Using GAO's Technology Readiness Assessment Guide

Presentation to the Naval Postgraduate School Annual Acquisition Research Symposium

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May 10, 2018

GAO Guides and Best Practices

Currently Published Materials

- Purpose of these documents is two-fold:
  - Provide criteria for GAO audits
  - Provide guidance for agencies

- GAO has published the following guides:
  - Cost Estimating and Assessment Guide
    http://www.gao.gov/new.items/d093sp.pdf

  - Schedule Assessment Guide
    http://www.gao.gov/assets/680/674404.pdf

  - Technology Readiness Assessment Guide
    http://www.gao.gov/assets/680/679006.pdf

GAO Guides and Best Practices

Expert Group Process

- To develop these guides, GAO compiles a list of experts in that area to discuss topics

- For example, the Cost Expert Group was established in 2005 and has since grown to include experts on schedule analysis and earned value management
  - Group meets twice a year to discuss a variety of related issues
  - Contributions have been invaluable both in
    - Providing historical information and experience
    - Keeping the Guide current with industry trends

- GAO has currently assembled an Agile Expert Group
  - The group's first meeting occurred on August 30, 2016

Upcoming Guides: GAO Agile Assessment Guide
and update to the GAO Cost Estimating Guide

GAO Guides and Best Practices

How the Expert Group Works

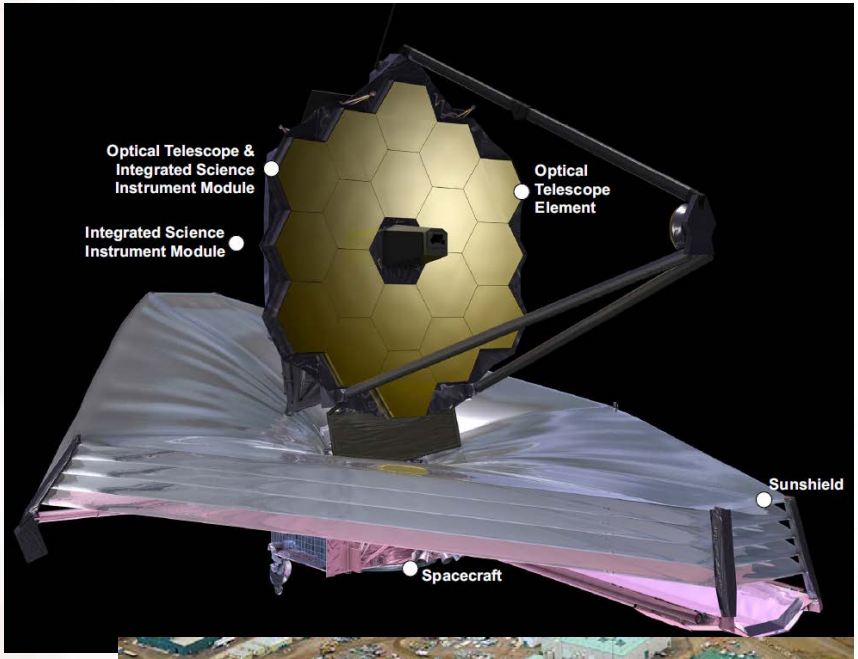
Develop Initial Guides

- Collect names to develop extensive contact list of experts in the field
- GAO researches various topics and develops drafts
- Expert Panel reviews drafts provided by GAO
- GAO vets comments to finalize Exposure Drafts
- Exposure Draft is published on the Internet and an open comment period is established
- GAO vets comments and incorporates them into the final version of the initial Guide

Updated Guides

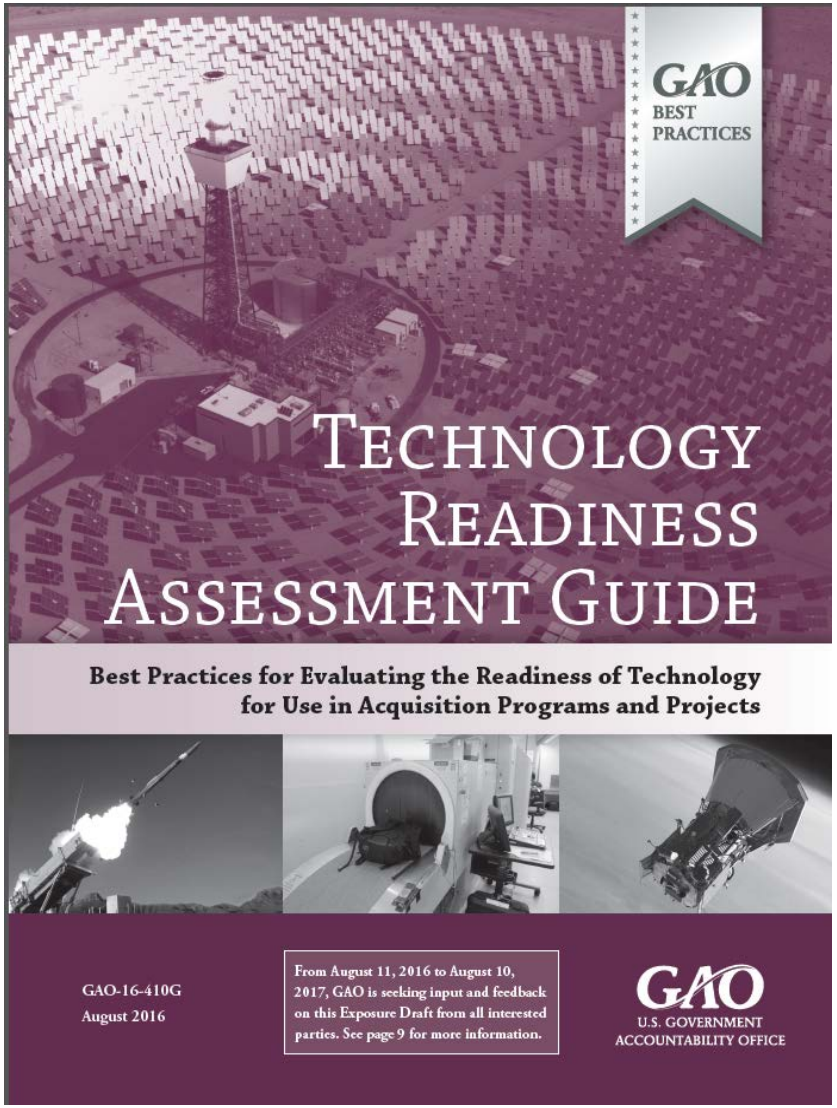
- GAO adds names to the contact list to ensure that the list of experts is inclusive
- GAO attends conferences/meetings to determine topics that should be discussed at meetings
- Broad Expert Meetings are held twice a year at GAO in March and September; agendas are sent out one month prior and GAO compiles and disseminates detailed meeting minutes
- GAO updates the chapters based on updated policies and research
- An open comment period is established and GAO vets and incorporates comments
- GAO issues an updated Guide

Technology Risk Assessment and Management is a Government-wide Challenge

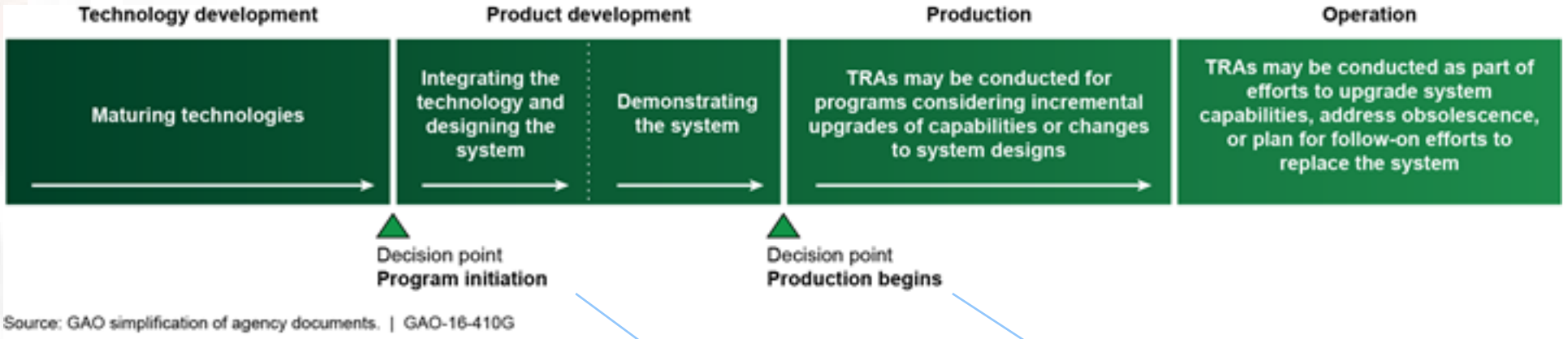


Technology Readiness Assessment Guide

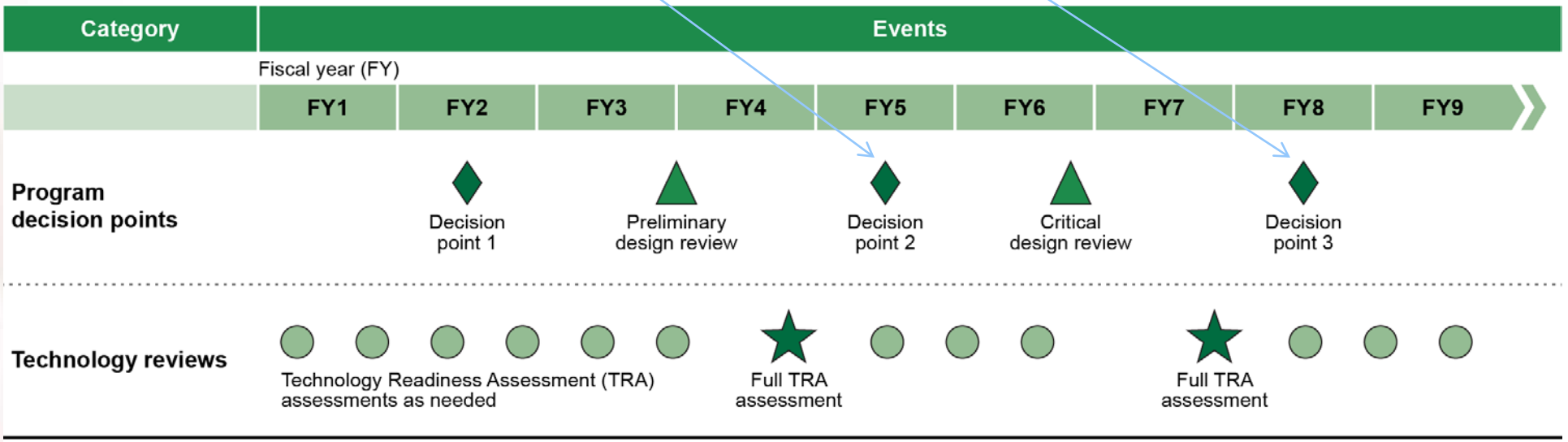
- Public exposure draft released on August 11, 2016
- Outlines criteria for evaluating technology maturity and readiness to move past key decision points where major resource commitments are made
- Contains 6 steps and related best practices for conducting TRAs
- Provides case studies from prior GAO audits to show typical findings related to technology readiness assessment
- Public comment period has concluded and adjudication process is underway



Phased Acquisition Cycle with Decision Points

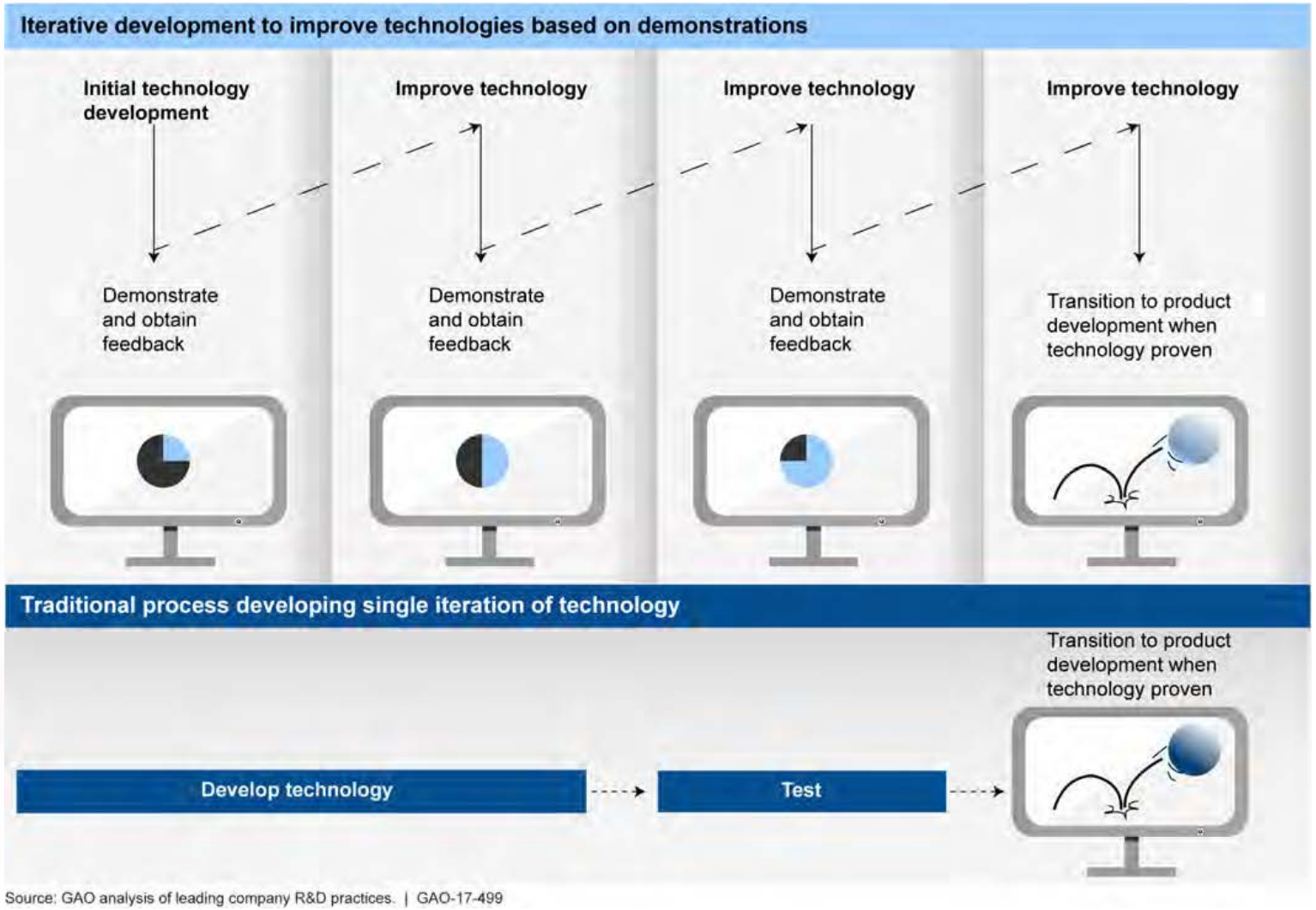


Source: GAO simplification of agency documents. | GAO-16-410G



Source: GAO analysis of agency documents. | GAO-16-410G

Iterative Technology Development Based on Demonstrations



Source: GAO analysis of leading company R&D practices. | GAO-17-499

Technology Readiness Levels

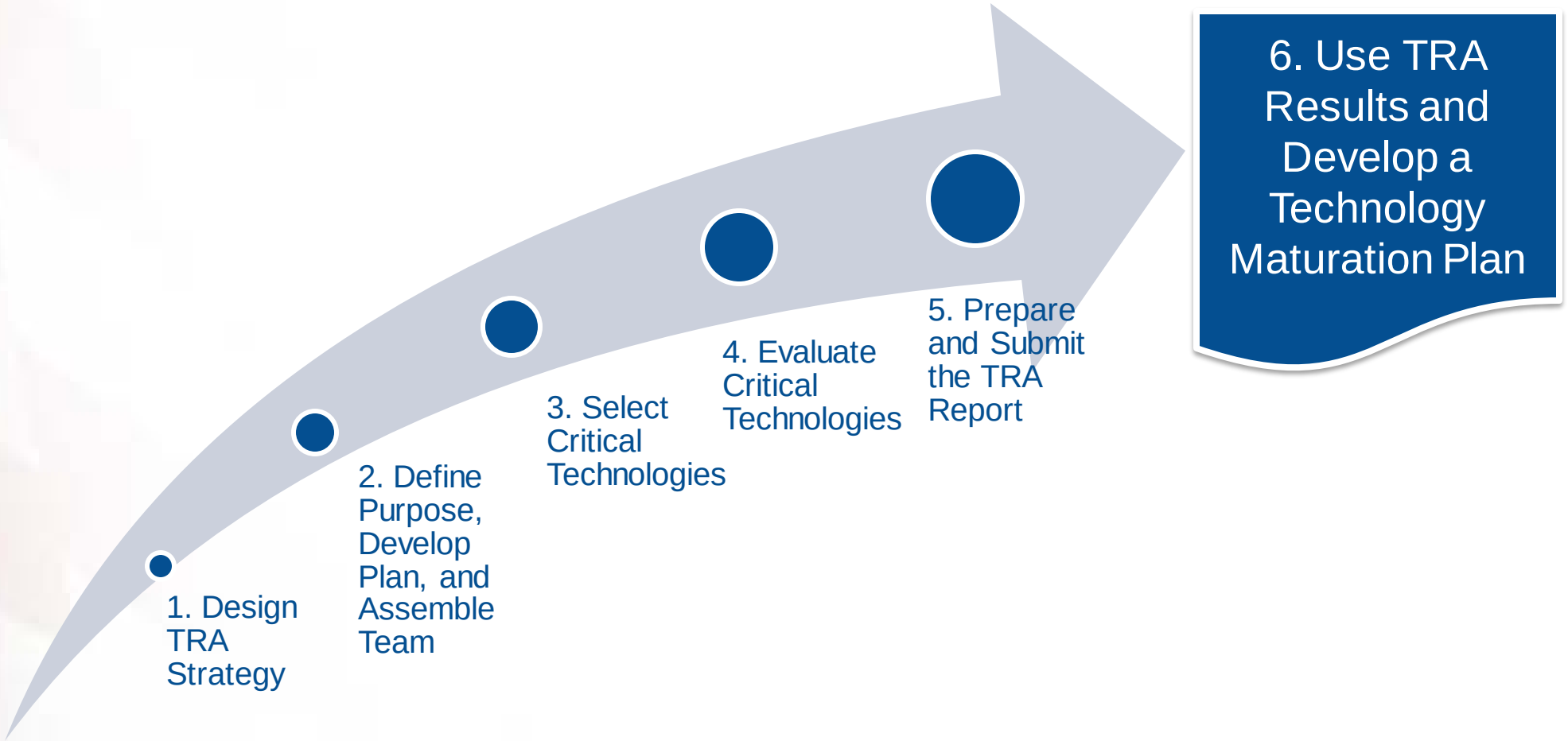
Technology readiness level (TRL)	Description
1 Basic principles observed and reported	Lowest level of technology readiness. Scientific research begins to be translated into applied research and development. Examples include paper studies of a technology's basic properties.
2 Technology concept and/or application formulated	Invention begins. Once basic principles are observed, practical applications can be invented. Applications are speculative, and there may be no proof or detailed analysis to support the assumptions. Examples are limited to analytic studies.
3 Analytical and experimental critical function and/or characteristic proof of concept	Active research and development is initiated. This includes analytical studies and laboratory studies to physically validate the analytical predictions of separate elements of the technology. Examples include components that are not yet integrated or representative.
4 Component and/or breadboard validation in laboratory environment	Basic technological components are integrated to establish that they will work together. This is relatively low fidelity compared with the eventual system. Examples include integration of ad hoc hardware in the laboratory.
5 Component and/or breadboard validation in relevant environment	Fidelity of breadboard technology increases significantly. The basic technological components are integrated with reasonably realistic supporting elements so they can be tested in a simulated environment. Examples include high fidelity laboratory integration of components.
6 System/subsystem model or prototype demonstration in a relevant environment	Representative model or prototype system, which is well beyond that of TRL 5, is tested in its relevant environment. Represents a major step up in a technology's demonstrated readiness. Examples include testing a prototype in a high-fidelity laboratory environment or in a simulated operational environment.
7 System prototype demonstration in an operational environment	Prototype near or at planned operational system. Represents a major step up from TRL 6 by requirement demonstration of an actual system prototype in an operational environment (e.g., in an aircraft, a vehicle, or space).
8 Actual system completed and qualified through test and demonstration	Technology has been proven to work in its final form and under expected conditions. In almost all cases, this TRL represents the end of true system development. Examples include developmental test and evaluation of the system in its intended weapon system to determine if it meets design specifications.
9 Actual system proven through successful mission operations	Actual application of the technology in its final form and under mission conditions, such as those encountered in operational test and evaluation. Examples include using the system under operational mission conditions.

Source: GAO simplification of agency documents. | GAO-16-410G

Four Characteristics of a High Quality TRA

- **Credible** - Assessment design, execution, and reporting activity reflects understanding of requirements, critical technologies, relevant or operational environments; assessment team has right knowledge and expertise
- **Objective** - Assessment is based on objective, relevant and trustworthy data, analysis, and information; free from internal and external organizational bias or influence
- **Reliable** - Uses disciplined processes that facilitate repeatability, consistency, and regularity
- **Useful** – Stakeholders understand information; it has sufficient detail and is timely and can be acted upon

Six Steps to Develop a High Quality TRA



Six Steps to Develop a High Quality TRA

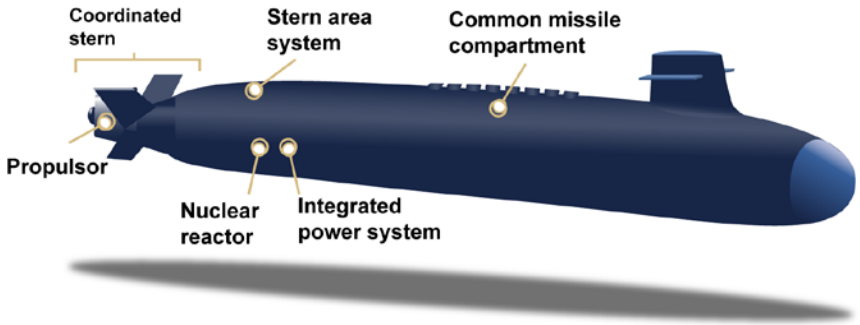
Develop TRA Strategy for Project	• Determine technology needs of a program and match up with assessment strategy • Document schedule for conducting assessments • Align assessment strategy to systems engineering management plan
Define Purpose, Develop Plan, and Assemble Team	• Determine purpose, level of detail, scope, TRL definition • Develop schedule and events • Determine specific team members and needed expertise • Outline the approach • Identify a plan for handling dissenting views
Select Critical Technologies	• Identify purpose, system, and performance characteristics in a technology baseline document • Use a Work Breakdown Structure that characterizes the system to select critical technologies • Use key questions and environment to determine if a technology is critical

Six Steps to Develop a High Quality TRA

Evaluate Critical Technologies	• Determine TRL definitions and required evidence prior to assessment • Determine acceptability of test articles and environments • Determine if testing results are sufficient and acceptable • Document all relevant information
Prepare and Submit the TRA Report	• Prepare an official report that documents actions from previous steps • Obtain report comments and explain dissenting views
Use TRA Results and Develop a Technology Maturation Plan	• Use TRA results to make decisions about the program's development priorities • Program management identifies TRA-related concerns and risks, including potential effects on cost and schedule estimates • Develop a technology maturation plan to track progress

Applying the TRA Guide: Columbia-class Submarine

- The Columbia-class program is a $126 billion effort to develop and build 12 new nuclear powered ballistic missile submarines.
- We used the criteria in GAO's TRA Guide to evaluate the quality and completeness of the Navy's assessment of technology readiness and risk.
- In December 2017, GAO reported that the Navy did not follow best practices for identifying the critical technologies for the program, resulting in an underrepresentation of the technical risk. The Navy's definition of critical technology was more restrictive than GAO's criteria.



Source: GAO analysis of of Navy documentation. | GAO-18-158

Conclusions

- Technology readiness assessment can play a critical role in good development planning, which can accelerate the fielding of new capabilities, shorten system development timeframes, and reduce risk.
- The GAO TRA Guide, Cost Guide, Schedule Guide can provide criteria to evaluate many types of large technology-oriented and/or capital acquisition projects.
- Risk assessments such as technology readiness assessments, and independent cost and schedule assessments are often not performed – or are incomplete or lacking in independence, resulting in significant program risk and cost overruns.
- GAO recommendations have been aimed at improving oversight to keep projects on cost and schedule and to risk manage critical technologies in complex acquisitions.
- Programs/projects which do follow the best practices demonstrate greater success in terms of outcomes and resource utilization.