# AF/A5/7
# CAPABILITY DEVELOPMENT GUIDEBOOK


## Volume 2D

### Annex A

### Analysis of Alternatives (AoA)

### December 2023

**Air Force Futures Office of Aerospace Studies**

**AF/A5/7DY-OAS, Pentagon 5C858**

**PREFACE**

This guidebook explains the activities and processes used by AF/A5/7 in support of overarching capability development to realize assessments of capability needs. The focus of Volume 2D, Annex A is an analytical comparison of the operational effectiveness, suitability, and life cycle/total ownership cost of alternatives that could satisfy validated capability requirement(s) documented in the Initial Capabilities Document. The AF/A5/7, Major Commands (MAJCOM)/Lead Agents, and the Office of the Director, Cost Assessment and Program Evaluation (ODCAPE) (if required) must align efforts in this analysis to enable deliberate and rapid Capability Development. This Guidebook synchronizes the latest guidance for AoA activities with the other portions of the current Air Force Operational Requirements processes, the Joint Capability Integration Development System (JCIDS), and DoDI 5000.84, Analysis of Alternatives.

Air Force Office of Aerospace Studies (OAS), AF/A5/7DY-OAS developed this guidebook not as a stand-alone source for planning, conducting, and reporting an AoA, but also to provide references to relevant supplemental and more detailed information in other OAS, Air Force, and Department of Defense (DoD) documents. It is grounded in over twenty-five years of experience providing analytic advice on Air Force and DoD AoAs and has been shaped by best practices gathered from over two hundred AoAs, and by observed expectations of USAF and DoD senior leaders. As expectations evolve, so will this guidebook. Please contact OAS with questions or for clarifications on how the guidance applies to your situation, or any other study issues or concerns. We welcome feedback and any suggestions for improvement. Contact OAS on Microsoft Teams or email at (AF.A5DY.Workflow@us.af.mil) or 703-614-7494 (DSN 224).

Although the AF/A5/7 Capability Development Guidebooks are not statutory or regulatory policy in nature, they represent official guidance and standard procedures developed by AF/A5/7D to ensure compliance with and implementation of overarching Requirements and Acquisition policies. Per AF/A5/7 direction and authority under HAF Mission Directive 1-57 (draft), to the maximum extent practicable all Air Force Sponsors will follow the guidance and procedures described in these guidebooks or coordinate with AF/A5/7DY (Office of Aerospace Studies) and/or the AF/A5/7DR (Requirements Oversight Enabling Team) for case-by-case process tailoring. The Office of Aerospace Studies functions as the AF's experts for operational capability requirements analysis and assessment activities.

There are no restrictions on release or distribution of this guidebook.

Additional guidance and information to supplement this Guidebook is located on the AF/A5/7DR Requirements Policy & Integration Portal Page:

- Go to the AF Portal, https://www.my.af.mil.
- Navigate to BASE, ORG & FUNCTIONAL AREA. Select "HAF" on the ribbon.
- Scroll to and select AF/A5/7 – Air Force Futures. Select "SUB-ORGANIZATIONS" in the left column.
- Select "AF/A5DR - Requirements Policy & Integration."

If you have questions regarding specific information within the Volume 2-series of Capability Development Guidebook(s), or if you have suggestions for improvements, please contact:

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For assistance with developing an AoA, please contact:
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**CHANGE SUMMARY**

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| Change Summary | Date |
|---|---|
| This is a new document in the USAF requirements family of documents and should be reviewed in its entirety. | Dec 2022 |
| Updated team training requirements. Admin changes | Jan 2023 |
| Added Operational Energy Assessment IAW 21 Apr 2022 DepSecDef Memo<br>Removed references to Requirements Roadmap | May 2023 |
| Added Appendix N, Modeling and Simulation Selection and Accreditation.<br>Administrative updates | Jul 2023 |
| Added Appendix O, Concept Characterization and Technical Description | Aug 2023 |
| Admin changes | Sep 2023 |
| Added Materiel Development Decision Guide and Best Practices as Appendix P | Dec 2023 |

**| NOTE: Changes from the previous version may be identified by a '|' in the left margin.**

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## SECTION 1. ANALYSIS OF ALTERNATIVES PROCESS AND APPROVALS

### 1.1. Analysis of Alternatives

The AoA is an assessment of options that have the potential to address Capability Requirements that are documented in a validated or approved operational requirements document. The AoA must provide compelling evidence of the capabilities and military worth of each alternative. The information provided in an AoA helps decision makers select courses of action to satisfy an operational capability need.

**Purpose**

As a key component of the Adaptive Acquisition Framework, the AoA helps decision-makers understand the trade space for 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 at the next milestone or decision point. The results should enable the Milestone Decision Authority (MDA) and other stakeholders 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 capability requirements and the Request for Proposal for the next acquisition phase. Furthermore, the AoA supplies the analytic basis for performance parameters documented in the appropriate requirements documents and provides the foundation for the development of documents required later in the acquisition cycle such as the Acquisition Strategy, Test and Evaluation Master Plan, and Systems Engineering Plan. The AoA may also contribute recommended changes to validated capability requirements that appear unachievable or undesirable from a cost, schedule, performance, or risk point of view.

**Direction**

DoDI 5000.84, Analysis of Alternatives, directs an AoA for Major Defense Acquisition Programs (MDAP). This regulatory direction is derived from statutory direction contained in Title 10 USC Sections 2366a and 2366b (a.k.a. Milestone A and B certifications to Congress, respectively), which requires an AoA for all potential or designated Acquisition Category (ACAT) I programs. Additionally, Title 40, Subtitle III of the U.S. Code (a.k.a. the Clinger-Cohen Act) requires AoA-like analysis in support of all Information System acquisitions to include National Security Systems (NSS) regardless of their potential or designated ACAT level. Be aware that Congress may modify the statutory requirements for AoAs via the annual National Defense Authorization Acts or other public laws. Although there is no statutory or regulatory guidance requiring an AoA for non-MDAPs, the MDA will likely require an AoA to support future milestone decisions.

**AoA and the Requirements Process**

The AoA is an important element of both the operational requirements and acquisition processes. Figure 1-1 shows the AF Deliberate Requirements Process and highlights when the AoA is conducted. In accordance with the direction in paragraph 1.1.2, the AoA is typically conducted during the Materiel Solution Analysis phase. Follow-on AoA updates may be conducted later during the Technology Maturation and Risk Reduction and the Engineering and Manufacturing Development phases as required.

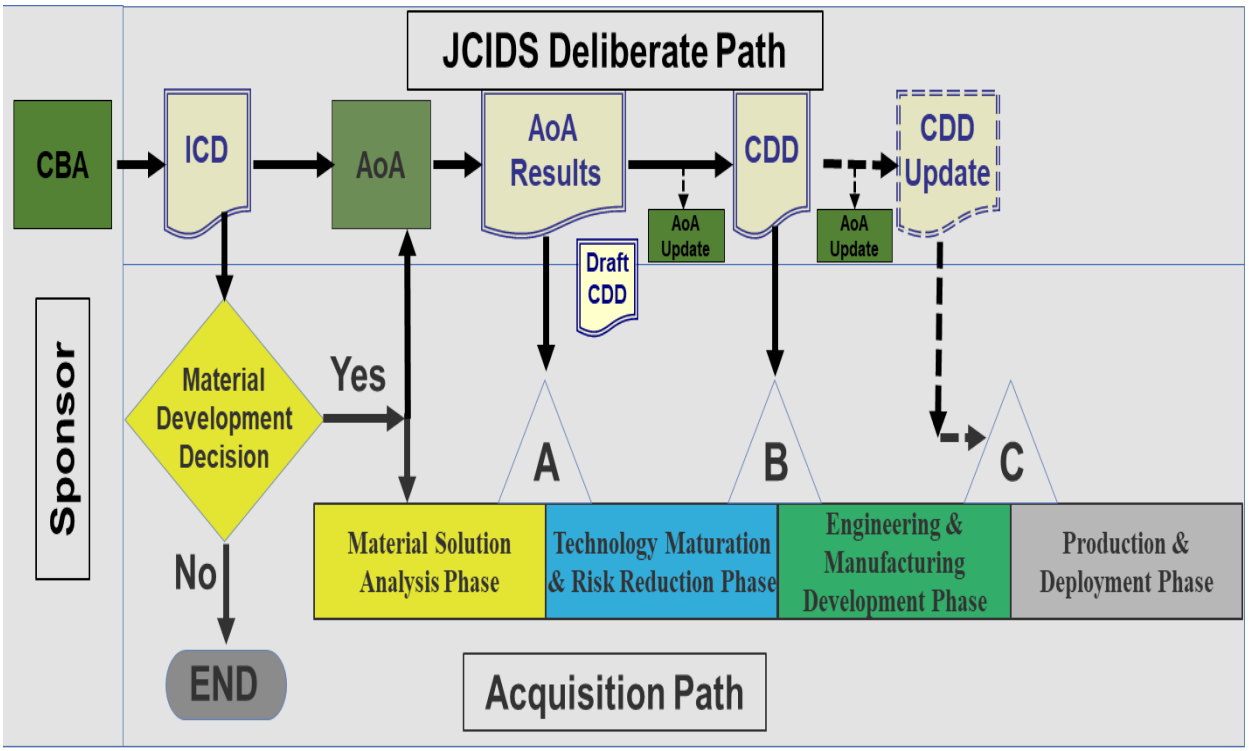



**Figure 1.1 – Deliberate Capability Development Process**

### 1.2. The AoA Process

The AF processes that trigger, initiate, plan, conduct, and approve the results of an AoA are shown in Figure 1.2. As the plans for developing the AF's future capabilities show the need for an AoA, the AF's process begins in the green "Start" block if all prerequisites are met. Figure 1.2 shows the three phases of an AoA (and associated documentation produced by the Sponsor) as well as the general duties and responsibilities at each level in the approval process. Each of the three phases will be discussed in the following sections.

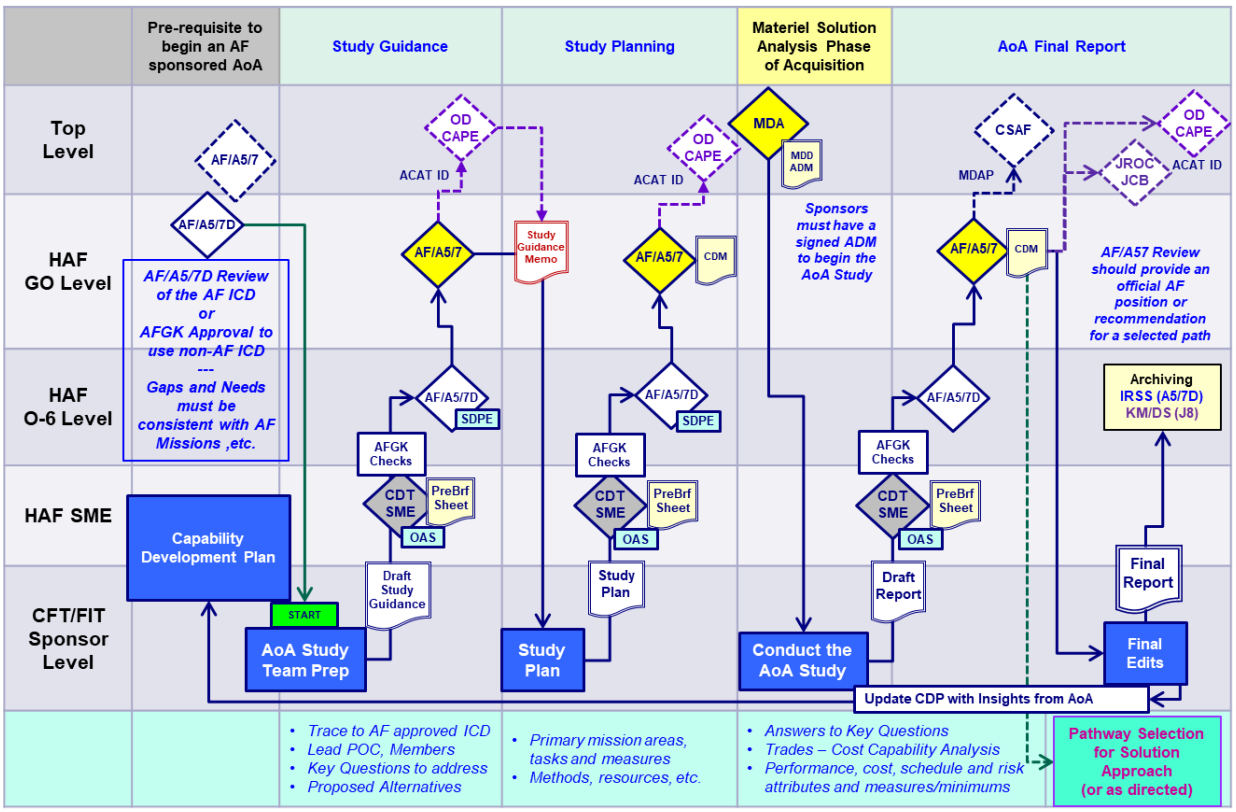



**Figure 1.2 – The AF AoA Process**

Note the inclusion of Director, Cost Assessment and Program Evaluation (DCAPE) in the AoA process. DCAPE is the approval authority for all AoA documents associated with ACAT I/Joint Requirements Oversight Council (JROC) Interest programs. For those AoAs where DCAPE elects not to provide oversight, the AF/A5/7D serves as the approval authority. It is a best practice to inform/consult with ODCAPE for all AoAs. There are circumstances where the Defense Acquisition Executive may delegate MDA to the Component-level or below. If that occurs, DCAPE will typically delegate AoA Study Guidance approval authority as well; however, one cannot assume that the first delegation implies the latter. AoA study leads should obtain documentation that explicitly captures the DCAPE delegation decision even if that entails nothing more than emails between the related action officers. Even when DCAPE 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.

The Office of Aerospace Studies (OAS) is a valuable resource in the conduct of an AoA. OAS has many 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. During AF-led AoAs, OAS is responsible for:

- Assisting AF/A5/7D, lead commands, and field agencies with the development of alternatives, Study Guidance, Study Plans, study organizing, and study execution.
- 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, Air Force Gatekeeper (AFGK), lead commands, teams, and stakeholders during the planning, execution, and review of the analysis.
- Facilitating study team efforts during development of the study guidance, and the study plan.
- Assessing the study guidance, the study plan, and the final report/briefing. The assessment is advisory and given to the team, lead command, AFGK, and AF/A5/7D.
- To fulfill these responsibilities, OAS appoints an advisor to help the study director during the initial planning stages of the AoA. The advisor assists the study director in identifying stakeholders and AoA study team members. Once the 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 the plan.

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. The advisor ensures that the study questions are fully addressed in the final report and comply with the study guidance. The advisor facilitates the staffing of all AoA documentation and assists the study director and team in preparing for all required AoA reviews.

As part of the AoA Study Plan staffing process, the OAS conducts a risk assessment of the plan for the AFGK and AF/A5/7D. This assessment assists the Air Force in determining the quality of the plan and the extent of the risks associated with conducting the AoA. During final report development, OAS assesses the final report for the AFGK and AF/A5/7D. This assessment assists the Air Force in determining the overall quality of the analysis and the risks associated with any recommended courses of action.

## 1.3. AoA Start and Approval of Study Initiation (Phase 1 of 3)

Figure 1.3 shows Phase 1 of the AoA process.

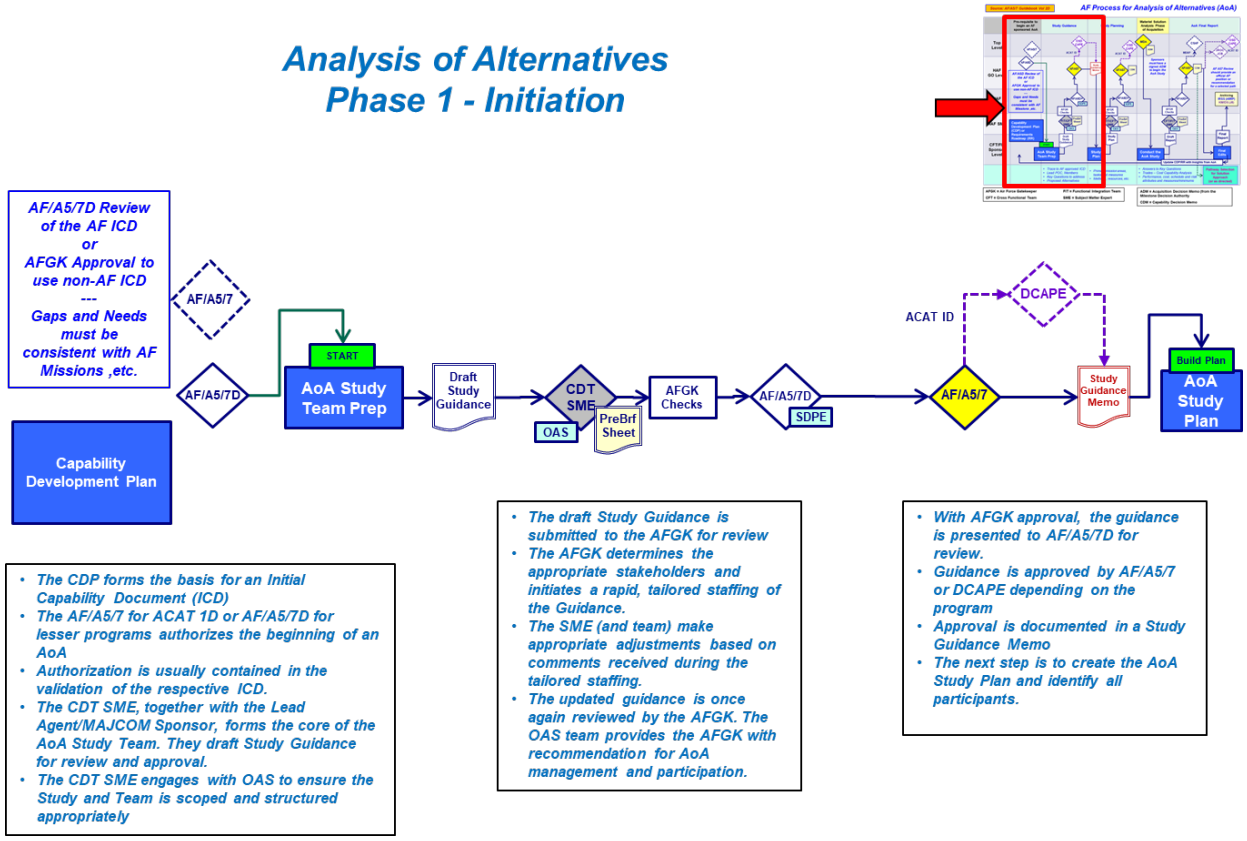



**Figure 1.3 – The AF AoA Process, Phase 1**

### Approval to Proceed

Generally, AoA activity is initiated by a lead command/sponsor in response to one or more validated capability gaps identified in an Initial Capabilities Document (ICD) or multiple ICDs following the determination (via early systems engineering and development planning or similar activity) that there are candidate solutions that have the potential to address the gaps effectively and affordably. The sponsor is typically a lead MAJCOM, but other types of organizations may also be designated as the lead for an AoA.

An AoA may also be initiated by the MDA. The AoA Study Plan and the AoA Final Report may also be updated as needed by the MDA later in the capability development and acquisition processes. The MDA my direct AoA updates to support Milestone B or C decisions.

Finally, an AoA may be initiated through higher-level guidance or direction. Organizations such as the Office of the Under Secretary of Defense for Acquisition & Sustainment (OUSD(A&S)), ODCAPE, and the United States Congress can provide guidance as to whether an AoA should be initiated.

Approval to proceed with AoA activity is dependent on several criteria including the status of the validation review of the associated ICD or AF/A5/7D 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.

When an AoA is initiated, typically a Study Advisory Group (SAG) is established. The details of SAG establishment and responsibilities are detailed later in this guidebook.

**Study Team**

The membership for an AoA Study Team will include representatives from the appropriate AF/A5/7D (Center 2) Capability Development Team (CDT). Study sponsors should also consider including the appropriate mission area, Lead Agent/MAJCOM, Operating/Implementing Command(s), HAF Division(s), Air Force Materiel Command) AFMC office of SDP&E, representatives from other agencies/services, combatant commands, and others as needed. The Study Team may subdivide into Working Groups to tackle specific tasks such as developing the study guidance and the study plan. Working groups are described later in this guidebook.

- Sponsors must use Requirements Manager Certification Training (RMCT)-certified requirements managers for the AoA management and for writing the Final Report. To comply with JCIDS guidance, AoA Study Leads must be at least RMCT Level B-certified (refer to AF/A5/7 Capability Development Guidebook Vol 2A, and 2021 JCIDS Manual for more information on RMCT).
- Study Sponsor/Lead and Working Group leads must complete AoA/study training provided by AF/A5/7DY-OAS, as well as the Defense Acquisition University online continuous learning module CLR 151, Analysis of Alternatives.
- All DWT members are encouraged to complete AoA/study training provided by AF/A5/7DY-OAS, as well as the Defense Acquisition University online continuous learning module CLR 151, Analysis of Alternatives.

Study Team planning, study activity and AoA document development (study initiation, study plan, and final report) must include direct assistance from AF/A5/7DY-OAS and the topic-appropriate AF Futures CDT Subject Matter Expert (SME). Study leads must be familiar and follow the AoA guidance described in this Guidebook as it represents the approved AF guidance and best practices for conducting the AoA. The study team should also review the AoA guidance in the 2021 JCIDS Manual and DoDI 5000.84, Analysis of Alternatives.

All AoAs involving nuclear deterrence capabilities or missions must include direct assistance from the AF Nuclear Red Team (AFNRT). Due to the sensitive nature and limited distribution of AFNRT findings, study leads need to utilize an AFNRT advisor/consultant to inform the study. OPR is the AF Nuclear Weapons Center (AFNWC.NT.Workflow@us.af.mil).

MAJCOM/Agency POCs need to notify AF/A5/7DR and AF/A5/7DY-OAS before initiation or participation in any study or analysis activities, regardless of AF or non-AF sponsorship/leadership. Provide AF/A5/7DR and AF/A5/7DY-OAS with courtesy copies of any study initiation, guidance, study plan, and final report for any non-AF studies and analyses in which AF MAJCOM/Agency members are participating.

**Study Initiation Notice**

For AoAs not subject to DCAPE approval of study guidance, such as for ACAT II or III programs, Sponsors will submit a Study Initiation Notice (SIN) to the Joint Staff studies repository. For AoAs subject to DCAPE approval of study guidance, such as for ACAT I programs, visibility into DCAPE approval of AoA study guidance serves to inform JCIDS stakeholders that an AoA is underway. The Sponsor completes the SIN and submits if via Information Resource Support System (IRSS) for review and approval by the AFGK (or higher), followed by submission to the Joint Staff Gatekeeper. This process is not on the AoA critical path and so is not shown in Figure 1.3. Details on submitting a SIN are in Appendix E of this Guidebook.

The Study Initiation Notice (SIN) is a memo signed by the Sponsoring MAJCOM/Agency Director of Requirements and provided to the Joint Staff Gatekeeper. It is loaded into the Joint Staff Studies Repository and facilitates greater visibility into ongoing studies, encourages collaboration, and reduces unnecessary duplication of current study efforts. The SIN informs the AF and Joint community, allows important stakeholders to participate, and ensures the AoA informs important capability development decisions.

If the AoA is terminated prior to providing any significant results, the Sponsor (working through the AF/A5/7 SME) must provide a Study Termination Notice (via IRSS) for review by the AFGK, followed by submission to the Joint Staff Gatekeeper. Refer to Appendix E of this Guidebook for details.

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 Working Integrated Product Team (WIPT), described later in this document, 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. The organization that ultimately approves and issues the study guidance will depend on several factors. As described previously, staffing, validation, and approval guidelines for the study guidance and study plan are dependent upon the Joint Staffing Designator (JSD) and anticipated ACAT level for the effort.

Sponsors obtain AFGK (or higher) approval prior to proceeding with development of the AoA Study Plan. The approval decision and associated actions/guidance related to the AoA are documented in writing (e.g. Capability Guidance Decision Memo (CDGM), meeting minutes, email, staff summary, decision chart, etc.) and archived in IRSS. AF/A5/7DY-OAS (in consultation with AF/A5/7 CDT SME) provides a review/assessment of the SIN and this review must be conducted prior to AFGK review/approval.

## 1.4. AoA Study Plan and Execution (Phase 2 of 3)

Figure 1.4 shows Phase 2 of the AoA process, Study Plan development and AoA execution

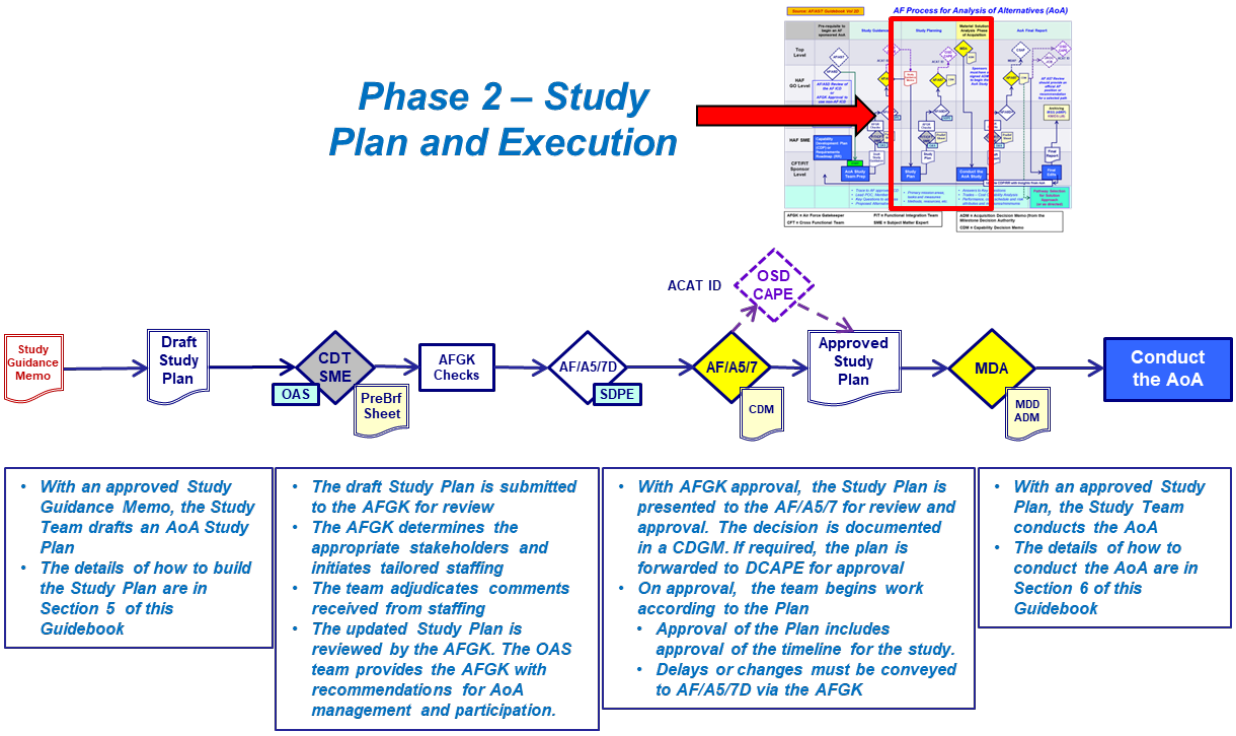



**Figure 1.4 – The AF AoA Process, Phase 2**

With approved study guidance the study team develops 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. 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, DCAPE). The draft study plan undergoes formal staffing and review before it is approved.

Following development and coordination of the AoA study plan, the team will brief the MDA at the Materiel Development Decision (MDD). The MDA is 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 officially directs execution of the AoA and designates the AoA lead Component/MAJCOM (as appropriate); determines the acquisition phase of entry; and identifies 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. The MDD planning process, best practices, and a sample MDD Notification Memo are at Appendix P.

### 1.5. Approval of Findings and Final Report (Phase 3 of 3)

The process for review and approval of the AoA Final Report and associated findings and recommendations is shown in Figure 1.4 below.

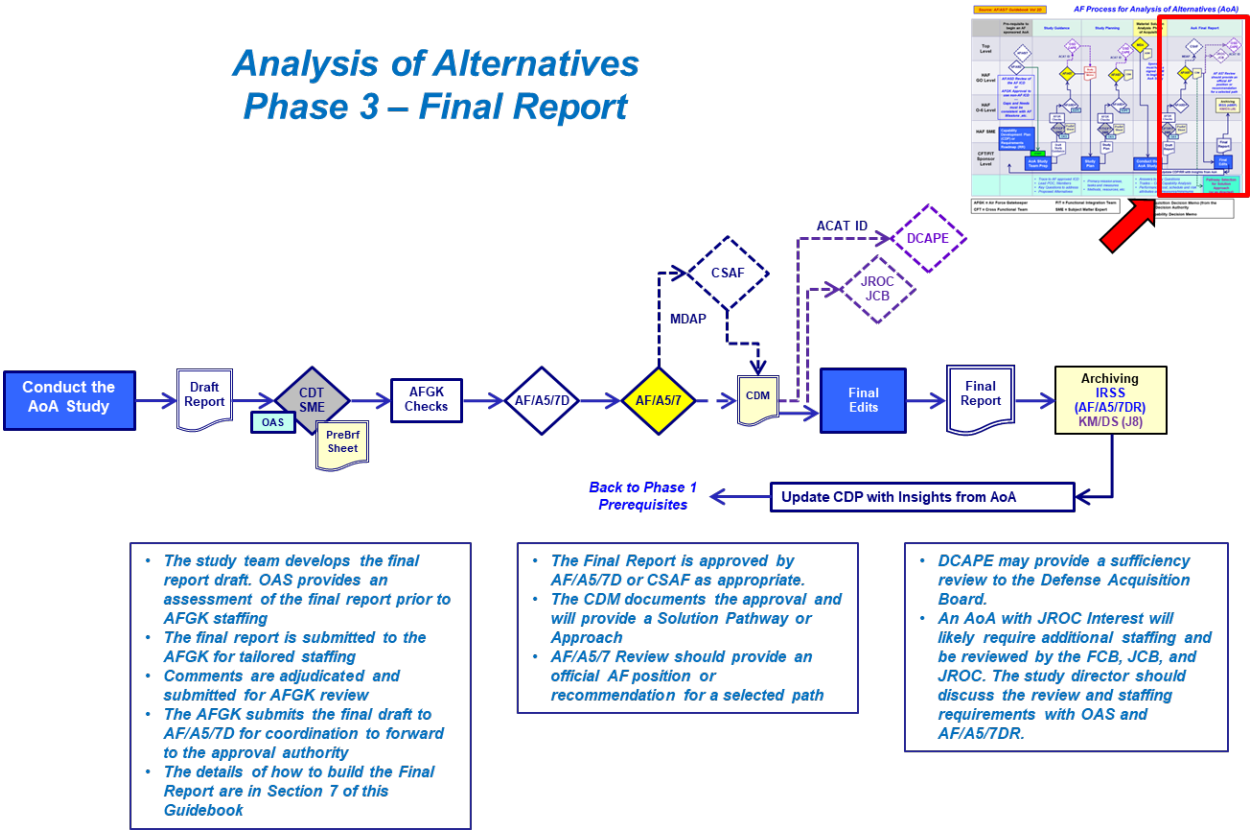



**Figure 1.5 – The AF AoA Process, Phase 3**

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 (appendix) in this guidebook, which can be tailored for the study, as a guide in developing the Final Report.

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, the MDA, and other appropriate Office of the Secretary of Defense (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 this guidebook. Teams should be aware that the Final Report is not complete until it has been reviewed, validated, and approved by (as appropriate) the SAG, the AFGK, the MDA, other stakeholders, and has been deemed sufficient by DCAPE or AF/A5/7D.

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. A calculator for determining the cost of a study or report can be found on the ODCAPE Cost Guidance Portal under the "DoD studies and reports" (https://costguidance.osd.mil/CostGuidance/). Contact DCAPE for more information on estimating the cost of the AoA.

The AoA Final Report captures and presents the methodology and results of the assessments and analysis derived from the Study Guidance and Study Plan. Additional guidance for how to write a AoA Final Report is available in Section 7 of this Guidebook.

In compliance with JCIDS guidance, Sponsors must use RMCT certified requirements managers for development of the Final Report. Study Leads must be certified at least RMCT Level B. Additionally, Sponsors and Study Teams must have direct assistance from AF/A5/7DY-OAS to conduct the AoA and write the AoA Final Report.

## SECTION 2. FORMING THE STUDY TEAM

### 2.1. Forming the AoA Study Team

This section 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 Document Writing Team (DWT) membership as well as the CBA and pre-MDD analysis study teams.

### 2.2. When is the Study Team Formed?

As described in Section 1, there are several ways that an AoA can be initiated. The sponsor 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 stakeholder.

Given that there are several ways that an AoA may be initiated, there may be situations where the sponsor 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.

### 2.3. Determining the Level of Effort

Regardless of how the AoA is 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.

In the past, some AoAs have lasted more than two years – DoDI 5000.84 now specifies AoA execution must be scoped to 9 months. This tight timeline requires study teams to carefully plan the AoA prior to study execution. Study teams must thoroughly review DoDI 5000.84 to develop an executable plan. Pay careful attention to long-lead items such as the security construct, alternatives, and modelling.

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?
- 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 the concepts sufficiently documented in Concept Characterization and Technical Descriptions (CCTDs)?
- Will this AoA require special security considerations?
- What remaining information needs to be learned from the AoA?
- Are significant Doctrine, Organization, Training, materiel, Leadership and Education, Personnel, Facilities, and Policy (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 are 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 contracts. Also, Federally Funded Research and Development Centers 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.

### 2.4. 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. These risks must be identified to the AoA Study Guidance approval authority so that the appropriate AoA scope, time, and resources are

defined. 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, when compared to the same study conducted with less constrained time and resources. 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 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. For more information about the AoA risk assessment, see Section 5.

### 2.5. Stakeholder 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.

#### 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 because of these activities. Asking the following questions can help identify members of the stakeholder community:

- Who are the end-users (e.g., Combatant Commands, 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?
- 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., CDT, 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). AF/A5/7D representatives (including OAS, AF/A5/7DR, and/or CDT 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 this Guidebook, at a minimum) to participate in the study since they will likely be candidates for membership in the WIPT.

**Study Director**

The study director leads the study team in planning and conducting the AoA. The study director is sometimes referred to as the study lead. For this document, the study director and study lead are used synonymously. The study director is normally appointed by the CDT, or lead command. The study director must be a government employee (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. A M&S Accreditation Guide is at Appendix N of this Guidebook.
- Coordinating approval of required documentation.
- Briefing special groups and stakeholders.

**Study Team Members**

Team membership normally includes operators, logisticians, intelligence analysts, cost estimators, and other functional specialists. As noted above, study team membership should include representatives from the stakeholder community such as the appropriate CDT, 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.

**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 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 study. The lead command, HAF/A5/7D representatives (including OAS, A5/7DR, or CDT 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 forms a WIPT to help coordinate and manage the activities of the working groups. The WIPT may also be referred to as the Core Team or some other terminology. For this guidebook, this team will be referred to as a WIPT.

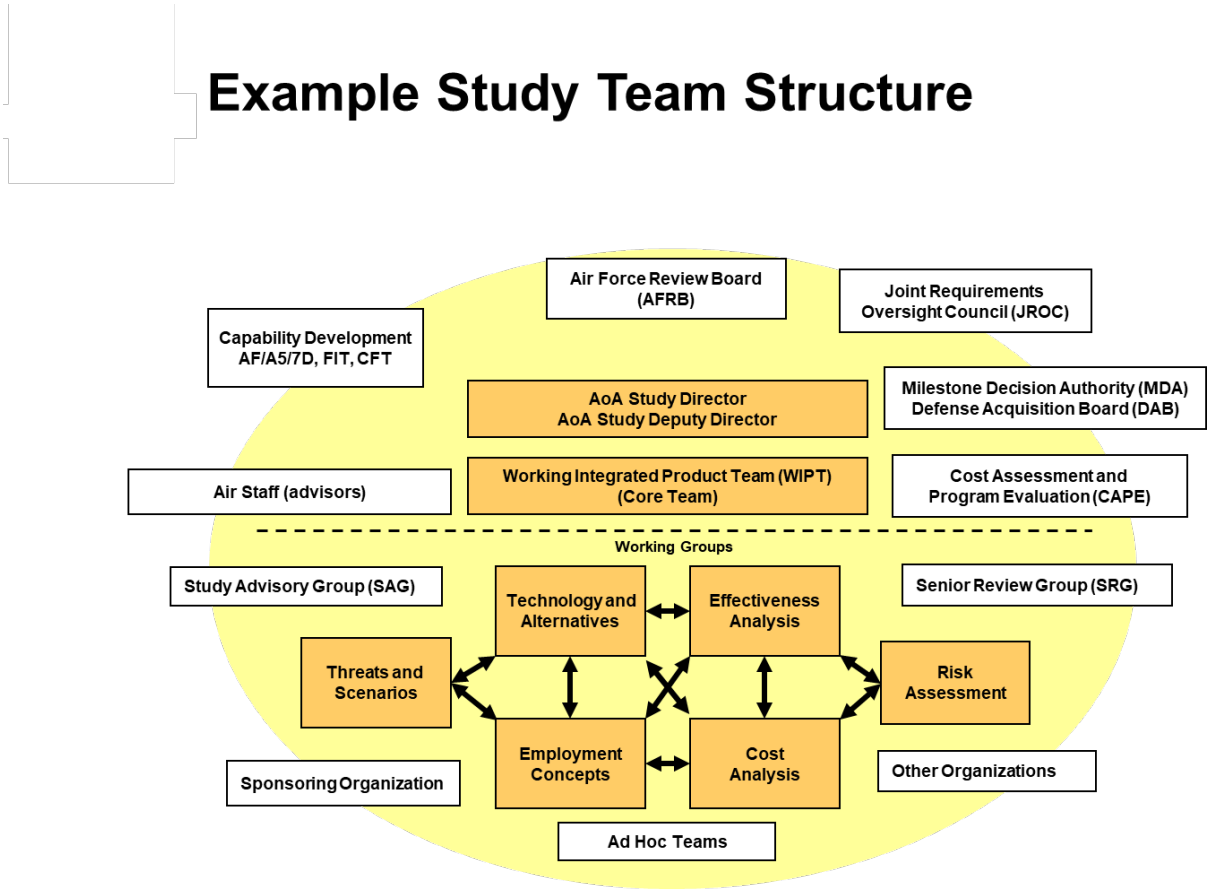



**Figure 2.1 – Example Study Team Structure**

### 2.6. 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 Microsoft Teams, 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 Development Planning (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:

- Identify appropriate scenarios (and/or vignettes) for use in the study. If necessary, develop a stressor matrix to compare multiple scenarios and identify most appropriate

- Present scenarios and vignettes to the WIPT and other study oversight groups for approval
- If needed, develop detailed vignettes based on the selected scenarios
- If needed, 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 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. Another name commonly used for this group is the Operational Concepts Working Group (OCWG).

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.
- 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.

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 the appropriate CBA, ICD, or Capability Development Plan (CDT).

**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)
- 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. AFCAA should respond to the team's request and identify what, if any, involvement they will have in the AoA.
- 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

**Risk Assessment Working Group**

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

**2.7. Ad-Hoc Teams or Groups**

Ad hoc teams or groups may be formed during 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 guidebook). The team would be responsible for integrating the effectiveness, cost, and risk results to identify the most viable alternatives.

All studies involving nuclear deterrence capabilities or missions must include direct assistance from the AF Nuclear Red Team (AFNRT). Due to the sensitive nature and limited distribution of AFNRT findings, study leads need to utilize an AFNRT advisor/consultant to inform the study. OPR is the AF Nuclear Weapons Center (AFNWC.NT.Workflow@us.af.mil).

**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 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 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):

- The USD (A&S) is the MDA for ACAT ID programs and ACAT IAM programs that have not been delegated. The USD (A&S) conducts Defense Acquisition Board (DAB) Reviews for ACAT ID and IAM programs at Major Milestone decision points, at the Full-Rate Production (FRP) Decision Review, at Interim Program Reviews, and at other times as necessary. (See DoDI 5000.02 for more information). For these programs, a representative from USD A&S will likely chair or co-chair the AoA SAG.
- The DCAPE develops and issues study guidance and approves study plans for the AoAs for MDAPs. CAPE evaluates the adequacy of each AoA for MDAPs. (See DoDI 5000.84 for more information). A major responsibility of ODCAPE is assessing whether the AoA final report is sufficient to inform future acquisition decisions. For these programs, a representative from ODCAPE will likely chair or co-chair the AoA SAG.
- If USD A&S 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 likely 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 United States (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. Before going directly to the Joint Staff, discuss JCS participation with the appropriate Air Staff functional and Air Staff Functional Capability Board (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:
    - AF/A5/7D: AF/A5/7 Air Force Futures, Center 2
    - 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.

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**

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 several 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.

**Other Oversight Groups**

There are several other oversight groups that may be involved in the AoA. Roles and responsibilities for the AFGK, CDT, FCB, JCB, and JROC are described in the Capability Development Guidebooks and other publications. 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 that reviews and approves AoA documents and presentations before they are released to organizations external to the command.
- Air Force Review Board (AFRB). For MDAPs, AFRBs are used to develop the AF corporate consensus prior to an OSD DAB (pre-DAB within AF) or Information Technology Acquisition Board.

  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 a program requires an AFRB. 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 Overarching Integrated Product Team (OIPT) described below. Membership is tailored as required to address potential issues.
- OSD Overarching Integrated Product Team: An Integrated Product Team (IPT) led by the appropriate OSD director, and composed of the Program Manager (PM), PEO, component staff, user/user representative, and OSD and Joint Staff members involved in the oversight and review of a particular ACAT ID or ACAT IAM program.
- Defense Acquisition Board (DAB): is supported by the OIPT. Each OIPT facilitates communication and vets issues before the DAB meets. At the Milestone Decision Review, the OIPT leader provides the DAB members with an integrated assessment of program issues gathered through the Integrated Product Team (IPT) process as well as various independent assessments. Success is defined as affordable, executable programs that provide the most value achievable for the resources invested by the Department.

## SECTION 3. PLANNING THE WIPT

The AoA study guidance and plan are normally developed during two separate WIPT events comprised of AoA study team members and other stakeholders. This section describes the WIPT and offers some recommendations for planning the event.

### 3.1. How Does the WIPT Relate to the DWT?

In the Air Force, Document Writing Teams (DWTs), are used to develop requirements documents. As much as possible, core members of the various DWTs that are formed to develop documents are reconvened as requirements mature. This concept is referred to as the enduring DWT. The objective of the enduring DWT 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 as concepts mature; 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 DWT, and others may be added, when appropriate.

Ideally, the AoA study team evolves from the ICD DWT 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.

**WIPT Lead**As noted in the previous section, the CDT, 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 participants, leading the execution of the WIPT, and providing support to document WIPT outcomes and actions.

**Facilitator**

As described in this Guidebook, the Sponsor develops the draft AoA study guidance and plan with direct assistance from AF/A5DY-OAS. If requested by the WIPT lead, OAS will facilitate the WIPTs for developing the AoA study guidance and plan. 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
- 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. The facilitator prepares for the WIPT event by reviewing and understanding the Strategic Requirements Document (SRD), Capability Development Plan (CDP), CBA, Solution Pathway Review (SPR), ICD, 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 event will also allow the facilitator to gain insights into the politics, issues, subject matter, and personalities involved.

**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 ODCAPE and OUSD(A&S), 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 ODCAPE is willing to provide a draft of their guidance for discussion and/or proposed revision at the WIPT. This is also true when HAF/A5/7 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/A5/7D. As described previously, the AoA study guidance and study plan WIPTs should be an extension of the enduring DWT that was initiated for developing the ICD or other efforts. 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 Section 2 for additional guidance regarding WIPT membership). In addition, the WIPT lead should consider the following:

- CBA Study Team Members and ICD Document Writing Team (DWT) Members. The study team members of the CBA(s) and members of the ICD DWT 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.

**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.

**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 MS Teams or 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.

### 3.3. 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.

### 3.4. 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.

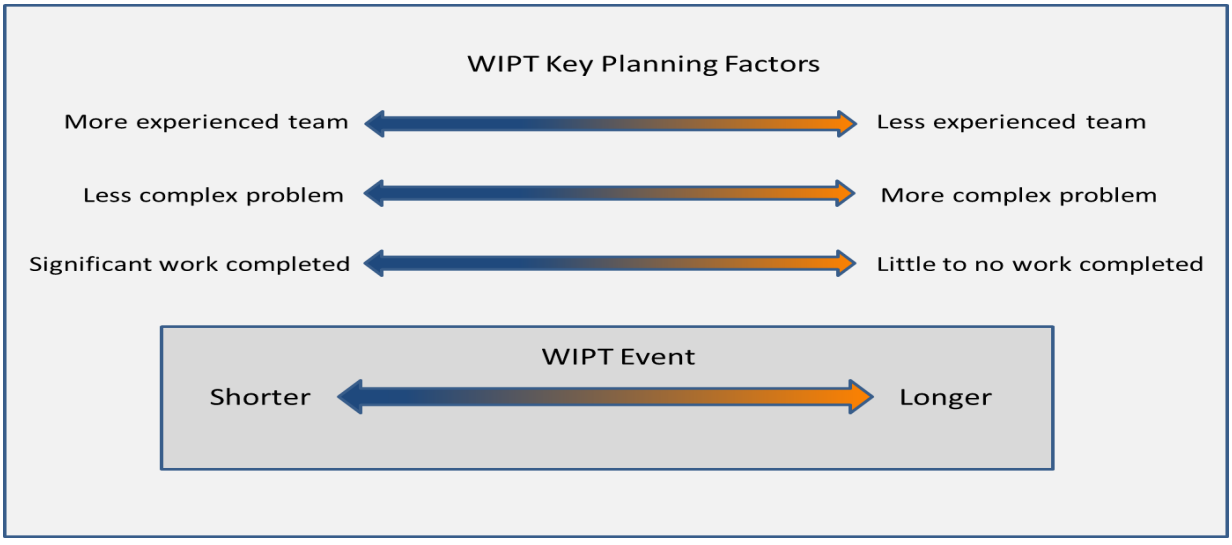



**Figure 3.1 – Key Planning Factors and Length of WIPT Events**

### 3.5. 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 ODCAPE study guidance template (Appendix F). Unlike ODCAPE, for AF delegated studies, AF/A5D does not have an official study guidance template. Given that the ODCAPE study guidance template addresses most of these items, OAS recommends that the WIPT use the ODCAPE template as a starting point and tailor it as necessary to develop the HAF/A5/7-issued study guidance.

For some studies, there may be reasons to add, omit, or change parts of the ODCAPE study guidance template. In these situations, it is vital to discuss template modifications with ODCAPE as early as possible. In addition, it is also possible that the Air Force will have concerns and questions that ODCAPE does not view as a priority. These may need to be addressed by the WIPT, documented, and discussed with ODCAPE for inclusion in the ODCAPE-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 AF/A5/7D).

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 Section 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 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.

### 3.6. 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 G). 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 Section 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.

### 3.7. 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 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.

#### 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 subject area 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. 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. 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:

- Defense Technical Information Center: www.dtic.mil
- Information and Resource Support System (IRSS): SIPR account required, contact OAS advisor or AF/A5/7DR for assistance.
- Defense Acquisition University (ACQuipedia): https://www.dau.edu/tools/t/ACQuipedia
- Department of Defense Chief Information Officer Website: http://dodcio.defense.gov/Library/DoDArchitectureFramework.aspx
- Rand Corp: www.rand.org
- The Knowledge Management/Decision Support system: For instructions go to the JCIDS NIPRNet page: https://intellipedia.intelink.gov/wiki/JCIDS

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 above, the team should review the following key documents:

- Relevant CBAs, AoAs, and capability development documents (SRD, CDP). 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 JCIDS documents are particularly useful for understanding the traceability of requirements.
- Solution Pathway Review (SPR). There may be multiple SPRs that should be reviewed. The initial SPR is typically conducted after the CBA to garner approval to proceed with developing a requirements document, but follow-on SPRs may have been completed for other purposes.
- Concept Characterization and Technical Description (CCTD) documents. There may be CCTD documents that have been developed in previous DP efforts or in other studies that describe concepts to 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.
- OAS Products. In addition to this guidebook, there are several OAS products that are useful for planning and conducting an AoA contained as Appendices to A5/7 Guidebook, Vol 2J, Document Writing Team:
    - Measures, Appendix A guides analysts in developing and analyzing measures of effectiveness, suitability, and performance for the AoA and other capability requirements studies. It supplements the AoA Guidebook by providing more detailed measures development and analysis guidance.

- Survey Research, Appendix B 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, it also presents an approach to conducting expert elicitation in the AoA and other operational capability requirements studies. The Survey Research appendix supplements the AoA Guidebook and Measures appendix by providing a comprehensive discussion of survey research principles.

## SECTION 4. AoA STUDY GUIDANCE

### 4.1. Developing the AoA Draft Study Guidance

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

### 4.2. What is the 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. The organization that ultimately approves and issues the study guidance will depend on several factors. 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. DOD-5000.84 and this Guidebook provide details regarding these guidelines. AoA study guidance (and study plan) must be provided prior to the MDD.

### 4.3. WIPT Tasks

As described in the previous section, 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 ODCAPE study guidance template (Appendix F). Depending on the planning factors discussed in Section 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 AF/A5/7 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 adjust 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 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 section, there may be reasons to add, omit, or change parts of the ODCAPE study guidance template for some programs. In these situations, it is vital to discuss template modifications with ODCAPE 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 ODCAPE does not view as a priority. In this case and if needed, AF/A5/7D approves any additional AF guidance to supplement the ODCAPE guidance. This AF-specific guidance supplement may need to be addressed by the WIPT and documented, but not necessarily included, in the ODCAPE-issued guidance. Finally, for AF-delegated studies, AF/A5/7D approves the AoA study guidance.

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

**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 ODCAPE AoA Study Guidance is being developed, the WIPT lead, or facilitator should strongly consider providing a review of the ODCAPE 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 appropriate CDT 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.

**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, as well as the documents that have been produced (e.g., SRD, CDP, CBA, CDM, 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, SPRs, ICDs, memorandums, ODCAPE discussions, and existing pre-MDD analyses to develop the AoA Study Guidance.

**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. 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 by describing what is, and is not, in the study. Ultimately, the scope is driven by the information decision makers need to decide; previous analyses; and ground rules, constraints, and assumptions.

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

- Decision to be supported
- Capability gaps to be assessed
- 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
- End-to-end mission effects chain
- 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 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).

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, 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.

**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 AF/A5/7D, 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 AF/A5/7D, or higher-level review and approval.

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, to focus on more important sections of the study guidance.

**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 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.

ODCAPE emphasizes the exploration of the full range of viable modifications to baseline systems in the AoA. These alternatives are generally referred to as baseline+ or modified baseline. The WIPT should consider having multiple alternatives with appropriate modifications, rather than one with all potential modifications.

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.

Like 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.

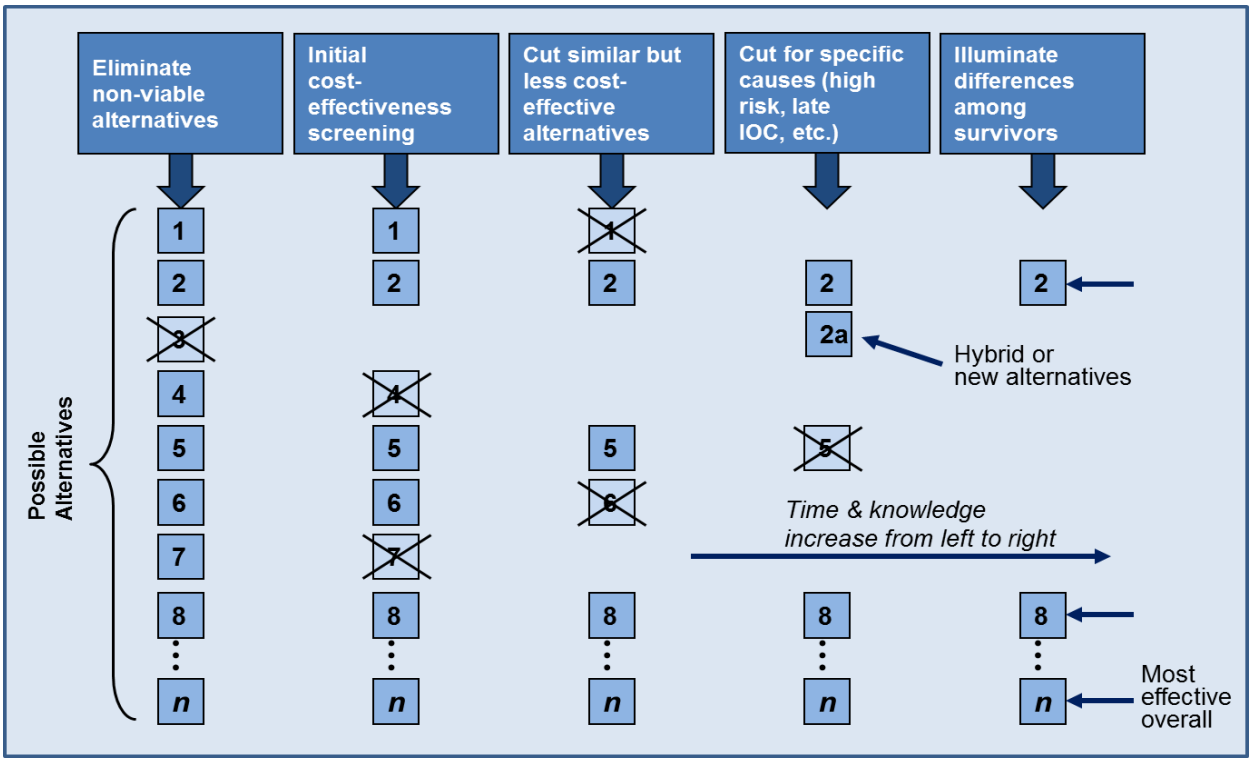



**Figure 4.1 – Screening Alternatives**

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, ODCAPE, 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.

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

Depending upon the JSD and anticipated ACAT level for the effort, AoA Study Guidance may be issued by either ODCAPE or AF/A5/7D. If the guidance is issued by ODCAPE, the Air Force typically will propose

questions or provide a draft 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 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 considers 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 ODCAPE AoA Study Guidance Template (Appendix F) 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 is 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 AF A5/7 direction the CDT or lead command should have received prior to forming the WIPT. Some questions will reflect issues ODCAPE or other stakeholders have that the CDT or lead command may not have considered.

**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 Concept of Operations (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 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 to (intentionally or unintentionally) 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.

**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). The WIPT may not know what all the measures are at this time but should acknowledge they must be developed to conduct the analysis. DoDAF views OV-2, OV-5a, CV-2, and CV-6 may be useful in developing measures.
- Specific tools or techniques that the study team plans to use or is considering, such as M&S applications (e.g., BRAWLER, SUPPRESSOR), parametric analysis, expert elicitation.
- Cost capability analysis and other sensitivity analysis that will be conducted. 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 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., JCIDS Manual Risk Assessment; 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 ODCAPE 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. If one or more vignettes from standard scenarios will be used, the study team should describe them and provide rational for their use. 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.
    - 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. 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.
- 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 should be 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 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).

- 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 ICD and draft 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 ODCAPE AoA 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 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 director will:
        - Ensure the Fully Burdened Cost of Energy (FBCE) method is used in computing costs for the 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.

- Requirements sponsors will notify SAF/IEN after MDD to facilitate data gathering for Energy Supportability Analysis during the AoA in support of a prospective Energy KPP

**Task 9: Developing the Administrative Guidance**

The administrative guidance describes the oversight and staffing requirements associated with the AoA Study Plan and the AoA Final Report. The ODCAPE study guidance typically describes a staffing or review process for presenting the AoA Study Plan and the AoA Final Report for review and approval (see the ODCAPE AoA Study Guidance template in Appendix F). After CDT, or lead command review, the study guidance is submitted to the AFGK for review, and then AF/A5/7D (or higher) for approval to be released to ODCAPE, if required. For those AoAs where DCAPE elects not to provide study guidance, AF/A5/7D will serve as the approval authority.

Administrative guidance that is specific to the ODCAPE AoA Study Guidance includes the following:

- Study Advisory Group. 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.
- 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.
- For Air Force-issued guidance: The WIPT will need to determine what aspects of the administrative guidance apply. For DCAPE-issued guidance, see Appendix F (ODCAPE) AoA Study Guidance template) for more information.

### 4.4. 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 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 CDT, or lead command review, the study guidance is submitted to the AFGK for review, and then AF/A5/7D (or higher) for approval to be released to ODCAPE, as required. For those AoAs where DCAPE elects not to provide study guidance, the AF/A5/7D will serve as the approval authority.

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.

## SECTION 5. AoA STUDY PLAN

### 5.1. Developing the AoA Study Plan

Like the AoA Study Guidance, the AoA Study Plan can be developed in a 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 section provides guidelines on developing the AoA Study Plan.

### 5.2. 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 and 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 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 some 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, ODCAPE.

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. This guidebook describes the staffing requirements for an AoA Study Plan.

### 5.3. 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 G). Depending on the planning factors discussed in Section 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 ensure 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 section provides specific guidance for each of the tasks. Upon completing the tasks, the WIPT will have developed an initial AoA Study Plan.

**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 AoA Study Plan template, or any other issues.

**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 or AF/A5/7D as well as the documents that have been produced (e.g., SRD, CDP/RR, CBA, 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 SRD, CDP, CBA, ICD, CD memorandums, ODCAPE discussions, and existing pre-MDD analyses to develop the AoA Study Plan.

**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.

**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:

**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 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.

**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.

The purpose should highlight how the results of the AoA will be used to inform the MDA at the next milestone. 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.

**Section 1.3: Study Guidance**

The key aspects of the AoA Study Guidance from ODCAPE 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.

**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 AF/A5/7D, the WIPT lead and facilitator should ensure the capability gaps that will be addressed in the AoA align with those described in the CBA and ICD. Any changes to the capability gaps identified in the ICD(s) will require AF/A5/7D or higher review and approval.

**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 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.

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

In this section, the WIPT describes the key AoA 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 Section 4).

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.

**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 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 section 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 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.

**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 Section 2 (Alternatives) of the study plan. The following provides specific guidance for each section of the chapter:

**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 Section 4).

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 Section 2, the 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.

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 AF A5/7D 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. During 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, alternatives may be further screened from the study with the approval of the SAG or senior review group during development of the plan.

CCTDs are required at the AFRB that is conducted prior to MDD. For more information about the CCTD, see the Concept Characterization and Technical Description (CCTD) Guide, SAF/AQ.

**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, and family of systems
- 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

**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 Section 4). 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.

Often 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 (formerly known as the Analytical Agenda) products such as DPSs), Multi-Service Force Deployment documents, Analytical Baselines, and 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 SAG.

**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. 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 CDD Update; DoDAF views; and other sources of information (e.g., Tactics, Techniques, and Procedures (TTPs), Combat Air Forces standards, Joint Mission Essential Task Lists (JMETL), Universal Joint Task Lists (UJTL). 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 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. Figure 5-1, General Approach for Effectiveness Analysis, shows the flow of analysis tasks required for a typical study.

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 and whether Intelligence Supportability Analysis (ISA) is required. For more information about suitability, see Appendix I.

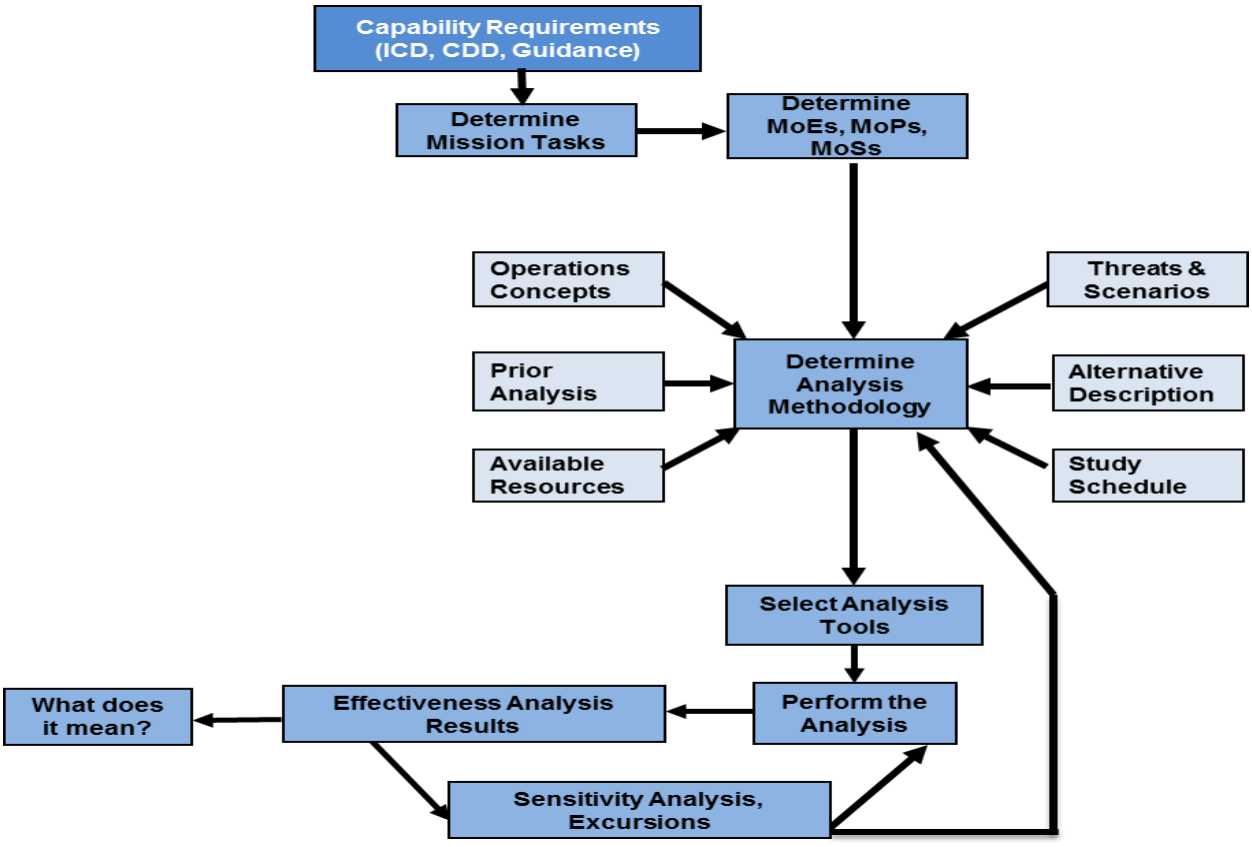



**Figure 5.1 – General Approach for Effective Analysis**

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:

**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 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. 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 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.

The mission is a statement of the action to be taken and the reason behind the action. A task describes what is expected to be performed and is commonly expressed as an action or activity. An attribute is a quality or feature of something (e.g., survivability, persistence, availability). Conditions describe the environment under which the mission will be performed.

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.

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 Appendix to A5/7 Guidebook Vol 2J.

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.

For more information about identifying tasks, attributes, and conditions, see The Measures Appendix to A5/7 Guidebook Vol 2J.

Other sources of information include the following:

- Joint Capability Areas (JCAs),

- Task lists (e.g., UJTL, JMETL, Mission-Essential Task List, Air Force Task List, other Service task lists)
- Support for Strategic Analysis (formerly known as the Analytic Agenda) documents (e.g., Defense Planning Scenarios (DPSs), ISCs)
- Planning and operations-related documents (e.g., OPLANs, Concept Plans, CONOPS, CONEMPs, and TTPs)
- Concept documents (e.g., CCTDs, JCTD reports, SRD, and CDP)
- 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 MOEs, MOSs, and MOPs. Measures should address what is most important in accomplishing the tasks to include relevant enabling capabilities such as 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.

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 |

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 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. 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 M&S, parametric analysis, and expert elicitation. 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.

**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:

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

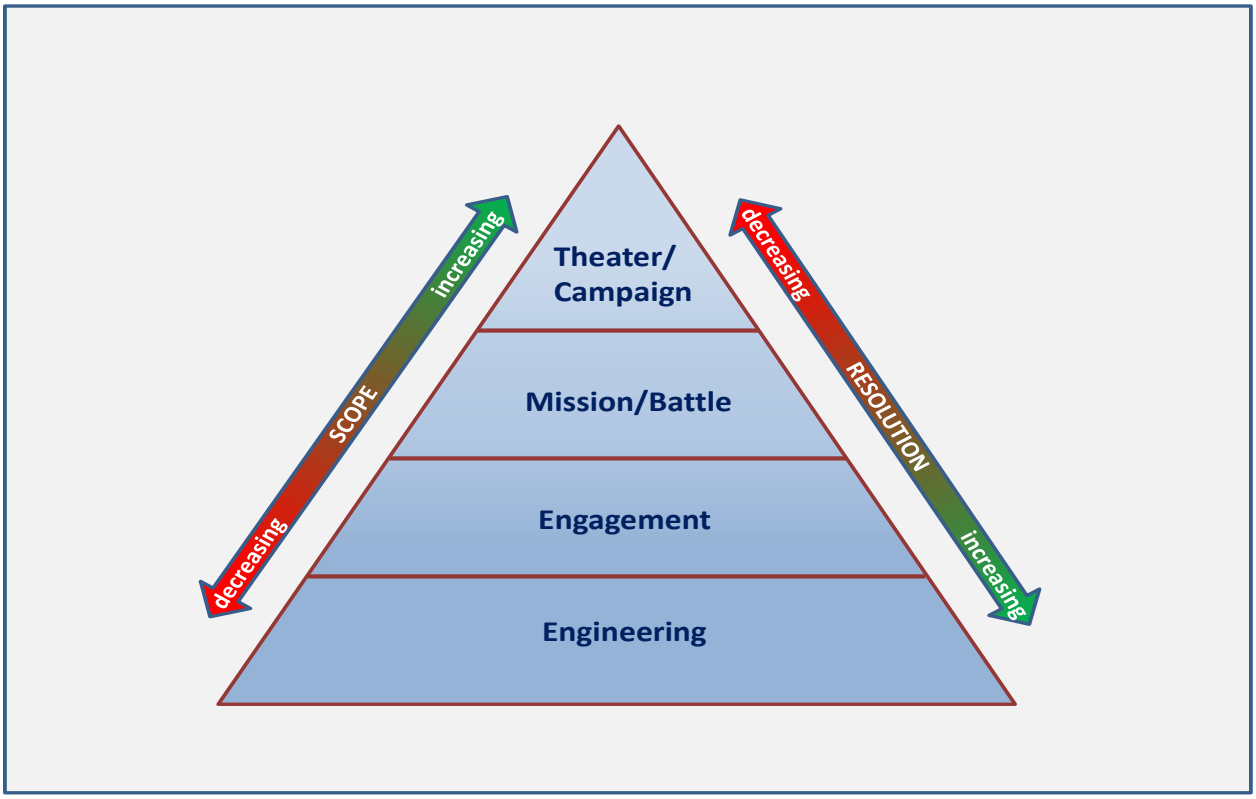



**Figure 5.2 – Levels of Analysis Hierarchy**

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.

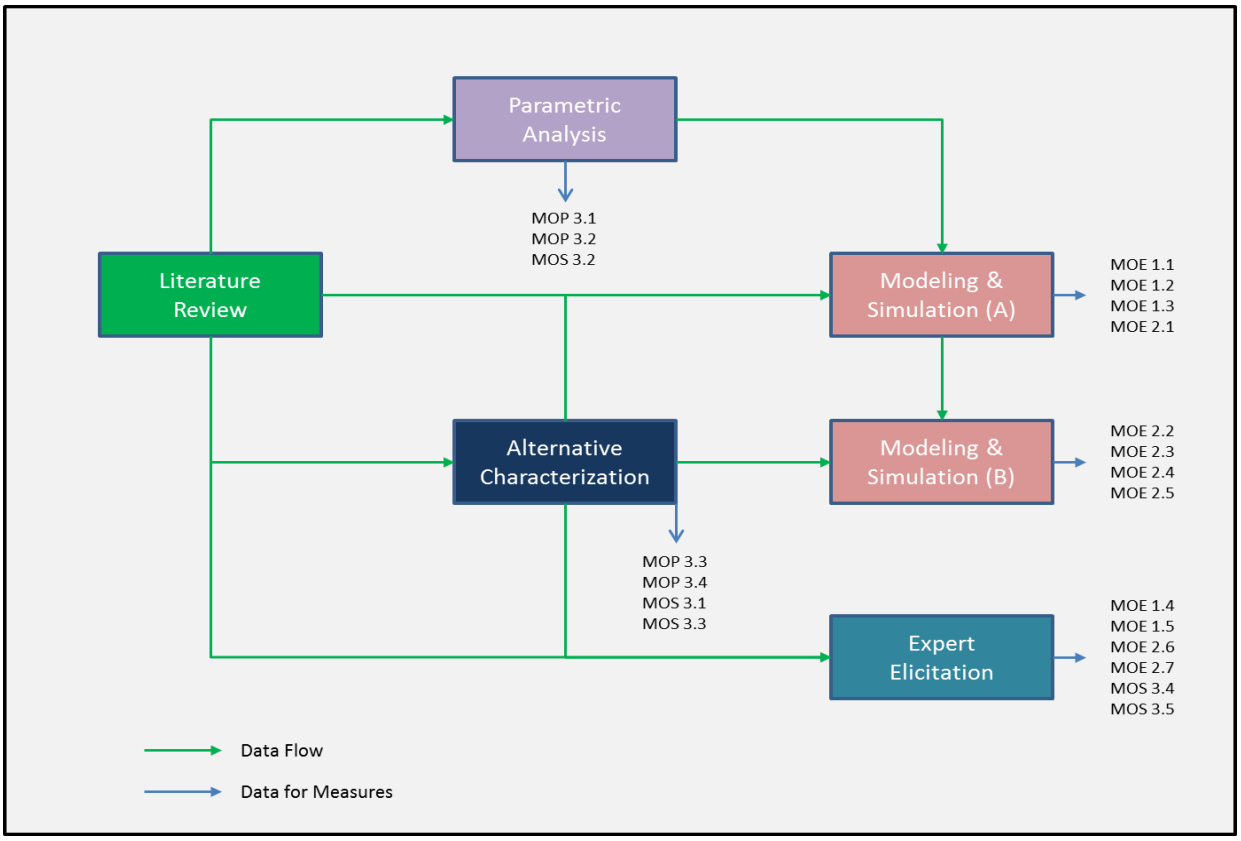



**Figure 5.3 – Linkage Diagram of Data Collection and Analysis Methods and Measures**

### 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.

### 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). Appendix N of this Guidebook contains guidance, techniques, and reporting templates.

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 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.

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 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. The accreditation authority reviews the assessment and makes an accreditation decision that is documented in an M&S accreditation report. This report is included as an appendix to the AoA Final Report.

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.

### Section 3.4: Intelligence Supportability Analysis

One important action that must be accomplished is the determination of whether an 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 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 Intelligence (IN) office to determine whether an ISA must be accomplished as part of the AoA. Air Force Life Cycle Management Center (AFLCMC)/IN 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.

If there is no local IN office, the DWT lead should contact the AFLCMC/21st Intelligence Squadron. For space systems, the ISA is conducted within US Space Command, contact the A2 Branch at the headquarters.

**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.

The study team should use the study guidance as a starting point. 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 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).

For more detailed guidance about cost analysis and cost estimating contact AFCAA.

**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,
- MILCON requirements
- Intelligence, HSI, and other enabler support requirements
- Environmental costs
- Personnel requirements and constraints
- Affordability constraints
- Fully Burdened Cost of Energy (FBCE)

- Requirements sponsors will notify SAF/IEN after MDD to facilitate data gathering for Energy Supportability Analysis during AoA (Energy KPP).

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 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 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 may be collected for developing new estimating methods or techniques. For instance, if an appropriate Cost Estimating Relationship (CER) does not exist, 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.

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 collected data 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 flexibility in estimating. Break out the data in as much detail as possible and reflect the main factors which affect the estimate's cost elements.

The methodology should also describe what methods will be used or what methods are being considered. Table 5-3 shows a range of methods available for estimating different cost elements. Each method is suited for specific applications given its strengths and weaknesses. 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, 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).

Cost tools described in Table 5-3, are used to develop cost estimates and 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 L.

**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.

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 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 (FOC, which will be based upon the study assumptions).

Figure 5-4 illustrates the concept of evaluating the baseline and all alternatives across the same life cycle time frame.

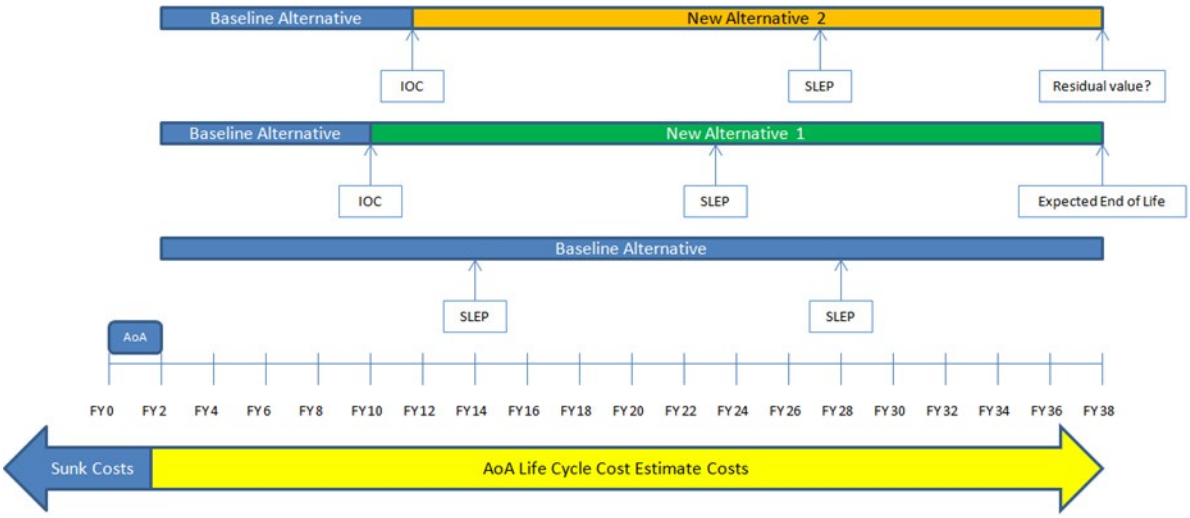



**Figure 5.4 – Life Cycle Time Frame Comparisons**

In this example, the life cycle spans from Fiscal Year (FY)02 to FY38. As shown in the figure, each alternative has a different IOC date when it becomes an operational asset. In addition, each alternative requires at least one 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 are replaced by the new alternatives. 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.

The baseline includes 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.

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 consider 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.

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 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 because 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.

**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). This structure is used to define and allocate costs across multiple categories. At a minimum, costs should be defined according to their WBS elements, Operating and Support (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**

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 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. OAS recommends 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 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 |
| | | 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 |

| Level 1 | Level 2 | Level 3 |
|---|---|---|
| | 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 | | |

**Operating and Support Cost Element Structure**

Like 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 ODCAPE 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 interim contractor support or 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 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 materiel (e.g., fuel and training materiel), unit support services, and unit travel. Excludes materiel 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 ODCAPE O&S Cost-Estimating Guide.

**Life Cycle Phases for the Cost Estimate**

In AoA studies, a 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, and Engineering and Manufacturing Development, 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 items, and 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 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, 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 forms 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 activities as necessary. Research and development costs are funded from RDT&E appropriations. Investment costs are funded from Procurement, 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.

**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. 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 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.

**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, | |

There are several methods and cost tools that can be used to conduct the cost risk and uncertainty analysis. The most 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 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. 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.

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.

**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. 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. |

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.

**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 JCIDS manual provides a framework for assessing operational risk. 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. 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.

In this guidebook, 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.

**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 the risk assessment approach is used, the working group must describe how the risks will be identified. The intent is to answer the 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), 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 SRD, CDP, and 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.

**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 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 TRLs and 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 Section 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 RMG, or other 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.

**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 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.

**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 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 trade space when deciding 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.

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). 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). See Section 7, for presentation examples.

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 KPPs, KSAs, Additional Performance Attributes, or Other System Attributes.
- 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:

- 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.

**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:

**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 Section 2 (Forming the AoA Study Team) of this guidebook 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, 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.

**Section 7.2: AoA Review Process**

The AoA review process will largely depend on whether the AoA has ODCAPE/OUSD(A&S) or Air Force oversight. The DCAPE AoA Study Guidance typically describes a staffing or review process for presenting the AoA Study Plan and the AoA Final Report for review and approval (see the ODCAPE AoA Study Guidance template in Appendix F). 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. Section 1 provides more detailed information regarding the review and staffing requirements of AoA Study Plans.

**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)
- AFGK study plan review
- AF/A5/7D approval,
- If required, DCAPE approval of study plan
- MDD

- Materiel Solution Analysis Phase /Study execution phase
- SAG reviews during study execution phase
- Final report staffing phase
- AFGK final report review
- AF/A5/7D final report review and validation
- If required , DCAPE 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.

**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.

**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 ODCAPE 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 G). 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.

**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.

**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, and AF/A5/7D that addresses the quality of the study plan and the extent of the risks associated with conducting the AoA. See Appendix J for the OAS study plan assessment criteria. The study plan is reviewed by the appropriate CDT before it is reviewed by the AFGK and approved by the AF/A5/7D 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.

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.

## SECTION 6. AoA STUDY EXECUTION

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 section describes some fundamental lessons learned (best practices and landmines) for conducting the AoA.

### 6.1. Best Practices for Successful AoA Execution

#### 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.

#### 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, Task 5 for more information regarding screening.

#### 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, the WIPT meetings can usually be held less frequently.

#### 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.

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.

#### Report Back to Stakeholders and Sponsors Frequently

As the study progresses, 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 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

**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.

**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.

As part of the analysis, the analyst gains information about the data and its characteristics through graphical and numerical representations. With these data representations, the analyst can discover patterns and anomalies and identify potential causes. 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 insights entails answering straightforward questions of the data. 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. To completely understand the output data and address these questions, the team must fully understand the characteristics of the input data.

**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. 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 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. 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.

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.

**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 result.

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. But with these possibilities, there is the challenge of finding the most effective way to communicate the 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. 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 several 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.

**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. 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 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.

**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.

**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 in the study and adjust the study as appropriate based upon these early results.

**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 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:

**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.

**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.

**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 RFI, for which Industry partners receive no remuneration.

**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.

**A Little Late is Too Late**

A perfect analysis provided too late is no good. The Government Accountability Office (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.

**Entering an AoA with a Predetermined 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.

**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 functional area or mission area may limit or bias the results of the study.

**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 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.

**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 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.

**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 Guidebook and ensure the AoA adequately evaluates the risks (cost, schedule, technical, and operational) of the alternatives.

**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.

**Quantifying Without Rationale**

AoA teams sometimes tend 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 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.

**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.

**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 to address the concerns outlined in Sections 4 and 5.

**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.

## SECTION 7. AoA FINAL REPORT

### 7.1. Reporting the Results

Unlike the AoA Study Guidance and plan, the AoA Final Report is generally not developed using the 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 section begins with a discussion of general reporting principles that, when followed, will enhance the quality of the report. The remainder of this section provides guidance for writing the final report.

### 7.2. 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 H, 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, AF/A5/7D, RDA, 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 this 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 AF/A5/7D, the RDA, the MDA, and other agencies, and has been deemed sufficient by ODCAPE or AF/A5/7 (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 ODCAPE Cost Guidance Portal under the "DoD studies and reports" link (https://costguidance.osd.mil/CostGuidance/).

### 7.3. 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. Given the importance of a good presentation, the study team has a responsibility to communicate the study results clearly and objectively.

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. 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 communicate the results of the study clearly and objectively. Fortunately, there are guidelines the study team can follow to effectively present study results:

- 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:
    - Measure statement
    - Criteria and criteria reference or rationale
    - Measure rating
    - Measure rating discussion
    - Rationale or justification for rating
    - Task and mission performance implications and 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. Generally, 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. Generally, 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. Generally, 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.

### 7.4. 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. 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.

### 7.5. Writing the Introduction

The introduction is Chapter 1 of the OAS AoA Final Report template. The introduction is comprised of the following sections:

- Purpose and Scope
- Study Guidance
- Capability Gaps
- Stakeholders
- Key Ground Rules, Constraints, and Assumptions
- 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.

### 7.6. 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.

#### Measure-Level Results

There are several approaches the analyst can use to present the results of the measure analysis. One approach entails using a measure rating scale to describe whether or not a measure meets the criteria.

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."

**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 |

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.

**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<br>Scenario: A | |
| MOE 1.3: Range | |
| Criteria: | Threshold = 1500 NM T = O<br>Objective: NA |
| 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<br>Objective: NA |
| 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>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 capability. |
| 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 (cont)**

| EXAMPLE 3 | |
|---|---|
| ALTERNATIVE: 3 (DIRECT ATTACK) | |
| Mission Task: 1 (Defeat Target)<br>Scenario: A | |
| MOE 1.3: Range | |
| Criteria: | Threshold = 1500 NM T = O<br>Objective: NA |
| 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 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 | | | | |

| Alternative | Overall Rating | Scenarios | | |
|---|---|---|---|---|
| | | A | B | C |
| 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<br>Red: Did Not Meet Criterial – Significant Shortfall | | | | |

**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.

Like 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<br>Yellow: Substantial Operational Impact<br>Red: Severe Operational Impact | | | | |

**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.

### Sensitivity Analysis Results

Once, the measure, task, and mission-level results have been presented, the results of the sensitivity analysis are 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.

## 7.7. 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 and Then Year 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.

Like 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 Physical 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

Generally, the documentation package may be tailored depending on its purpose or the information it incorporates. Though there is some discretion in what is or is not included, the 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 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?

**7.8 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.

The study team can display the risk assessment results in various ways to facilitate an understanding of the results. Table 7-10 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 7.10 – 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 |

### 7.9. 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 way 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 CDP). 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 7-11. 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 7.11 – Notional Example of Comparison Analysis Results**

| Alternatives | Mission Task 1 Defeat Target | | | Mission Task 2 Survive Threat | | Mission Task 3 Support System | | Risk | LCCE $B |
|---|---|---|---|---|---|---|---|---|---|
| | Key Measures | | | Key Measures | | Key Measures | | | |
| | 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** | | |
| 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?

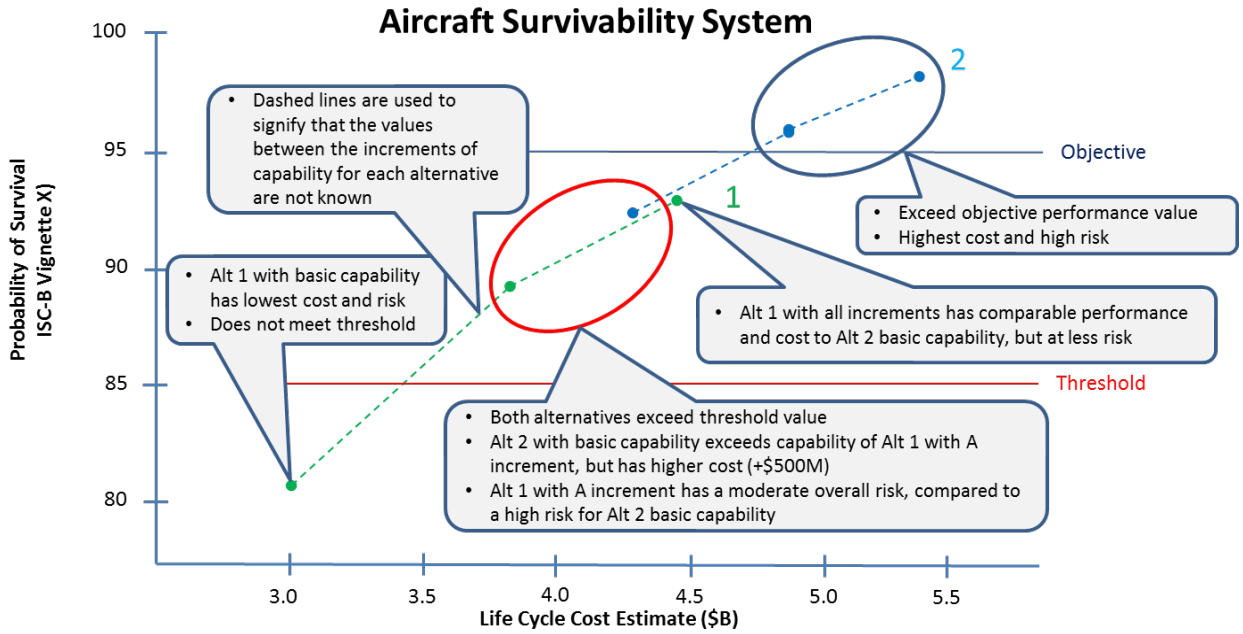
The focus of the cost capability analysis presentation is the comparisons between performance parameters and costs to facilitate cost and performance tradeoff discussions. Figure 7-1 shows an example presentation of the cost capability analysis results for a notional Aircraft Survivability System. Alternatives 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.

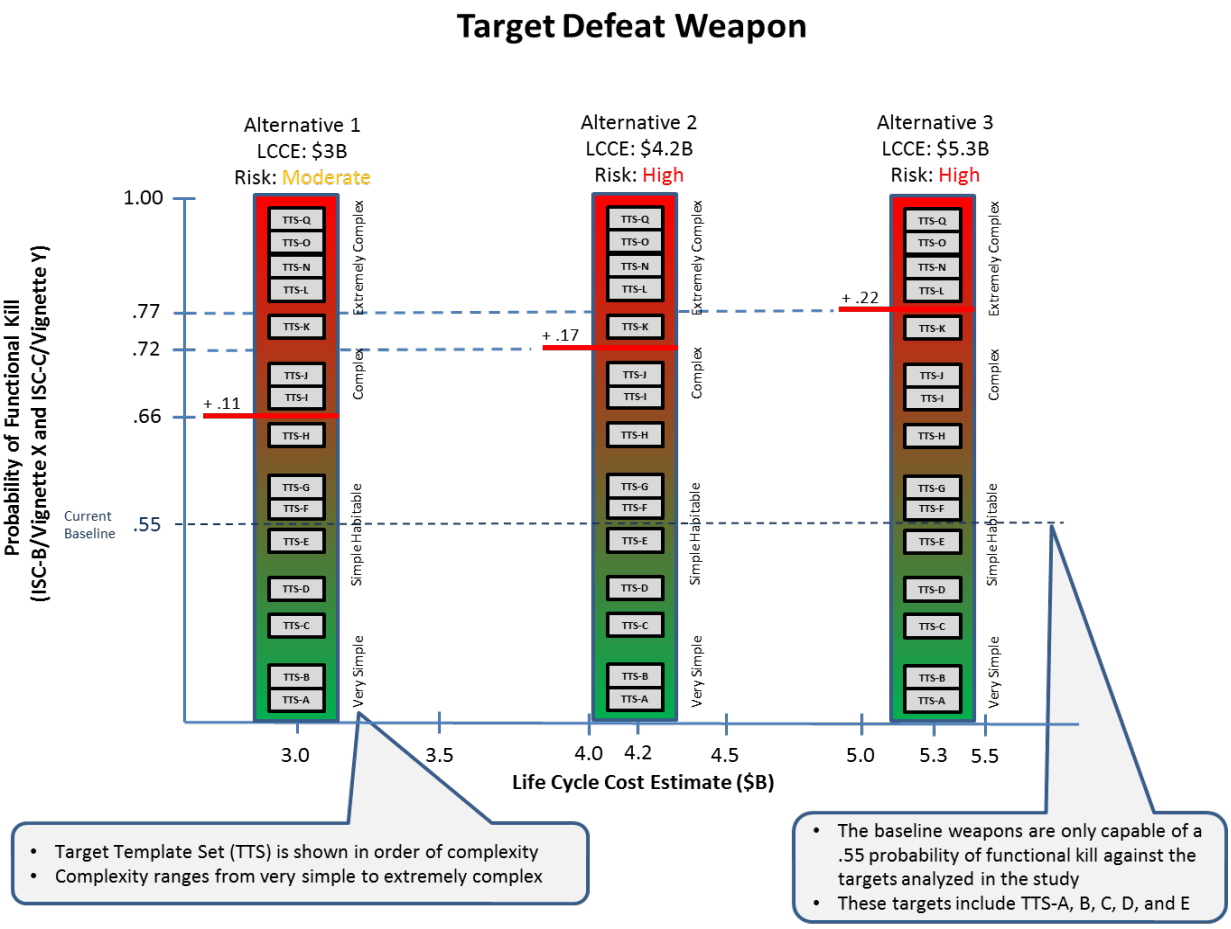



**Figure 7.2 – Target Defeat Weapon Cost Capability Analysis Example**

### 7.10. Reporting the Conclusions and Recommendations

Conclusions and recommendations are discussed in Chapter 6 of the AoA Final Report (see Appendix H). 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.

### 7.11. Appendices in the Final Report

There are several appendices that are typically included in the final report (see Appendix H, 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 ODCAPE 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:

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

CCTDs are included as appendices to the AoA Study Plan and the AoA 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 includes complete CCTDs. For more information about the CCTD, see the Concept Characterization and Technical Description (CCTD) Guide, SAF/AQ.

#### 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, 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. A guide to M&S accreditation and report templates are in Annex N of this guidebook.

#### 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 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 Intelligence office or AFLCMC/21st Intelligence Squadron works with the AoA study team to develop the ISA. For space systems, the ISA is conducted by US Space Command, consult the A2 Branch at the headquarters for more information. The ISA report is included as an appendix in the AoA Final Report.

**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 Guidebook 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

### 7.12. 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 AF/A5/7D. 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 and AF/A5/7D. The final report is reviewed by the appropriate CDT before it is reviewed by the AFGK and AF/A5/7D. After AFCDC (or higher) approval, the final report is released, if required, to the ODCAPE for a sufficiency review (see DoDI 5000.84 for details concerning the ODCAPE assessment of AoAs) before the DAB. 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 AF/A5/7D. Appendix K of this guidebook contains the AoA Final Report assessment criteria used by OAS.

Appendix F (ODCAPE AoA Study Guidance Template) not only provides the study guidance format and content requirements, but also ODCAPE 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 ODCAPE expectations.

# Appendix A -Acronyms and Glossary

## Acronyms

| | |
|---|---|
| ACAT | Acquisition Category |
| ACEIT | Automated Cost Estimating Integrated Tool |
| ACC | Air Combat Command |
| AFCAA | Air Force Cost Analysis Agency |
| AFGK | Air Force Gatekeeper |
| AFI | Air Force Instruction |
| AFLCMC | Air Force Life Cycle Management Center |
| AFMC | Air Force Materiel Command |
| 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 Tool Kit |
| AoA | Analysis of Alternatives |
| APUC | Average Procurement Unit Cost |
| ATD | Advanced Technology Demonstration |
| BCS | Baseline Comparison System |
| C2 | Command and Control |
| CAE | Component Acquisition Executive |
| CAIV | Cost As an Independent Variable |
| 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 |
| CDP | Capability Development Plan |
| CER | Cost Estimating Relationship |
| CES | Cost Element Structure |
| CM | Configuration Management |
| CONEMP | Concept of Employment |
| CONOPS | Concept of Operations |
| CSAF | Chief of Staff of the Air Force |
| DAB | Defense Acquisition Board |
| DCAPE | Director of Cost Assessment and Program Evaluation |
| DCR | DOTmLPF-P Change Recommendation |
| 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 (in this version of the acronym, “m” refers to existing materiel in the inventory) |
| DP | Development Planning |
| DPS | Defense Planning Scenario |
| EAWG | Effectiveness Analysis Working Group |
| ECWG | Employment Concepts Working Group |
| EMD | Engineering & Manufacturing Development |
| FBCE | Fully Burdened Cost of Energy |
| FCB | Functional Capability Board |
| FOC | Full Operational Capability |
| FoS | Family of Systems |
| FRP | Full Rate Production |
| FY | Fiscal Year |
| FYDP | Future Years Defense Program |
| GAO | Government Accountability Office |
| GRC&As | Ground Rules, Constraints, and Assumptions |

| | |
|---|---|
| HSI | Human Systems Integration |
| IBS | Inputs-Based Simulation |
| ICD | Initial Capabilities Document |
| IIPT | Integrating Integrated Product Team |
| IN | Intelligence |
| IOC | Initial Operational Capability |
| IRSS | Information and Resource Support System |
| ISA | Intelligence Supportability Analysis |
| ISC | Integrated Security Construct |
| ISR | Intelligence, Surveillance, and Reconnaissance |
| 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 |
| JDAM | Joint Direct Attack Munition |
| JMETL | Joint Mission-Essential Task List |
| JROC | Joint Requirements Oversight Council |
| JSD | Joint Staffing Designator |
| KPP | Key Performance Parameter |
| KSA | Key System Attribute |
| LCCE | Life Cycle Cost Estimate |
| LCOM | Logistics Composite Model |
| LRU | Line Replaceable Unit |
| M&S | Modeling and Simulation |
| MAJCOM | Major Command |
| MANTECH | Manufacturing Technology |
| MDA | Milestone Decision Authority |
| MDAP | Major Defense Acquisition Program |
| MDD | Materiel Development Decision |
| MILCON | Military Construction |
| MILPERS | Military Personnel |
| MOE | Measure of Effectiveness |
| MOP | Measure of Performance |
| MOS | Measure of Suitability |
| MRL | Manufacturing Readiness Level |
| MS | Milestone |
| MSA | Materiel Solution Analysis |
| MT | Mission Task |
| O&M | Operations & Maintenance |
| O&S | Operations and Support |
| OAS | Office of Aerospace Studies |
| OBS | Outputs-Based Simulation |
| OCWG | Operational Concepts Working Group |
| ODCAPE | Office of the Director, Cost Assessment and Program Evaluation |
| OIPT | Overarching Integrated Product Team |
| OPLAN | Operation Plan |
| OSD | Office of the Secretary of Defense |
| OUSD | Office of the Under Secretary of Defense |
| OV | Operational View |
| PBL | Performance Based Logistics |
| PEO | Program Executive Officer |
| POM | Program Objective Memorandum |
| R&D | Research and Development |
| R&E | Research and Engineering |
| RAWG | Risk Assessment Working Group |
| RDT&E | Research, Development, Test and Evaluation |
| RFI | Request For Information |
| RFP | Request For Proposal |
| RMG | Risk Management Guide |
| ROM | Rough Order of Magnitude |
| S&T | Science and Technology |
| SAF | Secretary of the Air Force |
| SAG | Study Advisory Group |
| SE | Systems Engineering |
| SLEP | Service Life Extension Program |
| SME | Subject Matter Expert |
| SoS | System of Systems |
| SPO | System Program Office |
| SPR | Solution Pathway Review |
| SRG | Senior Review Group |

| | |
|---|---|
| T&E | Test and Evaluation |
| TAWG | Technology and Alternatives Working Group |
| TRL | Technology Readiness Level |
| TSWG | Threats and Scenarios Working Group |
| TTP | Tactics, Techniques, and Procedures |
| TTS | Target Template Set |
| UJTL | Universal Joint Task List |
| USD(A&S) | Under Secretary of Defense for Acquisition and Sustainment |
| USD(R&E) | Under Secretary of Defense for Research and Engineering |
| V&V | Verification and Validation |
| VCSAF | Vice Chief of Staff of the Air Force |
| VV&A | Verification, Validation, and Accreditation |
| VV&C | Verification, Validation, and Certification |
| WBS | Work Breakdown Structure |
| WIPT | Working Integrated Product Team |

## Glossary

Analysis of Alternatives (AoA) – An analytical comparison of proposed materiel solutions to gaps/shortfalls in operational capability, to help in identifying prospective solutions that best balances cost, effectiveness, and risk. AoAs provide comparative cost, effectiveness, and risk assessments of proposed alternatives against a baseline, typically the current operating system.

Capability-Based Assessment (CBA) - The analytic basis of the JCIDS process, responsible for identifying, developing, and validating all joint defense-related capability needs to be satisfied by future systems. CBA activities evaluate the entire spectrum of materiel and non-materiel approaches, to include alternative uses of existing systems as well as assets that may be available from non-AF or non-DoD sources. CBA consists of analyzing what is required across all functional areas to accomplish the mission (defining the capability required), comparing the capability needs to the capabilities provided by any existing or planned systems (gap analysis), identifying associated gaps/shortfalls and/or redundancies, and offering recommendations on whether the gaps/shortfalls can be addressed by non-materiel means, materiel means, or both.

Concept – A prospective materiel solution to an identified operational capability need. It is distinctly different from an operational concept or Concept of Operations (CONOPS).

Concept Characterization and Technical Description (CCTD) - A principal Early SE artifact that provides evidence of traceability from capability need to materiel requirements. It supports both the sponsor and the acquirer in developing appropriate technical analyses, the investment business case for MDD, and implementation-focused risk assessments. At the time of issuance of this Guide, the CCTD is unique to the Air Force DP and Early SE processes.

Development Planning (DP) – The materiel contribution to AF capability planning. It is a collaborative process bridging warfighter-identified capability needs to planning for acquisition of materiel solutions. DP supports the trade space evaluation of emerging capability needs, includes system-of-systems assessments, identifies and assesses technology maturity and risk drivers, and incorporates comprehensive life cycle planning contributing to initiation of a high confidence acquisition program.

Early Systems Engineering (Early SE) – The tailored application of SE (defined as the comprehensive planning, management, and execution of rigorous technical efforts to develop, field, and sustain robust products and systems) prior to MS A and particularly prior to MDD. Early SE is regarded as the key enabler of the technical aspects of DP.

Family of Systems (FoS) – An aggregation of numerous individual and related systems, e.g., transport aircraft, weather satellites, portable secure communications systems, etc. The loss of any element may or may not degrade the performance of the entire FoS.

Sponsor – The initiator of an operational capability requirement; advocates for POM (budget) resources; presents the operational case to the AFRB and the AFROC; leads the AoA; selects COA(s);

System of Systems (SoS) – A combination of numerous individual systems that provides a capability greater than any of the constituent systems can deliver independently, e.g., Air or Space Operations Center, Airborne Electronic Attack, etc. The loss of any element will generally degrade the performance of the entire SoS.

# Appendix B - References and Information Sources

*AF/A5/7 Capability Development Guidebook, Vol 2J, Document Writing Team, Appendix A, Measures, Appendix B, Survey Research,* OPR: AF/A5/7DY-OAS.

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

AFI 16-1001, *Verification, Validation and Accreditation (VV&A)*.

AFI 63-101, Integrated Life Cycle Management.

AFI 65-508, *Cost Analysis Guidance and Procedures*.

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AFPAM 63-128*, Integrated Life Cycle Management*.

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AFPD 65-5, *Cost and Economics*.

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

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

*Cost Estimating and Assessment Guide*, Government Accountability Office (GAO) (Document number: GAO-09-3SP.

*Cost Risk and Uncertainty Analysis Handbook*, Air Force Cost Analysis Agency (AFCAA).

CJCSM 3500.04F, *Universal Joint Task List Manual*.

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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? |
| Guidebook Knowledge | Do you have a copy of AF Capability Development Guidebook, Vol 2D and Vol 2D Annex A, AoA? Are you familiar with them? Do you need other documents such as Guidebook Vol 2C, CBA or Vol 2J DWT? |
| 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, DoDI 5000.84, 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 AF/A5/7D, CDT? 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? |
| CAPE and/or USD(A&E) Engagement | Have you talked to anyone at ODCAPE or USD(A&E)? 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)? |

| Topics | Questions |
|---|---|
| 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? |
| 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)**

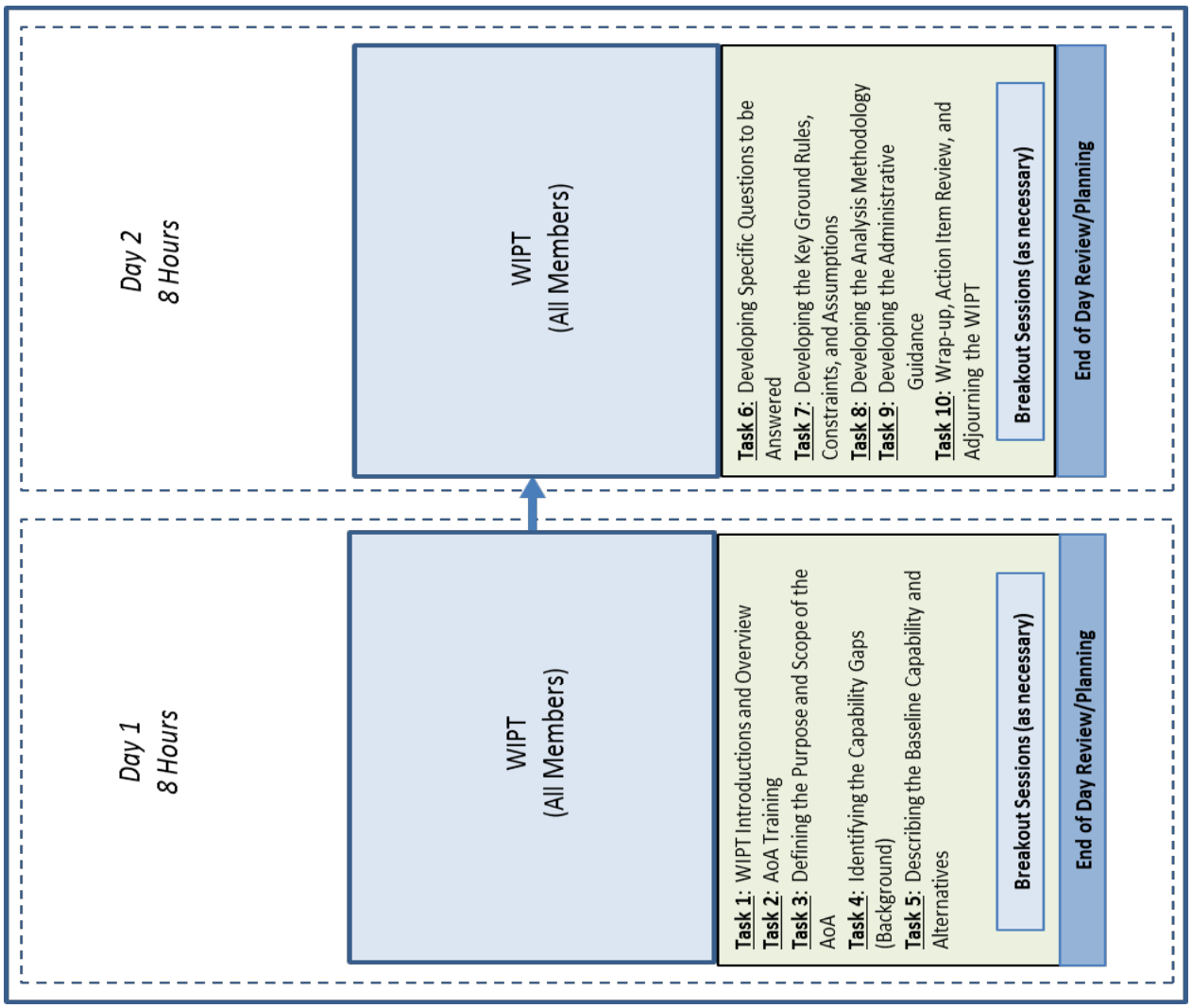


**Table D 2: AoA Study Guidance Development (Long Version Example)**

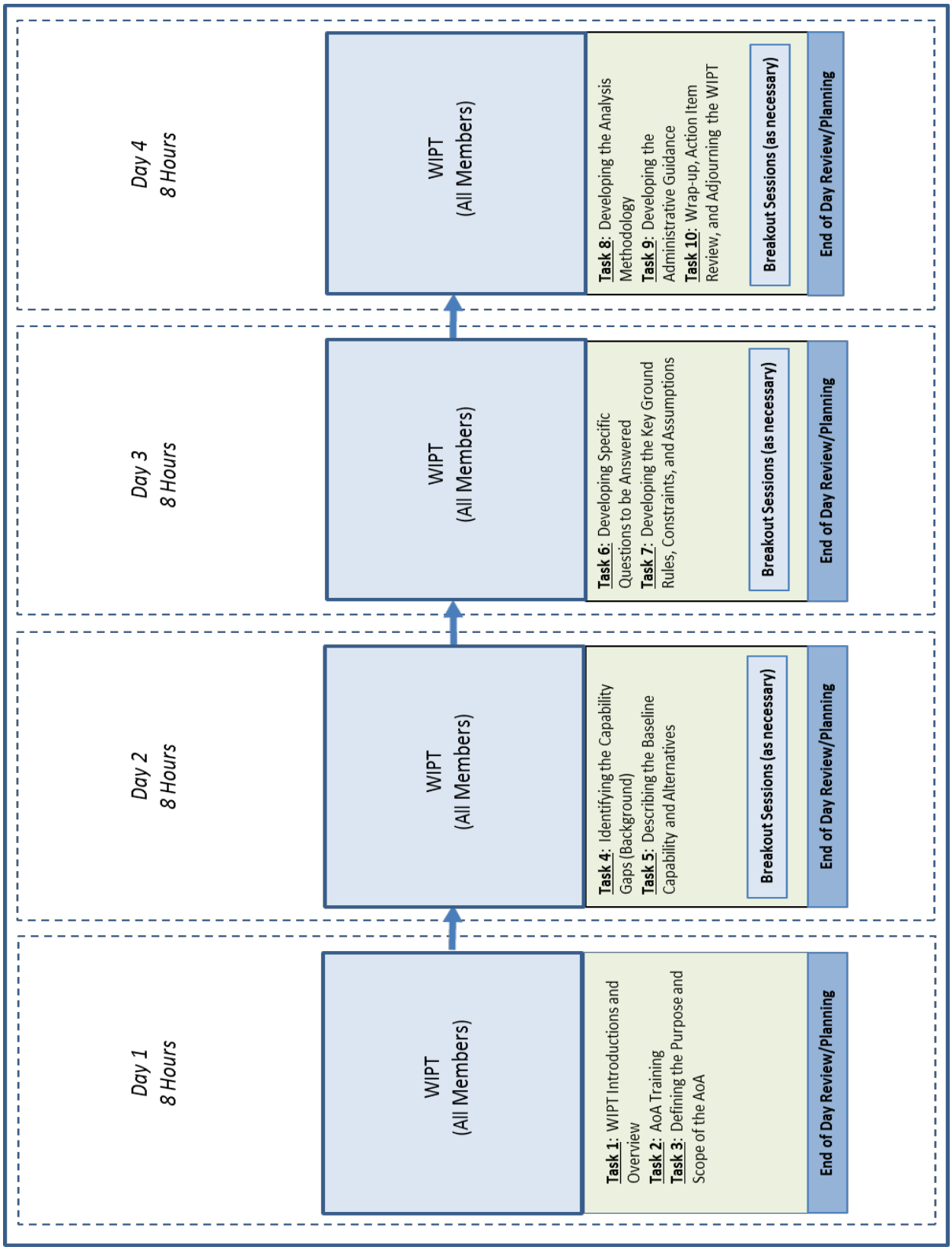


**Table D 3: AoA Study Plan Development (Short Version Example)**

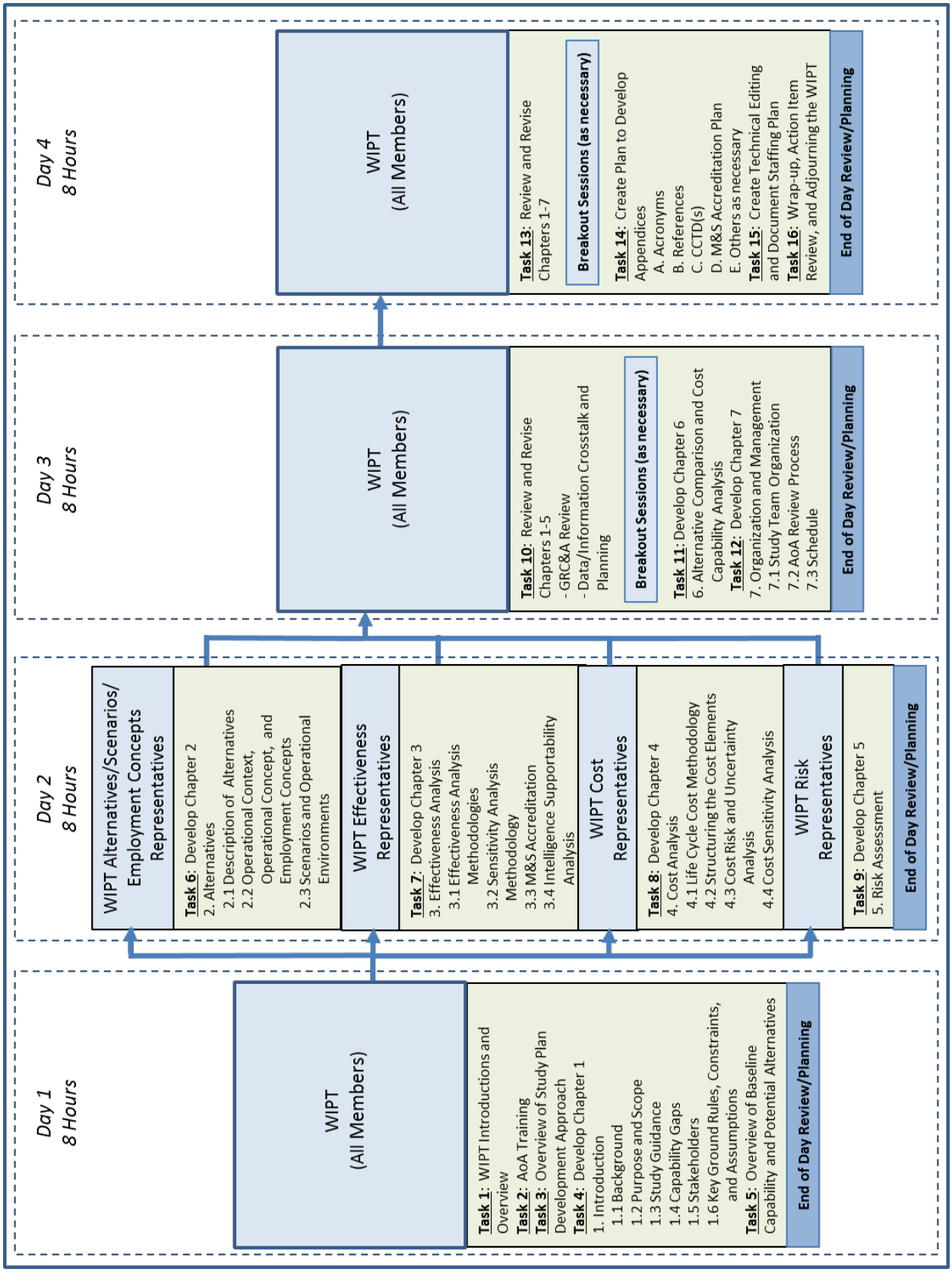


**Table D 4: AoA Study Plan Development (Long Version Example)**

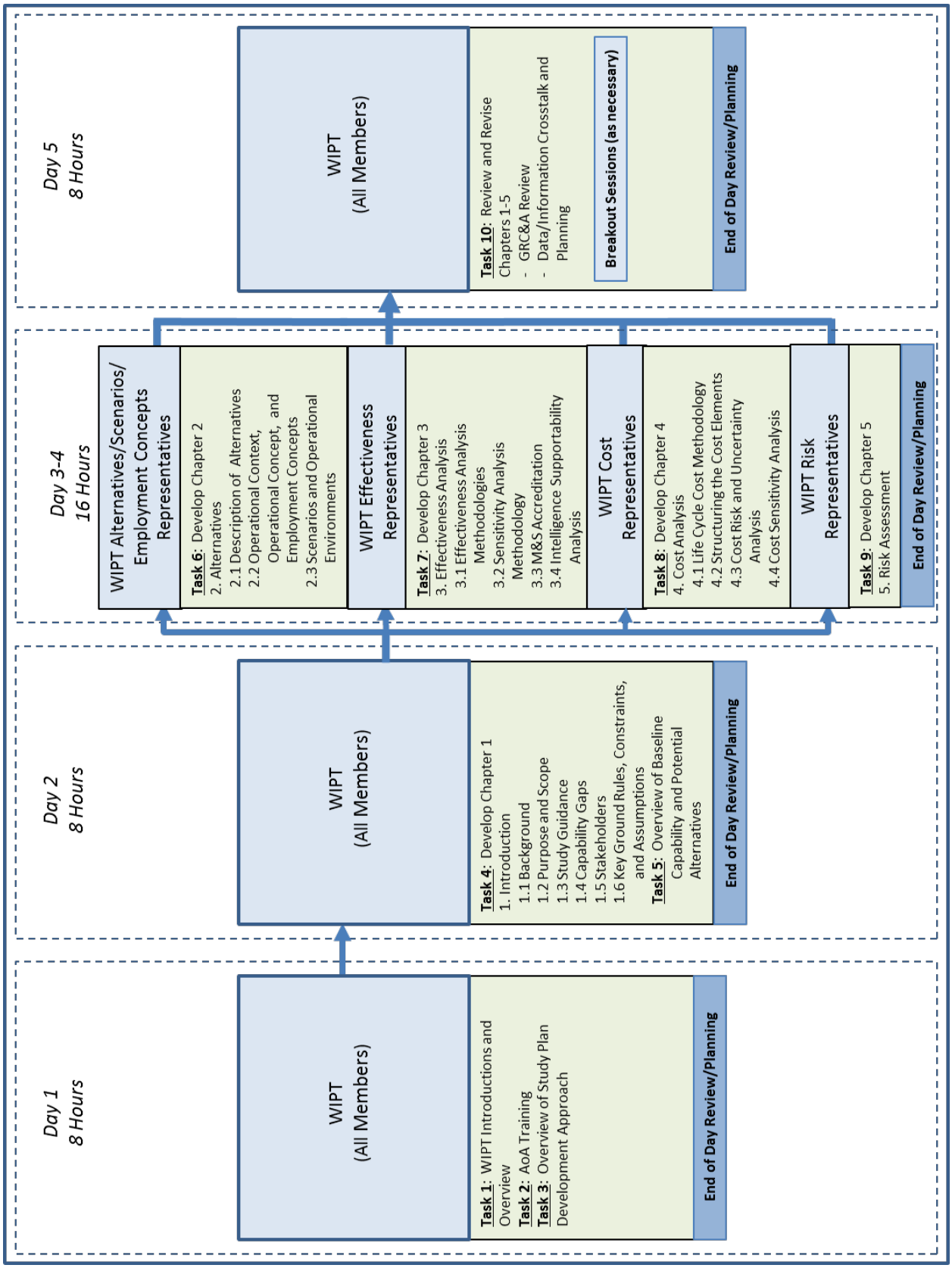
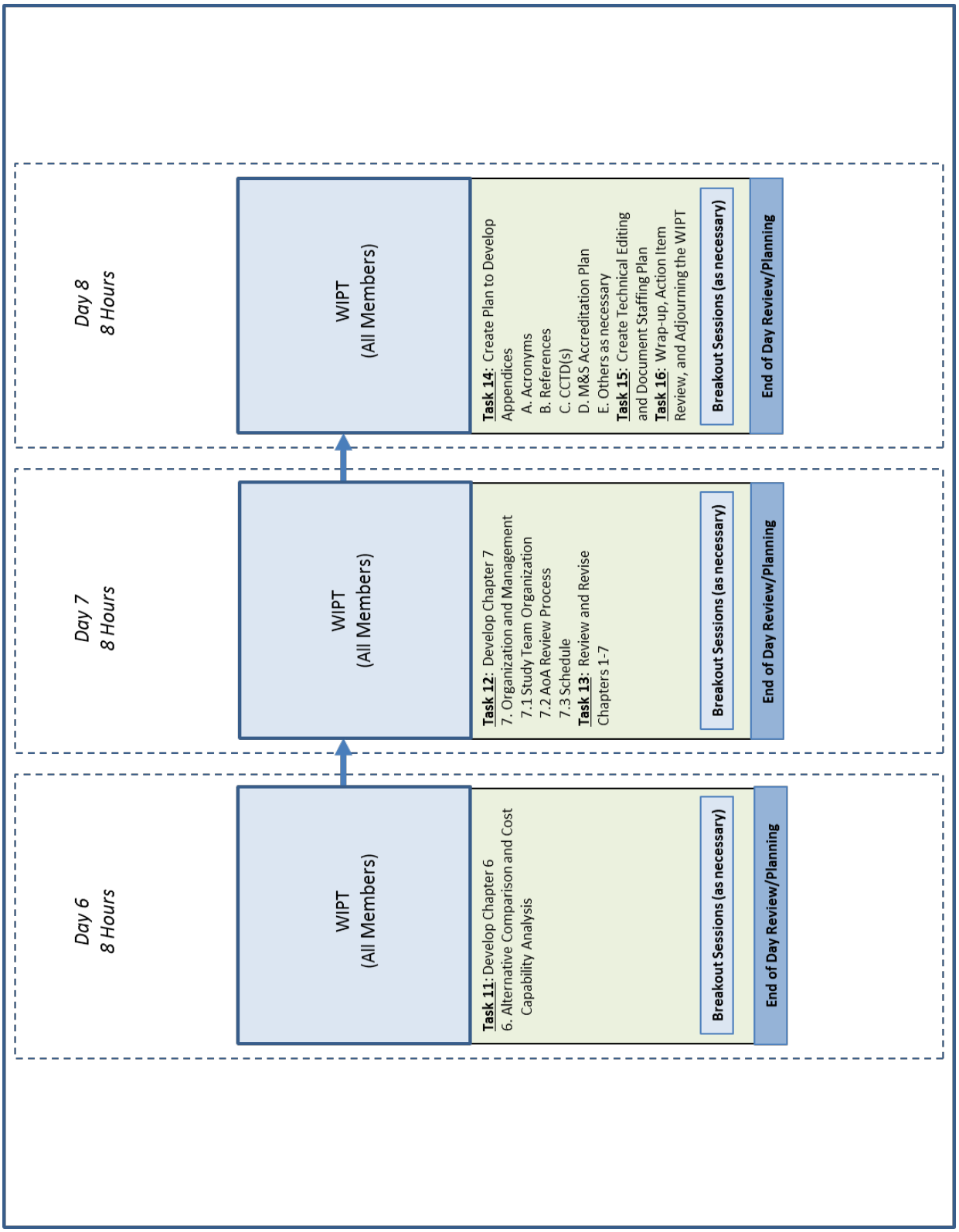


**Table D 4: AoA Study Plan Development (Long Version Example) Continued**



## Appendix E – Study Initiation Notice

**Study Initiation Notice.** The Study Initiation Notice (SIN) is a memo signed by the Sponsoring MAJCOM/Agency Director of Requirements and provided to the Joint Staff Gatekeeper. It is loaded into the Joint Staff Studies Repository and facilitates greater visibility into ongoing studies, encourages collaboration, and reduces unnecessary duplication of current study efforts. The SIN informs the AF and Joint community, allows important stakeholders to participate, and ensures the AoA informs important capability development decisions.

For AoAs not subject to CAPE approval of study guidance, such as for ACAT II or III programs, Sponsors will submit a Study Initiation Notice (SIN) to the Joint Staff studies repository. For AoAs subject to CAPE approval of study guidance, such as for ACAT I programs, visibility into CAPE approval of AoA Study Guidance serves to inform JCIDS stakeholders that an AoA is underway. The Sponsor completes the SIN and submits it via IRSS for review and approval by the AFGK (or higher), followed by submission to the Joint Staff Gatekeeper.

The following information should be included in the notice. This format is not obligatory, but all of this information should be provided. The notional length is two to three pages, but it may be more or less depending upon the complexity of the issue.

**1. Summary/Overview**

- Per JCIDS, the Study Initiation Notice must contain the following elements:
- Title of study, executive summary/purpose
- Participating organizations and intended completion date
- Study Sponsor/Lead POC contact information
- Tier 1-3 JCAs, or lowest JCA tier related to primary focus of study
- AF use only: Linkage to Joint Concepts, AF Concepts, SecAF's Operational Imperatives, Capability Development Plan (CDT).

**2. Justification -- Answer the question - Why it is important to conduct this AoA now?**

- Discuss why this specific mission area or bounded set of activities needs to be assessed at this time as described in the ICD(s) OV-1. The specifics of the gaps will be addressed in Section 3, Scope. The AF is short of analytic resources and the intent is to show why this is a high priority activity that needs to be done now.
- Identify key dependencies with other efforts. Does/will other work answer some of the key questions? Does previous analysis scope out some aspects of the problem? Will this effort in turn defer part of the problem to subsequent studies that this effort will feed? Are AF/A5/7AA (Decision Analytics Team) Mission Engineering Threads informed by or utilized in the study?
- Identify the expected next step(s), i.e. key decisions the AoA is intended to support.

**3. Scope -- Answer the question - What is the proposed scope of the AoA?**

- Provide a summary of the ICD gap(s) the AoA will address. Identify what specific mission area or bounded set of activities will be addressed by the assessment and/or analysis, and why that scope is appropriate.
- Identify the timeframe(s) (near, mid, or far) in which this capability is anticipated to deliver, and if known, the operational scenarios and missions that will be examined.

- Broadly identify the alternatives that will be considered. Identify the questions to be answered by the assessments and/or analysis and describe why any limits were placed on potential alternatives.

**4. Study Execution**

- Provide a short synopsis (1-2 paragraphs) of the analytic approach/methodology. Literature search? Statistical analysis of past data? Campaign modeling? Basic physics first principles? SME voting? Major data sources: actual data, Defense Intelligence Agency projections, data call from industry, etc.? Typically, there will be several approaches and data sources.
- Expected schedule (when will it start, when is it expected to be finished), and what resources (money and manpower) will be used to conduct the assessments and/or analysis.
- Identify key precursor products: Joint and AF Concepts, JCAs related to the primary focus of the study, Service CONOPS, baseline architectures, ICD(s), threats and how they affect the schedule/resources needed.
- Which organizations are proposed to be on the core team executing the AoA? Who will be the Study Lead and what is their RMCT certification?
- Identify any key challenges to meeting the timeline.
- Identify the anticipated classification level of the assessment/analysis and study report. Identify any classification limitations that may influence the results (ex. limited or no TS, SAP/SAR data will be part of the assessment/analysis, etc.)

The AFGK is the minimum review/approval authority for SIN. The AFGK will review the Notice and initiate a rapid, targeted staffing with all appropriate stakeholders. Following that staffing, the AFGK may elect to elevate the level of SIN approval (e.g. AF/A5/7D or AF/A5/7, as appropriate). Approval includes both the AF decision and direction/guidance regarding: 1) approval of the proposed study initiation and 2) approval to forward the SIN to the Joint Staff or other organizations as applicable.

If the AoA is terminated prior to providing any significant results, the Sponsor (working through the AF/A5/7 SME) must provide a Study Termination Notice (via IRSS) for review by the AFGK, followed by submission to the Joint Staff Gatekeeper. Include the following information in the Study Termination Notice:

- Include the date and title of study from the original Study Initiation Notice.
- Purpose/reason for cancellation, and Sponsor POC contact info.

## Appendix F – ODCAPE AoA Study Guidance Template

The following is provided by ODCAPE 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 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 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 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 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 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, 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 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 TRLs/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 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 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 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 FBCE method is used in computing costs for the 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.
    - AF requirements sponsors will notify SAF/IEN after MDD to facilitate data gathering for Energy Supportability Analysis during AoA (Energy KPP).

**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), Director, Operational Test and Evaluation (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 Materiel 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 DCAPE 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.

## Appendix G – 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

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**C. CCTD(s)**

**D. Modeling and Simulation Accreditation Plan**

**F. Other appendices as necessary**

**----------Study 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 CBAs, JCTDs, or 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 ODCAPE, 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 IOC and 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 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 WBS will be developed.
- Describe how the 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 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.

**Appendices**

**A. Acronyms**

**B. References**

**C. CCTD(s)**

**D. Modeling and Simulation Accreditation Plan**

**E. Other appendices as necessary**

## Appendix H – 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 AI JCOM>

<Date>

Cost of Study: $ X,XXX,XXX

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

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**---------- Final 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 ODCAPE, 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 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**

# Appendix I – 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 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 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.

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

**Table I-1: Suitability Concepts and 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 (Materiel) | 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) |

| Concept/ Attribute | Description |
|---|---|
| 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 materiel 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 materiel 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) |
| 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. (Guidebook) |

| Concept/ Attribute | Description |
|---|---|
| Manpower Supportability | The identification and acquisition of military and civilian personnel with the skills and grades required to operate and support a materiel 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 Effects and Impacts | 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 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. 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 I-2: Measures 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 model used to identify the 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, 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.

**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.

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.

## Appendix J – Study Plan Assessments

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, AF/A5/7D, and ODCAPE. 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 AFGK.

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 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 K – Final Report Assessments

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, AF/A5/7D, and others. 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 AFGK.

**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 L – 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* | | |

# Appendix M – Risk Assessment Using the 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 appendix, 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 sec 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. 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” 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:

“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 chapter 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 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).

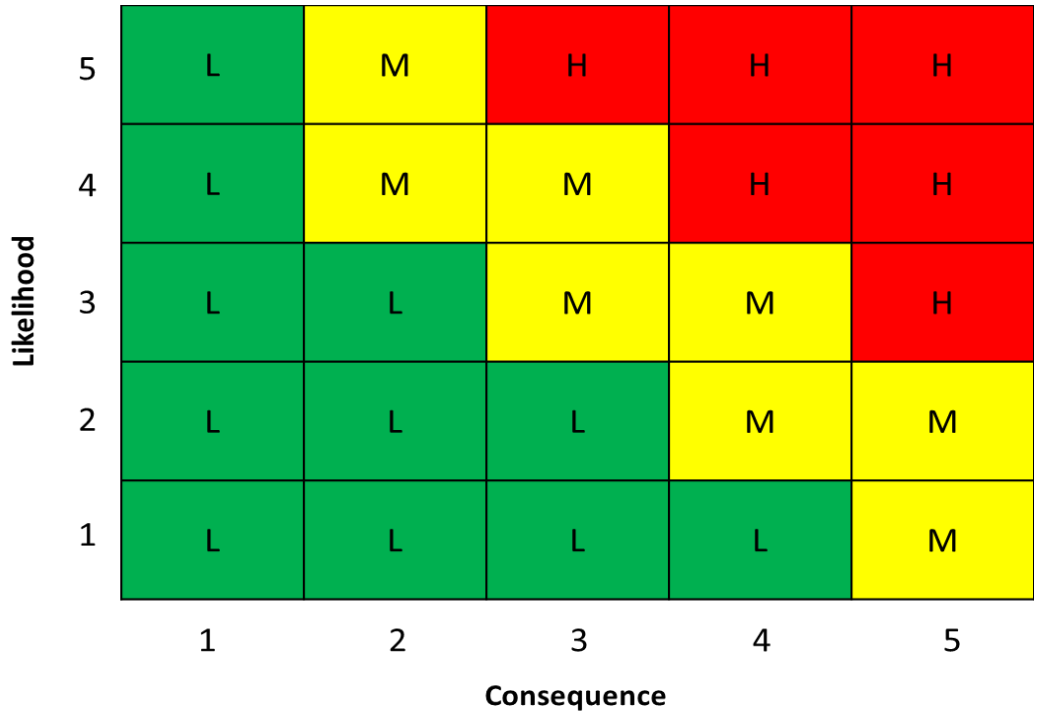


**Figure M-1: Risk Reporting Matrix**

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 of 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 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.<br>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 capabilities 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.

The Service Capability Development Team (CDT) responsible for moving target indicator capability is Global Integrated Intelligence, Surveillance, and Reconnaissance (GIISR). A key objective of the GIISR CDT 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). The numbering scheme used to identify the risks.

**Note**: 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.

**Table M-3: Risk Identification**

| Risk Statement | Risk Number |
|---|---|
| Dense Signal Environment | 1 |
| Global Network | 2 |
| Technology Readiness Level | 3 |
| Identification Ambiguity | 4 |
| Radio Frequency Interference | 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.

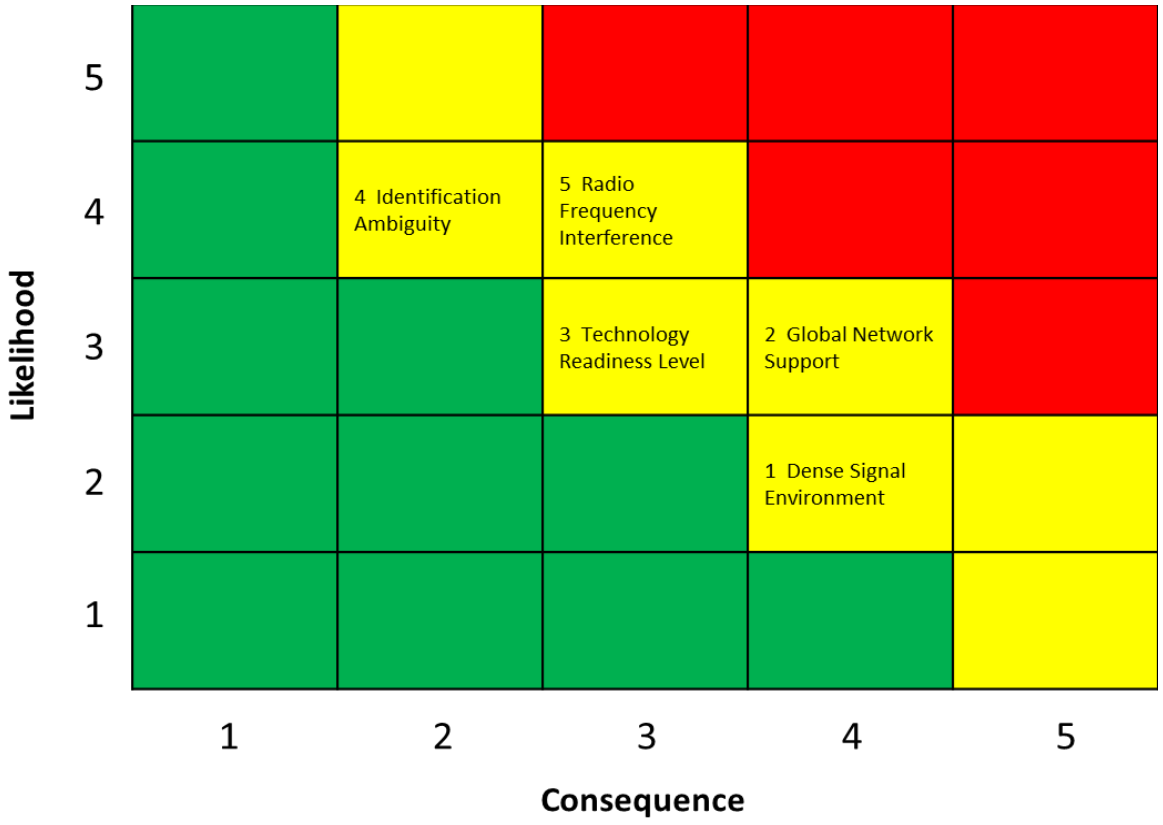


**Figure M-2: Risk Reporting Matrix Results**

# Appendix N - M&S Selection and Accreditation

**Preface**

This appendix provides guidance for the model selection and accreditation process for the Analysis of Alternatives (AoA). In addition, it provides a template for the Models and Simulations (M&S) Accreditation Report required for AoAs. The M&S Accreditation Report is completed prior to execution of the AoA. Upon completion of this report, the M&S AoA Accrediting Authority reviews the document and determines if the tools to be used in the AoA are the appropriate tools. Specifically, will these tools provide reasonable analysis and deliver results that are realistic, repeatable, and believable.

**Selection of Models and Data**

Models and simulations (collectively referred to as models for this discussion) are idealized representations of reality. They are the heart and soul of analysis and can consist of everything from hand-written steps executed with a "stubby pencil" to elegant mathematical formulations represented by thousands of lines of computer code. In some cases, they may include person-in-the-loop simulations. Whatever their complexity or form, there comes a point when the AoA team must decide which models to use for evaluating the alternatives.

The AoA Study Team must select models that provide the realism needed to stress and to assess the alternatives under consideration. Operational effectiveness is determined by the alternatives selected, Measures of Effectiveness (MoEs) used, and the scenarios employed. Once these are known, the necessary level(s) of analysis (i.e., engineering, engagement, mission/battle, theater/campaign) can be identified and a search can be conducted for models suitable for MoE and other calculations. In general, models selected to support Air Force AoAs should be accepted by the Air Force analysis community.

The search for models considers the following:

- Model inputs (alternatives, threats and scenarios, operations concepts, MSFDs) Model outputs (MoEs, Measures of Performance (MoPs))
- AoA scope (constraints, assumptions)
- Who is capable and available to run the model Data availability and quality
- What level of funding is available for the modeling effort
- Can the model(s) support the projected schedule and funding constraints What level of acceptance does the model have in the analysis community
- Interoperability (ability to receive and feed data to/from other models in the appropriate format.)

**Model Selection**

As is the case with most things in the world of M&S, there are many ways to acquire models for use in an AoA. Before selecting models for an AoA, the study team must first define exactly what the focus of the study is. It is only after the study focus is determined and the required input and output is defined that we can proceed with the model section.

The questions that must be answered before deciding to use any model are:

- Can we provide the correct input data?
- Does the model produce the correct output for our needs?
- Are the processes used in the models representative of what is being analyzed?

- Is threat data available in the appropriate format and at the appropriate level of detail for the models being considered?
- Does the model realistically simulate the operational environment being considered for your study?

The output must be able to either stand alone, if that is required, or be able to feed into the next model or tool used in the analysis tool confederation. Only by having the appropriate analysts exchange ideas early on in the selection process can we be assured of correct and adequate linkage between the models or tools involved in the study.

The first consideration for model selection should be to consider well-known and previously accredited models found in the Air Force Standard Analysis Tool Kit (AFSAT). Information on these models can be obtained by accessing the SAF/SA website ("analytical community" header) through the Air Force Portal. These models have been used in numerous studies and have extensive documentation and a functioning user's group to provide support. AFSAT models, when used with a pedigreed database, should provide the study team with a high quality output with little or no additional programming.

If the models in the AFSAT do not satisfy the analysis requirements, then models outside the toolkit need to be considered. A search should be performed to find models that have undergone previous accreditation, have been successfully used in earlier studies, satisfy the input criteria and provide appropriate measures for determining the effectiveness of the alternatives under consideration.

If a model from the above two categories does not meet the analytical needs, then a solution must be reached from the remaining options. These options include:

- Select a model that fits the analytical needs of the study (this model may have little or no history)
- Use a model that can be modified to fit the needs of the study
- Build a model from scratch (usually the last resort)

These options may incur more costs than using an off-the-shelf model already accepted by the analysis community. Additional risk will be introduced into the analysis if the model has not undergone a thorough accreditation process. They will have to be scrutinized for things such as fidelity, functionality, and methodology.

The model options that we choose will ultimately depend on the availability of appropriate models within the M&S community. A thorough search of models by a subset of the AoA Effectiveness Analysis Working Group (EAWG) can initiate this process. Selection should begin in earnest after the overall analysis architecture has been defined and should include key members of the Threats and Scenarios and Operations Concepts Working Groups. This architecture will directly address each MoE and MoP defined in the AoA study plan.

All models selected should be accredited prior to the start of the analysis. Even though a model was previously validated and used in prior studies, it must be reviewed in terms of how it is to be used in each individual effort. Past model usage and/or inclusion in the AFSAT does not imply that the model is appropriate for use in the current analysis. Analytical items such as data input, scenarios, model output, model linkages, and overall rigor are different for each analysis effort and must be evaluated in light of current requirements. Therefore, all models included in the analysis model architecture, and their linkages, must be reviewed by the accreditation team during the formal M&S accreditation process.

Before deciding on a final integrated set of models, the study team must be satisfied that the set is sufficient for the AoA. This can be done by constructing a linkage diagram (see Figure 1 below). Such a diagram shows the source of every MoE and MoP value and depicts a system level diagram of how the

models are supposed to work together. In addition, it will show how the pieces are expected to fit together and what signals or information should be handed-off between them. Since models are often extremely complicated and rarely can one individual know the detailed workings of all the models, it is critical that a team approach be used. Open discussion among the model experts is essential for a successful confederation of analysis tools.

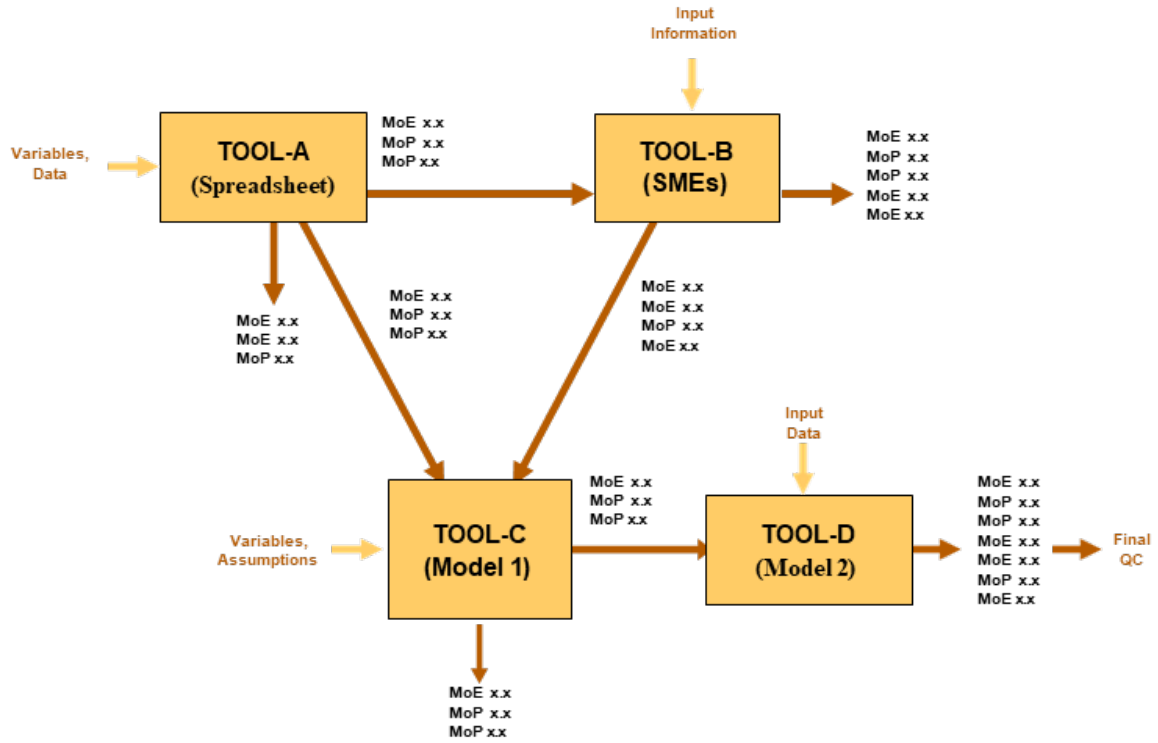


**Figure N-1. Confederation of Analysis Tools**

Experienced, competent analysts who are model experts are the best guarantee of obtaining reliable, consistent results. Availability of qualified analysts will impact model support options, specifically the choice of a support agency or contractor. This choice may be further limited by sources of funding and available contracting vehicles.

Every model requires time and effort to set up and run. A particular model should be selected only if the resources are available to perform all necessary runs in a timely manner.

The last area of consideration is model acceptance. Does the analysis community deem the model suitable for the intended usage? If not, is it reasonable to believe that the model can be accredited for that usage? If the model is a legacy model used in an accepted way, the answer will be easy. If not, the analysis community may need to be convinced of the appropriateness of the proposed usage. In any case, accreditation must be performed for each model used in the AoA.

If there are no existing models that are found to be suitable in their off-the-shelf state, then either existing models must be modified or new models must be developed. Because of the need to find funds for this work and the likelihood of extensive delays, these are normally options of last resort.

Air Force Materiel Command (AFMC) product centers, as well as other analysis agencies and modeling centers, can provide modeling and data support. The Air Force Office of Aerospace Studies (OAS) can also provide advice related to appropriate models and data.

**Data Selection**

When selecting data, it is essential that the data representing the many parameters involved in the AoA study be carefully selected and accredited. Models will generally process appropriately formatted data that is being input, but unless all of the data employed is evaluated for quality, the output of the model cannot be assured of providing quality measures. Models that have been accredited have associated data that has become pedigreed through a history of "Model-Test-Model" adaptation and verification. When models are used in AoAs, pedigreed data should be used to the maximum extent possible. However, because AoAs frequently evaluate new concepts, new data must often be used for these evaluations. The following must be considered when developing data for input to models supporting AoAs:

- What input parameters can we find pedigreed data for?
- What data adaptations do the new concepts require?
- Is there research and development (R&D) data that can be leveraged?
- What is the vetting procedure for the new data?

Experience has shown that data can often be a long lead item. Identifying the location of the data, resources to provide the data, reformatting the data and quality assessment of the data, often add to the process of data acquisition. Start the data identification and acquisition process early in the AoA effort.

**Legacy Model Toolkit and Pedigreed Databases**

SAF/SA maintains/manages AFSAT which contains approximately 20 legacy models. The purpose of the toolkit is to meet the needs of the analysis community while minimizing the costs of model proliferation. The toolkit models all have a long history of use which lend them credibility, and they can be accredited for uses consistent with their history. The toolkit model managers are asked to provide a standard version of the model and a corresponding "pedigreed" database. They are also expected to work with system program offices (SPOs) to ensure that current and new weapons systems are represented accurately in their models. Any study that uses a model not in the toolkit will need to justify the use of that model.

Engineering level models are beyond the scope of the toolkit. The Air Force recognizes that these are so specific in application and so numerous as to preclude tracking and controlling them in a centralized manner.

**Data Sources and Modifications**

Models outputs will typically provide information for existing systems that has been validated against real test results. However, an AoA may need to evaluate existing systems as well as new concepts that constitute the alternatives under consideration. For instance, a new concept aircraft will need to carry an existing weapon such as a Joint Direct Attack Munition (JDAM). The model will typically provide valid results for the JDAM, but not for the new aircraft concept. The data for the new aircraft concept will come from the Concept Characterization and Technical Description (CTTD) developed by members of the AoA study team. The CTTD describes all the pertinent technical data for the concept to include: weapons carriage, speed, release data, and concept of employment. In order for the model to realistically support the new concept, data from an aircraft that is similar to the new concept can be altered to simulate the new aircraft. These modifications will need to undergo some measure of accreditation.

Performance data must be technically and operationally validated by engineering assessments or performance tests. Additionally, current tactical and employment doctrine must be reflected in the CTTD. An organization creating, maintaining, using, and disseminating cost or effectiveness data must ensure the reliability of the data for their intended use.

The cost data selected to support the AoA should be accredited by the accreditation team before presenting any cost analysis results to the responsible costing agency. The Defense Intelligence Agency (DIA) should validate the threat data. Data is a long lead item—start the collection process early.

**Accreditation**

There is no time to validate, verify and accredit (VV&A) all of the models to be used in the study. Actual VV&A for any model is a long, expensive process whereby rigorous methods are used to ensure the model provides valid output data that simulates the real world.

Consequently, only model accreditation is (normally) required to support AoAs. The AoA study team's accreditation effort is intended to show the analysis community that the models are of acceptable fidelity, there is supporting documentation, that the data used is valid, and that the models used are appropriate for use in this analysis. This gives credibility to the AoA and documents the risk that has been identified concerning the analysis. For the simplest case, this may mean accrediting only one or two models. However, in most cases, the AoA study team may be using several models that must interact with one another. Careful planning is required to ensure that models selected for accreditation are of acceptable quality and are compatible with one another in the overall architecture. We must always keep in mind what questions we want the analysis to answer and which MoEs and MoPs need to be evaluated. Each AoA will have its own analysis requirements and therefore its own model requirements. An accreditation panel can be formed for clarifying and resolving AoA modeling issues.

**Accreditation Panel**

The formal Accreditation Panel is appointed by the AoA Study Director to review and evaluate the models selected. The panel is normally comprised of experts from within the Air Force, Department of Defense (DOD), and contractor communities that have an extensive background in M&S or specific knowledge related to the AoA subject matter. Some or all of the members of the panel may be identified as voting members. This means they will be called upon to cast a vote as to whether or not a model is suitable for the AoA based on a predefined set of criteria. There should be approximately 5 to 10 voting members on the panel. Any more would be hard to manage, any less would not provide for a broad base of experience. The non-voting members on the panel are present strictly in an advisory capacity. Non-voting, subject matter experts can provide information as needed to explain technical questions.

When assessing potential models, the panel must first agree upon the set of criteria with which all of the models will be judged. There are no pre-determined criteria established to cover all AoAs. Each AoA Study Director must decide what criteria are important. Table 1 below contains criteria and evaluation methodology that have been used in previous efforts.

| | Criteria | Rating Scale |
|---|---|---|
| **Model Accuracy** | Assess the analysis for 1) timely and accurate representation of the natural environment, 2) authoritative representation of human behavior, and 3) authoritative representation of the subject(s) | **RED:** Model not appropriate for intended purpose; do not use for this study<br>**YELLOW:** Relevant model of environment, behavior, or system<br>**GREEN:** Demonstrated adequacy for intended purpose |
| **Input Data** | Assess the input data used to describe the three representations above | **RED:** Data are arbitrary or best guess; data not reviewed<br>**YELLOW:** Most data are traceable to certified sources; data reviewed<br>**GREEN:** All data are valid or certified or pedigreed |
| **Critical Elements Modeled** | Compare the M&S capability to the application criteria...can the model address the inherent issues associated with the MoEs? | **RED:** MoE functionality not modeled<br>**YELLOW:** Functionality indirectly contributes to the MoE, or offline analysis required<br>**GREEN:** MoE functionality directly modeled |
| **User Experience** | Assess the experience, credibility, and capabilities of the person or team running the model | **RED:** User has no modeling experience, nor prior expertise with this model<br>**YELLOW:** User has limited expertise with this model<br>**GREEN:** User has expertise with this model, or is the developer |
| **History** | Review the M&S development history, summarize past application(s), and define the application domain based on a description of the capabilities by the M&S developer (AFI 16-1001) | **RED:** No history; new model<br>**YELLOW:** Some history, primarily undocumented; well documented lineage<br>**GREEN:** Lineage completely documented |
| **Configuration Management** | Review the adequacy of the model's configuration version control; complete an acceptable face validation examination, if appropriate (AFI 16-1001) | **RED:** No formal configuration management process<br>**YELLOW:** Some configuration management process for all major upgrade/code changes<br>**GREEN:** CCB process for all changes |
| **Documentation** | Ensure model documentation exists and is current/sufficient for the intended use (normally includes M&S conceptual model, user's guide, and programmer's and analyst's manuals) (AFI 16-1001) | **RED:** No published documentation<br>**YELLOW:** Published documentation for previous version; change documentation developed but not published<br>**GREEN:** Complete set of documentation exists for version used |
| **User Community** | Compare the analysis with known US and international analysis standards and techniques | **RED:** Limited user community for specialized applications not related to current use<br>**YELLOW:** Small user community; no formal users group<br>**GREEN:** Formal users group representing wide range of application |
| **Prior Accreditation** | Ensure data sources have been identified and that both producer and user data VV&C were accomplished (AFI 16-1001) | **RED:** No prior Accreditation<br>**YELLOW:** Some Accreditation on previous version<br>**GREEN:** Well documented Accreditation including live test results and/or model comparisons |

**Table 1. Criteria for Evaluating Models**

Using these types of criteria, the Accreditation Panel voting members would assess and judge the models and linkages. The scoring process and procedures are up to the Accreditation Panel to define; however, they should be designed to impart information on the risk assumed if the models are used. Previous

accreditations have used the stoplight (red, yellow, green) scheme, and some have used a scheme which considers poor, fair, good, or very good gradations. All scales have their own pluses and minuses--the idea should always be to identify risk, not obscure or bury it.

The overall score for each model and their linkages would be shown on a chart similar to Table 2 below with each criterion and model's overall score displayed as a color. *Good* and *Very Good* scores would rate a ‑green color assignment and indicate the model can be accredited for the type of analysis it was rated. *Fair* scores would rate a ‑yellow color assignment and indicate that the model would require additional work to achieve accreditation. *Poor* scores would merit a ‑red color assignment and indicate that the model is not appropriate for the study. This would indicate the model, in its current form, is unsuitable for use in the analysis.

| | Criteria 1 | Criteria 2 | Criteria 3 | Criteria 4 | Etc. * | Total |
|---|---|---|---|---|---|---|
| Model 1 | Good | VeryGood | Good | Good | * | Good |
| Model 2 | Very Good | Good | Good | Very Good | * | Good |
| Model 3 | Fair | Good | Good | VeryGood | * | Fair |
| Model 4 | Good | Good | Fair | Good | * | Fair |
| Model 5 | Good | Good | VeryGood | Good | * | Good |
| Model 6 | VeryGood | Good | Poor | Good | * | Poor |
| Model 7 | Good | VeryGood | Good | Good | * | Good |
| (Other) | | | | | * | |

**Table 2. Model Evaluation**

It is the primary task of the Accreditation Panel to show the M&S approach is sound and that risk has been mitigated to the greatest extent possible. OAS is available for help in setting up and conducting Accreditation Panels.

**Model Summary**

Once the Accreditation Panel has evaluated each model, they can summarize each model for the Accreditation Report. Typically, the accreditation process uses a categorical grading scheme to describe model suitability. An example of a categorical suitability range would be:

- ***Use***Has prior accreditation and extensive use
- AoA use mirrors intended use
- Data is credible

- ***Use with limitations***
  - Has prior accreditation and extensive use
  - AoA use may extend outside intended use
  - Some data may be conceptual

- ***Conduct additional accreditation***
  - Has little or no prior accreditation and limited use
  - AoA use mirrors intended use
  - Some data may be conceptual
- ***Additional model development needed***
  - Has no prior accreditation and limited use
  - AoA use may extend outside intended use
  - Some data may be conceptual
- ***Do not use***
  - Risk in all areas is unacceptable

**Risk Mitigation**

If the model summary is anything but ***Use***, then there is risk associated with using that model. The Accreditation Panel must summarize the risk associated with the model and develop a risk mitigation plan. For example, if the summary for a model is ***Conduct additional accreditation***, then the risk mitigation plan should detail who will conduct this additional accreditation and what that effort would entail.

**Accreditation Timing**

Model accreditation should be accomplished before the AoA analysis has begun. Often, problems will surface during the accreditation processes that are not otherwise evident. Careful screening of candidate models must be accomplished before the AoA Study Plan is finalized to ensure only the most applicable models are selected for inclusion. The accreditation plan should be included in the AoA Study Plan.

A vehicle should be in place that allows Accreditation Panel members to review documents describing all candidate models. This process will allow Accreditation Panel members to ask questions of the modelers prior to accreditation meeting(s). This document review and follow-on discussion will insure that most of the obvious questions have been asked (and answered) prior to the panel members interviewing the modelers face-to-face. Ideally, it should be a face-to-face meeting between the modelers and Accreditation Panel members during the accreditation process. Graphical presentations of information are highly encouraged during accreditation meetings as it is much easier to visualize model characteristics with the use of graphics than just verbal communication.

**Accreditation Report**

The Accreditation Panel is required to produce an Accreditation Report at the conclusion of its activities. The Accreditation Authority, usually the lead command's A5, is required to approve and sign off on this report. The template for the Accreditation Report is included as Appendix A in this Guidebook. The AoA Accreditation Report is included as an appendix to the AoA Final Report. OAS personnel are available to help AoA study teams develop the Accreditation Report.

It is recommended that a follow-on look at the AoA Study Plan be taken by the Accreditation Panel to determine how the plan has actually worked midway through the AoA. This is to assure that risk encountered has been assessed and thoroughly documented. Often this is referred to as a Phase II Risk Assessment. This Phase II activity is done as a way to take a step back from the analysis activities and take another big picture look at the risks being incurred. If it is determined that there is excessive risk using

the initial plan, it is possible to adapt the study methodology before heading too far in the wrong direction. This Phase II effort may have an associated formal report or it could be just an input into the AoA Final Report. It is the discretion of the AoA Study Lead or higher leadership as to where this information is presented.

## Accreditation Report Template

ACCREDITATION STATEMENT – TRANSMITTAL COVER MEMO

DD-MMM-YY

MEMORANDUM FOR HQ *MAJCOM*/A5

FROM: HQ *MAJCOM*/A5A

*Address*

SUBJECT: Accreditation Report for *Project Name* Analysis of Alternatives (AoA).

I have reviewed the recommendations contained in the attached model accreditation report. On the basis of this review, I accredit the use of the following model(s) by HQ *MAJCOM*/A5A for the *Project Name* AoA:

*List the Model(s)*

*List any restrictions*

*Signature Block for* HQ *MAJCOM*/A5

Attachments:

1. Title Page for the **Model and Data Accreditation Report**
2. TABLE OF CONTENTS, **Model and Data Accreditation Report**
3. Executive Summary for **Model and Data Accreditation Report** for *Project Name* AoA
4. **Model and Data Accreditation Report** for *Project Name* AoA

# Models and Data Accreditation Report Format

**For**

*Project Name*

**Analysis of Alternatives (AoA)**

**Date**

**Prepared by**

*MAJCOM*/A5

*Author*

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5.1.4.1. User Experience

5.1.4.2. Functionality

5.2. Model Name and Short Description **(Second Model)**

**(Repeat Para 5.1 Contents for each model under consideration)**

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## EXECUTIVE SUMMARY

**For**

**Models and Data Accreditation Report For**

*Project Name* **Analysis of Alternatives (AoA)**

**1. Problem Statement**

State the Mission Tasks (MTs) from the AoA, list the proposed models that will evaluate the corresponding Measures of Effectiveness (MoEs), and explain what you expect the analysis to provide in terms of alternative solutions.

**2. Usage of Selected Models**

Write a description of each model giving a quick look at its proposed utility. Explain the MoEs that the model will address, and how they relate to the MTs or functional objective. Show the overall model architecture and associated federations.

**3. Key Participants**

List the participants in the accreditation process. Identify the voting and non-voting members that were included on the panel. Also include their organizations and their roles/responsibilities. Finally, state who the overall accreditation officer is and provide his/her office symbol.

**4. Model selection and Data Requirements**

Explain the selection process that led to the identification and selection of the model(s) to be used in this analysis. Describe the overall data requirements for the analysis, the intended sources, and the expected pedigree of the data.

**5. Accreditation Methodology**

Give a brief explanation of the accreditation plan and process. Include a list of criteria that will be used to evaluate the acceptability of the model(s). If possible, some type of collaborative system should be used during the accreditation meeting so that comments and discussions can be captured and included in the final accreditation document. Also, during the meeting, such things as how data linkages between models are established need to be addressed in detail. The best way to confirm models will work together is to have the model user‘s talk face to face on their models‘ capabilities and data requirements. Also, explain which MoEs are addressed by which models. All MoEs should be supported by analysis and support specific mission tasks.

**6. Summary of Model(s) Accreditation Results**

List each model and summarize the accreditation results. Show how each model scored against the chosen selection criteria. This is best shown by the use of a ―stop-light chart‖. Models that have scored well on specific criteria are given a green color for that area. Models that have some problems concerning specific criteria are given a yellow. A green/yellow indicates minor changes can be made that would allow the score to become green. A yellow/red indicates significant changes to the model must be made in order for it to be useful in the analysis. The color red is given to criteria that make the model unacceptable for use in the analysis. For models other than green and green/yellow, the extent of changes required needs to be explained. Such things as cost, schedule delays, and risk need to be shown in detail. Remember also, the overall model architecture (to include all model linkages) must be reviewed and accredited; and that any major model change will affect this overall federation. Again, this architecture is best evaluated by

face-to-face discussion between the accreditation panel and the model operators during the accreditation process.

**7. Acceptability Criteria and Model Assessments**

Provide a statement of confidence for each model(s) resulting from the accreditation process. At this point it would be best to show a chart displaying the models to be used (based on this accreditation), their linkages, and the MoEs associated with each model. This will provide a clear picture of the planned analysis process. Any perceived risks in using the accredited models should be fully explained and proposed ways to mitigate the risks should be addressed.

OAS will be able to provide samples of past reports for other AoAs if requested to do so

**8. Summary Comments and Recommendations**

Summarize the success potential for the models selected along with the potential federated model architecture for the study being executed. Include pertinent comments on the accreditation process used and the potential of the models to successfully support the planned study. Provide the recommendation from the MAJCOM/A5 on the desired accreditation of all the models being evaluated for this study.

**REPORT BODY**

**For**

**Models and Data Accreditation Report**

**For**

*Project Name* **Analysis of Alternatives (AoA)**

**1. Problem Statement**

1.1. State the goal of this report in terms of model(s) accreditation for your AoA analysis architecture in terms of Mission Tasks (MTs)

1.2. Provide a statement that this document will fulfill the requirement for formal accreditation of all models and their architecture proposed for the AoA analysis.

1.3. Describe AoA and analysis requirements.

1.4. Explain what you expect the model(s) to produce in terms of alternative solutions

**2. Usage of Selected Models**

2.1. Describe the expected utility of each listed model

2.2. Identify MoEs

2.3. Indicate that each MoE will be addressed by at least one model

2.4. Show overall model federation for the analysis

**3. Key Participants**

3.1. List all participants and their office symbols in the accreditation process

3.2. Highlight voting members

3.3. State who is the Accreditation Officer and his/her office symbol

**4. Model Selection and Data Requirements**

4.1. Threat and Scenarios

- Explain the selection process for scenarios to be used in the analysis
- Discuss the pedigree of the threat databases to be used in the analysis
- Identify any expected problems with either scenario or threat data

4.2. Model Architecture

4.2.1. Input data

- Discuss input data requirements for models and the source of this data

  Discuss pedigree of input data

4.2.2. Output Data

- Describe expected output data from each model
- Describe how it will flow as input to the next model

4.2.3. Linkage Diagram

- Provide a detailed chart explaining the data linkages and associated MOEs

**5. Accreditation Methodology (Model Evaluations)**

5.1. Model Name and Short Description **(First Model)**

5.1.1. Evaluate model in terms of supporting MTs and MoEs

5.1.2. Explain history and past model usage

5.1.3. Accreditation History

5.1.3.1. Configuration Management (CM)

- Evaluate quality of CM

5.1.3.2. Version Changes and Enhancements

- Evaluate CM in terms of major changes (if any)

5.1.3.3. User Documentation available

- Evaluate quality of User Manuals,etc.

5.1.3.4. Assumptions, Limitations, and Possible Errors

- Assess any limiting assumptions, shortcomings, and obvious errors in the accreditation process

5.1.4. Evaluate model in terms of all other criteria selected for evaluation in the Accreditation process

5.1.4.1. User Experience e.g.

5.1.4.2. Functionality e.g.

5.1.4.3. Other Supportive information on the Model, etc.

5.2. Model Name and Short Description **(Second Model)**

- Repeat paragraph 5.1 for each model under consideration

**6. Summary of Model(s) Accreditation Results**

6.1. List models

- Show how they fared with respect to accreditation criteria

6.1.1 Provide Rationale

6.2. Show ―Stoplight Chart‖

6.3. Linkage Assessment

**7. Acceptability Criteria and Resultant Model Assessments**

7.1. Risk Assessment

7.1.1. Assess Risks

- Address risk involved in using planned models/architecture
- Explain plan for mitigating risk

7.2 Show summary of total architecture to include all MOEs and associated linkages

7.3 Summary Comments

**8. Summary Comments and Recommendations**

8.1 Accreditation Comments

- Summarize success potential of model architecture

8.2. Recommendations

- MAJCOM A5 or Study Director

## Appendix O – Concept Characterization and Technical Description

This appendix describes the process and documentation of the Concept Characterization and Technical Description (CCTD). The CCTD is a methodology to examine, document and communicate data and information associated with concepts (prospective materiel solutions developed to address both emerging and validated operational capability needs). It provides information to help capture the results of Early System Engineering (Early SE) performed to develop and mature materiel concepts during the pre-Milestone A phase of the Defense Acquisition Management System (ref: DoDI 5000.02T). It also provides engineering background to aid in shaping other technical and acquisition documents, and to clearly communicate engineering information to decision makers.

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**Introduction**

This appendix provides a narrative discussion that describes each CCTD element in a manner that conveys its level of maturity. Maturity has both qualitative and quantitative aspects, which depend on the nature of the concept as well as the degree of understanding of its anticipated operating environment. Maturity also reflects the state of the art in developing, analyzing, refining, verifying, and validating the concept. Therefore, the Guide should be viewed as a framework to capture information of various types and quality that provide indications of maturity in support of acquisition decisions, rather than as a source of definitive or quantitative statements about maturity.

This appendix does not provide process information about Development Planning (DP), Science & Technology (S&T), requirements, acquisition, or any other related activities. Instead, it should be used in conjunction with DoDI 5000.02, the Defense Acquisition Guidebook, and AF/A5/7 Capability Development Guidebooks.

From a hierarchical perspective, DP is the materiel contribution to Air Force or AF-led capability planning. As such, it has a far broader focus than just technical and technology areas.

Early SE enables the technical aspects of DP, and the CCTD is a principal artifact of Early SE. In this context, it is essential to remember that the CCTD must include both technical and programmatic content to effectively present decision support information.

**Definition**

For purposes of this document, a "concept" is a prospective materiel solution to gaps or shortfalls associated with realizing a viable operational concept. As decision support information, a CCTD summarizes the technical planning and analyses that have been accomplished and identifies areas of further work needed to mature the concept. While a CCTD addresses operational concepts as part of its content, it primarily serves to capture evolving knowledge of a materiel concept and its constituent elements.

Each materiel concept should have a CCTD, although a single CCTD may contain aggregated information for a family of related concepts. A CCTD should not be discarded, even if it is determined to be insufficient to meet the instant capability need for which the concept was developed. CCTDs will be collected and maintained in a repository for potential future use as technologies mature and operational needs evolve over time.

Information in a CCTD represents the analytic basis upon which a materiel concept was developed, the rationale for decisions made during that development, and the relevant technical documentation that results from early application of Systems Engineering (SE) processes and activities. A CCTD is typically not "approved" or "rejected" beyond the responsible originating organization, but instead is used to make informed decisions.

**Purpose**

The primary purpose of a CCTD is to provide information to decision makers. A CCTD presents:

- A description of how a concept represents a potentially viable solution to meet a stated operational capability need, for communication to sponsors and acquisition leadership. This communication can take various forms, such as:
    - Informing a Milestone Decision Authority (MDA) and staff prior to a Materiel Development Decision (MDD)

  - Informing sponsor discussions with the Office of the Secretary of Defense (Cost Assessment and Program Evaluation) (OSD(CAPE)) on the Analysis of Alternatives (AoA)Study Guidance
  - Providing information and a basis for the AoA Study Plan during the Materiel Solution Analysis (MSA) phase
  - Describing, in the AoA Final Report, the concept as evaluated by the AoA Study Team
  - Providing information such as cost estimates and risk assessments to inform the MS A decision.
  - Identifying potential S&T efforts
- Information for the preparation of various requirements documents and related strategic decisions, such as the Solution Pathway Review (SPR), the Capabilities-Based Assessment (CBA) Report, the Initial Capabilities Document (ICD), and the Capability Development Document (CDD.)
- Information for the preparation of various acquisition documents and related strategies, such as the Acquisition Strategy, System Requirements Document (SRD), Technology Development Strategy (TDS), and technical baselines, with realistic vectors toward fielding a solution.

Information presented in the sections on Principal Elements and Detail Elements of the CCTD is intended to guide the thought processes of the concept developers and analysts as they populate the knowledge base for a concept or family of concepts. It is not expected that the actual text in this guide would be included in a CCTD that is presented for review or decision support outside the originating team or organization. The CCTD will eventually contain all SE products and analytical results for the concept or family of concepts developed in response to an identified capability need.

**Context**

Figure 1 depicts the Early SE process framework as an adaptation of the classical SE “V” diagram. The Early SE Guidebook describes the process steps and product contributions to the definition of a concept (prospective materiel solution to an identified capability need), whether it points to a new program start, a modification or upgrade to a legacy system, or an information technology approach. The CCTD is a principal artifact of Early SE; it captures the results of activities associated with developing, populating, maintaining, and transitioning the technical and analytical knowledge base for a concept under development as a means of achieving a desired capability. It supports the pre-acquisition activities leading up to a Materiel Development Decision (MDD) and Analysis of Alternatives (AoA), as well as the AoA and preparation for the Milestone A decision.

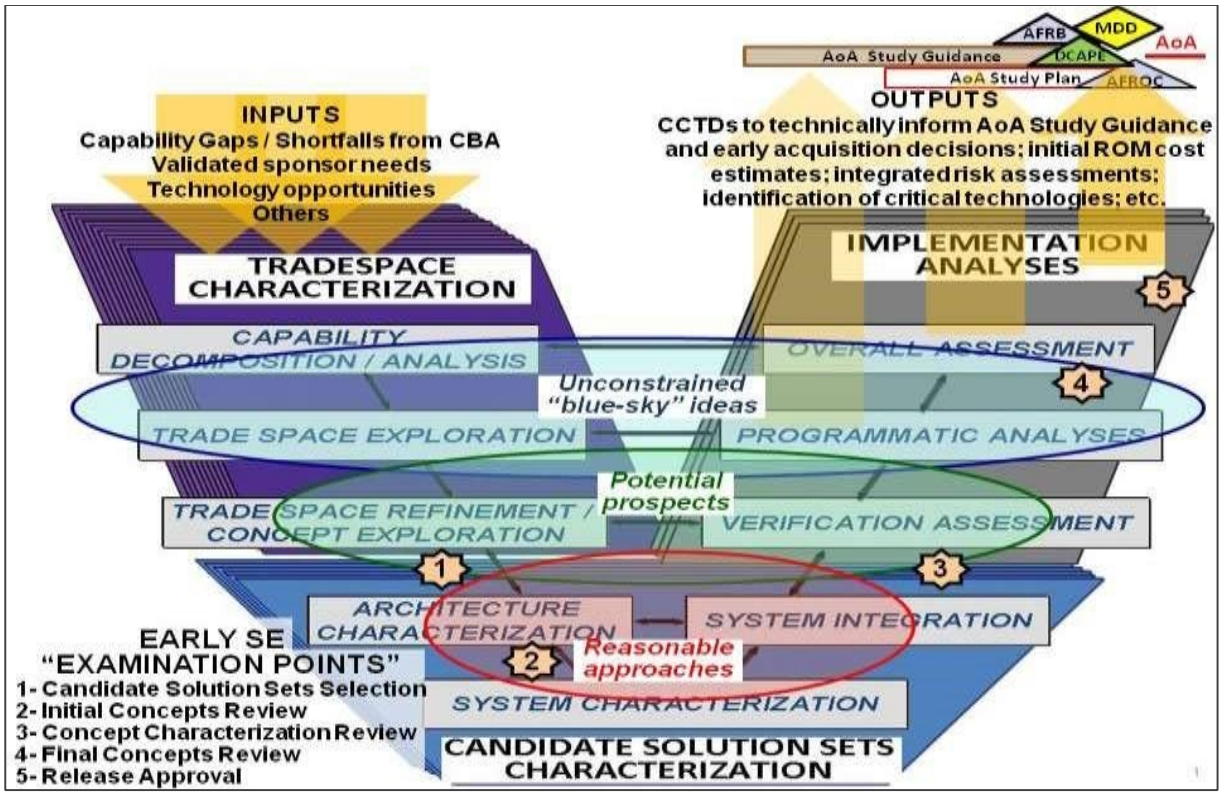


**Figure 1. Early Systems Engineering "V" Diagram.**

MDD Decision. DoDI 5000.85 states, "The MDD is the mandatory entry point into the major capability acquisition process and is informed by a validated requirements document (e.g., an initial capabilities document (ICD) or equivalent) and the completion of the analysis of alternatives (AoA) study guidance and the AoA study plan. The Director of Cost Assessment and Program Evaluation (DCAPE) (or DoD Component equivalent for ACAT II or below programs) will present the AoA study guidance, and the DoD Component will present the AoA study plan. For MDAPs, DCAPE issues the AoA study guidance, and approves the AoA study plan. The DoD Component will provide the plan to staff and fund program activities up to and including the next decision point, usually Milestone A. The MDA will determine the acquisition phase of entry and the initial review milestone. MDA decisions will be documented in an ADM. The approved AoA study guidance and study plan will be attached to the ADM."

The CCTD is intended to support the MDD decision, emphasizing the rigor and maturity behind the current analytical basis of the concept. This information will aid sponsor and acquisition leadership in crafting recommendations to the MDA and other decision makers.

It is important to note that decision makers may apply different criteria for the various CCTD elements at different times in the decision process. For example, a low level of completeness, understanding, or maturity of a particular detail element may be sufficient for the MDA, if there is evidence of due diligence and rigor having been applied. The AoA Working Group leads and the Study Director, though, will likely require significantly more technical and/or analytical evidence by the end of the AoA.

Preparation, Review, and Approvals. The operational user or sponsoring organization, generally a Major Command (MAJCOM), leads team efforts to identify capability gaps and shortfalls, and to identify potential solutions across the entire DOTMLPF (Doctrine, Organization, Training, Materiel, Leadership and Education, Personnel, Facilities) continuum. The acquiring command provides technical subject matter

experts (SME) to assist the sponsor; these may include system architects, technologists, cross-domain SEs, analysts, and representatives from other disciplines who can provide unique perspectives because of education and/or experience.

The sponsor prepares documentation required by the Joint Capabilities Integration and Development System (JCIDS); a multi-functional team, generally led by the acquiring command, prepares the technical and planning documentation required by acquisition leadership. Collaboration with other stakeholders (including but not necessarily limited to SMEs representing the sponsor, the appropriate AF Capability Development Team, and the Office of Aerospace Studies (OAS)) during CCTD development will facilitate sharing of essential information in support of reviews and decisions.

Preparation of the CCTD will be the responsibility of the lead acquisition organization, typically a product center Capabilities Integration organization (XR). Other applicable stakeholders provide inputs as needed to develop a complete picture of the concept. Other organizations are also encouraged to use the CCTD format to document capability concepts.

CCTD content, whether recorded in a physical document or an electronic repository/database, will continue to mature throughout DP and pre-acquisition activities, as well as throughout the MSA phase. The level of analysis and detail in the CCTD depends upon the nature of the problem being addressed and the time in the process it is viewed. All principal CCTD elements (i.e., sections with single-level numbering) should be addressed to some degree from the beginning of concept exploration; detail elements (i.e., sections with multiple-level numbering) should be included as the information becomes known. Additional elements unique to the concept being described may be added as the sponsor and/or developer determine appropriate to give a more complete picture of the concept. If an element is not populated, the plan to develop or acquire the information should be included. If any detail element is deemed unnecessary, rationale for exclusion must be provided.

The concept development team/organization leadership will generally review a CCTD in conjunction with each of the Early SE "Examination Points" depicted in Figure 1. While the organization director and the Center-level Technical Authority (or their delegate) should approve CCTDs before releasing them to outside organizations, sponsor discussions on AoA Study Guidance with OSD (CAPE) may be based on an in-process version.

Inclusion of a concept in the AoA Study Plan should be taken as evidence of endorsement that the concept described in the CCTD meets sponsor expectations in terms of having the potential to fulfill the stated operational capability need.

**Principal Elements**

Introduction. Provide the title of the concept; any contextual information needed for the concept, for example, the sponsoring command or agency for the concept; where the concept is being developed (e.g., Air Force Research Laboratory (AFRL), the Defense Advanced Research Projects Agency, industry, program office, etc.); whether it is a completely new concept, a concept based on a legacy system, or an update to a previously developed concept; and the organization or team responsible for generating the CCTD.

Additional information that can provide a frame of reference for both the overall concept and the specific detail in the remainder of the CCTD should also be included.

1. Mission / Capability Requirements / CONOPS.

This section captures the first step in any engineering process: define the problem. Typically, this information is a product of the Capabilities-Based Assessment (CBA) of the Joint Capabilities Integration and Development System (JCIDS) process. This section may be taken directly from the ICD or validated

warfighter gap/shortfall that the concept is addressing; as such, it is not concept-specific but gap/shortfall-specific. (Note, though, that engagement between concept developers and sponsors during the CBA is valuable in terms of ensuring mutual understanding of expectations.) Information from a Concept of Operations (CONOPS), whether pre-existing or developed as part of the CBA, should be referenced or included here. This section can include the mission tasks under consideration and the capability requirements and should describe in general terms how the concept addresses the stated capability requirements. The sponsor will be the primary source of inputs for this section.

The CBA should provide the information needed to define the Measures of Effectiveness (MOE) and Measures of Suitability (MOS); the operational point of view is generally the source for this information. The sponsor and acquirer must work together to ensure that MOEs/MOSs are defined so that they can be appropriately measured.

If the CCTD is being developed for a concept solution that is not in specific response to the JCIDS process, this paragraph can be tailored. For example, for an AFRL CCTD this paragraph might define a projected capability need based on analysis of future threats. In this case the MOEs will not be defined in an ICD, but may come out of analysis of future threat environments enabled by modeling and simulation (M&S). Linkages to an AF CONOPS should be made if possible. This section should be as thorough and accurate as early as possible because it is the foundation for all analysis.

2. Concept Overview (OV-1).

The concept overview is a high-level description of the concept. Consider using the description of the Operational View-1 (OV-1) from the DoD Architectural Framework (DoDAF). The overview should identify systems that the concept is expected to operate and/or interface with, information flows (also see the OV-2), the physical operating environment, and threats the concept will encounter.

It should take into consideration what is known about the concept's relationship with other systems, Families of Systems (FoS), or Systems of Systems (SoS). Additional text can describe how the OV-1 "frames" the operational concept.

3. Trade Space Characterization.

This section provides the scope, assumptions, and criteria of the trade space to help decision makers to understand the boundaries of the trade space, particularly with respect to the set of concepts being considered at MDD.

Trade Space Characterization restructures user needs into quantifiable boundaries: it collects potential solution ideas, filters the collected data to the most promising subset, and applies various methods to establish several possible solutions. A trade space consists of attributes that define an optimum boundary space for these prospective solutions to be evaluated against user needs. These can include initial Measures of Military Utility, operational measures, environment, ownership costs, user limitations, etc. A key consideration is the manpower/personnel/training impacts on manning and skill levels of anticipated system operators and maintainers.

4. Evaluation (Studies, Analysis, Experiments).

This section contains the analytical data and decision history that represent a concept's technical "pedigree," including study findings and/or results of any prior analyses or experiments accomplished. It should also identify shortfalls of these efforts that will need to be addressed in future evaluations such as an AoA. Results of other evaluations that support the Early SE effort, but which may have been performed for a different reason, (e.g., in AFRL, under contractor-funded efforts, etc.), should also be included here.

Concept developers and sponsors are free to present relevant information in any aggregation that provides a representative description of the analytical efforts behind the concept(s), e.g., by subsystem (communication, displays, processing) or domain aspect (fixed wing, rotary wing).

Provide references and/or links to actual reports and data products if available. If at any point in the evaluation it is determined the concept cannot satisfy the capability need and no further concept characterization will be performed, document the rationale in this section and ensure that the CCTD is appropriately archived.

5. Concept Characterization/Design.

This section contains architectural and design information. As a concept matures, more details such as options for design can be provided in additional architecture data supporting more detailed DoDAF views. Concept Characterization and Concept Evaluation are iterative processes; studies, analyses, and experiments identified in Section 4 can continue to provide additional details of the concept design. For concepts (or a family of related concepts) based on existing systems, this section can be mostly complete at the earliest stages of development; for materiel solutions that represent entirely new approaches to a capability, it will generally be at a high-level view.

6. Program Characterization / Implementation Analysis.

This section describes the efforts envisioned to develop, test and evaluate, manufacture, and sustain the materiel concept should it ultimately be selected to become an acquisition program.

7. Risk Assessment and Decision-Certain Consequences (must support sponsor endorsement).

This section describes identified risks, risk levels based on probability and consequence, and mitigation approaches. In the earliest phases, the focus is on top-level operational risks (e.g., threat analysis, mission completion, etc.) associated with not having the desired capability at the desired time; the next evaluations generally examine the impact of technology shortfalls, i.e., only partially achieving a MOE. The sponsor must have a thorough understanding of these risks to make an informed recommendation about the concept to decision makers.

If no other guidance on risk assessment is available (e.g., an organization guide or instruction on how risk assessments will be accomplished), the Department of Defense Risk, Issue, and Opportunity Management Guide for Defense Acquisition Programs provides basic guidance for executing risk management https://www.cto.mil/wp-content/uploads/2023/09/RIO-2023.pdf; it can also be a source of additional information on risk assessment.

8. DOTmLPF Implications and Other Interdependencies.

CBA activities evaluate the entire spectrum of materiel and non-materiel approaches, to include alternative uses of existing systems and interagency or foreign systems, as well as policy options. Doctrinal approaches to the military problems in the scenarios also need to be considered a part of the DOTmLPF analysis. Architectures capture the interfaces and interoperability of the materiel solution, however there are other significant non-materiel interdependencies such as training; security; infrastructure; data protection, transfer, and storage; and the like. Capture those DOTmLPF implications and other interdependencies of fielding the concept here.

9. Conclusions (Capability Description; Traceability to Need Statement).

Summarize the concept description and provide a recommendation of the overall maturity of the concept. Also summarize the risk analyses here to support the maturity recommendation. For added emphasis,

screening criteria used in earlier sections, i.e., rationale for continuing to develop a particular concept or family of concepts in support of a MDD or AoA, may be reiterated here.

This section provides a description of the capability and conclusions made about the overall concept. If available, a Requirements Traceability Tool or a Requirements Correlation Table should be included here to show the traceability to needs (i.e., identify how needs are addressed or any that are unmet). The section may also document conclusions that suggest follow-on work (analyses, M&S, prototyping, etc.) that may be needed in support of other acquisition documentation (e.g., the AoA Study Guidance and the AoA Study Plan). If a concept has been shelved (i.e., is not undergoing further maturation for this effort) or has otherwise been removed from consideration, this section also contains the conclusions that led to that decision.

This section should make clear to the reader what is currently known about the concept in terms of elements in the CCTD, what is not known (known unknowns), and what additional work is recommended to provide necessary information at future reviews and decisions.

**Detail Elements of the CCTD**

A1. Mission/Capability Need Statement/CONOPS

A1.1. Stakeholders

Stakeholders are organizations, groups, and/or individuals that are impacted by or invested in the need and/or the solution concept. Examples include end users (operators/warfighters), planners, developers, acquirers, decision makers, owners/users of outputs and/or inputs to the concept, operators, testers, maintainers, modeling and simulation experts, Human Systems Integration (HSI) experts, technical specialists, the intelligence community, cost and business experts, logisticians, outside agencies and organizations, industry partners, and Science and Technology (S&T) communities including AFRL and academia. As the concept evolves, the stakeholders may change; the list should be reviewed periodically to ensure all stakeholders are identified. At a minimum the stakeholder list should be reviewed and updated at significant transition points (e.g., identified "Examination Points") in the Early SE process.

A1.2. Capability Need Statement / CONOPS; Measures of Effectiveness

Document the capability gap or shortfall, using documentation from the JCIDS CBA process if available. Results of analyses of future threats can also support information in this section. Discuss the capability needed, mission tasks, MOEs, MOSs, operational concepts, support concepts, and any other operational information that impacts the concept.

A2. Concept Overview (OV-1)

Include DODAF architecture view

A3. Trade Space Characterization

A3.1. Scope

Define the scope of the trade space in terms balancing key characteristics such as affordability, feasibility, schedule (near-term [fielded in 0-8 years], mid-term [fielded in 9-15 years], or far-term [fielded in 15-23 years]), military utility, threshold needs and objectives, and technical constraints to allow proper evaluation of concepts.

A3.2. Assumptions and Constraints

Assumptions are premises that must be true for the trade space to be viable, e.g., programmatic, technical, cost, schedule, and/or performance. Any assumptions regarding how the future system will integrate and interoperate as part of the FoS or SoS environment should be documented here. Constraints are limitations of any nature, e.g., programmatic and/or scientific. Leverage work done in CBA, especially to define assumptions, boundaries, constraints, dependencies, and enablers. Some constraints may be known at the beginning of the concept development activities, but participants and stakeholders may identify more during the characterization process.

There may also be other externally imposed non-technical limitations that may restrict the range of potential solutions (e.g., Laws of Armed Conflict prohibit use of lethal directed energy against personnel).

A3.3. Interfaces

This section describes all major external and internal interfaces. It identifies those that will be available to support the fielded solution, as well as those that may require additional technology and/or infrastructure development. Both physical and functional interoperability issues should be addressed.

Ensure that the OV-1 captures known detail such as order-of-magnitude estimations for interfaces required between nodes, users, or systems, as well as how the concept is expected to fit in a SoS or FoS

environment. The OV-2 and 3 may be referenced here if they are available. Identify interfaces with infrastructure and enabling systems (e.g., intelligence and data transfer) that the concept is dependent upon to be a successful materiel solution; also capture unique internal interface considerations (hardware, software, or human) that could be design drivers or risk items. Identify and document anticipated future interfaces and schedules for availability.

A3.4. Operating Environment

Early SE is performed in the context of the CONOPS and considers characteristics of the operational environment that reflect both human and natural conditions. The operational point of view should include descriptions of the relevant domain (space, air, surface, nuclear, cyber), and may also include other environmental considerations relevant to the concept, (e.g., day, night, climate, atmospherics, vegetation, terrain, electromagnetic environment, nuclear environment, and anti-access). Relevant battlefield environment(s) (contested, denied, etc.) should be identified here as well.

An understanding of user needs, constraints, and limitations in the operating environment assists with developing MOEs that can be used to assess military utility of a concept, including operational performance (e.g., reliability, maintainability, availability, supportability, sustainability, testability, deployability, etc.). For example, chemical or biological warfare (human-caused conditions) may impact the working environment for operational crews and logistics support personnel.

A3.5. Key Parameters/Attributes

Capture measurable MOEs, KPPs, and other qualitative attributes as they can be detailed from the analysis. When feasible, define measures that can be related to military utility. Specific values of measures may not be known early in the concept development but identify general parameters as soon as they are known. These parameters should be measurable and/or calculable parameters that can be used to characterize and evaluate concepts within the trade space.

MOEs can be further detailed to define MOPs as a concept is analyzed to lower levels of detail, and specific design features begin to emerge. MOPs are quantitative and include metrics to measure one or more MOEs, such as bandwidth, throughput, probability of kill, range, weapon load-out, logistics footprint, etc. MOPs should generally be traceable to Key Performance Parameters (KPP) or other parameters defined as part of a capability need.

A3.6. Compliance Issues

Identify any laws, standards, or regulations that may provide compliance issues for the concept solutions (e.g., Federal Aviation Administration airworthiness certification, Federal Communications Commission regulations, spectrum availability, International Law, Environmental Protection Agency criteria, etc.). Consider the operating environment, including network integration, when determining compliance issues and determine if any compliance issues should be a measure to be used in the trade space. Capture compliance risks in the risk analysis.

A4. Evaluation (Studies, Analysis, Experiments)

A4.1. Common Assumptions and Methodologies

Describe common methodologies and assumptions used in studies, analyses, and experiments across the evaluation of the candidate solutions. Identify any limitations relative to conclusions due to these methodologies and assumptions. Each study, analysis, and/or experiment should define the unique assumptions and methodologies, and capture these in their respective reports.

A4.2. Parametric Studies

Parametric studies are an effective way to show dependency of evaluation measures to key design parameters. They identify the sensitivity of measures, and therefore capability, to design parameters, indicating when additional performance does not provide an equivalent increase in capability (i.e., the "knee in the curve"). Parametric studies and sensitivity analyses are particularly relevant in an AoA.

Summarize results of any parametric studies (e.g., carpet plots for weight, power, throughput, cooling, etc.) performed over the lifetime of the concept to support objective evaluation of the concept. Provide references and/or links to full study reports. Identify limitations of any models or simulations used and characterize the risk/uncertainty due to these limitations; also identify any information shortfalls and recommend studies that could provide pertinent information.

A4.3. Analyses

Provide summaries of results of all analyses performed that are relevant to the evaluation of the concept. Provide references and/or links to full analysis reports. Identify assumptions and data sources; identify essential information that is still needed, and recommend additional analyses to provide it. Identify limitations of any models or simulations used, and characterize any impacts these limitations may have on the results. Analysis can be subjective (qualitative) and objective (quantitative); both are important, and need to be balanced with one another depending on the concept under investigation and the state of its development/maturation.

A4.4. Experiments

Summarize the results of all experiments performed over the lifetime of the concept that are relevant to the evaluation. Experiments that result in the identification of critical technologies, or that address already-identified critical technologies, are of particular interest. Provide references and/or links to final reports of the experiments; identify shortfalls and recommend additional experiments and/or prototyping to provide needed information. For example, if the experiment was not done in an environment representative of this concept's operating environment, it should be repeated in a relevant environment, or a recommendation should be made to accomplish it as part of the AoA or elsewhere in the Materiel Solution Analysis phase.

A4.5. Modeling & Simulation (M&S) and Associated Data

M&S can provide mechanisms and environments to develop and refine concepts, and as such is an important tool for developers, analysts, and users to gain insight into how well a concept might satisfy operational needs. It is often the only way to evaluate a solution in a realistic (simulated) operational environment, including environmental, threat, and SoS or FoS considerations. Use of constructive models with virtual and live components can provide an effective venue for concept evaluation, especially when assessment of the user interface is important. M&S enables experimentation and other evaluations such as mission-level and parametric analyses.

Provide summaries of relevant M&S activities throughout the life of a concept. Provide references and/or links to information on actual models, simulations, and related tools used, as well as associated data. Specific tools and data set(s) used to conduct M&S enabled experiments, assessments and analyses should be identified in the appropriate reports. Pedigree information (i.e., verification, validation, and accreditation history) of all M&S tools and data should be documented.

A4.6. Evaluation Results and Conclusions

Capture the results from evaluation activities and summarize the concept's ability to meet key measures. These evaluations help to identify candidate solutions, select those that merit further analysis, and then refine candidate solutions.

Summarize additional studies, analyses, and experiments needed to fully evaluate the concept. Provide rationale for recommendations to discontinue further work on a concept.

This section provides critical information to developers and decision makers as it contains the baseline of analyses from which further work will proceed. Identify M&S tool enhancements and data needs required to fully evaluate the concept.

A5. Concept Characterization/Design

A5.1. Design Description and Variants

A concept may have more than one design configuration that will address the identified capability need. Document or reference possible design configurations, including candidate systems, subsystems, and interfaces; identify enabling and critical technologies associated with the design. When available, capture approaches to further validate and determine if the design is feasible. Contents of this section will contain more detail as the materiel concept evolves. This paragraph may reference or include drawings, draft performance specs, industry specs, to a level of detail appropriate for the state of the concept. Include traceable justification for design attributes, system configurations, and trade studies. Provide enough detail to be able to identify key technologies and interfaces.

A5.2. Operating Concept

Define how the materiel concept is expected to be used in the operational environment, including all DOT_LPF considerations and enablers such as infrastructure, support required, environmental factors, and similar constraints. Identify whether these enablers currently exist or are new requirements to support the concept. Consider using DoDAF models and/or sponsor-provided operating/enabling concepts where appropriate to provide context information.

A5.3. Architecture Considerations (Interfaces / Interoperability / System-of-Systems Approach / Integration)

Use the DoDAF products, and augment as appropriate. However, when all aspects of an architectural view are not yet known, do not hesitate to capture what is known (i.e., provide a partial view). Document expected interfacing and interoperating systems, processes, practices, capabilities, users, and/or technologies. Consider documenting or referencing any DoDAF architectural products (including Operational, System, and Technical views, inclusive of expected human contributions and unique interface requirements) that are appropriate for the materiel concept, if the data is available and the view is appropriate. Identify how open architecture considerations are being addressed. Document architectural conclusions as appropriate.

A5.4. Critical Design Constraints

Identify constraints that limited choices for concept design – e.g., cost, immature technology, requirements that exceed current technological capabilities, etc. When applicable, provide recommendations to alleviate those constraints (e.g., a technology maturation program, AFRL Manufacturing Technology (MANTECH) program, requirement change). Consideration may be given to address these recommendations in the AoA Guidance or ICD development. It is critical that these constraints be identified, documented, and provided to appropriate stakeholders for consideration as early as possible; concept exploration and refinement is an iterative process.

A5.5. Critical Technology Elements (CTE)

“A technology element is “critical” if the system being acquired depends on this technology element to meet operational requirements (within acceptable cost and schedule limits) and if the technology element

or its application is either new or novel or in an area that poses major technological risk during detailed design or demonstration."

Identify the technology elements or types of technology that are critical to the concept, and provide rationale for identifying those technology elements. To the extent possible, describe the maturity level of the CTEs in terms of technology readiness levels (TRL), and recommend which CTEs require additional technology maturation. Reference: https://acqnotes.com/acqnote/tasks/technology-readiness-level

The TRL definitions follow:

TRL 1: Basic principles observed and reported

TRL 2: Technology concept and/or application formulated

TRL 3: Analytical and experimental critical function and/or characteristic proof of concept

TRL 4: Component and/or breadboard validation in a laboratory environment

TRL 5: Component and/or breadboard validation in a relevant environment

TRL 6: System/subsystem model or prototype demonstration in a relevant environment

TRL 7: System prototype demonstration in an operational environment

TRL 8: Actual system completed and qualified through test and demonstration

TRL 9: Actual system proven through successful mission operations.

When completed, this section will provide a top-level description of CTEs and their TRLs that supports characterization of the concept as near-term (fielded in 0-8 years), mid-term (fielded in 9-15 years), or far-term (fielded in 15-23 years). Maturation details will appear in Section 6.2.

A5.6. Supportability / Sustainment / Logistics Features

Document features or constraints important to supportability and sustainment of the materiel concept. Identify and document any new requirements that this concept will add to the logistics infrastructure.

Areas of consideration may include, but are not limited to, such things as airfield capacity, maintenance skills, technical data, repair and supply concepts, system and operator certifications, and the like.

A5.7. Cost Drivers

For each major phase of the acquisition life cycle, identify which characteristics of the concept will drive the cost. Also describe why cost drivers may be related to technology, hardware, software, integration, logistics support, data, manufacturing, infrastructure, training, testing, production quantities, cost per flying hour, manpower, safety, etc. This information will aid cost estimators in developing their cost estimates for the concept, and can also aid characterization of the program needed to address the cost drivers. It will also help to identify budget appropriation categories (i.e., "color of money") that could be impacted, namely:

- Research, Development, Test and Evaluation (RDT&E) (3600) funds can be impacted by cost drivers associated with the Technology Development (TD) and Engineering & Manufacturing Development (EMD) phases
- Procurement (30x0) funds can be impacted by cost drivers associated with the EMD and Production & Deployment phases
- Operations & Maintenance (O&M) (3400) funds for sustainment can be impacted by cost drivers associated with the Operations and Support (O&S) phase

- Disposal cost drivers can impact several appropriation categories
- If applicable, Military Construction (MILCON) funds might also be needed for one or more of the above phases, such as facilities construction and related civil works
- Personnel and workload costs, considering appropriation categories

It is important to identify which cost drivers are related to nonrecurring costs and recurring costs. Nonrecurring costs are one-time expenditures (generally for activities that occur at the beginning of the life cycle) and that do not need to be repeated, e.g., design, prototyping, and software development. Recurring costs are repeating expenditures associated with each development unit, production unit, or deployment location.

Early recognition of factors that could potentially contribute to or impact the costs of acquiring and sustaining a materiel concept, such as data rights, can be useful even when uncertainties are too large to prepare high-confidence cost estimates.

A5.8. Required Enabling Capabilities

Use appropriate SMEs to describe specific analyses (e.g., HSI strategy; supportability concepts; logistics; communications; Intelligence, Surveillance, and Reconnaissance [ISR]; etc.) that are relevant to the concept, and document appropriate results here.

Example: Consider involving the operational users, technology community, and ISR support community to identify the baseline ISR support the concept needs to be effectively employed. ISR support often needed include data (e.g., system signatures, digital terrain data), target folders, bomb damage indication, and the like.

A6. Program Characterization / Implementation Analysis

A6.1. Critical Technologies (including S&T needs / feed-forward)

For the identified CTEs, describe the current state of the art in industry and DoD, focusing on those with low TRLs. Describe current and planned efforts to improve the TRL in industry and DoD labs in the context of the envisioned timeframe for acquisition and fielding. Identify any gaps between the current and planned TRL improvement efforts and needs of the concept. Identify any alternate technology solutions to meet concept needs. Also identify potential technology needs associated with concepts that may not meet current development or fielding time horizons for further research in AFRL, industry, academia, etc.

A6.2. Technology Maturation Approach

The technology maturation approach will play a large role for decision makers in determining where the concept enters the acquisition cycle, as it describes much of the technical work that remains to mature the concept. In some cases, the path forward may be to defer embarking on a new system for several years in favor of investing in additional technology efforts.

Describe the approach to address the identified technology gaps. The approach can include new AFRL efforts, prototyping, and planned technology development efforts as part of the acquisition process and should identify when CTE TRLs will be reassessed in the context of the envisioned timeframe for acquisition and fielding. The maturation plan will serve as the basis for the Technology Development Strategy that is submitted at MS A, and details how critical technologies will be advanced to TRL 6 by MS B.

A6.3. Test & Evaluation (T&E) / Verification & Validation (V&V) Approach

Describe the approach for accomplishing T&E activities on the materiel system and subsystem concepts. Identify a test strategy to verify that the concept is testable, that user requirements are met, and to validate that it is a viable solution in terms of operational measures. As an important stakeholder, the T&E community can provide valuable input here. Identify and document test resources (e.g., models, simulations, and simulators) and limitations, as well as other test considerations (e.g., ranges, platforms, targets, environment, etc.). Be sure to include any lessons learned from experiments and/or other M&S activities done as part of the evaluation of the concept. As T&E/ V&V efforts are completed, document or reference the results here.

A6.4. Prototyping Approach

Department of Defense Prototyping Guidebook: "The NDS emphasizes adopting a risk-tolerant approach to capability development through the extensive use of prototyping and experimentation to drive down technical and integration risk, validate designs, gain warfighter feedback and better inform achievable and affordable requirements, with the ultimate goal of delivering capabilities to the Joint warfighter at the speed of relevance. In order to retain U.S. global technological dominance, DoD must adopt and mature this approach quickly, using all existing authorities at its disposal and new authorities provided by Congress in recent law. (https://acqnotes.com/wp-content/uploads/2014/09/DoD-Prototyping-Guidebook-v2.0.pdf)

Prototyping can be done at different architectural levels as needed (e.g., component, sub-system, and/or system). Describe prototype efforts here, along with the rationale for the approach to prototyping. If prototyping was done as part of earlier concept exploration or refinement, document or reference the results here. If prototyping will not be performed, provide rationale.

A6.5. Manufacturing / Producibility Approach

Describe the approach to ensure the concept solution will producible. Assess the manufacturing readiness level (MRL) of the concept and key components. Guidance on defining MRLs of the concept and components can be found in the Manufacturing Readiness Level Deskbook (http://www.dodmrl.com/). The MRLs are defined as:

MRL 1: Basic Manufacturing Implications Identified

MRL 2: Manufacturing Concepts Identified

MRL 3: Manufacturing Proof of Concept Developed

MRL 4: Capability to produce the technology in a laboratory environment

MRL 5: Capability to produce prototype components in a production relevant environment

MRL 6: Capability to produce a prototype system or subsystem in a production relevant environment

MRL 7: Capability to produce systems, subsystems, or components in a production representative environment

MRL 8: Pilot line capability demonstrated; Ready to begin Low Rate Initial Production

MRL 9: Low rate production demonstrated; Capability in place to begin Full Rate Production

MRL 10: Full Rate Production demonstrated and lean production practices in place

MRLs 1-3 highlight manufacturing issues requiring attention prior to the end of the MSA Phase. Unless the concept is an off-the-shelf product or system, or based on one currently in inventory, it will likely be at the MRL 1-3 level at MDD.

Identify any gaps in the MRLs to meet the needs of the concept and recommend efforts to address those gaps (e.g., AFRL MANTECH program). The approach should identify event driven opportunities to re-assess the MRL of the products. As efforts to improve manufacturing readiness are complete, document or reference the results here.

The manufacturing readiness of the concept will be a key consideration for the MDA in determining where the concept enters the acquisition cycle as it determines whether a concept is producible or not.

A6.6. Sustainment / Supportability Approach

Document the approach to support and sustain the materiel concepts and incorporated technologies in the operational environment. Describe current sustainment infrastructure that will be used (e.g., aircraft hangars, Special Test Equipment, etc.) and identify new programmatic requirements for life cycle sustainment. Provide as much information as possible since sustainability is a major contributor to the total cost of ownership analysis.

A6.7. Other Relevant Considerations

As the concept matures, unique issues associated with actualizing the concept (e.g., resources, processes, politics) begin to emerge. Capture these considerations in this section as they are identified. At a minimum, initial planning for program protection issues such as security and anti-tamper should be addressed here. Additional areas may include intelligence, manpower, budget environment, potential for competition during the development and production phases, potential for joint or foreign military sales, etc. These may influence the eventual acquisition strategy.

A6.8. Schedule Assumptions and Methodologies (need date from ICD)

Capture all schedule assumptions and methodologies for the materiel concept here. The Initial Operational Capability (IOC) date should match that identified by the sponsor in the ICD. Summarize and reference any reports from completed schedule analyses. Identify any disconnects between the operational need date and the expected concept maturation (e.g. technical readiness, manufacturing readiness, logistics infrastructure, etc.) that can be used in the risk assessment.

A6.9. Cost Analysis Assumptions and Methodologies

Capture all cost analysis assumptions and methodologies that will be used to estimate total cost of ownership of a materiel concept here. The costs for the entire life cycle of each concept should include the cost for R&D (including concept generation and prototyping), Investment, Production and Deployment, O&S, and Disposal. As the concept matures, more information will be available for cost analysis and the cost assumptions will also need to be revised over time. Costs should be estimated in base year dollars (i.e., without escalation for inflation in future years), and the assumed base year used needs to be included in the cost analysis assumptions. The dependencies and impacts on other systems and/or programs should also be addressed in the estimate and included in the assumptions.

Typically, few technical, design, and operational details are available during early concept definition. Nevertheless, it is still possible to develop a cost analysis framework, which sets up a cost element structure (CES) that can be used to track costs as the concept matures. The list of cost elements should be sufficiently detailed to provide visibility into tracing how specific cost drivers contribute to the total cost of each life cycle phase.

Using the best available information at concept inception, individual cost elements that comprise the cost estimate can be estimated by using one or more standard methods, such as analogy, cost estimating relationships, parametric estimating relationships, and engineering build-up (“bottom up”). Specialized

cost estimating tools that could be useful for portions of or the entire cost estimate might also be available.

It is also necessary to determine the kind of input data that needs to be collected. Data should be collected from systems that possess similar features or capabilities to the concept under investigation. It is useful to examine more than one similar system to obtain cost range information for cost driving parameters of interest. Vendor or contractor quotes, catalog prices, and SME judgment can also provide useful inputs.

A6.10. Cost Estimates

Capture all cost estimates and document confidence levels. Initial cost estimates will necessarily be at a Rough Order of Magnitude (ROM) level, but both detail and fidelity will increase as the concept becomes more clearly defined. Cost estimates for proposed concepts should be sufficiently documented to ensure replication by an independent cost analyst; documentation should include a description of the basis of estimate for each cost element, as well as a summary of the cost estimating rationale used to calculate the results, the inputs used to estimate the costs, a list of ground rules and assumptions, and, if available, a WBS dictionary describing each major cost element.

Results should be presented in base year dollars in several summary tables, showing cost breakouts by life cycle phase, by budget appropriation code, by CES or WBS cost element, and by year. For a ROM estimate, it may be appropriate to round the cost numbers in a way that is consistent with the accuracy of the estimate. OSD CAPE has developed an AoA Cost Estimating Handbook at the link referenced below https://www.cape.osd.mil/files/Reports/AoACostHandbook2021.pdf .

A7. Risk Assessment and Decision-Certain Consequences

A7.1. Operational Risk

Document risks of the materiel concept satisfying the capability gap in the operational environment. Also address risk with respect to completeness of the definition of the capability need statement and associated measures (MOEs, MOPs, KPPs, etc.). Be sure to consider items such as threats, infrastructure, policy, compliance issues, etc. Provide or reference a risk assessment and risk mitigation approach for each.

A7.2. Program Risk

Assess the risk in the proposed program. Baseline the risks in cost, schedule, and performance and outline the risk mitigation approach. Identify in an event driven manner when an integrated risk assessment will be accomplished.

A7.3. Technology Risk

Based on the CTEs and the technology maturation plan, quantify the risks associated with the technology challenges including anticipated cost and schedule impacts of the technology risks. Specifically address how the technology maturation approach mitigates risk with an event driven schedule (e.g., risk waterfall chart). As part of the technology risk assessment, describe the consequence of a technology not being matured to the point of inclusion in the concept. Describe the backup approach if applicable, and any impact to the concept satisfying the capability need.

A7.4. Intelligence Risk

Assess the risk associated with providing intelligence to the proposed program throughout the lifecycle of the system. This includes the ability to collect, process, analyze, and disseminate the information at the proper fidelity, quantities, and timeliness required to meet program needs.

A8. DOTmLPF Implications and other interdependencies

Outline implications and interdependencies for each alternative.

A9. Conclusions (Capability Description; Requirements Traceability)

Provide a summary and linkage to existing requirements.

## References

Department of Defense Architectural Framework (DoDAF) Version 2.02, https://dodcio.defense.gov/library/dod-architecture-framework/

Department of Defense Risk, Issue, and Opportunity Management Guide for Defense Acquisition Programs, https://www.cto.mil/wp-content/uploads/2023/09/RIO-2023.pdf

Major Capability Acquisition (MCA) | Adaptive Acquisition Framework (dau.edu)

DoD Instruction (DoDI) 5000.02, Operation of the Adaptive Acquisition Framework, https://www.esd.whs.mil/Portals/54/Documents/DD/issuances/dodi/500002p.pdf

OSD CAPE AoA Cost Estimating Handbook, https://www.cape.osd.mil/files/Reports/AoACostHandbook2021.pdf

Technology Readiness Levels, https://acqnotes.com/acqnote/tasks/technology-readiness-level

Manufacturing Readiness Level Deskbook, http://www.dodmrl.com/

DOD Protyping Guidebook, https://acqnotes.com/wp-content/uploads/2014/09/DoD-Prototyping-Guidebook-v2.0.pdf

## Appendix P – Materiel Development Decision Guide and Best Practices

**Preface**

The MDD is the mandatory entry point into the major capability acquisition process and is informed by a validated requirements document (an ICD or equivalent) and the completion of the AoA study guidance and the AoA study plan. The Director of Cost Assessment and Program Evaluation (DCAPE) (or DoD Component equivalent for ACAT II or below programs) will present the AoA study guidance, and the DoD Component will present the AoA study plan. For MDAPs, DCAPE issues the AoA study guidance, and approves the AoA study plan. The DoD Component will provide the plan to staff and fund program activities up to and including the next decision point, usually Milestone A.

The decisions expected at the MDD include:

- The MDA will determine the acquisition phase of entry and the initial review milestone.
- MDA decisions will be documented in an ADM.
- The approved AoA study guidance and study plan will be attached to the ADM.

**Notes for Clarification:**

- The AoA Sponsor provides stakeholders to SAF/AQ (ACAT I) or PEO (ACAT II, III) for MDD consideration.
- Congressional language directs that service components are the acquisition authority by default for ACAT I. For Air Force programs SAF/AQ (SAE) is the acquisition authority, and chairs the MDD; however, OUSD A&S may elect to oversee ACAT I programs (chair MDD) by exception. PEO is acquisition authority for ACAT II, III and chairs the MDD.
- The AoA Study Guidance & Study Plan will be routed through AFGK (AF/A5DR), and AF/A5D, to OUSD CAPE (ACAT I) or PEO (ACAT II, III).
- SAF/AQX (ACAT I) or PEO (ACAT II, III) schedules the MDD and Milestone A, B, C.

**The Planning Process**

MDD Planning Process (Projected MDAP (ACAT-I)):

1. The AoA Sponsor will coordinate with the PEO counterparts in the scheduling of the MDD. Include the proposed date.
2. PEO counterparts will coordinate with the SAF/AQ Program Element Monitor (PEM) and SAF/AQX to schedule the MDD with the Service Acquisition Executive (SAE).
    a. The proposed MDD date must be at least 60 business days (approximately 90 calendar days) from the current date.
3. SAF/AQX will:
    a. Schedule and coordinate the MDD event with the SAE.
    b. Draft and informally coordinate the ODCAPE MDD notification memo with stakeholders (SAF/AQ PEM, AF/A5DR, Capability Development Team, AoA Sponsor, and OAS (AF/A5DY))
    c. Notify ODCAPE of the upcoming MDD for an impending MDAP.

    **Best Practice**: Provide AF coordinated AoA Study Guidance with MDD Notification Memo to ensure CAPE has the official proposed AF version of the study guidance for consideration. If the

study guidance is not available or was sent previously by AF/A5/7, consider adding a note to CAPE in the MDD Notification Memo stating, "You will receive / have received the proposed AF AoA Study Guidance for consideration from AF/A5/7 separately."

4. AoA study guidance/plan are coordinated with AF/A5/7 and CAPE IAW the timeline described in DoDI 5000.84 leading up to the MDD. AoA sponsor and PEO counterparts will collaborate to deliver a combined MDD brief for SAE approval.
5. The SAE will document the MDD via an Acquisition Decision Memorandum (ADM). The approved AoA study guidance and plan will be attached to the ADM. The PEO counterparts are responsible for drafting the ADM and staffing it through SAF/AQ for approval.

MDD Planning Process (Non-MDAP (ACAT-II or ACAT-III)):

1. AoA Sponsor will coordinate with PEO counterparts in scheduling the Materiel Development Decision (MDD). Include the proposed date.
2. PEO counterparts will coordinate with the appropriate MDA to schedule the MDD.
3. The AoA study guidance/plan are coordinated with AF/A5/7 and PEO IAW the timeline described in DoDI 5000.84 leading up to the MDD.
4. The AoA sponsor and PEO counterparts will collaborate to deliver a combined MDD brief for MDA approval.
5. The MDA will document the MDD via an ADM. The approved AoA study guidance and plan will be attached to the ADM.

**Example MDD Notification Memo**

DEPARTMENT OF THE AIR FORCE
WASHINGTON DC

OFFICE OF THE ASSISTANT SECRETARY

25 OCT 2023

MEMORANDUM FOR ODCAPE

FROM: SAF/AQX

SUBJECT: Next Generation Air-refueling System (NGAS) Materiel Development Decision (MDD) Notification

In accordance with DoDI 5000.84, I am notifying the Office of the Director, Cost Assessment and Program Evaluation (ODCAPE) that NGAS, an impending Major Defense Acquisition Program (MDAP), will conduct an MDD review on 25 January 2024. NGAS is projected to be an ACAT-IB program with the Air Force Service Acquisition Executive (SAE) as the Milestone Decision Authority. NGAS delivers a next generation family of systems to meet air refueling demands in the future contested environment. It is envisioned to be a clean sheet, purpose-built design to address projected threats and needed capabilities with first delivery projected in the mid- to late- 2030s. With an approved MDD, acquisition planning can begin the Materiel Solution Analysis (MSA) phase while Air Mobility Command (AMC) concurrently leads an NGAS Analysis of Alternatives (AoA) based on DCAPE's approved study guidance and plan.

The requirements validation documents used to justify this impeding MDAP are the Advanced Air Refueling (AAR) Capabilities Based Assessment (CBA) dated 30 September 2017, and the Initial Capabilities Document (ICD) for AAR validated 4 November 2020. AMC will use attributes determined in the NGAS AoA to create an NGAS Capability Development Document, projected in FY25.

The SAF/AQ MDD POC is Maj Max Reuning, DSN: 260-0382, the SAF/AQ NGAS POC is Lt Col Adam Brueggen, DSN: 260-0500, and the AMC NGAS AoA POC is Col Robert Bittner, DSN:779- 3368.

Mark Murphy

MARK MURPHY, SES, DAF
Associate Deputy Assistant Secretary
(Acquisition Integration)

2 Attachments:
(S) AAR CBA
(S) AAR ICD