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Technology Readiness Assessment for the Nuclear Weapons Program

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Overview

- Technology Readiness Assessment (TRA)
- What's Its Purpose?
- Why Use It?
- Approach
- What is the DP RL Calculator?
- Applications

What's the Purpose of TRA?

Identify

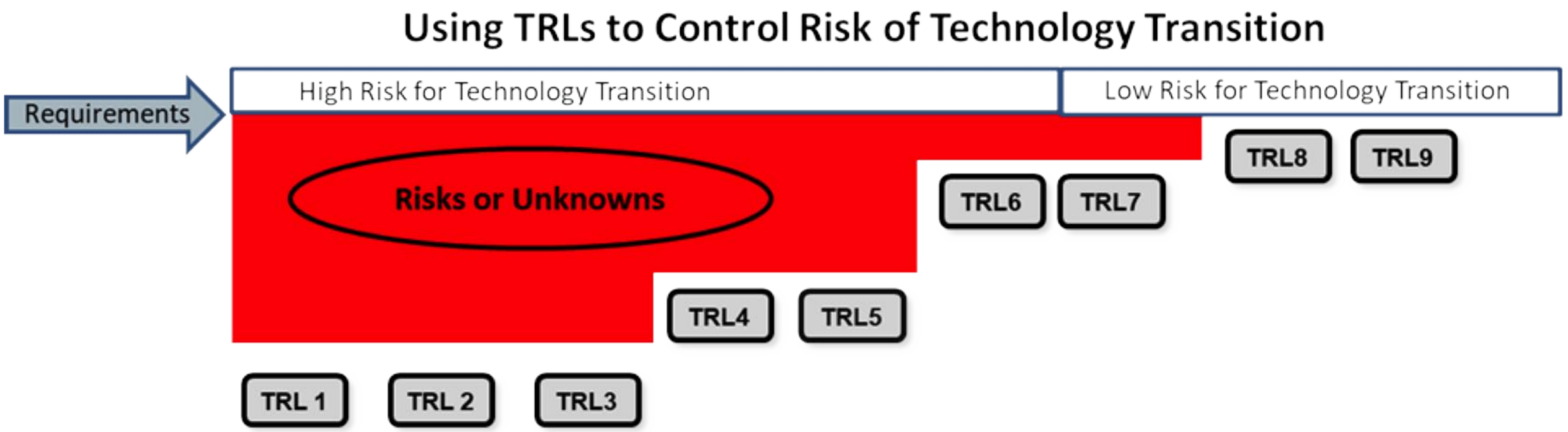
- Elements and processes of technology development required to reach proven maturity levels to ensure success
- Potential drivers for development; and the benefits, risks, and potential consequences of implementing or not implementing these technologies in DP programs
- Informs acquisition process

In the climate of declining budgets and increased budget scrutiny, it is prudent as early as possible within a program schedule to determine viability of the technologies, and the ability of those technologies to support the specific project as well as the DP mission.

Why Use TRA?

- Provide a communication tool between technologists and managers
  - Snapshots in time; should be a living tool
- Enable the identification of risks for informed decision making and funding needs
- Structured process to provide a common understanding of science and technology exit criteria
  - Needs to be credible, objective, reliable and useful
- Provide a method of measuring a technology’s maturity and its readiness for transitioning to the next stage of development

Why Use TRA? Continued



Why Use TRA? Continued

- Not only looks at the technology's technical maturity, but also the ability to manufacturing and program readiness
  - if key program management processes (e.g. requirements, risk, and cost management) are in place and being employed as the technology matures.
- Identifies technologies that will not be feasible to mature within time constraints and drop from the project or program.
- Increases visibility of risks and helps to identify any follow on activities that need to take place to mitigate the risks.

The TRA <u>does not</u> provide down select recommendations of one technology over another, nor is it an assess the overall Technology Maturation process.

Readiness Levels

Technical Readiness Level (TRL) - focuses on a technology's technical maturity and is designed to measure technical maturity, and indicate what has been accomplished in the technical development of that technology. TRL is a quantitative measure used to assess the maturity of evolving technologies (materials, components, devices, etc.) prior to incorporating that technology into a system or subsystem.

The TRL scale ranges from 1 (basic principle observed) through 9 (total system used successfully in project operations).

Manufacturing Readiness Level (MRL) - quantitative measures used to assess the maturity of a given technology, component or system from a manufacturing perspective. They are used to provide decision makers at all levels with a common understanding of the relative maturity and attendant risks associated with manufacturing technologies, products, and processes being considered.

The MRL scale ranges from 1 (basic manufacturing implications identified) through 9 (capability in place to begin full rate production).

Project/Program Readiness Level (PRL) - the level of maturity of the program management steps at that phase of the program for the insertion of the technology. It provides a means of communicating the degree to which a program is prepared to execute. PRLs address program management concerns, such as documentation of programmatic milestones, documentation, plans etc. seen as vital to successful technology product development.

The PRL scale ranges from 1 to 8 utilizing established DP milestones for the various program management implementation processes.

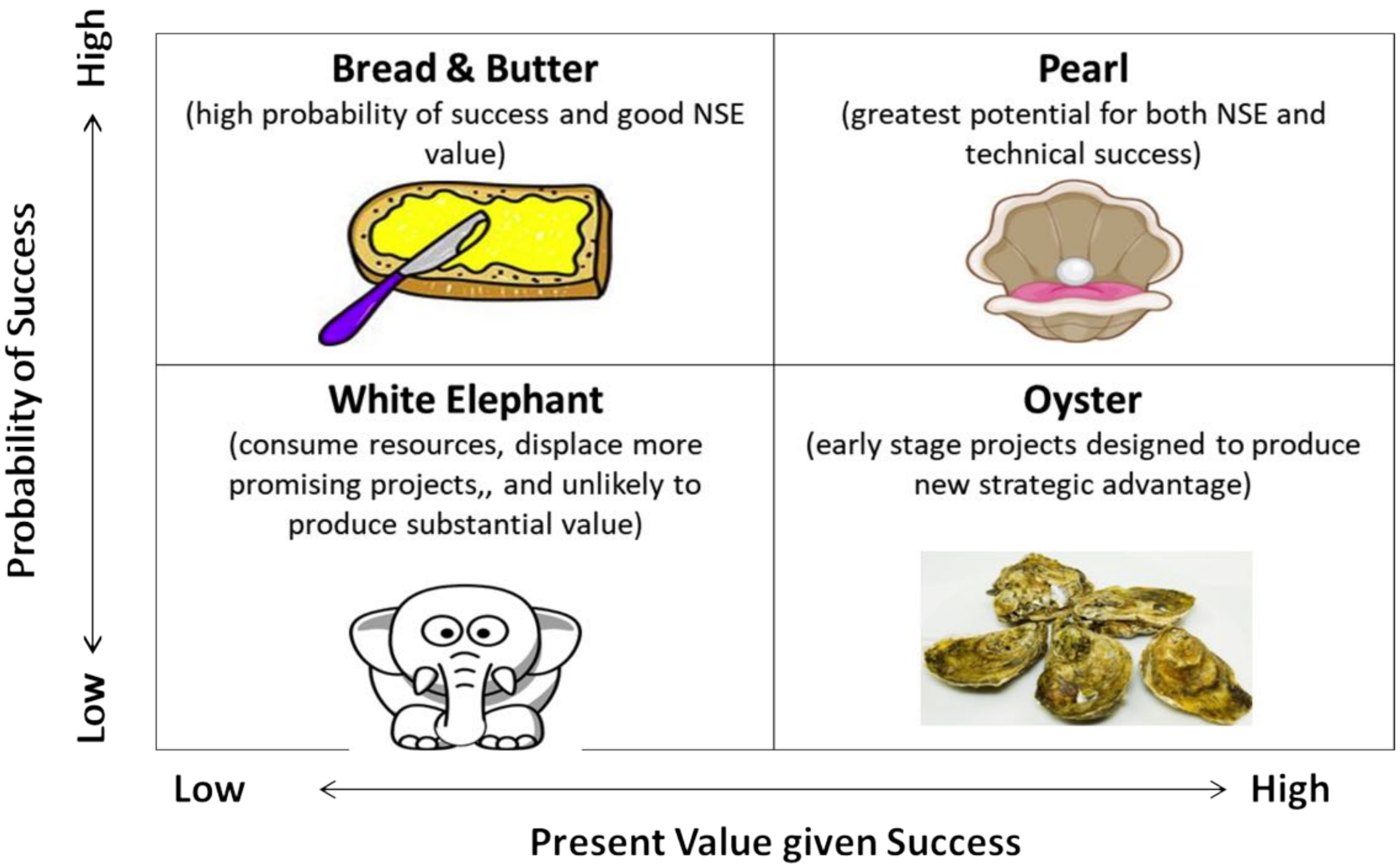
Additional Reference: GAO-16-410G Best Practices TRA Guide Draft August 2016

Nuclear Weapon Life-Cycle

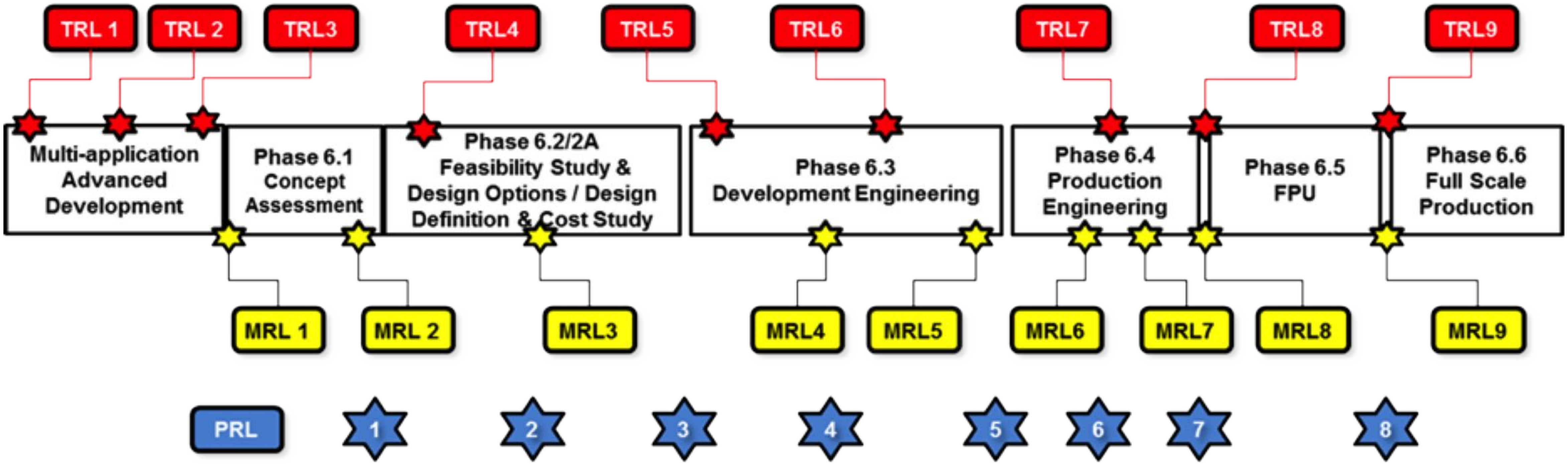
Phase 1	Phase 2	Phase 2A	Phase 3	Phase 4	Phase 5	Phase 6		Phase 7
Concept Assessment	Feasibility Study	Design Definition and Cost Study	Full-Scale Development	Production Engineering	First Production	Quantity Production	Stockpile Maintenance and Evaluation	Retirement and Dismantlement

Phase 6.1	Phase 6.2	Phase 6.2A	Phase 3	Phase 4	Phase 5	Phase 6.6
Concept Assessment	Feasibility Study and Design Options	Design Definition and Cost Study	Development Engineering	Production Engineering	First Production	Full-Scale Production

Planning a Balanced Tech Portfolio



Readiness Levels for Nuclear Weapon Program Phases



What is the DP RL Calculator?

- Tool for applying Technology Readiness Levels (RLs) to technology development programs
- Microsoft Excel spreadsheet application
  - Standard set of questions about the program
  - Comprises of questions related to technical, programmatic and manufacturing readiness levels
- Provides repeatable system for measuring a technology's maturity
  - "Snap shot" of program maturity at a given time
  - Historical picture of what's been done so far
- RLs are a uni-dimensional scale used to provide a measure of technology maturity

Key Benefits of the DP RL Calculator

- Provides a standard communication tool amongst technologies and between technologists and managers
- Enables the decision making process
- Provide a common understanding of science and technology exit criteria

Approach to TRAs in NNSA/Defense Programs

- TRAs should be completed as part of, or prior to, proceeding to the next phase of a project
  - Enables risks to be integrated into the overall project risk assessment
  - Programs' expectations for readiness levels (RLs) at each phase are weighing their particular technology complexity, as deemed applicable and appropriate
  - Any discrepancy/gaps in the technology either triggers a plan to bring the technology RL in par with the expectations for RL, or evaluation for removal from the program
- The Federal Program Manager (FPM) is made aware of the resulting risks in a quantifiable form, to include safety and security implications.
  - Deviating from the recommended approach could result in project risks that are not identified and captured

Evaluation Results - Grouping

Must Do: The technology is the only one to provide the functionality to meet the threshold requirement or "need". Generally "Must Do" means there are no alternatives or options.

Must Do (Trade Space}: The technology is one that has a required functionality that meet the threshold requirement, thus a "Must Do". However, there is more than one alternative option available "Trade Space". Further analysis of the "Trade Space" technology is necessary as part of the design process to select the best value proposition within the final design architecture.

Trade Space: This technology is one of several that can meet an objective requirement or "want".

Analysis also includes an evaluation of the Risks and Benefits of each Technology for the Program assessed and for the NNSA Enterprise

Limitations

- Depends on the use of a skilled team
- Needs to have credible data and evidence
- Snapshot in time; needs to be a living tool
- Needs to be followed up with a development plan

DP Applications

- W80-4 Life Extension Program
  - Evaluated about 60 different technologies at various Readiness Levels
  - About a third were included for insertion into the program and continued development on others
- Inter-operable Warhead Program
  - Evaluated over 150 technologies
  - About 10 technologies were essential and ~120 needed a business case or trade space evaluation since they were competing technologies
- Recommendations to Leadership

Summary

- TRA is a structured process to assess Readiness Levels for consistent standardized outputs
- RL calculator is a tool that is available to all NNSA personnel for internal evaluations
- Helps us identify risks and mitigation strategies to overcome the “Valley of Death”

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Backup Slides

Technology Readiness Levels

1	Basic principles observed and reported	This is the first level of technology readiness and includes fundamental scientific research. At this level basic scientific principles are being studied analytically or experimentally. Examples might include paper studies of a technology's basis properties.
2	Concept and application formulated	Practical application are beginning to be invented or identified. Applications are still speculative and there is no proof or detailed analysis to support assumptions. Examples might include applied research in a field of potential interest.
3	Concepts demonstrated analytically of experimentally	Active research and development is initiated. This includes analytical and laboratory-based studies to physically validate analytical predictions of key elements of the technology. These studies and experiments should constitute "proof-of-concept" validation of the applications/concepts formulated at TRL 2. Examples include the study of separate elements of the technology that are not yet integrated or representative.
4	Key elements demonstrated in laboratory environment	The key elements must be integrated to establish that the pieces will work together. The validation should be consistent with the requirements of potential applications, but it is relatively low-fidelity when compared to a final product. Examples include integration of ad-hoc hardware or software or with mock material in the laboratory such as breadboards, low-fidelity development components, and rapid prototypes.
5	Key elements demonstrated in relevant environment	Fidelity of the key elements increases significantly. Key elements are integrated with realistic supporting elements so that the technology can be tested and demonstrated in simulated or actual environments.
6	Representatives of the deliverable demonstrated in relevant environment	Represents a major step in a technology's demonstrated readiness. Examples include testing a prototype or representative of a deliverable in a high-fidelity, simulated environment or actual environment.
7	Final development version demonstrated in operational environments	Development version of the deliverable is near or at the planned operational system. This represents a significant step beyond TRL 6 and requires the demonstration of an actual development version of the deliverable in the operational environment. In almost all cases, this TRL coincides with the end of development. Examples include integration and demonstration within the next assembly, and advanced concept technology demonstrations of integrated systems such as flight testing.
8	Actual deliverable qualified through test and demonstration	The technology has been proven to work in its final form under expected conditions based on certification and qualification activities. Examples include: developmental test and evaluation of the actual deliverable in its intended application to validate that it meets design requirements, product definition requirements, and that the first production unit was accepted per a qualified process or as a qualified product.
9	Operational use of deliverable	Application of the technology in its final form and under mission conditions such as those encountered in operational test t and evaluation. An example includes using the deliverable under operational mission conditions. This TRL does not include ongoing or planned product improvement of reusable systems.

Program Readiness Levels

1	Identification of basic scientific concepts and performers with preliminary or proposed planning element and tentative schedule identified.
2	Establishment of program with 1) identified customer and technology with more detail program planning and strategies in place for technology maturation or acquisition and 2) a program/project team formed.
3	Establishment of formal program/project planning documents in place, including risk plan, requirements plan and requirement documentation, and configuration management. Work scope, schedule, and cost have been formally identified.
4	Program/project planning (acquisition strategies, maturation plans, etc.) are updated to reflect the results of the conceptual design development and finalization of requirements, including updates to the Integrated Master Plan/Schedule (IMP/S) and some form of a Performance Baseline (including total project cost, schedule, and scope) have been completed and issued.
5	The design requirements have been baselined, documented, and initial production or manufacture requirements or strategies identified and the cost and schedule updated to fully represent what is need to implement/produce the baseline design.
6	Technology design has been demonstrated that it meets requirements. Production affordability issues (i.e. cost reduction and avoidance strategies) built into initial production/construction, engineering drawings (i.e. wiring diagrams, mechanical drawing, building layouts, etc.) have been finalized and provided to manufacture/construction agency
7	Technology design and production have been verified and validated that it meets requirements. Production affordability issues (i.e. cost reduction and avoidance strategies) are incorporated, as appropriate, for production/construction. Planning and funding are in place to begin production/construction.
8	Technology is design, produced, or constructed and the customer agrees to accept product.
9	NA