MITRE and AEROSPACE

Key Questions for Acquisition Success

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Acknowledgments

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Comments or Corrections

If you have any comments or corrections that you'd like to bring to our attention, please send an email to acquisition-success-list@lists.mitre.org.

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1 Purpose

This document contains a checklist of *Key Questions for Acquisition Success*, herein referred to as the "Checklist." The Checklist is intended to aid those responsible for formulating and/or executing a Federal Acquisition Program in improving the program's chance of success. It provides program managers, systems engineers, and contract specialists with important reminders and associated guidance that are applicable across a range of acquisition programs—large, major acquisitions and those leveraging agile acquisition methods. The document also includes affordability, efficiency, and effectiveness best practices.

2 Background

Over the past two decades, systems acquisition programs have experienced significant schedule delays and cost growth. Some underlying contributors to these poor acquisition results are listed below. [19, 20, 21]

1. Eroding skill base and relevant experience in government and industry
2. Cost, schedule, and performance planning inadequately informed by systems engineering (SE) rigor
3. Lack of process discipline and integrity
4. Eroding industrial-base capability being applied to government acquisitions
5. Poor understanding of risk aggregation over time
6. Poor communication and shared understanding of requirements and test and performance metrics across the government and industry

The MITRE Corporation (MITRE) and The Aerospace Corporation (Aerospace) teamed together to develop this Checklist, drawing upon lessons learned, best practices, and a broad and deep technical expertise supporting a wide range of acquisition programs spanning many federal agencies and organizations across government and industry. For over 50 years, these organizations have supported Department of Defense (DoD) and civilian agency Acquisition Programs as Systems Engineering and Integration (SE&I) Federally Funded Research and Development Centers (FFRDC), providing objective analysis and risk assessment of sensitive, proprietary, and programmatic information.

In creating this Checklist, the MITRE/Aerospace Team researched a comprehensive collection of reference documents comprised of Systems Engineering (SE) and Mission Assurance best practices. The challenge was to create a *concise* and *understandable* checklist, focusing its questions on key factors that, if not properly addressed, could cause a program to fail (i.e., over budget and/or over schedule and/or with incomplete requirements implemented). The team intends to offer this Checklist and its supporting documentation to Acquisition Program Offices, along with experienced practitioners and mentors, to assist in the disciplined planning and execution of acquisition programs. This approach is aimed at concurrently providing expert knowledge, continuity, and assistance to address current acquisition challenges.

3 Guidelines for Creating Checklist

The MITRE/Aerospace Team used Atul Gawande's book, *The Checklist Manifesto: How to Get Things Right* [26], as guidance when creating this Checklist. Gawande postulates that a well-designed checklist can improve outcomes even in complex, high-intensity fields of work, such as medicine. While the best-known use of checklists is in the field of aviation, Gawande makes a solid case that checklists can reduce the risk of human error and costly mistakes that can be made by competent professionals in stressful and complicated environments. In complex environments, even experts are prone to memory lapses and distractions; even experts can knowingly decide to skip certain steps because they have "never been a problem before…until one day it is."

Just as a pilot uses a checklist to walk through the key steps to the complex step-by-step checks for takeoff, flight, landing, and taxiing, a PM needs a checklist to make sure none of the critical factors for success are overlooked or ignored.

The team used the following guidance from Gawande's book:

1. A checklist should not be lengthy—the key is to focus on the "killer items" that are often missed.
2. Wording should be simple and exact—use language familiar to the profession.
3. Clutter free—no unnecessary information, colors, mismatched fonts, etc.
4. In complex environments, it is critical that the checklist encourages communication.
5. In complex environments, checklists should not try to be a comprehensive how-to guide—they should instead highlight critical and often missed items.
6. Always test the checklist in a real operational setting, which invariably results in changes and a better product.

The team also used insights shared by Watts S. Humphrey (Software Engineering Institute) and others in various articles and forums that addressed the value of checklists. In *Why Can't We Manage Large Projects?* [4], Humphrey notes:

> Program management is a matter of detail, and every step must be done precisely and correctly. Just like airline pilots when they do their final preflight checks, they follow a detailed checklist. While they know every step and have done it thousands of times, studies have shown that most airplane accidents involve at least one case of a skipped step or an improperly followed checklist.

Based on Humphrey's insight, the MITRE/Aerospace Team developed this Checklist. While not a detailed, systematic checklist like many that exist today, it is a checklist of key success factors that should be used like a pilot's checklist. If the Program or Project Management Office (PMO) cannot answer "yes" to each critical question, then the likelihood of program success is significantly lessened.

The Checklist on its own by no means guarantees success. It requires execution by experienced practitioners who truly understand the issues and know how to mitigate the risks related to the Checklist questions.

4 Application

The authors' designed this Checklist to be applicable to a broad range of federal acquisition models and diverse program types, from missions of critical national significance to experimental prototype demonstrations. Hardware-centric, software-centric, information technology (IT), and process-centric endeavors, as well as combinations thereof, are accommodated. The authors also considered ground, air-borne, and space-borne civil and military government missions, as well as varying contract types.

The goal is for Checklist users to identify the section that most closely represents their program's execution phase for guidance on the most critical acquisition success elements. In any given phase, the user is encouraged to review previous sections to verify that important steps or decisions were not missed and, similarly, to look ahead at subsequent sections to anticipate and facilitate future phase planning.

Although this Checklist was developed based on over 100 years of combined MITRE and Aerospace experience supporting government acquisitions, and early reviews have assessed it as value-added, it has not been applied in practice in its current form. Its efficacy, relevance, and feasibility will be evaluated by vetting it with a suite of programs in a prototype, pathfinder context. Feedback and lessons learned from these pathfinder experiences will inform future versions of the Checklist.

The Checklist's questions are intentionally short to ensure they are quickly comprehended, actionable, not bureaucratic, cognizant of a program's and PM's rapid operations tempo, and modular for easy navigation. Finally, this Checklist is not intended to assess the quality of any given acquisition process or product—it cannot be used to judge a "good" or "bad" Systems Engineering Plan.

5 Organization

In building this Checklist, the MITRE/Aerospace Team realized there are many checklists used throughout a program's life cycle, such as the *DoD Milestone A Checklist*. The intent of this Checklist is not to replace the manifold existing program checklists, but rather to supplement them with concise continual aid to the PM as the program progresses from one phase to another. It should be considered a top-level guide, focused on the *most critical* elements for program success. There are 15 activity areas defined in this Checklist (i.e., Program Definition, Stand up PMO, etc.) as listed in Section 7. These activity areas have been mapped into the life cycle context described as follows.

6 Life Cycle Context

The life cycle used for this document is illustrated in Figure 1. Crossing the life cycle are three different horizontal tracks aligned to the three primary disciplines needed to support an acquisition program: (1) program management, (2) SE, and (3) acquisition. Each track contains a set of activity areas across the life cycle for a total of 15 activity areas. The Checklist questions are then aligned with each activity area, keeping the number of questions for each activity area small and focused on critical success factors.

This figure should be used by chief engineers (CE), PMs, or acquisition specialists to gauge approximately where to enter the Checklist. For example, at contract "Kick-off," a CE should first look at the "Develop Feasible Design" and "Engineer the Solution" activities; however, activities preceding and following them, such as "Develop Architecture/Requirements/ Capabilities" should be consulted also.

Each activity area in the Checklist is intentionally short, focusing only on the *most critical* elements. All elements in an activity area should be reviewed at the beginning of that activity to ensure emphasis is placed on addressing Checklist items early, as well as reviewed at its conclusion to ensure these critical elements have, in fact, been addressed.

The reality of developing a system is that life cycle activities are not always started in the same order, nor do they always finish in the same order, and in addition, they don't overlap in completely predictable ways. Furthermore, in some programs, there are iterations and repetitions throughout the life cycle. [27]

In this Checklist, the activities are depicted separately and sequentially for simplicity and illustrative purposes. The complexity of real programs makes all life cycle diagrams only an approximation. With this understanding, the Checklist questions are applicable to approaches, such as spiral development and evolutionary acquisition, and there is a discussion of agile methods in the next section.

Regardless of the tailoring due to particular circumstances, throughout the life cycle and across the disciplines of program managers, systems engineers, and acquirers, the key measures of affordability, efficiency, and effectiveness (AEE) must be continuously considered as all decision are made. See Appendix C for an elaboration of Affordability, Efficiency, and Effectiveness (AEE) best practices.

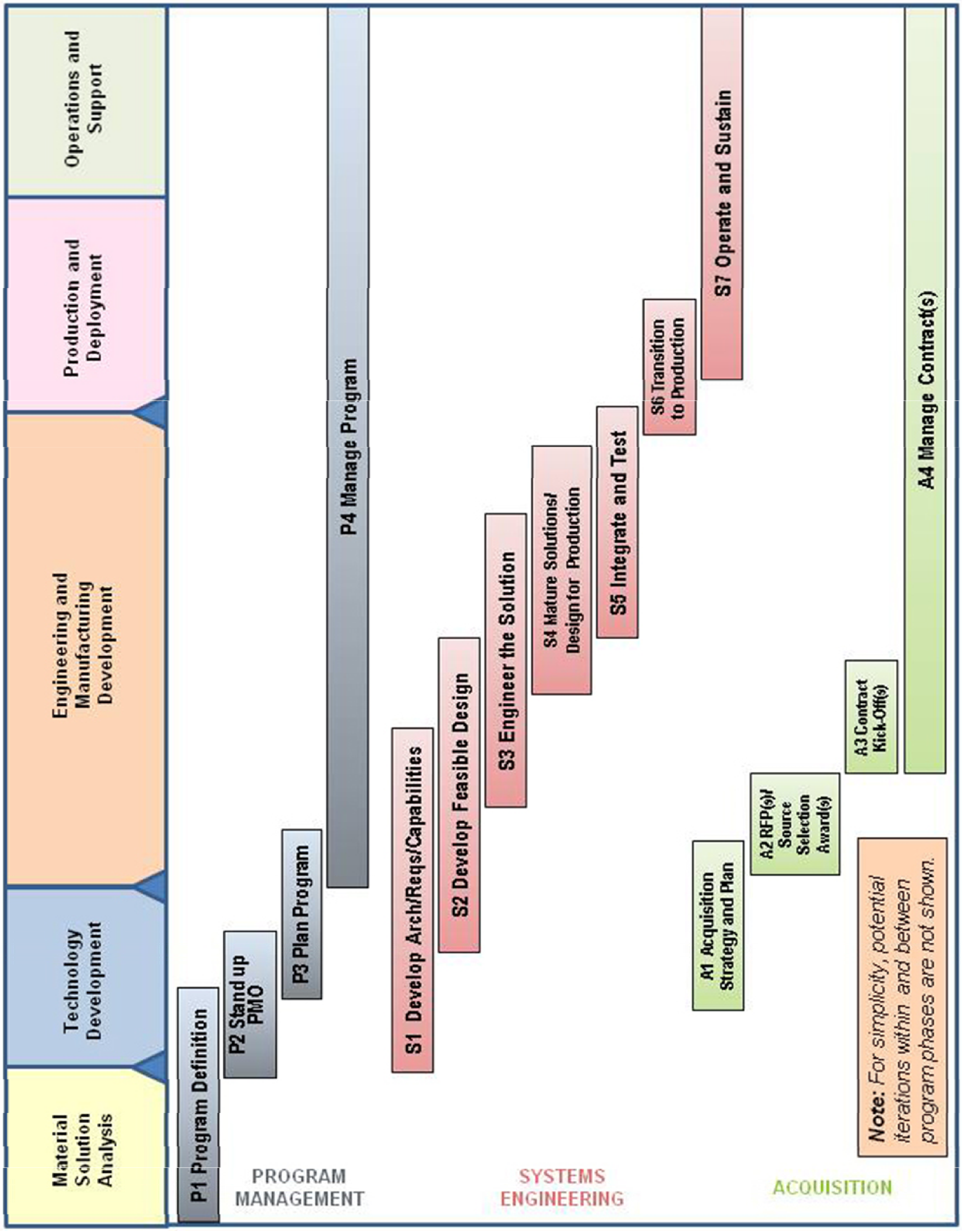

Figure 1. Life Cycle Context

Throughout the Checklist, the reader will see that some questions have  in the number column. Although a PM should ideally be able to answer “yes” to each question in this Checklist, there may be situations beyond the PM’s control where yes cannot be responded; however, the MITRE/Aerospace Team feel strongly that if the PM cannot answer “yes” to questions with a stop sign associated, the PM should not proceed forward with the project until the PM can either (1) properly affirm compliance, (2) return to the stakeholder(s), (3) disclose a need for relief from a requirement or lower expectations, and (4) secure documented concurrence—this can be via performance relief, budget increase, or schedule extension. If unable to respond “yes,” moving forward will place the project at a significant risk of a large budget overrun and/or schedule delay. It will also most likely result in a solution that does not meet user needs. Continuing forward without responding “yes” to these selected questions will likely result in future project rework, larger budget overruns, and schedule delays, more so than if the issue(s) had been dealt with earlier.

7 Agile Acquisition

Agile acquisition is generally appropriate for two types of system development: (1) enterprise systems with a high degree of functional requirements uncertainty, and (2) small, tactical systems (often software-intensive) that may have a short life but address an immediate need. Both focus on satisfying pressing user needs by the rapid development and deployment of capabilities in close collaboration with the users. In the first case, total system requirements cannot be fully defined at the beginning, and an initially deployed partial solution is refined and extended to add more capability over time through a series of incremental deliveries guided by interactions between developers and users. The second case is similar, often with less than complete requirements and rigorously pre-determined specifications, with even more emphasis on the need for a solution as soon as possible, even if not the 100% solution. The subsequent iterations here are more aimed at refinement with fewer substantial capability extensions expected. For both, the keys to success of this strategy are close alignment with stakeholders on expectations, and agreement with a limited set of users for providing continuous, rapid user feedback in response to each capability increment.

Agile methodologies usually require a stable infrastructure, significant management and technical oversight to ensure compatibility of ensuing releases, and often sacrifice documentation and logistics concerns in favor of rapid releases for fielding.

Where they need to be considered in the context of specific questions in this Checklist, agile considerations have been included. See Appendix A for additional guidance on using the Checklist in agile environments. Appendix A further expands on the important issues to consider when applying agile acquisition methods.[1]

[1] Also see the MITRE *Systems Engineering Guide* article on Agile Acquisition Strategy at http://tinyurl.com/3runngp.

8 Activity Area Definitions

The horizontal track activity area definitions listed below describe key work elements conducted in each activity area. See APPENDIX B: Activity Area Descriptions for detailed descriptions of each activity area, as well as a description of who is primarily responsible.

Program Management Horizontal Track (P)

- Program Definition (P1)—Defining the program is the first activity area in the Program Management horizontal track and typically occurs as part of a Program's concept development work. The objective is to ensure a clear and valid need that can be met with a practical and cost-effective solution.
- Stand Up PMO (P2)—Once operational need is sufficiently defined and approved funding has been received, the typical first step is to stand-up a PMO with the appropriate organizational structure and right resources.
- Plan Program (P3)—This activity begins by defining a program with realistic objectives within the PM's span of control to enable rapid, successful outcomes via acquisitions.
- Manage the Program (P4)—In this activity area, the PMO begins to implement and execute all management processes fully.

Systems Engineering Horizontal Track (S)

- Develop Architecture/Requirements/Capabilities (S1)—The first activity in this horizontal track includes refining the high-level requirements into a more detailed set of operational and technical requirements. This activity may also include early prototyping.
- Develop Feasible Design (S2)—In this activity, the operational needs and requirements are translated into a solution.
- Engineer the Solution (S3)—This activity begins with the planning and development of the Systems Engineering Plan, which identifies performance parameters and security and mission assurance implications associated with the proposed solution, and addresses risks associated with the proposed solution.
- Mature Solutions/Design for Production (S4)—Also referred to as implementation activities, maturing the solutions and related designs so the system is production ready. It includes all tasks needed to fully develop and incrementally integrate and test the capability.
- Integrate and Test (S5)—This activity area includes the testing and evaluation of deficiencies or possible deficiencies in the system, including the inability to meet operational and technical requirements.
- Transition to Production (S6)—Activities conducted in this area are actual transition, documentation of results, and documentation of lessons learned.
- Operate and Sustain (S7)—This activity is to execute and maintain the system and new capabilities in the Production environment.

Acquisition Horizontal Track (A)

- Acquisition Strategy and Plan (A1)—The purpose of this activity is to establish how needed capabilities will be acquired and supported throughout the life cycle, from development to operations to retirement.
- Requests for Proposals/Source Selection Awards (A2)—This activity includes the development of the Requests for Proposals (RFP) and supporting Source Selection Plan(s), as well as the actual Source Selection(s) and results in the successful award of contracts necessary to fulfill program goals and objectives.
- Contract "Kick-Off" (A3)—This is typically a short and quick activity to ensure that the contractor(s) gets off on the right foot.
- Manage Contracts (A4)—This activity includes the on-going, long-term tasks required to manage the duration of the contract(s) under the PMO's control.

9 Checklist

Table 1. P1 Program Definition

P1 Program Definition		
#	**Question**	**Guidance**
P1.1	• Does the program meet an **urgent need**?	Program success must be judged according to whether or not it meets a set of well-stated requirements.
P1.2	Has the program been clearly defined: • Do **key program objectives** meet user mission needs? • Do they align with the program's business case? • Are they attainable within given cost, schedule, risk, and resource constraints? • Have **outcome-based** performance measures been defined and are they linked to the user's strategic goals? • Have the scope and system boundaries been clearly defined and the basis of this definition documented?	This question addresses the challenge of scoping the requirements and ensuring that they are necessary for achieving the mission purpose intended for the system. Key Performance Indicators inform development of Key Performance Parameters (KPP) in the Acquisition Program Baseline (APB): Make sure that cost, schedule, resources are available to accomplish program objectives.
P1.3	• Are your program objectives reasonable, given multiple stakeholder and user interests? • Is there stakeholder and user buy-in on the program definition and objectives? • Is the stakeholder and user community prepared to provide the support necessary to make this program a success? • Have cost drivers been associated with key program objectives and are their sensitivities understood?	Although formal cost estimates are premature, high level cost-sensitivity must be considered early in the program definition phase.
P1.4	• Have the complex processes necessary to implement this new system, interfacing and integrating it with other legacy systems and other systems also under development, been identified, and addressed in the budget and schedule?	The rise of "system of systems" requiring the interaction of multiple systems that were not designed together can greatly increase the difficulty of creating a stable requirements base for a new system, as well as increase the complexity of implementing and interfacing a new system. The concept of coherence should also be addressed (i.e., the constituent systems should work together to efficiently achieve corporate or enterprise objectives).
P1.5	• Is the program achievable given the **political environment**? • Have any **policy issues** (e.g., small business set-asides) that might overly constrain the program been addressed? • Is there **buy-in** from appropriate oversight organizations?	The program executives should ensure that they have the appropriate advocacy. They should also be defining the user constituencies that will have a say in the program and developing a plan to engage them. If needed, the program should also work with the United States Government Accountability Office (GAO), the Office of Management and Budget (OMB), and other oversight organizations.

P1 Program Definition		
#	**Question**	**Guidance**
P1.6	• Does the program have a **senior champion** who provides top cover? • Does the program have processes in place to avoid excessive oversight?	Without a senior champion, the project is likely to struggle to get the needed attention from its stakeholder and user communities. It is also likely to be unable to get staff with the needed expertise for its critical PMO roles. A senior champion can also help shield a program from excessive oversight. These are only a few of the obstacles the project is likely to face without the top cover to address them. [13]
P1.7	• Does the program have a high-level acquisition approach for delivering necessary capabilities?	
P1.8	• Have the key risks been defined and the level of risk tolerance determined? • Have the risks been costed?	
P1.9	• Has the necessary paperwork for standing up a program (e.g., a user needs statement) received the necessary approvals? • If not, has this been factored into the risk assessment?	
P1.10	• Does the program funding include management reserve and is it adequate?	
P1.11 	• Has an initial, high-level, **independent cost estimate** (ICE) that aligns with allocated program funding been completed? • Does it align with the program's Technical Baseline (i.e., have all elements been costed)?	An initial high-level cost estimate should be done based on typical design drivers, such as hardware and software. This estimate should be developed at the end of the Program Definition Phase, when there should be sufficient architecture and engineering completed to support it. It should be updated throughout the life cycle and a Life Cycle Cost Estimate (LCCE) will be completed to validate the budget in subsequent phases of the life cycle. Both the budget and the ICE should be refined throughout the life cycle, as additional program information unfolds.

Table 2. P2 Stand up PMO: Build a PMO with the "Right" Competencies

P2 Stand up PMO: Build a PMO with the "Right" Competencies		
#	**Question**	**Guidance**
P2.1 	• Have **critical PMO positions** (e.g., PM, Deputy PM, CE, chief architect, budget and financial manager, scheduler, lead systems engineers) been staffed with personnel who have proven hands-on government experience with programs of similar size and complexity?	The PM and persons in other key roles should have appropriate certifications (e.g., Defense Acquisition Workforce Improvement Act (DAWIA) Level III). They should have knowledge and experience about how the government works and how associated industrial base and commercial providers do business.
P2.2	• Will your **software and system security engineers** be an integral part of your SE Team?	
P2.3	• Are there clear **lines of organizational responsibility** among PMO, Engineering, Legal, Contracting, Oversight, and the various Systems Engineering and Technical Assistance (SETA), FFRDC, and agency partners on the government PMO Team to achieve program objectives, and **have they been documented**?	
P2.4 	• Has the program developed a strong, clear governance structure and process to work with its stakeholders and users? • Does the governance structure clearly define responsibilities, accountabilities, and the decision-making process and authorities? • Does the governance structure address both technical and non-technical issues?	
P2.5	• Does the PM own all contracts that touch the program? • If not, are there tools or means to influence or control all interfaces to the program?	Most new programs need to interface with other programs, which themselves are often under development or being updated. When this occurs, the PM needs to be aware of the schedule and potential risks associated with these other programs and preferably have some influence regarding their development (e.g., a requirement critical to the release of a particular increment does not get pushed back to a later increment in the other program's release schedule).
P2.6 	• Is the **PMO** adequately staffed with qualified and experienced personnel, such that it is capable of a peer relationship (technical understanding) with the development contractor(s)?	
P2.7	• Has the PM ensured that the PMO Team is effectively and consistently **communicating**, thereby breaking down stovepipes (i.e., does the structure of the PMO encourage communication among the various functional disciplines)?	
P2.8	• If using matrixed support, has the PMO thoroughly defined **roles and timeframes** and put **written commitments** into place?	

P2 Stand up PMO: Build a PMO with the "Right" Competencies		
#	**Question**	**Guidance**
P2.9	• Do your contract and program plans comply with all relevant higher headquarters policies and directives? • If not, have you planned to compile and present the data, analyses, and arguments necessary to obtain waivers?	
P2.10	• Does the program have effective channels to clarify **requirements**, preferably involving customer/user participation in development IPTs?	In complex programs, opportunities for progress to stop are overwhelming. It takes careful preparation, planning, and coordination efforts to overcome them. Frequent clarification of requirements, frequent opportunities for decision-making, making progress visible to all, using the most effective communications and coordination practices, and using effective tools are critical [7]. Make sure that requirements clarifications are continuously reflected in the program technical baseline and cost estimate.
P2.11	• Has an initial high-level Integrated Master Schedule (IMS), consistent with your program office cost estimate, been developed?	

Table 3. S1 Develop Architecture, Requirements, and Capability: Define the "Right" Solution

S1 Develop Architecture, Requirements, and Capability: Define the "Right" Solution		
#	**Question**	**Guidance**
S1.1	• Has a system architecture been developed and is it aligned with the appropriate enterprise-level architectures? [5]	
S1.2	• Is the system architecture aligned with available funding?	Need to ensure the system architecture is affordable (i.e., can it be built with the available funds).
S1.3 	• Does the system architecture clearly identify the software subsystems or the subsystems that are software-intensive?	Early planning stages must consider and plan for any required software. Experienced software engineers must define the software architecture in the context of the overall system architecture with iteration, as needed.
S1.4	• Are the architecture and requirements defined such that software elements (increments) can be delivered within 24 months or less? • If not, have alternative approaches been put in place to enable timely delivery within the constraints of cost and capability needs?	
S1.5	• Does the PMO have the leeway to trade functionality for timely delivery and reasonable costs, as long as KPPs are met? • Do established processes facilitate quick collaborative decision-making when needed?	See P2.4 and P2.10.
S1.6	• Does the solution being developed avoid the use of proprietary interface solutions and standards to the extent possible? • If proprietary solutions or standards are proposed, have the appropriate trade-offs been assessed and necessary approvals been received?	
S1.7	• Have the planned **requirements management** process and tool(s) been implemented?	
S1.8	• Does the architecture address enterprise interoperability implications and infrastructure implications and have these implications been appropriately documented? • Has a Government Reference Architecture been established?	Reference architecture is used to assist in defining requirements flow-down for preliminary costing and eventual RFP and contractor technical evaluation.
S1.9	• Is there a sufficient collection of models and an appropriate simulation environment to validate the Concept of Operations (CONOPS) and preferred system concept against KPPs?	In large, complex programs, the development of models early and continual updating, as the design is later refined, can be very important to the later management of requirements' changes and performance verification. This will facilitate affordability, efficiency, and effectiveness tradeoffs.
S1.10	• Have **requirements** been designated as negotiable vs. non-negotiable, and has the PMO ensured that the requirements are testable and supportable? [8]	

S1 Develop Architecture, Requirements, and Capability: Define the "Right" Solution		
#	**Question**	**Guidance**
S1.11	• Has the PMO begun transition planning? • Is the Operations and Maintenance (O&M) organization being brought into this planning?	Begin early with transition planning and make this a deliberate activity in the life of the program. Transition planning should be refined at each major milestone decision point as well as at the beginning of each new increment, if incremental development and deployment is planned. It is critical to get the O&M organization involved in your program as early as possible, inasmuch as 70-80% of a system's LCC can be in operations and maintenance This will make the transition go much smoother and result in a shorter transition phase. It is suggested that you even get one or two good O&M analysts involved during the design, development, and implementation phases and then bring on additional O&M personnel as you begin transition planning and conduct the testing.
S1.12	• Have various test organizations been involved early and continuously as requirements are developed and modified to ensure all requirements are testable?	Well-run programs will typically have their test organizations begin operational scenario and test script development early in the life cycle as requirements are being firmed up. By doing so, the organizations ensure that the requirements really reflect what users want and that the requirements are written in such a manner that they can be tested.
S1.13	• Have you developed as comprehensive an inventory as possible of the information products used or generated by your planned system?	
S1.14	• Have you developed a **system hardware/software security architecture** that clearly delineates security mechanisms (e.g., devices, modules, software, configurations) for acceptable risk reduction? • Has the associated cost been incorporated into the technical baseline and program cost estimate?	Security architectures must capture sufficient architectural details to ensure protection of both the information in the system and the operation of the system itself. The security architecture must be sufficient to enable security risk management decisions, security risk tolerance decisions, and acquisition tradeoff decisions, as well as to guide developers in their implementation of system security. The security architecture needs to consider *resilience*, (i.e., ability to operate even when under attack and after penetration). In addition, ensure that you have considered supply chain risks.
S1.15	• Have you developed a **system privacy protection** approach for the collection, use, and retention of Personally Identifiable Information (PII) by the system? • Is this system consistent with applicable privacy laws, guidance, and the organization's privacy policy and goals?	For PII, systems should employ mechanisms to: (1) collect only the minimum amount of PII needed for system purposes and authorized by law; (2) provide notice and consent mechanisms, where appropriate; (3) verify PII accuracy; and (4) manage PII consistent with the purposes for which it was originally collected, including protecting PII from unauthorized access and inappropriate use, as well as limiting the sharing and retention of PII.

S1 Develop Architecture, Requirements, and Capability: Define the "Right" Solution		
#	**Question**	**Guidance**
S1.16	• Will your **software and system security engineers** play a major part in the development of your system architecture and support development of cost estimates?	
S1.17	• Have you planned a high-level Failure Modes and Effects Analysis (FMEA), involving both hardware and software, to support the initial development of your system architecture and its required responses to various errors and anomalous conditions? • Have you planned regular iterations of the FMEA as the system design becomes more detailed to ensure the error management architecture remains robust and comprehensive?	There are two issues regarding error management that all builders and acquirers of modern systems should plan for and know about. Successful modern systems are defined by their behavior—not only nominal behavior, but off-nominal behavior also. This means that a competent and comprehensive error management architecture must be part of the system architecture, lest the latter be incomplete and ineffectual. To support development of such a system, we need to conduct repeatedly more detailed FMEAs as we refine and deepen the design of the new system. In this case, FMEA not only includes the errors/anomalies/faults/failures that occur, but how the new system will determine there has been an error/anomaly/fault/failure. Only subsequently, in the development of the responses specified by the error management architecture, should we consider the issues of Mean Time Between Failures (MTBF), Mean Time To Repair (MTTR), operational availability, and so forth.
S1.18	• Have response categories in the elements of your error management architecture been reviewed by all stakeholders to ensure system behavior is consistent with their expectations?	
S1.19	• Has a rigorous definition of software requirements been performed prior to initiating the software development effort and have they been integrated into the technical baseline and program cost estimates? • If not, are measures in place to allow recovery from the impact of imprecise or ambiguous requirements?	The PM needs to be able to detect inadequate software requirements in order to be successful. Software can, and frequently is, one of the key cost drivers. When working in an agile software development environment, where, for example, releases are moved into production every 12–18 months, requirements need to be built iteratively in close collaboration. This collaboration between users and developers is especially important to realize the advantages while minimizing the disadvantages of the attendant uncertainty. It is still critical that the software requirements for the upcoming iteration be clearly defined at this point. The PMO should consider using prototyping in this type of environment to help better define these requirements.

S1 Develop Architecture, Requirements, and Capability: Define the “Right” Solution		
#	**Question**	**Guidance**
S1.20	• Has the PMO begun identifying the various alternatives for implementing both the architecture and the solution?	This is the highest leverage point to effect affordability. The PMO should begin identifying alternatives for implementation early in the program life cycle, while the architecture is being developed and requirements solidified. In conjunction with this effort, potential suppliers may be identified and risk assessments may be performed on these suppliers.
S1.21	• Has the PMO considered early prototyping, especially of potential architectures at this point, and possibly even potential solutions?	Early and continuous prototyping (generally with user participation) will help the PMO better define the requirements and reduce the risks with the ultimate solution chosen. It may also help the PMO avoid choosing a solution with downstream problems that could have been anticipated had prototyping been done.
S1.22	• In early project phases, have the KPPs been identified in clear, comprehensive, and concise terms that are understandable to system users? • Have the appropriate changes to the initial assumptions of the cost and program estimates been incorporated into budget submissions?	It is critically important that KPPs be expressed in terms understandable to all stakeholders. Failure to do so simply and clearly in early phases is a first step to requirements instability and cost and schedule overruns later. Often, the focus of a program is on the next succeeding milestone. Annual budgetary submissions are just repeated initial estimates that may not reflect current requirements

Table 4. A1 Acquisition Strategy and Plan: Create an "Executable" Strategy

A1 Acquisition Strategy and Plan: Create an "Executable" Strategy		
#	**Question**	**Guidance**
A1.1	• Has your **Acquisition Strategy** been appropriately tailored to required capabilities, technology, funding, risk profile, and need date, as well as staff capabilities and experience? [2, 11] • Does it demonstrate **compliance with current policies (**e.g., efficiency initiative, net centricity, and information assurance requirements)? • Has consideration been given to employing an **agile (e.g., evolutionary) Acquisition Strategy** when the ultimate system requirement is uncertain or immature; where there is a need for continuous user feedback to help refine the requirement; where the operational capability is needed in a short timeframe; or where significant technical, budget, or cost uncertainties exist?	It is desirable that objectives be decomposed into increments or modules to allow for quicker, partial deliveries, (e.g., agile acquisition).
A1.2	• Has the program explored the full range of alternatives, including existing solutions that may be available within your agency or from other agencies, make-buy, etc.? • Has the Analysis of Alternatives (AoA) been conducted with total LCCEs and the risks associated with potential suppliers? • Have the costs/benefits for each alternative been reviewed and this information factored into the decisions regarding the Acquisition Strategy? • Has anything changed since the AoA was completed that would warrant a revision of the assessment or outcome? • Has the Program Office considered all ownership/ operating options, for example, Government Owned/ Government Operated (GOGO), Government Owned/Contractor Operated (GOCO), or Contractor Owned/Contractor Operated (COCO)?	These early tradeoffs are critical to affordability. Note that the AoA is developed over time with the full AoA completed as part of the Acquisition Strategy. The AoA is begun as part of the *Develop Architecture, Requirements, and Capability* activity area and continues into the *Develop Feasible Design* activity area and culminates here. A number of different types of resources need to be involved in AoA development. It requires systems engineers, cost analysts, and acquisition specialists to work together to develop an accurate, quality AoA. The conclusions and underlying analyses then need to be clearly articulated to important stakeholders so that they fully buy-in to and support the approach going forward.
A1.3	• Has the **cost confidence** level (based upon predicted minimum and maximum costs of the proposed solution) clearly reflected the degree of risk for the program and has it been accepted, *via signatures,* by program **stakeholders**? • Are potential risks and cost consequences that may occur in later phases being captured early and monitored in the risk management database?	It is important that stakeholders understand the degree of risk so that they will not disrupt the program as inevitable program surprises unfold later on. In early phases, it will not be possible to identify all the risk areas that might surface later in a program, but a frank, early disclosure of potential risks in later phases, based on historical data from other similar programs, can help sustain stakeholder support later. A cost analyst should be included in all discussions of risk identification and risk management.

A1 Acquisition Strategy and Plan: Create an "Executable" Strategy		
#	**Question**	**Guidance**
A1.4	• Has the program developed a plan for early and frequent engagement with industry, for example, Requests for Comments (RFC)/Requests for Information (RFI), Industry Days, draft RFPs, advisory multi-step process (Federal Acquisition Regulation 15.202), and one-on-ones? • Have you given industry an opportunity to comment on your proposed **Acquisition Strategy**? • Have you given industry an opportunity to formulate and propose solution(s)?	These efforts will help to uncover affordability issues early in the program. Interactions with industry must be balanced with a well-defined operations security strategy to protect critical information within the program.
A1.5 STOP	• Is the **Acquisition Strategy aligned with the SE strategy** and appropriate operations security to protect critical information, and does it delineate the different SE roles of government and contractors? [5] • Is this strategy reflected in the program cost estimates?	
A1.6	• In developing the Acquisition Strategy, has the Program Office and Contracting Officer (CO) considered the need for government rights to data and how this will be expressed in the RFP? If there is the potential for the contractor to have proprietary rights to its applications, does the Acquisition Strategy and resulting RFP include the necessary requirements and Non-Disclosure Agreements (NDA), so the government and its support contractors can have the needed access to the data generated by these applications?	
A1.7	• Does the Acquisition Strategy address whether the development contractor will also maintain the system once deployed (i.e., O&M)? • If the O&M contractor is expected to be other than the development contractor, has the appropriate language been considered for the RFP to address hand-offs to the O&M contractor, including issues related to proprietary rights and security?	
A1.8	• Has the Program Office considered approaches to maximize competition and **maintain a competitive environment throughout the life cycle of the program** (e.g., advisory multi-step process or multiple award contract vehicles)?	Market conditions will influence the level of competition required during various phases of the program's development. A comprehensive market analysis should be accomplished and updated.
A1.9	• Has the Program Office made maximum use of Performance-Based Acquisition (PBA) methods (e.g., Quality Assurance Surveillance Plan (QASP), Service Level Agreements (SLA), Performance Work Statements (PWS), and incentive fees)?	
A1.10	• Have appropriate early evaluation phases, such as competitive prototyping, benchmarking, and piloting, been considered for high-risk/low-maturity components of the system?	Consider up-front prototyping, proofs-of-concept, and pilots.

A1 Acquisition Strategy and Plan: Create an "Executable" Strategy		
#	**Question**	**Guidance**
A1.11	• Is the software development cycle aligned with the system development cycle?	For example, if the system development cycle is spiral then the software development cycle must be spiral and documented in the Software Development Plan (SDP).
A1.12	If using incremental development: • Have the most important **requirements** been scheduled to be delivered first? • Can each increment stand on its own (i.e., if the program ended, could the increment still be operational with no dependency on future increments)? • Is the acquisition planned with contractual exit options that allow the PMO to stop work by accountable contractors whose performance fails to meet expectations?	
A1.13	• Have you revisited your PMO Staffing Plan and program office structure, including the use of matrixed support, based on the **Acquisition Strategy**?	The PMO structure and staffing will be different for different acquisition strategies. Once the Acquisition Strategy has been determined, the PM should revisit the initial PMO design to ensure that the PMO has been appropriately sized and structured based on historical data or data on analogous programs. This needs to be recosted as well.
A1.14	• Does the Acquisition Strategy address supply chain risk management, including performance of all-source intelligence threat assessments for suppliers of all critical components?	

Table 5. S2 Develop Feasible Design

S2 Develop Feasible Design		
#	**Question**	**Guidance**
S2.1	• Did the **government CE,** who is responsible for delivery of the technical solution, produce a feasible architecture or system design decomposed to the level of detail required by the chosen Acquisition Strategy, including identification of all critical components? • Did the government CE ensure that the design included the subsystem and component levels with external interfaces? • Were the government CE's architecture and design used to produce a defensible schedule and cost estimate?	
S2.2	• Has the feasible system design been used to determine the **maturity of the key technologies** (i.e., assess the development risk associated with using them)?	
S2.3	• In designing the solution, has the CE considered, and perhaps conducted, a trade-off analysis on how the design would impact the transition to production and ultimately the Production environment?	For example, would the design dictate use of novel manufacturing or assembly materials, infrastructure, and procedures, or require a complete new set of servers and networks from those used today, extending the transition period and increasing overall program cost? If so, is this feasible for the procuring Agency?
S2.4	• Is mature technology being used in an environment or in a way that is new for it? • If so, has its applicability for the new intended use been assessed?	
S2.5	• Have provisions in the architecture and systems design at contract award been made to allow sub-sequent insertions of anticipated new technology?	Insertions should be accomplished without adding to design complexity or requirements instability and unreasonable cost and schedule implications.
S2.6 STOP	• Has the feasible system design been used to **validate operational and technical feasibility** through mission, functional, and data thread analysis? • Has the PMO ensured that the design will be able to meet all of the **KPPs**?	

S2 Develop Feasible Design		
#	**Question**	**Guidance**
S2.7 	• If proposed by the contractor, have the PM and CE considered all of the possible ramifications of using modified Commercial-Off-the-Shelf (COTS) as a development solution? • Has the O&M organization been involved in any discussions regarding possible use of modified COTS? • Have senior officials in the organization or appropriate governance entities been briefed on the impact and approved the use of modified COTS?	Vendors will often proposed modified COTS as a solution and the government also often drives the vendor to this type of solution due to inflexibility of some of its requirements (requirements which typically result in new systems looking much like current systems). The PM and CE need to understand that once modified COTS have been implemented, it will be much harder to maintain the system inasmuch as COTS upgrades cannot be easily applied and often require recoding of the tailored product each time a new version of the COTS product is released. This increases the cost to the government as well as the risk, since each time the tailored code is modified there is a possibility of introducing new errors. This also forces a long-term dependency on the contractor since only the contractor knows how it tailored the COTS and the contractor may include proprietary rights as part of this tailoring. Finally, it makes transitioning to the O&M organization more difficult, as this organization must now rely on the contractor for maintenance as well, and the funding and contract vehicles may not be in place to accommodate this, which can drive costs even higher.
S2.8	• Have the challenges of COTS *hardware* product integration been planned for and assessed in the overall system context, including potential supply chain risks?	COTS vendors are often market-driven and the federal government is not the market driver. The government then has to accept the COTS hardware as-is and live with its limitations. COTS hardware limitations can result in some system requirements not being met or can result in new software requirements to accommodate use of the COTS hardware. Project plans should include resources required to overcome the integration challenges of COTS hardware.

S2 Develop Feasible Design		
#	**Question**	**Guidance**
S2.9	• Have the challenges of COTS *software* product integration been planned for and assessed in the overall system context, including potential supply chain risks?	Multiple issues arise when the choice is made to use software COTS. Among these is the fact that COTS vendors can go out of business or be acquired by another company, either can impact program success. If the COTS vendor no longer exists, then the software is never updated and that can tie the program to a fixed hardware and operating system. If the COTS vendor is acquired by another company, then the new company may phase out that software, which also results in no software updates. Where possible, consider putting source code into an escrow account for potential mitigation of these issues. Another issue is raised by the interdependencies between different software COTS packages. Most software COTS applications are tied to a specific version of the operating system. When the operating system is updated, a new version of the software COTS may be required. When multiple software COTS applications are used and one application requires a new version of the operating system to fix a certain bug/problem, it means that all the software COTS applications must be updated in order to work with the new operating system. This issue is magnified because the software COTS vendors perform their software updates on different schedules. If multiple software COTS packages from different vendors are employed, then the vendors' software upgrade schedules should be part of the overall IMS. Finally, prototyping can be used to discover and scope potential issues with integrating COTS software from different vendors.
S2.10	• Has the O&M organization been brought in to participate in developing the design or to review the design to ensure that it allows for affordable system operational effectiveness including reliability, maintainability, operability, and supportability?	The O&M organization needs to be brought into the Program early in the life cycle to ensure that the Program considers operational requirements and impacts, and plans and budgets for these. At a minimum, the O&M organization should be considered a key stakeholder and participate in any stakeholder meetings.
S2.11	• Does the system design include considerations for **mission assurance** including, but not limited to, system resiliency, reliability and maintainability, parts obsolescence, and the ability to upgrade (i.e., an open architecture)?	An open systems architecture is often the best choice for enabling incremental development and adaptation to changes in technology and/or requirements. Also, it is important to understand the cost and budget implications of mission assurance decisions.
S2.12	• Have current interface standards and interface technology (e.g., Application Programming Interfaces (APIs), technical maturity level) been assessed and factored into the development of the interface requirements and feasible design?	

S2 Develop Feasible Design		
#	**Question**	**Guidance**
S2.13 	• Has the government CE conducted the **rigorous up-front engineering** and **performance modeling** required to ensure that any potential performance issues are addressed? • Is iterative modeling being done, based on the proposed system design, to ensure that the design can meet performance requirements, scalability needs, etc., and to explore how any potential performance bottlenecks could be mitigated while still in the design phase? • Has benchmark testing been done?	If the answers to these questions are "no" due to schedule implications, the potential ramifications, including significant schedule delays and increased costs later in the program, likely will far exceed the time and cost of conducting this early rigorous engineering. The PM should re-consider conducting these early analyses.
S2.14	• Has the PMO conducted a trade-off-analysis, pilots, prototypes, and/or proofs-of-concept and have the outcomes from these been assessed to inform the solution definition?	
S2.15	• Has the Test and Evaluation (T&E) Strategy been developed and does it relate to critical operational requirements, technical parameters, and exit criteria?	
S2.16	• Have the number of test articles and test tools/facilities been matched to program needs and are they consistent with supplier threat assessments, schedule, and cost plans?	A potential threat mitigation for accepting software or hardware components from a supplier considered high risk may be additional testing; this should be considered in the identification of the program testing needs.
S2.17	• Have you planned and purchased resources for the software development and test environments (e.g., computers, workstations, cross-compilers, unit test tools, and integration test tools)?	The PMO needs to plan for these ahead of time to allow for vendor's lead time. This should be done in conjunction with selecting resources for the hardware development environment. The resources need to be able to debug software on the target hardware. When systems include embedded specialty hardware, there should be a plan in place for how software developers will debug the software on the embedded system (i.e., you 'cannot just use "print statements" or standard debuggers). Note that development tools are a source of attacks and threat assessments should be performed and appropriate mitigations implemented.
S2.18	• Have the critical software pieces been prototyped? • Have the risky software pieces been prototyped? • Have the critical software interfaces been prototyped?	
S2.19	• Does the SE approach address personal and organizational information product security requirements, operations security, cyber security, program protection (i.e., supply chain risk management, software assurance, anti-tamper, etc.) and mission assurance?	

S2 Develop Feasible Design		
#	Question	Guidance
S2.20	• As part of the Transition Planning, has it been determined whether the development organization will have a continued role in the Production, O&M Phase? • Is the development organization prepared to provide the resources needed to perform a continuing role into the Production, O&M Phase? • If so, does the Transition Plan clearly define what this role is and when the development organization would no longer perform this role?	
S2.21	• Has the PMO completed the AoA? • Did the PMO consider continuing with the current system as one of the alternatives? • Is the AoA completed early enough in this activity area to inform the Acquisition Strategy?	The AoA is a critical leverage point to establish program affordability. Appropriate rigor and depth of detail will facilitate a broad set of alternatives not only to achieve affordability goals, but even cost avoidance or cost savings.

Table 6. S3 Engineer the Solution

S3 Engineer the Solution		
#	**Question**	**Guidance**
S3.1	• Has an appropriate **systems integration approach** been defined for the program solution?	
S3.2	• Does the PMO have a way to systematically identify and revisit the **critical system-level needs** of the users?	
S3.3 	• Does the program demonstrate the **technical feasibility** of the component technologies and their integration into an end-to-end system/solution?	
S3.4	• Is there **continual monitoring of increment and interface dependencies** to ensure that, if an interface slips, the increment relying on it is adjusted?	
S3.5	• Has the **complexity of the architecture** been minimized so that the system can be partitioned into parts that can be separately developed and tested, and have the internal and external interface complexities been minimized? • If not, have mitigations been put in place or have steps been taken to minimize complexity?	
S3.6	• Have the **risks** associated with the maturation of new technologies or new application of old technologies been assessed and have the appropriate mitigation plans been developed?	The development of risky new technologies in parallel with a major development program can be costly in terms of both time and money and almost always increases the risk in a program. Estimate the cost exposure presented by these risks and incorporate them into program plans and budgets.
S3.7 	Does your Systems Engineering Plan: • Propose the use of cross-functional teams made up of the most experienced and compatible people at the start of the project to look at a broad range of solution sets; *and,* • Anticipate and plan to resolve as many downstream issues and risks as early as possible to prevent downstream problems; *and,* • Specify technical indicators of progress that are linked to thresholds, risks, risk mitigations, and contingency plans in the SE strategy (i.e., is there a “Plan B” for when bad things happen to good programs); *and,* • Describe an agile process to anticipate, accommodate, and communicate changing customer requirements (and their implications back to stakeholders); *and,* • Enable an environment in which both SE and development activities are appropriately integrated?	Often Programs will continue down a path with a particular engineering solution even when there are indicators that the solution may not work. The PM and CE should determine what these trigger points or indicators might be early on as the solution is being developed and monitor these carefully to determine if there might need to be a minor or major change in the solution approach. The earlier you catch this; the lower the cost and schedule impact will be to make the change.

S3 Engineer the Solution		
#	**Question**	**Guidance**
S3.8	Does the Test and Evaluation Master Plan (TEMP), which should be developed no later than this phase of the life cycle, identify: • Critical technical characteristics and operational issues that need to be considered in testing; *and,* • Objectives, responsibilities, resources, and schedules for all completed and planned T&E, including Modeling and Simulation (M&S) tools used in the T&E process; *and,* • Subordinate plans (e.g., Development Test and Evaluation [DT&E] and Operational Test and Evaluation [OT&E] Plans) and assign responsibility for preparing and approving these plans?	There are times when program testing becomes a target for funding cuts. It may therefore be necessary to establish the resource requirements for testing early in the life of the program. This baseline will be invaluable in accomplishing necessary trades to understand and explain the implications of accommodating the funding cuts, if and when they occur.
S3.9	• Will your software systems engineers be an integral part of your Integration and Verification Team?	
S3.10	• Have you thought through your hardware and software requirements in relation to their maturity, so you architected the design with the flexibility to accommodate potential requirements changes down the line?	The hardware requirements should be documented in a specification and should mesh with the software requirements, which are documented in the software requirements specification. The hardware design should trace to the hardware requirements in the hardware specification just as the software design should trace to the requirements in the software requirements specification. When the software development moves into the design phase, a hardware interface document should exist and be under configuration control so that the hardware and software engineers are working to the same interface.
S3.11	• Does a formal configuration management process and review board exist to manage requirements, design, and development changes?	

<table>
<tr><th colspan="3">S3 Engineer the Solution</th></tr>
<tr><th>#</th><th>Question</th><th>Guidance</th></tr>
<tr><td>S3.12</td><td>Is there a Transition Plan for the program to move into the “Production, O&M” phase?
Has the O&M organization been brought in to collaborate on the transition planning?
Does the Transition Plan include SLAs?
Does it describe the strategy for transitioning from the current state to the Full Operational Capability (FOC) state?
Does it clearly articulate whether there will need to be a period of parallel operations as part of the solution transition into the “Production, O&M” phase?
If so, is the period of parallel operations clearly defined and the rollover approach documented?
Does it define how backup and recovery will be done while in parallel operations?
Has the cost of transition been estimated and budgeted?</td><td>Include items such as the following in the Transition Plan:
Planned deployment (i.e., how, where, and when) to include addressing the rollout to multiple locations, perhaps over a staggered schedule
Possible simultaneous operations of legacy and new systems
Data migration strategy
Sunsetting of current implementations (i.e., how and when)
Development of necessary User Guides and other documentation and training
Support issues in fielding the system, especially if this support needs to be provided by the O&M organization
Backup, recovery, failover, and operational/system integrity requirements in the Production environment for the new system
Development of SLAs, if appropriate, for the O&M phase
Description of how the new capability’s performance should be measured
It is critical to get the O&M organization involved in your program as early as possible. This will make the transition smoother and result in a shorter transition phase. It is suggested that you even get one or two good O&M analysts involved during the design, development, and implementation phases and then bring on additional O&M personnel as you begin transition planning and conduct testing.</td></tr>
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Table 7. P3 Plan Program: Develop "Right" Program Plan, Processes, and Procedures

P3 Plan Program: Develop "Right" Program Plan, Processes, and Procedures		
#	**Question**	**Guidance**
P3.1	• In planning the program, has the PMO studied the life cycle and determined the tailoring that best fits this program? • In tailoring, has the PMO minimized contractor deliverables to only those truly needed so to maximize contractor time on the most important tasks? • Has the PMO looked at each document deliverable, as well, and tailored those to only the information required?	
P3.2	• Have a realistic Integrated Master Plan (IMP) and IMS been developed? • Has the IMS been updated to add the contractor's schedule once the contractor is onboard? [5] • Has the planning and scheduling been reflected in the program cost estimate and budget?	
P3.3	• Does the IMS include sufficient time for all test activities and events, e.g., contractor's and government's development testing, Initial Operational Test and Evaluation Testing (IOT&E), integration testing, user testing, training, performance testing, operational testing, regression testing, and Independent Verification and Validation (IV&V) of test management processes, products, and results?	Since testing is one of the last phases of a program's life cycle, it is often forgotten until just prior to the need to test. This results in insufficient time to prepare for test events, which in turn often leads to insufficient testing. Program oversight bodies will quickly pick-up on this and not approve a milestone exit, causing a large program delay as retesting is required. It is not unusual for a software development organization to expend 40% of the total project effort on testing, as noted by Roger Pressman [14], yet PMs fail to recognize the time required to get through all the testing events and gates and fail to begin planning for the test events early in their program life cycle.
P3.4	• Has the program's technical baseline, cost estimate, and schedule been kept current and aligned (i.e., updated regularly) and does each update consider the management reserve and whether it needs to be adjusted based on the program's current status (i.e., adjusted because the risk factors have grown or changed)?	The program office's estimate of cost (POE) should be reviewed and adjusted as necessary as the program moves from one life cycle phase to the next [1], and any inconsistencies with the ICE should be resolved.
P3.5	• Is there an effective risk management process in place with critical risks being elevated, as appropriate, for leadership decisions? • Has the risk exposure been costed and accommodated in program plans and budgets?	
P3.6	• Does Earned Value Management (EVM) consider the "value" earned in terms of performance, not just cost and schedule variances? • Does EVM synchronize with SE management efforts, including technical performance metrics?	The Earned Value plan should be structured as much as possible on project achievement of definitive technical accomplishments consistent with the appropriate levels of the IMS.

P3 Plan Program: Develop “Right” Program Plan, Processes, and Procedures		
#	**Question**	**Guidance**
P3.7 STOP	• Is the program Work Breakdown Structure (WBS) reflected in the program’s IMS and reflected in the program’s budget as well? • Does the schedule identify the critical path to achieving key program milestones? [1]	Program status, schedule, and metrics should all be based on the WBS.
P3.8 STOP	• Have test scripts been developed well in advance of each testing event? • Have these scripts been reviewed and approved by the stakeholder and user communities? • Have the entry and exit criteria for each test event been clearly articulated? • Have you planned early for the infrastructure (e.g., test beds, simulators, chambers, certifications, permits, licenses) that will host or support these scripts and tests? • Have the test resources been costed and budgeted?	
P3.9	• Have the types of users and portions of the solution they would use during testing (e.g., subsystems, services) been defined early, along with associated resource commitments, costs, and budgets, so you can get agreement from these user communities to support your test activities well in advance of actual testing dates?	If you do not line up users to participate in the user and operational testing well in advance of the test dates, then most likely you will not have this necessary support in the development of test scripts and in the actual testing of the solution that will be rolled out to them. This should be part of the integrated team planning and reviewed in periodic PM meetings.
P3.10	• Has an active and disciplined requirements management process been established? [9, 10]	This should include a Requirements Traceability Matrix (RTM) and the tracking of requirements volatility. It is not sufficient to only have a requirements management process, there must be strong discipline in executing each step and in active monitoring of the process by those empowered to make decisions. Requirements should be traceable to requirement(s) within a subsystem requirements specification. Requirements should be maintained in a tool, such as Dynamic Object-Oriented Requirements System (DOORS), so traceability can be continuously maintained (i.e., the PMO should not just create a traceability matrix once a month or for milestones).
P3.11	• Has an active and disciplined CM process been established by the contractor(s) and the government PMO?	The contractor’s Program Management Plan should include an active and disciplined CM process that establishes appropriate authority for the government PMO.

P3 Plan Program: Develop "Right" Program Plan, Processes, and Procedures		
#	**Question**	**Guidance**
P3.12	• Has a disciplined **change management methodology**, including a release management process, been implemented and have all stakeholders been made aware of the importance of change management?	Any new application or system always involves change. It is critical to identify the impacts, including cost, early in the program (e.g., right after design) and start a change management program at that time so when the system is rolled out, the impacted users are well aware of any changes from their perspective, have been trained on these changes, and have come to accept them.
P3.13	• Have the operational test and Certification and Accreditation (C&A) communities been brought into the process early?	
P3.14	• Do program trade-offs balance the equities of all applicable stakeholders? • Are the trade-offs being analyzed based on an authoritative assessment of risks and opportunities that consider the cost, schedule, and performance trade-space?	
P3.15	• Has program oversight been made a partner (e.g., has oversight been invited to major program reviews, have they had the opportunity to review and provide input to program metrics, has oversight been invited to life-cycle tailoring discussions?	
P3.16 	• Have interprogram dependencies, interfaces, and commitments been defined? • Have Memorandum(s) of Understanding (MOU) and/ or Memorandum(s) of Agreement (MOA) been put in place between the programs to inform and emphasize their importance?	Make sure you know how and where they are documented and who is responsible for maintaining and updating them as the program progresses. These items need to be revised and updated on a routine basis.
P3.17	• Has a program **CONOPS** been developed early in the program that includes operational scenarios and clearly describes the current system operations at a conceptual level (e.g., operational principles, constraints, and subsystem or increment descriptions)? • Has this CONOPS been vetted and signed-off through the stakeholder and user communities? • Is there a configuration-controlled document?	If a modification of a legacy system is required, provide the justification for and description of the proposed changes.
P3.18	• Has a program budget been developed and approved? • Does the it align with approved funding?	If the LCCE is greater than the Congressional funding being provided to the program, then the program needs to consider what requirements and associated functionality can be removed from the program, such that the LCCE is within the approved budget. At a minimum, the LCCE needs to be updated throughout the life cycle and monitored carefully so these decisions can be invoked when needed.

Table 8. A2 RFP(s) and Source Selection(s): Award to the "Right" Contractor(s)

A2 RFP(s) and Source Selection(s): Award to the "Right" Contractor(s)		
#	**Question**	**Guidance**
A2.1	• Have you taken full advantage of performance-based contracting methods in the solicitation?	
A2.2	• Have the government PM and CE developed contract requirements to ensure that the selected contractor is contractually obligated to **address dependencies on external systems and interoperability** to include the development of interface specifications, interface agreements, service level expectations, and a Test and Operational Evaluation Plan?	
A2.3 	• Does the RFP contain requirements for the contractor to define how it will address security and privacy requirements, such as cyber security, certifications and accreditations, and supply chain risk management that will likely apply to IT intensive solutions going forward?	
A2.4	• Have the PMO and O&M organization jointly determined whether the development contractor will be used in the Production and O&M phase? • If the intent is for continued development contractor support after transition to O&M occurs, have the PM and CE ensure the right contract vehicle(s) for this support is being put in place, such that there is no work disruption as the program transitions into the Production, O&M Phase?	These all need to be considered early in the program and continually throughout the life cycle to the point of transition. An example of chaos that could ensue without adequate transition planning early in the program is that contract(s) vehicles needed to transition to production and enter into a maintenance mode that may not be in place by the time needed and may not include the necessary tasks.
A2.5	• Does the RFP properly reflect whether the development contractor will also be the O&M contractor? • If not, does the RFP include requirements to address the need for the government and its other contractors to have access to the data produced from the development contractor's applications? • Have the data requirements been costed and budgeted?	If the development contractor is different from the O&M contractor, it is important that the boundaries and interfaces are identified to avoid finger-pointing between these contractors. The data needed by the O&M support contractor are often high cost items, and will change as the design matures and is tested.
A2.6 	• Are test requirements included in the RFP that clearly define the contractor's roles and responsibilities for each test event, including evidence and products that emerge from them?	
A2.7	• Are transition requirements included in the RFP that clearly define the contractor's role in transitioning the solution into the operational environment (e.g., responsibilities for parallel processing, decommissioning the legacy system[s])?	

A2 RFP(s) and Source Selection(s): Award to the "Right" Contractor(s)		
#	**Question**	**Guidance**
A2.8	• Are measures in place to protect the government's rights to data, including NDAs, if necessary? • Are these measures appropriately documented in the RFP?	The government needs to reserve the right to access all relevant data (i.e., information about the system itself as well as the operational and user data it stores). This is critical since data often has to be shared between multiple systems. Additionally, should the government move from one vendor's product to another's, the government needs to own the data so it can be moved.
A2.9	• Has an Independent Government Cost Estimate (IGCE) been conducted for the acquisition and is this cost within the program's budget? • If not, what requirements will be removed from the RFP so the IGCE reflects a cost that is within the budget's scope?	Remember that each time requirements are added, modified, or removed, the IGCE needs to be updated to reflect the changes. [1, 6]
A2.10	• Do the source selection criteria focus on critical factors and allow for discrimination among proposed solutions? [5, 10, 12]	Creating too many factors or sub factors will diffuse the ability to truly differentiate between vendors.
A2.11	• Have the PM and Contracting Office identified, funded, and scheduled adequate resources to support Source Selection Teams and processes. Have all team members been briefed on procurement integrity, as well as the details of the source selection process described in the Source Selection Plan? [12]	Evaluators must be informed they must evaluate proposals in accordance with the RFP and Source Selection Plan and avoid any substantive basis for a protest.
A2.12	• Does the RFP make clear the government's preference for the use of standard, non-proprietary interface solutions whenever possible and do the source selection criteria give appropriate weight to this preference?	
A2.13	• Is past performance one of the evaluation factors? • Has enough weight been placed on this factor to avoid awarding to contractors who have underperformed in the past on jobs that offer meaningful insight into likely performance on the current contract?	Make sure to put the correct wording in the RFP (e.g., "related jobs" is better than "similar in size and scope"). If a contractor already failed on a prior job that was about the same in functionality or scope, but smaller in size, consideration of that performance should not be excluded.
A2.14	• Have "graybeards" been invited to advise on source selections to include making visits to contractor facilities to gain insight on capabilities? [5,8]	
A2.15	• Has the contractor been sufficiently incentivized to make it worth their while *over the course of the whole program* to deliver on time and on budget, invest their best talent on this program, and to make its success a priority compared to other programs they are supporting?	Guard against the common custom of moving the experienced "A-Team" to the next new program proposal and leaving a less experienced team to cope with the existing program late in its integration and test phase.
A2.16	• For complex integrations or solutions that will be using leading edge technologies, is the government ensuring the contractor has a requirement to iteratively conduct performance testing as the solution is being developed, even if only using continuous M&S and benchmark studies?	If the contractor is not required to continuously conduct performance testing against its solution throughout the development phase, the program runs a much higher risk that the final solution will not meet the KPPs or be sustainable.

A2 RFP(s) and Source Selection(s): Award to the "Right" Contractor(s)		
#	**Question**	**Guidance**
A2.17 	• Have all incentives and disincentives been negotiated and agreed upon prior to contract award?	The government loses its advantage if negotiations (e.g., on SLAs or award fee plans) take place post-award. On the other hand, it is recognized that on certain award fee plans, the government has the unilateral right to revise the award fee evaluation factors periodically (e.g., every six months).
A2.18	• Has the approach for visibility into the Contractor's risk processes and risk database been defined (e.g., integrating PMO and Contractor risk management processes)?	
A2.19	• Have KPPs and top-level requirements been settled before a development contract has been awarded? • If not, have measures been taken to ensure that, when the Development Contractor Team is onboard, they will have sufficient direction to proceed and avoid having them participate in collaborative, but expensive, "what if" requirements debates that are not likely to converge quickly?	

Table 9. A3 Contract Kick-Off(s): Get Contractor(s) off on “Right Foot”

A3 Contract Kick-Off(s): Get Contractor(s) off on “Right Foot”		
#	**Question**	**Guidance**
A3.1 	Is the PMO fully prepared to kick-off the contract and hold the initial “Kick-off” meeting, to include: • Post-award briefing that includes government expectations; *and,* • PMO’s Engagement Plan defined (e.g., contractor interface roles and responsibilities defined; government organizational structure and roles shared; and expectations of government, contractor and other organizations involved, such as an FFRDC, defined); *and,* • Contractor Acquisition Management Plan (CAMP) and processes fully in place; *and,* • IMS, budget, and technical performance indicators (e.g., KPPs), updated and accurate; *and,* • Schedule and agendas for initial meetings with the contractor defined and in place; *and,* • Agenda coordinated with the CO?	If not, the contractor’s ability to begin working against their scheduled items will be impaired and the contractor will begin defining the expectations instead of the PMO.
A3.2	• Do the PMO and Contractor, together, have a metrics-based **cost and schedule** baseline that integrates technical accomplishments into a baseline plan and that has as many discretely measured milestones as possible? • Does this include an understanding of the critical path, risks, and internal and external dependencies? [10]	If your development contractor does not have a plan that realistically reflects how the system can be built, any measurements made against that plan cannot be trusted to provide meaningful information (e.g., any EVM reports will be unrealistic and overly optimistic).
A3.3 	• Are the major known performance, cost, and schedule drivers and risks explicitly identified, and is there a plan to track and reduce uncertainty?	Identifying the major cost and schedule risk areas can help focus management and stakeholders on these issues early and facilitate trades
A3.4	• Has the approach to conducting the Integrated Baseline Reviews (IBR) been defined and is the process documented and available to provide to the contractor during the “Kick-off” meetings?	Need to set expectations up front with the contractor as to the need for IBRs and how the government plans to conduct them, including the types of information the contractor must provide and, if a specific format must be followed for any of this information, provide the format as well.

Table 10. P4 Manage Program

P4 Manage Program		
#	Question	Guidance
P4.1 	• Is the program baseline (including technical baseline) being maintained using configuration control and reviewed on a periodic basis (i.e., at least monthly)? [10, 12] • Does it integrate program cost, schedule, and performance aspects? • Is it based on approved and *available* program funding and resources? • Does it contain a management reserve that is periodically adjusted based on the known and anticipated risks at that time? • Can you assure nothing has changed since the AoA was completed that would warrant a revision of the assessment or outcome?	Especially relevant are Technical Performance Measures (TPM) that are linked to KPPs identified in the development program baseline, since these represent essential system capabilities that must be achieved. TPMs should always be measurable quantities. At the system level, they are typically top-level parameters, such as range, endurance, reliability, and radar cross-section. TPM trends that diverge from expectations provide strong evidence that design maturity is not progressing. They are an indicator of potential problems in component, subsystem, or system designs. Additionally, the baseline, which is typically developed prior to bringing resources on board, should be reviewed for accuracy once staffing is complete. At this review, PMs should ensure that the project resources assigned to complete the work do, in fact, have the skills sets and capabilities, as well as recent and relevant experience, assumed during development, of the initial baseline. If not, the PM should make appropriate adjustments.
P4.2	• Is the user community an active participant in program reviews, trade-off discussions, requirements refinements, etc.?	
P4.3	• Is there a plan to manage and track the status of TPMs?	TPMs should be allocated to the subsystem level and tracked/monitored at that level continuously. Subsystem TPMs can then be rolled-up to the system level to determine if the system KPPs would still be met. It is especially important to track software TPMs, such as Central Processing Unit (CPU) usage, memory, and throughput, as well as important hardware TPMs, such as power requirements.
P4.4	• Are you tracking any **Leading Indicators** on your program?	A leading indicator is a measure for evaluating the effectiveness of how a specific activity is applied on a project in a manner that provides information about impacts that are likely to affect the system performance objectives. A leading indicator is predictive of future SE performance and SE performance itself could be an indicator of future project execution and system performance. [9] The goal is to create objective, reproducible, and quantifiable measurements to assist in schedule and budget planning, software debugging, software performance optimization, and quality assurance. [9]

P4 Manage Program		
#	**Question**	**Guidance**
P4.5	• Is the program constantly monitoring requirements implementation to ensure that a “bow wave” trend that endangers budget programming, delivery, and product success is not developing?	While it is expected that the PMO has defined an appropriate allocation of requirements across releases, it is unrealistic to expect that everything will execute exactly as planned up front. Therefore, some degree of flexibility to adjust requirements satisfaction among later releases is necessary. However, good SE and program management must understand the implications of such circumstances and differentiate between when adjustments represent prudent and appropriate reaction to events and when a bow wave is beginning to emerge. If you see functionality continuing to be slipped into future increments, due to poor planning or schedule management, this should raise alarms. Once a program begins down this path, it is difficult to end this cycle and the longer this continues, the more difficult it will become to get control over the program again. This practice of continually deferring picks up more and more ripples until the project is hit by a “bow wave.” [22]
P4.6	• Is the PMO managing risk in areas often forgotten about early in the program (e.g., security, privacy, C&A, testing, mission assurance) when the PMO may still be able to mitigate them?	
P4.7	• Are there clear pass/fail criteria, including affordability, for periodic or event-driven Program reviews?	Examples of these types of reviews are preliminary and critical design reviews (CDR), milestone reviews (e.g., Milestone A, B, C), functional and physical configuration audits, IBRs, readiness reviews, and contractor performance reviews. For any of these types of reviews, it is critical to have both entrance and exit criteria, which are often missing. Thus, a review may be considered successful when, in fact, it may not have been.
P4.8	• Is a *small* set of critical (key) outcome-focused program and software metrics being used to assess progress towards achieving program goals and objectives, and are they tied to high-risk (e.g., cost, schedule, performance) aspects of the program? • When there are indications of variance from the expected, is a formal mechanism in place to “listen to the data” actively and understand the implications? [9]	Disciplined attention to indications of trouble and deliberate and explicit response plans will help eliminate a common tendency to rationalize the variances or bow-wave making difficult trade-off decisions in the hope it will improve later. Program metrics that focus on items, such as cost, schedule, risk, and performance, are critical to ensure the program is successful; however, software metrics are equally important to ensure the software requirements have been implemented correctly and completely, and that they are traceable to system requirements.
P4.9	• As the PMO learns about and works through uncertainties, is it maintaining control of the program’s scope through rigorous processes (e.g., requirements and risk management) that mitigate risks and exploit opportunities?	

P4 Manage Program		
#	Question	Guidance
P4.10	• Are the relationship and communications between the users/sponsor and the developer clear and open so requirements can be stabilized quickly and effectively in the program's formative phase?	

Table 11. A4 Manage Contract(s)

A4 Manage Contract(s)		
#	Question	Guidance
A4.1 	• Are contract incentives still aligned with the achievement of program objectives? • Do incentives reward achievement of outcomes or significant results? • Do they incentivize the desired behavior?	The program should strive to tie a significant percentage of contractor incentives to outcomes or objectives that are truly reflective of its mission in the field or most closely coupled to critical capabilities being fielded (e.g., tying a significant percentage of contractor incentives to performance level or to the operational stand-up of a user facing net-centric service with a minimum of 100 users using this service).
A4.2	• Are stakeholders and end users involved early and frequently as the contractor develops the solution?	Give thought to the range and characteristics of user representatives, e.g., a transformational system may find enthusiastic support and valuable feedback from relatively junior users, but it may encounter resistance from well-established users with many years in the current system. This is not to imply that input from one user demographic is more valuable than another—all input is valuable. It is meant to avoid the error of assuming users are a homogenous population, and to note that care and thought is required in structuring user input activities.
A4.3	• Are contractor deliverables meeting or exceeding the requirements and expected performance levels? • Do contractor document deliverables have the correct content to meet program needs?	If deliverables are not of sufficient quality and do not meet deliverable requirements, then the schedule will inevitably slip. Accepting low-quality deliverables to maintain the published schedule only delays correction of the problem and ultimately results in greater schedule delays than had the problem been addressed immediately. In stating that document deliverables must be of "sufficient quality," it means the document contains the needed level of information for the program to proceed forward. This question is not suggesting that time and effort be focused on editorial or formatting changes not critical to moving the program forward. It is the government's responsibility to review, validate, and accept or reject, as appropriate, all contract deliverables, ensuring they meet or exceed requirements. Delivery of inferior products could indicate the contractor does not really understand government expectations or the program's scope, or the requirements are not clear. A program can recover from an occasional misfire; however, if a trend begins to appear with regard to poor deliverables, then the PM must begin to ask what the real problem is and implement corrective measures. On serious performance problems, the PM must involve the CO. The criteria for "meets," "fails to meet," and "exceed" must be well-documented and clear.

A4 Manage Contract(s)		
#	**Question**	**Guidance**
A4.4	• Is the government overseeing the contractor's EVM data (or other data that shows progress) to ensure it is accurately captured and the program is on schedule and within cost?	The most critical factor in using EVM data is to ensure the appropriate method is being used for each set of data being tracked. If the method does not provide accurate data with regard to progress, then the EVM is of little use. The second most critical factor is the government must know how to thoroughly read and understand EVM data and ask questions. For example, it is not uncommon for a contractor to move charges between codes when funds run out under one code—when this is done, the government loses the ability to accurately track status.
A4.5	• Are the PM and CE carefully monitoring contract scope to ensure any proposed modifications are truly out of scope and also necessary?	The government can quickly overrun its budget via the implementation of many contract modifications. It is critical that the Program Leadership Team understand the contract as well as the contractor does so the PMO does not get taken advantage of, i.e., "trust but verify." The PM should also ensure that any new direction to the contractor is provided formally by the CO. Modifications to a contract should be made for work within the general scope of work. Out-of-scope modifications imply that a new competitive contract may be needed.

Table 12. S4 Mature Solutions/Design for Production

S4 Mature Solutions/Design for Production		
#	**Question**	**Guidance**
S4.1	• If the Interface Control Document (ICD), Capability Development Document (CDD), or other design and development document drives any support requirements that are not part of the technical baseline and program cost estimates, are there means outside of the program's resources by which they will be accommodated? • If so, are other necessary contract documents and/or memoranda of agreement in place? • If not, and the new support requirements are urgent and compelling, are there means at the PM's disposal to accommodate them (i.e., is there a "Plan B")?	Sometimes, support requirements (e.g., a test range) are not within the program's budget. In this sort of situation, there should be something in place that assures that the necessary resource will, in fact, be available and paid for as expected. If that's not the case, then the program needs to have (and move to) a plan B.
S4.2	• Has a clear process for data standards implementation that engages all stakeholders been developed and is it being followed?	It is imperative that data passed from subsystem to subsystem within a system or between systems for a system of systems (SoS) be correctly interpreted and understood. There should be a process involving all applicable stakeholders for defining how the data will be structured and how changes to the data will be handled. For enterprise applications, especially when there may be subsequent, unanticipated data users, the reuse of widely accepted data standards is generally advisable.
S4.3	• Has the development contractor decomposed the system **requirements** and applied KPPs, or where not applicable, established performance requirements for each functional area and interface?	
S4.4	• Have the government CE and lead engineers maintained their role as enterprise integrator as the development contractor continues to progress toward final design and solution development? • Are the government CE and lead engineers continually monitoring the development contractor's technical progress ensuring the solution being defined meets Agency standards, fully addresses the requirements, and aligns with the architecture defined by the government, is being developed using an agile (e.g., modular or incremental) approach and uses "pure" COTS solutions to the greatest extent practical?	
S4.5	• Is iterative modeling and testing being used by the development contractor to ensure the solution will meet performance requirements, scalability needs, backward compatibility, or interoperability with other systems? • Is modeling being done frequently to ensure any bottlenecks or issues are identified early in solution development, such that they can be addressed with little-to-no schedule or budget impact?	Reminder: 'Do not forget that these items must be addressed in the RFP and resulting contract.

S4 Mature Solutions/Design for Production		
#	**Question**	**Guidance**
S4.6	• Does the government PMO have adequate insight into the development contractor's solution development, engineering analyses, engineering trade studies, M&S exercises, and prototyping activities? • Is it clear from this insight that these engineering activities are informing each other and being refined, as needed, based on results from these activities?	
S4.7	• Have system performance management studies been conducted as the system evolves to assess increases in users, data, and complexity? • Is the O&M organization involved in these studies or at least made aware of results early so it can make needed adjustments in the O&M environment?	
S4.8 STOP	• Does the organization have the needed **O&M infrastructure** in place to support the hand-off of this new system or capability (e.g., help desk established and help desk support trained, mechanisms to monitor system performance in place, backup mechanisms ready, contingency plans in place)?	
S4.9	• Are you leveraging best practices in your hardware supply chain (e.g., synchronizing interrelated processes, reducing bottlenecks and the number of touch points? • Are you extending supply chain best practices to software and cyber? [23, 24]	Managing the cyber supply chain requires alignment between supply chain management and computer security, necessitating a higher level of collaboration among security, IT, and supply chain risk managers than has been the historical norm. [25] Risks include insertion of malware and insertion of hidden monitoring and data gathering capabilities.
S4.10	• Are **software architectures** partitioned so that "perfective maintenance" can be performed, i.e., so that the software maintenance staff can do things better, if and when the opportunity arises?	After deployment, the operating system, programming language(s) and COTS software vendors may change. A system may be operating on obsolete hardware that is no longer supported by a vendor.
S4.11 STOP	• Is Transition Planning and the associated Transition Plan complete with resources identified and committed for the actual transition? • Are test scripts and other test documentation complete, the Test environment ready, and resources identified and committed for various test events?	If the test and transition planning and resources are not ready at this point, the program continues at great risk. Examples of negative outcomes that could occur if these are not in place at this time are: • Lengthened testing and transition schedules • Lower quality in testing and perhaps shortcuts that would have to be taken to keep to schedule • Unsuccessful transition requiring a new application be backed out of the production system and perhaps even requiring additional changes to the application and re-testing to work in the Production environment

Table 13. S5 Integrate and Test

S5 Integrate and Test		
#	Question	Guidance
S5.1	• If the time to test has been compressed (i.e., test schedule shortened to meet required delivery dates), has the Program Office and testing organization reviewed the test approach to ensure the most critical testing can be completed in the new timeframe?	
S5.2	• As you are entering the various test phases, are you conducting comprehensive dry runs, or at a minimum, preliminary meetings of all test personnel, including stakeholders and users, to ensure they clearly understand their roles and the test scripts?	
S5.3	• Has the PMO ensured that all entry criteria for each test event are met prior to proceeding with the test and that all exit criteria are met prior to classifying the test event as successful?	
S5.4	• Are clear records of test events and problem reports being captured and addressed prior to moving from one phase of testing to the next?	
S5.5	• Are lessons learned being captured during the various test events, including what should be changed if the test event were conducted again?	Lessons learned are critical to better enable the success of future system increments and to share with the Program Office managing programs of similar complexity.

Table 14. S6 Transition to Production

S6 Transition to Production		
#	**Question**	**Guidance**
S6.1	• Has a **detailed review** of qualification requirements, baseline processes, manufacturing control flow plans, and key process points been conducted?	
S6.2 	• Is there a clear set of **hand-off criteria** between the development and O&M organizations so it is clear to everyone, including the user community and development contractor, when the O&M organization has assumed responsibility?	Without this set of criteria, it will be easy to continue to justify why the development organization needs to continue maintaining the system for a prolonged period of time (e.g., not all problems are fixed from the testing phase). This can have many negative impacts, such as users continually calling PMO staff for assistance rather than the help desk, resulting in use of program funds when O&M funds really should be being used, etc.
S6.3	• If a parallel production period is conducted, is good data being captured so it can be used to determine whether to conduct a final cut-over at the end of the period?	
S6.4	• Are lessons learned, including any conditions that might have required a new application to be backed out during parallel production, being captured for use in future increment rollouts?	

Table 15. S7 Operate and Sustain

S7 Operate and Sustain		
#	**Question**	**Guidance**
S7.1	• If required, is the O&M organization using specific **logistics metrics** that are collected in a joint agency/contractor information system, including detailed, objective, quantitative measures? • Does the measurement framework include end-to-end performance?	
S7.2	• Has proper planning been done early in the O&M phase for the retirement of component parts and ultimately the entire system? • Has retirement been costed and budgeted?	

APPENDIX A: Using the Checklist in Agile Environments

There are several reasons for moving towards "agile" processes, such as quickly responding to an immediate and pressing need or engaging with users throughout the development process to ensure that what is developed meets their needs. Regardless of the stability of final system requirements, an agile Acquisition Strategy focuses on getting incremental capabilities to the user quickly rather than waiting years for the final system delivery. Being agile need not inherently imply accepting more risk. In general, agile methods are compatible with the items in this Checklist, and in fact they may be *more* essential for agile acquisitions to ensure that program managers don't inadvertently miss key points.

An agile acquisition is generally appropriate for two types of system development: (1) systems with a high degree of functional requirements uncertainty, even if the purpose and intent of the system is known; and (2) small, tactical systems (often software intensive) that may have a short life, but address an immediate and pressing need. In the first case, total system requirements cannot be fully defined at the beginning, and an initially deployed partial solution is refined and extended to add more capability over time through a series of incremental deliveries guided by interactions between developers and users. The second case is similar, often with less than complete requirements and rigorously pre-determined specifications, with even more emphasis on the need for a solution as soon as possible, even if not the 100% solution. The subsequent iterations here are more aimed at refinement with fewer substantial capability extensions expected. Some suggestions for implementing or operating in an agile environment are covered in this Checklist in questions S1.19, A1.1, and S3.7.

The keys to this strategy's success are a clear understanding of stakeholder expectations and needs and continual involvement with user representatives to provide continuous and rapid feedback throughout each capability increment. These issues are covered in this Checklist in questions P1.3, P2.4, S1.22, A1.3, S3.7, P3.12, and A4.2.

Some advantages of this strategy are that (1) development can begin once high value functional requirements have been identified and approved by the sponsor; and (2) significant user involvement during development ensures that delivered capabilities meet the user's most pressing needs and will be used effectively.

The challenges are that agile methodologies: (1) usually require a stable infrastructure; (2) require significant management and technical oversight to ensure that the highest priority needs are being worked, and that these releases are compatible with successive releases; and (3) there is substantially less documentation than in a typical plan-driven acquisition program. Agile methods strive to produce 'just enough' documentation to convey the required information.

The use of agile methods should be carefully considered for all development efforts. Agile methods are highly disciplined and require a close working relationship with the project sponsor. When using this Checklist in an agile environment, there may be more iterations of the activity areas and omission of others due to changing requirements. Additionally, on larger projects, development teams may need to work in parallel within the same development environment without interfering with each other.

If you implement an agile methodology, ensure that there are processes in place to enable the communications and tools to support collaboration and parallel development and testing. Quality measurements should be captured and monitored, to include testing successes/failures, defect rates, user comments, and feedback (negative/positive). Some other suggestions for monitoring and measuring quality are covered in this Checklist in questions A1.9, P4.4, and A4.3.

Agile Environments Checklist References

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APPENDIX B: Activity Area Descriptions

This appendix contains detailed descriptions of the 15 life cycle activity areas introduced in Section 7 and illustrated in Figure 1. *Life Cycle Context* (repeated here for convenience). The life cycle activities below are organized by discipline required to perform that activity successfully. The three disciplines are (1) program management, (2) SE, and (3) acquisition.

Each detailed description includes a discussion of who is primarily responsible for each activity area (e.g., government or development contractor). For those activity areas where the government should maintain responsibility (e.g., program definition), the government often requests the assistance of an independent company, such as a FFRDC or a University Affiliated Research Center (UARC), to provide the technical engineering and integration expertise it may not have resident in its staff.

Program Management Horizontal Track (P)

Program Definition (P1)

The first activity area in this horizontal track, **Program Definition (P1)**, typically occurs as part of a Program's concept development work. Shaping the acquisition initiative into a credible and executable program and laying the foundation for the program is critical to the success of subsequent system or capability development. As part of this activity, the government must ensure there is a clear and valid need that is expressed by applicable user communities that can be met with a practical and cost-effective solution. Equally important to shaping the need is ensuring that the user and sponsor communities back this need and are willing to support it with appropriate and adequate resources, as well as that there is a clear champion for the program to help make it successful. This activity area should also highlight the communications vehicles needed, including any necessary external governance structures, the high-level Acquisition Strategy, and the most critical risks identified at this early stage of the life cycle. Finally, a high-level ICE should be created at this time.

The work in this activity area is predominately completed by the government. A PMO may or may not exist at this time, but typically it is not yet stood up. Government personnel supporting this early program definition work may or may not ultimately move into the PMO. The primary effort during this activity area is led by the requirements organization in coordination with the Acquisition Office and the end users.

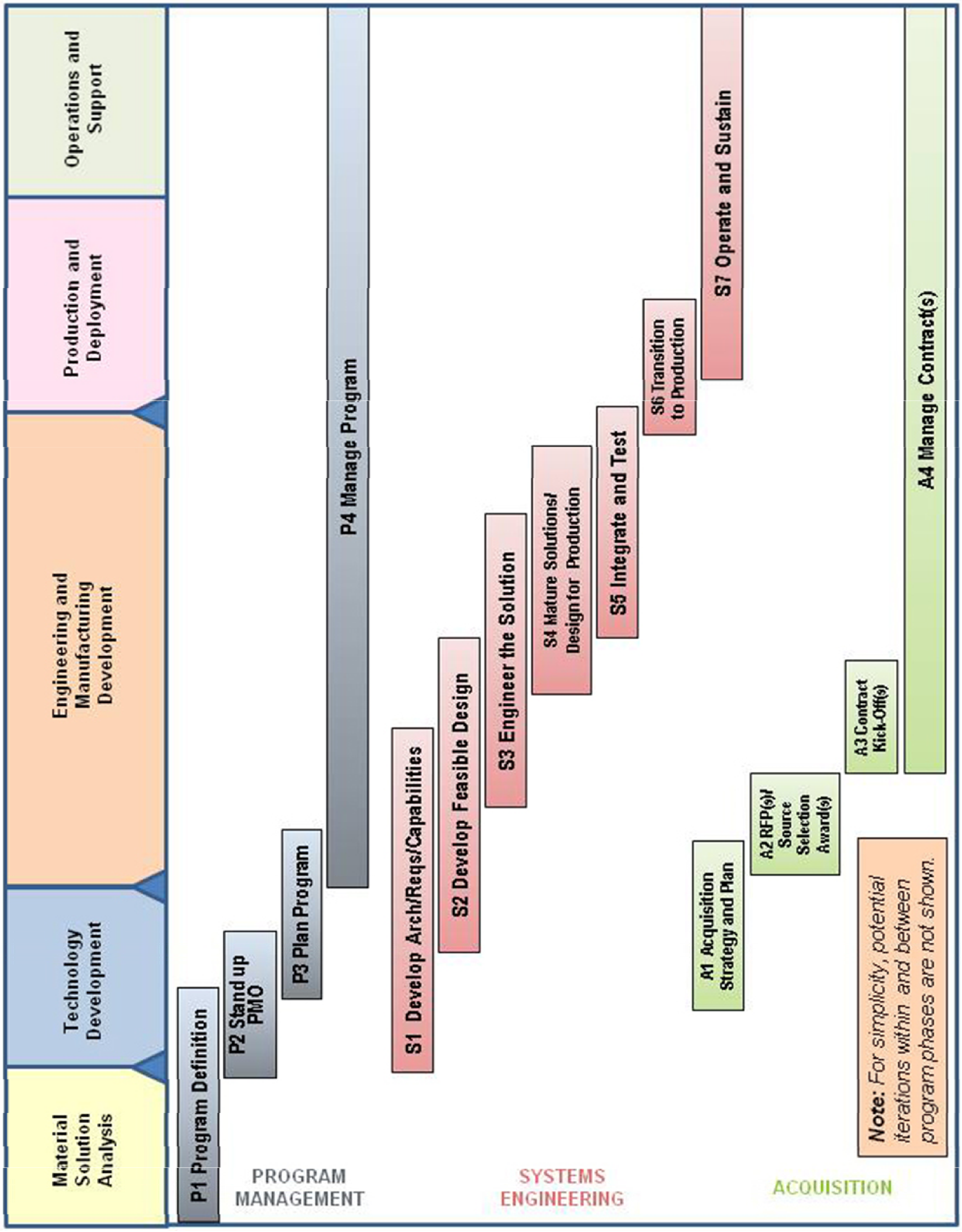

Figure 1. Life Cycle Context

Stand Up PMO (P2)

Successfully formulating a program and implementing its solution requires a team of staff with needed technical and managerial competencies and operational experience. Once the operational need has been sufficiently defined and receives approval funding to become a program, the first step is most often to implement this second activity area, **Stand Up PMO (P2)**. Critical in standing up this office is determining the appropriate organizational structure and acquiring the right resources. The most critical of these resources are the project manager, chief engineer, chief architect, and project financial manager. It is also critical that, as part of this activity area, the roles and responsibilities of various PMO entities and external interfaces are clearly defined, including the authorities and accountabilities associated with each. The governance structure and lines of communication also need to be defined and the managerial processes and procedures defined. Finally, an initial schedule should be established and tied to funding.

Standing up a PMO is a government responsibility. Most often the PMO manager is selected and then given the responsibility to establish and implement the PMO. As part of standing up the PMO, the government may acquire a program management support contractor to help with the execution of the PM activities. When this occurs, the Acquisition horizontal track is concurrently executed to acquire this support contractor.

Plan Program (P3)

Per FAR, Section 2.101, *Definitions*, acquisition planning means “the process by which the efforts of all personnel responsible for an acquisition are coordinated and integrated through a comprehensive plan for fulfilling the agency’s need in a timely manner and at a reasonable cost. It includes developing the overall strategy for managing the acquisition.” The **Plan Program (P3)** activity area begins by defining a program with realistic objectives that are within the PM’s span of control to enable rapid, successful outcomes via acquisitions. Key elements in planning the program include requirements development and management, defining and developing CONOPS, implementing configuration management (CM) control and tracking, tailoring the life cycle to best support the program’s needs and outcomes, implementing a strong risk management process, beginning the planning for testing, updating the initial schedule to include more detail, and updating the initial high-level cost estimate, creating a first, full LCCE. The culmination of these efforts is documented in the APB, which establishes the baseline cost, schedule, and performance parameters for the program or project.

The government clearly needs to lead this activity area and perform many of these elements. This activity area is primarily the PMO’s responsibility; however, the PMO may request that Integrated Project Teams (IPT) be established to support this, and that these IPTs include users and stakeholders.

Manage the Program (P4)

In the **Manage the Program (P4)** activity area, the PMO begins to implement and execute all its management processes fully. One of the most important aspects of effectively managing the program is maintaining the APB, including the technical baseline, using strong configuration control. The PMO must also conduct continuous and active risk management, schedule, and cost management, as well as implement needed program reviews, including tracking and monitoring actions resulting from these reviews.

The government is ultimately responsible for this activity area and the PMO leads its implementation and execution; however, a PM support contractor often assists in the execution of these activities.

Systems Engineering Horizontal Track (S)

Develop Architecture/Requirements/Capabilities (S1)

During the Program Definition phase, the operational needs were defined in a set of high-level requirements. The first activity area in this horizontal track, **Develop Architecture/ Requirements/Capabilities (S1)**, is to refine these into a more detailed set of operational and technical requirements. Although the ultimate responsibility for doing this lies with the PM, to be successful, it is critical to involve end users and stakeholders as well. Cost analysts should be working with engineers during this activity to ensure that the level of detail and data necessary for costing are developed. At the same time, the PMO begins defining the architecture. Alternate architectures should be considered as part of this activity with a focus on creating a standards-based, yet flexible architecture that supports agile, performance-based implementation. The key capabilities are also clearly defined as part of this activity area. Finally, the PMO may begin some early prototyping of different architectures or even early candidate solutions during this phase.

The government must maintain responsibility for this activity area. The PMO should be the ultimate program integrator and drive requirements and architecture development. The CE plays a critical role in performing activities in this area.

Develop Feasible Design (S2)

It is the PM's responsibility to implement a sound SE approach to translate the operational needs and requirements into the solution. The **Develop Feasible Design (S2)** activity area is where this is accomplished. To make this translation, a preliminary and then detailed design is developed. The DoD 5000.02 states, "The design approach shall partition a system into self-contained, functionally cohesive, interchangeable, and adaptable elements to enable ease of change, achieve technology transparency and mitigate risk of obsolescence. It shall also use rigorous and disciplined definitions of interfaces and where appropriate, define the key interfaces within a system by widely supported standards (including interface standards, protocols, and data interchange language and standards) that are published and maintained by recognized standards organizations."

A common start for this activity area is to gain a full understanding of the range of possible solutions, including their costs, schedules, performance implications, and ability to satisfy operational and technical requirements. This is typically done via an AoA, which should at least be started in this activity area, even if it is not completed until the *Engineer the Solution* activity area.

As part of this activity area, the government may also consider using M&S to make an early determination whether the design is feasible. It should also consider using trade-off analyses and prototyping. It is critical to ensure that the design can be implemented into a feasible operational and technical solution. Another aspect is to develop the test strategy, begin planning for the test environment, and consider any potential operational constraints that may impact the architecture or design.

The government needs to be highly engaged in this activity, taking on the integrator role; however, the design is typically developed in conjunction with the development contractor once that contractor is aboard.

Engineer the Solution (S3)

A common start for the **Engineer the Solution (S3)** activity area is the planning and development of the Systems Engineering Plan. This plan is the most critical engineering document used to guide implementation activities. In addition, as part of this activity area, performance parameters are identified, security and mission assurance implications associated with the proposed solution identified, and risks associated with the proposed solution addressed. Again, cost analysts should be working with engineers during this activity to ensure that the level of detail and data necessary for costing are developed. The O&M organization should also be engaged as part of this activity area so it understands the alternative solutions and the proposed solution it would be maintaining, so the PMO and development contractor understand any Operational environment constraints that could impact these solutions.

Critical to this activity area is ensuring the PMO has a clear integration strategy and part of this strategy it has to consider the implications using COTS products, especially if they are modified-COTS. Before this activity area is completed, the PMO should have a solid programmatic and technical baseline. This is the basis of all affordability analyses. It should also begin its transition planning and continue its test planning, with the development of the Test and Evaluation Master Plan being completed as part of this activity area and the beginnings of test scripts created. Prototyping should also continue as part of the early engineering of the solution.

The development contractor generally performs the activities in this area, although the government can also do this, or have an UARC or FFRDC help, especially with conducting an AoA and prototyping. The PMO should maintain responsibility for integration.

Mature Solutions/Design for Production (S4)

The **Mature Solutions/Design for Production (S4)** activity area is also referred to as implementation. The chosen solution from the “Engineer the Solution” activity area is fully developed and incrementally tested as it is being developed. The O&M organization should also be involved during this activity area to better understand what is required to operate this new system and to continue to identify any possible new constraints in the Operational environment. Test scripts should be completed and its associated Test environment stood up. Planning for the transition to production should be completed by this time as well, with a clear and completed Transition Plan completed.

The development contractor takes the lead for activities in this area with the government operating in an oversight and integration role.

Integrate and Test (S5)

A number of different test activities are conducted as part of the **Integrate and Test (S5)** activity area. The T&E reveals any real or possible deficiencies in the system, including the inability to meet operational and technical requirements. The first activity is typically DT&E and the testing usually culminates with the OT&E. Other test activities include security and performance testing, as well as any other additional tests needed for the system being implemented. Throughout test activities, results need to be documented, lessons learned captured, and reports developed.

The government PMO is responsible for these test activities and for ensuring that the solution is fully integrated. Key players in this activity area are the users and stakeholders. The development contractor supports testing, as needed, and fixes problems identified during these tests.

Transition to Production (S6)

To avoid unacceptable interruptions in the production system, the transition must occur using an orderly and planned approach. It is critical that the implementation of the new capabilities into the production environment not disrupt other legacy applications. The planning efforts for the transition are already completed prior to entering the Transition to Production (S6) activity area. The PM and CE should oversee and coordinate the transition activities required to fully deploy the solution. The development contractor executes the transition under this oversight, along with the O&M contractor, who plays a key role in the actual transition. The activities conducted in this area are the actual transition, documentation of results, and documentation of lessons learned.

The PM and CE oversee and coordinate the transition activities required to fully deploy the solution. The development contractor executes the transition under this oversight with the O&M contractor, who plays a key role in the actual transition.

Operate and Sustain (S7)

At this point, responsibility for the execution of the system in the Production environment is transferred to the O&M organization. Planning for the O&M phase of the life cycle occurs prior to entering the Operate and Sustain (S7) activity area. This area is specifically for the operation and sustainment of new capabilities in the Production environment and for the introduction of needed changes or enhancements.

The O&M organization is responsible for this activity area. The PMO has handed over responsibility for the Acquisition Program to the O&M organization, which often uses a contractor to help execute and maintain the system. This contractor could be the same development contractor or a different O&M contractor.

Acquisition Horizontal Track (A)

Acquisition Strategy and Plan (A1)

The **Acquisition Strategy and Plan (A1)** activity area establishes how needed capabilities will be acquired and supported throughout the life cycle, from development to operations to retirement. Developing the Acquisition Strategy and supporting Plan is most often an iterative process with updates made as early uncertainties and risks are resolved through further definition and solution formulation. The strategy is also updated as a result of conducting an analysis of alternative solutions, most effectively done via involvement of user and stakeholder communities.

The government must lead this activity area and often may perform the activities in this area solely using government staff. It is inappropriate for any development contractor or even most PM support contractors to assist in this area. The government must ensure that any outside support it gets in this activity area, as well as any other acquisition horizontal track activity areas, is free of any possible conflicts of interest. As such, the government will often use an FFRDC to provide guidance and support in these areas.

RFP(s)/Source Selection Award(s) (A2)

The focus of the **RFP(s)/Source Selection Award(s) (A2)** activity area is to develop the RFP(s) and supporting Source Selection Plan(s) and to conduct the actual source selection(s). Typical procurement activities are conducted at this time. In conducting these activities, the solicitation must address items, such as performance-based contracting, incentives and disincentives, government's data rights protection, and dependencies on external systems. In addition, the PMO must also determine if the development contractor(s) will be the O&M contractor(s) and ensure that an IGCE is conducted. One key decisions the PMO, with the support from the CO, must make is to determine the type of contract vehicle to use and if it wants to award work to one or more contractors.

The government is responsible for executing this activity area with the PM and CO as primary responsible entities. It is critical that the CO be included as part of the PMO, typically through a matrixed support approach, so the CO is equally responsible for meeting program schedules.

Contract "Kick-Off" (A3)

The **Contract Kick-Off (A3)** activity area is a fairly short and quick activity to conduct. The primary purpose of the Contract "Kick-Off(s)" is to ensure that development contract(s) get off on the right foot. Working the relationship between the PM and its PMO, the CO, and the contractor is critical to effectively executing the contract(s). This is where those relationships are initially established. This is also the PMO's first opportunity to share additional information and documents with the contractor to ensure the contractor fully understands the need, the environment it will be operating in, and any other government expectations.

The PM and CO lead this activity and are supported by the PMO in setting an agenda, gathering information to be shared, preparing briefings to be used, etc. The development contractor(s) also *play a role in this activity by participating in the "Kick-Off" meeting(s) and being prepared to present on any topics requested by the government.*

Manage Contracts (A4)

The **Manage Contracts (A4)** activity area is an ongoing, long-term activity that exists for the duration of the contract(s) under the PMO's control. The PM and PMO must balance the amount of contract management and controls it puts in place with the need to execute on schedule and within budget. Yet, at the same time, the PMO must put enough management oversight in place to ensure it can quickly recognize and take proactive corrective actions when the contractor efforts begin to fall off plan. The PM and CO must keep the contractor(s) focused on achieving end-to-end performance within program constraints. Another key aspect of this activity area is to ensure contractor deliverables are quality materials and meet requirements.

The PM and CO must continually monitor contract requirements to ensure any proposed new requirements are really out-of-scope and must monitor and properly implement incentives and disincentives established as part of the contract(s). Engineering and financial management should be engaged in this activity as well.

The CO, supported by a Contracting Officer's Technical Representative (COTR), is ultimately responsible for this area; however, the PM and PMO conduct most day-to-day oversight. This activity area needs to be conducted by the government.

APPENDIX C: Affordability, Efficiency, and Effectiveness (AEE) Best Practices

AEE is not achieved through application of any single analytic approach or engineering or management practice, or even a small set of the same. AEE practices need to be integrated throughout enterprise and program engineering and acquisition management activities. Achieving AEE of acquisition programs or in enterprise operations requires a continuous conscious effort on the part of all stakeholders.

Determining the maximum budget constraint and/or goal is a political and subjective responsibility of senior government planners. Understanding that this goal is hard or soft and what drives its sensitivity is an important variable in the affordability equation.

The following practices are fundamental to engineering for affordability, efficiency and effectiveness and achieving successful acquisitions. They reflect some examples of best practices and are derived from lessons learned:

1. ***Understand the operational mission***, its context and the current systems or solutions employed. Understand what is changing, and what is influencing these changes. What do these changes imply in terms of new operational needs? As an engineer, understand the current program architecture and system operations to be able to evaluate impacts of these changes. Also understand principles of the enterprise architecture, the data and system interdependencies and required interoperability. Affordability considerations extend beyond the system boundaries. Engineers can gain this understanding through discussions with end users, participation in exercise / experiments.

2. ***Understand the operational gaps***, mission deficiencies or enhanced / new capabilities being sought by users. What are the users' imperatives (threat, time, consequences) to meet these needs? Determine required vs. desired capabilities and performance levels. At what performance level would an improved capability provide no substantive value beyond current capabilities? At what performance level would an improved capability exceed that required to accomplish the mission? Resources spent delivering performance in excess of that needed could be more effectively applied to other needs. This understanding can be gained through examining the after-action assessments of operations, various operational lessons learned, etc.

3. ***Conduct market research*** to determine where exploiting or adapting commercial products or services in devising solutions may be possible. Understand the product marketplace, product maturity and the business as well as the technical / operational and logistics risks of reliance on commercial or government products. Many technology and capability assessments exist as well as product reviews that can help engineers as well as reaching out to FFRDCs, external industry and academia.

4. ***Assess the value proposition.*** From a portfolio point of view, valuate the cost effectiveness of solutions as compared to alternative expenditures of available resources on other needs or capabilities. Is the expenditure of resources "worth it?" Does the

desired enhanced/new capability provide value to users higher than addressing other important needs? Engineering assessments highlighted below (e.g., analysis of alternatives) provide techniques for evaluating the value proposition

5. ***Use early systems engineering*** to define the trade space in which alternatives can be developed and evaluated. Define multiple concepts and characterize them technically with sufficient information to support rough order of magnitude cost estimation. Use concept modeling, modeling and simulation, prototyping and/or experimentation to examine concept feasibility. Seek to identify cost and schedule drivers of these concepts as they relate to specific requirements. Involve system users in identifying technical or performance requirements that can be traded off to achieve cost and schedule objectives, or to define what capabilities can be affordably delivered. Identify the requirements that drive cost and/or schedule, that impose greater risk to timely delivery of needed capabilities. Work with the users and other stakeholders as needed to define evolutionary approaches to meeting these requirements.

6. ***Assess and compare the life cycle cost, effectiveness, and risks of alternatives*** in selecting a solution; ensure that your decision processes drive efficient and effective solution choices. Measure the affordability of each solution against a current budget profile and assess the affordability risk if the budget is changed. Engineers should understand and use established cost estimating tools to help determine cost drivers and major risks associated with the AEE of a capability.

7. ***Assess user stakeholder expectations against realism of budgets, time and technology maturity***. Understand the basis of budgets and funding profiles. Ensure they are consistent with the chosen solution / technical approach, based on a cost estimate of a suitable technical baseline, and include assessment of cost and schedule risk. Be wary of downward directed schedules. Develop engineering-based timelines showing the critical paths and dependencies; ensure that risks and uncertainty have been incorporated. For developmental items ensure that a technology readiness assessment accurately characterizes the technology maturity, and that the effort and time to advance maturity to achieve desired performance or other requirements is adequately assessed. Present the realism in cost as well as operational terms of what mission aspects will be and might not be totally satisfied by the recommended approach along with the feasibility / projection of capability satisfaction over time / future evolutions to help stakeholders assess tradeoffs. Create a time-phased roadmap highlighting the recommended AEE strategy for implementation of capabilities.

8. ***Establish, document and maintain a comprehensive, costable technical baseline*** to support timely cost analysis and design trades. The technical baseline of a chosen solution becomes the foundation for the program cost estimate and program planning and execution. Through program implementation, it serves as the basis for performance of design and strategy tradeoffs, risk management and mitigation analyses. For these purposes, the technical baseline must provide a holistic description of the system that includes its technical and functional composition, and its relationships and interdependencies with other elements of the enterprise.

9. ***Communicate the technical baseline*** to ensure its understanding by cost analysts. Work with the cost analysts in developing a comprehensive work breakdown structure that captures all aspects of the technical baseline. Provide credible engineering basis and make clear any assumptions regarding input to the technical baseline. Ensure that stakeholders—user community, acquisition community, oversight organizations, etc.--are all aware of, familiar with, and understand the trade-offs of the technical baseline and its role in AEE.

10. ***Assess the completeness and realism of the program's cost and schedule estimate***, its alignment and completeness with respect to the technical baseline and any changes thereto, and the adequacy with which uncertainty and risk have been integrated. As system requirements and program strategies change, the technical baseline as well as the program cost estimate should be updated.

11. ***Integrate management of cost and technical baselines throughout the program.*** Ensure cost, engineering and management teams work together (ideally co-located) to keep the technical baseline and program cost estimate current, and maintain a list of risks, cost drivers and alternative COAs/mitigations to address moderate/high risk areas.

12. ***Treat cost and schedule as part of the design-capabilities trade space***, just like size, weight, power, security, throughput, and other engineering parameters. Understand user expectations/targets for total system cost, and particularly unit procurement and sustainment costs for systems with large quantities to be installed or fielded. Assess the ability of the chosen design to meet these targets.

13. ***Understand and document all system interfaces, interoperability requirements, dependencies on other systems, programs and resources, and assess their associated risk*** as it would impact the program. The interfaces and dependencies of capabilities from independent, yet associated efforts can be a big contributor to cost due to schedule mismatches, reworking of misunderstood interface exchanges, increased complexity in testing, etc. Include consideration of these tasks and dependencies in the technical and cost baselines along with the operational utility/value of the interfaces, dependencies, and interoperability. Various crown jewel and map-to-mission techniques can be used to help accomplish this. These techniques are frequently used for cyber mission assurance assessments and are equally valuable to these AEE analyses.

14. ***Manage affordability as a key risk parameter in the contractor's system development effort.*** Use periodic design reviews to ensure each component of the system is on track from a risk perspective (technical, cost, and schedule) to meet functional, performance and interface requirements. Monitor design change for impacts to production and sustainment costs.

15. ***Inform key design and programmatic decisions*** with assessment and understanding of affordability implications and associated risks. Maintain and measure progress against AEE objectives (metrics) in design, engineering, and management reviews and decision

processes. Ensure “affordability” is communicated to decision-makers. Conduct independent assessments when confronted with significant change in affordability risk.

16. ***Keep users well informed and involved*** in major engineering decisions affecting requirements satisfaction, trade-offs, and affordability. Present the AEE risks (as highlighted below) to the user community for their decisions in accepting the risks (e.g., increased costs balanced against increased effectiveness) to achieve an overall best value solution.

Acronyms

Acronym	Definition
Aerospace	The Aerospace Corporation
AoA	Analysis of Alternatives
APB	Acquisition Program Baseline
API	Application Programming Interface
C&A	Certification and Accreditation
CAMP	Contractor Acquisition Management Plan
CDD	Capabilities Definition Document
CDR	Critical Design Review
CE	Chief Engineer
CM	Configuration Management
CO	Contracting Officer
COCO	Contractor Owned/Contractor Operated
CONOPS	Concept of Operations
COTR	Contracting Officer's Technical Representative
COTS	Commercial Off-the-Shelf
CPU	Central Processing Unit
DAWIA	Defense Acquisition Workforce Improvement Act
DoD	Department of Defense
DOORS	Dynamic Object-Oriented Requirements System
DT&E	Development Test and Evaluation
EVM	Earned Value Management
FAR	Federal Acquisition Regulation
FFRDC	Federally Funded Research and Development Center
FMEA	Failure Modes and Effects Analysis
FOC	Full Operational Capability
GAO	Government Accountability Office
GOCO	Government Owned/Contractor Operated
GOGO	Gov't Owned/Gov't Operated
IBR	Integrated Baseline Review
ICD	Initial Capabilities Document
ICE	Independent Cost Estimate

Acronym	Definition
IGCE	Independent Government Cost Estimate
IMP	Integrated Master Plan
IMS	Integrated Master Schedule
INFOSEC	Information Security
IOT&E	Initial Operational Test & Evaluation
IPT	Integrated Project Team
IT	Information Technology
IV&V	Independent Verification and Validation
KPP	Key Performance Parameter(s)
LCCE	Life Cycle Cost Estimate
M&S	Modeling and Simulation
MTBF	Mean Time Between Failures
MITRE	The MITRE Corporation
MOA	Memorandum of Agreement
MOU	Memorandum of Understanding
MTTR	Mean Time to Repair
NDA	Non-Disclosure Agreement
O&M	Operations and Maintenance
OMB	Office of Management and Budget
OT&E	Operational Test and Evaluation
PBA	Performance Based Acquisition
PII	Personally Identifiable Information
PM	Program Manager
PMO	Program Management Office
PMO	Project Management Office
PM	Program Manager
PWS	Performance Work Statement
QASP	Quality Assurance Surveillance Plan
RFC	Request for Comments
RFI	Request for Information
RFP	Request for Proposal
RTM	Requirements Traceability Matrix
SCRM	Supply Chain Risk Management
SDP	Software Development Plan

Acronym	Definition
SE	Systems Engineering
SE&I	Systems Engineering and Integration
SETA	Systems Engineering and Technical Assistance
SLA	Service Level Agreement
SoS	System of Systems
T&E	Test and Evaluation
TEMP	Test and Evaluation Master Plan
TPM	Technical Performance Measure
UARC	University Affiliated Research Center
WBS	Work Breakdown Structure

Glossary

Bow Wave	*A bow wave is the wave that forms at the bow of a ship when it moves through the water. A ship's bow wave defines the outer limits of a ship's wake. A large bow wave slows the ship down by pulling energy away from the ship. The bow wave dynamic is often used to illustrate a pattern of failure in program management. For example, a PM may decide to defer a difficult or complex development task to a subsequent increment. While this decision may temporarily improve the program's cost/schedule performance, the action actually compounds the program risk (like a wave that pulls energy away from the program) by adding work to subsequent increments without considering the additional schedule or resources required to complete that work.*
Leading Indicator	*A measure for evaluating the effectiveness of how a specific activity is applied on a project in a manner that provides information about impacts that are likely to affect the system performance objectives.*
Mission Assurance	*The disciplined application of proven scientific, engineering, quality, and program management principles toward the goal of achieving mission success. Mission assurance follows a general SE framework and uses risk management and independent assessment as cornerstones throughout the program life cycle.*
Program Office Estimate	*A detailed estimate of acquisition and ownership costs normally required for high-level decisions. The estimate is performed early in the program and serves as the base point for all subsequent tracking and auditing purposes*
Program Success	*Meets users' needs within cost, schedule, and performance constraints.*
Service Level Agreement	*The part of a service contract in which the level of service is formally and quantitatively defined, e.g., MTBF, MTTR, Quality of Service, various data rates.*
Technical Baseline	*The technical baseline defines technical goals, objectives, and scope and provides the basis for estimating project cost and schedule. It should be established in such a way that technical requirements can be understood, broadly communicated, and effectively controlled throughout the life of the project. The technical baseline should include design requirements, criteria, and characteristics that provide the basis for project definition.*

Tradeoff Analysis	*The process of evaluating and selecting among system technical, acquisition strategy, and/or funding alternatives with the intent of achieving desired capabilities, performance, and mission effectiveness within cost and schedule objectives.*

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