholders informed of the study's progress. These updates provide an opportunity for the study team to receive feedback and direction on the planning and execution of the study. When appropriate, the study team should seek assistance from the special groups and stakeholders for any problems that cannot be resolved by the team.

Involving the special groups and stakeholders not only facilitates the planning and conduct of the study, but also builds buy-in and support over the course of the study and later in the capability development and acquisition processes. When all appropriate stakeholders are involved, the likelihood of serious unintended consequences or missed considerations is greatly reduced.

A major goal of meeting with the stakeholders is to get their approval to adjust or modify later parts of the study based upon what is learned during execution. Adjustments are typically requested by the team and approved by the stakeholders when:

- A question or analysis area is adequately addressed or no longer needs to be addressed. The team should document it and move onto the remainder of the study,
- An alternative is shown to be non-viable. The team should document it and stop expending effort on it,
- Early results raise new questions. The team should modify the plan and possibly the schedule.

### *6.1.6 Keep it simple*

AoAs can sometimes be enormously complex. In these cases, there is a tendency for analysts to want to employ sophisticated analytic methods. Though these methods can be academically interesting or fun for analysts to develop, complex methods can have the adverse effect of blurring the message of an AoA. New and complex methods can also make the AoA take longer to complete. Teams must remember that the primary reason for using any method in an AoA is to facilitate an understanding of the data. Hence, the team should strive to use the simplest method possible to learn the meaning of the data and explain the outcome. Whatever methods are used, the team must ensure the meaning of the data is fully expressed and not lost or masked by the complexity of the methodology. Often, the most successful studies address the broad problem in a relatively simple way; after identifying the most promising or most sensitive variables, the team delves into those with more complex analysis as needed.

### *6.1.7 Take the Time to Understand the Data*

As data is collected, there is usually considerable anticipation amongst the stakeholders and study team members to produce results as quickly as possible. There is an eagerness to begin inputting data into models and equations to generate preliminary results and determine whether they align with expectations. Though the pressure can feel overwhelming, the analyst must first take the time to understand the data.[66]

As part of the analysis, the analyst gains information about the data and its characteristics through graphical and numerical representations.[67] With these data representations, the analyst can discover patterns and anomalies and identify potential causes.[68] The information helps facilitate understanding and interpretation of the data, enabling the analyst to describe and present results in more meaningful ways. Taking the time to examine the data can be the best way to see unexpected relationships or dependencies and to potentially decompose a complex problem into several simpler problems.

One important benefit of using data representations is that it provides insights into the nature of the variation of the underlying processes or attributes being measured. These insights can help the analyst determine the best approach to conduct the analysis. Identifying whether a variable has a discrete or continuous probability distribution, for example, is important since it influences the development of measures and selection of analytical techniques.

To facilitate an understanding of the data, the analyst should start by determining whether there are any relationships or associations between the variables of interest in the study. There are two basic types of relationships: dependent and independent. A dependent relationship is one in which there are both independent and dependent variables. The variation of one variable (the dependent variable) depends on the variation of one or more independent variables. In an independent relationship, there are two or more variables of interest, but none are dependent on or influenced by the others. There are statistical techniques the analyst can use to identify these relationships. For instance, analyses such as correlation, regression, and discriminate analysis are commonly used to identify dependent relationships, whereas factor analysis can be used to identify independent relationships.

With the limited time and resources often available to conduct capability requirements studies, it is likely that the analyst will not learn all the meanings of the data. One useful technique for gaining

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[66] The term "analyst" as used in this handbook generally refers to one or more individuals or members of a study team responsible for conducting all or some aspect of an analysis.

[67] Tufte, Edward R. (1997). *Visual Explanations: Images and Quantities, Evidence and Narrative*. Cheshire, CT: Graphics Press, Chapter 2.

[68] Examples of graphical representations include histograms, bar graphs, and box and whisker plots. Numerical representations include measures of central tendency such as the mean, median, and mode and measures of variability such as range, variance, and standard deviation.

insights entails answering straightforward questions of the data.[69] What is causing the knee in the curve? Why does performance change when operational conditions change? What are the prominent parameters that influence performance? Though the technique is not complicated, the effort required to fully answer questions such as these is not trivial, but in the end it is usually worthwhile given the knowledge that can be gained. In order to completely understand the output data and address these questions, the team must fully understand the characteristics of the input data.

### *6.1.8 Know When to Quantify*

The results in AoA studies are often expressed quantitatively in the form of numerical values. To create the values, various statistics are used depending on the level of measurement of the data.[70] As a best practice, the analyst strives to use the highest levels of measurement that are possible and suitable for the study. Integral to determining the appropriate levels of measurement, the analyst identifies how the data will be represented.

In AoAs, like other studies, there will be reasons not to represent information numerically because of its purpose in the analysis. For instance, subjective data such as judgment or opinions regarding a specific problem or question that is elicited from experts may not need to be expressed as numerical values. In other cases, a quantitative approach may actually hinder the interpretation of the data by masking meaningful information. For example, using a mathematical equation and data elicited from experts to determine the overall risk ratings of alternatives may not be sufficient. Oftentimes, the insights expressed by the experts or respondents provide more meaningful information than the numerical value itself. In this example, presenting the rationale used by the experts to establish the risk ratings would convey more meaningful information.

There are other concerns when using sophisticated analysis methods. Though these methods can be academically interesting, the primary reason for using them is to facilitate an understanding of the data.[71] The analyst should strive to use the simplest method possible to learn the meaning of the data and explain the outcome. Whatever methods are used, the analyst must ensure the meaning of the data is fully expressed and not lost or masked through the manipulation and organization of the data.

Additionally, every study has a finite budget and schedule. Often, quantifiable methods take longer and cost more. While a quantitative methodology might provide a more precise answer, it may not be the best use of the resources available. Some questions do not need to be addressed in great fidelity. The level of effort must be balanced with the fidelity required.

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[69] Leedy, Paul D. (1997). Practical Research: Planning and Design, Sixth Edition. Upper Saddle River, NJ: Prentice-Hall, Inc., p. 286.

[70] There are four general levels of measurement: nominal, ordinal, interval, and ratio. The levels of measurement range in sophistication from low (nominal) to high (ratio). For more information regarding levels of measurement, see *The Measures Handbook*, OAS.

[71] Leedy, Paul D. (1997). Practical Research: Planning and Design, Sixth Edition. Upper Saddle River, NJ: Prentice-Hall, Inc., pp. 36-37.

Other factors that can shape the decision to quantify or not include the availability of data and whether there is enough understanding of the problem to have numerically meaningful relationships between data elements.

No matter what decisions are made about when to quantify and when not to, the team must understand why an approach was chosen and the risks inherent in that approach.

### *6.1.9 Integrate the Results*

By design, the AoA entails analyzing complex problems across multiple perspectives, the most common being operational effectiveness, cost, and risk. The challenge for the study team is to explain the end product or outcome by integrating results across all relevant perspectives. The study team must consider all the results to develop thorough and convincing explanations. Though focusing on one or two variables is analytically easy to do and simple to understand, complex problems typically require an integration of results across several variables to fully explain the end result.[72]

With a multivariate approach, there are many possible ways to explain outcomes and highlight important differences and similarities of the entities being assessed in a study.[73] But with these possibilities, there is the challenge of finding the most effective way to communicate the end result. Since there is no one best way that will work in all situations, the study team must explore several different approaches to using words, numbers, tables, and figures to construct an integrated message.[74] Feedback from stakeholders as well as others not involved in the study can be helpful in determining the most effective approach that maintains continuity of thought and enhances readability and comprehensibility. Often there is not one integrated answer, but rather a number of insights and partial answers. For instance, the findings may show performance differences in various operating environments (e.g., a laser may not perform as well in a desert environment as it does in an ocean environment). Integrate only as much as required to illuminate the findings.

### *6.1.10 Interpret the Results*

Before results can be reported, they must first be interpreted. More than just presenting results, interpretation entails making inferences and drawing conclusions from the results of the analysis.[75] Interpretation is an integral part of analysis, requiring the study team to search the results for meaning. The interpreter provides the "so what" of the analysis; in other words, why the results are important.

Though there are numerous ways to analyze data and produce results, the sensitivity analysis is distinct in that it can yield new and meaningful insights that can profoundly influence the interpretation of the results. One purpose of the sensitivity analysis is to highlight performance stability or robustness of the

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[72] Tufte, Edward R. (2006). *Beautiful Evidence*, Cheshire, CT: Graphics Press, pp. 129-130.

[73] Ibid.

[74] Ibid., p. 131.

[75] Leedy, Paul D. (1997) *Practical Research: Planning and design, Sixth Editions*. Upper Saddle River, NJ: Prentice-Hall, INc., p. 286.

system, solution, or concept being assessed in the study. This is accomplished by varying performance parameters, operational conditions, scenarios, or assumptions to determine the resulting changes in performance.

Sensitivity analysis not only enhances the credibility of the analysis, but also facilitates the identification of key performance tradeoffs. The results of this analysis often serve as the basis for study conclusions; recommendations; decisions; and KPPs, KSAs, and other attributes. The AoA provides the underlying analysis for attributes which will be further refined throughout the acquisition process.

The audience must understand the study team's level of confidence in the interpretation of the results. This is particularly a concern when there is some uncertainty in the interpretation due to issues with the data, analysis, or some other aspect of the study. When uncertainty exists, the study team must discuss its source and how it affects the interpretation.

Conclusions cannot stand alone, but instead require explanations of how they were derived from the results. The study team must fully discuss the specific results or evidence that substantiates each conclusion. With an understanding of the analytical basis, the audience can determine whether each conclusion is sound and meaningful. Ideally, the discussion should naturally lead the audience to draw the same conclusions.

Given that interpretation is a subjective endeavor, it is not uncommon for stakeholders involved in a study to view the same data and results in very different ways. In these situations, discussion and honest scrutiny are necessary to remove perceptual biases, but, ultimately, there will often be legitimate dissenting interpretations that should be discussed in the study report. The analysis should be complete and unbiased and not advocate one interpretation at the exclusion of other viable interpretations.

#### *6.1.11 Challenge the results*

A good study team will not always accept initial results at first blush. Critical thinking and analysis will help avoid groupthink and a rush to conclusions. Various analytic techniques such as red teaming can help teams uncover root causes and verify results.

#### *6.1.12 Deliver some early results*

Senior leaders value quick results. Even though a study may be scheduled to last a year or more, studies may yield some early crucial findings. Study leads should strive to report early findings back to the senior decision makers early (after taking time to understand the data (see 6.1.7)) in the study and adjust the study as appropriate based upon these early results.

#### *6.1.13 Clearly communicate what could not be analyzed in the study*

AoA study reports correctly focus on what was analyzed in the study, but they often do not address limitations of the analysis. These limitations could be the result of insufficient time, resources, data, or a lack of tools, etc. Such limitations are simply part of the territory of doing analysis, and decision makers need to know about these limitations before they make decisions based on the results.

Therefore, AoA teams should make a full disclosure of study limitations as part of the process of reporting results.

One aspect of this is to identify how far the results of the study can be extrapolated and still be valid. This depends on many things, including the particular tools and data used in the analysis. If there are known limits, they should be clearly stated (e.g., exceeding a certain velocity may require a new type of propulsion that was not addressed in the study).

## 6.2 Landmines to Avoid

OAS has advised and facilitated several hundred AoA studies over the years. The following is a list of common pitfalls that have adversely impacted study teams during the execution of their AoAs:

### *6.2.1 Failure to communicate*

AoA study teams are often geographically dispersed. Occasionally, a team lead will focus communications on team members in his or her proximity, while forgetting about the more distant members. Even with the best intentions, this separation can lead to communication challenges and breakdowns, which in turn can lead to delays or wasted effort, if some team members are not informed about decisions as they are made.

### *6.2.2 Failure to report problems when they arise*

Unlike fine wine, most problems encountered in the AoA do not get better with age. Problems that the study team cannot solve on its own should be reported to the appropriate lead command organizations and study oversight groups (e.g., SAG, SRG). Some examples of possible resolutions may include re-scoping the study, changing the methodology, using a different data collection and analysis method, or providing additional resources such as time, funding, or expertise.

### *6.2.3 Over-reliance on Industry-provided information*

Information provided by Industry during or prior to the AoA must be carefully evaluated by Government experts. Typically, this information is collected via a Request for Information (RFI), for which Industry partners receive no remuneration.

### *6.2.4 Striving for the 100% answer*

Some AoA teams have gotten bogged down trying to attain some final bits of information or complete a last bit of analysis. Consider the 80-20 rule: is that last bit of analysis worth spending 80% of the effort and time? Teams must remember that at the end of the day, an AoA is simply an analysis, which means it is just one part of the decision making process. The goal of the AoA is to help inform the decision; it is not usually necessary to do a perfect AoA.

### *6.2.5 A little late is too late*

A perfect analysis provided too late is no good. The GAO assessment of AoAs found that sometimes, AoAs are conducted under compressed time frames in order to meet a planned milestone review or fielding date, and their results come too late to inform key tradeoff decisions. Study leads must keep

aware of decision making timelines (e.g., POM and budget timelines) and ensure study results are provided in sufficient time to help inform the decision. Conversely, some deadlines are arbitrary and not driven by fixed events. Even when there is a hard deadline, the team needs to know which parts of the analysis are vital to a particular decision and which can slip with minimal or no serious impact. The team needs to understand exactly what is driving their deadlines.

### *6.2.6 Entering an AoA with a pre-determined solution or an overly narrow set of alternatives*

The GAO found that, sometimes, service sponsors lock into a solution early on when a capability need is first validated through DoD's requirements process, and before an AoA is conducted. Acquisition programs that conducted a limited assessment of alternatives before the start of system development tended to experience poorer outcomes than the programs that conducted more robust AoAs.

A related problem is an overly narrow set of alternatives. An overly narrow set of alternatives limits the ability of the AoA to evaluate tradeoffs among performance, cost, and risks. The GAO reported that the AoAs that considered a broad range of alternatives tended to have better cost and schedule outcomes in their subsequent acquisition programs than the efforts that looked at a narrow scope of alternatives.

### *6.2.7 Failure to include all relevant expertise on the study team*

The GAO found that when the analysis supporting a capability proposal is conducted by the operational requirements community within a military service, it sometimes contains only rudimentary assessments of the costs and technical feasibility of the solutions identified. Failure to include acquisition personnel, analysts, and cost estimators on the study team can result in severe shortcomings in the study and lead to problems in the subsequent acquisition program. Likewise, only including personnel from one core function or mission area may limit or bias the results of the study.

### *6.2.8 Making unnecessary assumptions*

It is tempting to make assumptions to simplify a study. Unnecessary assumptions can cause the AoA to overlook important elements or criteria, which can severely limit the validity of an AoA. Teams should carefully scrutinize all assumptions to determine if they are necessary. A common and dangerous mistake is to assume enabling capabilities such as manpower, communications, intelligence, and logistics are available at no additional cost. This may overstate the operational effectiveness of the alternatives and understate the cost to the government.

### *6.2.9 Concept definitions lacking CONOPS*

For new concepts, failure to define proposed CONOPS in the CCTD can lead to problems in the AoA. When a new technology or a major increase in performance is in play, it can take a significant amount of time to come up with reasonable employment approaches. Assuming a new system will be employed identically to the baseline is a potentially fatal analytic flaw. The process to develop new CONOPS or CONEMPs is typically iterative. The team defines an initial set of ideas about how an alternative will be employed which are then analyzed. This analysis is then used to modify the CONOPs or CONEMPs to take better advantage of the alternative. Eventually the employment ideas and the resulting

operational effectiveness will approach some best state. This is what should be used in the analysis keeping in mind that DOTmLPF-P changes will need to be made. This can also be true for less revolutionary systems, but most big employment changes occur with new technologies or significantly new applications of old technologies. In these situations, the ECWG (or OCWG) will need to develop the CONOPS and CONEMPS during the course of the study.

In some cases, CCTDs may not adequately describe the operational concepts, in part, because they are developed by the acquisition community during Development Planning and may have had little or no input from the operational community. Use of DoDAF views OV-1, OV-2, OV-4, and OV-5a may help the team more fully document the operational concepts.

#### *6.2.10 Failure to adequately assess risks*

The GAO examined the performance of acquisition programs and linked that performance back to the quality of the AoA. GAO found that while many factors can affect program cost and schedule, acquisition programs with AoAs that conducted a more comprehensive assessment of risks tended to have better cost and schedule outcomes than those that did not. Study team leads should review the risk analysis section of this Handbook and ensure the AoA adequately evaluates the risks (cost, schedule, technical, and operational) of the alternatives.

#### *6.2.11 Using the wrong analytic tools just because of familiarity*

In practice, it is not uncommon for analysts to favor particular data collection and analysis methods over others. Familiarity and prior success with using a particular method often reinforces its use, even when it is not the most suitable method for addressing a specific study question. The study questions should drive the methodology, not the other way around.

#### *6.2.12 Quantifying without rationale*

AoA teams sometimes have a tendency to quantify data or findings that should not be quantified. For instance, subjective data such as judgment or opinions regarding a specific problem or question that is elicited from experts may not need to be expressed as numerical values. In some cases, a quantitative approach may actually hinder the interpretation of the data by masking meaningful information. Subjective data obtained by interviewing experts can oftentimes be expressed more meaningfully without attempting to quantify it.

#### *6.2.13 Aggregating without rationale*

Aggregating a large amount of data may be necessary to improve understanding the results of the study. However, teams should avoid over-simplifying the results as this may mask important aspects of the study. Finding the right level of aggregation is a difficult art form, not an exact science.

#### *6.2.14 Failure to conduct robust sensitivity analysis*

Sometimes, study sponsors do not ensure enough time and resources are allocated to conducting sensitivity analysis, or they leave the sensitivity analysis until the end of the study rather than conducting it throughout the course of the AoA. Teams should plan for an appropriate level of sensitivity

analysis and time throughout the study in order to address the concerns outlined in sections 4.10 and 5.9.2.

### *6.2.15 Failure to address necessary security structures from the beginning*

If your study will have SAP/SAR or SCI aspects, these issues, and appropriate clearances, need to be worked long before the study starts. This is often the longest lead item in the AoA, and, if key people cannot see critical elements of the data or the alternatives, then it is nearly impossible for them to do complete analysis.

# 7 Reporting the Results

Unlike the AoA study guidance and plan, the AoA final report is generally not developed using the Working Integrated Product Team (WIPT) process, but rather by the AoA study team. Typically, the individual working group chairs and working group members are responsible for developing their sections of the final report. This chapter begins with a discussion of general reporting principles that, when followed, will enhance the quality of the report. The remainder of the chapter provides guidance for writing the final report.

## 7.1 What is the AoA Final Report?

The final report is the enduring record of the AoA that describes what was done, how it was accomplished, and the results of the analysis. The final report requires significant time and effort to produce and staff. The study team should use the OAS AoA final report template in Appendix G, which can be tailored for the study, as a guide in developing the final report.

Since team members may disperse quickly after their work on the study is completed, it is important to continuously document the process and results throughout the study. If the final report is not finalized shortly after the end of the study, there may be little to show for what was accomplished during the AoA. As a general rule, a study not documented is a study not done.

Though the final report is the enduring record of the study, the briefing that is developed from the final report will likely receive most of the initial attention. The information contained in the final report briefing is what the AFGK, CDWG, AFCDC, Milestone Decision Authority, and other appropriate OSD and government agencies primarily review in making their decisions. It is therefore important that the briefing is an accurate and complete representation of the final report. Both the final report and briefing should follow the staffing and review process as outlined in the A5R Guidebook. Teams should be aware that the final report is not complete until it has been reviewed, validated, and approved (as appropriate) by the SAG, the AFGK, the CDWG, the AFCDC, the MDA, and other agencies, and has been deemed sufficient by OSD(CAPE) or HAF/A5R (as appropriate).

Teams should also be aware that the Secretary of Defense requires that all teams track and publish the actual cost of preparation of every report and study. This cost shall be reported on the front page of the final study report. More information on how to do this along with a calculator for determining the cost of a study or report can be found on the OSD(CAPE) Cost Guidance Portal under the "DoD studies and reports" link (https://www.cape.osd.mil/CostGuidance).

## 7.2 Write Well

Though AoAs have evolved over time, there are principles that continue to underpin the reporting of results. This section describes these principles and offers some recommendations for reporting AoA results.

Even though the final report is the enduring record of a study, there is a tendency to not give adequate attention and effort to writing the study report. The adverse consequence of this practice is that a

poorly written report or briefing can significantly diminish the value of the study. In the end, the audience's impressions of a study are largely shaped by the quality of the presentation.[76] Given the importance of a good presentation, the study team has a responsibility to clearly and objectively communicate the study results.

Before writing, the study team should first consider the audience. Understanding the needs and preferences of the audience will help the study team determine the discussion length and level of detail that will be required. The greater the knowledge gap in the subject between the audience and study team, the greater the challenge for the study team to fully explain the results.[77] If the knowledge gap is unknown or uncertain, the study team should prepare to provide a full discussion.

The act of writing should start early and continue through the course of the study. It is an iterative cycle of thinking, writing, re-thinking, and re-writing. In practice, however, there is a tendency to defer writing to the end of the study. At this stage, there is often little time remaining for focused thinking and editing which are essential to enhancing the quality of the presentation.

Good presentation is vital to conveying information clearly and accurately and maintaining continuity of words, sentences, and paragraphs from the opening statement to the conclusions and recommendations. Given the importance of a good presentation, the study team has a special obligation to clearly and objectively communicate the results of the study. Fortunately, there are guidelines the study team can follow to effectively present study results:[78]

- Prewriting considerations. Before writing, there are several factors the study team should consider. Foremost, the study team should keep the purpose of the study in mind when reporting results. Studies are initiated to achieve specific objectives and address questions from stakeholders and decision makers. Keeping the study purpose in mind will help the study team focus on meeting the objectives of the study and answering the study questions.
- Writing outline. A writing outline helps specify what to write and how to state it. By using a writing outline, the study team can express the essential thoughts associated with a specific topic. Below is an example of a writing outline for reporting measure results:

  A. Measure statement

  1. Criteria and criteria reference or rationale

  2. Measure rating

  3. Measure rating discussion

  a) Rationale or justification for rating

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[76] Emory, C. William. (1985). *Business Research Methods, Third Edition*. Homewood, IL: Richard D. Irwin, Inc., p. 426.

[77] Ibid., p. 420.

[78] Ibid., pp. 419-424.

b) Task and mission performance implications

- Presentation considerations. Good presentation is essential to conveying information clearly and accurately. The following are fundamental guidelines to good writing that will help enhance the quality of a report:
    - Choose words that communicate thoughts fully, clearly, and accurately. Plain discourse not only helps enhance readability and comprehensibility, but also avoids ambiguity. Jargon or arcane words do not facilitate understanding and should not be used.
    - Summarize and repeat critical or difficult points to ensure the reader gains an understanding of the message. Tables and graphics are also useful for explaining critical or difficult points.
    - Use a topic sentence to capture the main thought or subject of the paragraph. A topic sentence helps prepare the reader for the rest of the paragraph and provides a focal point for the supporting details, facts, figures, and examples.
    - Use shorter paragraphs to highlight key points and provide a visual relief to readers. Avoid using large blocks of unbroken text since it produces a daunting appearance that is unpleasant to readers. Each paragraph should represent a distinct thought. As a general rule, a paragraph longer than half a page should be scrutinized to ensure it is necessary.
    - Use headings and subheadings to create homogeneous sections of the report. Headings and sub-headings help organize the report and serve as signs for the reader to follow.
    - Indent parts of text that represent lists or examples.
    - Use table and figure labels that are self-explanatory.
    - Proofread the document for incorrect spelling, poor punctuation, and improper grammar. Proofreading, preferably by several people, is essential to catching these mistakes and making the necessary corrections (if possible, a review by a professional technical editor can help enhance the quality of the report as well).

There are many references the study team can use to facilitate good writing. Two examples include the Air Force's *Tongue and Quill* and the American Psychological Association's *Publication Manual*. Some general principles and guidelines from these publications include the following:

- Active/passive voice. Although passive voice is sometimes appropriate (i.e., when the doer or actor of the action is unknown, unimportant, obvious, or better left unnamed), the study team can enhance the quality of the report by using active voice. Active voice maintains the natural subject-verb-object pattern and conveys the message more clearly and concisely with fewer words. As a general rule, to identify passive voice, the study team should watch for forms of the verb "to be" (am, is, are, was, were, be, being, been) and a main verb usually ending in "ed" or "en." There is also a tendency to confuse passive voice with past tense. Past tense (along with present tense and future tense) is a tense of a verb and is not the same as passive voice. Below is an example of a sentence written in active and passive voice (note the subject-verb-object pattern of the active voice):

  Passive: The ball was thrown by the girl.

Active: The girl threw the ball.

- Fewer words (economy of expression). Short words and sentences are easier to understand than long ones. As a general rule, the longer it takes to say something, the weaker the communication. Unnecessary words do not help convey a message to the reader and should be removed or replaced with working words. Each word in a sentence should be checked to determine whether the message changes when the word is removed from the sentence. Sentences more than 20 words should be examined to determine whether the message can be conveyed more effectively with fewer words or by dividing the sentence into multiple shorter sentences.
- Orderly presentation. The study team should aim for continuity of words, sentences, and paragraphs from the opening statement to the conclusion. Continuity can be achieved through punctuation marks and transitional words. Punctuation marks cue the reader to pauses (comma, semicolon, and colon), stops (period and question mark), and detours (dash, parentheses, and brackets). Transitional words help maintain the flow of thought. Some examples include the following:
    - Time links: then, next, after, while, since.
    - Cause and effect links: therefore, consequently, as a result.
    - Addition links: in addition, moreover, furthermore, similarly.
    - Contrast links: but, conversely, nevertheless, however, although, whereas.

## 7.3 Writing the Executive Summary

The main goal of the executive summary is to provide a condensed version of the content contained in the longer report. It is usually designed for decision makers who do not have time to read the whole report. As a general guide, executive summaries are usually one to ten pages in length and no longer than ten percent of the original document.

The executive summary should be written after the report is finished to ensure that it is an accurate summary of the study. The summary does not need to be one long block of text. Headings can be used to organize the major themes of the summary and help orient the reader. Graphics can be included that summarize the key results.

In writing the executive summary, the study team should begin with a brief overview of the study, focusing on the purpose, scope, and analytical approach. Key organizations involved should also be identified. The remainder of the executive summary should present the key results, answers to key questions, conclusions, and recommendations.

## 7.4 Writing the Introduction

The introduction is Chapter 1 of the OAS AoA final report template. The introduction is comprised of the following sections:

1.1 Purpose and Scope

1.2 Study Guidance

1.3 Capability Gaps

1.4 Stakeholders

1.5 Key Ground Rules, Constraints, and Assumptions

1.6 Description of Alternatives

Given that much of this information is already contained in the AoA study plan, the study team should use this information to develop these sections of the final report. As necessary, the study team should update or revise the information to ensure it is current and complete and addresses any redirection or changes from the SAG, AFGK, CDWG, AFCDC, etc. Additionally, any deviations from the study guidance and study plan should be discussed.

## 7.5 Reporting the Effectiveness Analysis Results

The effectiveness analysis results are presented in Chapter 2 (Operational Effectiveness Analysis) of the OAS AoA final report template. This section provides several examples of presenting measure, task, and mission level results in the AoA final report.

### *7.5.1 Measure-Level Results*

There are several approaches the analyst can use to present the results of the measure analysis.[79] One approach entails using a measure rating scale to describe whether or not a measure meets the criteria. Note: these criteria may differ from the criteria eventually applied to KPPS, KSAs, and other attributes. For measures that have threshold equals objective (T=O) criteria or have no expressed objective criterion, there are four possible measure ratings as shown in Table 7-1 For these measures, the measure value is rated against the threshold criterion. When a measure value does not meet the threshold criterion (yellow and red rating), operational significance becomes the key consideration. Whether the shortfall is significant or not ultimately depends on the impact to the task.

When a shortfall has only minimal operational impact, the measure should be rated as "did not meet criteria—not a significant shortfall." When the shortfall has a substantial or severe operational impact, the measure should be rated "did not meet criteria—significant shortfall." In both cases, it is important to capture the rationale used to justify the rating. This means describing the operational impacts. This will enable others to evaluate whether the rationale is credible and defensible.

When there is insufficient information to assess a measure, it should be rated as "inconclusive." When there is no information to assess a measure, it should be rated as "not assessed."

When an objective criterion is expressed, an alternative rating scale which incorporates an additional rating for the objective criterion is shown in Table 7-2.

[79] For more information about rating measures, see *The Measures Handbook*, OAS.

**Table 7-1: Measure Rating Scale**

| Color Code | Rating |
|---|---|
| G | Met Criteria |
| Y | Did Not Meet Criteria—Not a Significant Shortfall |
| R | Did Not Meet Criteria—Significant Shortfall |
| | Inconclusive or Not Assessed |

**Table 7-2: Measure Rating Scale for Measures with Objective Criterion**

| Color Code | Rating |
|---|---|
| B | Met Objective |
| G | Met Threshold |
| Y | Did Not Meet Threshold—Not a Significant Shortfall |
| R | Did Not Meet Threshold—Significant Shortfall |
| | Inconclusive or Not Assessed |

Table 7-3 shows notional examples of how the measure results can be reported. Given the number of alternatives, scenarios, and measures in a study, the study team should use discretion in determining what goes in the body of the final report and what should go in an appendix. For example, the results of key measures may be shown in the body of the report, and the results of all other measures shown in an appendix.

**Table 7-3: Notional Examples of Measure Results**

| EXAMPLE 1 | |
|---|---|
| ALTERNATIVE: 2 (STANDOFF) | |
| Mission Task: 1 (Defeat Target) Scenario: A, B | |
| MOE 1.3: Range | |
| Criteria: | Threshold = 1500 NM T = O |
| Value: | 1700 NM |
| Rating: | Met Criteria |
| Rationale: | Performance exceeds the threshold requirement. |
| Data Source/Methodology: | The range value was sourced from the Standoff Weapon CCTD. A munitions expert panel reviewed the CCTD data and validated the value. |

| EXAMPLE 2 | |
|---|---|
| ALTERNATIVE: 4 (LONG RANGE) | |
| Mission Task: 1 (Defeat Target) | |
| MOE 1.1: Probability of Kill | |
| Criteria: | Threshold = .90 T = O |
| Value: | .82 |
| Overall Rating: | Did Not Meet Criteria- Significant Shortfall |
| Rating (Scenario A) | Did Not Meet Criteria-Not a Significant Shortfall |
| Rating (Scenario B, C) | Did Not Meet Criteria- Significant Shortfall |
| Rationale: | Scenarios B and C included complex tunnel targets. With the limited penetration capability of the Long Range weapon, the probability of kill performance was particularly poor for these types of targets. Given that most of these types of targets are priority 1 and 2, the reduced probability of kill performance is a significant shortfall in capability.<br><br>Scenario A included only simple and simple-habitable tunnel targets. Though the Long Range weapon did not meet the threshold requirement, there were only ten priority 4 simple/simple-habitable tunnel targets that could not be held at risk. Failure to hold these targets at risk does not pose a significant shortfall in |
| Data Source/Methodology: | The probability of kill value was determined through M&S runs with the Integrated Munitions Effects Assessment (IMEA) and Hazard Prediction Assessment Capability (HPAC) models. |

**Table 7-3: Notional Examples of Measure Results (continued)**

| EXAMPLE 3 | |
|---|---|
| ALTERNATIVE: 3 (DIRECT ATTACK) | |
| Mission Task: 1 (Defeat Target) | |
| MOE 1.3: Range | |
| Criteria: | Threshold = 1500 NM T = O |
| Value: | 1450 NM |
| Rating: | Did Not Meet Criteria-Not a Significant Shortfall |
| Rationale: | Performance was 50 NM short of the threshold range requirement. In scenarios A and B, the reduced range was not a shortfall since all targets could be held at risk. In scenario C, seven priority 3 and ten priority 4 targets could not be held at risk due to the reduced range performance. The specific targets are not high priority targets. Failure to hold these targets at risk does not pose a significant shortfall in capability. |
| Data Source/Methodology: | The range value was determined through a comparison analysis of similar types of direct attack weapons. |

Tables 7-4 and 7-5 show notional examples of summary charts that can be used to display the measure results by alternative and scenario. In Table 7-4, the results of key measures are shown by alternative. In table Table 7-5, a rating is shown for each measure by scenario and an overall rating is shown that was based on each alternative's performance in meeting the threshold criteria for all three scenarios. In summary tables such as these, it is important to include a discussion that describes the results. Just presenting the information without an accompanying discussion is not sufficient.

**Table 7-4: Example 1 of a Summary Chart of Measure Results (Notional)**

| Key Measures | Alternatives | | | | |
|---|---|---|---|---|---|
| | Baseline | 1 | 2 | 3 | 4 |
| MOE 1.1: Probability of Kill | | | | | |
| MOE 1.3: Range | | | | | |
| MOE 1.4: Collateral Damage | | | | | |
| MOE 2.2: Probability of Survival | | | | | |
| MOE 2.3: Counter Threats | | | | | |
| MOS 3.1: Deployability | | | | | |
| MOS 3.2: Maintainability | | | | | |

Green: Met Criteria Yellow: Did Not Meet Criteria – Not a Significant Shortfall Red: Did Not Meet Criterial – Significant Shortfall

**Table 7-5: Example 2 of a Summary Chart of Measure Results (Notional)**

| Alternative | Overall Rating | Scenarios | | |
|---|---|---|---|---|
| | | A | B | C |
| Alt 1 Penetrator Weapon | | | | |
| MOE 1.1: Probability of Kill | | | | |
| MOE 1.2: Number of Weapons to Defeat Target | | | | |
| MOE 1.3: Range | | | | |
| MOE 1.4: Collateral Damage | | | | |
| MOE 2.1: Time to Launch | | | | |
| MOE 2.2: Probability of Survival | | | | |
| MOE 2.3: Counter Threats | | | | |
| MOS 3.1: Deployability | | | | |
| MOS 3.2: Maintainability | | | | |
| MOS 3.3: Mission Reliability | | | | |
| Alt 2 Standoff Weapon | | | | |
| MOE 1.1: Probability of Kill | | | | |
| MOE 1.2: Number of Weapons to Defeat Target | | | | |
| MOE 1.3: Range | | | | |
| MOE 1.4: Collateral Damage | | | | |
| MOE 2.1: Time to Launch | | | | |
| MOE 2.2: Probability of Survival | | | | |
| MOE 2.3: Counter Threats | | | | |
| MOS 3.1: Deployability | | | | |
| MOS 3.2: Maintainability | | | | |
| MOS 3.3: Mission Reliability | | | | |

Green: Met Criteria  Yellow: Did Not Meet Criteria – Not a Significant Shortfall  Red: Did Not Meet Criterial – Significant Shortfall

### *7.5.2 Task-Level Results*

After all the measures have been rated, the focus of the assessment shifts from individual shortfalls at the measure level to the collective operational impact at the task level. The EAWG must rely on specific evidence in the study and operational experience and expertise of subject matter experts to assess the overall impact to a task. The assessment must be defensible and credible since the foremost concern on the skeptical reader's mind is the "so what" question (e.g., What is the relevance of the issue? How important is it? Why should I care?). Since there is seldom one right answer, the quality and weight of

evidence is crucial to answering these questions. Through effective communication, decision makers should ascertain that the results are valid and the assessment is sound and credible.

In some cases, there may be one or more measures that are very influential to how well a task is achieved. Such measures may address prominent attributes or parameters associated with the task and have the potential to become KPPs and KSAs. The EAWG should focus the discussion on these measures by explaining the relationships and impacts to task performance including the minimum threshold requirements. DoDAF views CV-2, CV-6, OV-2, and OV-5a as well as the other sources described in paragraph 5.9.1 can aid in the discussion.

In other cases, there may be measures that have significant interdependencies that must be considered when determining the significance of the impact. For example, a particular system may exhibit superior performance in detecting threats, but performs marginally in identifying threats. Detection and identification are interdependent capabilities and fundamental to the tasks of finding and tracking threats. When explaining the operational impact, it is important that the EAWG maintain a holistic view that is based on an understanding of the interdependencies that exist.

The EAWG should avoid relying on the preponderance of measure ratings to assess the collective impact at the task level. For instance, stating that three out of five measures met the criteria so the task is assessed as "green" oversimplifies the assessment and can be misleading. In addition, mathematical and heuristic-based rollup or weighting techniques are never the best way to communicate results. Although simple to use, these techniques can mask important information that underpins the assessment. In cases when there is insufficient information to make an assessment, the EAWG should simply state that the results are inconclusive and explain why.

There are several approaches the EAWG can use to present the results of the task level assessment. One approach entails using a task rating scale to help describe the impact at the task level. A task rating scale enables the EAWG to assign an overall task rating based on the results of the measures that support the task. The task rating scale shown in Table 7-6 is comprised of four color-coded ratings with definitions. When using a rating scale such as this, the EAWG should seek assistance from the OCWG members and others with relevant experience and expertise to determine the appropriate rating. Given that the ratings are subjectively determined, it is particularly important that the EAWG fully explain the rationale used to assign the ratings in the assessment discussion. This will enable readers to ascertain the validity of the ratings. Lastly, the EAWG can use other rating scales, but must ensure the scale ratings are sound and the associated rating definitions are clear.

Similar to the measure results, the task results can be summarized in a table such as the one displayed in Table7-7. In this notional example, a rating is shown for each mission task by scenario. In addition, an overall rating is shown that was based on each alternative's ratings for all three scenarios. In summary tables such as these, it is important to include a discussion of the results that addresses the factors that drove the overall ratings. Just presenting the information is not sufficient. Finally, given the number of alternatives, scenarios, and measures in a study, the study team may need to use some discretion in what is shown in the body of the final report and what should go in an appendix.

**Table 7-6: Example of a Task Rating Scale**

| Color Code | Rating | Definition |
|---|---|---|
| G | No or Minimal Operational Impact | No or some effectiveness and/or suitability shortfalls identified with minimal impact on the task |
| Y | Substantial Operational Impact | Effectiveness and/or suitability shortfalls identified with substantial impact on the task |
| R | Severe Operational Impact | Effectiveness and/or suitability shortfalls identified with severe impact on the task |
| | Inconclusive | Insufficient information to support an assessment |

**Table 7-7: Notional Example of Mission Task Rating Results**

| Alternative | Overall Rating | Scenario | | |
|---|---|---|---|---|
| | | A | B | C |
| Alt 1 Penetrator Weapon | | | | |
| MT 1: Defeat Target | | | | |
| MT2: Survive Threat | | | | |
| MT 3: Support System | | | | |
| Alt 2 Standoff Weapon | | | | |
| MT 1: Defeat Target | | | | |
| MT2: Survive Threat | | | | |
| MT 3: Support System | | | | |

Green: No or Minimal Operational Impact

Yellow: Substantial Operational Impact

Red: Severe Operational Impact

### *7.5.3 Mission-Level Results*

Once the tasks have been assessed, the EAWG can evaluate the collective operational impact at the mission or higher level, if necessary. At the mission level, the EAWG must consider how well each task is achieved and how it impacts mission accomplishment. It is likely that the contribution or influence of each task to mission accomplishment will vary (i.e., the ICD may have identified some tasks that are more important than others in accomplishing the mission). With assistance from OCWG members and others with the appropriate operational experience and expertise, the EAWG should address, as part of the assessment discussion, the overall impact of each task on the mission.

Another aspect the EAWG must address is the degree to which the capability gaps have been mitigated and the impact of the associated operational risks. The EAWG uses the collective results of the measure analysis, task assessment, and mission or higher level assessment as well as the operational experience and expertise of appropriate subject matter experts to explain the extent to which the gaps have been mitigated and the impact of the operational risks. Although it is subjective, the assessment must be supported by a credible and defensible explanation. With the OCWG, the EAWG should focus on the most important influencing aspects of the measures, tasks, and mission (or higher level) to explain the degree to which the capability gaps have been mitigated and the impact of the associated operational risks.

### *7.5.4 Sensitivity Analysis Results*

Once, the measure-, task-, and mission-level results have been presented, the results of the sensitivity analysis is provided to present the cost, schedule, and performance drivers and illuminate the trade space for decision makers. The sensitivity analysis presentation should highlight the stability or robustness of the concepts, systems, or alternatives that were assessed in the study. The sensitivity analysis will enhance the credibility of the analysis by showing potential performance tradeoffs and cost savings.

The sensitivity analysis may have also involved altering the operational conditions or scenarios to assess capabilities and limitations of systems in different environments. The results of the analysis should show how robust the systems are in a wider range of operational conditions and scenarios.

The study team should also present analysis that demonstrates if features that provide substantive operational benefit to one (or more) alternatives apply to all viable alternatives. For example, if a particular type of sensor was found to provide improved effectiveness for one alternative, the study team should present the results of analysis conducted to determine if incorporating the sensor in all alternatives is feasible.

## 7.6 Reporting the Cost Analysis Results

During the conduct of the study, the CAWG lead should be tracking the preliminary cost results and determining how best to present them in the AoA final report. It is important not to wait until the cost analysis is complete to begin working on the presentation. The presentation format should have been identified, or at least outlined, during the study planning stage. Though there is no common or

standardized Air Force presentation package or format that can be used for all estimates, the presentation must be clear, concise, and complete. All key cost analysis results must be included and addressed in a logical manner. The effective communication of the results depends on clear and direct statements. This requires identifying the essential types and levels of information needed to fully explain the results.

Tables 7-8 and 7-9 show example formats typically used in AoA studies to present the cost analysis results. The example formats can be used to report results in both Base Year (BY) and Then Year (TY) dollars. Table 7-8 shows the cost by life cycle phase and total cost for the baseline and alternatives. Table 7-9 shows the cost by fiscal year and appropriation for a specific alternative.

In addition to the presentation of the results, the documentation of the cost estimate is an important requirement of cost estimating. The primary reasons for documenting an estimate are to explain how it was prepared, the degree of credibility it has (based on program, schedule, and cost uncertainty/risk and sensitivity), and how it provides the cost information needed for a decision. Cost estimate documentation is the only way of understanding the estimate in the absence of those who developed it. Documentation provides a detailed record of the data, methods, assumptions, and actions used to develop an estimate.

Similar to the presentation of the cost analysis results, the documentation must be clear, complete, and concise. In developing the documentation package, the analyst should assume that the reader or reviewer knows nothing about the program or estimate. If too much information is provided in the first drafts, it can be edited to a manageable size for the AoA final report. The information contained in the documentation package should be sufficient to enable analysts not familiar with a program to replicate the estimate and its results. The most likely user of the documentation is another cost analyst who needs, in the future, to either update the documented estimate or pull historical data from it.

**Table 7-8: Example of Cost by Life Cycle Phase and Total Cost**

| | R&D | Investment | O&S | Disposal | Total LCC |
|---|---|---|---|---|---|
| Baseline | | | | | |
| Alternative 1 | | | | | |
| Alternative 2 | | | | | |
| … | | | | | |
| Alternative n | | | | | |

**Table 7-9: Example of Cost by Fiscal Year and Appropriation**

| Alternative 1 | FY01 | FY02 | … | FYn | Total |
|---|---|---|---|---|---|
| 3010 Aircraft Procurement | | | | | |
| 3020 Missile Procurement | | | | | |
| 3080 Other Procurement | | | | | |
| 3300 Military Construction | | | | | |
| 3400 Operations and Maintenance | | | | | |
| 3500 Military Personnel | | | | | |
| 3600 RDT&E | | | | | |
| Total | | | | | |

Proper documentation of cost estimates is an important responsibility of the professional cost analyst. Documentation should begin in the earlier steps of the estimating process and continue through the entire process. Documenting the estimate as it is developed makes its preparation easier and improves its contents. The documentation should also discuss the reasons why certain estimating methods were investigated, but not selected, since this information can be insightful to other estimators and analysts. Good documentation has a variety of uses and applications since it:

- establishes the credibility of the estimate,
- informs decision makers and helps them judge the reliability of the estimate,
- explains the rationale for selecting and using particular cost methods,
- explores how sensitive the estimate is to changes in cost drivers,
- explains the effect of uncertainty/risk on the estimate through the Cost Uncertainty/Risk Analysis,
- aids in the analysis of changes and growth in program cost,
- adds to the library of estimates that can be drawn upon when estimating the cost of a future program.

As a general rule, the documentation package may be tailored depending on its purpose or the information it incorporates.[80] Though there is some discretion in what is or is not included, the

[80] For more information about cost estimate documentation, see the following:

(1) *Air Force Cost Analysis Handbook*, AFCAA.

documentation that is included in the AoA final report should be sufficient to answer the following questions in the affirmative:

- Is the documentation well organized, cohesive, supportable, and easily understood?
- Is it organized according to a Work Breakdown Structure (WBS), or in another logical manner?
- Are the WBS definitions included or available?
- Is the documentation complete; that is, does it contain all supporting data with all supporting narratives?
- Are pertinent historical information and funding data included?
- Are prior costs documented?
- Are the narratives that explain the estimating methods understandable?
- Are the data values and sources clearly shown in the documentation?
- Can the estimating methods used to develop the estimates be easily followed and replicated?

## 7.7 Reporting the Risk Assessment Results

The results of the risk assessment can be influential in the decision making, but only if they are clearly communicated. The final report must contain all aspects of the risks considered (e.g., consequences, likelihood, scenarios, and assumptions). It is important to use presentation methods (e.g., graphics, tables, and text) that contribute to the understanding of the risks associated with the alternatives.

Table 7-10 shows a notional example of risk statements for an alternative assessed in an AoA using the Risk Assessment Framework (RAF). Given that the study team used subject matter experts, the analytic rigor level was set at "2" in the two risk statements. Since the study team assessed an alternative that will provide new capability beyond the FYDP, the force structure statement was the programmed force extended plus the alternative. As shown in the table, the study team also developed an overall rating for the alternative based on the operational and force management risk ratings.[81]

(2) AFI 65-508, *Cost Analysis Guidance and Procedures*, specifically Chapter 5 and Attachment 3 to the same instruction contains a cost documentation checklist useful in determining the completeness of the cost documentation.

[81] Creating an overall rating is optional.

**Table 7-10: Notional Example Presentation of Risk Statements**

| Alternative | Overall Rating | Operational Risk Rating | Force Management Risk Rating |
|---|---|---|---|
| 3 | Moderate | Low | Moderate |
| | | *According to the AoA study team, the operational risk of providing moving target indicator support to maneuver and surface forces is low with analytic rigor level 2 for ISC G and H, timeframe 2025-2040, and the programmed force extended plus Alternative Y assuming the DOTmLPF-P solutions identified in the Moving Target Indicator CBA are developed.* | *According to the AoA study team, the force management risk of providing moving target indicator support to maneuver and surface forces is moderate with analytic rigor level 2 for ISC G and H, timeframe 2025-2040, and the programmed force extended plus Alternative Y assuming the DOTmLPF-P solutions identified in the Moving Target Indicator CBA are developed.* |

Whether the RAF or RMG approach is used, the study team can display the risk assessment results in various ways to facilitate an understanding of the results. Table 7-11 shows a notional example that lists the primary risk drivers for each alternative.

The results should include a description of the initial acquisition schedule for each alternative and provide an assessment of existing TRLs/MRLs for critical technologies which may impact the likelihood of completing development, integration, and operational testing on schedule and within budget. This should include an assessment of the likelihood of achieving the proposed schedule for each alternative.

The results should include potential mitigation options associated with any risks that were identified in the study. A discussion of how these mitigation options were considered in determining the overall risk of an alternative should be included. The descriptions of the risk mitigation options should be specific and address what should be done, when it should be accomplished, and the resources required to implementing the risk mitigation.

**Table 7-11: Notional Example of Risk Assessment Results**

| Alternative | Risk Rating | Risk Drivers |
|---|---|---|
| 1 | High | - Obsolescence of integrated circuits<br>- Diminishing manufacturing sources<br>- Maintainability<br>- Limited adaptability<br>- Performance in dense signal environment |
| 2 | Significant | - System integration requirements<br>- Programmatic dependencies<br>- Intelligence support requirements<br>- Security requirements<br>- Simultaneous jamming capability<br>- Performance in dense signal environment |
| 3 | Moderate | - Technology readiness level<br>- Intelligence support requirements<br>- Program schedule<br>- Installation complexity<br>- System compatibility |

## 7.8 Reporting the Comparison Analysis and Cost Capability Analysis Results

The alternative comparison analysis and cost capability analysis results are presented in Chapter 5 (Alternative Comparison) of the OAS AoA final report template. The information should be clear, concise, cogent, and unbiased. The presentation should accurately depict the analysis results, present understandable interpretations, and support the conclusions and recommendations. The more straightforward and clear manner in which the results are presented, the easier it is to understand the differences among the alternatives. The study team should strive to help decision makers understand differences among the alternatives.

The study team should describe how alternatives compare in terms of effectiveness (and suitability), cost, and risk. In addition, the study team should discuss the results of any effectiveness, cost, and risk sensitivity analyses that were conducted. The discussion should highlight why specific alternatives do well or poorly and identify and discuss the key aspects that differentiate the alternatives. If specific alternatives are deemed non-viable by the study team, the rationale should be included in the discussion. If one or more viable alternatives are identified, the study team should describe how they mitigate or close the capability gaps and reduce the associated operational risk (as identified in the CBA, ICD, and appropriate Core Function Support Plans (CFSPs)). Finally, the study team should describe the operational impact of failing to meet threshold values for key measures used in the study. If appropriate, the study team should recommend changes to validated capability requirements if the changes would result in acceptable tradeoffs.

There are many possible ways to present the comparison analysis results. The study team should explore different ways that maintain both continuity of thought and enhance readability and comprehensibility. One example presentation is shown in Table 7-12. In this notional example, the results of the key measures associated with each mission task are displayed by alternative. The overall risk ratings and life cycle cost estimates are also included. The discussion that accompanies a presentation such as this should highlight the specific areas where each alternative does well or poorly.

**Table 7-12: Notional Example of Comparison Analysis Results**

| | Mission Task 1 Defeat Target | | | Mission Task 2 Survive Threat | | Mission Task 3 Support System | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Key Measures | | | Key Measures | | Key Measures | | | |
| Alternatives | MOE 1.1 **Probability of Kill T = .90** | MOE 1.3 **Range T = 1500** | MOE 1.4 **Collateral Damage** | MOE 2.2 **Probability of Survival T = .80** | MOE 2.3 **Counter-Threats** | MOS 3.1 **Deploy** | MOS 3.2 **Maintain** | Risk | LCCE $B |
| Baseline | .90 | 1100 | | .82 | | | | | 3.1 |
| Alt 1 Penetrator | .87 | 1300 | | .89 | | | | | 4.3 |
| Alt 2 Standoff | .86 | 1700 | | .92 | | | | | 4.9 |
| Alt 3 Direct Attack | .94 | 1450 | | .87 | | | | | 3.9 |
| Alt 4 Long Range | .82 | 1900 | | .84 | | | | | 5.1 |

**Measure Rating Legend**
Red: Did not meet threshold, significant shortfall
Yellow: Did not meet threshold, not a significant shortfall
Green: Met threshold

**Risk Rating Legend**
Red: High
Yellow: Moderate
Green: Low

Closely associated with the comparison analysis, the cost capability analysis is used to define the trade space between cost and operational capabilities. Like the comparison analysis, cost capability analysis

results can be presented in many possible ways and will depend on the study. Regardless of the approach used, the message must be clear and cogent.

Cost capability analysis results should identify the set of dominant alternatives (i.e., no alternative has both lower cost and higher capability). Results should highlight how the alternatives stand in terms of military worth (e.g., most to least). Results should show how robust the alternatives are to changes (e.g., changes in assumptions, performance, or conditions) and how they impact the overall ranking of alternatives. At minimum, the analysis should answer the following questions:

- What is the military worth of increased (or decreased) operational capability for each gap?
- What are the tradeoffs between cost and capability?
- What is the preferred alternative(s)? Is it cost effective? Does it fit within the affordability goals?
- For the preferred alternative(s), what are the primary drivers of performance and cost?

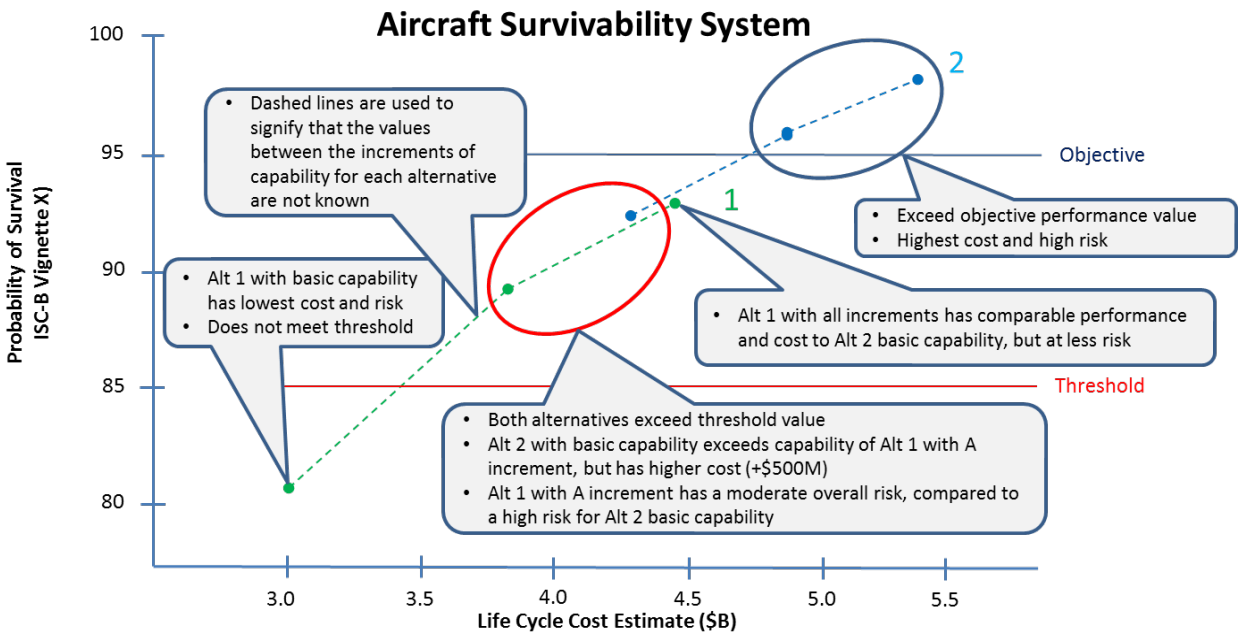
The focus of the cost capability analysis presentation is the comparisons between performance parameters and costs to facilitate cost and performance tradeoff discussions. Figure 7-1 shows an example presentation of the cost capability analysis results for a notional Aircraft Survivability System. Alternatives 1 and 2 are the most viable of the alternatives analyzed and are shown in the figure (note that non-viable alternatives are not displayed). The life cycle cost estimates are shown in $B along the x-axis. The y-axis shows the probability of survival for a specific ISC and vignette. The results from other scenarios and vignettes can be shown in separate charts to help the decision makers understand how robust the alternatives are in different scenarios/vignettes. Alternatively, the results associated with all the scenarios and vignettes analyzed in the study can be combined and presented in one chart. Probability of survival was selected since it will be a Key Performance Parameter (note that the threshold and objective values are highlighted on the chart). Other possibilities for the y-axis include reduction in lethality, loss exchange rate, or a weighted composite of parameters (e.g., survivability, threat detection and identification capability, threat defeat capability, maintainability).

The table below the graph provides a summary showing the probability of survival and LCCE values as well as the overall risk rating of the alternative for the increments of capability for each alternative. The color rating for the probability of survival is based on whether the alternative meets the threshold/objective value:

- Red: Did not meet threshold, significant shortfall.
- Yellow: Did not meet threshold, not a significant shortfall.
- Green: Met threshold.
- Blue: Met objective.

Alternative 1 with the basic capability is significantly below the threshold value and is therefore rated red, whereas alternative 2 with the basic capability meets the threshold and is rated green. Alternative 1, with the A and B increments of capability, meets the threshold and is rated green, while alternative 2, with the X and Y increments of capability, meets the objective value, and is therefore rated blue. In

situations where there is no objective value (threshold = objective), then only the red, yellow, and green ratings should be used. In other situations where threshold and objective values do not exist, the team will need to explain the difference in performance without referencing these values. In this example, Alternative 1 with the A increment and Alternative 2 with the basic capability (circled in red) may be the best value options. Alternative 2 with the X and Y increments (circled in blue) are the high performance, cost, and risk options.




| Alt | Performance, Cost, and Risk | T | O | Increments | | |
|---|---|---|---|---|---|---|
| | | | | Basic | + A | + B |
| 1 | Probability of Survival | .85 | .95 | .81 | .89 | .93 |
| | LCCE ($B) | | | 3.0 | 3.8 | 4.5 |
| | Risk | | | Low | Moderate | Moderate |
| | | | | | | |
| | | | | Basic | + X | +Y |
| 2 | Probability of Survival | .85 | .95 | .92 | .96 | .98 |
| | LCCE ($B) | | | 4.3 | 4.9 | 5.4 |
| | Risk | | | High | High | High |

**Figure 7-1: Aircraft Survivability System Cost Capability Analysis Example**

Figure 7-2 shows another example presentation of the cost capability tradeoff analysis results for a notional Target Defeat Weapon. Alternatives 1, 2, and 3 are the most viable of the alternatives analyzed and are shown in the chart. The life cycle cost estimates are shown in $B along the x-axis. The y-axis shows the probability of functional kill for two ISC vignettes. The vertical bars show the Target Template Sets (TTS) analyzed in the study. TTS range from very simple to extremely complex and are defined in terms of hardness, depth, construction design, and function (e.g., command and control, operations, storage, leadership, etc.). The current baseline performance is shown on the chart (probability of functional kill = .55).

Alternative 1 provides increased probability of functional kill (+.11 over the current baseline systems) and is capable of functional kills in the TTS-F, G, H that are not possible with the existing baseline weapons. LCCE is $3B and the overall risk was rated moderate. Alternative 2 provides additional functional kill capability (+.17 over the current baseline systems) and is capable of functional kills in the TTS-F, G, H, I, and J that are not possible with the existing baseline weapons. LCCE is $4.2B and the overall risk was rated high. Finally, alternative 3 provides the most functional kill capability (+.22 over current baseline systems) and is capable of functional kills in the TTS-F, G, H, I, J, and K that are not possible with existing baseline weapons. LCCE is $5.3B and the overall risk was rated high.

It is important to note that none of the alternatives are capable of functional kills in the TTS-L, N, O, and Q. If TTS-L, N, O, and Q include targets that are the most critical to the warfighter, the determination of whether any of the alternatives are a best value option becomes more difficult despite the additional capability each of the alternatives provide over the baseline.

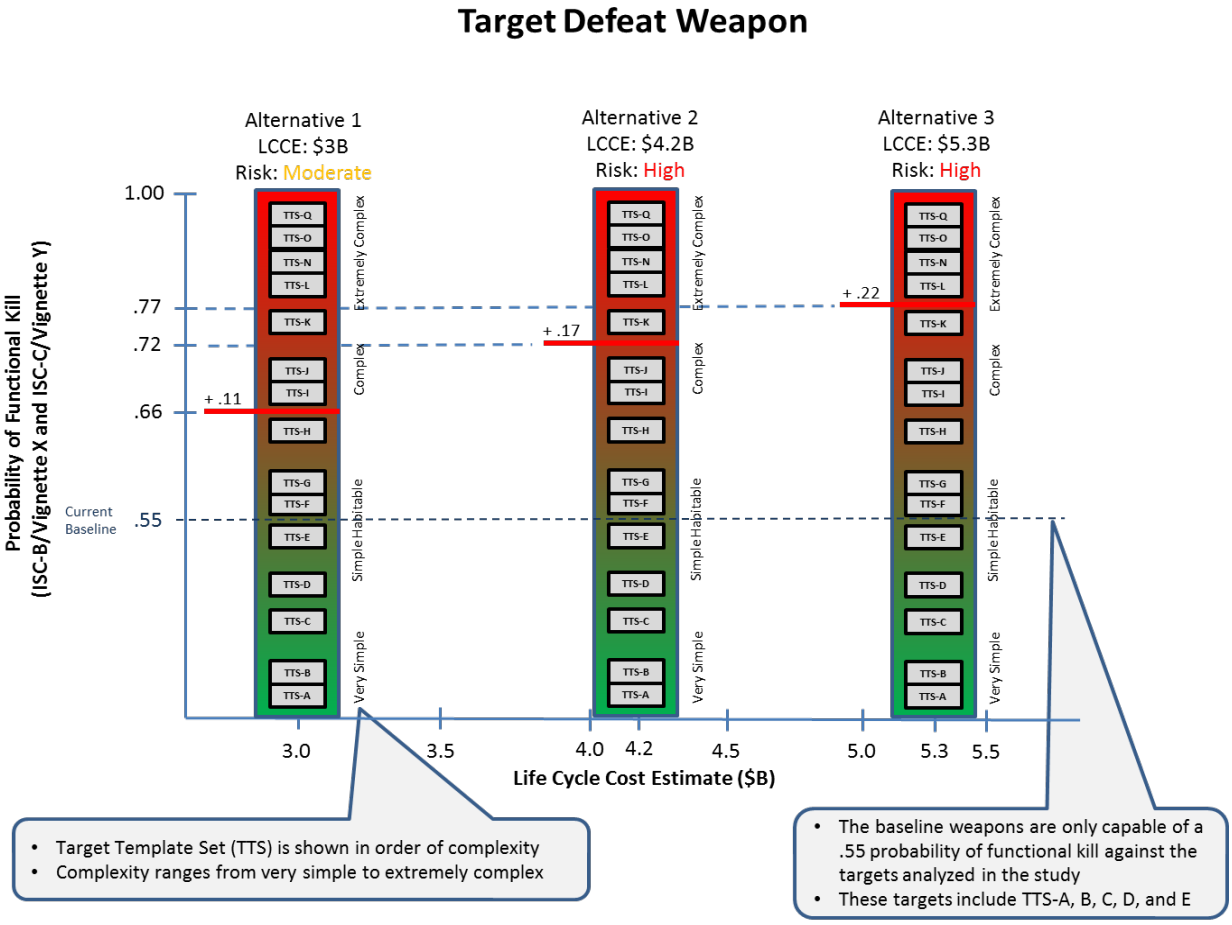



**Figure 7-2: Target Defeat Weapon Cost Capability Analysis Example**

## 7.9 Reporting the Conclusions and Recommendations

Conclusions and recommendations are discussed in Chapter 6 of the final report (see Appendix G). To draw conclusions, the study team must interpret the results of the analysis. Interpretation is an integral

part of analysis, requiring the study team to search the results for meaning. Conclusions cannot stand alone, but instead require explanations of how they were derived from the results. The study team must fully discuss the specific results or evidence that substantiates each conclusion. With an understanding of the analytical basis, the audience should be able to determine that each conclusion is sound and meaningful.

Like conclusions, recommendations should be grounded in the results of the analysis. Recommendations typically describe courses of action for consideration. It is possible that there may be no viable alternatives worth pursuing at this time. In these cases, the study team is not required to recommend one or more alternatives for further consideration. The study is still considered worthwhile given the valuable insights that are gained. Some examples of courses of action include:

- Pursuing (or not pursuing) one or more alternatives,
- Recommending changes in DOTmLPF-P; CONOPS; or TTPs, as well as updates to the DoDAF views,
- Recommending changes to capability requirements that appear unachievable or undesirable from a cost, schedule, risk, or performance perspective,
- Recommending changes to the initial objective values in the associated ICD(s),
- Conducting more research in specific areas.

One fundamental purpose of the AoA is to answer questions for the study sponsor and stakeholders. In the conclusions and recommendations section of the final report, the study team provides answers to the study guidance questions as well as any other questions that arise during the course of the study. Answers to study questions provide insights into specific areas of interest in the study and help inform decision making.

It is important that the study team fully answer the questions. The answers should stand alone and not require the reader to refer to other parts of the final report to understand the answers. Failing to properly address the study questions will limit the study's value, and in some cases, require additional analysis or another study.

## 7.10 Appendices

There are a number of appendices that are typically included in the final report (see Appendix G, AoA Final Report template). The study team has some discretion in determining what information to place in appendices. It is customary to place more detailed information about the study methodology and analysis results in an appendix rather than the body of the final report. If OSD(CAPE) has oversight of the study, they may direct the study team to limit the length of the report to no more than 50 pages, including the executive summary. In this case the study team must place the more detailed information in appendices to meet this page limit requirement. The following provides more guidance for specific appendices:

### *7.10.1 Concept Characterization and Technical Description (CCTD) documents*

CCTDs are included as appendices to the AoA study plan and final report. In the study plan, the CCTDs are preliminary and may not fully describe the concepts. During the course of the study, the CCTDs are further developed as new data and information requirements are identified by the study team. There is an expectation that the final report include complete CCTDs.[82]

### *7.10.2 Modeling and Simulation (M&S) Accreditation Final Report*

If M&S was used in the AoA, an M&S accreditation final report must be included as an appendix to the AoA final report. Accreditation is an official determination by an accreditation authority that an M&S application is acceptable for a specific purpose. The accreditation methodology must be in accordance with AFI 16-1001, *Verification, Validation and Accreditation (VV&A)*.

The M&S accreditation final report should describe the results of the assessment of the potential risks associated with results produced by the M&S applications. The M&S accreditation final report should be approved by the accreditation authority before the AoA final report is completed. The report should clearly indicate the accreditation authority's decision for each M&S application used. According to AFI 16-1001, there are five possible decisions:[83]

- Full accreditation – the M&S produces results that are sufficiently credible to support accreditation.
- Limited or conditional accreditation – constraints should be placed on how the M&S can be used to support the application of the M&S in the study.
- Modification of the simulation is needed – the M&S capabilities are insufficient to support either full or conditional accreditation; modifications and subsequent V&V are needed to correct deficiencies.
- Additional information is needed – the information obtained about the M&S is insufficient to support either full or conditional accreditation; additional information should be generated or otherwise obtained; supplemental verification, validation, and/or testing should be conducted to provide the necessary information before the accreditation decision is made.
- No accreditation – the results of the assessment show the model or simulation does not adequately support the application of the M&S in the study.

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[82] For more information about the CCTD, see the *Concept Characterization and Technical Description (CCTD) Guide*, SAF/AQ.

[83] For more information about the M&S accreditation process, see AFI 16-1001, *Verification, Validation and Accreditation (VV&A)* and the OAS *Models and Simulation Selection and Accreditation Handbook*.

### *7.10.3 Intelligence Supportability Analysis (ISA)*

AoAs that address systems and operations that are intelligence sensitive (i.e., either produce intelligence products or consume intelligence products during development and/or operation) require acquisition intelligence support and an ISA. Acquisition intelligence is the process of planning for and implementing the intelligence information and infrastructure necessary to successfully acquire and employ future capabilities. The purpose of the ISA is to compare each alternative's stated or derived intelligence support requirements (i.e., data and infrastructure) with the intelligence support capabilities expected throughout an alternative's life cycle. The ISA enables analysts to identify the derived intelligence requirements (DIRs) and deficiencies, the supporting intelligence infrastructure necessary to successfully acquire and field capabilities, the costs of that infrastructure, and the associated impacts to both acquisition and operational capability if the required intelligence is not provided.

The local Air Force Life Cycle Management Center (AFLCMC)/Intelligence (IN) office or AFLCMC/21st Intelligence Squadron works with the AoA study team to develop the ISA.[84] For space systems, the ISA is conducted within the Air Force Space Command A2/3/6 YA Branch at the headquarters, and is conducted at the sustainment center within SMC/IN for collateral programs and SMC/SYEI for Special Access Programs. The ISA report is included as an appendix in the AoA final report.

### *7.10.4 Lessons Learned*

Lessons learned during the planning and conduct of the AoA should be recorded by the study team. This information can be beneficial to other study teams involved in planning or conducting a study as well as future study teams. Some examples of lessons learned from the past that have led to best practices outlined in this handbook include the following:

- Meet regularly either in person or virtually,
- Decision-maker buy-in at all levels is critical,
- Things will change; documentation and open and consistent communication is critical.

## 7.11 Review and Staffing

The review and staffing requirements will depend on the specific program. Timing for the reviews and staffing requirements must be negotiated between the study sponsor, study team, OAS advisor, and HAF/A5R-P. Ideally, OAS reviews the final report and briefing, and provides feedback to the study director and team throughout their development. After appropriate SRG and SAG reviews of the final report and final report briefing, the study director provides the documents to OAS for a formal review and assessment. After the formal review, OAS provides an assessment of the final report to the study team, AFGK, CDWG, and AFCDC.[85] The final report is reviewed by the CFL or lead command before it is

[84] The AFLCMC/21st Intelligence Squadron is located at Wright-Patterson Air Force Base.

[85] See Appendix I for the AoA final report assessment criteria used by OAS.

reviewed by the AFGK and CDWG and approved by the AFCDC.[86] After AFCDC (or higher) approval, the final report is released, if required, to the OSD(CAPE) for a sufficiency review (see DoDI 5000.02 and DoDD 5105.84 for details concerning the OSD(CAPE) assessment of AoAs) before the Defense Acquisition Board (DAB).[87] Additional staffing may be required based on the JSD for the effort. For example, an AoA final report with JROC Interest will likely be reviewed by the FCB, JCB, and JROC. The study director should discuss the review and staffing requirements with OAS and HAF/A5R-P.

[86] See the A5R Guidebook for the CDWG and AFCDC AoA final report review criteria.

[87] Appendix K (OSD(CAPE) AoA Study Guidance Template) not only provides the study guidance format and content requirements, but also OSD(CAPE) expectations of the AoA. Some examples of these expectations include: provide an understanding of why options do well or poorly; address non-operational risks with the same level of rigor as operational risks; identify practical risk mitigation strategies; and identify estimated schedules for each alternative. When developing the final report, the study director should review this template and use it to assess whether the final report will meet OSD(CAPE) expectations.

# Appendix A: Acronyms and Terms

| | |
|---|---|
| ACAT | Acquisition Category |
| ACEIT | Automated Cost Estimating Integrated Tools |
| ACC | Air Combat Command |
| ACCRB | ACC Requirements Board |
| ACCROC | Air Combat Command Requirements Oversight Council |
| AETC | Air Education and Training Command |
| AF | Air Force |
| AFCAA | Air Force Cost Analysis Agency |
| AFCDC | Air Force Capability Development Council |
| AFGK | Air Force Gatekeeper |
| AFGSC | Air Force Global Strike Command |
| AFI | Air Force Instruction |
| AFLCMC | Air Force Life Cycle Management Center |
| AFMC | Air Force Materiel Command |
| AFMCPAM | Air Force Materiel Command Pamphlet |
| AFOTEC | Air Force Operational Test and Evaluation Center |
| AFPAM | Air Force Pamphlet |
| AFPD | Air Force Policy Directive |
| AFRB | Air Force Review Board |
| AFSAT | Air Force Standard Analysis Toolkit |
| AFSOC | Air Force Special Operations Command |
| AFSPC | Air Force Space Command |
| AFTL | Air Force Task List |
| AMC | Air Mobility Command |
| AoA | Analysis of Alternatives |
| APA | Additional Performance Attributes |
| APUC | Average Procurement Unit Cost |

| | |
|---|---|
| ASD | Assistant Secretary of Defense |
| ASD(A) | Assistant Secretary of Defense for Acquisition |
| ASD(R&E) | Assistant Secretary of Defense for Research and Engineering |
| AT&L | Acquisition, Technology, and Logistics |
| ATD | Advanced Technology Demonstration |
| BCS | Baseline Comparison System |
| BR | Break Rate |
| BY | Base Year |
| C2 | Command and Control |
| CAE | Component Acquisition Executive |
| CAF | Combat Air Forces |
| CAIV | Cost As an Independent Variable |
| CAPE | Cost Assessment and Program Evaluation |
| CARD | Cost Analysis Requirements Document |
| CAWG | Cost Analysis Working Group |
| CBA | Capabilities-Based Assessment |
| CCA | Cost Capability Analysis |
| CCTD | Concept Characterization and Technical Description |
| CDD | Capability Development Document |
| CDWG | Capability Development Working Group |
| CER | Cost Estimating Relationship |
| CES | Cost Element Structure |
| CFL | Core Function Lead (formerly known as the Core Function Lead Integrator (CFLI)) |
| CFSP | Core Function Support Plan (formerly known as Core Function Master Plan (CFMP)) |
| CFT | Core Function Team |
| CJCS | Chairman of the Joint Chiefs of Staff |
| CJCSI | Chairman of the Joint Chiefs of Staff Instruction |
| CLS | Contractor Logistic Support |
| COCOM | Combatant Command |

| | |
|---|---|
| CONEMP | Concept of Employment |
| CONOPS | Concept of Operations |
| CONPLAN | Concept Plan |
| CPD | Capability Production Document |
| CSAF | Chief of Staff of the Air Force |
| CURA | Cost Uncertainty/Risk Analysis |
| DAB | Defense Acquisition Board |
| DAE | Defense Acquisition Executive |
| DAU | Defense Acquisition University |
| DCAPE | Director of Cost Assessment and Program Evaluation |
| DCR | DOTmLPF-P Change Recommendation |
| DIR | Derived Intelligence Requirement |
| DLR | Depot Level Reparable |
| DoD | Department of Defense |
| DoDAF | Department of Defense Architecture Framework |
| DoDD | Department of Defense Directive |
| DoDI | Department of Defense Instruction |
| DOT&E | Director, Operational Test and Evaluation |
| DOTMLPF-P | Doctrine, Organization, Training, Materiel, Leadership and Education, Personnel, Facilities, and Policy |
| DOTmLPF-P | Doctrine, Organization, Training, materiel, Leadership and Education, Personnel, Facilities, and Policy (in this version of the acronym, “m” refers to existing materiel in the inventory) |
| DP | Development Planning |
| DPS | Defense Planning Scenario |
| DTIC | Defense Technical Information Center |
| DTM | Directive-Type Memorandum |
| EAWG | Effectiveness Analysis Working Group |
| ECWG | Employment Concepts Working Group |
| EMD | Engineering and Manufacturing Development |

| | |
|---|---|
| FBCE | Fully Burdened Cost of Energy |
| FCB | Functional Capability Board |
| FFRDC | Federally Funded Research and Development Center |
| FOC | Full Operational Capability |
| FoS | Family-of-Systems |
| FR | Final Report |
| FRP | Full Rate Production |
| FY | Fiscal Year |
| FYDP | Future Years Defense Program |
| GAO | Government Accountability Office |
| GRC&As | Ground Rules, Constraints, and Assumptions |
| HAF | Headquarters Air Force |
| HPT | High Performance Team |
| HSI | Human Systems Integration |
| IBS | Inputs-Based Simulation |
| ICD | Initial Capabilities Document |
| ICS | Interim Contractor Support |
| IIPT | Integrating Integrated Product Team |
| IMD | Intelligence Mission Data |
| IN | Intelligence |
| INO | Intelligence Squadron, Early Acquisitions Office |
| IOC | Initial Operational Capability |
| IRSS | Information and Resource Support System |
| ISA | Intelligence Supportability Analysis |
| ISC | Integrated Security Construct |
| ISR | Intelligence, Surveillance, and Reconnaissance |
| ITAB | Information Technology Acquisition Board |
| JCA | Joint Capability Area |
| JCB | Joint Capability Board |

| | |
|---|---|
| JCIDS | Joint Capabilities Integration and Development System |
| JCS | Joint Chiefs of Staff |
| JCTD | Joint Concept Technology Demonstration |
| JMETL | Joint Mission-Essential Task List |
| JROC | Joint Requirements Oversight Council |
| JS | Joint Staff |
| JSD | Joint Staffing Designator |
| KM/DS | Knowledge Management/Decision Support |
| KPP | Key Performance Parameter |
| KSA | Key System Attribute |
| LCC | Life Cycle Cost |
| LCCE | Life Cycle Cost Estimate |
| LCOM | Logistics Composite Model |
| LRIP | Limited Rate Initial Production |
| LRU | Line Replaceable Unit |
| M&S | Modeling and Simulation |
| MA | Materiel Availability |
| MAIS | Major Automated Information System |
| MAJCOM | Major Command |
| MDA | Milestone Decision Authority |
| MDAP | Major Defense Acquisition Program |
| MDD | Materiel Development Decision |
| MER | Manpower Estimate Report |
| METL | Mission-Essential Task List |
| MILCON | Military Construction |
| MILPERS | Military Personnel |
| MOE | Measure of Effectiveness |
| MOP | Measure of Performance |
| MOS | Measure of Suitability |

| | |
|---|---|
| MRL | Manufacturing Readiness Level |
| MSA | Materiel Solution Analysis |
| MSFD | Multi-Service Force Deployment |
| MT | Mission Task |
| MTBCF | Mean Time Between Critical Failure |
| MTBM | Mean Time Between Maintenance |
| NACA | Non-Advocate Cost Assessment |
| NDAA | National Defense Authorization Act |
| NIPRNet | Non-classified Internet Protocol Router Network |
| O | Objective |
| O&S | Operations and Support |
| OAS | Office of Aerospace Studies |
| OBS | Outputs-Based Simulation |
| OCWG | Operational Concepts Working Group |
| OGC | Other Government Cost |
| OIPT | Overarching Integrated Product Team |
| OPLAN | Operation Plan |
| OSA | Other System Attribute |
| OT&E | Operational Test and Evaluation |
| OSD | Office of the Secretary of Defense |
| OUSD | Office of the Under Secretary of Defense |
| P3I | Pre-Planned Product Improvement |
| PBL | Performance Based Logistics |
| PEO | Program Executive Officer |
| POM | Program Objective Memorandum |
| PPBE | Planning, Programming, Budgeting, and Execution |
| R&D | Research and Development |
| R&E | Research and Engineering |
| RAF | Risk Assessment Framework |

| | |
|---|---|
| RAWG | Risk Assessment Working Group |
| RDT&E | Research, Development, Test and Evaluation |
| RFI | Request For Information |
| RFP | Request For Proposal |
| RMG | Risk Management Guide (DoD Risk, Issue, and Opportunity Management Guide for Defense Acquisition Programs) |
| RSR | Requirements Strategy Review |
| S&ST | Strategic and Tactical Systems |
| S&T | Science and Technology |
| SAF | Secretary of the Air Force |
| SAG | Study Advisory Group |
| SBM | Scenario-Based Method |
| SDB | Small Diameter Bomb |
| SE | Systems Engineering |
| SEP | Systems Engineering Plan |
| SETA | Scientific, Engineering, Technical, and Analytical |
| SG | Study Guidance |
| SIL | System Integration Labs |
| SLEP | Service Life Extension Program |
| SIPRNet | Secure Internet Protocol Router Network |
| SME | Subject Matter Expert |
| SoS | System-of-Systems |
| SP | Study Plan |
| SRG | Senior Review Group |
| SSA | Support for Strategic Analysis |
| T | Threshold |
| TAWG | Technology and Alternatives Working Group |
| TDS | Technology Development Strategy |
| TEMP | Test and Evaluation Master Plan |

| | |
|---|---|
| TES | Test and Evaluation Strategy |
| TMRR | Technology Maturation and Risk Reduction |
| TOC | Total Ownership Cost |
| TRA | Technology Readiness Assessment |
| TRL | Technology Readiness Level |
| TSWG | Threats and Scenarios Working Group |
| TTP | Tactics, Techniques, and Procedures |
| TTS | Target Template Set |
| TY | Then Year |
| UJTL | Universal Joint Task List |
| US | United States |
| USC | United States Code |
| USD | Under Secretary of Defense |
| V&V | Verification and Validation |
| VCSAF | Vice Chief of Staff of the Air Force |
| VV&A | Verification, Validation, and Accreditation |
| WBS | Work Breakdown Structure |
| WIPT | Working Integrated Product Team |
| WSARA | Weapon Systems Acquisition Reform Act |
| WSR | Weapon System Reliability |

# Appendix B: References and Information Sources


AF/A5R Capability Development Guidebook, Volume 1 - Air Force Implementation of the JCIDS Deliberate Process.

AFH 33-337, *The Tongue and Quill*.

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**Websites:**

Contract Studies Registry Program

Joint Lessons Learned Information System: NIPRNET, https://www.jllis.mil/usaf SIPRNET, http://www.jllis.smil.mil/usaf

DTIC: www.dtic.mil

Information and Resource Support System (IRSS): https://www.my.af.smil.mil/IRSS/irss7/pkg_portal.prc_main (requires SIPRNet Air Force Portal account, as well as permission from HAF/A5R)

Defense Acquisition University (ACQuipedia): https://dap.dau.mil/acquipedia/Pages/ArticleDetails.aspx?aid=d5461b4c-2887-4be8-8cd9-b09920308670 and https://dap.dau.mil/acquipedia/Pages/Search.aspx?q=AoA

Department of Defense Chief Information Officer Website: http://dodcio.defense.gov/Library/DoDArchitectureFramework.aspx

Better Buying Power: http://bbp.dau.mil/

Rand Corp: www.rand.org

The Knowledge Management/Decision Support system (KM/DS): For instructions go to the JCIDS NIPRNet page: https://intellipedia.intelink.gov/wiki/JCIDS

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# Appendix C: Examples of Initial Questions for the WIPT Lead

| Topics | Questions |
|---|---|
| Experience, Background | What is your experience with conducting or participating in Analyses of Alternatives? With other requirements studies? What is your background (Air Force Specialty Code (AFSC), past assignments, accomplishments)? What is your current job title and what responsibilities do you have? |
| Mission Area Knowledge | What is known about the mission area under study? What background documentation exists? Was there a CBA that directly led to this? Other analyses? What JCIDS documents exist? |
| OAS Familiarity | How familiar are you with OAS? What are your expectations of OAS throughout the study? How do you envision OAS involvement and assistance? Would you like AoA training for your study team? |
| OAS AoA Handbook Knowledge | Do you have a copy of the OAS AoA Handbook? Are you familiar with it? Do you need other documents from OAS such as the CBA, Measures Development, Survey Research, or HPT Facilitation Handbooks? |
| WIPT Familiarity | How familiar are you with a Working Integrated Product Team? Have you ever served as a leader or member of a WIPT? If so, what WIPT(s)? |
| Guidance/Process Knowledge | How familiar are you with the JCIDS manual, DoD 5000.02, the A5R Capability Development Guidebook, and other guidance relevant to your area of study? Do you have any questions regarding the JCIDS process or conducting an AoA? |
| Air Staff Engagement | Have you spoken with the functional representative at HAF/A5R? If so, who? Have you talked to anyone else in the Air Staff? If so, who? What do they want from the study? Have they articulated any issues, key questions, scope, or other study requirements? |
| Concept Development | What concepts will you consider for development? Why these? Where did they come from? How mature are the concepts? Are you familiar with the CCTD process? What is the stage of development of the initial CCTDs? |
| OSD(CAPE and/or AT&L) Engagement | Have you talked to anyone at OSD(CAPE) or OUSD(AT&L)? What do they want from the study? Have they articulated any issues, key questions, scope, or other requirements? |
| MAJCOM Engagement | What other directorates/divisions/offices in your MAJCOM have you collaborated with regarding this AoA study? What do they want from the study? Have they articulated any issues, key questions, scope, or other study requirements? |
| Stakeholders | What organizations do you think are stakeholders? What efforts have been made to contact them? What specific issues or concerns have been expressed by any of the stakeholders? Which stakeholders should have membership in special or oversight groups (SRG or SAG)? |
| WIPT Goals | What are the goals of the WIPT (i.e., develop draft document, develop final document)? How many days do you think are needed for the WIPT event? What administrative support do you have? What assistance do you need in planning and arranging the WIPT event? |
| WIPT Members | What organizations should have WIPT membership? How many members do you think you need for the WIPT? Who have you already invited for WIPT membership? Who are you considering for WIPT membership? What experience do the selected members and those you are considering have in conducting an AoA? What expertise do they have? What expertise is needed? What assistance do you need from OAS in forming the WIPT? |

| Topics | Questions |
|---|---|
| AoA Study Schedule and MDA/MDD | What is the projected schedule or timeline for this study? What is the coordination timeline/process for this study? Who is the MDA? Has the MDD been scheduled? If no, when do you anticipate the MDD taking place? What has been accomplished in preparing for the MDD? AFRB? SAF/AQR review/approval? How much of the MDD entry criteria have you met? |
| AoA Study Team | Have you thought about key organizations (or people) you will need on the AoA team? What specific skills are needed? Are there organizations that need to participate for political reasons? Who are the key people who have been involved in the effort to date? Based upon this, who do you need to have on the WIPT? |
| Funding | Do you have funding for the WIPT? The AoA? To the next milestone? |

# Appendix D: WIPT Task Assignments

**Table D-1: AoA Study Guidance Development (Short Version Example)**

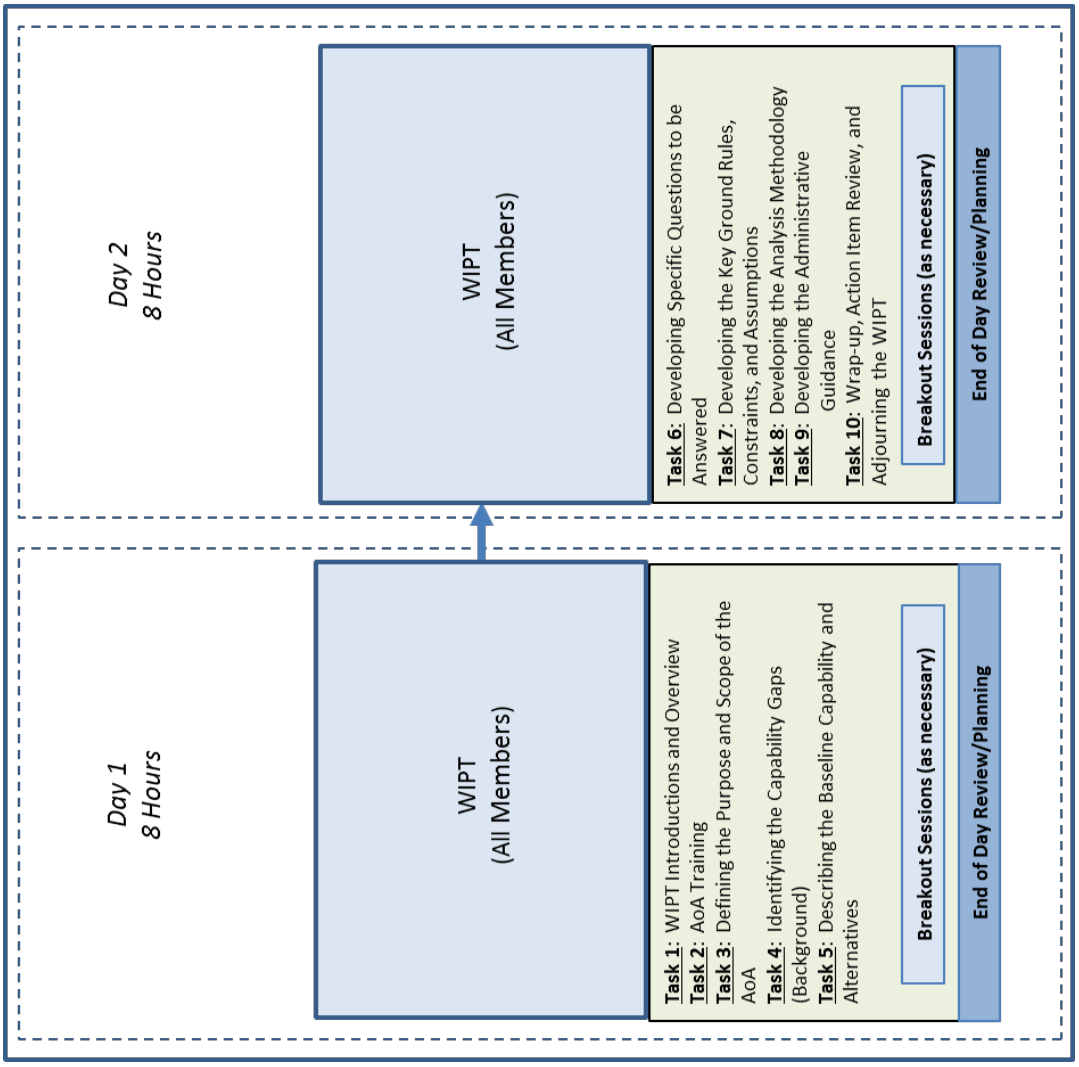


**Table D-1: AoA Study Guidance Development (Long Version Example)**

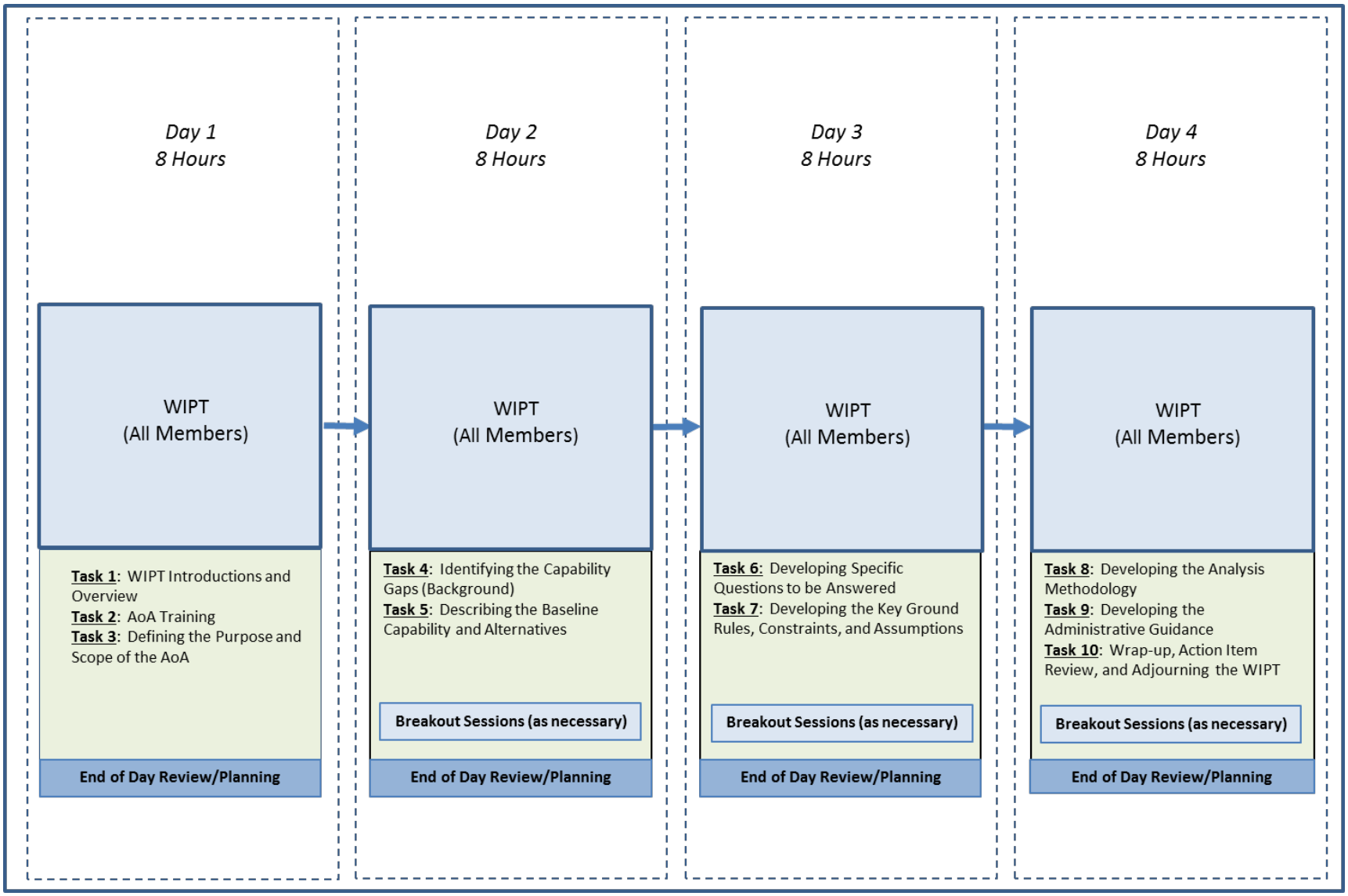
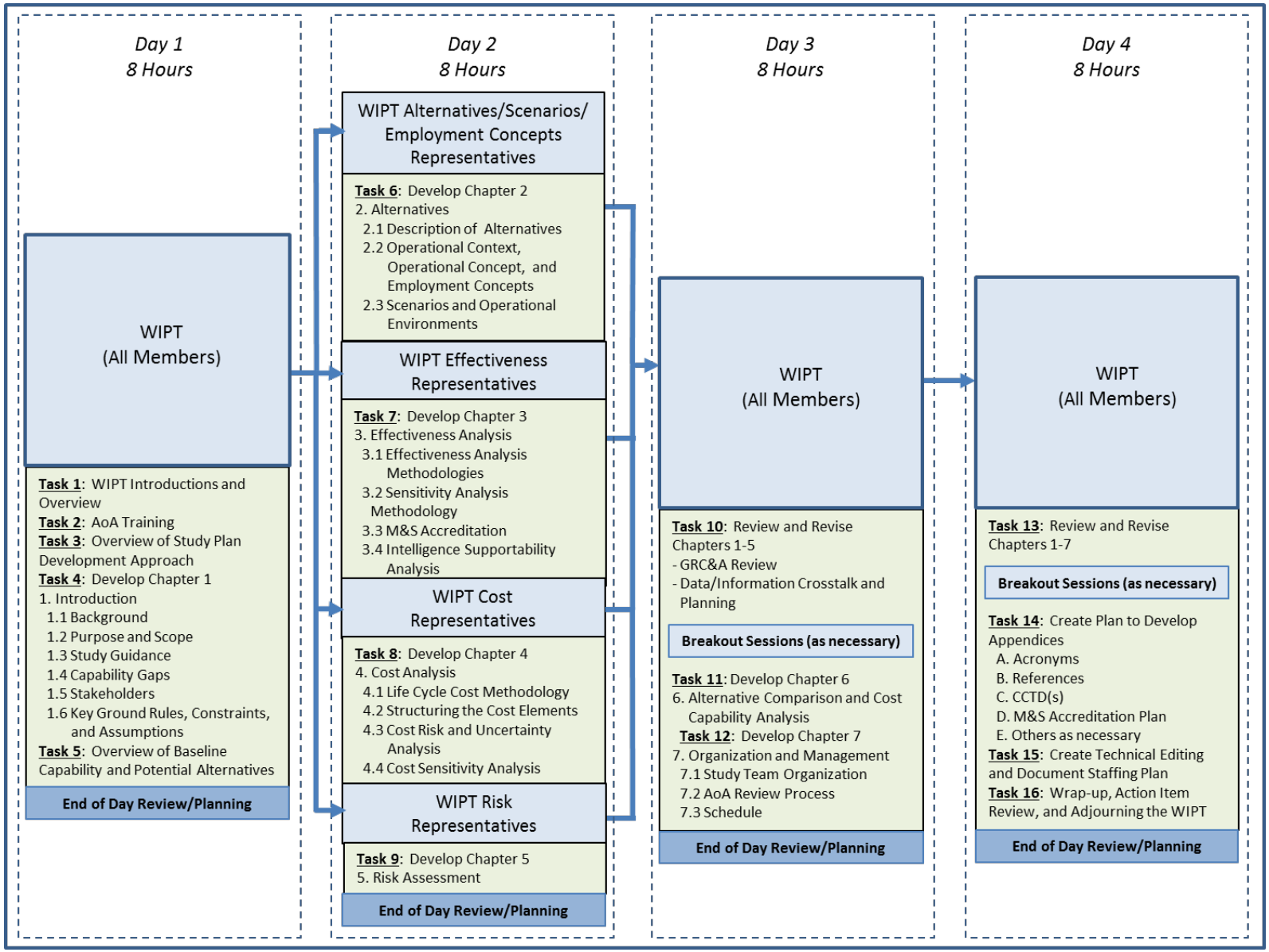


**Table D-2: AoA Study Plan Development (Short Version Example)**



## Table D-3: AoA Study Plan Development (Long Version Example)

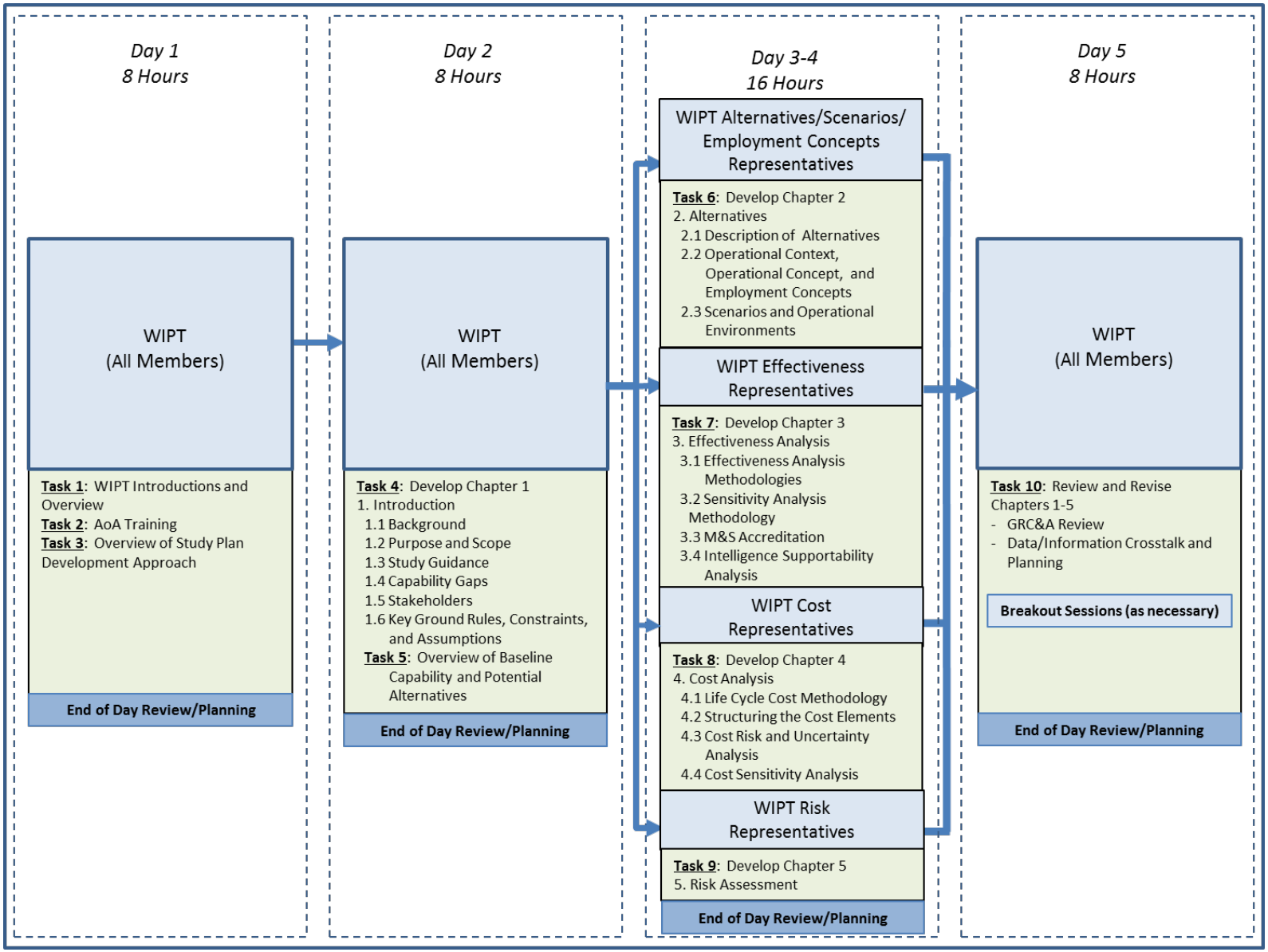
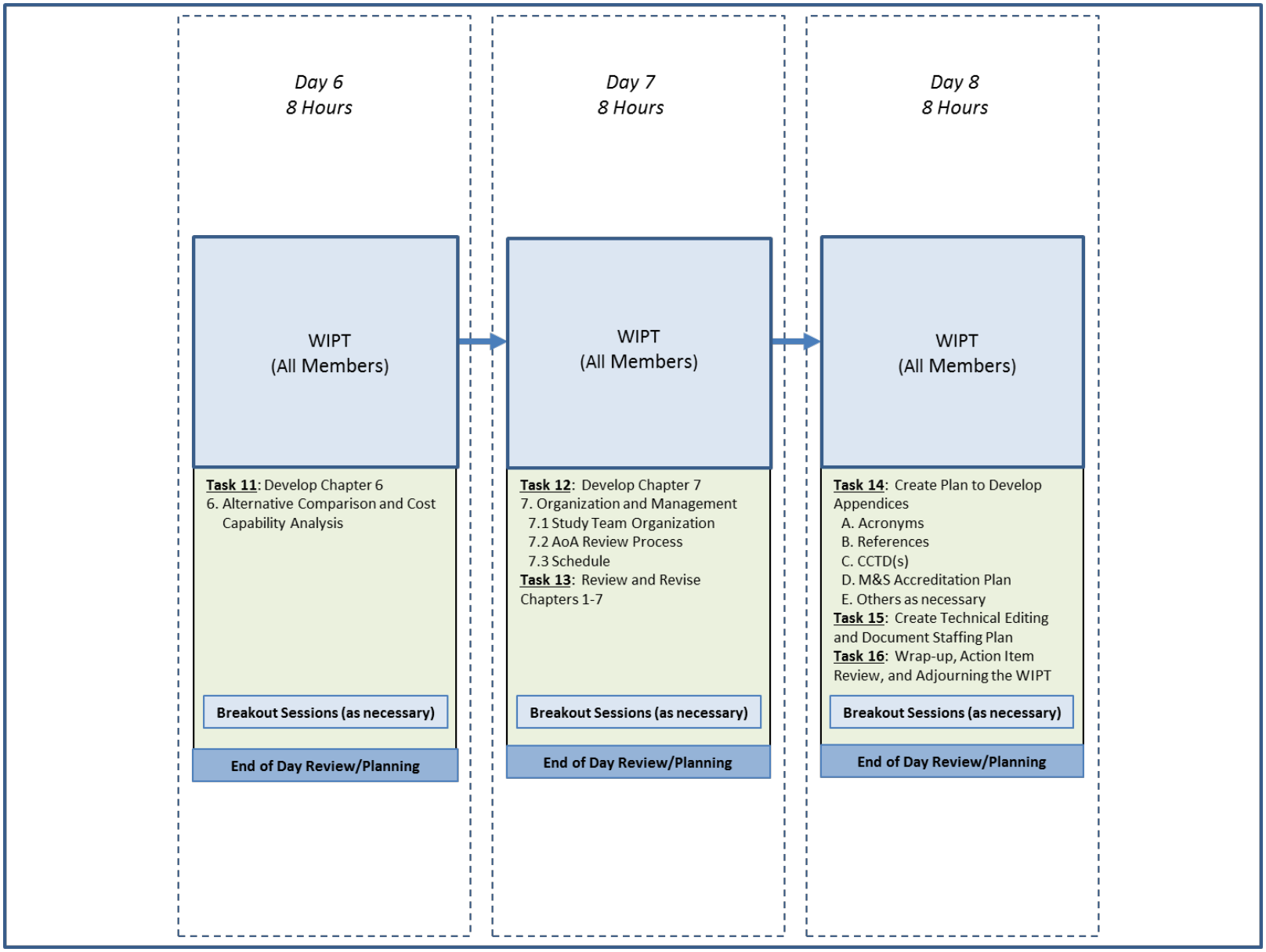


**Table D-4 continued**



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# Appendix E: Assessing Suitability in the AoA

**Introduction**

Acquiring systems that are both effective in meeting mission requirements and sustainable at lower total ownership costs continues to be a top priority in the Air Force. Early decisions in the acquisition life cycle have long-term suitability implications that impact costs and mission effectiveness. Since most of the life cycle costs of a program are locked-in early during the technology development phase, it is important to address suitability early in the acquisition process. The early stages of the acquisition process provide the best opportunity to maximize potential suitability and mission capability. Accordingly, suitability should be addressed in the AoA to ensure Air Force senior leaders make informed decisions that result in suitable and effective systems that meet mission requirements.

**What is Suitability?**

The Defense Acquisition Guidebook (DAG) contains this definition of operational suitability: "The degree to which a system can be placed satisfactorily in field use with consideration given to availability, compatibility, transportability, interoperability, reliability, wartime usage rates, maintainability, safety, human factors, manpower supportability, logistics supportability, natural environmental effects and impacts, documentation, and training requirements."

Sustainability (a part of suitability) is a system's capability to maintain the necessary level and duration of operations to achieve military objectives. Sustainability depends on ready forces, materiel, and consumables in enough quantities and working order to support military efforts. Sustainability encompasses a wide range of elements such as systems, spare parts, personnel, facilities, documentation, and data. Suitability (and sustainability) performance not only impacts mission capability, but is also a major factor that drives the life cycle cost of a system. A system with suitability issues such as maintainability problems, for example, could considerably increase life cycle costs by increasing the number of maintainers needed to sustain a system in the field. In other situations, significant Human System Integration (HSI) issues may increase an operator's workload, or poor reliability performance could result in low operational availability.

**Defining the Maintenance Concept and Product Support Strategy**

Defining how alternatives will be employed in the operational environment is an essential step in conducting the suitability analysis in the AoA. The concept of employment (CONEMP) for each alternative should be defined in the CCTD document and include descriptions of the projected maintenance concept and product support strategy. Given that the alternatives are primarily developmental or conceptual at this early stage of the life cycle, defining the maintenance concept and product support strategy can be challenging and may require the assistance of system engineers and acquisition logistics, maintenance, supply, and transportation specialists. In some situations, the maintenance concept and product support strategy may be based on similar existing systems that are relevant to the alternatives being considered in the AoA. In situations where the alternative systems are new concepts, there may not be any existing systems that are sufficiently similar to use in defining the maintenance concept and product support strategy. In these cases, assistance from system engineers

and other logistics specialists to help define the maintenance concept and product support strategy is particularly important.

The maintenance concept is a general description of the maintenance tasks required in support of a given system or equipment and the designation of the maintenance level for performing each task. The maintenance concept is eventually implemented through a Life Cycle Sustainment Plan. As an example, assume the "system" is a computer, with a CPU, keyboard, and mouse. The maintenance concept for this system is a two-level concept, organizational and depot. The organizational level maintenance will restore the computer to service by the removal and replacement of the Line Replaceable Units (LRU) (e.g., the CPU, mouse, and keyboard). The organizational level will forward the failed LRU to the depot for repair by removal or replacement of failed assemblies, subassemblies, or parts based on economic criteria (i.e., repair or discard).

Product support consists of the management and technical activities and resources needed to implement the maintenance concept, and establish and maintain the readiness and operational capability of a weapon system, its subsystems, and its sustainment infrastructure. Product support encompasses materiel management, distribution, technical data management, maintenance, training, cataloging, configuration management, engineering support, repair parts management, failure reporting and analyses, and independent logistics assessments.

Product support is implemented by the Performance-based Logistics (PBL) strategy which seeks to optimize system availability while minimizing cost and the logistics footprint. The PBL strategy should be tailored to fit the individual system in the intended operational environment for the duration of its projected service life. The PBL strategy defines performance in terms of military objectives using criteria such as operational availability, operational reliability, total cost, logistics footprint, and logistics response time. PBL applies to both retail (base or organizational level) logistics operations and wholesale (depot) logistics operations. While the provider of the support may be public, private, or a public-private partnership, the focus is to achieve maximum weapon system availability at the lowest Total Ownership Cost (TOC).

**Suitability Performance, Cost, and Risk**

The suitability of materiel solutions should be analyzed in the AoA in terms of performance, cost, and risk. The following provides key methodological insights into the analysis of suitability with respect to performance, cost, and risk. More detailed information can be found in the reference sources listed at the end of this section.

***Suitability Performance Analysis***

The AoA provides the analytic basis for establishing an initial set of performance measures associated with concepts of suitability such as reliability, availability, and maintainability. These measures are referred to as measures of suitability (MOS) and are designed to measure a system's capability to support mission accomplishment. MOSs are essential for conducting the suitability analysis and should address suitability related performance requirements identified or implied in previous studies such as Capabilities-Based Assessments (CBAs) and requirements documents such as the Initial Capabilities

Document (ICD). The analyst should consider the suitability attributes described in Table E-1 in developing the MOSs.

**Table E-1: Suitability Concepts/Attributes**

| Concept/ Attribute | Description |
|---|---|
| Availability | A measure of the degree to which the segment (launch, space, control, and user) is in an operable and committable state at the start of a mission when the mission is called for at any (random) time. (AFPAM 63-128) |
| Availability (Material) | A measure of the percentage of the total inventory of a system operationally capable (ready for tasking) of performing an assigned mission at a given time, based on materiel condition. (JCIDS Manual) |
| Availability (Operational) | $A_o$ is the probability that a system can be used for any specified purpose when desired. It includes both the inherent R&M parameters and logistics support effectiveness of the system that relates to the total time the system might be desired for use. (AFOTECPAM 99-104) |
| Availability (Stock) | $A_s$ is the probability a system or weapon's specified resources are available for use (not in the repair pipeline) over a storage life at a random point in time. (AFPAM 63-128) |
| Compatibility | The capability of two or more items or components of equipment or material to exist or function in the same system or environment without mutual interference. (JP 1-02) The capability of a system to be operated, maintained, and resupplied by persons wearing a full complement of individual protective equipment, in all climates for which the system is designed, and for the period specified in the capabilities documents. (AFOTECPAM 99-104) |
| Transportability | The capability of material to be moved by towing, self-propulsion, or carrier through any means such as railways, highways, waterways, pipelines, oceans, space, and airways. (Joint Publication 1-02, DoD Dictionary of Military and Associated Terms) |
| Interoperability | The ability of systems, units, or forces to provide services to and accept services from other systems, units, or forces and to use the services so exchanged to enable them to operate effectively together. (AFOTECPAM 99-104) |
| Reliability | The ability of a system and its parts to perform its mission without failure, degradation, or demand on the support system. (DAG) |

| Concept/ Attribute | Description |
|---|---|
| Wartime Usage Rates | The quantitative statement of the projected manner in which the system is to be used in its intended wartime environment. (*DOT&E Operational Suitability Guide, Volume I – A Tutorial*) |
| Maintainability | The ability of an item to be retained in or restored to specified condition when maintenance is performed by personnel having specified skill levels, using prescribed procedures and resources, at each prescribed level of maintenance and repair. (AFPAM 63-128) |
| Safety | Freedom from conditions that can cause death, injury, occupational illness, damage to or loss of equipment or property, or damage to the environment (*DOT&E Operational Suitability Guide, Volume I – A Tutorial*). Promotes system design characteristics and procedures to minimize the potential for accidents or mishaps that: cause death or injury to operators, maintainers, and support personnel; threaten the operation of a system; or cause cascading failures in other systems. (Human Systems Integration Requirements Pocket Guide, USAF Human Systems Integration Office) |
| Human Factors (Human Systems Integration) | A body of scientific facts about human characteristics. The term covers all biomedical and psychological considerations; it includes, but is not limited to, principles and applications in the areas of human engineering, personnel selection, training, life support, job performance aids, and human performance evaluation. (AFOTECPAM 99-104) Includes the integrated and comprehensive analysis, design, and assessment of requirements, concepts, and resources for system manpower, personnel, training, environment, safety, occupational health, habitability, survivability, and human factors engineering. (A5R Guidebook) |
| Manpower Supportability | The identification and acquisition of military and civilian personnel with the skills and grades required to operate and support a material system over its lifetime at peacetime and wartime rates. ("Memorandum of Agreement on Multi-Service Test & Evaluation and Operational Suitability Terminology and Definitions") |
| Logistics Supportability | The degree to which the planned logistics support allows the system to meet its availability and wartime usage requirements. Planned logistics support includes the following: test, measurement, and diagnostic equipment; spare and repair parts; technical data; support facilities; transportation requirements; training; manpower; and software. (DAG) |
| Natural Environmental | Environment—Used as a general reference, environment includes the generic natural environment; e.g., weather, climate, ocean conditions, terrain, and vegetation. Environment includes those conditions observed by the system during |

| Concept/ Attribute | Description |
|---|---|
| Effects and Impacts | operational use, standby, maintenance, transportation, and storage. (AFOTECPAM 99-104) This includes air, water, land, space, cyberspace, markets, organizations, living things, built infrastructure, cultural resources, and the interrelationships that exist among them. Environmental considerations may affect the concept of operations and requirements to protect systems from the environment and to protect the environment from system design, manufacturing, operations, sustainment, and disposal activities. (Human Systems Integration Requirements Pocket Guide, USAF Human Systems Integration Office)<br><br>Environmental Effects—The effects of the natural environment on the system. For example, corrosion is a natural environmental effect caused by weather and ocean conditions. ("Memorandum of Agreement on Multi-Service Operational Test and Evaluation and Operational Suitability Terminology and Definitions")<br><br>Environmental Impacts—The system's impact on the natural environment as a result of its operational use, maintenance, transportation and storage. For example, impacts include pollution (noise, air, and water), threat to endangered species, and threat to public health. ("Memorandum of Agreement Multi-Service Operational Test and Evaluation and Operational Suitability Terminology and Definition") |
| Documentation | Comprises operator and maintenance instructions, repair parts lists, and support manuals, as well as manuals related to computer programs and system software. (AFOTECPAM 99-104) |
| Training and Training Support | The processes, procedures, techniques, training devices, and equipment used to train civilian and active duty and reserve military personnel to operate and support a materiel system. (AFOTECPAM 99-104) |
| Deployability | A function of system reliability, characteristics of required maintenance equipment, processes that support the flow of required spares and support equipment, and the maintenance concept. Deployability can be expressed as required airlift to support deployment of initial and follow-on support elements, numbers of personnel required for setup and operation of any equipment (air, power, etc.), and the amount of resupply. (AFPAM 63-128) |
| Occupational Health | Promotes system design features and procedures that serve to minimize the risk of injury, acute or chronic illness, or disability; and enhance job performance of personnel who operate, maintain, or support the system. (Human Systems Integration Requirements Pocket Guide, USAF Human Systems Integration Office) |

The analyst must consider various factors such as the study questions and objectives, the maturity of the alternative concepts, and data availability when selecting measures for the analysis. For example, emerging or developmental systems may not have sufficient data to measure certain aspects of suitability. Given these factors, the analyst must use some judgment in determining whether the selected measures are sufficient for conducting the suitability performance analysis.

The description of the MOSs should include the supported mission task, attribute, measure statement, criteria, and data information.[88] Table E-2 provides an example of a suitability task and its associated measure parameters. At a minimum, the measure criteria should identify the threshold standard (i.e., the minimum acceptable operational value of a system capability or characteristic below which the utility of the system becomes questionable) and if necessary, an objective standard (i.e., an operationally significant increment above the threshold). An objective value may be the same as the threshold when an operationally significant increment above the threshold is not identifiable.

**Table E-2: Measure of Suitability Description Example**

| Mission Task | Attribute | Measure | Metric | Criteria (Threshold) | Data |
|---|---|---|---|---|---|
| Manage and Sustain Network | Availability (Operational) | Operational availability (MOS/KPP) | Percent | ≥ 97% | Time between downing events, total down time |
| | Dependability | Operational dependability (MOS) | Percent | ≥ 99% | Time between critical failure, time to restore functions after critical failure |
| | Reliability (Mission) | Time between critical failure (MOS/KSA) | Mean (MTBCF) | ≥ 4500 hours | Number of critical failures, number of operating hours |
| | Maintainability | Downtime (MOS) | Mean (MDT) | ≤ 3 minutes | Total downtime, number of critical failures |
| | | Time to restore functions (MOS) | Mean (MTTRF) | ≤ 45 minutes | Total critical restore time, number of critical failures |

Analysts typically rely on a combination of study methods to collect and analyze data and assess the suitability of alternative systems. Selection of the study method depends largely on the data requirements, availability of applicable tools or techniques, and the maturity and specificity of the alternatives. Several commonly used methods are described below:

Modeling and Simulation (M&S): A model is a physical, mathematical, or logical representation of a system, entity, phenomenon, or process that allows for investigation of the properties of the system. A simulation is a method for implementing a model over time. M&S offers several advantages such as repeatability and control since events can be replicated under controlled conditions.

An example of M&S that has been used to analyze suitability of systems is the Logistics Composite Model (LCOM). LCOM is an Air Force Standard Analysis Toolkit (AFSAT) model used to identify the

[88] For more information about measures of suitability, see *The Measures Handbook*, OAS.

best mix of logistical resources to support a given weapon system under certain operational constraints (e.g., aircraft sortie rates, maintenance and supply policies, manpower levels, and spare part quantities). Logistics resources include manpower, spare parts, support equipment, and facilities. The supportability of design alternatives can be evaluated by varying the reliability and maintainability characteristics of the components and tasks contained in the database. The impact of policy decisions (e.g., organizational, maintenance concepts, and personnel) upon resource requirements or sortie generation capability can be analyzed as well.

Alternative Characterization: Also referred to as "concept characterization," this method uses data and information gleaned from CCTD documents, Requests for Information (RFI), and other documents (e.g., reports, studies, and analyses). Once verified by the analyst, the data and information can be used in various ways. For example, data may be used as inputs to parametric, statistical, or simulation models (e.g., altitude and range parameters are used along with other variables as inputs to a model to determine survivability of a system). Other possible uses of the data and information include resolving measures (e.g., the number of 463L pallet positions required for transport of an alternative identified in the CCTD is used to determine whether the alternative meets the two pallet position threshold standard for transport) as well as identifying operational, technical, and programmatic risks associated with suitability.

Expert Elicitation: Expert elicitation is a structured approach for gathering subject matter expert judgment and answering questions concerning issues or problems of interest in a study. Since expert judgment is affected by the approach used to gather it, a specially designed process is required that includes procedures for developing questions, conducting the elicitation, and handling biases that may arise. Although the process is formal and structured, it can differ in terms of the degree of interaction between experts, level of detail in information elicited, number of meetings, type(s) of communications method(s), and degree of structure in the elicitation process. Individual or group interviews are commonly used to elicit the information.

Expert elicitation is particularly useful for collecting information from subject matter experts regarding the deployability, transportability, and maintainability of alternatives. For example, after reviewing technical and design information associated with each alternative, maintenance experts are asked to answer a series of questions on the ease of maintainability of critical components of each alternative.[89]

Comparative Analysis: The purpose of the comparative analysis it to select or develop a Baseline Comparison System (BCS) that represents characteristics of the new system for projecting supportability related parameters, making judgments concerning the feasibility of the new system's supportability parameters, and determining the supportability, cost, and readiness drivers of the new system.

[89] For more information about expert elicitation, see the *Survey Research Handbook: Using Survey Research in the Operational Capability Requirements Study*, OAS.

A BCS may be developed using a composite of elements from different existing systems when a composite most closely represents the design, operation, and support characteristics of a new system alternative. The analysis requires the use of experience and historical data on similar existing systems that are relevant to the materiel solutions being considered in the AoA. If support parameters (e.g., resupply time, turnaround times, transportation times, and personnel constraints) are to be projected, then current systems (support systems) which are similar to the new system's support concept must be identified. This may be a support system completely different than the one supporting systems with similar design characteristics.

The level of detail required in describing comparative systems will vary depending on the amount of detail known about the new system's design, operational, and support characteristics and the accuracy required in the estimates for new system parameters. Early in the system life cycle, when the design concept for the new system is very general, only a general level comparative system description should be established. For this preliminary analysis, the analyst should identify existing systems and subsystems (hardware, operational, and support) useful for comparative purposes with new system alternatives. The results of the analyses can help identify supportability, cost, and readiness drivers of each significantly different new system alternative.

***Suitability Risk Assessment***

The design, maintenance concept, product support strategy, support system design, and availability of support data and resources are significant sources of risk to the suitability of a system. Risks associated with suitability should be assessed early in the acquisition since failing to do so could cause significant consequences in the program's latter phases.

The risk assessment of suitability constraints and concepts should be an integral part of the suitability analysis. The assessments should identify risk drivers, determine the sensitivity of interrelated risks, and quantify risk impacts. Again, the analyst should rely on experience and historical data to help identify risk factors.

For more information, refer to the following sources of information:

- *The Measures Handbook*, Office of Aerospace Studies.
- AFPAM 63-128, *Integrated Life Cycle Management.*
- *Department of Defense Risk, Issue, and Opportunity Management Guide for Defense Acquisition Programs*, Office of the Deputy Assistant Secretary of Defense for Systems Engineering.
- AFOTECMAN 99-101, *Operational Test Processes and Procedures*.
- AFOTECPAM 99-104, AFOTEC Operational Suitability Test and Evaluation.
- *Human Systems Integration Requirements Pocket Guide*, USAF Human Systems Integration Office.
- Joint Publication (JP) 1-02, *Department of Defense Dictionary of Military and Associated Terms*.
- AF/A5R Capability Development Guidebook, Volume 1 - Air Force Implementation of the JCIDS Deliberate Process

# Appendix F: Study Plan Template

This appendix contains the OAS AoA study plan template. The template can be tailored as necessary to meet the objectives of the study.

**----------Cover Page ----------**

<Name of Project Here>

# Analysis of Alternatives (AoA)

# Study Plan

<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 the Scientific & Technical Information (STINFO) Officer for help in choosing which of the available statements best fits the AoA

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

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

## ----------Plan Section Contents----------

**1. Introduction**

**1.1. Background**

- Briefly describe the history of the effort and related programs. Summarize relevant analyses that preceded this study such as applicable Capabilities-Based Assessments (CBAs), Joint Concept Technology Demonstrations (JCTDs), or Advanced Technology Demonstration (ATD) efforts. This should include any lessons learned from previous efforts, especially those that were cancelled.
- Explain why the study is being conducted now and the key decisions that have been made to this point.

**1.2. Purpose and Scope**

- Describe the scope and purpose of the AoA. Describe any tailoring or streamlining used to focus the study.
- Identify potential areas of risk and/or roadblocks pertinent to the study (particularly schedule, lack of required data, lack of stakeholder participation, etc.)
- Identify the key acquisition or other issues that will be addressed in the analysis. Also explain why any key issues will not be considered or addressed in the analysis.
- Identify the milestone decision the analysis will inform.

**1.3. Study Guidance**

- Summarize the AoA study guidance from the Air Force and/or OSD(CAPE), as appropriate.
- Identify the key questions in the guidance.

**1.4. Capability Gaps**

- Identify and describe the specific approved capability gaps that will be addressed in the AoA. Identify the validated sources of these gaps.
- Identify the initial objective values in the ICD and how they will be treated as reference points to explore the tradespace.
- Identify the timeframe for the operational need.

**1.5. Stakeholders**

- Identify the stakeholders for this AoA and explain their roles/responsibilities in the AoA.
- Describe how methodologies, alternatives, evaluation criteria, and results will be reviewed by the stakeholders and oversight groups (e.g., Senior Review Group, Study Advisory Group, etc.).

**1.6. Key Ground Rules, Constraints, and Assumptions**

- Identify the key AoA ground rules, constraints, and assumptions (identified in the AoA study guidance and during development of the study plan). Describe the implications of the ground rules, constraints, and assumptions.
- Identify the projected Initial Operating Capability (IOC) and Full Operating Capability (FOC) milestones.

**2. Alternatives**

### 2.1. Description of Alternatives

- Describe the baseline (existing and planned systems) capability.
- Describe the alternatives specified in the AoA study guidance and how the alternatives will be employed in the operational environment. Explain the rationale for including them in the study. Explain the rationale for excluding any specific types of alternatives in the study.
- Discuss dependencies associated with each alternative and how the dependencies will be addressed in the analysis.
- Identify the appendix that contains the CCTD(s) or similar documentation for the baseline and each alternative.

### 2.2. Operational Context, Operational Concept, and Employment Concepts

- Identify organizational functions and operations performed during the mission. This includes describing logistics and maintenance concepts.
- Describe what enablers exist and how they interface with the alternatives. This includes identifying the dependencies of each alternative.
- Discuss significant tactics, techniques, procedures, and doctrine used.
- Discuss significant interfaces with other systems.
- Identify any peacetime and contingency operation implications. Describe any deployment issues.

### 2.3. Scenarios and Operational Environment

- Describe the scenarios that will be used in the AoA and rationale for their selection. This includes an explanation of how the scenarios represent the operational environment.
- Describe the expected operational environment, including terrain, weather, location, and altitude. Describe how the environment will impact the alternatives.
- Describe the enemy tactics (include potential countermeasures).

## 3. Effectiveness Analysis

### 3.1. Effectiveness Analysis Methodologies

- Describe the effectiveness analysis methodology for collecting, analyzing, and interpreting data.
- Describe the methodology to assess suitability concepts such as reliability, availability, and maintainability.
- Identify any ground rules, constraints, or assumptions that apply to the effectiveness analysis.
- Describe the scope, level of analysis, and resources required to conduct the analysis.
- Identify the data collection and analysis methods that will be used or are being considered (e.g., parametric, expert elicitation, and modeling and simulation).
- Describe how the mission tasks, attributes, conditions, standards, and measures will be developed from the capability gaps. If any mission tasks, attributes, conditions, standards, or measures have already been identified or are being considered, list them.
- Describe how the measure criteria (or standards) and metrics will be developed.
- Describe the relationship or linkage between the data collection and analysis methods and measures.
- Describe how the methodology and associated measures will be reviewed by the appropriate stakeholder and oversight groups (e.g., Senior Review Group, Study Advisory Group).

### 3.2. Sensitivity Analysis Methodology

- Describe the sensitivity analysis that will be conducted to identify cost, schedule, and performance drivers to illuminate the trade space for decision makers.

### 3.3. Modeling and Simulation Accreditation

- Describe the modeling and simulation (M&S) accreditation plan, if M&S will be used or is being considered.
- Include the M&S accreditation plan as an attachment to the study plan.

### 3.4. Intelligence Supportability Analysis

- Describe the plan for determining if an ISA is needed and, if so, the plan for completing it, to include the responsible organization.

## 4. Cost Analysis

### 4.1. Life Cycle Cost Methodology

- Describe the cost analysis methodology.
- Identify any ground rules, constraints, or assumptions that apply to the cost analysis.
- Describe the data collection and analysis methods (e.g., analogy, parametric) that will be used or are being considered.
- Describe the cost tools (e.g., ACEIT, Crystal Ball) that will be used or are being considered.
- Identify the life cycle time frame and key events such as IOC and FOC.
- Describe how time phasing of the estimate will be accomplished.
- Describe how the data will be reviewed and normalized.
- Describe how the cost analysis methodology will be reviewed by the stakeholders and oversight groups (e.g., Senior Review Group, Study Advisory Group).

### 4.2. Structure of the Cost Estimate

- Describe how the Work Breakdown Structure (WBS) will be developed.
- Describe how the Cost Element Structure (CES) will be developed.
- Describe how the LCCE will be broken out into life cycle phases and budget appropriations.

### 4.3. Cost Risk and Uncertainty Analysis

- Describe the cost risk and uncertainty analysis methodology including the methods and tools that will be used or are being considered.

### 4.4. Cost Sensitivity Analysis

- Describe the sensitivity analysis methodology. Identify the potential factors (e.g., duration of life cycle, purchase schedule, acquisition strategy) that are being considered. Describe the Cost As an Independent Variable (CAIV) approach that will be used or is being considered.

## 5. Risk Assessment

- Describe the risk assessment methodology for identifying risks.
- Describe the sources of information that will be used to identify risk root causes.
- Describe how risk mitigation options will be explored.

- Describe how the risk assessment methodology will be reviewed by the stakeholders and oversight groups (e.g., Senior Review Group, Study Advisory Group).

**6. Alternative Comparison and Cost Capability Analysis**

- Describe the alternative comparison methodology and how the results of the effectiveness, cost, and risk analyses will be incorporated into the alternative comparison.
- Describe the cost capability analysis methodology that will be used or is being considered. If possible, describe the manner in which the results of the analysis will be presented.
- Describe how the alternative comparison and cost capability analysis methodologies will be reviewed by the stakeholders and oversight groups (e.g., Senior Review Group, Study Advisory Group).

**7. Organization and Management**

**7.1. Study Team Organization**

- Identify how the team is organized and a general description of the responsibilities of each working group.
- Describe the stakeholders and oversight groups (e.g., Senior Review Group, Study Advisory Group) and their roles.

**7.2. AoA Review Process**

- Describe the review process and the oversight groups involved (e.g., Senior Review Group, Study Advisory Group).

**7.3. Schedule**

- Describe the AoA schedule (a chart of the timeline with key decision points and events is suggested). Discuss the ability of the study team to execute the study plan according to the schedule. Identify potential schedule risk pertinent to the study.

**<u>Appendices</u>**

**A. Acronyms**

**B. References**

**C. CCTD(s)**

**D. Modeling and Simulation Accreditation Plan**

**E. Other appendices as necessary**

# Appendix G: Final Report Template

This appendix contains the OAS AoA final report template. The template can be tailored as necessary to meet the objectives of the study.

**----------Cover Page ----------**

<Name of Project Here>

# Analysis of Alternatives (AoA)

# Final Report

<Lead MAJCOM>

<Date>

Cost of Study: $ X,XXX,XXX

## Distribution Statement

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Ask the Scientific & Technical Information (STINFO) Officer for help in choosing which of the available statements best fits the AoA

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

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

## ---------- Report Section Contents----------

**Executive Summary**

- Describe the purpose of the study, scope, and analysis approach
- Identify key organizations associated with the study.
- Present the key results, answers to key questions, conclusions, and recommendations.

**1. Introduction**

**1.1. Purpose and Scope**

- Describe the scope and purpose of the AoA. If applicable, discuss how the AoA scope was tailored to address the AoA study guidance and ADM. Explain the reason for any incomplete analysis and the plan to complete any remaining analysis.
- Identify any key MDA or other issues that were not considered or addressed in the analysis. Explain the reason for any unanswered questions and the plan to address them.
- Identify the Milestone Decision the analysis results will inform.

**1.2. Study Guidance**

- Summarize the AoA study guidance from the AF and/or OSD(CAPE), as appropriate.
- Identify the key questions in the guidance.
- Summarize any changes made to the study guidance or plan by the SAG and the rationale for those changes.

**1.3. Capability Gaps**

- Identify and describe the specific approved capability gaps that were addressed in the AoA. Identify the validated source of these gaps.

**1.4. Stakeholders**

- Identify the stakeholders for the AoA and explain their roles/responsibilities in the AoA.
- Describe how the methodologies, alternatives, evaluation criteria, and results were reviewed and accepted by the stakeholders and oversight groups (e.g., Study Advisory Group).

**1.5. Key Ground Rules, Constraints, and Assumptions for the AoA**

- Summarize the key AoA ground rules, constraints, and assumptions.
- Describe the expected need timeframe.

**1.6. Description of Alternatives**

- Describe the baseline (existing and planned systems) capability.
- Describe each of the alternatives assessed in the AoA (include any discriminating features).
- Describe why any alternatives were screened out during the course of the AoA.
- Describe what enablers were addressed and how they align with those identified at MDD and in the AoA guidance.
- Identify all DOTmLPF-P implications for each alternative.

**2. Effectiveness Analysis**

**2.1. Effectiveness Analysis Results**

- Describe the results of the effectiveness and suitability analysis.
- Describe how intelligence supportability and mandatory KPPs were measured and analyzed.

**2.2. Effectiveness Sensitivity Analysis Results**

- Describe the sensitivity analysis conducted.
- Identify the key parameters highlighted by the sensitivity analysis (performance drivers) and how they were fully explored.

**3. Cost Analysis**

**3.1. Life Cycle Cost Results**

- Describe the results of the cost analysis. This includes presentation of the life cycle cost estimates (LCCEs).
- Identify how the cost of each alternative aligns with the affordability constraints identified at MDD and in the AoA study guidance.

**3.2. Cost Risk and Uncertainty Analysis Results**

- Identify the cost risks and level of uncertainty associated with each alternative.

**3.3. Cost Sensitivity Analysis**

- Identify the cost drivers highlighted by the sensitivity analysis and how they were fully explored.

**4. Risk Assessment**

- Describe the results of the risk assessment.
- Describe the initial acquisition schedule for each alternative, assessment of existing TRLs/MRLs for critical technologies which may impact the likelihood of completing development, integration, and operational testing on schedule and within budget. This should include an assessment of the likelihood of achieving the proposed schedule.
- For significant risks, identify practical mitigation strategies to minimize the impact to delivering operational capability and, if applicable, potential workarounds in the event risks are realized.

**5. Alternative Comparison and Cost Capability Analysis**

- Describe the results of the alternative comparison and cost capability analysis.
- Identify the key aspects (performance, cost, risk) that differentiate the alternatives, including any significantly different demands on infrastructure/enablers (i.e., basing changes, manpower, communications, etc.).
- Explain why alternatives do well or poorly.
- If applicable, explain why specific alternatives are deemed non-viable.
- If one or more viable alternatives are identified, describe how they mitigate or close the capability gaps and reduce the associated operational risk.
- Describe the operational impact of failing to meet threshold values for key measures used in the study.
- Identify where the tradeoffs exist and to what degree the capability gap(s) have been mitigated.
- Identify the dominant set of alternatives (i.e., no alternative has both lower cost and higher capability).
- Describe the key performance, cost, schedule, and risk drivers.

- Describe how robust the alternatives are to changes (e.g., changes to assumptions, performance, or conditions).
- Identify the "knee in the curve" (if one exists) in terms of cost, schedule, risk, and capability—is there a best value alternative that balances affordability, capability, and risk?

**6. Conclusions and Recommendations**

- Provide conclusions and recommendations based on the analysis.
- Provide answers to the key questions identified in the AoA study guidance.

**APPENDICES**

**A. Acronyms**

**B. References**

**C. CCTD(s)**

**D. Detailed Description of the AoA methodologies**

**E. Lessons Learned**

**F. Modeling and Simulation Accreditation Final Report**

**G. Intelligence Supportability Analysis (ISA)**

**H. Other appendices as necessary**

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# Appendix H: Study Plan Assessment

This appendix contains the AoA study plan assessment criteria used by OAS in their independent assessment of an AoA study plan and associated briefing for presentation to the AFGK, CDWG, AFCDC, and OSD(CAPE). This assessment will be presented in bullet fashion, highlighting the risk areas with the credibility and defensibility of the analysis results as it progresses outside of the AF to the decision makers. OAS will provide an initial assessment and get-well plan after the initial review to determine readiness for submission to HAF/A5R.

**1. AoA purpose, definition and scope consistent with guidance**

- Identification of the specific gaps that are being addressed in the AoA.
- Identification of the key questions identified in the AoA study guidance.
- Definition of the baseline (existing and planned systems) capability.
- Identification of the alternatives identified by the AoA study guidance. This includes discussion about the implications and/or dependencies identified for the alternative and how the dependencies will be addressed in the analysis.
- Discussion of previous related studies and their relevance to this study.

**2. Appropriate stakeholders, issues, constraints addressed**

- Identification of the stakeholders and their roles/responsibilities in the AoA.
- Identification of how each part of the stakeholder and oversight communities will participate in the study and review processes.
- Addresses all ground rules, constraints, and assumptions (GRC&As) from the guidance. Additional GRC&As are reasonable and do not artificially constrain the outcome of the study.

**3. Analytic Methodology**

- Methodology to develop mission tasks, attributes, conditions, standards, and measures (i.e., Measures of Effectiveness, Suitability, and Performance) is appropriate.
- Modeling and Simulation Accreditation Plan is acceptable.
- Traceability of the AoA measures to the requirements and initial objective values identified in the ICD (from the CBA).
- Cost estimating structure described.
- Methodology to determine capability of alternatives to close or mitigate gaps.
- Methodology to explore tradespace and description of what sensitivity analysis will be accomplished to determine key parameters and T/O values.
- Methodology to conduct the cost capability analysis.
- Methodology for addressing the dependencies identified for each alternative.
- Scenarios to represent the operational environment.

**4. Level of effort and schedule is reasonable**

- Includes a schedule for AoA activities.
- Addresses potential milestones that are driving the AoA.

- Addresses the ability of the AoA study team to execute the study plan within the allotted time constraints.
- Identifies potential areas of risk and/or roadblocks pertinent to the study (particularly schedule risk, lack of required data, lack of stakeholder participation, etc.).

# Appendix I: Final Report Assessment

This appendix contains the AoA assessment criteria used by OAS for their independent assessment of AoA Final Reports and associated briefings for presentation to the AFGK, CDWG, and AFCDC. This assessment will be presented in bullet fashion, highlighting the risk areas with the completeness, credibility, and defensibility of the analysis results as it progresses outside of the AF to the decision makers. OAS will provide an initial assessment and get-well plan after the initial review to determine readiness for submission to HAF/A5R.

**1. Scope and problem definition consistent with guidance**

- Description of the scope and purpose of the AoA. Demonstrated consistency with guidance. Discussed how AoA scope was "tailored" to address the AoA study guidance and ADM
- Identified any key MDA or other issues that were not considered or addressed in the analysis (if applicable). This included identification and rationale for any unanswered questions and/or incomplete analysis and description of the recommended plan to answer these questions and to bring any remaining analysis to closure.
- Description of any changes made to the study guidance or plan by the SAG.

**2. Appropriate stakeholders, issues, constraints addressed**

- Identification of stakeholder and oversight communities and explanation of their roles/responsibilities in the AoA
- Description of how methodologies, evaluation criteria, and results were reviewed and accepted by stakeholder and oversight communities

**3. Analytic Execution**

- Description of each alternative under consideration including discriminating features.
- Assumptions and rating criteria used in the evaluation.
- Identification of which enablers were addressed and how they align with those outlined at the MDD and in the AoA guidance.
- Identification of the performance, cost, and risk drivers and how they were fully explored in sensitivity analysis.
- Identification of how sensitive each of the alternatives are to the analysis assumptions and if they are sensitive to specific scenarios.
- Identification of the key parameters and analytical evidence to support the thresholds and objectives identified. This must include identifying what the associated cost drivers are for those values and how sensitive the cost is to those values.
- Identification of technical feasibility of thresholds and objectives based on the affordability constraints identified.
- Identification and scoping of what additional information/analysis is needed prior to initiation of any acquisition activities, to include requesting a milestone decision.
- Identification of how the cost of each alternative lines up with the affordability constraints identified at MDD and in the AoA study guidance.

- Identification of Measures of Suitability and how they are intended to be supported in the intended operational environment.
- Identification of the metrics used, any weighting factors applied, and the rationale for applying each weighting factor. Analysis should illustrate interrelationship between the metrics and cost to facilitate cost/capability/risk/schedule tradespace discussions.
- Identification of the operational and non-operational (e.g., technical, cost, schedule) risks. It is important that the study team address the non-operational risks with the same level of fidelity/rigor as the operational risks. Non-operational risks can be significant contributors to future program failure.
- Identification of DOTmLPF-P implications for each alternative.

**4. Recommendations and Conclusions Supported by AoA Findings**

- Answers to the key questions identified in the AoA study guidance. These must be answered sufficiently for decision makers to support the upcoming decisions.
- Illustration of the cost/capability/risk tradespace. This must clearly identify for the decision makers where the trade-offs exist, operational risk associated with the performance, and to what degree the capability gap(s) have been mitigated.
- Rationale for disqualifying any alternatives from further consideration.
- If appropriate, recommended changes to validated capability requirements for consideration if changes would allow more tradespace for cost, schedule, and risk.
- Explanation of why alternatives do well or poorly. This must include rationale for the results.
- Explanation of how variations to CONOPS or attributes might mitigate cost drivers or low ratings on assessment metrics. This should include characterizing the circumstances in which each alternative appears superior and the conditions under which it degrades.
- Identification of estimated schedules for each alternative, and assessment of existing TRLs/MRLs for critical technologies which may impact likelihood of completing development, integration, and operational testing on schedule and within budget. This should include an assessment of the likelihood of achieving the proposed schedule.

# Appendix J: Commonly Used Cost Tools

| Name | Description | Source and Access |
|---|---|---|
| @Risk<br>@Risk for Project | Monte Carlo simulation tool add-ins for<br>Microsoft Excel and Microsoft Project which help analysts develop risk and sensitivity analyses of estimates and schedules.<br>@Risk may be used as a stand-alone package or as part of the Decision Tools decision analysis suite. | Palisade Corporation<br>http://www.palisade.com/risk/<br>http://www.palisade.com/decisiontools_suite/<br>http://www.palisade.com/riskproject/ |
| ACEIT<br>(Automated Cost Estimating Integrated Tools) | Suite of tools that supports program managers and cost analysts during all phases of a program's life cycle; incorporates life cycle cost estimating and analysis, and includes estimate development and documentation, risk analysis, and CER development and application; contains the Automated Cost Database (ACBD) building and search/query tool which allows users to create/share their own tailored database. | ACEIT<br>http://www.aceit.com/Default.aspx |
| COCOMO II<br>(Constructive Cost Model) | Estimates cost, effort, and schedule of a software development program; provides a range on cost, effort, and schedule estimates (best, most likely, worst), and performs 'what ifs' by determining the effect on the estimate of adjusting requirements, resources, and staffing. | University of Southern California<br>Center for Software Engineering<br>http://sunset.usc.edu/index.html<br>http://sunset.usc.edu/cse/pub/tools/ |
| Crystal Ball | Monte Carlo simulation add-in for Excel, used for cost risk, uncertainty, and sensitivity studies; can be used as a stand-alone package or as part of the Crystal Ball decision suite (e.g., in conjunction with the OptQuest optimization program). | Oracle<br>http://oracle.com |
| PRICE H<br>PRICE HL<br>PRICE M | Hardware acquisition, hardware lifecycle, and microcircuit and electronic module estimating models. | PRICE Systems<br>http://www.pricesystems.com |
| PRICE S<br>True S<br>True COCOMO | PRICE S/True S are the PRICE Systems software sizing, development, and support cost estimating models.<br>True COCOMO is PRICE Systems' implementation of COCOMO II. | PRICE Systems<br>http://www.pricesystems.com |

| Name | Description | Source and Access |
|---|---|---|
| SEER-H<br>SEER-IC<br>SEER-Spyglass | SEER-H and SEER-IC estimate the lifecycle costs of hardware and integrated circuits (including ground, air, space, and sea items and devices).<br>SEER-Spyglass estimates development and production costs of space-based electro-optical sensors. | SEER by Galorath<br>http://galorath.com/ |
| SEER-SEM<br>SEER-SEM Client<br>SEER-AccuScope | SEER-SEM estimates software development and lifecycle costs.<br>SEER-SEM Client is a software project planning tool for Microsoft Project.<br>SEER-AccuScope sizes the scope of projects, software, and hardware. | SEER by Galorath<br>http://galorath.com/ |
| Source: *Air Force Cost Analysis Handbook*, 2008, pp. 9-27 to 9-50 | | |

# Appendix K: OSD(CAPE) AoA Study Guidance Template

The following is provided by OSD(CAPE) as a template to begin drafting the AoA Study Guidance. The word draft appears to indicate any study guidance developed from this template will be draft guidance, the template is not a draft.

DRAFT (XXXXX PROGRAM NAME)

ANALYSIS OF ALTERNATIVES GUIDANCE

**Month xx, 2xxx**

**Program Name (Abbreviation) Analysis of Alternatives Guidance**

**Purpose**

The goal of Analysis of Alternatives (AoA) guidance is to facilitate high caliber analysis, fair treatment of options, and decision-quality outcomes to inform the Milestone Decision Authority (MDA) at the next Milestone and shape/scope the Request For Proposal (RFP) for the next acquisition phase. *CAPE guidance should direct the AoA to explore tradespace in performance, schedule, risk and cost across a full range of options to address validated capability requirements.* Additionally, the guidance should support an AoA feedback mechanism to the requirements process of recommended changes to validated capability requirements that, upon further study, appear unachievable and/or undesirable from a cost, schedule, risk and/or performance point of view.

**Background**

The guidance should provide a brief background on why the AoA is being conducted and how we got here. It should discuss the history of the effort and characterize related programs, to include lessons learned from previous cancellations. This section should also include a discussion of the Joint Requirements Oversight Council (JROC)-approved capability gaps and their role in the AoA study. *The guidance should make clear that the values of the capability gaps in the Initial Capabilities Document (ICD) and draft Capability Development Document (CDD) should be treated as reference points to frame decision space rather than minimum standards to disqualify options*. The AoA should illuminate the operational, schedule, risk and cost implications of tradespace around the validated capability gaps.

**Assumptions and Constraints**

Defining and understanding key assumptions and constraints are important in properly scoping the issue, defining excursions, and limiting institutional bias. Assumptions that are standard or trivial and therefore provide limited insight on what is actually driving the answer are not of interest. Since assumptions can determine outcomes, *the guidance should direct the study team to identify the key assumptions driving the AoA results*. Significant assumptions can include U.S.: enemy force ratios, threat characterization, CONOPs, etc. All major/key assumptions and constraints should be validated by the Study Advisory Group (SAG) as they are developed, but prior to beginning analysis.

**Alternatives**

This section should delineate the base case set of alternatives. These alternatives typically include a baseline (legacy systems and their approved modifications through the current POM), modified legacy systems, modified commercial/government/allied off the shelf systems, and new development alternatives. The alternatives should be distinctly defined, with enough detail to support the analytic approaches used. The alternatives should be grounded in industry, national lab or other agency responses; the AoA should avoid contriving unrealistic, “idealized” options.

The guidance should direct the AoA to explore a full range of viable modifications to legacy systems. For all alternatives, the AoA should assess features that appear to provide substantive operational benefit and apply to all viable alternatives (e.g., if a type of sensor is found to provide notably improved effectiveness for one alternative, the AoA should explore incorporating that feature in all alternatives).

Alternatives should also consider variations or excursions for attributes that are significant cost drivers. The intent is to find the "knee-in-the-curve" for the cost driver to ensure consideration of cost effective solutions rather than single point solutions that turn out to be unaffordable.

**Analysis**

The analysis should be based on sound methodologies and data that are briefly outlined in the Study Plan. The guidance should establish an early milestone/date for the AoA team to present their detailed methodology and data approaches, tools, scenarios, metrics, and data in- depth to the SAG and other stakeholders.

The AoA should spell out the scenarios and CONOPS used and explain the rationale for the inclusion of non-standard scenarios. If non-standard scenarios are employed the study team should explain in depth outcomes unique to those scenarios. The guidance should direct that a range of less stressing and more stressing scenarios be used, rather than using only highly demanding scenarios.

The guidance should instruct the AoA to spell out the metrics used, any weighting factors applied to these metrics, and the rationale for applying each weighting factor. Metrics should include comparisons between the (weighted) metrics and cost to facilitate cost, performance and schedule tradeoff discussions.

A problem with many legacy AoAs is that they have focused on operational benefits and downplayed technical, schedule, and cost risk. To avoid this, the guidance should instruct the AoA team to give full treatment to non-operational risks, since these factors have been a major cause of failed programs in the past. Within the technical risk area, empirical data should guide the AoA's assessment, with particular focus on integration risk.

***The guidance should direct the AoA team to explain the rationale for the results, which goes well beyond simply presenting outcomes.*** The AoA team should understand that the value of the analysis is in understanding ***why*** options do well or poorly. The study guidance should require the AoA team to acknowledge the limitations and confidence in the results due to lack of mature or reliable data at the time of the AoA. The team should also explain how/if variations to CONOPS or attributes of alternatives might mitigate cost drivers or low ratings on assessment metrics. Also, many AoAs have presented preferred options only for those cases advantageous to the option. The guidance should instruct the AoA to characterize the circumstances in which a given option appears superior and the conditions under which its outcomes degrade (a useful example of this was in the AoA for the replacement of the M113 armored personnel carrier, which showed how casualties varied according to the explosive weight of improvised explosive devises).

**Cost Analysis.** Provide an analysis of life cycle costs that includes estimates of development, production, operating and support (O&S), and disposal costs. These estimates should be of sufficient quality to support acquisition and investment decisions, but are not to be of budget quality.

- O&S cost estimates will cover a common life cycle period for the system under consideration (for most, a 20-year period) for all alternatives, consistent with the Operating and Support Cost-Estimating Guide (Cost Analysis Improvement Group, Office of the Secretary of Defense, October

2007). The estimates shall include point estimates for the Average Procurement Unit Cost (APUC), as well as total life cycle cost.

- Life cycle estimates should be calculated as point estimates and also shown as 50% and 80% confidence levels.
- The cost analysis will identify APUC estimates for varying procurement quantities, if applicable. Present-value discounting should be used in comparing the alternatives, in accordance with OSD and Office of Management and Budget guidelines.
- Costs should be expressed in current-year dollars and, if appropriate in the context of FYDP funding, in then-year dollars. Costs should be presented at the major appropriation level with defined risk ranges to communicate the uncertainty associated with the estimates.
- The cost portion of the analysis should include an assessment of how varying the annual procurement rate affects cost and manufacturing risk when appropriate (e.g., procuring items faster to complete the total buy sooner vice buying them more slowly over a longer period of time).

**Schedule and Technology/Manufacturing Readiness Assessment.** The AoA should include estimated schedules for each alternative, as well as an assessment of existing Technology Readiness Levels (TRLs)/Manufacturing Readiness Levels (MRLs) for critical technologies which may impact the likelihood of completing development, integration, and operational testing activities on schedule and within budget. Since legacy AoAs have often proposed development and procurement schedules that were more aggressive than we actually achieved, future AoAs should include an assessment of the likelihood of achieving the proposed schedule based on our experience. Where significant risks are identified, the assessment should outline practical mitigation strategies to minimize impact to delivering the operational capability to the warfighter, and if applicable, notional workarounds in the event the risks are realized.

**Sensitivity Analysis.** The AoA will identify assumptions, constraints, variables and metric thresholds that when altered, may significantly change the relative schedule, performance, and/or cost-effectiveness of the alternatives. The sensitivity analysis should identify cost, schedule, and performance drivers to illuminate the trade space for decision makers. (e.g., identify performance attributes that make the largest changes to the force's mission effectiveness or are likely to most influence development and/or production cost.)

**Other specified analysis as required:**

- All mandatory Key Performance Parameters (KPPs) as noted in the Joint Capabilities Integration and Development System (JCIDS) manual should be analyzed, as applicable. Additionally, if a value has been specified within the requirements documents for these KPPs, describe the risk incurred for failing to achieve these values.
- **DOTmLPF-P Assessment.** The AoA will evaluate the implications for doctrine, organization, training, materiel, leadership and education, personnel, facilities, and policy (DOTmLPF-P) for each alternative.

- **Operational Energy Assessment.** If applicable, the AoA will include an examination of demand for fuel or alternative energies under each of the alternatives, using fully burdened costs. The study director will:
    - Ensure the Fully Burdened Cost of Energy (FBCE) method is used in computing costs for the Life Cycle Cost Estimate (LCCE) and documented in the final report.
    - Brief the SAG as to whether FBCE significantly differentiate between the alternatives being considered.
    - In cases where it does not significantly differentiate between alternatives, the Service shall complete the FBCE work external to the AoA.

**Specific questions to be answered by the AoA**

Additional program-specific questions should be included that do not repeat the requirements described elsewhere in the guidance. Rather, these questions should probe issues that are specific to the program (e.g., how a program would achieve high reliability; how a program might mitigate risk if the technology required fails to materialize; how a program might trade lethality versus survivability if cost (or weight) is a limiting factor). This section of the guidance should be a description of ideas that are substantive to the specific program and pose questions that, when answered, ***will highlight the truly important aspects of the tradespace for the program*.**

**Administrative Guidance**

A SAG will oversee the conduct of the AoA and ensure that the study complies with CAPE guidance. The group will be co-chaired by OSD CAPE and a Service representative and will include representatives from OUSD(AT&L), OUSD(P), OUSD(C), OUSD(P&R), ASD(R&E), ASD(OEPP), DOT&E, the Joint Staff, and the Services. The SAG is responsible for ensuring that the study complies with this guidance. The SAG has the authority to change the study guidance.

The organization performing the AoA will present an AoA study plan (not to exceed 10 pages) for CAPE approval 30 days after the issuance of the AoA Study Guidance or no less than 30 days prior to the Material Development Decision. The organization performing the AoA will work with OSD CAPE to develop a schedule for briefing the SAG on the AoA study team's progress. The briefings should be held bimonthly unless needed more frequently. In between briefings to the SAG, the study lead will maintain dialogue with OSD CAPE.

The guidance should set strict time limits on the analysis timeline – shorter is better. If the AoA analysis is expected to take longer than 6-9 months, the scope of work should be reconsidered to ensure the analysis planned is truly necessary to inform the milestone decision.

The final deliverables will include a briefing to the SAG and a written report. The written AoA report is due to D,CAPE at least 60 days prior to the Milestone Decision (to allow for sufficiency review) and to the other SAG members to properly inform the stakeholders prior to the release of the RFP for the next acquisition stage. The final report will provide a detailed written record of the AoA's results and findings and shall be on the order of no more than 50 pages in length, plus the Executive Summary which should be no more than 10 pages in length.

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# Appendix L: Risk Assessment Framework

The RAF is a scalable risk assessment approach that fosters consistency and uniformity in the use of risk-related terminology within and across the Air Force. The RAF is linked to the Chairman's Risk Assessment definitions and the CJCS Integrated Risk Matrix.

This appendix describes an eight-step process based on the RAF to help study teams identify and rate risks associated with the alternatives. The following resources will aid in conducting the risk assessment:

- CJCS Integrated Risk Matrix and associated AF/A9 Risk Assessment Framework (RAF)
- Core Function Support Plans

## Operational and Force Management Risks

The RAF provides a structured way for identifying and translating operational and force management risks into a consistent and comparable format. Operational risks are associated with the ability of the planned force to execute strategy successfully within acceptable human, materiel, financial, and strategic costs. Consideration of operational risk requires assessing the Department's ability to execute current, planned, and contingency operations in the assessed timeframe. Force Management risks are associated with the ability of the Service to recruit, train, educate, and retain the force. This requires the Service to examine its ability to provide trained and ready personnel in the near, mid, and long-term.

Operational risk is driven by our ability to provide National Authorities with air, space, and cyber capability effects as called for within planning constructs to meet anticipated challenges. The Service creates force structures that are capable of providing the needed effects in the anticipated threat environment. Operational risk is measured in terms of the air, space, and cyber effects envisioned in strategic planning documents. Under the operational risk category, the following Air Force criteria are intended to inform the CJCS operational risk category:

- **Air Force Capability to Support Combatant Commander Objectives** – Within the planning threat context, Air Force forces are capable of delivering a sufficient level of effect (Capability).
- **Air Force Capacity to Support Combatant Commander Objectives** – Within the planning context, the Air Force is planned to have sufficient force structure to deliver effect quantities (Capacity).

Force Management Risk is driven by the anticipated ability to maximize the effectiveness of the force structure chosen to meet operational requirements. Metrics designed to measure the ability to deliver a percentage of the force are appropriate as long as the success and failure points for the risk assessment have a basis in the assessed scenario. For force management, it is valid to assess the Air Force's ability to deliver numbers and types of systems in the scenario based on the availability of enabling resources. Under the force management risk category, the following Air Force criteria are intended to group like issues:

- **Munitions/Expendables**. Munitions and expendables include the availability and condition of munitions or similar expendables and whether those levels are sufficient to fully enable the force structure to meet planned needs. Factors such as projected numbers on hand, weapon system

performance objectives, weapon/expendable supply and demand, and munitions effectiveness should be considered.

- **Training**. Training includes all issues related to the availability and effectiveness of training resources. Factors such as ready aircrew program accomplishment rate, flying hour program (or equivalent), check ride results, exercise funding, annual training waiver rates, time to attain mission readiness analysis, inspection results, exercise participation, and mishap rates should be considered.
- **Equipment**. The Air Force's ability to fully maintain the force structure required to meet planning needs. It looks at maintenance and support capabilities, capacities, and parts resourcing. The ability to forecast measures such as aircraft availability, alert rates, launch availability, satellite replacement rates, non-mission capable rates, depot due date performance, unfinanced depot and commodity repair work, abort rates, mission equipment reliability rates, changes in war reserve material and engine levels, cannibalization rates, and break rates should be considered.
- **Infrastructure.** Includes all built (facilities/infrastructure) and natural (air, land, water) infrastructure required for sustainable installations necessary for support, redeployment, and operations (i.e., headquarters, airfields, communications, facilities, stores, port installations, and maintenance stations). Factors such as range capability, capacity, and assessment; facility requirements; preventative vs. corrective maintenance ratios; ISR SATCOM/Terrestrial availability; and ISR mission data architecture should be considered. NOTE: For AoAs, infrastructure includes the manufacturing capability of the industrial base needed to develop and sustain systems.
- **Personnel**. Personnel includes the Air Force's ability to recruit and retain personnel with the proper skill mix to adequately man the force structure required to meet planning requirements. Factors such as recruitment quality and capacity, retention, non-prior service accession rates for AFRC, skill level/grade level manning, instructor/evaluator and experienced personnel ratios, upgrade training status, authorized/assigned percentages, stressed career fields, and the 'deploy–to-dwell' ratio of Active Component (AC) and Reserve (RC) force use should be considered.

As illustrated in Figures L-1 and L-2, operational and force management risks are identified using risk trees. The base of the tree represents the aggregation of Service Core Function objectives. Branches of the tree connect to nodes representing objectives and the activities that are vital to the accomplishment of the objectives. Finally, the activities are connected to metrics that are designed to measure resource, schedule, or other performance factors that impact the activities. The Service Core Function, objectives, activities, and metrics are linked together to facilitate analytic assessment.

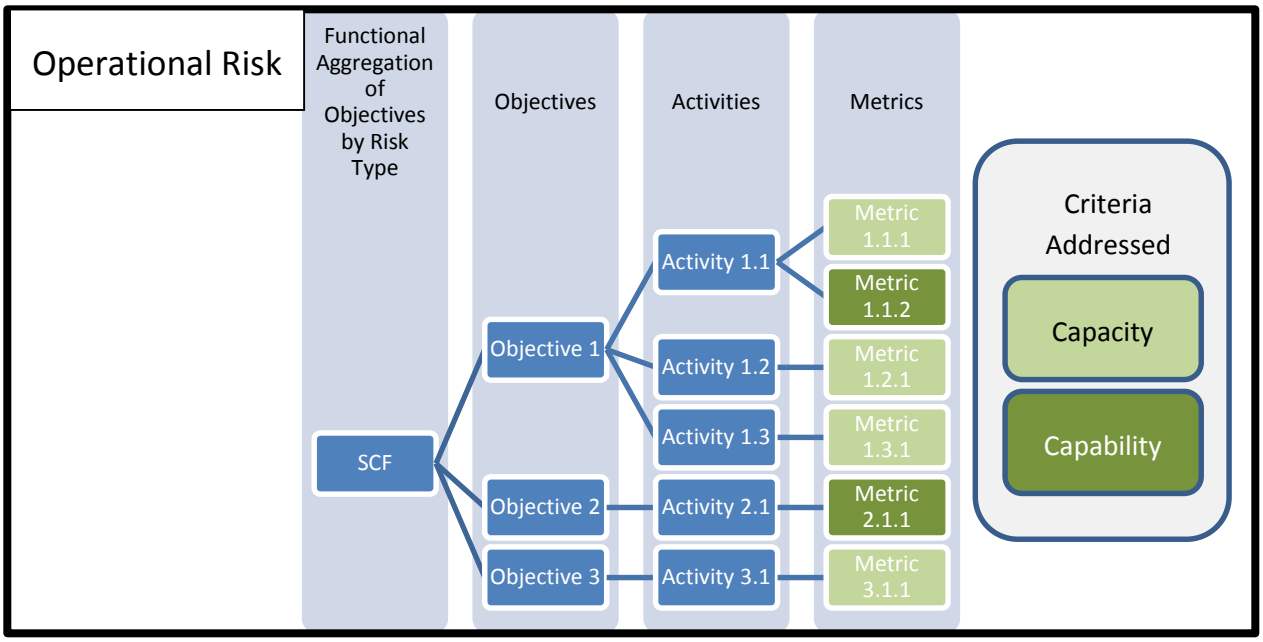



**Figure L-1: Operational Risk Tree Example**

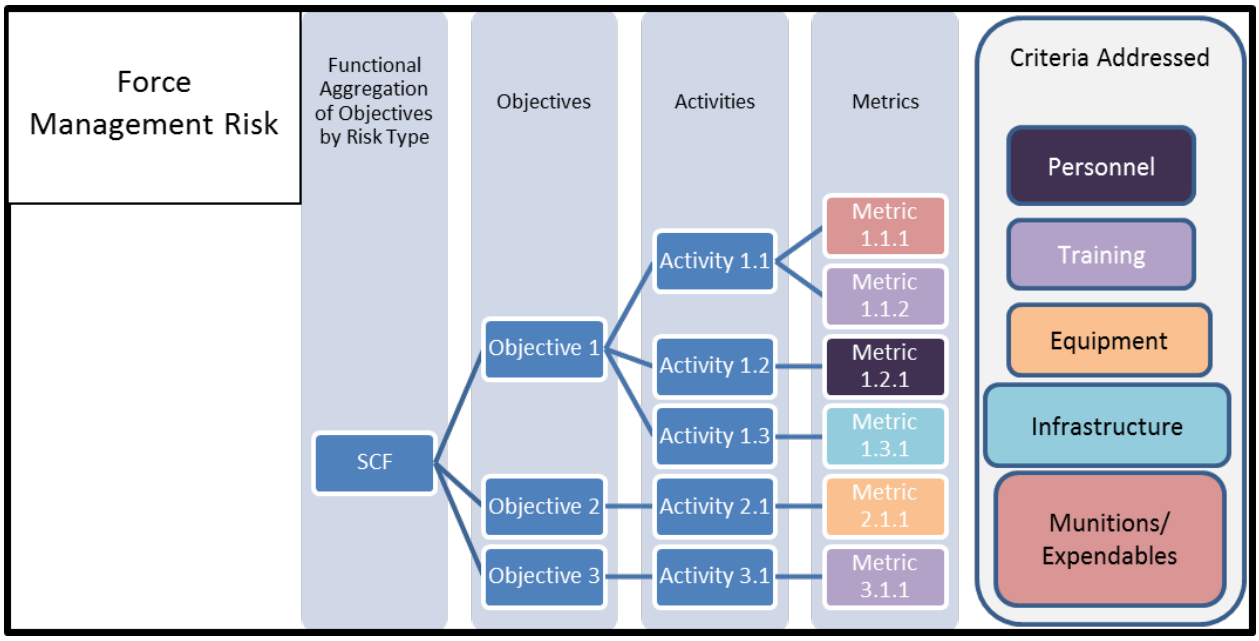



**Figure L-2: Force Management Risk Tree Example**

## Eight Step Risk Assessment Process

For AoAs, the study team (or RAWG or other group designated to conduct the risk assessment) uses an eight step process to identify the Service Core Function, define the objectives, activities, and metrics, and determine the operational and force management risk assessment (Figure L-3). As the study team completes the steps, there are opportunities to review previous work and verify the linkage between what is defined and assessed in the study. The remainder of the chapter provides a detailed description of the eight steps.

To help facilitate an understanding of the RAF, an example is used to illustrate the eight steps of the risk assessment process. The context of the example is moving target indicator support. The Theater commander must provide moving target indicator support to maneuver and surface forces across a Corps-sized area. The moving target indicator capabilties include detecting, tracking, and identifying a wide range of potential target categories and classes and communicating that information to enable the targeting and prosecution of those targets.

***Note that all data and information used in the example are notional and do not represent actual or future performance, operational requirement, capability, capacity, operating environment, or acquisition phase.***

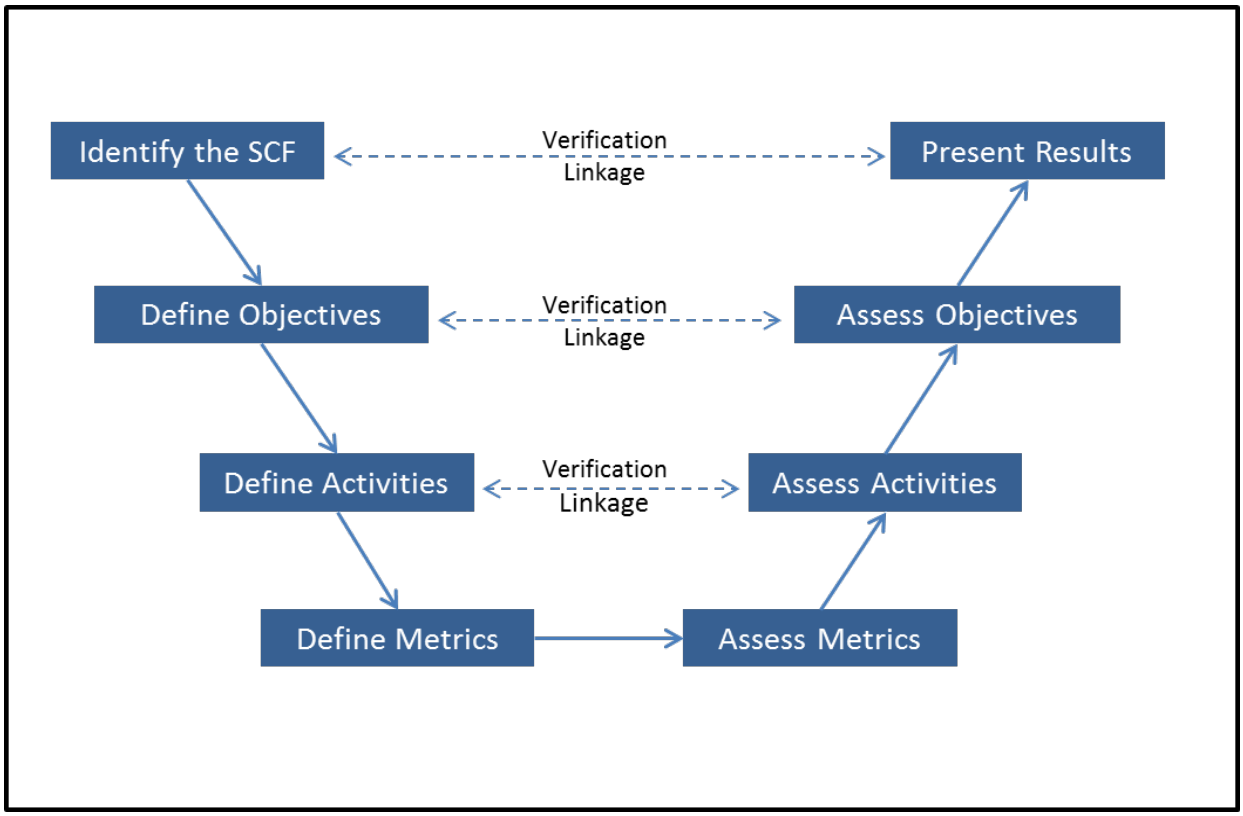



**Figure L-3: Eight Step Risk Assessment Process**

### *Step 1. Identify the Service Core Function*

Assigned by the Secretary of Defense, the Service Core Functions provide a framework for balancing investments across DoD capabilities. Service Core Functions were established by DoDD 5100.01, *Functions of the Department of Defense and Its Major Components*. For the Air Force Core Functions, the Secretary of the Air Force and Chief of Staff of the Air Force designated Core Function Leads (CFLs) to serve as leaders and principal integrators for their assigned Core Functions. Each CFL has a Core Function Team (CFT) that serves as a support staff. In collaboration with stakeholders across the Air Force, CFLs provide strategic guidance for the stewardship and maturation of their Core Functions by establishing a strategy of long-term development through the annual submission of investment-related Core Function

Support Plans (CFSPs), Program Objective Memorandums (POMs), capability development, and Science and Technology (S&T) prioritization. As shown in Table L-1, there are twelve Core Functions that are assigned to CFLs across seven MAJCOMs.

AoA studies address capability requirements identified in ICDs or other capability documents. These capability requirements fall under one or more Service Core Functions. For each of the capability requirements that will be addressed in the AoA, the study team should work with the MAJCOMs responsible for the Service Core Functions to ensure the appropriate Service Core Function is identified.

**Table L-1: Core Function and MAJCOM Alignment**

| Core Function | MAJCOM |
|---|---|
| Agile Combat Support | Air Force Materiel Command (AFMC) |
| Air Superiority | Air Combat Command (ACC) |
| Command and Control | Air Combat Command (ACC) |
| Cyberspace Superiority | Air Force Space Command (AFSPC) |
| Education and Training | Air Education and Training Command (AETC) |
| Global Integrated Intelligence, Surveillance, and Reconnaissance | Air Combat Command (ACC) |
| Global Precision Attack | Air Combat Command (ACC) |
| Nuclear Deterrence Operations | Air Force Global Strike Command (AFGSC) |
| Personnel Recovery | Air Combat Command (ACC) |
| Rapid Global Mobility | Air Mobility Command (AMC) |
| Space Superiority | Air Force Space Command (AFSPC) |
| Special Operations | Air Force Special Operations Command (AFSOC) |

**Example:** The study team identified the Service Core Function responsible for moving target indicator capability as Global Integrated Intelligence, Surveillance, and Reconnaissance (GIISR) (see Figure L-4).

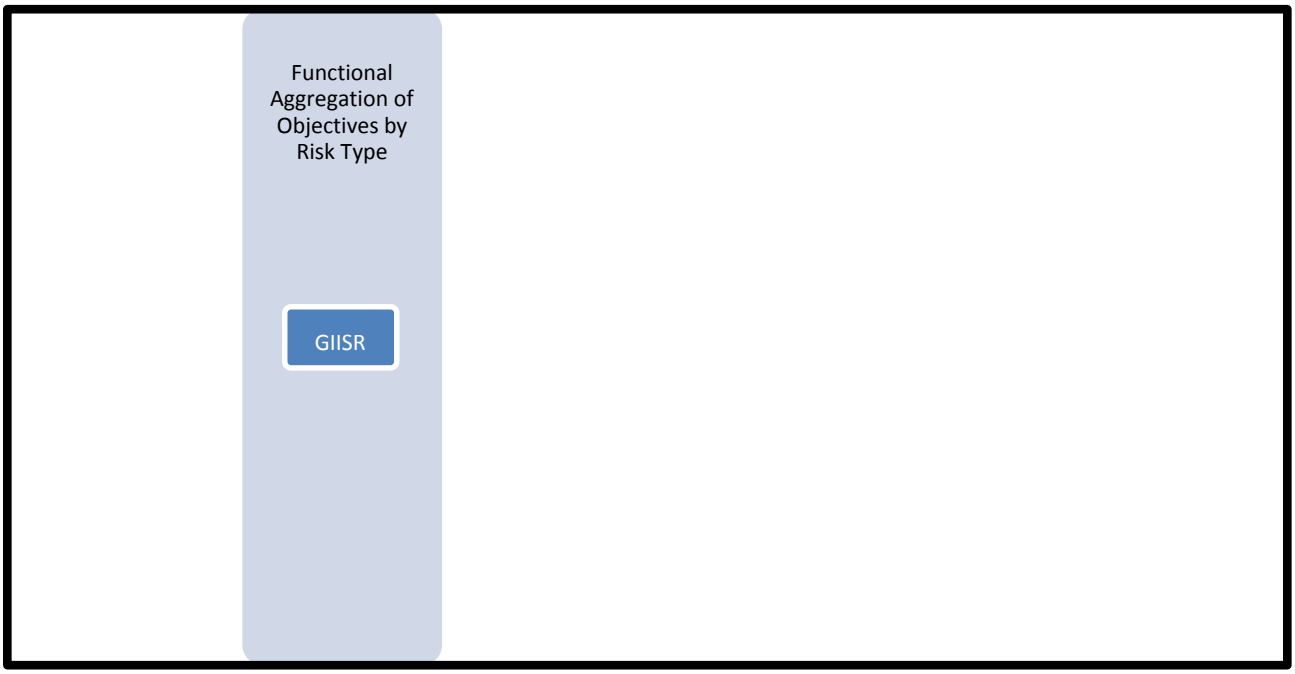



**Figure L-4: Identifying the Service Core Function (Step 1)**

### *Step 2. Define Objectives*

Once the Service Core Function has been identified, the next step is to define the objectives. Objectives are high-level statements that are associated with the capability requirements identified in the ICD or other capability documents that will be addressed in the AoA. Objectives define the desired end state of the construct under assessment.

**Example:** Continuing the example from step 1, the study team defined a key objective of the GIISR SCF as providing moving target indicator capability (Figure L-5). The study team stated the objective as: Provide moving target indicator support to maneuver and surface forces.

If there are multiple capability requirements that will be addressed in the AoA, the study team may identify multiple objectives associated with the capability requirements.

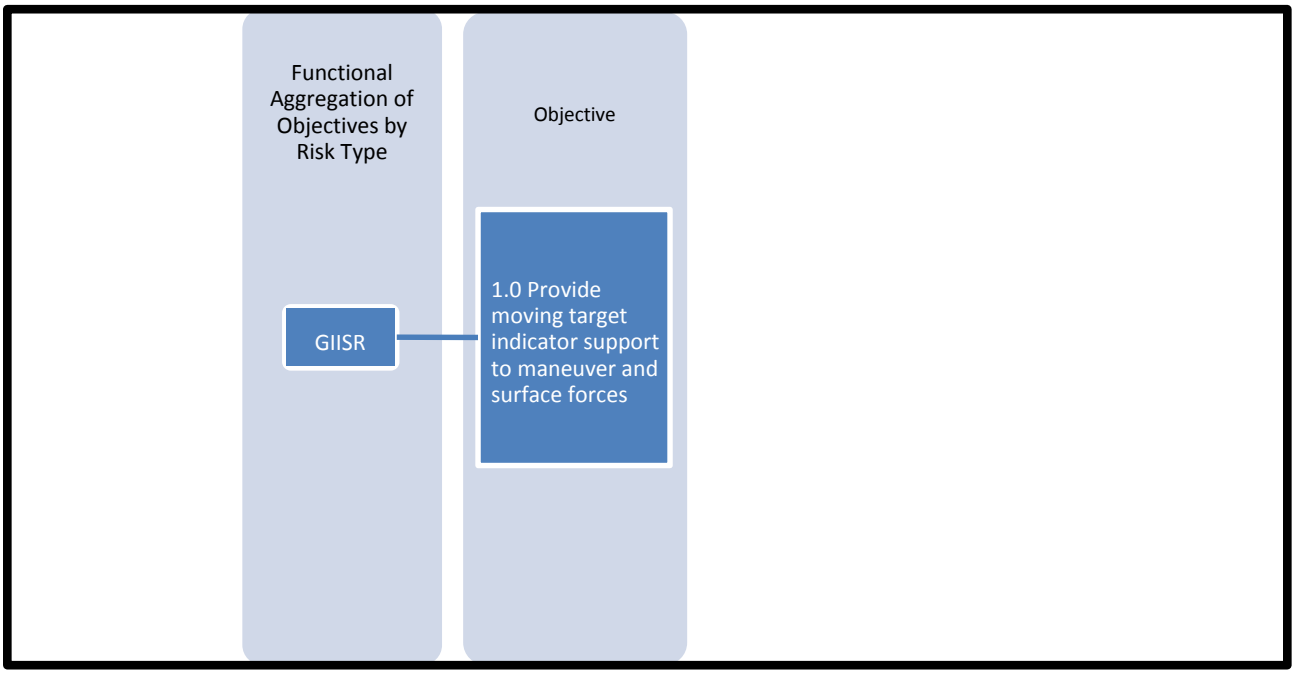



**Figure L-5: Defining the Objective (Step 2)**

### *Step 3. Define Activities*

The next step is to define the activities associated with the objectives. Activities are those actions performed or supported by the construct which are vital to achieving one of more objectives. In AoAs, the mission tasks that are developed for the effectiveness analysis may be used as the activities in the risk assessment. The study team should define activities that are linked to the objectives and are meaningful and measurable.

**Example:** Continuing the example from step 2, the study team defined activities that support the objective (provide moving target indicator support to maneuver and surface forces). The study team used the mission tasks that were defined for the effectiveness analysis as the activities for the risk assessment (Figure L-6). The activities are as follows:

- Find target (detect, identify, classify)
- Fix target
- Track target
- Communicate information (transmit, receive, process data)

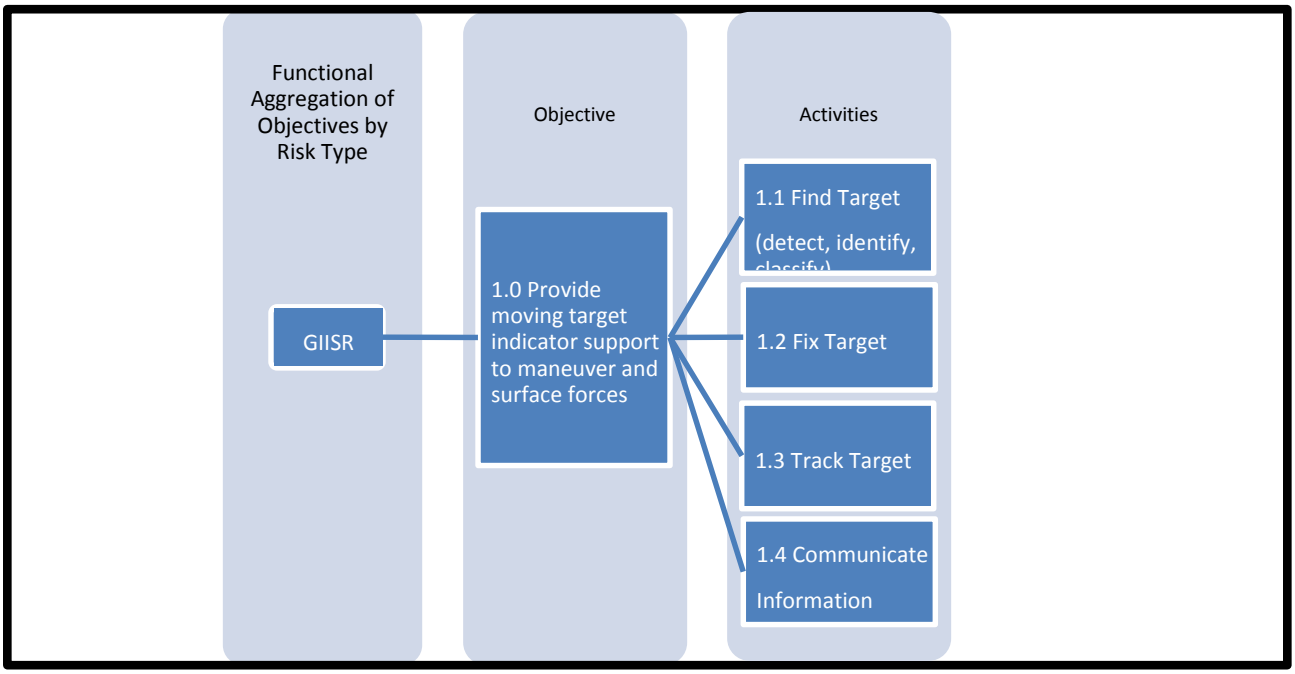



**Figure L-6: Defining the Activities (Step 3)**

### *Step 4. Define Metrics*

In Chapter 5, Developing the AoA Study Plan, the term "metric" was defined as a unit of measure that coincides with a specific method, procedure, or analysis (e.g., function or algorithm). In the context of the risk assessment, the term "metric" has a different meaning. A risk assessment metric is the element that captures the consequence of the risk in terms of the probable impact to the objective assuming the risk root cause will occur. The following provides more detailed discussion regarding how metrics are defined and used in the risk assessment.

The foundation of the RAF rests on the concept that activities conducted by the Air Force will have supporting resource, schedule, and other-performance measures that can be used to predict the likelihood of success or failure. This entails the development of metrics with specific threshold values to assess risk. The metrics are associated with the activities defined in Step 3 that are impacted by resource, schedule, or other (RSO) performance. Each risk metric for an activity is defined with two points (typically the success and failure endpoints) and successive levels between the two endpoints. The lowest point of risk for a metric is set such that the activity is assured of success as far as that metric is concerned. In other words, no additional improvement in that metric will increase the activity's chance of success. Similarly, the highest point of risk for a metric is set such that the activity is assured to fail as a result of the critical factor associated with that metric. In other words, no degradation in that metric will worsen the activity's chance of failure. In between the low and high risk points, there are thresholds marking risk assessment transitions from low to moderate to significant to high.

The key to a defensible and repeatable risk process is to have predetermined context-based metrics for assessment. Both quantitative and qualitative measures can be used to develop risk metrics within the RAF. The following rule sets are offered to provide a consistent approach for the creation of RAF risk metrics.

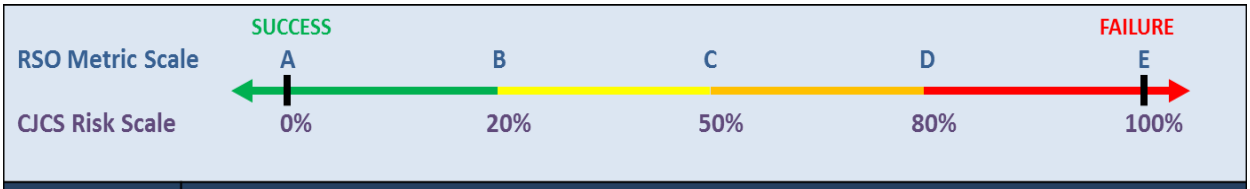
**Quantitative Metrics.** Risk level definitions by themselves are insufficient for an analytically rigorous assessment process. The RAF metric threshold definitions (Table L-2) are based on guidance provided for higher-level CJCS matrix criteria. These thresholds provide the basis for developing a quantifiable metric vs. risk level scale.

**Table L-2: Metric Threshold Level Definitions**

| | LOW | MODERATE | SIGNIFICANT | HIGH |
|---|---|---|---|---|
| **Resources / Schedule (quantitative)** | Req'ts <20% of max acceptable deviation | Req'ts 20-50% of max acceptable deviation | Req'ts >50-80% of max acceptable deviation | Req'ts >80% of max acceptable deviation |
| **Other (qualitative)** | >80% probability of achieving objective | 50-80% probability of achieving objective | 20-50% probability of achieving objective | <20% probability of achieving objective |

Creating a risk metric from each measure requires identification of two risk related points on the measure's scale (preferably the success and failure endpoints). The values for the two points will then be used to calculate the remainder of the metric threshold values (Table L-3). If the study team is unable to determine a value on the measure for both success and failure, it may be able to identify a value representing one of the other thresholds. The study team can use that information to replace an endpoint as an entry point for calculating the remainder of the thresholds. If the linear step function method presented in Table L-3 is not used to establish the thresholds for a metric, then the study team must provide analytically based rationale for that metric's threshold values.

**Table L-3: Calculating Thresholds for a Quantitative Metric**




| Known Points on Metric vs. Risk Scale | Metric Scale Threshold Calculations | | | | |
|---|---|---|---|---|---|
| | Success | Green/Yellow | Yellow/Orange | Orange/Red | Failure |
| A and E | A | A + ((E – A) x .2) | A + ((E – A) x .5) | A + ((E – A) x .8) | E |
| A and D | A | Abs(.75A + .25D) | Abs((.5D + .3A)/.8) | D | Abs((D - .2A)/.8) |
| B and E | Abs((5B - E)/4) | B | Abs((.6E + B)/1.6) | Abs((3E + B)/4) | E |
| B and D | Abs((5B - 1.25D)/3.75) | B | Abs((B + D)/2) | D | Abs((.8D - .2B)/.6) |

Once two threshold points for the metric are identified, the remaining metric threshold values are calculated using the RAF threshold step function (Table L-3). Point A in the table represents the metric's success value. Point B represents the metric threshold between green and yellow. Point C represents the metric threshold between yellow and orange. Point D represents the metric threshold between orange and red. Finally, Point E is the metric's failure value. The metric threshold values will most likely be different for each metric (even if they are based on the same measure) based on the planning context and perceived threat. However, the percentage of the measure's spectrum of risk encompassed by each risk level remains consistent with the values found on the CJCS Risk Matrix.

Once each particular metric is scaled, consistent and comparable information can be presented to senior leadership. If the underlying risk distribution for a metric can be proven to be non-linear, assessors may use the appropriate points ($0^{th}$, $20^{th}$, $50^{th}$, $80^{th}$, $100^{th}$ percentiles) on the known distribution to determine the metric thresholds points rather than using the linear-based RAF method above.

**Qualitative Metrics.** The "Other-Performance" type of metric allowed within the RAF provides for those vital metrics that are difficult to quantify or do not involve resources or schedule. The procedures outlined above for calculating a RAF scale should be used if the "other-performance" metric is quantifiable. For those metrics that cannot be quantified, the study team should identify a range of distinct outcomes for the metric. For each metric outcome, the study team will then estimate the probability that the supported activity will succeed given the metric outcome. Once these probabilities are estimated, the study team will bin/group the outcomes by risk level using the estimated probability of activity success to determine level of risk as shown on the "Other-Performance" row of Table L-2. For every metric, all four risk levels must be represented by at least one possible metric outcome. The resulting metric outcome vs. risk level scale replaces a metric vs. risk level scale for a non-quantifiable "Other-Performance" metric.

**Example:** Continuing the example from step 3, the study team identified operational risk metrics associated with each of the four activities. Figure L-7 shows one example of a metric associated with Activity 1.1 Find Target. There is an operational risk that the signal environment in the future (2025-2040) will be more dense, thereby degrading the capability to detect targets. Since the signal environment could not be analyzed parametrically or through modeling and simulation in the effectiveness analysis, the study team identified it as an operational risk that could impact target detection performance. The study team determined the metric was qualitative since it was too difficult to quantify.

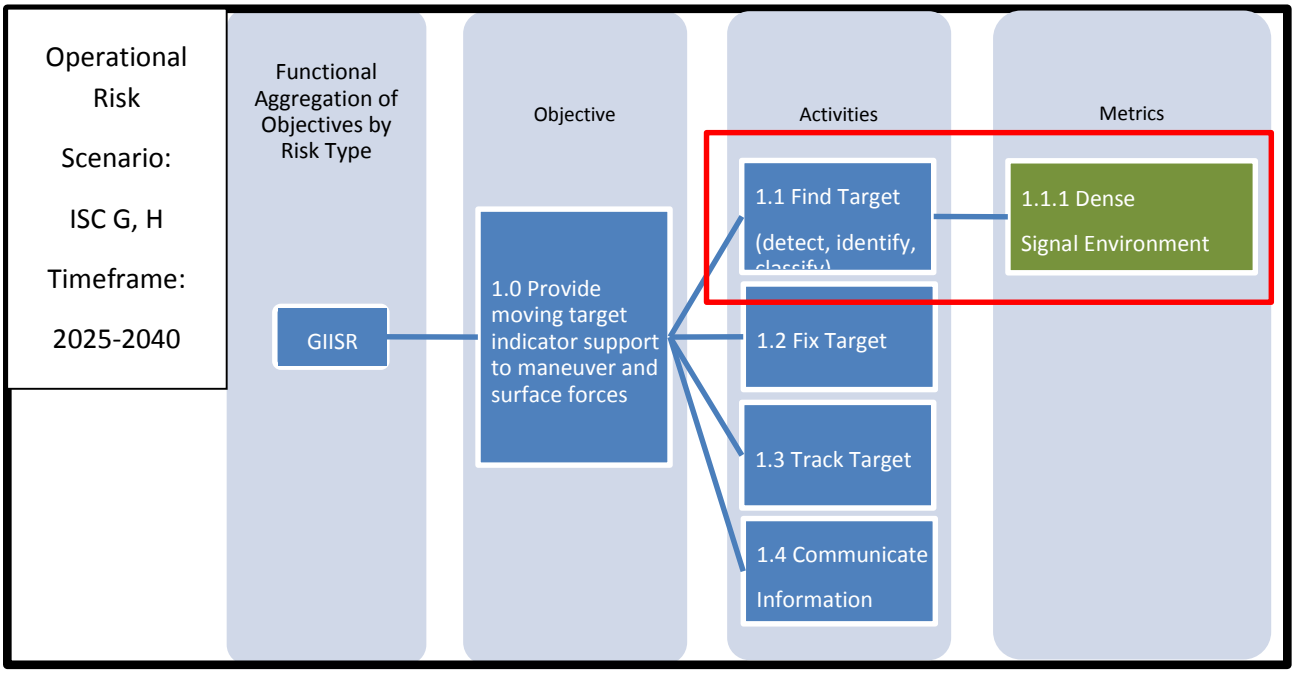



**Figure L-7: Defining a Metric (Example 1)**

The study team also identified an operational risk metric that applies to all four of the activities (Figure L-8). Since the activities will be supported by a system, the Technology Readiness Level (TRL) of the system is a risk that must be accounted for in the risk assessment. Milestone B is planned for January, 2018 and the system must be at TRL 6. Delays in achieving TRL 6 by January 2018 could adversely impact the Air Force's ability to maintain sufficient assets to provide moving target indicator capability to the warfighter.

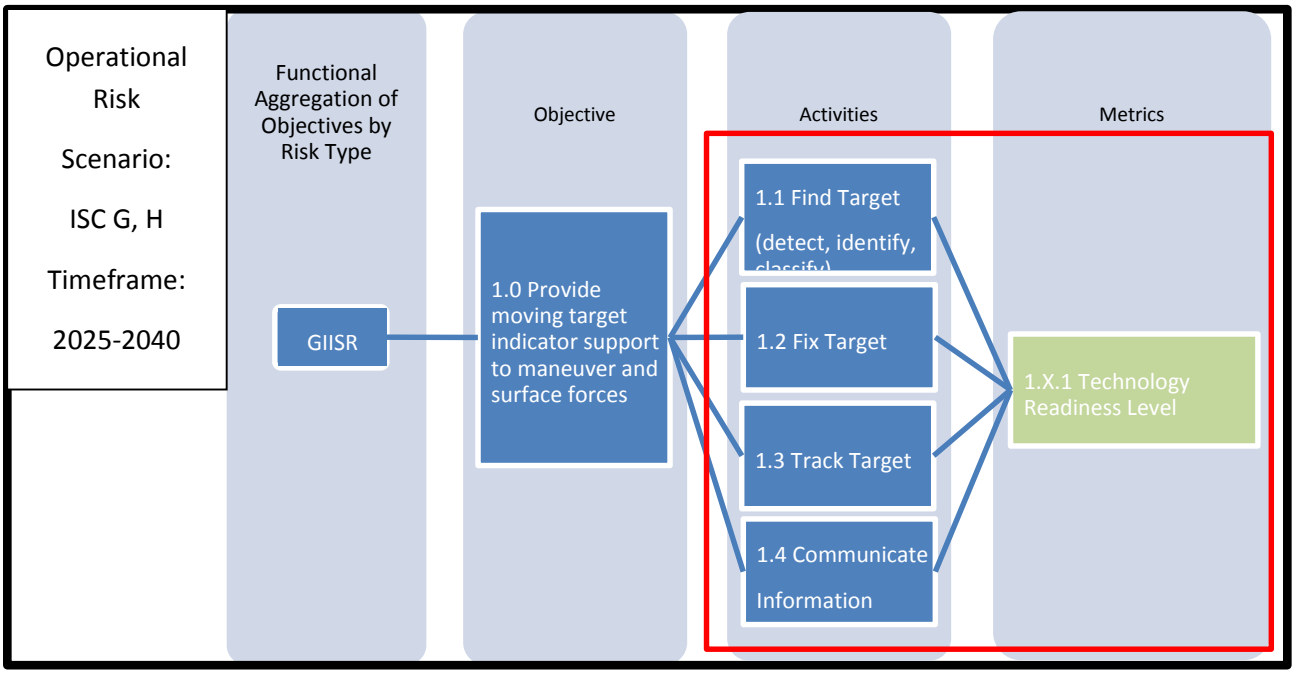



**Figure L-8: Defining a Metric (Example 2)**

The study team also identified force management risk metrics associated with each of the four activities. Figure L-9 shows one example of a metric associated with Activity 1.4 Communicate Information. There is a force management risk that the infrastructure in the future (2025-2040) may not fully support the capability to transmit and receive data. The capability to communicate information is dependent on the development of the Global Network that will enable systems to transmit and receive data. Each of the alternatives assessed in the AoA have different Global Network capacity requirements. Since the dependence on the Global Network could not be analyzed parametrically or through modeling and simulation in the effectiveness analysis, the study team identified it as force management risk that could impact data transmission and reception performance. The study team determined the metric was qualitative since it was too difficult to quantify.

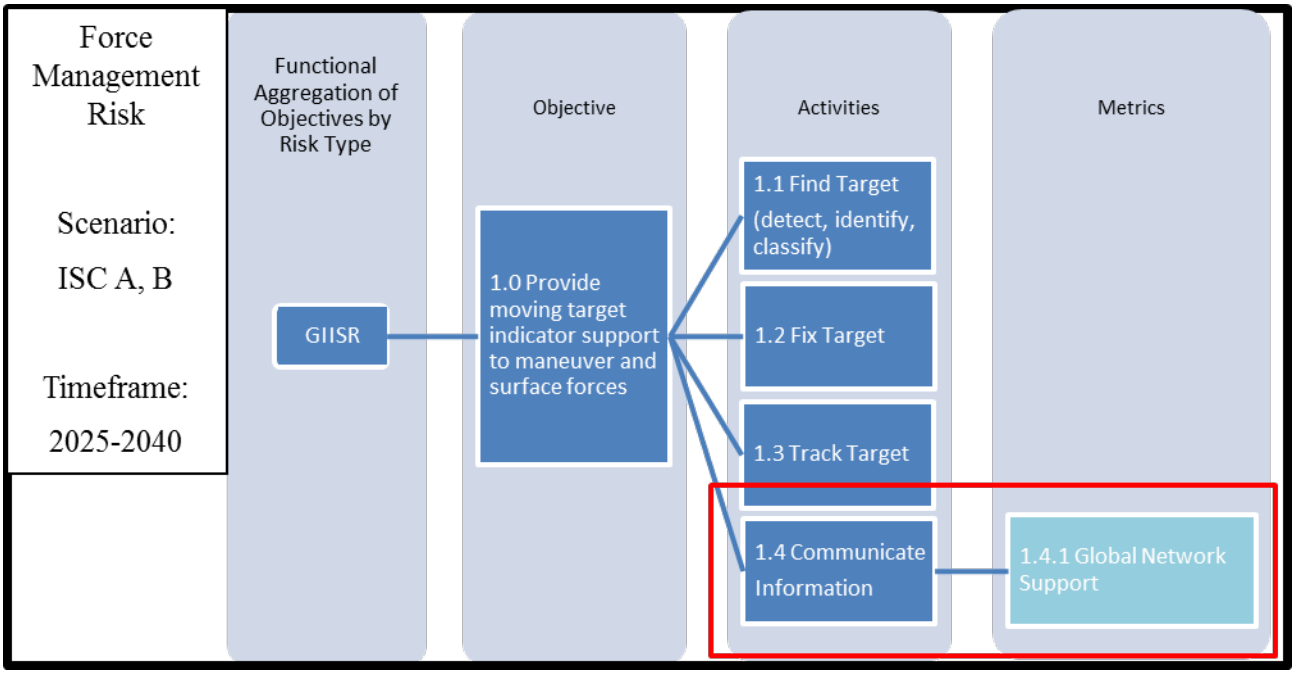



**Figure L-9: Defining a Metric (Example 3)**

### *Step 5. Assess Metrics*

Once the metrics have been defined, various techniques such as professional military judgment, modeling and simulation, and data analysis can be used to determine the risk rating for each of the alternatives assessed in the AoA. The analysis is conducted to determine where on the scale the particular metric falls for any given time frame, set of scenarios, and alternative.

**Example:** Continuing the example from step 4, the study team identified Metric 1.1.1 Dense Signal Environment associated with Activity 1.1 Find Target (Table L-4). The study team used subject matter experts to determine the probability of maintaining full capability to find targets in the dense signal environment of the future. The subject matter experts assessed the probability as .75. Since the metric is qualitative, the study team used the "other" row in Table L-2 to rate the metric as "moderate".

**Table L-4: Assessing a Metric (Example 1)**

Alternative: X

Metric 1.1.1 Dense Signal Environment (Operational)

Rating: Moderate

Assessment Technique: Expert Elicitation

| Metric | Low | Moderate | Significant | High |
|---|---|---|---|---|
| Dense Signal Environment | >.80 probability of finding targets in dense signal environment | .50-.80 probability of finding targets in dense signal environment | .20-.50 probability of finding targets in dense signal environment | <.20 probability of finding targets in dense signal environment |
| Assessment: | | .75 | | |
| Rationale: | Previous studies have investigated the effects of signal density on detection capability for moving target indicator systems. Given the technology used in Alternative X, it will likely perform with little or no degradation in detection capability in signal environment up to 13 million pulses per second. The studies indicate that over the next several decades, the signal environment could grow to 15-20 million pulses per second. In such an environment, it is anticipated that Alternative X will experience some degradation to detect targets. | | | |

The study team identified Metric 1.X.1 that applies to all four of the activities (Table L-5). The study team determined the TRL is a quantitative measure and used the first row in Table L-3 since the success and failure points (A and E) were known. Success (point A) is defined as the system achieving a TRL 6 by January 2018. Failure is defined as the system not achieving TRL 6 by January 2020. Using the formulas in the first row of Table L-3, the study team calculated the metric threshold values (dates in this case) between the success and failure endpoints. The subject matter experts assessed Alternative X was capable of achieving TRL 6 in the latter half of 2018 (July – December). Based on the scale, the study team rated the metric “moderate”.

**Table L-5: Assessing a Metric (Example 2)**

Alternative: X

Metric 1.X.1 Technology Readiness Level (Operational)

Rating: Moderate

Assessment Technique: Expert Elicitation

| Metric | Low | Moderate | Significant | High |
|---|---|---|---|---|
| TRL 6 Date | January 2018 - June 2018 | July 2018 – January 2019 | February 2019 – July 2019 | Aug 2019 – January 2020 |
| Assessment: | | July – December 2018 | | |
| Rationale: | Alternative X is currently at TRL 4 and requires a significant amount of additional development to achieve TRL 6. The sensor technology used in Alternative X is new and has failed several key laboratory tests. Given the amount of additional development time required and the recent test failures of the sensor technology, it is anticipated that Alternative X will be capable of achieving TRL 6 in the latter half of 2018. | | | |

The study team also identified metric 1.4.1 Global Network Support associated with Activity 1.4 Communicate Information (Table L-6). The study team used subject matter experts to determine the probability the Global Network can support the transmission and reception of data. The subject matter experts assessed the probability as .50. Since the metric is qualitative, the study team used the "other" row in Table L-2 to rate the metric as "significant".

**Table L-6: Assessing a Metric (Example 3)**

Alternative: X

Metric 1.4.1 Global Network Support (Force Management)

Rating: High

Assessment Technique: Expert Elicitation

| Metric | Low | Moderate | Significant | High |
|---|---|---|---|---|
| Global Network Support | >.80 probability of Global Network Support | .50-.80 probability of Global Network Support | .20-.50 probability of Global Network Support | <.20 Probability of Global Network Support |
| Assessment: | | | .50 | |
| Rationale: | The Global Network is currently in the Engineering Manufacturing Development phase of the acquisition cycle. The planned maximum capacity of the network is 5 terabytes. It is anticipated that Alternative X will be capable of generating a maximum of 7 terabytes. Moving target indicator systems can generate at maximum levels during complex operations. The program manager of the Global Network is addressing the limited network capacity, but no plans have been developed to address the shortfall. | | | |

### *Step 6. Assess Activities*

The risk level for each activity is assessed as low, moderate, significant, or high using the metrics associated with the activity (Figure L-10). Typically, the risk assessment of the activity is the same as the highest (worst) risk for the supporting metrics. If the worst-case is not appropriate, professional military judgment may be applied, but the rationale should be explained. It is important to note that the risk rating of each activity is determined for each alternative assessed in the AoA.

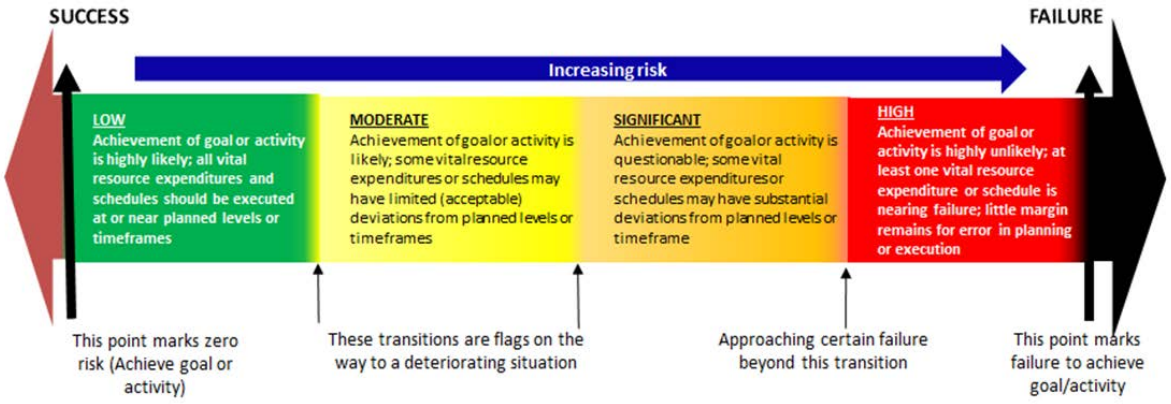



**Figure L-10: Rating Scale for Objectives and Activities**

**Example:** Continuing the example from step 5, the study team assessed the operational risk rating for Activity 1.1 Find Target for Alternative X (Figure L-11). In addition to Metric 1.1.1 Dense Signal Environment and Metric 1.X.1 Technology Readiness Level, the study team identified two other operational risk metrics associated with Activity 1.1 Find Target (Metric 1.1.2 Identification Ambiguity and Metric 1.1.3 Radio Frequency Interference). Since Metric 1.1.3 Radio Frequency Interference was rated the worst (significant), the risk assessment of Activity 1.1 Find Target for Alternative X was rated significant as well.

The study team used the same approach to determine the rating for the other activities (Activities 1.2 - 1.4). The study team determined a rating for each of the metrics associated with the activity to determine the risk rating of the activity for each alternative. As shown below, Activities 1.2 – 1.4 were rated moderate for Alternative X.

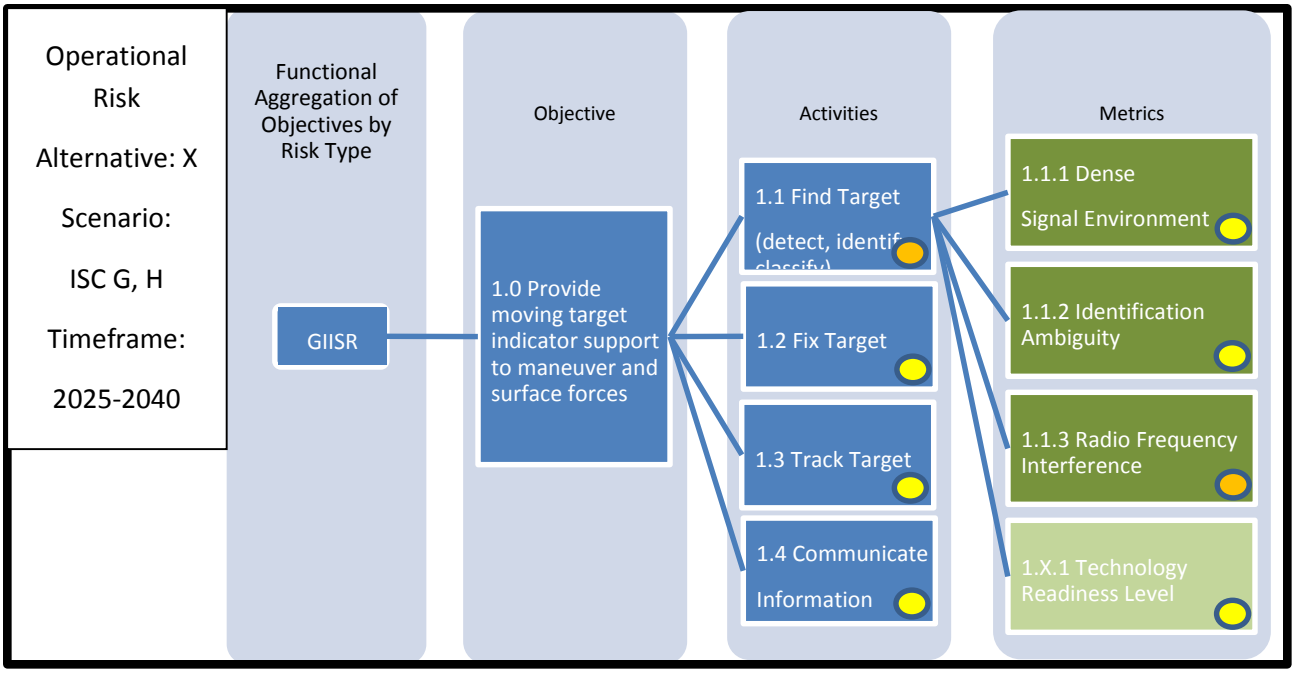



**Figure L-11: Assessing an Activity (Example 1)**

The same approach is used to determine the force management risk rating of each activity by alternative (Figure L-12). As determined in step 5, Metric 1.4.1 Global Network Support was rated significant. Since this was the only force management metric associated with the activity, the risk assessment of Activity 1.4 Communicate Information was rated significant as well.

The study team used the same approach to determine the rating for the other activities (Activities 1.1 - 1.3). The study team determined a rating for each of the metrics associated with the activity to determine the risk rating of the activity for each alternative. As shown in Figure L-12, Activities 1.1 – 1.2 were rated moderate, while Activity 1.3 was rated low for Alternative X.

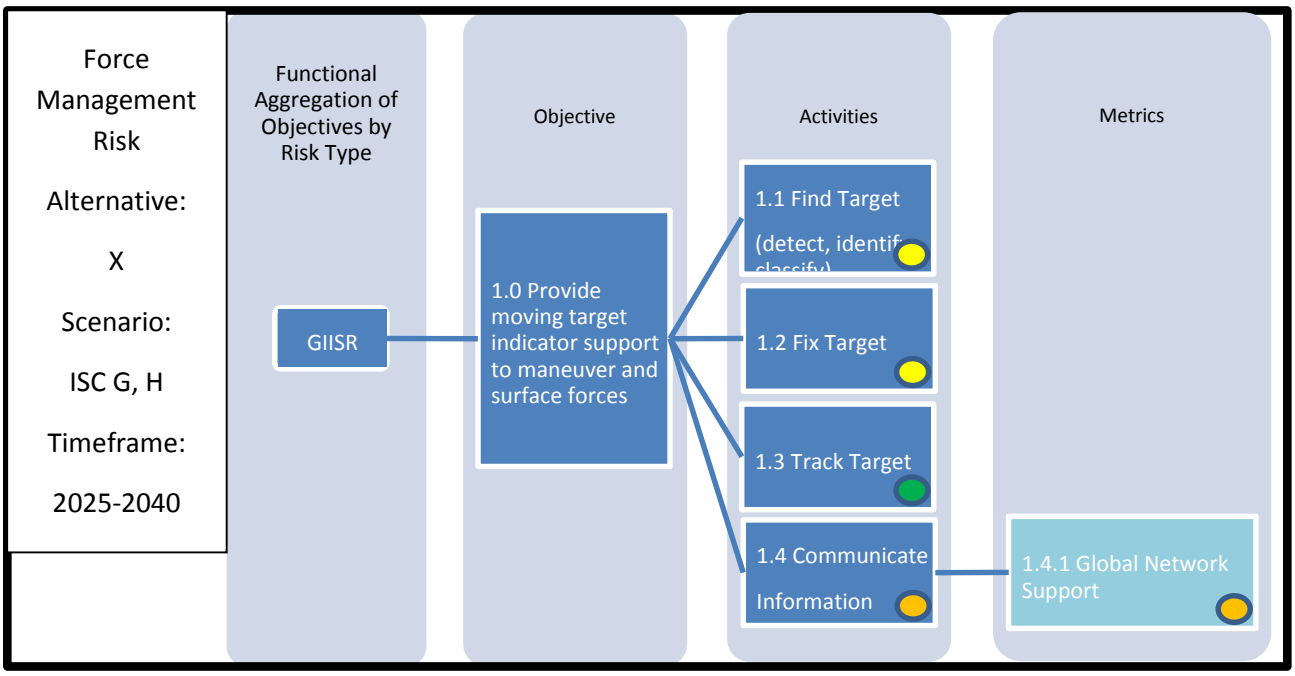



**Figure L-12: Assessing an Activity (Example 2)**

### *Step 7. Assess Objectives*

Similar to step 6, the risk level for each objective is assessed as low, moderate, significant, or high (see Figure L-10) using the activities associated with the objective. Typically, the risk assessment of the objective is the same as the highest (worst) risk for the supporting activities. If the worst-case is not appropriate, professional military judgment may be applied, but the rationale should be explained. It is important to note that the risk rating of each objective is determined for each alternative assessed in the AoA.

The study team should explore the impact of changes to assumptions, criteria, scenarios, force structures, and time frames on the risk ratings for the activities and metrics and how they impact the ratings of the objectives. Those changes should be highlighted when presenting the results (step 8).

**Example:** Continuing the example from step 6, the study team assessed the operational risk rating for Objective 1.0 (Figure L-13). Since Activity 1.1 Find Target was rated the worst (significant), the operational risk assessment of Objective 1.0 for Alternative X was rated significant as well.

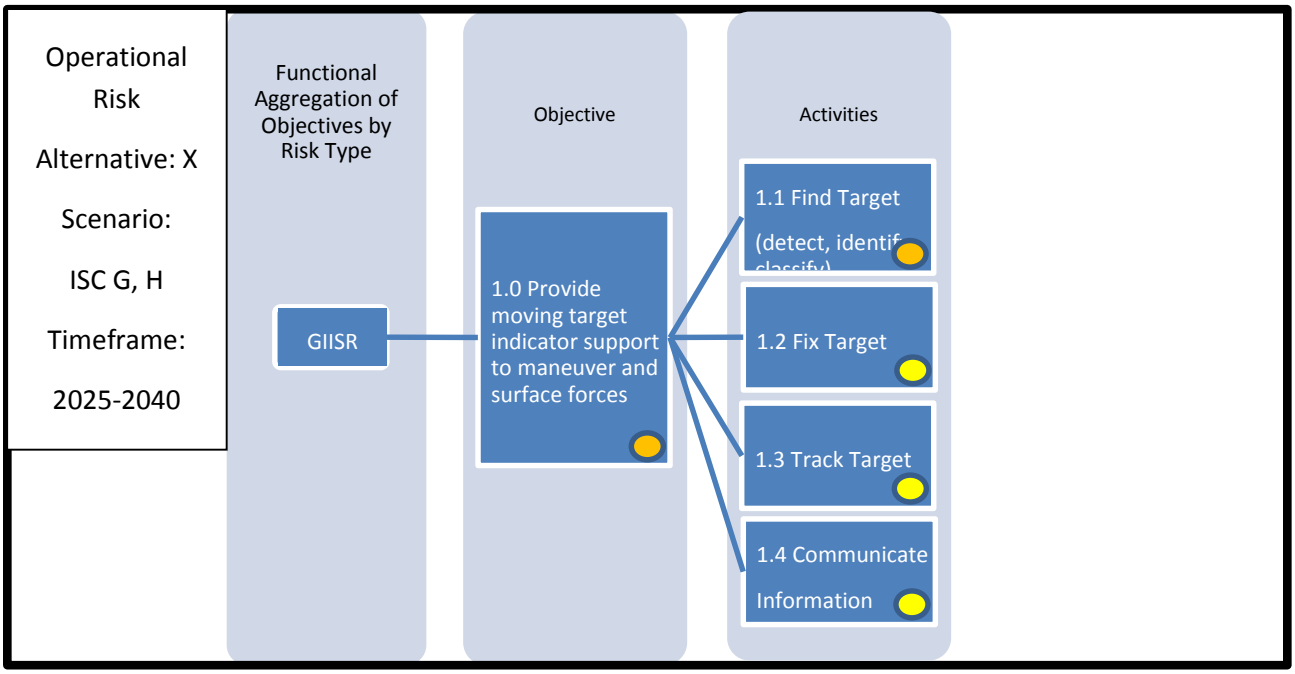



**Figure L-13: Assessing the Objective (Operational Risk Example)**

The study team used the same approach to determine the force management risk rating for Objective 1.0 (Figure L-14). Since Activity 1.4 Communicate Information was rated the worst (significant), the force management risk assessment of Objective 1.0 for Alternative X was rated significant as well.

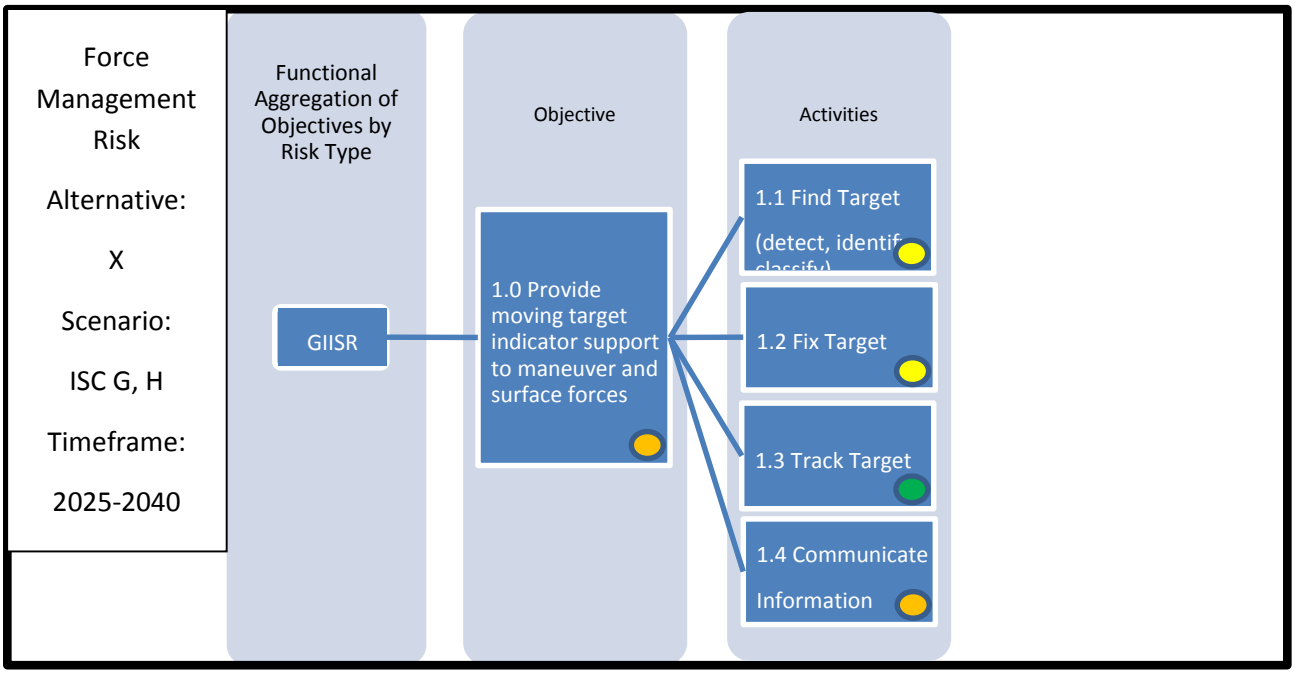



**Figure L-14: Assessing the Objective (Force Management Risk Example)**

### *Step 8. Present Risk Assessment Results*

Presentation of the risk assessment results is expected to utilize a common risk statement format. A risk statement is required for each type of risk (operational or force management) identified in the risk assessment. The study team will also need to identify the scenario(s), timeline(s) and force structure(s) utilized for the AoA and their relationship to the identified risk element. The format for the risk statement is:

"According to *(Organization)*, the *(Type)* risk of *(Objective or Activity)* is *(Assessment)* with (*Analytic Rigor Level*) for *(Scenario), (Time-Frame), and (Force Structure)* assuming *(Mitigation/Measures/Authority)*."

The key terms in the risk statement are defined as follows:

- Organization - organization accomplishing the risk assessment (study team)
- Type of risk – operational or force management
- Objective or Activity – these are the nodes of the risk tree as described above.
- Assessment - defined risk levels of low, moderate, significant, and high (See Table L-2 for risk level definitions).
- Analytic Rigor Level - gives leadership a quick understanding of how well the assessment embodies the desired attributes (defendable, measurable, repeatable, traceable, linkable, implementable, scalable, and incorporates military judgment). Each activity's analytic rigor level will be set at the lowest rigor level of the metrics driving the activity level risk assessment. Levels 1-3 are the most appropriate for an AoA. The assessment levels are defined as:
    - **Level 1** – This is the entry level of assessment. At a minimum, the assessor reports risk in context using the elements of the common format risk statement with a six-color scale.

The assessment incorporates military judgment through mechanisms to apply senior military leader judgment and/or subjective input based on recognized experience or expertise.

- **Level 2** – At this level, structure and defensibility are improved through the use of an objective-activity-metric tree structure. Metrics are in the maturing stage and portions may be informed solely by subject matter expert judgment.
- **Level 3** – Analytic processes replace subjectivity in the development of metrics (success/fail points) and metric assessment.
- **Level 4** – Mechanisms are in place to allow the assessment to incorporate results from subordinate-level assessments or to integrate into higher-level assessments. The assessment provides information about the mitigating assumptions that have been included in the assessment and how changes to those assumptions impact the assessed risk level.

- Scenario - this element is intended to provide additional information needed to specifically frame the environment within which the functional objective(s), or activity, is assessed. It includes amplifying information such as Operation Plans (OPLANs) considered (for near-year assessments) or Defense Planning Scenarios (DPSs) for future-year assessments. The decision-maker should set or approve the scenarios to be used for an assessment.
- Timeframe - timeframe for each assessment must be provided in guidance since it will drive both friendly and hostile force assumptions.
- Force Structure - this element provides the force structure assumption behind an assessment. The decision maker should set or approve the force structure assumptions to be used for an assessment. For timeframes within the current Future Years Defense Plan (FYDP), the risk assessment force structures will most likely consist of the programmed force (i.e., the current baseline capability) plus the capabilities of the alternative systems assessed in the AoA. For timeframes extending beyond the current FYDP (which is most likely the case in an AoA), the risk assessment force structures will be the programmed force extended[90] plus the capabilities of the alternative systems assessed in the AoA. The force structure descriptions, when including a specific alternative, will depend on the nature of the alternative:
  - For alternatives that represent new capability or will augment the force structure, the description of the force structure will be the programmed force plus Alternative X or the programmed force extended plus Alternative X.
  - For alternatives that will fully replace one or more systems of capability, the description of the force structure will be the programmed force replaced by Alternative X (at some

[90] There are two different force structure plans. The first is the fiscally-constrained Air Force Program of Record or "Programmed" Force that falls within the current fiscal year defense plan (FYDP). The second, called the "Programmed Force Extended," moves that force out twenty years, coinciding with the time horizon of the congressionally-mandated Quadrennial Defense Review.

specific point in the future) or the programmed force extended replaced by Alternative X (at some specific point in the future).

- For alternatives that will partially replace one or more systems of capability, the description of the force structure will be the programmed force plus Alternative X in lieu of (list of replaced capabilities or Programs of Record) or the programmed force extended plus Alternative X in in lieu of (list of replaced capabilities or Programs of Record).

- The definition of the programmed force extended will depend on the particular alternative being assessed in the AoA. For example, for an alternative that is designed to replace a specific program of record, the programmed force extended would not include this specific program of record but would instead include the alternative along with other programmed forces necessary to achieve a capability in the future. In other cases, an alternative may not be designed to replace any programs of record but, instead, augment them. In this case, the programmed force extended would include the alternative along with other programmed forces necessary to achieve a capability in the future.
- Mitigation/Measures/Authority - identifies mitigation actions already taken or assumed across the areas of doctrine, organization, training, materiel, leadership, personnel, facilities, and policy (DOTMLPF-P) by the organization making the assessment. This information is essential to aid decision makers in understanding what actions have been taken to date in order to best evaluate the situation and explore their risk management options.

As noted in step 7, the study team should explore the impact of changes to assumptions, criteria, scenarios, force structures, and time frames on the risk ratings for the activities and metrics and how they impact the ratings of the objectives. The study team should highlight any significant findings in the AoA report.

**Example:** Continuing the example from step 7, the study team assessed risks for three alternatives assessed in the study (Alternative X, Y, and Z) as shown in Table L-7. Given that the study team used subject matter experts to assess the metrics in an objective-activity-metric tree structure, the analytic rigor level was set at "2" in the two risk statements. Since the study team assessed alternatives that will provide new capability beyond the FYDP, the force structure statement was the programmed force extended plus the alternative. As shown in Table L-7, the study team also developed an overall rating for each alternative based on the operational and force management risk ratings (note that creating an overall single rating is optional).

**Table L-7: Example Presentation of Risk Statements**

| Alternative | Overall Rating | Operational Risk Rating | Force Management Risk Rating |
|---|---|---|---|
| X | Significant | Significant | Significant |
| | | *According to the AoA study team, the operational risk of providing moving target indicator support to maneuver and surface forces is significant with analytic rigor level 2 for ISC G and H, timeframe 2025-2040, and the programmed force extended plus Alternative X assuming the DOTmLPF-P solutions identified in the Moving Target Indicator CBA are developed.* | *According to the AoA study team, the force management risk of providing moving target indicator support to maneuver and surface forces is significant with analytic rigor level 2 for ISC G and H, timeframe 2025-2040, and the programmed force extended plus Alternative X assuming the DOTmLPF-P solutions identified in the Moving Target Indicator CBA are developed.* |
| Y | Moderate | Low | Moderate |
| | | *According to the AoA study team, the operational risk of providing moving target indicator support to maneuver and surface forces is low with analytic rigor level 2 for ISC G and H, timeframe 2025-2040, and the programmed force extended plus Alternative Y assuming the DOTmLPF-P solutions identified in the Moving Target Indicator CBA are developed.* | *According to the AoA study team, the force management risk of providing moving target indicator support to maneuver and surface forces is moderate with analytic rigor level 2 for ISC G and H, timeframe 2025-2040, and the programmed force extended plus Alternative Y assuming the DOTmLPF-P solutions identified in the Moving Target Indicator CBA are developed.* |
| Z | Significant | Moderate | Significant |
| | | *According to the AoA study team, the operational risk of providing moving target indicator support to maneuver and surface forces is moderate with analytic rigor level 2 for ISC G and H, timeframe 2025-2040, and the programmed force extended plus Alternative Z assuming the DOTmLPF-P solutions identified in the Moving Target Indicator CBA are developed.* | *According to the AoA study team, the force management risk of providing moving target indicator support to maneuver and surface forces is significant with analytic rigor level 2 for ISC G and H, timeframe 2025-2040, and the programmed force extended plus Alternative Z assuming the DOTmLPF-P solutions identified in the Moving Target Indicator CBA are developed.* |

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# Appendix M: Risk Assessment Using Risk Management Guide

This appendix describes the application of the concept outlined in the *DoD Risk, Issue, and Opportunity Management Guide for Defense Acquisition Programs* and the *SAF/AQ Guidance Memorandum: Life Cycle Risk Management* to conduct the risk analysis of the various alternatives under consideration. It is important to note that the purpose of the DoD Risk, Issue, and Opportunity Management Guide for Defense Acquisition Programs, referred to as the Risk Management Guide or RMG in this handbook, is to provide effective risk management tools over the entire acquisition process. The AoA is only a portion of that process and, therefore, only a subset of the guidance is applicable. The main tasks to be accomplished are risk identification, analysis, reporting, and, occasionally, risk mitigation identification.

## Introduction

The RMG is the basic guidance for executing risk management throughout the entire acquisition process. It defines risk as having three components:

- A future root cause (yet to happen), which, if eliminated or corrected, would prevent a potential consequence from occurring,
- A probability (or likelihood) assessed at the present time of that future root cause occurring, and
- The consequence (or effect) of that future occurrence.

The intent of the risk analysis is to answer the question: How big is the risk? Risk analysis is accomplished by considering the likelihood of the root cause occurrence, identifying the possible consequences in terms of performance, schedule, and cost, and communicating the risk level using a risk reporting matrix. Analysis begins with a detailed study of the risks that have been identified. The objective is to gather enough information about future risks to judge the root causes, the likelihood, and the consequences if the risk occurs. The remainder of this chapter presents a tailored risk analysis approach based on the RMG.

## Risk Assessment Approach

Risk identification is the first step in conducting the risk assessment. Risk identification entails identifying a future root cause which, if eliminated or corrected, would prevent a potential consequence from occurring.[91] At this stage, the focus of the study team (or RAWG or other group designated to conduct the risk assessment) should be on identifying risks and risk root causes and not on how the risks should be classified (i.e., performance, schedule, and cost).

A key aspect of risk identification using the RMG approach is a well-framed risk statement. Though there are multiple approaches to writing risk statements, the preferred format is the two-part "if-then"

[91] For more information about risk identification, see Chapter 5, section 5.11.

statement that contains the potential event and the associated consequences. If known, the risk statement should include the existing contributing circumstance or cause of the risk. The following shows the basic structure of the "if-then" risk statement:[92]

*"If" some event or condition occurs, "then" a specific negative impact or consequence to program objectives will result.*

Once the risks have been identified, the study team then uses the risk reporting matrix (discussed in the next section) to assess the probability of occurrence and consequence of each risk to performance, schedule, and cost. It is important to note that all three types of risk are assessed since it is not uncommon to have one or more risks that impact multiple elements of performance, schedule, and cost. The study team should consider the questions below when determining the consequence of each risk to performance, schedule, and cost.

### *Performance Considerations*

*Is there a possible impact to performance and to what level?* If so, this risk should be evaluated for its performance consequence. For each alternative analyzed in the study, the study team should assess the impact of the risk to operational performance and to the larger (campaign-level) effort.

### *Schedule Considerations*

*Is there a possible impact to the current schedule and to what level?* The study team should analyze the impact of the risk to the fielding schedules of alternatives being evaluated, to include:

- Analyzing the alternative schedules, incorporating the potential impact from all fielding, maintenance, and other schedules and associated government activities;
- Incorporating technical assessment and schedule uncertainty inputs into the alternative schedule models;
- Quantifying schedule impacts from outside influences including resource constraints and review/staffing requirements; and
- Projecting a forecast of the planned completion dates for major milestones.

### *Cost Considerations*

*Does the risk impact life cycle cost?* If so, the risk should be evaluated for its cost consequence and should be accounted for in the Cost Analysis section of the final report. A cost risk may impact the life cycle cost estimates of the alternatives. The RAWG or other group designated to conduct the risk

[92] For more information about "if-then" risk statements, see *Department of Defense Risk, Issue, and Opportunity Management Guide for Defense Acquisition Programs*, Office of the Deputy Assistant Secretary of Defense for Systems Engineering, Washington DC.

assessment must work closely with the Cost Analysis Working Group to ensure these risks are accounted for in the analysis.

## Risk Reporting Matrix

Each undesirable event that might affect the success of an alternative should be identified and assessed as to the likelihood and consequence of occurrence. The risk reporting matrix shown in Figure M-1 is typically used to determine the level of risks identified in a study. The risk reporting matrix provides a standard format for evaluating and reporting risks. The combination of probability and consequence in the risk reporting matrix is associated with a color-coded reporting scheme that enables one to report the level of risk for each root cause as low (green), moderate (yellow), or high (red).

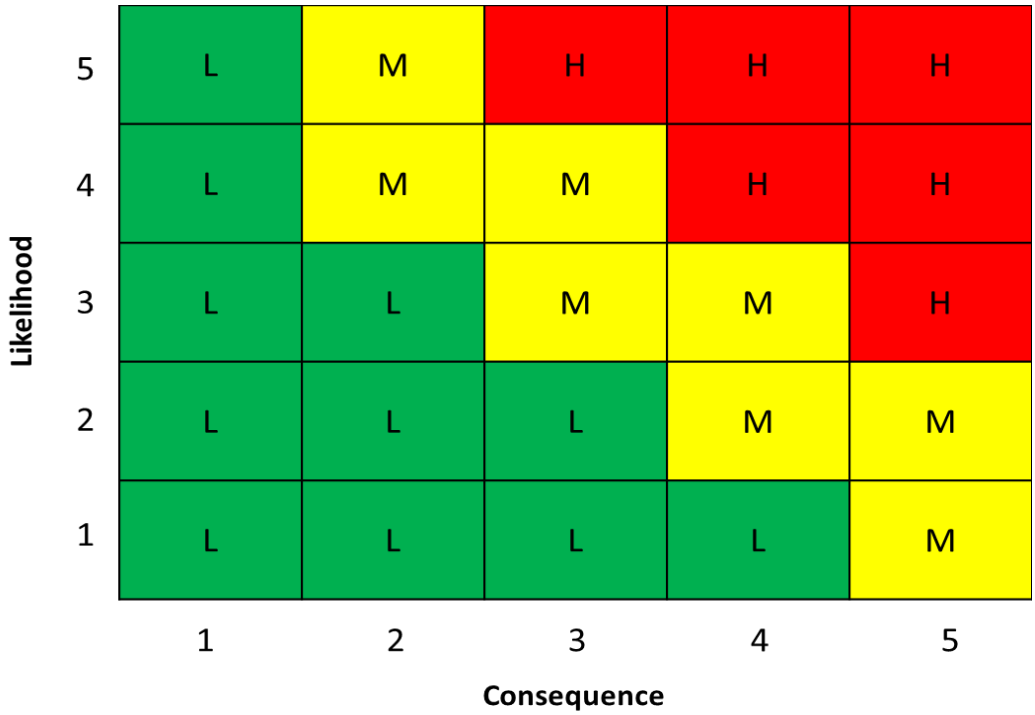


**Figure M-1: Risk Reporting Matrix**

The level of likelihood of each root cause is established utilizing specified criteria (Table M-1). For example, if the root cause has an estimated 50 percent probability of occurring, the corresponding likelihood is Level 3. Estimating the root cause likelihood is most often accomplished by using a SME panel. It is critical that the panel represent the operational, maintenance, supply, test, and any other communities that may have valid input. The membership of these SME panels should be in the final report.

**Table M-1: Levels of Likelihood Criteria and Indicators**

| Level | Likelihood | Probability of Occurrence | Indicators |
|---|---|---|---|
| 1 | Not Likely | 5% - 20% | – Approach and processes exist<br>– Off-the-shelf hardware<br>– Success independent of separate programs, subcontractors, or customer<br>– Mature alternative exists |
| 2 | Low Likelihood | 21% - 40% | – Approach and processes well understood and documented<br>– Most system technology validated<br>– Minor system complexity<br>– Some dependency upon activity beyond program span of control<br>– Moderately mature alternative exists |
| 3 | Likely | 41% - 60% | – Approach and processes partially documented<br>– Un-validated technology shown feasible by analogy, test, or analysis<br>– Moderate system complexity<br>– Moderately dependent upon activity beyond program span of control<br>– Alternative(s) exist or are in development |
| 4 | Highly Likely | 61% - 80% | – Approach and processes not well documented<br>– Technology available but not validated<br>– System complexity above normal<br>– Success dependent upon developmental activity beyond program span of control<br>– Alternative exists but immature in development |
| 5 | Near Certainty | 81% - 99% | – Approach and processes cannot mitigate this risk<br>– State-of-the-art technology<br>– System very complex<br>– Success highly dependent upon developmental activity beyond program spans of control<br>– No alternatives exist in development |
| Source: SAF/AQ Guidance Memorandum: Life Cycle Risk Management | | | |

The level and types of consequences of each risk are established utilizing criteria described in Table M-2. Continuing with the prior example of a root cause with a 50 percent probability of occurring, if that same root cause has no impact on performance or cost but may likely result in a minor schedule slip that will not impact key dates, then the corresponding consequence is a Level 2 for this risk. For clarity, it is also classified as a schedule risk since its root cause is schedule-related.

**Table M-2: Levels and Types of Consequence Criteria**

| Level | Performance | Schedule | Cost |
|---|---|---|---|
| 1 | Minimal consequences to technical performance but no overall impact to the program success. | Negligible schedule slip. | Pre-MS B: <= 5% increase from previous cost estimate.<br>Post MS B: limited to <= 1% increase in Program Acquisition Unit Cost (PAUC) or Average Procurement Unit Cost (APUC). |
| 2 | Minor reduction in technical performance or supportability, can be tolerated with little or no impact on program success. | Schedule slip, but able to meet key dates (e.g., PDR, CDR, FRP, FOC) and has no significant impact to slack on critical path. | Pre-MS B: > 5% to 10% increase from previous cost estimate.<br>Post MS B: <= 1% increase in PAUC/APUC with potential for further cost increase. |
| 3 | Moderate shortfall in technical performance or supportability with limited impact on program success. | Schedule slip that impacts ability to meet key dates (e.g., PDR, CDR, FRP, FOC) and/or significantly decreases slack on critical path. | Pre-MS B: > 10% to 15% increase from previous cost estimate.<br>Post MS B: > 1% but < 5% increase in PAUC/APUC |
| 4 | Significant degradation in technical performance or major shortfall in supportability with moderate impact on program success. | Will require change to program or project critical path. | Pre-MS B: > 15% to 20% increase from previous cost estimate.<br>Post MS B: >= 5% but <10% increase in PAUC/APUC. |
| 5 | Severe degradation in technical/supportability threshold performance, will jeopardize program success, or will cause one of the triggers listed below:<br>- Will not meet KPP threshold<br>- CTE will not be at TRL 4 at MS A<br>- CTE will not be at TRL 6 at MS B<br>- CTE will not be at TRL 7 at MS C<br>- CTE will not be at TRL 8 at FRP<br>- MRL will not be at 8 by MS C<br>- MRL will not be at 9 by FRP<br>- System availability threshold will not be met | Cannot meet key program or project milestones. | Pre-MS B: > 20% increase from previous cost estimate.<br>Post MS B: >= 10% increase in PAUC/APUC danger zone for significant cost growth and Nunn-McCurdy breach). |

Source: SAF/AQ Guidance Memorandum: Life Cycle Risk Management.

Terms: PDR-Preliminary Design Review, CDR-Critical Design Review, FRP-Full-Rate Production, FOC-Full Operational Capability, CTE-Critical Technology Element, KPP-Key Performance Parameter, TRL-Technology Readiness Level, MRL-Manufacturing Readiness Level.

## Risk Assessment Illustration

This section provides an example to illustrate how the RMG is used. The context of the example is moving target indicator support. The Theater commander must provide moving target indicator support to maneuver and surface forces across a Corps sized area. The moving target indicator capabilties include detecting, tracking, and identifying a wide range of potential target categories and classes and communicating that information to enable the targeting and prosecution of those targets.

***Note that all data and information used in the example are notional and do not represent actual or future performance, operational requirement, capability, capacity, operating environment, or acquisition phase.***

The Service Core Function responsible for moving target indicator capability is Global Integrated Intelligence, Surveillance, and Reconnaissance (GIISR). A key objective of the GIISR Service Core Function is to provide moving target indicator support to maneuver and surface forces.

Several risks (notional) are used as examples to illustrate the use of the RMG approach (Table M-3). Note that these risks are used as examples in Appendix L as well to illustrate the use of the Risk Assessment Framework. The only difference is the numbering scheme used to identify the risks. This should help the reader understand the similarities and differences between the two approaches.

**Table M-3: Risk Cross Reference Between Appendix L and M**

| | Risk Number | |
|---|---|---|
| Risk Statement | Risk Assessment Framework | Risk Management Guide |
| Dense Signal Environment | 1.1.1 | 1 |
| Global Network | 1.4.1 | 2 |
| Technology Readiness Level | 1.X.1 | 3 |
| Identification Ambiguity | 1.1.2 | 4 |
| Radio Frequency Interference | 1.1.3 | 5 |

### *1 Dense Signal Environment Risk*

The study team identified a performance risk that the signal environment in the future (2025-2040) will be more dense, thereby degrading the capability to detect targets. Since the signal environment could not be analyzed parametrically or through modeling and simulation in the effectiveness analysis, the study team identified it as an operational performance risk that could impact target detection performance.

Using a panel of subject matter experts, the study team assessed the probability of not detecting targets in a dense signal environment as ".30" which corresponds to a likelihood level "2" for Alternative X. The study team assessed the performance impact as a "significant degradation" which corresponds to a consequence level of "4" for Alternative X. The study team used the following as rationale (notional) for rating the risk:

> Previous studies have investigated the effects of signal density on detection capability for moving target indicator systems. Given the technology used in Alternative X, it will likely perform with little or no degradation in detection capability in signal environments up to 13 million pulses per second. The studies indicate that over the next several decades, the signal environments could grow to 15-20 million pulses per second. In such environments, it is anticipated that Alternative X will experience some degradation to detect targets. The consequences of the degradation could be significant since it is possible that some of the most lethal and prolific threats may not be detectable.

### *2 Global Network Support*

The study team also identified a performance risk associated with the Global Network support. The study team used subject matter experts to determine the probability the Global Network can support the transmission and reception of data. The subject matter experts assessed the probability as ".50" which corresponds to a likelihood level "3" for Alternative X. The study team assessed the performance impact as a "significant degradation" which corresponds to a consequence level of "4" for Alternative X. The study team used the following as rationale (notional) for rating the risk:

> The Global Network is currently in the Engineering Manufacturing Development phase of the acquisition cycle. The planned maximum capacity of the network is 5 terabytes. It is anticipated that Alternative X will be capable of generating a maximum of 7 terabytes. Moving target indicator systems can generate at maximum levels during complex operations. The program manager of the Global Network is addressing the limited network capacity, but no plans have been developed to address the shortfall. The consequences of the degradation could be significant since it is possible that the Global Network may not be capable of supporting the communication exchange during complex operations which may result in mission failure.

### *Risk Reporting Matrix Results*

Using the risk reporting matrix, the study team reported the two risks as shown in Figure M-2 along with several other example risks. Although the combination of likelihood and consequence was different for each risk, the risks were rated as "moderate" in the risk reporting matrix. Based on the individual risk results, the study team assessed the overall risk rating for Alternative X as "moderate."

It is important to note that determining an overall risk rating for an alternative requires the study team to consider the significance of each individual risk and use judgment in determining an overall risk rating. For example, an alternative with a couple of high consequence/high likelihood risks could be rated red (high) overall if the team determines the impact is significant. The study team should provide the rationale or justification for the overall rating. This will enable the reader to understand the basis for the rating and determine whether the rating is credible and appropriate. The study team should avoid using mathematical or quantitative approaches to score the risks and compute an overall risk rating. Such

approaches can oversimplify the interpretation of the risks and mask important information through the manipulation and organization of the data.

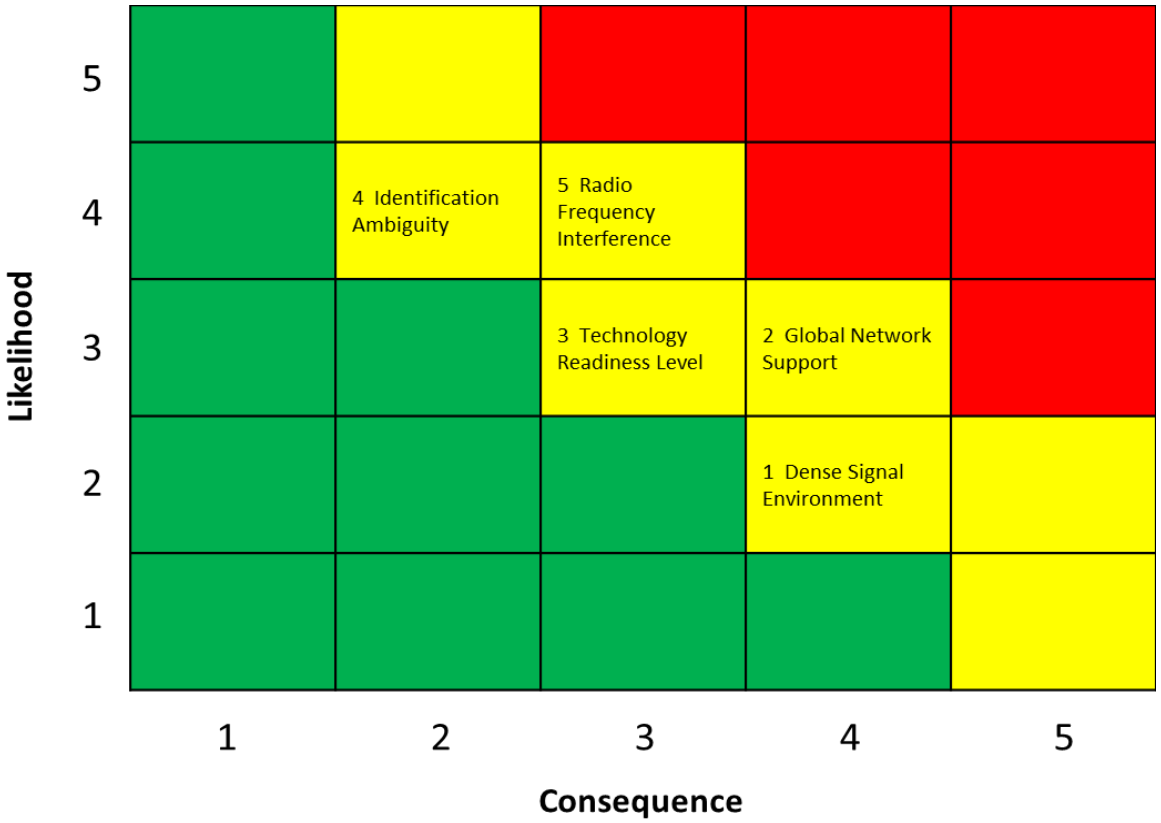


**Figure M-2: Risk Reporting Matrix Results**

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# Appendix N: Cost and Length of an AoA

How much does an AoA cost, and how long does it take? The answer depends on many factors. Conducting an AoA may take anywhere from a few months to more than 2 years and cost from a few hundred thousand to several million dollars depending on its scope and complexity. Since 2011, the Air Force has conducted two surveys examining the costs of AoAs:

- 2011 Office of Aerospace Studies (OAS) survey presented in briefing for HAF: *How much does an AoA cost?…and how long does it take?*
- 2013 Survey of MAJCOMs for Vice Chief of Staff of the Air Force (VCSAF) study.[93]

In the VCSAF study, the Air Force surveyed nine AoAs and found durations ranging from 1.2 to 2.3 years, and costs ranging from $1.7M to $32M. The study analyzed the survey data to determine the following average values for AoAs:

- Average Cost $15M
- Average Cost per year $8.5M
- Average Duration 21 months
- Military manpower accounts for 18% of costs
- Civilian manpower accounts for 21% of costs
- Contractors account for 42% of costs
- Other (TDY and Administration) accounts for the remaining 19% of costs

In the Air Force surveys, it was difficult to determine the cost of an AoA because it was not always clear when the AoA officially "started" and when it officially "ended." For most efforts in the survey, the Development Planning and AoA planning costs were considered to be part of the AoA. Indeed, DP was found to be one of the biggest components of AoA cost, even though DP is typically conducted prior to the AoA. The 2014 survey separated the operational stages of an AoA into three sections:

- Prep Work – 11 months (52% of total AoA time)
- AoA Execution – 8 months (38% of AoA time)
- Post AoA – 2 months (10%)

As can be seen from the survey data, prep work takes up more than half of the time of the total effort. Often, AoAs that take too long during the execution phase are completing work that should have been done earlier in the CBA or during Concept Development (Development Planning.)

The bulk of costs during Development Planning include concept development and early acquisition planning. Depending on the number and complexity of the potential alternatives to be evaluated during the AoA, the costs of development planning can be significant. There has been a wide range of costs for concept development. In some cases, concepts were developed by government engineers at no cost other than government manpower costs. In other development planning efforts, funds were provided to

[93] Analysis of Alternatives Focused Business Case Analysis, 12 Dec 2013

Industry to design and develop concepts. In these cases, costs for developing concepts ranged from a few hundred thousand to tens of millions of dollars. This wide range of costs for pre-AoA work suggests that study planners must carefully consider the type of analysis to be conducted in the AoA and ensure the level of effort during development planning supports the objectives of the AoA as well as laying the foundation for subsequent systems engineering leading to program initiation.

If the appropriate preparation work (development planning, concept development, study planning, etc.) is successfully completed prior to the AoA, then AoA execution timelines and costs can be significantly reduced. In the 2011 survey, OAS found the following cost ranges for these primary components of ACAT I AoA work accomplished during the AoA execution phase:

- Develop support strategy $100K - $500K
- Perform effectiveness analysis $900K - $4500K
- Perform cost analysis $200K - $1M
- Perform risk analysis $70K - $200K
- Identify Intel & info needs $70K - $400K
- Identify KPP/KSA values $60K - $200K
- Package and staff results $100 - $400K

The last time OAS examined the duration of AoAs, the average time between briefing the AoA plan and the final report was found to be on average around 12 months. This time does not include time spent planning the AoA or doing development planning. Of course, there is a lot of variability in the duration of the AoAs. Duration depends on many factors, including ACAT level; the amount of prep work successfully completed; the degree of detail directed by the study guidance; the availability of models, data, and scenarios; and so forth. Some studies are given a strict timeline and budget a priori and are held to that. For other efforts, the study planning team will develop a cost and schedule proposal based on the study questions. More complex AoAs will naturally take longer than narrowly scoped AoAs. Study directors must consider all these factors when planning and estimating the cost and duration of an AoA.

Even though AoAs can be perceived to be costly and lengthy, they are a vital part of DoD decision making, and their cost is quite small compared to the cost of the eventual programs that may result from the study. As the 2014 VCSAF study found: “The information provided by an AoA is essential. AoAs inform decision makers for the Air Force’s highest cost programs. AoAs cost approximately one half of one tenth of one percent of total program costs (e.g., ~$100M in AoA support impacted ~$220B in decision-making).”