Capabilities-Based Assessment (CBA) Handbook

A Practical Guide to the Capabilities-Based Assessment

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Office of Aerospace Studies

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Preface

This is the initial version of the OAS Capabilities-Based Assessment (CBA) Handbook. Its publication is the result of the need for a handbook which consolidates joint and AF CBA requirements and incorporates CBA best practices observed across the Air Force. It is not a substitute for the JCIDS Manual or AFI 10-601, but is designed to serve as a primer for those charged with planning and conducting a CBA.

The intent of the handbook is to assist participants through all phases of CBA activities and to provide guidance when questions arise. This handbook does not propose to provide a recipe to follow to complete the CBA. As a CBA is one analytical activity supporting the Joint Capabilities Integration and Development System (JCIDS) process, so is this handbook with respect to other references. The document is one of an OAS handbook series which addresses key analytic issues across the requirements capability process.

Since the completed CBA is the initial requirements analytic effort, it is essential that it be complete, concise, consistent, and clear. The CBA serves as the foundational effort for identifying capability gaps and potential solution approaches to closing or mitigating those gaps. The quality of the effort put into the CBA can influence the effectiveness and success of the Air Force in both the near and distant future. It should go without saying that this is important work.

This handbook focuses on addressing the right requirements questions to the level of detail that the senior decision-makers need. We advocate frequent and open communication both to understand what the senior decision-makers need and to convey what the analysis uncovers. We advocate sound analytic processes, not specific tools. While detailed analytic tools may be used for key parts of a CBA, much can be learned with effective use of the simpler approaches described within this handbook.

This handbook is grounded in over twenty years of experience in providing analytic advice to Air Force and DoD study teams. It has been shaped by what OAS has learned from those studies, and by what we have understood to be the expectations of Air Force and OSD senior decision-makers. Those lessons and expectations keep evolving, and in response so will this handbook. If you have questions regarding the currency of your CBA handbook, if parts of the handbook are unclear, or if there are suggestions on how to improve the document; please contact OAS at (OAS.DIR@us.af.mil) or 505-846-8322 (DSN 246).

OAS promotes an effective dialogue with the CBA user community. We encourage you to contact us and ask questions, or to provide always appreciated feedback.

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Table of Contents

List of Figures

List of Tables

1 Introduction and Background

This chapter describes the Capabilities-Based Assessment and how it fits in the early acquisition framework.

1.1 What is a Capabilities-Based Assessment?

The Capabilities-Based Assessment (CBA) is the analytic basis for operational capabilities requirements development. The CBA is an integral part of the capabilities planning process and formally documents the capability gaps and provides recommendations for non-materiel and Materiel approaches to address the gaps. It provides broad advice on forms and functions of potential solutions and helps in identifying the solution spaces that can be further investigated during the Materiel Solution Analysis phase.

NOTE:

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

The CBA may be initiated by any DoD organization and is not intended to be a rigorous study at the engineering level. The CBA should be tightly focused and take no more than 90 days for most studies, while more complex CBAs dealing with significant uncertainties should take no more than 180 days. The actual time needed for execution is dependent upon the complexity of the problem, the amount of preparatory work completed, and the questions the decision-makers need answered. The schedule should be appropriate for the level of work that must be accomplished.

The emphasis of the CBA is on problem identification and the assessment of risk since the fundamental decision is whether the DoD should take action to solve a problem. The main objectives of the CBA are to:

- Identify required capabilities and their associated operational characteristics and attributes,
- Identify capability gaps and associated risks,
- Prioritize the capability gaps,
- Conduct an initial assessment of the viability of the potential solutions,
- Provide recommendations on the types of non-materiel, and if required, Materiel solutions to be pursued.

1.2 CBA Steps

Figure 1-1 describes a nine-step process for planning and conducting a CBA. Steps 1 and 2 are completed during the planning phase, while Steps 3 – 9 are completed when the study team conducts the CBA. Planning and conducting a CBA is an iterative process. As new information is learned during the CBA, it may be necessary for the study team to repeat previous steps. During the course of the study, several steps may be worked concurrently and may not be completed in order. Chapters 3 and 4 in this handbook provide more detailed information for each step. The steps and their associated major tasks are briefly described below:

- Step 1: Problem Identification
  - Develop the overarching problem statement
  - If necessary, develop sub-problem statements associated with the overarching problem
- Step 2: Define the Study
  - Define the study purpose, scope, and schedule
  - Define the timeframe of interest and operational context
  - Define the initial set of ground rules, constraints, and assumptions
  - Describe the baseline capability
- Step 3: Gap Analysis
  - Develop capability requirement statements
  - Define the tasks, conditions, and standards associated with each capability requirement statement
  - Analyze the baseline capabilities to identify capability gaps
  - Develop capability gap statements
- Step 4: Gap Characterization
  - Describe the reason(s) for the capability gaps
- Step 5: Risk Assessment
  - Identify the impact of the gap on risk to mission, force, and other important considerations
- Step 6: Gap Prioritization
  - Develop the initial prioritization of the capability gaps
- Step 7: Solution Analysis
  - Identify potential non-materiel and Materiel solutions, including critical support considerations (e.g., sustainability, interoperability, dependencies)
- Step 8: Cost Analysis
  - Develop the rough order of magnitude cost estimates for the potential solutions
- Step 9: Solution Viability Assessment
  - Assess the viability (i.e., strategic responsiveness, feasibility, affordability, requirements satisfaction) of the potential solutions
  - Develop recommendations

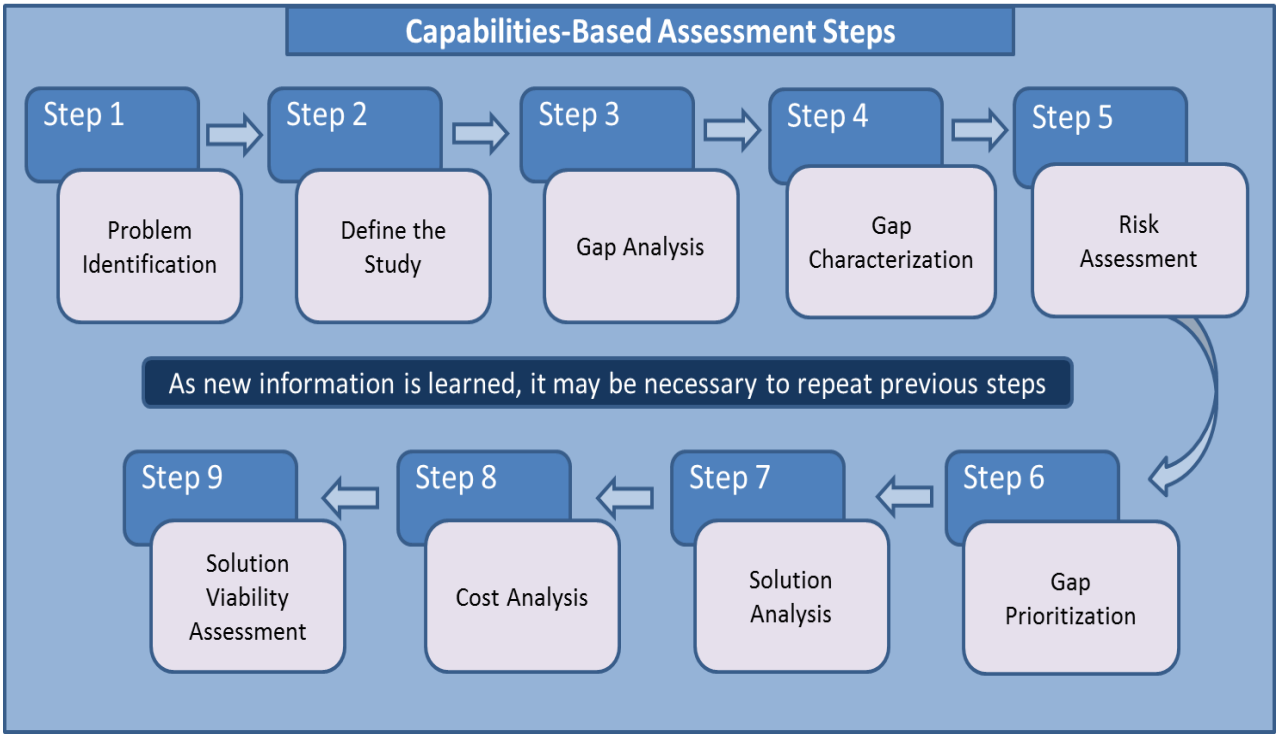

Figure 1-1: Capabilities-Based Assessment Steps

It is important to note that the nine-step process described in this handbook was developed to support planning and conducting a CBA when information is sparse or little is known about the potential capability gaps. In some situations, information may already exist at the start of the study that would require the study team to tailor one or more of the steps. For example, a study team may be assessing capability requirements that were previously identified in other studies or assessments (e.g., Joint Capability Technology Demonstration, experiment, exercise, etc.). Developing new capability requirements (part of Step 3 in the nine-step process) may not be needed in this case. In other situations, a study team may be analyzing existing capability gaps to better understand the extent of the gaps and priority for closing or mitigating them. In these cases, the study team should focus the analysis on the existing gaps.

The study team should consider the information that already exists and the purpose and scope of the study when determining what steps and associated actions described in this handbook are necessary or require adjustments to meet the objectives of the study. If potentially useful work exists, the study team should critically evaluate it to ensure it is applicable to the problem being addressed in the CBA. When previous work does shape the scope of the CBA, the study team should garner stakeholder agreement to include it in the study. Upon stakeholder agreement, the study team should provide rationale for including it and reference the source documents in the CBA study plan and final report.

In planning and conducting a CBA, the sponsor, stakeholders, and study team must consider the follow-on courses of action to address recommendations in the CBA final report. These actions may include development of a Joint Capability Integration and Development System (JCIDS) document (i.e., Joint

DOTmLPF-P Change Request (DCR), Initial Capabilities Document (ICD), Capability Development Document (CDD), and Capability Production Document (CPD)). Before proceeding with any of these actions, the Air Force Requirements Review Group (AFRRG) must conduct a Requirements Strategy Review (RSR) to approve the requirements strategy for addressing the identified capability gap(s) and proceeding with the recommended courses of action in the requirements development and acquisition processes. In preparing for the RSR, the sponsor must assess whether sufficient analysis has been completed to support the requirements strategy. The focus of this assessment will be on the analysis completed in the CBA(s) and other related studies and reports. By considering these potential post-CBA actions and the sufficiency of previous related analysis, the sponsor can ensure the CBA is appropriately designed to produce information that can help substantiate a requirements strategy. To better understand these post-CBA actions and associated analysis requirements, OAS recommends reading the entire handbook with particular focus on Chapter 4 (specifically Section 4.5 Recommendations) and Chapter 5 (Final Report Staffing and the Requirements Strategy Review). Additional information can be found in the OAS Pre-MDD Analysis Handbook.

The JCIDS manual (19 Jan 2012) describes a Joint Requirements Oversight Council (JROC) ten-step capability gap assessment and a seven step CBA process. Figure 1-2 shows how these processes map to the nine-step process described in this handbook. Several steps in the JROC ten-step capability gap assessment process (steps 1, 2, 7-10) do not directly link to the CBA process, but are important for identifying and categorizing gaps and staffing the recommended programmatic and non-programmatic actions to close the gaps. Conversely, the OAS nine-step process includes activities (e.g., cost analysis) that are not explicitly described in the JROC or JCIDS processes, but are important for assessing affordability and developing solution recommendations.

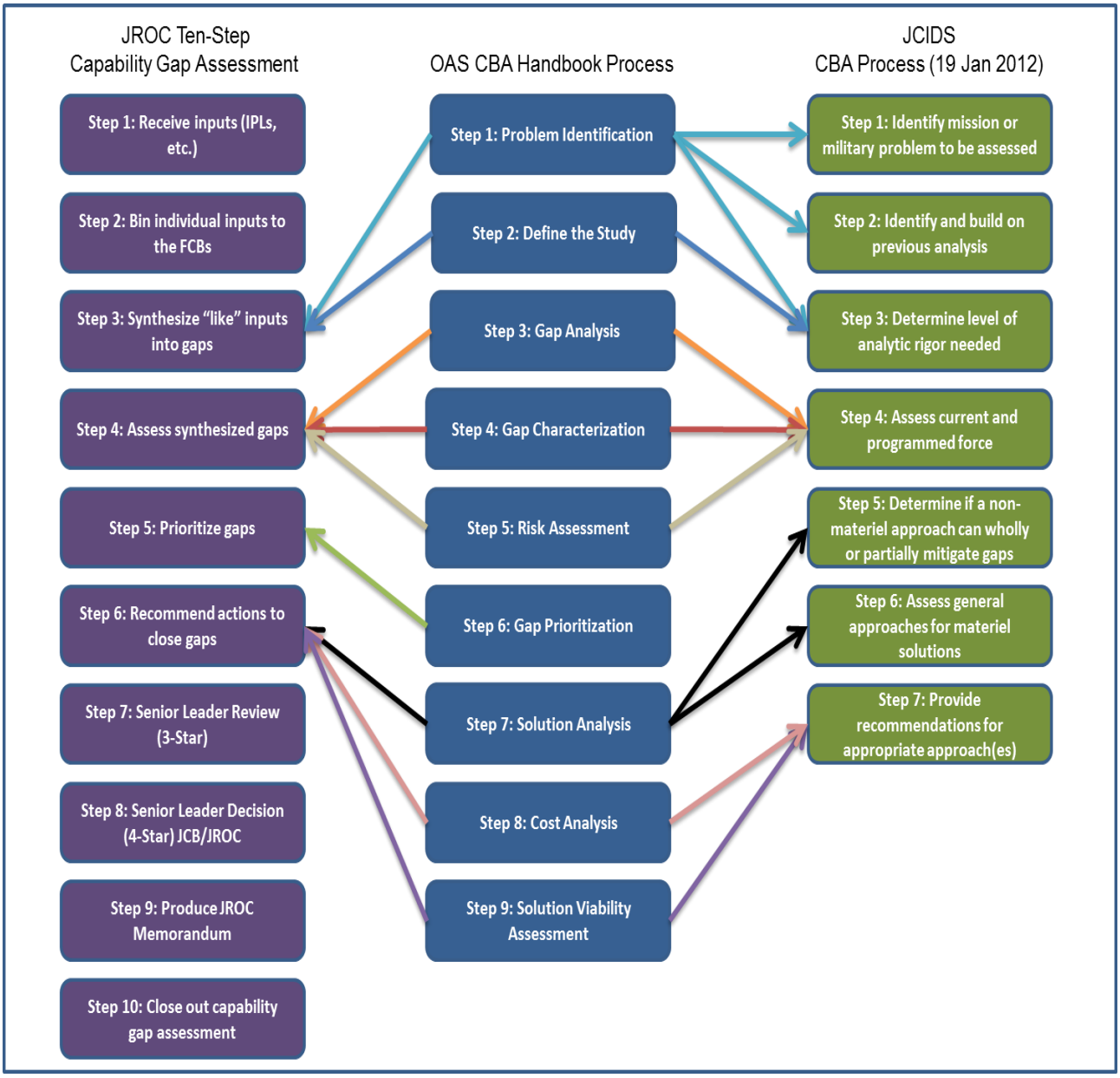

Figure 1-2: Mapping CBA Processes

1.3 Early Acquisition Framework and the CBA

As the analytic basis for operational capabilities requirements, the CBA is conducted early in the acquisition timeline (circled in red in Figure 1-3). The CBA sponsor requests approval from the major command (MAJCOM) requirements lead to initiate development of a CBA study plan. If approved, the study team is formed and begins developing the CBA study plan. A High Performance Team (HPT) is not required for a CBA study plan and there is no Headquarters Air Force (HAF) review or staffing required (see AFI 10-601, *Operational Capability Requirements Development*, for more details regarding entry and exit criteria for CBAs). The lead command is only required to submit a study initiation notice to AF/A5R-

P and Joint Staff (J-8) for inclusion in the studies repository (KM/DS) upon initiation of a CBA; however, AF/A5R-P encourages the lead command to establish effective dialog with key stakeholders to fully define the scope of the study. Once the study team completes the CBA study plan, the MAJCOM Director of Requirements, or higher, approves it. It is important to note that the CBA study plan must have specific content for approval (see Chapter 3 for more information regarding CBA study plan requirements). Finally, the lead command submits the completed study plan to AF/A5R-P for archive into the Information and Resource Support System (IRSS).

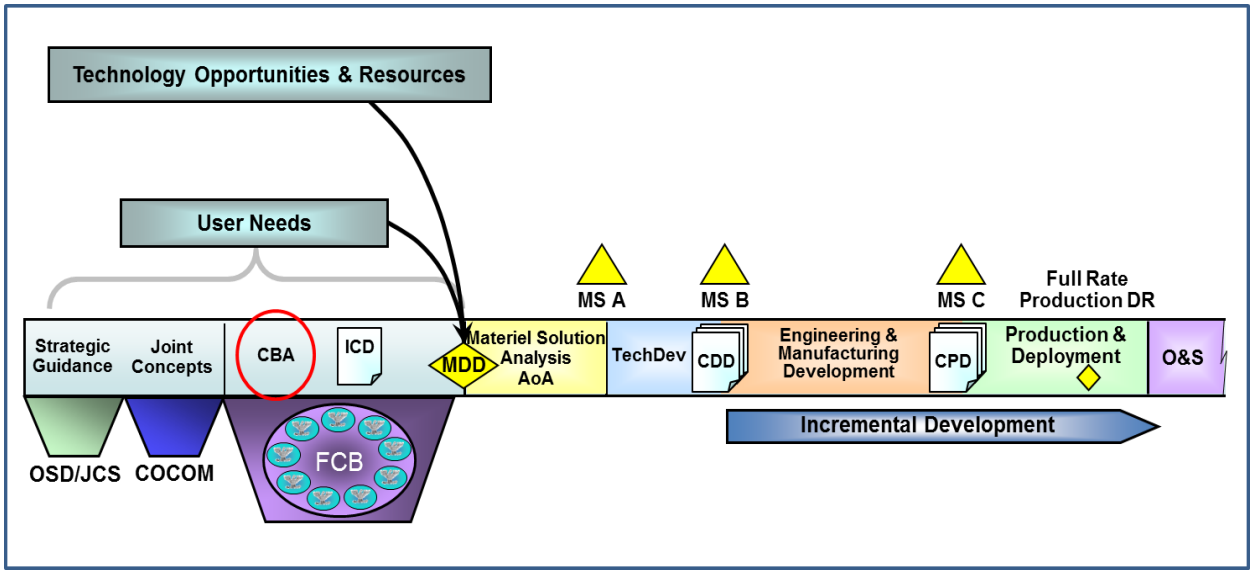

Figure 1-3: Early Acquisition Framework

With approval of the CBA study plan, the study team can proceed with the execution of the CBA. Similar to the CBA study plan, the CBA final report does not require an HPT and there is no HAF review or staffing required. While HPT and HAF review are not required, this does not preclude the study sponsor from building broader AF consensus of the final report through informal staffing. The MAJCOM Director of Requirements, or higher, approves the CBA final report. The CBA final report must have specific content for approval (see Chapter 4 for more information regarding CBA final report requirements). Once the CBA final report has been approved, the lead command requirements office will forward the final report to AF/A5R-P. AF/A5R-P will archive the final report in the IRSS database and submit the CBA, as appropriate, to the Joint Staff for entry into the Knowledge Management/Decision Support (KM/DS) database.

The Air Force Requirements Oversight Council (AFROC) will bi-annually review all ongoing and forecasted CBAs. During the review, topics are presented to the AFROC for validation, de-confliction, and prioritization. Emerging needs may drive the need for additional CBA topics, which may be presented to the AFROC at any time.

Using the results and findings from the CBA, the study team may develop one or more recommendations for future courses of action. There are several possible actions that may be taken based on the outcome of the CBA (see the JCIDS Manual, Enclosure A, and Chapter 4 of this handbook

for more information). The Air Force Requirements Review Group (AFRRG) may convene a Requirements Strategy Review (RSR) depending on the outcome of the CBA to review and approve the requirements strategy (see AFI 10-601 for more information about the RSR). For example, the AFRRG would convene an RSR if the sponsor recommended development of one or more DOTmLPF-P Change Recommendations (DCRs) and/or Initial Capabilities Documents (ICDs) (DOTmLPF-P is the acronym for Doctrine, Organization, Training, materiel, Leadership and Education, Personnel, Facilities, and Policy). A MAJCOM approved CBA or equivalent analysis is required to proceed with an ICD. The decision to proceed with an ICD is based upon the CBA, other existing analyses, initial affordability assessments, and other information. The AFRRG considers the following questions when making the decision to proceed with ICD development:

- Is there evidence that these gaps are critical enough to move forward with now?
- Is there evidence that viable solutions likely exist?
- Is this a set of gaps that logically belong in a single ICD?

The follow-on of an ICD could be one or more Capability Development Document (CDD), Capability Production Document (CPD), Joint DCRs, or a combination of these documents (reference the JCIDS Manual for additional guidance on ICDs).

1.4 Linkage to the Core Function Support Plans

Assigned by the Secretary of Defense, the Service Core Functions provide a framework for balancing investments across DoD capabilities. Service Core Functions were established by DoDD 5100.01, *Functions of the Department of Defense and Its Major Components*. For the Air Force Core Functions, the SecAF and CSAF designated Core Function Leads (CFLs) (formerly known as Core Function Lead Integrators (CFLIs)) to serve as leaders and principal integrators for their assigned Core Functions. Each CFL has a Core Function Team (CFT) that serves as a support staff. In collaboration with stakeholders across the Air Force, CFLs provide strategic guidance for the stewardship and maturation of their Core Functions. The CFLs establish a strategy of long-term development through the Core Function Support Plans (CFSPs) (formerly known as Core Function Master Plans (CFMPs), Program Objective Memorandums (POMs), and Science and Technology (S&T) priorities. As shown in Table 1-1, there are thirteen Core Functions assigned to CFLs across seven MAJCOMs.

Table 1-1: Core Function and MAJCOM Alignment

Core Function	MAJCOM
Agile Combat Support	Air Force Materiel Command (AFMC)
Air Superiority	Air Combat Command (ACC)
Building Partnerships	Air Education and Training Command (AETC)
Command and Control	Air Combat Command (ACC)
Cyberspace Superiority	Air Force Space Command (AFSPC)
Education and Training	Air Education and Training Command (AETC)
Global Integrated Intelligence, Surveillance, and Reconnaissance	Air Combat Command (ACC)
Global Precision Attack	Air Combat Command (ACC)
Nuclear Deterrence Operations	Air Force Global Strike Command (AFGSC)
Personnel Recovery	Air Combat Command (ACC)
Rapid Global Mobility	Air Mobility Command (AMC)
Space Superiority	Air Force Space Command (AFSPC)
Special Operations	Air Force Special Operations (AFSOC)

With support from the CFT, the CFL for each Core Function develops the CFSP which describes a 20-year construct for enhancing Global Vigilance, Global Reach, and Global Power across the range of military operations. The CFSP aligns strategy, concepts, and capability development with requirements development and programmatic decisions. The CFSP describes the health of each Core Function by identifying priorities, objectives, metrics, and risks.

NOTE:

Sometimes the timeframe addressed in the CBA extends beyond the 20-year timeframe that is typically addressed in most CFSPs. If this is the case, it is important that the stakeholders and decision-makers agree upon the projected environment (i.e., threats, scenarios, missions, capabilities) that will be used in the CBA.

Identification of capability requirements and associated capability gaps begins with an assessment of the MAJCOM's organizational functions, roles, missions, and operations in the context of a framework of guidance documents. The documents listed in the inner circle of Figure 1-4 are some of the significant documents that are used in requirements planning, strategy development, and JCIDS activities. These documents provide a common frame of reference for identifying capability gaps and developing the CFSP and CBA study plan and final report. Other documents such as the Defense Planning Guidance (DPG), the Guidance for the Employment of the Force (GEF), the Chairman's Risk Assessment (CRA), and the Joint Strategic Capabilities Plan (JSCP) contain further guidance for objectives and priorities. The items outside the inner circle are some examples of other documents and activities that may have information that can be used by the CFL/CFT and MAJCOM requirements lead to identify capability gaps.

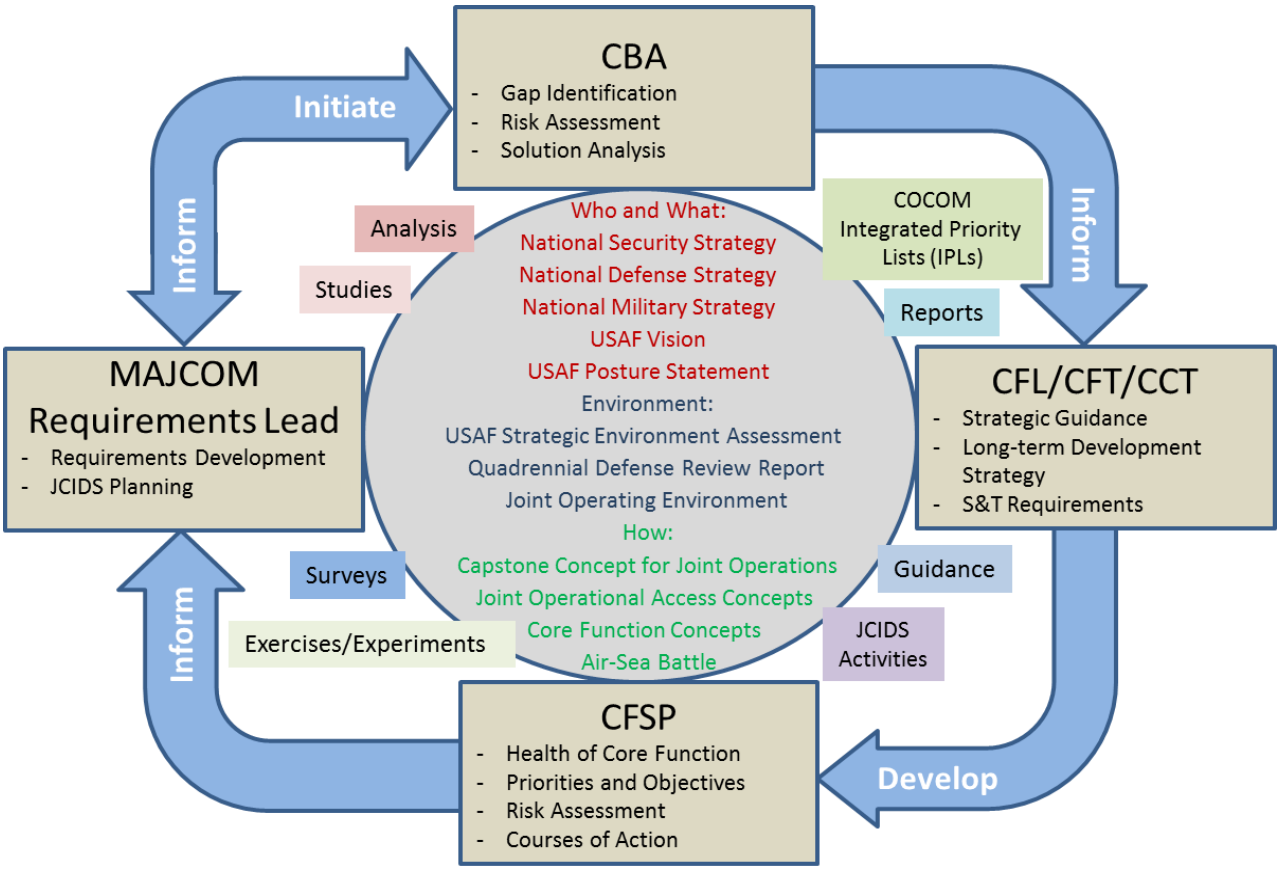

Figure 1-4: CBA Linkage to CFSP

It is important to note that the Core Functions are not necessarily independent. For instance, the Agile Combat Support, C2, Global ISR, and Cyber core functions are critically intertwined with almost every capability. Likewise, a CBA may originate in one CFT, but the analysis may reveal significant interdependencies with other core functions. It is important to examine these interdependencies in the CBA to ensure the CBA recommendations are viable and executable. As soon as these interdependencies are identified, the study team should bring the appropriate members of the other Core Functions into the CBA discussions.

As shown in Figure 1-4, the CBA and CFSP are linked together in that the results of the CBA help inform the CFL/CFT in developing the CFSP, and the CFSP has information that helps the MAJCOM requirements lead determine whether to initiate a CBA to identify capability gaps. The CBA forms the analytic basis for how capability needs are identified and is an integral part of the capabilities planning process. MAJCOMs initiate CBAs to identify capability gaps and recommend potential solutions to close or mitigate the gaps. The findings and recommendations from the CBA help inform one or more CFL/CFT as they develop the long-term strategy to develop and mature the Core Function(s). The information is documented in one or more CFSPs which describe the health of the Core Function(s), priorities and objectives, risk assessment, and courses of action. The MAJCOMs use the information in the CFSPs as well as other information to conduct requirements planning and initiate CBAs.

For CFL capability needs that require Materiel solutions, CFLs establish Capability Collaboration Teams (CCTs) to determine if Science and Technology (S&T) is required to address any associated technology needs (see AFI 61-101 for more information). The CCTs include subject matter expert representatives from the MAJCOM/CFL, appropriate Center and/or Program Executive Office (PEO), Air Force Research Laboratory (AFRL), and other stakeholders as appropriate. The output of the CCT is a set of vetted technology needs required for ongoing or prospective Materiel solutions supporting documented capability needs. Technology needs resulting from this process may be documented and prioritized by CFLs in their CFSPs.

1.5 Other Approaches for Identifying Capability Requirements

In addition to the CBA, the JCIDS Manual describes several other approaches for identifying capability requirements (see JCIDS Manual for more information):

- Operational Planning. Development of Operation Plans (OPLANS) and Concept Plans (CONPLANS) is one means to identify capability requirements related to combatant command roles and missions.
- Warfighting/Exercise Lessons Learned. Warfighting and exercise lessons learned may serve as a basis to establish capability requirements, if the documentation indicates sufficient military utility of certain capability.
- Joint Capability Technology Demonstration (JCTD). JCTD or other prototype assessments (e.g., the military utility assessment (MUA) completed at the end of a JCTD) which indicate sufficient military utility may serve as a basis to establish capability requirements.
- Joint Urgent Operational Need (JUON)/Joint Emergent Operational Need (JEON) solutions. Capability solutions for JUONs and JEONs that have positive operational utility documented by the sponsor may serve as a basis for transitioning capability requirements for sustainment and/or further development.
- Experiments. Reports or other documents of Joint or Air Force experiments that indicate sufficient military utility of a capability may serve as a basis to establish capability requirements.
- Joint Improvised Explosive Device Defeat Initiative Transition. The Joint Improvised Explosive Device Defeat Transition Packet, which is completed after the Joint Improvised Explosive Device Defeat Organization validates an initiative, may serve as a basis for establishing capability requirements.
- Defense Business System (DBS). Business case documents of a DBS developed through the Business Capability Lifecycle (BCL) process may serve as sources of capability requirements and solutions.
- Other studies. Other forms of studies, analyses, or assessments that cover some aspects of what is typically covered in a CBA may be used as sources of capability requirements. These studies may need to be augmented or further refined through additional efforts to generate JCIDS documents.

2 Forming the Study Team

This chapter describes how the study team is formed and provides information that will help facilitate the planning and execution of the CBA.

2.1 Study Team

The study team, formed and led by the study director, plans and conducts the CBA. The study director must be a government employee (military or civilian) and is appointed by the sponsor. The study director 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 CBA planning phase. The study director is responsible for providing funding and other resources necessary to successfully plan and conduct the CBA. Other important responsibilities include the following:

- Facilitate coordination with external organizations and agencies,
- Assist in acquiring security clearance guidance and special access clearances, and if required, develop a security plan for the study,
- Consolidate inputs and maintain configuration control of CBA documents (e.g., study plan, final report, briefing),
- Coordinate approval of required documentation,
- Brief special groups and stakeholders (see sections 2.2 and 2.3).

The study director should organize the study team in a way that facilitates achieving the objectives of the CBA. The structure of the study team depends upon the scope of the CBA 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 CBA. It is important to note that the size and focus of the team may change during the course of the study. OAS can assist the study director in organizing the team, training the team, and facilitating CBA planning and execution.

Team membership may include operators, logisticians, intelligence analysts, cost estimators, and other specialists. Ideally, membership of the study team includes representatives from the stakeholder community such as the appropriate CFLs, lead command, operating commands, implementing commands, HAF divisions, other agencies/Services, and combatant commands. Participants in previous applicable studies and others with special skills or expertise such as Human Systems Integration (HSI) specialists should be considered for team membership as well. While team membership is tailored to the study problem, it should almost always include members from outside the sponsoring MAJCOM to ensure a thorough understanding of the problem.

The study team should strive to plan and execute an unbiased and complete study within the time and resource constraints provided. The study team should present a clear and complete picture of the problem and let the results drive the conclusions and recommendations. All critical assumptions should

be investigated to ensure they are valid and appropriate for the study. Some recommended best practices include the following:

- Maintain an interactive relationship with the decision maker and key stakeholders to ensure the analysis is addressing their issues. The decision maker is the final arbitrator on acceptability of scope and assumptions.
- Make appropriate use of previous analysis, wherever feasible. This will help control the scope of the study and prevents "reinventing the wheel." Although titles or subject matter of previous analyses may be similar, the results may not be relevant to the CBA (e.g., key assumptions, context, and scenarios may be different).
- Develop a mechanism to capture each new ground rule, constraint, and assumption. Ensure the entire team is aware of new or revised ground rules, constraints, and assumptions to maintain consistency.
- Document any discussion within the team concerning how the analysis will be or is being conducted.

2.2 Stakeholders

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

- Who are the end-users (e.g., COCOMs, warfighters, etc.) of the capability?
- What enablers (e.g., intelligence, human systems integration, logistics, and communications) have interdependencies within the solution space being analyzed in the CBA?
- How do the other Services, DoD agencies, and government agencies fit into the mission area being explored in the CBA?

The study team should include appropriate members of the stakeholder community (e.g., sponsoring command/organization, other Air Force commands and agencies, combatant commands, Army, Navy and Marines, DoD, Joint Staff, and civilian government agencies). The study team should determine which key stakeholders should have membership in any of the special groups that may be formed for the CBA (the special groups are discussed in the next section). OAS can assist the study team in identifying the stakeholder community. The stakeholder community should be involved as early as possible, preferably before development of the study plan.

There are many benefits of having stakeholders involved in the CBA. Stakeholder involvement can help facilitate buy-in and 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 team should carefully select the stakeholders to participate in the study since they will likely be candidates for membership in the enduring High Performance Team (HPT) determined at the Requirements Strategy Review (RSR) (assuming the CBA leads to an RSR). The enduring HPT means that HPT membership is enduring throughout the requirements process to enhance the quality of requirements documents and facilitate the development, fielding, and sustainment of operational systems. Having the stakeholders involved from the beginning provides continuity of thought and helps ensure that the follow-on JCIDS documents (e.g., ICD, CDD) maintain a consistent interpretation of the operational issues. Depending on the results of the study, some stakeholders may no longer have a stake in the effort and will end their participation, whereas others may be added.

2.3 Special Groups

Special groups may be formed to keep the stakeholder community informed and to receive feedback and direction on planning, execution, analysis, and reporting decisions and products. The type and level of authority of the special groups will depend on the nature of the study (e.g., joint effort, level of interest in the problem, and stakeholders involved). OAS recommends the use of at least one special group to provide CBA oversight, ensure stakeholder issues are addressed, and assist with achieving the objectives of the study. This special group should be comprised of members of the stakeholder community and should focus on specific activities such as the following:

- Providing guidance as appropriate during the planning and execution of the study,
- Reviewing and validating the description of the baseline capability, required tasks, conditions, and standards, prioritized list of capability gaps, and CBA study plan and final report,
- Receiving periodic updates regarding the progress of the study,
- Approving major changes in study scope, assumptions, ground rules, and constraints,
- Providing recommendations for additional analysis,
- Providing access to resources (e.g., data, people, and previous studies).

3 Developing the CBA Study Plan

This chapter describes how to develop a CBA study plan and provides a notional example to help facilitate understanding of the material described in this chapter. Appendix D contains a template that describes the basic content of a CBA study plan. OAS recommends that the study team use the template as a starting point in developing the study plan.

3.1 Value of the Study Plan

There are several additional benefits that can result from the development of a concise and comprehensive CBA study plan. Foremost, the study plan serves as a roadmap to conduct the CBA and, as such, serves as the guide for scheduling, resource allocation, and team member responsibilities. A well-documented study plan allows the study team to focus its efforts and can serve as a tool to bring new or replacement team members up to speed as quickly as possible.

The study plan also serves as a historical record of the CBA. By garnering decision maker approval of the CBA study plan, it becomes the official document that describes the study. An uncoordinated study plan makes it challenging for the study team to achieve stakeholder buy-in to the study approach and can disrupt the execution of the CBA. A study plan that clearly documents the key stakeholder issues to be addressed in the study will likely increase stakeholder satisfaction at the completion of the study.

Finally, when the CBA team uses the study plan to document ongoing changes to the study, the study plan can serve as the foundation for creating the CBA final report. By leveraging the work already accomplished in the CBA study plan, the study team can reduce the time and effort required to develop a CBA final report. This will generally lead to a stronger and more useful final report. This is critical, as decisions regarding subsequent ICD and AoA activities will be made based upon the credibility and utility of the final report.

3.2 CBA Study Plan Contents

Since all CBAs are not the same, it is also true that all study plans are not the same. This means the study team has the latitude to develop a study plan that meets its needs and helps facilitate execution of the CBA. Although some latitude exists, there is some basic content that is expected in all CBA study plans. One of the several factors that are considered by the study plan approval authority (i.e., MAJCOM Director of Requirements, or higher) is whether the study plan meets the basic content requirements. The remainder of this chapter describes the basic content requirements of the CBA study plan and how it is developed.

3.3 Introduction and Background

The introduction and background should contain relevant information associated with the area of interest that will be assessed in the study. Examples of relevant information include key activities, concepts, events, decisions, processes, factors, systems, issues, and organizations. This section should

describe how the study was initiated, who initiated the study, and why the study is being conducted now. Significant findings and results from related studies germane to the CBA should be discussed as well. If study guidance was published by the sponsor, special group, or other organization, the study team should discuss the main points and significance to the study, including any major schedule drivers for the CBA such as the timing of the Program Objective Memorandum (POM) submission.

Air Force Nuclear Enterprise Example

The following provides some background information related to the example:

- In June 2012, the Air Force published a report which revealed systemic weaknesses within the Air Force Nuclear Enterprise.
- The report identified major weaknesses in nuclear enterprise sustainment activities in the area of technical information management and the associated engineering and technical order processes.
- To address the issues identified in the report, the Air Force Nuclear Enterprise developed a CBA study plan and conducted the CBA to assess technical information management within the Air Force nuclear enterprise.
- The purpose of the CBA was to identify and prioritize capability gaps in existing capabilities and identify solutions to close or mitigate the capability gaps.

3.4 Problem Statement

Identifying the problem is Step 1 of the CBA process (Problem Identification). The study team must identify the top-level or overarching problem and explain why it is important. This may sound like a simple task, but it will require significant effort and an in-depth knowledge of the area of interest in the study. The study team must describe the problem clearly and concisely in a problem statement. This is critical since the problem statement provides the basis for defining the tasks and performance measures that will be used in the study. Failing to state the problem correctly in the beginning of the study may result in expending unnecessary time and resources addressing the wrong problem. Once the study team reaches agreement with the focus and wording of the problem statement, it should garner stakeholder review and approval.

NOTE:

The problem should be stated in operational mission terms, not system terms. For example, the problem is "limitations exist in our capability to achieve air superiority in a communications-jammed environment," not "we must replace the XYZ aircraft."

There are various sources of information that the study team can use to define the overarching problem statement. Previous reports, studies, analyses, field observations, operational need statements, integrated priority lists (IPLs), and Core Function Support Plans (CFSPs) are just some examples of information sources that can be used (see Chapter 1 for additional sources of information). The CFSPs

are a particularly good source of information since they identify capability gaps and provide insights into the tasks, conditions, and standards applicable to the CBA. In some situations, the specific capability gaps identified in a CFSP may require a CBA to provide additional insights into the extent of the gaps and priority for closing or mitigating them. Additionally, the study team should consult the Contract Studies Registry Program for related or similar studies and the Joint Lessons Learned Information System database for any applicable information (see the section 3.11 for a list of information sources).

The study team should also work with subject matter experts knowledgeable of and experienced in the area of interest in the study to help develop the problem statement (see Appendix F for information about selecting experts). OAS recommends that the study team consult the stakeholder community and appropriate CFL(s)/CFT(s) to gain insights into their views of the problem.

Given the high-level nature of the overarching problem, it is often necessary to define sub-problems associated with the overarching problem to facilitate the analysis. Defining the associated sub-problems, if appropriate, will enable the study team to gain a better understanding of the problem and identify the capability requirements and gaps. The study team describes the sub-problems in statements similar to the overarching problem statement. To help develop the sub-problem statements, the study team should use subject matter experts knowledgeable of the area of interest in the study.

Air Force Nuclear Enterprise Example

Using numerous reports about the nuclear enterprise and information from subject matter experts, the nuclear enterprise study team identified an overarching problem and a number of associated sub-problems. The following shows the overarching problem statement and two examples of associated sub-problem statements:

> Overarching Problem Statement: The Air Force nuclear enterprise does not consistently generate, manage, or protect technical information in an accurate, reliable, secure, and timely manner to ensure nuclear system safety, security, and reliability.
>
> - Sub-Problem Statement 1. Cannot consistently respond to technical information requests to enable field and depot missions.
> - Sub-Problem Statement 2. Cannot effectively protect against unauthorized modification or destruction of technical information.

3.5 Study Purpose

The study purpose describes what the study team will accomplish. Describing the study purpose is an important task in Step 2 of the CBA process (Define the Study). The general purpose of a CBA is to identify capability gaps, assess the severity of the gaps (risk), and provide recommendations for potential Materiel and non-materiel solutions to close or mitigate the gaps. The study team should describe how the results of the study will be documented in a CBA final report and what decisions will be informed by the final report. The CBA final report informs decisions to develop one or more Initial

Capability Documents (ICDs), Air Force Form 1067 Modification Proposals, or DOTmLPF-P Change Requests (DCRs). See Figure 4-1 for more information.

NOTE:

The general purpose of a CBA is to identify capability gaps and provide recommendations for potential solution approaches to close or mitigate the gaps. The purpose of the study should not be to justify a preferred solution.

Air Force Nuclear Enterprise Example

The nuclear enterprise study team described the purpose of the study as follows:

> The nuclear enterprise continues to be a top priority for the Air Force. To help achieve this important objective, a Capabilities-Based Assessment (CBA) is needed to assess technical information management within the Air Force nuclear enterprise. The purpose of the CBA is to identify and prioritize capability gaps in existing capabilities and identify potential solutions to close or mitigate the capability gaps. The results of the assessment will be documented in a CBA final report that will provide information to help inform decision-makers regarding the development of one or more Initial Capability Documents (ICDs), AF Form 1067 Modification Proposals, or DOTmLPF-P Change Requests.

3.6 Study Scope and Schedule

Describing the study scope is another important task in Step 2 of the CBA process (Define the Study). 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.

The scope 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. This is more difficult than it seems and typically requires frequent and detailed discussions with stakeholders.

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

The study team should indicate the Tier 1 and 2 Joint Capability Areas (JCAs) related to the focus of the study (see JCIDS Manual for additional information). This enables the JCIDS Gatekeeper to notify the appropriate Functional Capability Boards (FCBs) that may have an interest in the study. Finally, the study team should gain decision maker approval of the scope of the study before conducting any analysis.

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 (described later in this chapter) that will be used to conduct the assessment.

NOTE:

A major mistake is to define critical study aspects as "out of scope" because they are difficult to answer, require additional data, cross the boundary into another Core Function, Service, or MAJCOM, or will not result in the "preferred" solution. These are never valid reasons to define something as out of scope.

The study team should indicate when the study plan is expected to be approved and the organization/office of the decision maker who will be the approval authority. As described in AFI 10-601, the sponsoring organization's Director of Requirements, or higher, approves the study plan. In addition, the expected time when the study will begin and end should be defined and when the final report is expected to be completed and approved.

Air Force Nuclear Enterprise Example

The nuclear enterprise study team described the scope of the study as follows:

> This study focuses on Air Force nuclear enterprise technical Information and how it supports the sustainment phase of the weapon system lifecycle. The focus of the study aligns with JCA 4.3 (Tier 1: 4 - Logistics; Tier 2: 3 - Maintain). The study team will assess capabilities required to generate, use, and manage technical information to include the mechanisms to apply revision, change, and release controls to the data in weapon system sustainment operations. The timeframe of interest in the study is FY 2014-2024 since it is anticipated that the solutions to close or mitigate the capability gaps will be delivered in this timeframe.
>
> The CBA study plan is expected to be approved by the AFMC/A2/5 in March 2014. Once approved, the study will begin in April 2014 and take approximately four months to complete. The CBA final report is expected to be approved by AFMC/A2/5 in September 2014.
>
> For the purpose of this study, technical information is defined as any data, physical or electronic, that conveys technical or operational details about a weapon system, weapon system support, or weapon system discrepancy. Some examples of technical information include technical

orders, specifications, engineering drawings, technical assistance requests, engineering orders, and test data.

3.7 Study Team Members and Stakeholders

As noted in the previous chapter, the study team, study director, stakeholders, and decision-makers are instrumental to the success of the CBA. The study team should identify the organization/office of the official sponsor and decision maker for the CBA as well as the organization/office of the study director, team members, and stakeholders. This information should be documented in the study plan. If special groups will be used (see section 2.3 for more information regarding special groups), it is important to identify the chairperson and group members and describe their roles and responsibilities.

NOTE:

By focusing on identifying capability gaps and potential solution approaches to close or mitigate the gaps, rather than on quickly completing the CBA, the study team is more likely to produce a quality study and save time, avoid rework, and reduce cost. For example, the CBA can often be completed faster by keeping the team very small and limiting stakeholder involvement, especially those with contrary points of view. However, the short amount of time "saved" in the CBA phase is invariably lost many times over later on. If the study results lead to the development of an ICD or DCR, the other stakeholders will get involved. If they were not part of the CBA discussions originally, work may need to be accomplished to address new concerns, thereby increasing time and cost. If relevant stakeholders exist outside the lead organization, it is invariably better to include them on the team from the beginning.

Air Force Nuclear Enterprise Example

The nuclear enterprise study team identified HQ AFMC/A4 as the sponsor of the study as well as the following stakeholders:

Headquarters Air Force Materiel Command (HQ AFMC): A4 Technical Director, A4UE, A4MW, A2/5, A6, A10
Air Force Nuclear Weapons Centers (AFNWC): EN, NI, NC, LG
Air Force Lifecycle Management Center (AFLCMC)
Air Force Sustainment Center (AFSC)
Air Force Global Strike Command (AFGSC)
Department of Energy (DOE)/National Nuclear Security Administration (NNSA)

The nuclear enterprise study team identified a Study Advisory Group (special group) to provide CBA oversight:

The Study Advisory Group will be chaired by AFMC/A2/5 who will serve as the approval authority of the CBA study plan and final report. The Study Advisory Group will receive periodic updates regarding the progress of the study, provide guidance during the planning and

execution of the study, and review and approve the description of the baseline capabilities and prioritized list of capability gaps. The Study Advisory Group will be comprised of senior members (i.e., general officer and senior executive service) from the all stakeholder organizations listed above.

3.8 Ground Rules, Constraints, and Assumptions (GRC&As)

The study team identifies the initial set of GRC&As in Step 2 (Define the Study). GRC&As can be used to help scope the CBA and must be carefully documented and coordinated with the stakeholders and decision-makers. Some GRC&As will be general in nature and encompass the entire study, while others will be more specific and cover only a portion of the analysis. The study team may identify GRC&As at any time throughout the CBA planning and execution. In some situations, the CBA guidance, if applicable, may describe one or more GRC&As for the study team to follow. The study team should note the source of and rationale for each GRC&A. Each GRC&A must be explicitly identified, checked for consistency, fully documented, and then accounted for in the scope of the CBA. Later, the study team will need to account for the GRC&As in the analytical methodologies.

GRC&As are typically misunderstood, resulting in the tendency to misuse the terms. This misunderstanding can cause study 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 rules – broadly stated procedures that govern 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.
- Constraints - imposed limitations that can be physical or programmatic. 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.
- Assumptions - conditions that apply to 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 that a certain infrastructure or architecture will be provided by another program.

Since GRC&As can be contentious, they should be reviewed by the stakeholders and decision-makers. The study plan will contain an initial set of GRC&As, but this set may change as the study progresses. Any changes to the GRC&As should be vetted with stakeholders and decisions makers and documented in the final report. The constraints and assumptions can often, intentionally or unintentionally, bias the analysis. Before finalizing the CBA, the study team should revisit the constraints and assumptions to assess their validity. If one or more constraints or assumptions are not valid and bias the study results, the study team may need to re-accomplish the affected parts of the study.

Related to this, the study team should also conduct a sensitivity analysis of the constraints and assumptions to determine whether changes yield different study results and conclusions. This analysis

can provide insights into the sensitivity of the results and conclusions to the constraints and assumptions. The more sensitive the results and conclusions are to even minor changes in the constraints and assumptions, the more the risk the decision-makers assume in following the study recommendations.

3.9 Operational Context

The operational context is determined during Step 2 of the CBA process (Define the Study). Operational context describes the realistic operational settings that apply to the capabilities that will be assessed in the CBA. Operational context includes descriptions of the operational scenarios, conditions, locations, and threats under which the mission is to be carried out and must be relevant to the problem and needs of the defense strategy (e.g., Defense Strategic Guidance (DSG) or other strategic guidance). Operational context provides 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 potential solutions. Sources of information to define the operational context include the following:

- Defense Planning Scenarios (DPSs), Integrated Security Constructs (ISCs), and Support for Strategic Analysis (SSA) products
- OPLANs, Contingency Plans, and Concepts of Operations (CONOPS)

NOTE:

Sometimes the timeframe addressed in the CBA extends beyond the timeframe of available DPSs, ISCs, OPLANs, CONPLANS, and other plans. This presents an additional challenge to the study team to find appropriate source documents to describe the projected operational environments (i.e., threats, scenarios, missions, capabilities). It is critical to vet these environments through the appropriate expert communities to maintain credibility of the analysis. The tasks, conditions, and standards used in the CBA, and in subsequent JCIDS products, should be anchored in a credible operational context. If the operational context is not credible, then the CBA is not credible.

The DPSs and ISCs should be used as a starting point for defining the operational context. The DPSs and ISCs describe scenarios that provide detailed descriptions of various operational elements to include locations, the enemy order of battle, and the corresponding enemy strategy and tactics ("the threat").

When selecting scenarios, the study team should consider the physical environments that are expected. The physical environment reflects both man-made and natural conditions. Natural conditions include weather, climate, terrain, vegetation, and geology. 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.

A range of scenarios may be needed to fully analyze the baseline and potential solutions. Scenarios used in previous analyses should be considered when determining which scenarios should be used in the

CBA. If a CONOPS is used to define the operational context, it must be previously endorsed by the JROC, combatant command, or at a minimum, the sponsoring DoD component.

In some situations, the study team may not have enough information to fully describe the operational context in the CBA study plan. The study team should at least describe the sources of information that will be used and possible scenarios that are being considered.

Air Force Nuclear Enterprise Example

The nuclear enterprise study team selected the Air Force Nuclear Enterprise Technical Information Management CONOPS to define the operational context:

> The CONOPS describes the capabilities and desired effects necessary to properly generate, manage, and protect nuclear enterprise technical information as well as how nuclear enterprise technical information management contributes to the lifecycle management of nuclear enterprise weapon systems. The CONOPS is endorsed by the Air Force Materiel Command, United States Air Forces in Europe, Air Force Global Strike Command, Air Force Safety Center, and Air Force Nuclear Weapons Center and supports the Air Force Agile Combat Support CONOPS and Air Force Nuclear Response CONOPS, and implements the tenets of the Information Protection CONOPS.

The study team will use the Technical Information Management CONOPS to develop scenarios to assess the baseline capability and potential solutions:

> The scenarios will be operationally realistic and address field and depot maintenance facility operations, headquarters staff functions and operations, peacetime and wartime operations tempo, and threats to the information systems. The scenarios will be based on the entire technical information order cycle to include the processes associated with technical assistance requests, temporary modifications to technical information, change requests, distribution, test data, and configuration management (e.g., engineering change proposals, modifications, and deficiency reporting). The scenarios will also address technical orders and time compliance technical orders as well as data sources such as specifications and engineering drawings.

3.10 Baseline Capability

The baseline capability is what currently exists and is programmed for in the future in the mission area of interest in the study. The baseline capability could be:

- Materiel (one or more systems),
- Non-materiel (doctrine, organization, training, materiel, leadership, personnel, facilities, policy),
- Combination of Materiel and non-materiel aspects.

The baseline capability usually includes anything that is currently funded in the Program Objective Memorandum (POM) and anything that is expected to be operational by the projected timeframe. The study team should exclude anything currently providing capability that is expected to be phased out for

removal from inventory before the projected timeframe of interest defined in the study scope. Sometimes it is difficult to clearly define the baseline capability because of guidance given to the CBA team, or the timeframe of interest is well beyond the end of the POM. In these cases, it is even more important to garner decision maker and stakeholder agreement of the baseline capability up front. Some sensitivity analysis may be required to ensure assumptions of the baseline capability in the timeframe of interest are appropriate.

The study team should consider the following questions to facilitate defining the baseline:

- How does the baseline capability support the overall mission?
- What outcomes are achieved by the baseline capability?
- What services are required to support the baseline capability?
- What is the functional scope and organizational span of the baseline capability?

There are various sources of information the study team can use to define the baseline capability. The Department of Defense Architecture Framework (DoDAF), for example, provides a framework for visualizing and understanding tasks, activities, systems, and infrastructure required to accomplish DoD missions. The baseline capability description may include the following:

- Missions, tasks, processes, decision points, business rules, and operational scenarios,
- Activities, relationships among activities, activity sequence and timing, activity responses to events, activity inputs and outputs, and delivery timing,
- Organizational and human roles and responsibilities,
- Manpower requirements and skill-sets,
- Intelligence support, logistics support, and other support services,
- Command, control, coordination, and other relationships among organizations,
- Systems, system-of-systems (SoS), and family-of-systems (FoS),
- 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 requirements.

The baseline capability description is typically completed in Step 2 of the CBA process (Define the Study). However, there may be cases when the study team does not have enough information to describe the baseline capability in the CBA study plan. In these situations, the study team will, as a minimum, describe the research approach to gather information to define the baseline capability.

Air Force Nuclear Enterprise Example

The nuclear enterprise study team described the following aspects of the baseline capability:

- Operational View-1 (OV-1) of technical information management,

- Automated information systems, policies, processes, and activities that support management of technical information,
- Organizations that have a role as users or sustainers of nuclear enterprise technical information,
- Functions that include oversight of mission execution, compliance evaluation, standardization of processes and policies, training, and resources.

3.11 Analysis Methodology

The analysis methodology describes how the study team will conduct the analysis and is a critical part of the CBA study plan. The analysis methodology addresses how Steps 3-9 will be conducted, specifically the gap analysis, gap characterization, risk assessment, gap prioritization, solution analysis, cost analysis, and solution viability assessment. Literature review, brainstorming, and expert elicitation are three commonly used methods to gather data and information needed to conduct these analyses. Brainstorming and expert elicitation each requires a broad, inclusive set of participants to avoid intentionally or unintentionally biasing the analysis. Two common errors committed by study teams when using these techniques are limiting participation to only a subset of the stakeholders and not allowing sufficient time for discussion, hence reducing the amount of data, information, and ideas collected. The following provides a brief introduction to the three methods:

Literature Review. The literature review is useful for creating a foundation to demonstrate knowledge of the current state of the field and should be conducted for most, if not all, studies. Through literature reviews, the study team can integrate sources of information to identify patterns and determine what is known and what, if anything, is missing. Literature reviews enable the study team to compare and contrast methods, approaches, and findings and critically discuss the strengths and weaknesses of the sources. The literature review can complement other data gathering techniques such as brainstorming and expert elicitation.

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 databases of government-sponsored technical documents:

- Contract Studies Registry Program: https://reg.dtic.mil/login/generic.jsp?TYPE=100728833&REALMOID=06-0b4e5624-5088-103f-84828396ac570cb3&GUID=&SMAUTHREASON=0&METHOD=GET&SMAGENTNAME=olHaYdeyHv4zVMCSUwGWlUHU1xuFRpPZyP9UtkOzntAsnDhgeCHhtOcc0sihXLiM&TARGET=SMhttps%3a%2f%2fwww%2edtic%2emil%2f
- Joint Lessons Learned Information System The Air Force-Joint Lessons Learned Information System: NIPRNET, https://www.jllis.mil/usaf SIPRNET, http://www.jllis.smil.mil/usaf
- DTIC: www.dtic.mil
- Information and Resource Support System (IRSS): https://www.my.af.smil.mil/IRSS/irss7/pkg_portal.prc_main (requires SIPRNet Air Force Portal account, as well as permission from HAF/A5R)

- Defense Acquisition University (ACQuipedia): https://dap.dau.mil/acquipedia/Pages/ArticleDetails.aspx?aid=d5461b4c-2887-4be8-8cd9-b09920308670
- Better Buying Power: http://bbp.dau.mil/
- Rand Corp: www.rand.org
- The Knowledge Management/Decision Support system (KM/DS): For instructions go to the JCIDS NIPRNet page: https://intellipedia.intelink.gov/my.policy
- Manual for the Operation of the Joint Capabilities Integration and Development System, 19 January 2012 (JCIDS Manual) Enclosure A: https://intellipedia.intelink.gov/wiki/JCIDS_Manual#Latest_Approved_JCIDS_Documents
- Includes detailed information on the "studies repository" concept and requirements and provides guidance on which databases to use when submitting a completed study

Brainstorming. Brainstorming is a technique that can be used with a small group (ideally 10 or fewer members, but the nature of the problem might necessitate more) to generate ideas. It can be conducted in-person or electronically. The main principles include focusing on quantity, withholding criticism, welcoming unusual ideas, and combining and improving ideas. Although there are a variety of techniques, the nominal group and group passing techniques are commonly used:

- Nominal group technique encourages all participants to have an equal say in the process. Participants write down their ideas anonymously and a moderator collects the ideas and presents to the group for a vote. Top ranked ideas are sent back to the group or subgroups for more brainstorming and elaboration.
- Group passing technique entails each person in a group writing down an idea on a piece of paper, then passing the paper to the next person who adds thoughts. This continues until everyone gets his or her original piece of paper back. In the end, each group member will likely have an extensively elaborated idea.

Expert Elicitation. Expert elicitation is a structured method of gathering expert judgment and answering questions concerning issues or problems of interest in a study. The Delphi method, developed by the RAND Corporation in the 1950s, is one of the first recognized expert elicitation methods. Over the years, many other elicitation methods have been developed and used by various organizations in both the private and public sectors. Expert elicitation can be used to gather a variety of information of interest in the CBA:

- Study assumptions, ground rules, and constraints,
- Baseline information,
- Capability gaps, tasks, conditions, standards,
- Capability gap priority, risks, and solutions.

There is a myriad of terms used to describe expert judgment such as expert opinion, subject matter expert assessment, subject matter expert analysis, subjective judgment, and expert knowledge. Whatever it is called, expert judgment is the data given by an expert in response to a question and represents an expression of opinion based on knowledge and experience. Judgment is shaped by the

expert's state of knowledge at the time of the response to the question, and because experts have different experiences and knowledge, their judgments can differ and change over time as new information is learned.

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. Once the questions have been developed, the study team uses personal or group interviews to conduct the elicitation. Personal interviews are usually done in private and in person and allow the interviewer to gather in-depth data from the experts without distraction or influence by other experts. Group interviews are conducted in person through a structured approach that defines when and how experts express and discuss their opinions. 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 of communication mode, and degree of structure in the elicitation process. Please see Appendix F for more information on the expert elicitation process.

3.11.1 Gap Analysis

The study team conducts a gap analysis of the baseline capability to determine whether capability gaps exist. To identify potential capability gaps, the study team should use available and relevant findings and data from previous studies and reports as well as information from subject matter experts. In some cases, the study team may need to conduct original analysis when relevant data does not exist.

To determine whether one or more capability gaps actually exist, the study team develops a set of tasks, conditions, attributes, measures, and standards to assess the baseline capability. The attributes, measures, and standards associated with the tasks provide the basis for the capability gap assessment. Using the results of the assessment, the study team identifies the capability gaps that will be analyzed in the study. The following provides more information about tasks, conditions, attributes, measures, and standards:

- Tasks are what a system is expected to perform. Tasks are performed under certain conditions.
- Conditions describe the operational environment in which tasks will be accomplished.
- Attributes are qualities or features of a task that form the basis for identifying and drafting measures. Examples include survivability, persistence, availability, and accuracy (see the JCIDS Manual for more examples of attributes).

NOTE:

Most the time, these attributes are not independent. It is important that the study team identify and understand the interdependencies that exist among the attributes and how they may affect the potential solution approaches.

- Measures convey information about the task being addressed. They include the dimensions, capacity, or amount of an attribute.

- Standards (also known as criteria) describe how well the tasks must be accomplished and are expressed in terms of criteria that define a minimum level of acceptable performance (threshold) and, if necessary, a desired level of performance (objective). Justification is required to substantiate the standards identified for the measures.

3.11.2 Gap Characterization

Once the capability gaps have been identified, the study team characterizes each gap. Although gap characterization is a subjective assessment, the study team should utilize the available information and data to substantiate the characterization. It is important that the study team record the reasoning used to characterize each gap. If necessary, the study team should seek assistance from subject matter experts. The study team characterizes each gap as to whether it is due to one of the following:

- Proficiency (inability to achieve the relevant effect in particular conditions),
- Sufficiency (ability to achieve effect but inability to bring needed force to bear due to force shortages or other commitments),
- Lack of fielded capability solution,
- Need for replacement due to aging (e.g., fatigue life, technological obsolescence) of a fielded capability solution,
- Policy limitations (inability to use the force as needed due to policy constraints).

3.11.3 Risk Assessment

The study team completes a risk assessment to identify the operational risks associated with the capability gaps. The study team assesses the risk in terms of mission (i.e., the ability to achieve the objectives of the scenario), force (i.e., the potential losses due to the capability gap), and other important considerations (e.g., resourcing risks, impacts on allies). The conditions and standards developed for the associated tasks provide the basis for the assessments.

The JCIDS Manual describes an approach the study team can use to assess the risks and consequences associated with a particular capability gap. As shown in Table 3-1, the capability gap is assessed based on its impact in several areas: strategic objectives, operational timelines, resources, unanticipated requirements, force provider resourcing, and institutional capacity.

Another risk assessment approach the study team should strongly consider using is the Air Force Risk Assessment Framework (RAF). The Air Force developed the RAF in an effort to provide a standardized approach for assessing, displaying, and discussing risk across the Air Force enterprise. The RAF is a scalable risk assessment approach that is linked to the Chairman's Risk Assessment definitions and the CJCS Integrated Risk Matrix. The RAF is used by the HAF/A5R functional representatives to assess risks associated with Core Function capabilities. For more information on the RAF, see the AF/A9 website. For assistance in using the RAF, contact OAS.

Table 3-1: JCIDS Manual Risk Assessment Matrix

	Risk			
Criteria	**Low**	**Moderate**	**Significant**	**High**
Strategic Objectives	Near certain achievement	Very likely achievement	Likely achievement	Significant risk of non-achievement
Operational Timeliness	As planned	Minor extension	Significant delay	Delays with significant risk of non-achievement
Resources	As planned	Requires resources from other plans or operations	Requires resources that create significant shortfalls	Requires resources that preclude other plans or operations
Unanticipated Requirements	Easily managed, minimal impact	Managed via minor adjustments to other plans	Managed via significant adjustments to other plans	Cannot manage
Force Provider Resourcing	Full capacity to source requirements	Sourcing requires limited duration capability gaps	Sourcing requires extended duration capability gaps	Requires full mobilization to cover capability gaps
Institutional Capacity	Full capacity to source requirements	Requires shifts within DoD components to meet requirements	Requires shifts among DoD components to meet requirements	Requirements exceed capacity of the Joint force

3.11.4 Gap Prioritization

The study team develops an initial prioritized list of the gaps by considering various factors such as the severity and consequence of risk, magnitude of the shortfall, alignment with strategic guidance, and stakeholder interests and priorities. The study team should provide an opportunity for the sponsor or special group to review the prioritized list to ensure leadership and stakeholder buy-in.

There are two commonly used methods to prioritize the capability gaps: rating scale and 1 to N ranking. The rating scale method is used to rate capability gaps based on a 1 to 5 rating scale. With this method, it is possible to have the same rating for multiple capability gaps. The definitions of the rating scale are shown below:

1. High impact on operational effectiveness; high operational risk if not mitigated,
2. Significant impact on operational effectiveness; significant operational risk if not mitigated,
3. Moderate impact on operational effectiveness; moderate operational risk if not mitigated,
4. Low impact on operational effectiveness; low operational risk if not mitigated,
5. No impact on operational effectiveness; no operational risk if not mitigated.

The 1 to N ranking method is used to determine an overall rank order of the capability gaps from 1 to N. The study team should consider the consequences (impact to mission) and likelihood (probability) of the risks associated with the capability gaps.

There may be other ranking methods that are appropriate for specific CBAs. The key point is to convey to the decision-makers the differences among the gaps which may be based upon various factors such as timeframe, scenario, consequence, and mission.

3.11.5 Solution Analysis

The purpose of the solution analysis is to identify potential Materiel and non-materiel solutions to close or mitigate the identified gaps. The solution analysis is not intended to be a rigorous study of the comparative benefits at the engineering level, but rather an identification of solution spaces that can be further investigated during Materiel Development Decision (MDD) preparation and the Materiel Solution Analysis (MSA) phase.

Although not every gap may need to be closed or mitigated, the study team determines whether a non-materiel (DOTmLPF-P), Materiel, or an integrated non-materiel and Materiel approach can close or mitigate each capability gap.

NOTE:

The lower case "m" in materiel signifies a solution that is limited to modifications of existing systems and/or procurement of more existing systems. Although called "materiel", these solutions are classified as non-materiel solutions. The upper case "M" in Materiel signifies a solution that is procured through a new acquisition program.

The objective of this analysis is to determine if the capability gap can be partially or completely addressed by DOTmLPF-P changes or updates. As part of the analysis, the study team identifies capability gaps for which actions are not recommended and provides justification as to why a solution is not warranted at this time. The DOTmLPF-P elements are described as follows:

- Doctrine. Doctrine is the fundamental principles that guide the employment of US military forces in coordinated action toward a common objective. Joint doctrine is based on existing capabilities and serves to make US policy and strategy effective in the application of US military power (see the JCIDS manual for more information). Joint doctrine is authoritative guidance and will be followed except when, in the judgment of the commander, exceptional circumstances dictate otherwise.

- Organization. Organization is a joint unit or element with varied functions and structures. Organization enables individuals to cooperate systematically, accomplish a common mission, and directly provide or support joint warfighting capabilities. Subordinate units and elements coordinate with other units and elements and, as a whole, enable the higher-level joint unit or element to accomplish its mission. This includes the joint staffing (military, civilian, and contractor support) required to plan, operate, sustain, and reconstitute joint warfighting capabilities.

- Training. Training of individuals, units, and staffs addresses the use of joint doctrine or joint tactics, techniques, and procedures. Training prepares joint forces or joint staffs to respond to strategic, operational, or tactical requirements considered necessary by the Combatant Commands to execute their assigned or anticipated missions.

- materiel. Materiel (little "m") includes all items necessary to equip, operate, maintain, and support joint military activities without distinction as to their application for administrative or combat purposes. Some examples of items include ships, tanks, self-propelled weapons, aircraft, and related spares, repair parts, and support equipment. Items do not include real property, installations, and utilities.

- Leadership/Education. Professional development of the joint leader is the product of a learning continuum that comprises training, experience, education, and self-improvement. The role of joint professional military education is to provide the education needed to complement training, experience, and self-improvement to produce the most professionally competent individuals possible.

- Personnel. The personnel component primarily ensures that qualified personnel exist to support joint capability requirements. This is accomplished through synchronized efforts of joint force commanders and DoD components to optimize personnel support to the joint force to ensure success of ongoing peacetime, contingency, and wartime operations.

- Facilities. Facilities include real property consisting of one or more of the following: buildings, structures, utility systems, associated roads and other pavements, and underlying land. Key facilities are defined as command installations and industrial facilities of primary importance to the support of military operations or military production programs. A key facilities list is prepared under the policy direction of the Joint Chiefs of Staff.

- Policy. Any DOD, interagency, or international policy issues that may prevent effective implementation of changes in the other seven DOTmLPF-P elemental areas.

NOTE:

If as part of the solutions, policy outside the AF or DoD should be changed or requires interpretation, the owner of that policy should be directly involved. Policy change and interpretation is often required for policies of the Director of National Intelligence Department of Energy, and Department of State.

If the non-materiel approaches do not partially or completely close the gap, the study team should recommend either accepting the risk associated with the remaining gap or pursuing a Materiel solution.

The study team identifies the type of Materiel solution and determines whether any non-materiel impacts are associated with the solution. Types of Materiel solutions (listed in terms of fielding uncertainty from low to high) include the following:

- Development and fielding of information systems (or similar technologies with high obsolescence rates) or evolution of the capabilities of existing information systems.
- Evolution of existing systems with significant capability improvement (this may include replacing an existing system with a newer more capable system, or simple recapitalization).
- Transformational systems that differ significantly in form, function, operation, and capabilities from existing systems and offer significant improvement over current capabilities or transform how we accomplish the mission.

OAS recommends that the study team use subject matter experts knowledgeable of various areas of interest in the study to identify potential solutions. It is important that the study team records the rationale used by the subject matter experts to select a particular solution since merely identifying the solution is not sufficient. This will enable the study team to develop credible and defensible justification statements that explain why a particular solution was selected. The explanation behind the solution selection is important and will give the decision-makers additional insights that will facilitate their understanding and approval of the solutions.

Subject matter experts should consider the tasks and the associated attributes, conditions, measures, and standards that were used to identify the capability gaps to determine whether non-materiel or Materiel solutions have the potential to either partially or wholly close or mitigate the capability gaps. They should not address specific details of how the solutions should be implemented, but rather provide enough detail to conduct the cost and risk analyses for the recommended solutions. Finally, the subject matter experts should identify interdependencies with other programs or efforts that are needed to provide the full capability to close or mitigate the capability gaps. This includes potential system dependencies for intelligence data (e.g., Intelligence Mission Data (IMD)).

Other sources of information the study team can use to identify potential Materiel solutions include the following:

- Concept Characterization Technical Description (CCTD) documents,
- Science and Technology reports and studies,
- Market research results,
- Requests For Information (RFIs) responses.

3.11.6 Cost Analysis

The study plan should describe the cost analysis methodology used to develop the cost estimates for the potential solutions. The intent of the cost analysis is to develop cost estimates to assess the affordability of potential solutions. Although there are various types of cost estimates, the rough-order-of-magnitude (ROM) cost estimate provides enough fidelity to determine whether potential solutions are realizable and can be resourced and implemented in the timeframe required.

There are several other reasons why the ROM cost estimate is recommended in the CBA. First, the time available to develop a cost estimate is typically very short. A ROM cost estimate is ideal in this situation since it can be completed in a relatively short period of time (i.e., hours or days). Second, the solutions identified by the study team may be new efforts that are not completely defined and lack historical information. The ROM cost estimate is best suited for these situations since it is understood that ROM cost estimates are often developed using data that is lacking in both quantity and quality. Finally, the resources available to develop the cost estimate can be limited in the CBA. For example, conducting interviews with program managers, engineers, functional experts, and other subject matter experts to collect information for the cost analysis may be restricted or impractical for completing the CBA. A ROM cost estimate can be developed with limited resources if necessary.

The cost estimates developed in the CBA are the total costs over the entire life cycle of each solution. The life cycle cost (LCC) includes costs incurred for research and development, investment, operations and support, and disposal. The following provides more specific information regarding the costs in each of the LCC phases:

- Research and Development. Non-recurring and recurring costs for prototypes, engineering development, equipment, and test and evaluation. Engineering costs for environmental safety, supportability, reliability, and maintainability as well as costs for supporting the research and development effort such as support equipment, training, and data.
- Investment. Cost of procuring the prime mission equipment and its support to include training, data, initial spares, war reserve spares, pre-planned product improvement program items, and military construction (i.e., cost of acquisition, construction, or modification of facilities necessary to accommodate a system).
- Operations and Support (O&S). Costs that are necessary to operate, maintain, and support system capability. Costs include all direct and indirect cost elements of a system and encompass costs for personnel, consumable and repairable material, and facilities. In most cases, the O&S costs are the largest portion of the cost, and therefore the biggest factor in determining whether or not an approach is affordable. A common error is to not include all the implied aspects of the O&S costs, or to assume the O&S costs of a future capability will be similar to the current baseline approach. Different approaches to address the gaps may have very different impacts on various factors such as manpower, basing, and communication needs. These need to be accounted for in the cost estimates.
- Disposal. Cost includes elimination of excess or surplus property or material from the inventory and may include costs for demilitarization, detoxification, redistribution, transfer, donation, sales, salvage, destruction, hazardous waste disposition, and environmental cleanup.

The general steps to develop cost estimates are the same regardless of the type of estimate. The following describes the basic steps for developing a cost estimate with additional emphasis on developing the ROM cost estimate in the CBA:

Step 1. Program Construct Formulation. Also known as program definition, this step primarily consists of identification of the ground rules, assumptions, technical content, schedule, and

determination of a program work breakdown structure (WBS). In the CBA, the cost analyst develops a program construct formulation for each solution that requires a cost estimate. What varies between a ROM cost estimate and a high quality cost estimate such as a Program Office Estimate (POE) or an Independent Cost Estimate (ICE) is the fidelity of the assumptions, amount of detail available, and time available to accomplish the estimate. A program construct formulation for a ROM estimate entails determining some very general ground rules and assumptions (e.g., quantities of systems), a very top level schedule, and a basic technical description of the solution. Due to resource limitations, the cost analyst may resort to working with a single program manager, engineer, or functional expert to collect information, unlike the case when developing a POE/ICE for which the cost analyst conducts numerous interviews with many different subject matter experts. Often times, the cost analyst must make his or her ground rules and assumptions for programmatic, technical, and cost aspects based on limited information.

Step 2. Data Collection. Data collection usually occurs concurrently with program construct formulation (Step 1). The only difference between a ROM cost estimate and a POE/ICE is the quality and quantity of information available, and the time the cost analyst has to collect it. A ROM cost estimate could be based on very high quality data that is simply presented at a higher estimating level in a summary fashion. For example, most force structure modeling and Air Force portfolio estimates are done in this manner; however, in most situations, the cost analyst is developing a cost estimate for a new effort for which relevant historical information is lacking. This usually tends toward lower fidelity and smaller amounts of information available to collect. Additionally, with the very short timelines normally associated with a ROM estimate, collection of data and program construct formulation will significantly overlap, thereby making the process much more concentrated in a shorter period of time.

Step 3. Data Analysis. For a ROM estimate, data analysis is usually accomplished concurrently with Step 2 (data collection). Data analysis is a function of the quality and quantity of data collected, the time allotted to perform the analysis, and the experience level of the cost analyst. Many of the tools employed (e.g., statistical modeling, risk simulation) are the same, the only difference being the aforementioned constraints. Although a number of estimating methods are available (see Table 3-2), the specific methods chosen depends to a large degree on the available data and type of solution. For most cost estimates, the cost analyst uses a combination of methods. Because the quality and volume of information is typically lacking in the CBA for new solutions, the cost analyst may rely on analogy, parametric, and/or expert opinion cost estimating methods. When the solution entails procuring more of an existing capability, the cost estimating method of extrapolation from actual data may be more appropriate.

ROM cost estimates are often based almost entirely on analogies with some subject matter expert input. The analogy method entails identifying a currently fielded system (reference system) similar in design and/or operation to the proposed system solution. The cost analyst uses historical data to identify the costs of weapon systems and subsystems that are similar to the proposed system. The cost of the proposed system is then calculated by adjusting the cost of the reference system to account for differences between it and the new system. Where data is limited, subsystems from other fielded systems (or if necessary, other developmental systems) may be used to represent the proposed system

estimate. Since the analogy method relies on the judgment of experts, the rationale used to arrive at a position should be clearly documented in the CBA final report.

Table 3-2: Most Common Cost Estimating Methods

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

The parametric cost estimating method can be accomplished quickly and produces accurate estimates if properly done. The parametric method entails using one or more parameters of a system being estimated and historical data about similar systems to build a Cost Estimating Relationship (CER). The CER is usually a regression analysis equation that is used to predict the cost of the system being evaluated. CERs relate cost to one or more variables (e.g., volume, weight, power). For example, horsepower and number of engines have proven to be reasonable predictors of rotary wing aircraft cost. The parameters are usually cost drivers in creating the system. Using the CER, the cost analyst develops a cost estimate for the system being evaluated. Since CERs are based on actual program cost history, they reflect the impacts of system growth, schedule changes, and engineering changes. When costs are captured at a very high level, however, visibility into more detailed levels is lost. The Air Force Cost Analysis Agency (AFCAA) and most cost estimating organizations have libraries of CERs that can be used if the data and assumptions are similar. The existence and accuracy of CERs varies significantly among

the solution approaches. For example, CERs for large aircraft are very mature, while those for cyber systems are in their infancy. CERs for transformational or evolutionary solutions may not exist at all.

Step 4. Modeling and Simulation (M&S). Spreadsheet models are the most popular and practical models for developing ROM cost estimates. A model is simply a system of data and inferences (more likely in a ROM estimate) presented as a mathematical description of an entity or state of affairs. The model is the representation and description of the complete system that is being evaluated. The complexity of the model is driven by the level of available data and analysis to be conducted. Models used in ROM cost estimates tend to be more simplistic representations and are based on higher levels of the WBS (typically WBS level 2 or 3 elements). The cost analyst should not underestimate the difficulty of packaging the program construct and data analysis information into a comprehensive model.

Once the point estimate is completed, a risk simulation on the finished product should be performed. The evaluation of risk is very important when developing a ROM cost estimate, although it can involve some creativity when information is limited. The experienced cost analyst usually develops ranges and probabilities instead of point estimates when preparing the final product.

Step 5. Reporting Results. The cost estimates of the potential solutions are included as part of the CBA final report. Along with the actual estimates, the cost analyst should record the ground rules, assumptions, and estimating methods used as well as subject matter experts interviewed and data collected. This will help the reader ascertain the validity of the estimates and may be useful in future analyses such as the Analysis of Alternatives. Documentation is also important in recreating the situation and analysis at a later date should a revisit of the material be necessary.

NOTE:

Because the cost work is often done independently from the rest of the study team, it is critical that the cost GRC&As are consistent with those used by other study team members. This requires close collaboration and communication across the study team.

3.11.7 Solution Viability Assessment

After the potential Materiel and non-materiel solutions have been identified and the cost analysis is completed, the study team assesses the viability of the solutions in closing or mitigating the capability gaps. The criteria that are used to assess the solutions include the following:

- Strategic Responsiveness—they are strategically responsive and deliver approaches when and where they are needed.
- Feasibility—they are feasible with respect to policy, sustainment, personnel limitations, and technological risk (i.e., technology maturation, concept attainment, time to implement).
- Affordability—they are realizable in that the DoD/component can actually resource and implement the approaches within the timeframe required. The Defense Acquisition University (DAU) further defines affordability as the degree to which the lifecycle cost fit into the long-range investment and force structure plans of DoD and its components.

- Requirements Satisfaction— they meet the requirement statements developed in the gap analysis portion of the CBA.

The study team assesses each potential solution using the criteria above and develops justification statements that explain why the solution meets, partially meets, or does not meet each criterion. The justification statements should be credible and defensible. Merely stating the potential solution meets the criteria is not sufficient. The explanation of why the criteria are met is important and will give the decision-makers more insights that will enhance their understanding of the viability of the solutions.

4 Conducting the CBA

As described in the previous chapter, the sponsor appoints a study director to lead a study team in planning and conducting the CBA. Once the CBA study plan is approved, the study team, led by the study director, can proceed with conducting the CBA. OAS can assist the sponsor, study director, and study team in the execution of the CBA by providing guidance, facilitation, and training.

As noted in the introduction in Chapter 1, the CBA should be tightly focused and the execution should take no more than 90 days for most studies. The study team should avoid excessive rigor and time consuming detail. Additionally, the study director should be aware of potential "scope creep," which can add to the duration of time needed to complete the study. The study director must endeavor to keep the scope of the study consistent with the approved study plan; however, as the study progresses and new information is learned, the study plan likely will change. In some cases, parts of the study plan may become obsolete, while in other cases, new questions may arise that require further study. When changes are necessary, they should be coordinated with the decision-makers and stakeholders as soon as possible to ensure the limited study resources are devoted to addressing the most important issues and questions. Finally, all changes should be documented in the CBA final report.

This chapter describes the steps for conducting the CBA. It continues with the notional example introduced in Chapter 3 to help facilitate understanding of the material. OAS recommends that the study team use the final report template in Appendix E to create the CBA final report.

4.1 Gap Analysis

In step 3 of the CBA process, the study team conducts a gap analysis of the baseline capability to determine whether capability gaps exist. The conditions, attributes, measures, and standards associated with the tasks for each capability requirement provide the basis for the capability gap assessment. Note that the operational conditions are derived from the scenarios used by the study team. To identify capability gaps, the study team uses findings and data from previous studies and reports as well as information from subject matter experts.

The specificity of the capability gaps will depend on the particular problem being analyzed in the study. In the nuclear enterprise example discussed below, the capability gap in providing responsive technical assistance depends on many factors such as user access to information, the accuracy, timeliness, and completeness of the information, and whether the information is relevant to the problem the user is solving. In this case, it is very difficult to identify when success or failure occurs. For example, having a user waiting too long for technical assistance is not appropriate, but specifically defining the maximum time that cannot be exceeded before a failure occurs is very difficult to determine and likely depends on the situation.

In other cases, the capability gap may be more specifically defined. For example, the electronic warfare protection suite on the F-22 aircraft may not be capable of countering an emerging surface-to-air missile

(SAM) threat. In this case, the capability gap may be very specific by identifying the particular SAM threat that makes the aircraft vulnerable.

The study team should attempt to describe capability gaps with as much specificity as possible, but understand that this may not always be possible. Capability gaps that are more specifically defined will help enable the study team to more clearly identify the risks associated with each capability gap and potential solutions to close or mitigate the gap.

4.1.1 Capability Requirement Statements

The study team uses the overarching problem statement and associated sub-problem statements, if applicable, to develop capability requirement statements and the associated tasks, conditions, attributes, measures, and standards. The capability requirement statements and the associated tasks, conditions, attributes, measures, and standards are used to determine whether shortfalls exist in the baseline capabilities of the force.

In addition to eliciting information from appropriate subject matter experts, the study team should use the Joint Capability Areas (JCAs), task lists (e.g., Universal Joint Task List (UJTL), Joint Mission-Essential Task List (JMETL), Mission-Essential Task List (METL), Air Force Task List (AFTL), other Service task lists), and other sources of information (e.g., Defense Planning Scenarios (DPSs), Integrated Security Constructs (ISCs), OPLANs, CONPLANs, CONOPS) to develop the capability requirement statements and associated tasks, conditions, attributes, measures, and standards.

Air Force Nuclear Enterprise Example

The nuclear enterprise study team identified an overarching problem and a number of associated sub-problems in the CBA study plan. Two examples of sub-problem statements are shown below (note that these were described in the CBA study plan):

> Overarching Problem Statement: The Air Force nuclear enterprise does not consistently generate, manage, or protect technical information in an accurate, reliable, secure, and timely manner to ensure nuclear system safety, security, and reliability.
>
> - Sub-Problem Statement 1. Cannot consistently respond to technical information requests to enable field and depot missions.
> - Sub-Problem Statement 2. Cannot effectively protect against unauthorized modification or destruction of technical information.

Using the sub-problem statements, the nuclear enterprise study team developed capability requirement statements. Two examples of capability gap statements are shown below:

> Capability Requirement Statement 1. Provide responsive (i.e., accurate, timely, complete, relevant) technical assistance to support field and depot mission accomplishment (derived from sub-problem statement 1).
>
> Capability Requirement Statement 2. Provide effective protections against unauthorized modification or destruction of technical information (derived from sub-problem statement 2).

The nuclear enterprise study team developed the associated tasks, conditions, attributes, measures, and standards for each capability requirement statement. Table 4-1 shows capability requirement statement 1 and the associated tasks, conditions, attributes, measures, and standards. In this example, the nuclear enterprise study team identified two tasks and associated attributes, measures, and standards for capability requirement statement 1. It is important to note that the study team may identify one or more tasks associated with each capability requirement statement. Additionally, each task may have multiple conditions, attributes, measures, metrics, and standards.

Table 4-1: Example of Capability Requirement Statement and Associated Information

Capability Requirement Statement 1: Provide responsive technical information assistance to support field and depot mission accomplishment (derived from Sub-Problem Statement 1).				
Task 1-1: Provide accurate technical information in response to technical assistance requests.				
Conditions: Field and depot maintenance facilities; headquarters staff facilities; environmentally controlled conditions for human occupation; continuous operations (24/7/365); peacetime and wartime operations tempo				
Attribute	**Measure**	**Metric**	**Standard**	**Standard Justification**
Accuracy	Number of accurate technical information assistance responses.	Percent	Threshold: ≥ 99.99% of technical assistance responses are accurate. Objective=Threshold	Personnel must have accurate technical information to enable field and depot mission execution. The number of technical assistance responses provided annually average about 110,000. This threshold equates to about 11 instances of inaccurate technical information responses per year across the nuclear enterprise. Previous studies and reports have shown that failing to meet this standard could create detrimental work stoppages and rework as well as increase risk to nuclear surety and physical safety. Sources: Depot Maintenance Rework Study: Causes and Implications (2010); Field Maintenance Production Report (2011).
Task 1-2: Provide access to technical information.				
Conditions: Field and depot maintenance facilities; headquarters staff facilities; environmentally controlled conditions for human occupation; continuous operations (24/7/365); peacetime and wartime operations tempo				
Attribute	**Measure**	**Metric**	**Standard**	**Standard Justification**
Availability	Number of successful attempts by users to access technical information.	Percent	Threshold: ≥ 97% of attempts by users to access technical information are successful. Objective=Threshold	Personnel must have access to technical information when needed to enable mission execution. Given the average number of actions to access technical information each day (436 actions), subject matter experts determined that anything less than the standard will result in work stoppages that will negatively impact the attainment of field and depot production goals. Source: Subject matter expert assessment.

4.1.2 Capability Gap Identification

Using the capability requirement statements and the associated tasks, conditions, attributes, measures, and standards, the study team determines whether shortfalls exist in the baseline capabilities of the force. The study team uses findings and data from previous studies and reports as well as information from subject matter experts to identify capability gaps.

Air Force Nuclear Enterprise Example

For capability requirement statement 1, the nuclear enterprise study team identified the following as the baseline capability:

> Materiel: Engineering Data Management System (EDMS). The EDMS is a digital repository for Department of Defense (DoD) engineering technical information. The system provides input services via electronic file transfer as well as hardcopy conversion (scanning) and data transfer, quality assurance review of engineering drawings, selective retrieval of technical information data using a relational database with built-in business rules, and output services (hardcopy or digital). Technical information can be accessed through a web browser.
> NOTE: EDMS is the baseline capability for task 1-1 and part of the baseline capability for task 1-2.
> Non-Materiel (Training): Technical Assistance Request (TAR) Process Training. The TAR process addresses all the actions performed by field maintenance organizations to request technical assistance from the System Program Office. The TAR training program provides instructions for creating and submitting technical information assistance requests relating to sustainment or maintenance issues requiring one-time Technical Order deviations or work stoppage situations.
> NOTE: TAR Process Training is part of the baseline capability for task 1-2.

To identify capability gaps, the nuclear enterprise study team used findings and data from previous studies and reports as well as information from subject matter experts. For capability requirement statement 1, the gap analysis results are shown in Table 4-2.

Table 4-2: Example of Capability Gap Results

Capability Requirement Statement 1: Provide responsive technical information assistance to support field and depot mission accomplishment.				
Task 1-1: Provide accurate technical information in response to technical assistance requests.				
Conditions: Field and depot maintenance facilities; headquarters staff facilities; environmentally controlled conditions for human occupation; continuous operations (24/7/365); peacetime and wartime operations tempo				
Attribute	**Measure**	**Metric**	**Standard**	**Standard Justification**
Accuracy	Number of accurate technical information assistance responses.	Percent	Threshold: ≥ 99.99% of technical assistance responses are accurate. Objective=Threshold	Personnel must have accurate technical information to enable field and depot mission execution. The number of technical assistance responses provided annually average about 110,000. This threshold equates to about 11 instances of inaccurate technical information responses per year across the nuclear enterprise. Previous studies and reports have shown that failing to meet this standard could create detrimental work stoppages and rework as well as increase risk to nuclear surety and physical safety. Sources: Depot Maintenance Rework Study: Causes and Implications (2010); Field Maintenance Production Report (2011).
Baseline Capability				
EDMS Assessment: Does not meet the threshold standard. Justification: Based on recent EDMS data from FY10-12, only 96% of the technical assistance responses, on average, are accurate. Most of the inaccurate data is due to delays in updating data and maintaining data currency and consistency. The Source: EDMS data FY10-12 and the EDMS Performance Assessment Report (2009-2010).				

Table 4-2: Example of Capability Gap Results (continued)

Task 1-2: Provide access to technical information.				
Conditions: Field and depot maintenance facilities; headquarters staff facilities; environmentally controlled conditions for human occupation; continuous operations (24/7/365); peacetime and wartime operations tempo				
Attribute	**Measure**	**Metric**	**Standard**	**Standard Justification**
Availability	Number of successful attempts by users to access technical information.	Percent	Threshold: ≥ 97% of attempts by users to access technical information are successful. Objective=Threshold	Personnel must have access to technical information when needed to enable mission execution. Given the average number of actions to access technical information each day (436 actions), subject matter experts determined that anything less than the standard will result in work stoppages that will negatively impact the attainment of field and depot production goals. Source: Subject matter expert assessment.
Baseline Capability				
EDMS Assessment: Does not meet the threshold standard Justification: Based on EDMS data from FY10-12, only 78% of the attempts by users to access technical information were successful. Source: EDMS data FY10-12. **TAR Process Training** Assessment: Does not support meeting the threshold standard. Justification: The instructions for accessing EDMS and requesting technical information assistance are vague and incomplete. Consequently, users can incorrectly submit technical assistance requests, resulting in unsuccessful attempts. Source: Subject matter expert assessment.				

4.1.3 Capability Gap Statements

Once the capability gaps have been identified, the study team describes them in terms of a shortfall of some aspect. Table 4-3 shows examples of capability gap expressions:

Table 4-3: Examples of Capability Gap Expressions

Inadequate policy enforcement to protect…	Intelligence collection is inadequate for…
Insufficient training to…	Current policy and guidance do not provide…
Unable to counter…	Forces lack trained and experienced personnel to…
No common data sources and processes to…	Policy and doctrine limit…
Insufficient capability to…	Forces do not have…
System X is vulnerable in…	Lack of trained personnel to…
Communications can be denied in…	Limited capability to detect and counter…

Air Force Nuclear Enterprise Example

Based on the results of the gap analysis, the nuclear enterprise study team developed capability gap statements. The capability gap statements were derived from the capability requirement statements. Two examples of capability gap statements are shown below:

> Capability Gap Statement 1. Insufficient capability to provide responsive (i.e., accurate, timely, complete, relevant) technical assistance to support field and depot mission accomplishment (derived from capability requirement statement 1).
> Capability Gap Statement 2. Ineffective protections against unauthorized modification or destruction of technical information (derived from capability requirement statement 2).

4.1.4 Gap Characterization

Once the capability gaps have been identified, the study team completes Step 4 in the CBA process to characterize each gap as to whether it is due to proficiency, sufficiency, lack of existing capability, need for replacement due to aging of an existing capability, or policy limitation. Although this is a subjective assessment, the study team should provide the justification used to characterize the capability gaps.

Air Force Nuclear Enterprise Example

The nuclear enterprise study team characterized the capability gaps identified in the study. One example of the capability gap characterization is shown in Table 4-4 below.

Table 4-4: Example of Gap Characterization Results

Capability Gap Statement 1: Insufficient capability to provide responsive technical assistance to support field and depot mission accomplishment (derived from Capability Requirement Statement 1).	
Due to:	**Justification**
Lack of Existing Capability	Shortfalls in existing EDMS capability and TAR training have adversely impacted the responsiveness of technical assistance support to field and depot organizations. Lack of existing capability has resulted in the following: • Engineers creating inaccurate technical assistance responses by using technical information stored in EDMS that has not been updated in a timely manner to maintain currency and consistency. • Users unable to accomplish tasks in a timely and effective manner due to limited access to technical information stored in EDMS. • Users unable to access technical information by failing to follow TAR procedures due to vague and incomplete instructions.

4.1.5 Risk Assessment

The study team completes a risk assessment in Step 5 of the CBA process to identify the operational risks associated with the capability gaps. The study team assesses the risks in terms of mission (i.e., the ability to achieve the objectives of the scenario), force (i.e., the potential losses due to the capability gap), and other important considerations (e.g., resourcing risks, impacts on allies). As noted in the

previous chapter, other methods such as the Risk Assessment Framework (RAF) can be used to assess risk (contact OAS for assistance in using the RAF). Regardless of the method used, the study team should provide the justification for rating risks associated with the capability gaps.

Air Force Nuclear Enterprise Example

The nuclear enterprise study team assessed the risks associated with the capability gaps identified in the study. One example of the capability gap risk assessment is shown in Table 4-5.

Table 4-5: Example of Risk Assessment Results

Capability Gap Statement 1: Insufficient capability to provide responsive technical assistance to support field and depot mission accomplishment.		
Risk to:	**Rating**	**Justification**
Mission	High	Failure to maintain correct configuration of nuclear weapon systems.
	High	Nuclear weapon system failures attributed to improper maintenance.
Force	Significant	Occupational Health and Safety incidents resulting from incorrect maintenance actions.
Resources	Moderate	Work stoppages and delays in field and depot maintenance activities.
	Moderate	Inefficient use of resources (e.g., rework required to reconfigure nuclear weapon systems back into correct configuration).

4.1.6 Gap Prioritization

The study team develops a prioritized list of the gaps in Step 6 in the CBA process by considering various factors such as the severity and consequence of risk, magnitude of the shortfall, alignment with strategic guidance, and stakeholder interests and priorities. The study team should provide an opportunity for the stakeholders or special groups to review the prioritized list to ensure decision-maker and stakeholder buy-in.

As described in the previous chapter, there are two methods that can be used to prioritize the capability gaps: rating scale and 1 to N ranking. Whatever method is used, the study team should provide the justification used to prioritize the capability gaps. In any case, the focus should be on identifying which of the gaps are important enough to be addressed now**.**

Air Force Nuclear Enterprise Example

The nuclear enterprise study team prioritized all the capability gaps identified in the study. One example of the capability gap priority is shown in Table 4-6.

Table 4-6: Example of Gap Prioritization

Capability Gap Statement 1: Insufficient capability to provide responsive technical assistance to support field and depot mission accomplishment.	
Rating	Justification
1 – High impact on operational effectiveness; high operational risk if not mitigated	This capability gap impacts core processes that support the entire product lifecycle management capability. Failing to close or mitigate this gap will negatively affect all other capabilities associated with product lifecycle management. Solutions to address this capability gap should provide visibility and control of weapon system technical information and its functional and physical attributes. Failure to provide this capability will result in absence of, questionable integrity of, or degraded confidence in technical information that will negatively impact mission execution and pose a high risk to nuclear surety and personnel safety.

4.2 Solution Analysis

For each identified gap, the study team makes the initial determination of whether the operational risk warrants a solution. In some cases, the sponsor may be willing to assume the risk of not closing or mitigating a capability gap. The study team must collaborate with the sponsoring organization's Director of Requirements and the appropriate Core Function Team(s) in making the determination of whether to accept the risk. For capability gaps with unacceptable operational risk, the study team must provide justification that substantiates the need to pursue a solution. The final determination of whether to accept the risk or pursue a solution is an Air Force or DoD level decision.

For only those capability gaps that require a solution, the study team conducts a solution analysis in Step 7 of the CBA process to determine whether a non-materiel (DOTmLPF-P), Materiel, or integrated non-materiel and Materiel solutions can close or mitigate the capability gap. The study team uses subject matter experts knowledgeable of the area of interest in the study to identify potential solutions. There are several different approaches to elicit information regarding potential solutions from the subject matter experts (see Appendix F for more information on expert elicitation). It is important that the study team document the justification used by the subject matter experts to select a particular solution. This will enable the study team to develop credible and defensible justification statements that explain why a particular solution was selected.

The study team should advise the subject matter experts to consider the tasks and the associated attributes, conditions, measures, and standards that were used to identify the capability gaps to determine whether non-materiel solutions, Materiel solutions, or a combination of both have the potential to close or mitigate the capability gaps.

If the non-materiel approaches do not solve or sufficiently mitigate the gap, the study team should recommend a Materiel solution. The study team identifies the type of Materiel solution and determines whether any non-materiel impacts are associated with the solution. Types of Materiel solutions include

the development and fielding of information systems, evolution of existing systems, and transformational systems (see previous chapter for more discussion regarding the types of Materiel solutions). As noted in the previous chapter, the subject matter experts should not address how the solutions should be implemented, but instead focus on the capabilities the solutions provide. If no Materiel solutions seem feasible, then the study team should recommend potential approaches such as Science and Technology (S&T) or Research and Development (R&D) investments.

When developing solutions, the study team should consider system-of-systems and family-of-systems. One common error is fixating on one aspect of a system. Many times, complex problems are best solved by making moderate improvements to multiple systems rather than a single, large improvement to one system.

Air Force Nuclear Enterprise Example

The nuclear enterprise study team used subject matter experts to identify potential solutions to address the capability gaps identified in the study. In the example shown in Table 4-7, the study team identified materiel and training solutions to address the capability gap 1.

Table 4-7: Example of Solution Analysis Results

Capability Gap Statement 1: Insufficient capability to provide responsive technical assistance to support field and depot mission accomplishment.	
Solution Type	Justification
materiel (little "m")	Permanent capability modifications (AF Form 1067) may be possible that add new capability and/or enhanced performance of EDMS to close the capability gap. Permanent capability modifications could address the causes of inaccurate technical information data. For example, one way engineers create inaccurate technical assistance responses is by using technical information that is not current. EDMS handles updates to technical information through a batch process which can delay the creation of current technical information. Performance enhancements may be possible that provide near real-time data updates, thereby minimizing delay time in updating technical information. Enhancing the availability of technical information by authorized users may require modifications that address the causes of unsuccessful attempts to access technical information such as frequent system downtime and limited capacity.
Training	Enhancements to the Technical Assistance Request (TAR) training program that provide better instructions on how to request engineering technical assistance could reduce the number of unsuccessful attempts by users to access technical information. Clearly defined instructions could help guide users in submitting technical assistance requests, resulting in more successful attempts to access technical information.

4.3 Cost Analysis

The study team develops a rough order of magnitude (ROM) cost estimate for each solution in Step 8 of the CBA process to assess the affordability of potential solutions. It is important that the study team consult with a cost analyst when conducting the analysis. The number of potential solutions and time available to conduct the analysis must be considered when determining cost analyst support.

The selection of a particular cost estimating method(s) is primarily driven by the quality and quantity of available cost data. In most CBAs, cost data is typically limited. In these situations, the analogy, parametric, and expert opinion cost estimating methods are typically used.

The CBA should focus on developing good ROM cost estimates to determine affordability and not on answering who is responsible for funding the solutions. The question of which organization(s) should provide funding can sometimes hinder completion of the analysis.

Air Force Nuclear Enterprise Example

The nuclear enterprise study team developed ROM cost estimates for the potential solutions to address the capability gaps identified in the study. In the example shown in Table 4-8, the study team used the analogy method to develop a cost estimate for a materiel solution (little "m") for capability gap 1. For the training solution for capability gap 1, the study team used cost expert opinions to determine that the costs of enhancing TAR training were nominal.

Table 4-8: Example of Cost Analysis Results

Capability Gap Statement 1: Insufficient capability to provide responsive technical assistance to support field and depot mission accomplishment.				
Solution	Description	ROM Cost Estimate		Methodology
materiel	AF Form 1067 Modification Proposal for EDMS (new capability modification) (see AFI 10-601 for more information about AF Form 1067).	R&D: Investment: O&S: Disposal Total:	$7-8M $21-24M $10-13M $1-2M $39-47M	Analogy
Training	Enhancements to the Technical Assistance Request (TAR) training program that provide clear and complete instructions on how to request engineering technical assistance.	Nominal cost		Expert Opinion

4.4 Solution Viability Assessment

Once the potential Materiel and non-materiel solutions have been identified and the cost analysis is complete, the study team assesses the viability of the solutions in closing or mitigating the capability gaps in Step 9 of the CBA process. The study team uses strategic responsiveness, feasibility, affordability, and requirements satisfaction as the criteria for assessing viability. For each solution, the study team develops justification statements that explain why the potential solution meets the criteria.

Air Force Nuclear Enterprise Example

The nuclear enterprise study team determined the viability of each of the potential solutions identified in the study. Table 4-9 shows the results of the study team's assessment of the materiel solution for capability gap 1.

Table 4-9: Example of Solution Viability Assessment Results

Capability Gap Statement 1: Insufficient capability to provide responsive technical assistance to support field and depot mission accomplishment.		
Solution Type	**Criteria Met**	**Justification**
materiel (AF Form 1067)	Strategic Responsiveness	It is anticipated that the materiel solution will significantly mitigate, or possibly close, the capability gap by providing permanent capability modifications and enhancements that address the causes of inaccurate technical information data and improve the availability of technical information to authorized users.
	Feasibility	The materiel solution is technically feasible and can be implemented within the timeframe of interest (FY14-18). Depending on the nature of the permanent capability modifications and enhancements, Joint Staff/J6 may require Net Ready-Key Performance Parameter certifications. (NOTE: It is important to get the right communities to speak for their areas of expertise: A2 for ISR supportability, A4 for sustainment, A6 for communications capacity.)
	Affordability	The ROM LCCE shows the R&D and Investment costs are well within the AF Form 1067 modification thresholds. The materiel solution can be resourced by the sponsor (AFMC).
	Requirements Satisfaction	It is anticipated the materiel solution will satisfy the capability requirement statement 1 (Provide responsive technical assistance to support field and depot mission accomplishment) and the associated tasks: • Task 1-1. Provide accurate technical information in response to a technical assistance request. • Task 1-2. Provide access to technical information.

4.5 Recommendations

Using the results and findings from the CBA, the study team may develop one or more recommendations for the decision-makers to consider. The recommendations should address future courses of action. As shown in Figure 4-1, there are a number of possible actions that may be taken based on the outcome of the CBA (see the JCIDS Manual for more information).

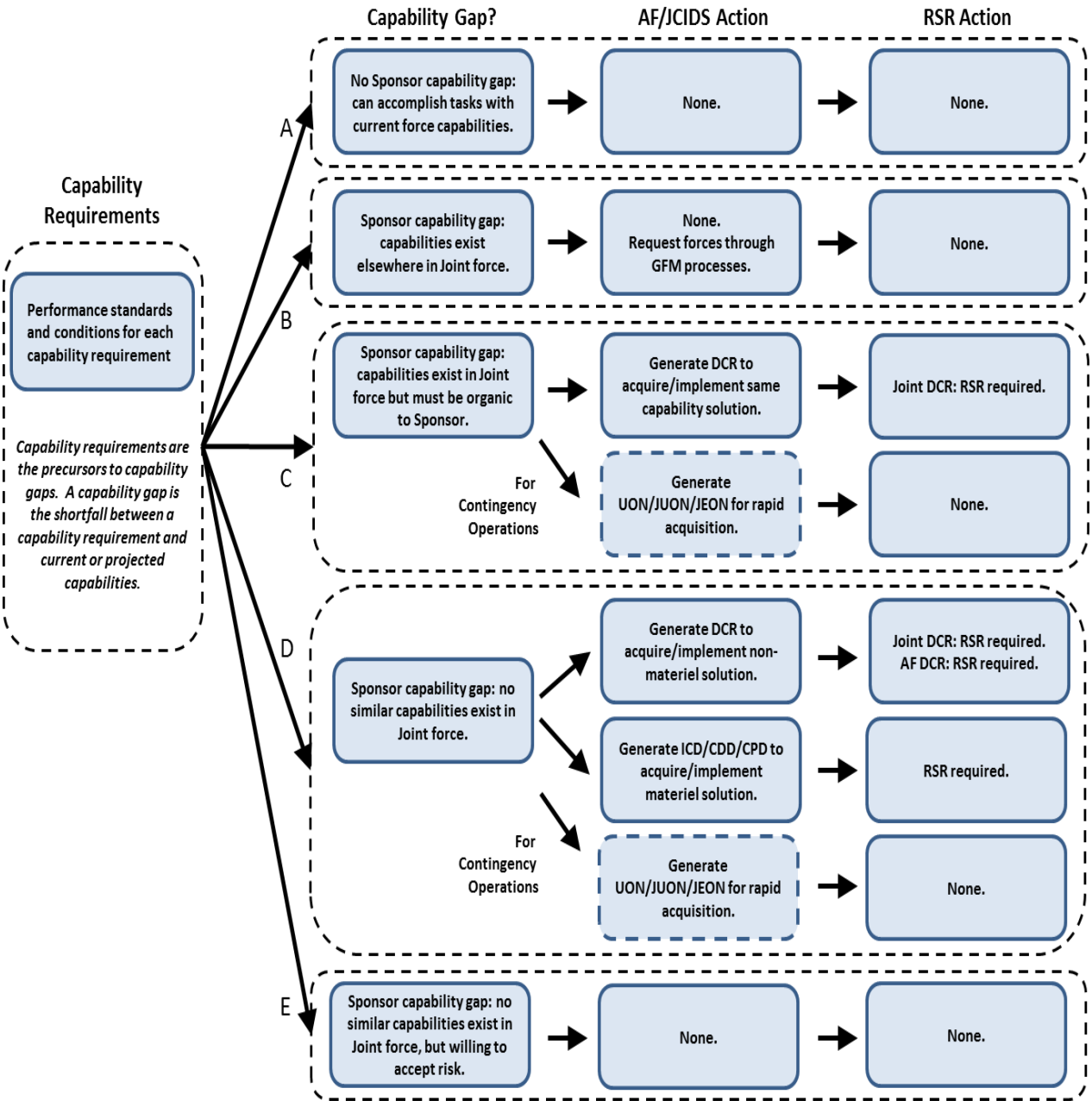

Figure 4-1: Post CBA – AF/JCIDS and RSR Actions (derived from JCIDS Manual and AFI 10-601)

It is important to note that several actions associated with outcomes C and D require a Requirements Strategy Review (RSR) by the Air Force Requirements Review Group (AFRRG) (see AFI 10-601 for more

information). Additionally, some outcomes, such as the Urgent Operational Need (UON), may require Air Force Oversight Council (AFROC) review and approval. The following describes the possible outcomes and associated actions:

- Outcome A. If the capability requirements can be satisfied with current or projected capability solutions, then a capability gap does not exist. For this outcome, a new JCIDS document is not required and the RSR is not required.
- Outcome B. If capability solutions which can satisfy the capability requirements exist elsewhere in the Joint force, the sponsor does not create a new JCIDS document but uses a Request for Forces (RFF) or Request for Capabilities (RFC) and the Global Force Management (GFM) process to request forces and their associated capabilities (see JCIDS Manual for more information). The RSR is not required.
- Outcome C. If capability solutions which can satisfy the sponsor capability requirements exist elsewhere in the Joint force, but must be organic to the sponsor organization, the sponsor has two options described below.
    - To leverage entire capability solutions "off the shelf," the sponsor may generate a Joint DCR for validation in JCIDS to establish the existing capability solution in the sponsor organization. To leverage only portions of other existing capability solutions that will be integrated into one or more of the sponsor's capability solutions, the sponsor may generate a Joint DCR to establish the requirement to leverage part of another sponsor's capability solution. The implementation of the Joint DCR may involve updates to existing CDDs or CPDs to provide for broadened scope, and submittal for review and revalidation. For this option, the RSR is required.
    - In urgent situations supporting ongoing or anticipated contingency operations, the sponsor may generate a Joint Urgent Operational Need (JUON), Joint Emergent Operational Need (JEON), or DOD Component Urgent Operational Need (UON) for greater expediency. Expect extra scrutiny during validation if it is unclear why use of the GFM process and leveraging the Joint force is not appropriate to satisfying the sponsor's capability requirement. For this option, the RSR is not required.
- Outcome D. If capability solutions which can satisfy the sponsor capability requirements do not exist in the Joint force, the sponsor has three options described below:
    - If the capability requirement can be satisfied through a non-materiel approach, the sponsor generates a Joint or Air Force DCR as required to establish a new non-materiel solution. Use of the Joint DCR must have impact to the Joint Force and requires an RSR, AFFRG review, AFROC validation, VCSAF approval, and Joint Staff validation. Air Force-specific changes are documented in an Air Force DCR. The Air Force DCR requires an RSR, AFFRG review, AFROC validation, and VCSAF approval.
    - If it is unclear whether the capability requirement can be satisfied through a non-materiel approach, Materiel approach, or both, the sponsor generates an ICD for validation in JCIDS. Sponsor analyses following ICD validation, such as an analysis of alternatives (AoA), additional DOTmLPF-P analysis, or other study, will determine which successor documents (i.e., Joint or Air Force DCRs for non-materiel solutions and/or

CDDs/CPDs for Materiel solutions) should be generated to support follow-on efforts. For this option, the RSR is required.

- If the capability requirements are driven by ongoing or anticipated contingency operations, and left unfulfilled would result in unacceptable loss of life or critical mission failure, the sponsor may generate a JUON, JEON, or DOD Component UON document for expedited staffing and validation in the JCIDS or DOD Component processes. The RSR is not required.

- Outcome E. If capability solutions which can satisfy the sponsor capability requirements do not exist in the Joint force, but the sponsor is willing to accept risk, then no JCIDS document is generated and the RSR is not required.

In addition to the actions described above, the study team must address the following (see AFI 10-601 for more information):

- Science and Technology investments required before initiation of any acquisition activity,
- Areas that require additional information or analysis before initiation of any acquisition activity.

If applicable, the study team can develop recommendations that address the following:

- Other analyses, to include possibly other CBAs, that should be initiated,
- Improvements to the CBA process.

5 Final Report Staffing and the Requirements Strategy Review

This chapter describes the final report staffing process and the Requirements Strategy Review (RSR). It provides some important insights that will help the sponsor prepare for the RSR.

5.1 Final Report Staffing

The CBA final report does not require an HPT and there is no HAF review or staffing required. The MAJCOM Director of Requirements, or higher, approves the CBA final report. The CBA final report must have specific content for approval (see Chapter 4 for more information regarding CBA final report requirements). Even if the final report does not identify any capability gaps, it is important that the study team complete the staffing process since the final report will serve as a historical record that may be useful in future studies.

Once the CBA final report has been approved, the lead command requirements office will forward the final report to AF/A5R-P. AF/A5R-P will archive the final report in the IRSS database and submit it, as appropriate, to the Joint Staff for entry into the Knowledge Management/Decision Support (KM/DS) database.

Further staffing of the CBA final report is suggested if the recommended way forward includes requesting an RSR to develop an ICD. The sponsor should brief HAF organizations, especially AF/A5R, that may have an interest in the capability gaps, potential solutions, and recommended courses of action. These actions should help familiarize organizations beyond the MAJCOM of the CBA results and build advocacy for the resolution of the capability gaps.

5.2 Requirements Strategy Review (RSR)

Before Air Force and JCIDS actions can be taken at the completion of the CBA, the sponsor prepares an initial requirements strategy and submits a request to AF/A5R-P for an Air Force Gatekeeper (AFGK) review. If approved by the AFGK, the Air Force Requirements Review Group (AFRRG) conducts an Initial Requirements Strategy Review (RSR) where the sponsor presents the initial requirements strategy for AFRRG approval.

The AFRRG is a corporately chartered, decision-making body which provides direct support to the AFROC. The AFRRG is chaired by the Deputy Director of Operational Capability Requirements, Deputy Chief of Staff for Air, Space and Information Operations, Plans and Requirements, Headquarters USAF (AF/A-A5R). The AFRRG is composed of O-6 level principals from designated MAJCOM, Field Operating Agency (FOA), Direct Reporting Unit (DRU), and Headquarters Air Force (HAF) organizations. AFRRG membership mirrors the AFROC principals and advisors. Membership and additional functions are outlined in the AFROC/AFRRG Charter on the AF/A5R-P Requirements web site.

The AFRRG is charged with reviewing all relevant CBAs in support of JCIDS documents as well as AoAs, Technology Development Documents, UONs, JUONs, JEONs, ICDs, IS-ICDs, Draft CDDs, CDDs, IS-CDDs,

CPDs, AF DCRs, and AF originated Joint DCRs. During these reviews, the AFRRG focuses on gap mitigation, operational utility, affordability, cost and performance tradeoffs, and operational and force management risk.

The purpose of the RSR is to provide an initial review of a program before entering the JCIDS process or to conduct a follow-on review of a program after it has entered JCIDS. There are two types of RSRs:

- Initial RSR. An Initial RSR is required for all Air Force-sponsored programs entering the JCIDS requirements process regardless of where the program enters the process. The Initial RSR is conducted by the AFRRG before the sponsor convenes the High Performance Team (HPT) event. The AFRRG provides a cross functional, corporate evaluation of identified requirement gap(s) and determines how to best to close the identified gap(s) through solutions which are Materiel, non-materiel, or a combination of both. An Initial RSR is also used in situations where a non-Air Force ICD is intended to be used in place of an Air Force-sponsored ICD to initiate an Air Force program. In this case, an RSR would be required before convening the HPT to begin work on the AoA Study Guidance and Study Plan.
- Follow-on RSR. A Follow-on RSR is normally conducted by the AFGK before convening the HPT event for follow-on requirements documentation for a previously approved and ongoing Air Force program (e.g., AoA Study Plan, AoA Final Report, CDD, and CPD). The RSR by the AFGK is an O-6 level review conducted by AF/A5R-P with appropriate AF/A5R division(s). The Follow-on RSR may be elevated to the AFRRG or AFROC, as directed, to review program changes that have occurred since the initial strategy was approved (e.g., significant changes in requirements, funding, or schedule).

As described in AFI 10-601, the AFGK/AFRRG accomplishes the following as applicable in its review of the requirements strategy:

- Review the sponsor's CBA, the traceability to CFSP(s), and the linkages to the foundational requirements documents,
- Review the risk assessment,
- Review relevant concepts that propose and describe solutions to the identified capability gap
- Determine if a Materiel solution, non-materiel solution, or a combination of the two is required to mitigate the gap, determine which gaps will be mitigated in the CDD, or review the gaps mitigated by the CPD,
- Determine/Review the scope for the proposed strategy/solution (e.g. single increment, multiple increments),
- Determine when the capability must be delivered and how it will be sustained,
- Project follow-on requirements oversight reviews and determine necessary interaction with the Joint Staff, other Services, and OSD (if required),
- Determine possible interaction(s) with other Air Force or joint systems,
- Review proposed nomenclature (the proposed name of the ICD should reflect the core gap; CDD/CPDs will normally reflect the proposed solution),
- Assess the initial affordability goal within the appropriate portfolio to close the identified gaps,

- Review the proposed or documented KPPs, KSAs, and additional attributes,
- Review costs to ensure solution(s) remain affordable,
- Review HPT membership and format (i.e., live or virtual).

At the completion of the RSR, the AFGK/AFRRG provides the sponsor with specific guidance and required actions to be accomplished. The RSR decision and associated actions are archived in IRSS. See the AF/A5R-P Requirements Portal pages for additional information on the RSR process (procedures, checklists, timelines, and templates).

5.3 Preparing for the RSR

With the completion of the CBA, there are several actions the sponsor should take in preparing for the RSR. The remainder of this section discusses four key actions: determining analysis sufficiency, building advocacy, answering the major questions, and seeking OAS assistance.

5.3.1 Determine Analysis Sufficiency

The sponsor develops the requirements strategy in collaboration with the appropriate CFL(s), operating commands (operators), and implementing command representatives (e.g., systems engineers, testers, sustainers, intelligence analysts). To develop the requirements strategy, the sponsor uses the results and findings from applicable CBA(s) and other related studies and reports. The sponsor must determine whether the analysis is sufficient to defend the requirements strategy. Some of the key aspects that should be addressed in the analysis include the following:

- Identification and assessment of capability gap(s) in the area of interest,
- Assessment of risks associated with the capability gap(s),
- Evaluation of potential Materiel and non-materiel solutions to close of mitigate the capability gap(s),
- Evaluation of current and future Science and Technology (S&T) efforts which may enable a future capability solution, or future enhancements to current or proposed capability solutions,
- Assessment of whether potential solutions are affordable and resources are available.

If the sponsor deems the analysis is not sufficient, then additional analysis should be conducted to address the shortfalls before finalizing the requirements strategy and proceeding with the RSR. For more information regarding the analysis sufficiency determination, please see the OAS Pre-MDD Analysis Handbook.

5.3.2 Spread the Word/Build Advocacy

It is likely that the capability gaps identified in the CBA will be of interest to other organizations beyond those that participated in the CBA. Identifying potential stakeholders and building advocacy does not end with the CBA. The sponsor should not simply “shelve” the final report, but instead should “spread the word” by presenting the results at appropriate forums. Although the CBA final report does not require HAF review, OAS recommends that the sponsor brief HAF organizations that may have an

interest in the capability gaps, potential solutions, and recommended courses of action. Other organizations across the Air Force, DoD, and government should be considered as well. These actions will help familiarize organizations beyond the MAJCOM of the CBA results and build advocacy for the resolution of the capability gaps. Finally, these actions will help identify the enduring HPT members who will be involved in the future JCIDS activities (i.e., development of the ICD, CDD, and CPD) and the AoA study.

5.3.3 Answer the Major Questions

There are a number of major questions the sponsor should be prepared to answer (see below). These questions are examples that should provide insights into the types of questions that require forethought and preparation. If properly done, the CBA should have addressed these questions. This is not an inclusive list and there may be other questions that are specific to a capability gap, potential solution, or course of action. If the sponsor cannot provide proper responses to these questions using the results of the CBA(s) and other previous analysis, then it is likely the sponsor is not ready for the RSR.

- Why are these capability gaps important?
- Why must these capability gaps be addressed now?
- What are the implications if these capability gaps are not addressed now?
- What are the risks associated with these capability gaps and why are they important?
- What Core Function(s) do these capability gaps link to?
- Who are the stakeholders and why do they have a stake?
- What are the cost estimates for the potential solutions?
- Are the potential solutions affordable?

5.3.4 Seek Assistance from the Office of Aerospace Studies (OAS)

If the sponsor has not involved OAS in the CBA, this is an opportunity to contact OAS and make arrangements for OAS support. OAS assists AF/A5R, MAJCOMs, and field agencies with the development of study guidance, study plans, study organization, and study execution for CBAs, pre-MDD analyses, and AoAs. In addition, OAS can assist the sponsor by serving as a facilitator for teams chartered to develop JCIDS documents (i.e., ICD, CDD, and CPD). Other OAS functions include the following:

- Train 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.
- Advise the Air Staff, AFROC, AFRRG, Lead Commands, teams, and stakeholders during the planning, execution, and review of the analysis.
- Assess the study plan and study final report/briefing. The assessment is advisory and given to the team, Lead Command, AFROC, and AFRRG.

Appendix A: Acronyms

AFCAA	Air Force Cost Analysis Agency
AFGK	Air Force Gatekeeper
AFMC	Air Force Materiel Command
AFRL	Air Force Research Laboratory
AFROC	Air Force Requirements Oversight Council
AFRRG	Air Force Requirements Review Group
AFTL	Air Force Task List
AoA	Analysis of Alternatives
BCL	Business Capability Lifecycle
CBA	Capabilities-Based Assessment
CCT	Capability Collaborative Team
CCTD	Concept Characterization Technical Description
CDD	Capability Development Document
CER	Cost Estimating Relationship
CFL	Core Function Lead (formerly known as the Core Function Lead Integrator (CFLI))
CFSP	Core Function Support Plan (formerly known as Core Function Master Plan (CFMP))
CFT	Core Function Team
CJCS	Chairman of the Joint Chiefs of Staff
COCOM	Combatant Command
CONOPS	Concept of Operations
CONPLAN	Concept Plan
COTS	Commercial Off-The-Shelf
CPD	Capability Production Document
CRA	Chairman's Risk Assessment

CSAF	Chief of Staff of the Air Force
DAU	Defense Acquisition University
DBS	Defense Business System
DCR	DOTmLPF-P Change Recommendation
DoD	Department of Defense
DoDAF	Department of Defense Architecture Framework
DoDD	Department of Defense Directive
DOTMLPF-P	Doctrine, Organization, Training, Materiel, Leadership and Education, Personnel, Facilities, and Policy
DOTmLPF-P	Doctrine, Organization, Training, materiel, Leadership and Education, Personnel, Facilities, and Policy (in this version of the acronym, “m” refers to existing materiel in the inventory)
DPG	Defense Planning Guidance
DPS	Defense Planning Scenario
DRU	Direct Reporting Unit
DSG	Defense Strategic Guidance
FCB	Functional Capability Board
FOA	Field Operating Agency
FoS	Family-of-Systems
GEF	Guidance for the Employment of the Force
GFM	Global Force Management
GOTS	Government Off-The-Shelf
GRC&As	Ground Rules, Constraints, and Assumptions
HAF	Headquarters Air Force
HPT	High Performance Team
HSI	Human Systems Integration
ICD	Initial Capabilities Document

ICE	Independent Cost Estimate
IMD	Intelligence Mission Data
IOC	Initial Operational Capability
IPL	Integrated Priority List
IRSS	Information and Resource Support System
IS-ICD	Information System Initial Capabilities Document
IS-CDD	Information System Capability Development Document
ISC	Integrated Security Construct
ISR	Intelligence, Surveillance, and Reconnaissance
JCA	Joint Capability Area
JCIDS	Joint Capabilities Integration and Development System
JCTD	Joint Concept Technology Demonstration
JEON	Joint Emergent Operational Need
JMETL	Joint Mission-Essential Task List
JROC	Joint Requirements Oversight Council
JSCP	Joint Strategic Capabilities Plan
JUON	Joint Urgent Operational Need
KM/DS	Knowledge Management/Decision Support
LCC	Life Cycle Cost
MAJCOM	Major Command
MDD	Materiel Development Decision
METL	Mission-Essential Task List
MSA	Materiel Solution Analysis
MUA	Military Utility Assessment
O&S	Operations and Support

OAS	Office of Aerospace Studies
OPLAN	Operation Plan
OSD	Office of the Secretary of Defense
PEO	Program Executive Office
POE	Program Office Estimate
POM	Program Objective Memorandum
R&D	Research and Development
RAF	Risk Assessment Framework
RFC	Request for Capabilities
RFF	Request for Forces
RFI	Request For Information
ROM	Rough Order of Magnitude
RSR	Requirements Strategy Review
S&T	Science and Technology
SAM	Surface-To-Air-Missile
SecAF	Secretary of the Air Force
SoS	System-of-Systems
SSA	Support for Strategic Analysis
UON	Urgent Operational Need
UJTL	Universal Joint Task List
VCSAF	Vice Chief of Staff of the Air Force
WBS	Work Breakdown Structure

Appendix B: References and Information Sources

Documents

AF/A9 Risk Assessment Framework, April 2013 (available at website listed below)

AFOTECMAN 99-101, *Operational Test Processes and Procedures*, 6 August 2010

Air Force Requirements Oversight Council Charter

AFPD 10-6, *Capabilities-Based Planning & Requirements Development*, 31 May 2006

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Office of Aerospace Studies, *Analysis of Alternatives Handbook: A Practical Guide to the Analysis of Alternatives,* 10 June 2013

Office of Aerospace Studies, *Pre-Materiel Development Decision Handbook*, forthcoming

OSD *Operating and Support Cost-Estimating Guide*, May 1992

Risk Management Guide for DoD Acquisition, Sixth Edition (Version 1.0), Department of Defense, August, 2006 and SAF/AQ Guidance Memorandum: Life Cycle Risk Management, 4 November 2008

Web Links

AF/A5R-P Requirements: https://www.my.af.mil/gcss-af/afp40/USAF/ep/globalTab.do?command=org&channelPageId=-569424&pageId=681742

AF/A9 Risk Assessment Framework: https://www.my.af.mil/gcss-af/USAF/ep/globalTab.do?channelPageId=s6925EC13500D0FB5E044080020E329A9

ACQ Notes – The JCIDS Process: http://www.acqnotes.com/Acquisitions/Capabilities%20Based%20Assessment%20(CBA).html

Air Force Cost Analysis Agency: http://www.saffm.hq.af.mil/organizations/index.asp

Air Force e-Publishing Online: http://www.e-publishing.af.mil/

Air Force Portal: https://www.my.af.mil/

Defense Technical Information Center: www.dtic.mil

Defense Acquisition University: http://www.dau.mil/default.aspx

Appendix C: Glossary

Attribute – A quality or feature of something. Attributes of tasks (e.g., survivability, persistence, availability, accuracy, etc.) form the basis for identifying and drafting measures. (AFOTECMAN 99-101)

Baseline – The capability that currently exists or is programmed for in the future. The Baseline can be Materiel, non-materiel, or a combination of both. (AFI 10-601)

Capability – The ability to execute a specified course of action. (JCIDS Manual 19 Jan 2012)

Capability Gap (or Gap) – The inability to execute a specified course of action. The gap may be the result of no existing capability, lack of proficiency or sufficiency in an existing capability solution, or the need to replace an existing capability solution to prevent a future gap. (JCIDS Manual 19 Jan 2012)

Capability Requirement (or Requirement) – A capability which is required to meet an organization's roles, functions, and missions in current or future operations. To the greatest extent possible, capability requirements are described in relation to tasks, standards, and conditions in accordance with the Universal Joint Task List or equivalent DOD Component Task List. If a capability requirement is not satisfied by a capability solution, then there is also an associated capability gap which carries a certain amount of risk until eliminated. A requirement is considered to be 'draft' or 'proposed' until validated by the appropriate authority. (JCIDS Manual 19 Jan 2012)

Conditions (Operational) – Describes the environment under which the mission will be performed. (AFOTECMAN 99-101)

Core Function Lead (CFL) – Formerly known as the Core Function Lead Integrator (CFLI). The CFL provides strategic guidance for the stewardship and maturation of their Core Functions by establishing a strategy of long-term development through the annual submission of investment-related Core Function Support Plans. There are 13 core functions. (Air Combat Command Strategic Plan 2012)

Core Function Support Plan (CFSP) – Formerly known as the Core Function Master Plan (CFMP). The CFSP is a written plan that aligns strategy, operating concepts, and capabilities to help guide Air Force investment decisions. (Air Combat Command Strategic Plan 2012)

DOTmLPF Change Recommendation (DCR) – DoD process to mitigate capability gaps using non-materiel approaches. The document contains recommended changes to existing elements when changes ARE NOT associated with a new defense acquisition program. (AFI 10-601)

Measure – A measure is a device designed to convey information about an entity being addressed. It is the dimensions, capacity, or amount of an attribute an entity possesses. (AFOTECMAN 99-101)

Metric – a unit of measure that coincides with a specific method, procedure, or analysis (e.g., function or algorithm). Examples include: mean, median, mode, percentage, and percentile. (AFOTECMAN 99-101)

Objective Value: The objective value is the desired operational goal associated with a performance attribute beyond which any gain in utility does not warrant additional expenditure. The objective value is developed only when absolutely necessary and is an operationally significant increment above the

threshold. An objective value will be the same as the threshold when an operationally significant increment above the threshold is not significant or useful. The default value for objectives in Air Force requirements documents will be the threshold value (i.e., T = O). In those situations where an objective value is required, the objective value must be analytically justified in terms of operational risk and impacts to program cost and schedule. (AFI 10-601)

Standards (Criteria) – Define levels of performance associated with operational capability requirements. It is often expressed as a minimum acceptable level of performance (threshold) and desired acceptable level of performance (objective). (AFOTECMAN 99-101)

Stakeholder – Any agency, Service, or organization with a vested interest (a stake) in the outcome of the pre-acquisition analysis. (OAS AoA Handbook)

Task (Operational or Mission Task) – An individual military operation that is accomplished in support of an operational objective. (AFOTECMAN 99-101)

Threshold. A minimum acceptable operational value below which the utility of the system becomes questionable. (AFI 10-601)

Appendix D: Study Plan Template

This appendix contains the study plan template for the CBA.

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

<Name of Project>

Capabilities-Based Assessment (CBA)

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 -- CBA information may be PROPRIETARY, SOURCE SELECTION SENSITIVE, OR CLASSIFIED, therefore mark as appropriate

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

----------Body of Study Plan----------

1. Introduction and Background

   - Provide relevant information associated with the area of interest that will be assessed in the study (e.g., key activities, concepts, events, decisions, processes, systems, issues, and organizations).
   - Describe how the study was initiated, who initiated the study, and why the study is being conducted now.
   - Discuss significant findings and results from related studies germane to the CBA.
   - If study guidance was published by the sponsor, special group, or other organization, discuss the main points and significance to the study.

2. Overarching Problem Statement

   - Define the top-level or overarching problem and explain why it is important. If sub-problem statements were defined, they should be included as well.
   - Describe how the study team identified the overarching problem and sub-problems, if applicable, and what sources of information were used.

3. Study Purpose

   - Describe what the study team will accomplish in the study.
   - Describe what decisions may be informed by the final report (generally, these are the development of one or more Initial Capability Documents (ICDs), Air Force Form 1067 Modification Proposals, or DOTmLPF-P Change Requests (DCRs)).

4. Study Scope and Schedule

   - Describe the focus of the study and what is and is not in the study. Identify factors that are driving the scope of the study (e.g., information needs of the decision-makers, previous analyses, resource or time constraints, etc.).
   - 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).
   - 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).
   - Indicate when the study plan is expected to be approved and the organization/office of the decision maker who will be the approval authority.
   - Indicate when the study will begin and end and when the final report is expected to be approved.

5. Study Team Members and Stakeholders

    - Identify the organization/office of the official sponsor and decision maker of the CBA as well as the organization/office of the study director, team members, and stakeholders.
    - Identify the chairperson and group member organizations of any special groups. Describe the roles and responsibilities of the chairperson and group members.

6. Ground Rules, Constraints, and Assumptions (GRC&As)

    - Identify the initial set of GRC&As for the study (including the source and rationale).
    - Describe how the study team will identify, check for consistency, and document new GRC&As during the course of the study.
    - Describe how the stakeholders and the decision maker will review and approve new GRC&As and changes to existing GRC&As.

7. Operational Context

    - Describe the operational context that will be used in the study to include the operational scenarios, conditions, locations, environments, and threats.
    - Identify the sources of information that were used to define the operational context (e.g., Defense Planning Scenarios (DPSs), Integrated Security Constructs (ISCs), OPLANs, Contingency Plans, and Concepts of Operations (CONOPS)).

8. Baseline Capability

    - Describe the baseline capability (existing and planned systems).
    - Describe how the baseline capability is employed in the operational environment.

9. Analysis Methodology

    - Describe how the study team will conduct the analysis, specifically the gap analysis, gap characterization, risk assessment, gap prioritization, solution analysis, cost analysis, and solution viability assessment.

----------Appendices----------

A. Acronyms

B. References

C. Other appendices as necessary

Appendix E: Final Report Template

This appendix contains the final report template for the CBA.

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

<Name of Project>

Capabilities-Based Assessment (CBA)

Final Report

<Lead MAJCOM>

<Date>

Distribution Statement

Refer to these sources for more information:

1. Department of Defense Directive (DODD) 5230.24, “Distribution Statements on Technical Documents”

2. Air Force Pamphlet (AFP) 80-30, “Marking Documents with Export-Control and Distribution-Limitation Statements” (to be reissued as Air Force Instruction (AFI) 61-204)

Ask the Scientific & Technical Information (STINFO) Officer for help in choosing which of the available statements best fits the AoA

REMEMBER -- CBA information may be PROPRIETARY, SOURCE SELECTION SENSITIVE, OR CLASSIFIED, therefore mark as appropriate

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

----------Body of Final Report----------

Executive Summary

- Briefly describe the overarching problem addressed in the study and relevant background information.
- Describe the purpose and scope of the study.
- Identify the key stakeholder organizations involved in the study.
- Summarize the results of the study.
- Discuss the recommendations.

1. Introduction

- Briefly describe the overarching problem addressed in the study and relevant background information.
- Describe the purpose and scope of the study.
- If study guidance was published by the sponsor, special group, or other organization, discuss the main points and significance to the study.
- Identify the organization/office of the official sponsor and decision maker of the CBA as well as the organization/office of the study director, team members, stakeholders, and special groups (if any).
- Briefly describe the baseline capability (existing and planned systems) and how it is employed in the operational environment.
- Identify the GRC&As for the study (including the source and rationale).
- Briefly describe the operational context that was used in the study to include the operational scenarios, conditions, locations, environments, and threats.

2. Gap Analysis Results

- Describe the results of the gap analysis; include the results of the gap characterization, risk assessment, and gap prioritization.

3. Solution Analysis Results

- Describe the results of the solution analysis.

4. Cost Analysis

- Describe the results of the cost analysis. This includes presentation of the rough order of magnitude (ROM) life cycle cost estimate (LCCE).

5. Solution Viability Assessment

- Describe the results of the solution viability assessment.

6. Conclusion and Recommendations

    - Discuss the conclusion and recommendations.

----------Appendices----------

A. Acronyms

B. References

C. Other appendices as necessary

Appendix F: Expert Elicitation

Introduction

Expert elicitation is a structured method of gathering expert judgment and answering questions concerning issues or problems of interest in a study. The Delphi method, developed by the RAND Corporation in the 1950s, was one of the first recognized expert elicitation methods. Over the years, many other elicitation methods have been developed and used by various organizations in both the private and public sectors. There are numerous examples of its use by federal agencies to include the United States Army Corps of Engineers, Nuclear Regulatory Commission, National Aeronautics and Space Administration, Department of Transportation, Department of Energy, Department of Agriculture, and the Environmental Protection Agency.

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. The process is designed to facilitate thinking and encourage experts to state their true opinions. Through the elicitation process, experts derive judgments from the available body of evidence ranging from direct empirical data to theory. 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 of communication mode, and degree of structure in the elicitation process.

Expert elicitation is different from sampling methods since respondents are not considered to be representative of a population (Chan et al, 2010). Instead, respondents are viewed as representing a large body of knowledge. Expert elicitation seeks to reflect the range of credible opinion regarding a specific question or problem, so the foremost concern is the quality and diversity of the participating experts.

After a brief overview of expert elicitation and judgment, this appendix presents an approach to conducting expert elicitation in the CBA. It provides insights regarding the selection of experts, development of questions, and design and conduct of the elicitation process.

What is an Expert?

Meyer and Booker (2001:3) define an expert as "a person who has background in the subject area and is recognized by his or her peers or those conducting the study as qualified to answer questions." It is natural to think of experts as professionals such as scientists, physicians, and engineers, but any person with sufficient knowledge of the subject matter can be considered an expert for the purpose of the study. Although an individual's knowledge is important, other factors such as personality, experience, and expertise in organizing and using his or her knowledge are critical to the success of the elicitation (O'Hagan et al, 2006:27). Achieving a balanced and broad spectrum of viewpoints may require eliciting judgments from individuals with various backgrounds and degrees of expertise.

Expert Judgment

There is a myriad of terms used to describe expert judgment such as expert opinion, subject matter expert assessment, subject matter expert analysis, subjective judgment, and expert knowledge. Whatever it is called, expert judgment is the data given by an expert in response to a question and represents an expression of opinion based on knowledge and experience. Judgment is shaped by the expert's state of knowledge at the time of the response to the question, and because experts have different experiences and knowledge, their judgments can differ and change over time as new information is learned.

Expert judgment is commonly expressed in quantitative terms, although it is possible to obtain expert judgment in a variety of other non-numeric or qualitative forms. Some examples of information elicited from experts are shown in Table F-1.

Table F-1. Examples of Information Elicited from Experts

Quantitative	Qualitative
Probability of an occurrence of an event	Impact of a change
Probability of failure of a system	Risks and consequence of a decision
Estimates of ranges of uncertainty	Variables, assumptions, and data used in an analysis
Likelihood of a causal relationship	Elements needed for decision making
Allocation of funding	Failure causes, potential failures, and potential solutions
Rating of the performance of a model	Methods to optimize performance

An Expert Elicitation Approach for the CBA

It is necessary to follow a formal and structured process to ensure the information elicited from experts is suitable for analysis. The following describes a seven-step approach to conducting expert elicitation in the CBA. It provides guidelines for the selection and preparation of experts, development of questions, design and conduct of the elicitation process, and analysis and reporting of data.

Step 1. Identify the Need for Expert Elicitation

In conducting the CBA, the study team must typically deal with many unknowns associated with new and complex concepts. Choosing the appropriate research methods to collect and analyze data is a foremost concern. Study objectives, data accessibility, time and resource constraints, and available tools and techniques are some important factors that the study team must consider when determining which research methods to use.

Expert elicitation can be a very useful technique for gathering data in the CBA study given the breadth of information that may be collected. Expert elicitation is appropriate in situations where traditional research methods are not feasible or data is insufficient, unattainable, or too costly or impractical to collect. Some examples of the information that can be elicited from experts in the CBA include the following:

- Establishing study ground rules, constraints, and assumptions,
- Identifying and rating risks and consequences,
- Identifying criteria (threshold and objective values) of performance measures,
- Providing estimates of performance measures.

Step 2. Develop the Questions

Expert elicitation relies on surveys to collect data of some aspect for analysis. Expert judgment is primarily elicited through face-to-face interviews. The choice of whether to use personal interviews (i.e., interview one expert at a time) or group interviews (i.e., interview experts in a group) will depend on various factors such as time constraints and the availability of experts. Whatever method is chosen, using good questions is an essential part of the survey process.

Good questions are unmistakably clear, precise, and unambiguous and ensure the recorded responses align with what the analyst is trying to measure. Questions are specifically worded to avoid creating different interpretations of what is being asked. Differences in answers should be due to differences among respondents rather than from different interpretation of the question's wording. If respondents do not have the same understanding of what the question asks for, error is likely to result. Good 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).

Crafting good questions requires careful forethought and a sound approach. Subject matter experts who are not among the experts in the panel can assist in developing the questions as well as any assumptions, definitions, or other supporting information associated with the questions. Expert insights gleaned during the question development process will help ensure the questions are eliciting the information of interest in the study. The CBA typically requires many different types of experts (e.g., aircraft operators, logisticians, intelligence experts), so it is critical to have the right ones participating at the right time.

The process begins by drafting a set of initial questions then using a small group of experts to design the final questions. Feedback from experts will be helpful in determining how specific questions should be worded, order and number of questions, and question format. Pre-testing the questions with several other experts can help refine the questions and identify problems such as unclear wording or misreading that must be addressed prior to using the questions in the elicitation.

There are several aspects of questions that should be considered during the question development process. For instance, whether a question is open or closed can significantly affect the type of data that is collected. Closed questions provide a list of acceptable responses to the respondent, whereas open questions do not provide the acceptable responses. For closed questions, respondents can perform more reliably in answering the question since the responses are given and analysts can more reliably interpret the meaning of the answers (Fowler, 1993: 82). Open questions are appropriate in situations where the list of possible responses is long, making it impractical to present to the respondents. Responses to open questions describe more closely the real views of the respondents and can elicit unanticipated responses.

Whether personal or group interviews are used, there are several guidelines to consider when administering the questions:

- Instructions should be clear and brief and question forms should be few in number to reduce respondent confusion,
- The number of questions and question wording should be kept to a minimum,
- Questions should follow a logical order (e.g., time sequence, process related),
- Questions should be asked in a neutral format without leading statements or clues to desired responses.

Step 3. Select the Experts

Selection criteria define the set of individuals that have a chance of being selected to participate as expert panel members in the study. It is important to establish selection criteria through careful deliberation since the selection of experts is a critical step in the process. Since the expert panel selection is not random, there is a risk of researcher bias when the researcher makes selections based on inappropriate criteria. Selection error present in an expert panel depends on the degree of expertise of the person making the selection decision. It is advantageous to consider a range of possible criteria by drawing from the expertise of the study director, study team members, study advisory group, and other appropriate groups and organizations.

A "good" expert has technical knowledge, experience, and intuition as well as an ability to integrate information and draw conclusions. Criteria such as level of training, type of skill, and years of experience can be used to ensure the panel consists of experts with the proper knowledge and expertise. Ultimately, selection criteria will depend on the objectives of the study. Table F-2 provides some examples of criteria that can be used to identify experts for participation in a study.

Table F-2. Examples of Selection Criteria

Criteria	Description
Knowledge of Area of Interest	Understanding of the area of interest, reputation as a technical authority, awards received, membership in organizations or groups in the area of interest.
Background and Experience	Years of experience, level and diversity of experience, type and number of past positions held.
Education and Training	Specialized training, type of advanced academic degree(s), special certification(s) and qualifications.
Published Work	Number and quality of publications in the area of interest.
Personal Skills	Interpersonal skills, communication skills, flexibility, impartiality, ability to generalize and simplify.
Economic or Personal Stake	Lack of economic or personal stake in the potential findings.
Availability and Willingness	Availability and willingness to commit needed time and effort to participate in the study, willingness to prepare for discussions and provide opinions.

Like other studies, the number of experts used in the CBA will be mostly driven by resources and time available to conduct the study as well as the number and availability of individuals who have the

expertise in the area being studied. Although there are no absolute rules regarding the number of experts, large panels increase the likelihood that all possible expert views are represented. While all are knowledgeable of the area of interest, experts have different experiences and perspectives that will shape their responses. Large panels can often produce insights that may not be possible with small panels.

Despite the lack of definitive approaches to determining the appropriate number of experts, a panel of practitioners in expert elicitation recommends at least six experts should be included and that the benefit of including additional experts beyond 12 begins to diminish (Cooke and Probst, 2006:16). Using panels with less than six members will likely reduce the chances of collecting a diversity of information.

Step 4. Prepare the Experts

Once the experts have been identified and selected, the next step entails preparing them for the elicitation by providing relevant information about the study. Experts must have a thorough understanding of the issues before being able to answer questions. Issue familiarization is the process used to help the experts understand the issues of interest in the study, purpose of their participation, expectations, study objectives, elicitation process, list of questions, terminology, and key assumptions and definitions. Depending on the objectives of the elicitation, information about the technical aspects of the baseline capabilities, potential solutions, study methodology, and performance measures may be required as well.

Whether done in a group or individually, it is important to present the same information to ensure a common understanding of the issues. Presentations, briefing books, and other documents should be assembled to provide the relevant information.

Step 5. Conduct the Elicitation

The approaches used to elicit judgments vary widely and will rely to a large degree on the objectives of the study. The amount of time required for the elicitation may range from a few hours to as much as a week depending on the size and complexity of the study. The analyst should consider a number of factors in designing the elicitation:

- Time and resources available for the study,
- Type of information to be elicited,
- Number of experts,
- Amount of time experts will need to provide judgments,
- Degree of interaction among the experts,
- Number and type of questions,
- Format for the answers,
- Mode(s) of communication,
- Type of interview.

Expert judgment is elicited through personal or group interviews. Personal interviews are usually done in private and in person and allow the interviewer to gather in-depth data from the experts without distraction or influence by other experts. Group interviews are conducted in person through a structured approach that defines when and how experts express and discuss their opinions.

Although personal interviews can be used, convening an in-person group meeting to conduct the elicitation has several advantages in the CBA. Most importantly, it provides an opportunity to introduce the issue, review the relevant information, and describe the elicitation purpose and process. It can serve as a forum to answer questions, share information, discuss expectations, describe how the results will be used, and gain feedback on any issues that require further clarification or additional information. The major drawback to group elicitation is the undesirable effects of dominant or vocal participants, something that is avoided by eliciting experts individually through personal interviews (Cooke and Probst, 2006:16).

In group elicitations, there are greater demands of time and effort on the interviewer to structure and facilitate the discussions and interactions amongst the experts. The interviewer is responsible for ensuring the integrity of the elicitation process and its implementation by initiating and maintaining effective discussions. Ayyub (2001:18) recommends using a facilitator or moderator to help create an environment that ensures equity in presenting views and a successful elicitation of opinions and information from each expert.

In the CBA, gaining insights into the underlying reasoning or rationale of an expert's response may be as important as the response itself. There are several techniques described by Meyer and Booker (2001) that can be used to interview experts and learn the rationale for a response:

- The verbal report involves instructing the expert to think aloud when answering a question and resembles someone talking to oneself. The technique can be time consuming since it is used on one expert at a time. It is important to note that not all experts are capable of verbalizing all their thoughts for various reasons (e.g., too difficult to articulate, thoughts are automatic or unconscious).
- The verbal probe entails phrasing questions in a way to minimize influencing the expert's thinking. The technique is a quick means of obtaining information and is suitable for both personal and group interviews.
- The ethnographic technique involves transposing the expert's words into questions. Because the questions are based on the expert's own words, it is a non-biasing form of questioning. The technique can be time consuming and is not suitable for group interviews.

In structuring the elicitation, it is important to understand and anticipate bias that may occur. Bias is a skewing that arises from our personal perceptions and understanding. There are various forms of bias and methods for dealing with them. Table F-3 provides a brief description of seven common forms of bias and when they are likely to occur.

Table F-3. Common Forms of Bias (derived from Meyer and Booker, 2001:133)

Bias	Description
Social Pressure – Data Gatherer	Individuals consciously or unconsciously alter the descriptions of their thoughts to gain acceptance and to be seen in the most positive light possible. Data gatherers can intentionally or unintentionally influence the individual through body language, facial expression, intonation, and word choice. More pronounced in cases when the interviewer uses leading questions.
Social Pressure – Group Think	Social pressure from others in a group induces individuals to alter their responses or silently acquiesce to what they believe will be acceptable to the group. More pronounced when individuals in a group desire to remain as members, are satisfied with the group, and view the group as cohesive.
Wishful Thinking	Individuals' hopes influence their judgment—what individuals think should happen will influence what they think will happen. More pronounced when individuals do not have to explain their reasoning and when individuals are personally involved or would gain from their answers.
Inconsistency	Individuals are inconsistent in solving of problems—as experts' thinking evolves over time, their current thoughts or answers may contradict those expressed earlier. More pronounced when: 1. Elicitation sessions are long and individuals forget instructions, definitions, and assumptions, 2. Complicated response forms such as probability distributions and percentiles are causing confusion, 3. Experts are asked to consider too many things and become confused and inconsistent.
Underestimation of Uncertainty	Individuals underestimate the uncertainty in the answers they provide. More pronounced when response forms are probabilities and other quantitative estimates.
Anchoring	Individuals receive additional information but do not adjust from their first impression in answering the question. More pronounced when experts have described their positions orally or in writing and fear losing face if they change their response.
Availability	Individuals do not mention more than one or two considerations in giving their responses which can mean the experts are drawing from data that is easier to recall. More pronounced when the expert does not receive any information from others that could help trigger less accessible data when formulating a response.

Several steps can be taken in designing the elicitation process to help mitigate anticipated bias. For example, to reduce social pressure from the data gatherer, the interviewer can use the verbal report, verbal probe, and/or ethnographic phrasing of questions instead of direct questions that may lead the experts. If complicated response forms such as probability and uncertainty estimates are being elicited, prepare the experts for the elicitation by conducting a training session that describes the fundamental principles of the response form. The training will help eliminate the potential of confusion and underestimation and give the experts an opportunity to rehearse providing responses to sample questions in the appropriate form. Finally, as part of the preparation for the elicitation, it is important to make the experts aware of the forms of bias and why they happen. Although bias cannot be completely eliminated, experts will not be able to control their own tendencies toward bias without first having a good understanding of it.

While much can be done to design the elicitation to help mitigate bias, the interviewer must still be alert to the occurrences of bias during the elicitation process and make the appropriate adjustments to counter it. For example, if there are inconsistencies in responses, the interviewer should ask the experts to reconsider their responses. If fatigue is a factor, the interviewer can shorten the elicitation sessions or schedule breaks to help preclude potential inconsistencies in responses. In group situations, the interviewer should suspect group think is occurring when no one in the group voices a difference of opinion or the experts defer to one or more other experts.

There are many different approaches to interview experts that would be appropriate in the CBA. In group situations, one approach commonly used involves interviewing each expert separately, reviewing the answers in a group, and then providing an opportunity for the experts to revise their responses. Depending on the objectives of the study, the analyst may be only interested in collecting responses to questions, whereas in other cases, the rationale for the response may be required as well. The following provides several examples of elicitation methods for group interview situations:

- Each expert is asked to provide a response to a question as well as rationale for his or her response that includes identification of issues that significantly influenced the response. After providing responses, the panel of experts is given an opportunity to review the results. During the review, each expert discusses the rationale for his or her response while the other panel members are encouraged to ask questions and contribute information. Following the review, the experts are given an opportunity to revise their responses and provide rationale in light of what was learned during the discussion. With the submission of the revised responses, the question is closed and the elicitation process resumes with the next question.
- Each expert is asked to provide an initial response to a question. To avoid social pressure, the individual responses are then displayed anonymously to the panel of experts through an on-screen graphical presentation. The experts are given an opportunity to discuss the results of the presentation. Following the discussion, the experts provide a final response. With the submission of the final response, the question is closed and the elicitation resumes with the next question.
- Questions with associated background information are provided to the panel of experts. To encourage knowledge sharing, the experts are given an opportunity to discuss the questions and information as a group. The interviewer monitors the discussion and responds to any questions from the panel members. If necessary, the interviewer provides additional information to help the panel in understanding the issues. The information may be requested by the panel or the interviewer, through observation, deems the information is needed to facilitate the discussion. When the panel discussion is complete, each expert is asked to provide a response to each of the questions. With the submission of the response, the questions are closed and the elicitation resumes with the next set of questions.

In personal interview situations, experts are interviewed separately in face-to-face meetings or by telephone. If the response requires clarification or there is a desire to collect the rationale for the response, the analyst can use the verbal report, verbal probe, or ethnocentric technique described earlier to gather the information. For example, an analyst can instruct the experts to explain in detail

their thinking process as they respond to the questions (verbal report). The verbal probe and ethnographic technique can be used to clarify responses and/or gain more insights into the rationale for the responses.

The questions used in the elicitation will depend on the objectives of the CBA. Questions can be designed to elicit opinions in a variety of forms such as quantities, uncertainties, relationships, parameters, or events. The following provides several examples of information that can be elicited:

- In determining the probability of a system failure, experts are asked to provide a best estimate as well as a degree of uncertainty. The best estimate is expressed as a percentage, although the decimal or ratio can be used as well. This estimate is viewed as the median value where there is a 50% chance that the "true" value will be higher, and a 50% chance the "true" value will be lower. Next, the experts are asked to estimate an upper bound where there is a strong likelihood (95% chance) that the "true" value will be lower than the estimate, and only 5% chance that the "true" value will be higher. In the analysis, these estimates are used as the 50^{th} and 95^{th} percentile values.
- After reviewing technical information of a system, the experts are asked to rate how easily the system can be configured for transport. Each expert is asked to answer a series of questions with five-point Likert scales ranging from "strongly disagree" to "strongly agree" and provide written rationale for his or her response. In the analysis, the median value is determined for each question and the rationale used by the experts is highlighted in the discussion of the results.
- Experts are given an opportunity to review five models used for predicting performance of a system. Each expert is asked to rate the plausibility of each model using a seven-point scale ranging from "1-Least Plausible" to "7-Most Plausible" and provide written rationale for his or her response. In the analysis, the responses from the experts are shown graphically along with the median rating for each model. The results provide a discussion of the median ratings and rationale used by the experts in rating the models.

Step 6. Aggregate the Data

In the CBA, there is typically a requirement to report a single value by combining responses. Whether judgments are elicited from experts separately or in a group, one can mathematically aggregate the responses using simple algorithms such as the mean, median, and geometric. More complex weighted means can be used to give more weight to experts who are viewed as having more expertise; however, the prevailing recommendation among practitioners in expert elicitation is to use equal weights since it is a simple and robust method for aggregating expert judgments (O'Hagan:2006,222; Meyer and Booker 2001; 329). Measurement scales such as the Likert scale produce ordinal data, so it is important to use appropriate statistics such as the mode or median.

If the judgments are elicited from experts in a group, another option is to use a behavioral aggregation that requires a convergence or consensus of opinion among the experts through discussion and interaction. A major risk of this approach is the undue influence of dominant participants.

Step 7. Report the Results

Since there is both potential value and danger of using expert judgment, some guidelines are necessary when reporting results derived from expert judgment. Traditional scientific research does not explicitly accommodate the use of opinions as scientific data. Expert opinions are subjective beliefs that may be useful data, but not scientific in the sense that it has been subjected to empirical inquiry and test. It is important to ensure the distinction between empirical data and expert judgment data is maintained by clearly identifying which analyses are based on empirical data and which are based on expert judgment data. Cooke (1991) recommends that sufficient information should be provided about the data and calculations so that the results can be reproduced by others.

Another important consideration is the generalizability of results. Unlike probability sampling, expert elicitation is unlikely to produce results that are representative of a population since all individuals in the population do not have equal chances of being selected. This means the study team should not make statistical inferences about a population from the expert judgment data. Expert elicitation does not entail randomly selecting individuals with the intent of making inferences about a population, but rather, individuals are selected based on their knowledge and experience with the intent of drawing conclusions about the existing knowledge base.

Finally, the study team should provide the names and background information of the experts used in the study in the final report. This will help readers ascertain the credibility of the experts.

Summary

Expert elicitation can be a useful technique for gathering various types of data for analysis in the CBA. Expert elicitation is a formal and structured process that entails the selection of experts, conduct of the elicitation, and analysis of data. The approach described in this appendix will help ensure the information elicited from experts is properly collected and suitable for analysis. It provides guidelines for the selection and preparation of experts, development of questions, design and conduct of the elicitation process, and analysis and reporting of data.

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