



Best Practices in Defense Technology Development and Technology Maturity Assessments

***Systems & Software Technology Conference
(SSTC)***

28 April 2010

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Defense Acquisition University***

***Lt Col Dian Hall
DTRA-RD***



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Presentation Objectives



- Describe the problem space – *Why are we here?*
- Describe a solution set focused in the *Technology Program Management Model (TPMM)*
- Describe how to *change the culture* of an S&T enterprise
- Discuss the *installed base* for TPMM
- Use the *TPMM Implementation Project at DTRA* to illustrate how organizations can take action

Demonstrate how one solution developed out of necessity at the Army Space and Missile Defense Command has captivated the attention of the Defense Acquisition University and changed the landscape for S&T





Quantifying the Effects of Immature Technologies



According to a GAO review in 2005 of 54 DoD programs:

- Only 15% of programs began System Design Decision [post MS B] with mature technology (TRL 7)
 - Programs that attempted to integrate with immature technologies averaged 41% cost growth and a 13 month schedule delay
- At Critical Design Review, 58% of programs demonstrated design instability (< 90% drawings releasable)
 - Design stability not achievable with immature technologies
 - Programs without stable designs at CDR averaged 46% cost growth and a 29 month schedule delay

Source: Defense Acquisitions: Assessments of Selected Major Weapon Programs, GAO-05-301, March 2005

[Follow-up reports by GAO in subsequent years have not indicated any significant change in the Findings]





5 Reasons Why This Happens



- **Doctrine** Promotes delay
 - The DoD 5000 doesn't call for the first Assessment of the technology until MS-B (too late in the process to have any real effect on an immature technology)
- **Predisposition** of Viewpoints
 - Users know the requirements, Acquisition Managers know how to build things, and Technology Developers know how to invent.
 - A Forcing Function is needed to effectively cross those boundaries
- **Communication** Breakdown
 - Tech solutions selected to fill gaps need continual re-alignment to ensure development is on schedule and that the "right" problem is still being solved
- **Culture** Within the Technology Development Community
 - Tradition of Invention and scientific endeavor in the Technology Community contributes to a lack of Transition Focus
- **Interpretation** Wide Enough to Drive a Humvee Through
 - TRL definitions are vague and sometimes too subjective which can lead to more questions than answers.

One Conclusion: A System Engineering and Programmatic-based criteria set needs to be applied as a standard earlier in the process.





Observation: Common Challenges Facing Most Tech Directors



Effectively managing technology development

- Programmatic problems
- Lack of Systems Engineering Principles

Successfully transitioning technologies

- Transition not considered as part of Tech Dev
- Lack of Customer/User identification/involvement

I don't so much care what the answer is so long as the Technology Manager has asked himself the question!

J. Granone (Former Director - USASMDC)



A TRL-based, Stage Gate Model that Assists:

• Program Definition

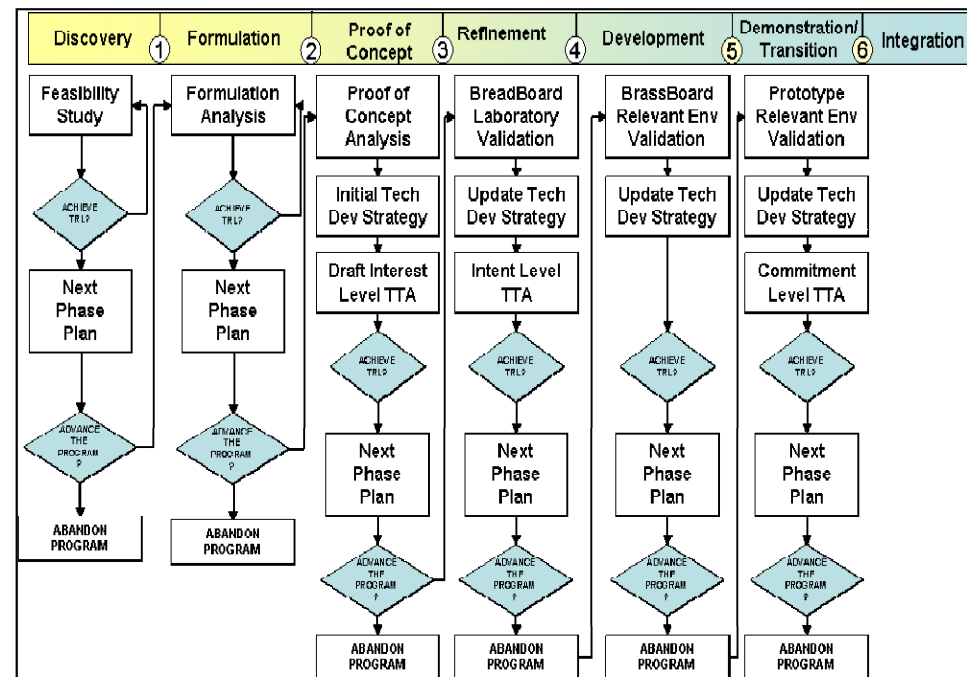
- Identify Activities that will be performed
- Identify Documents that will be produced
- Provide an Environment for Tailoring the Model
- Develop and Employ “Best Practice” Tools

• Transition Management

- Technology Transition
- Technology Transfer
- Technology Marketing

• Maturity Assessments

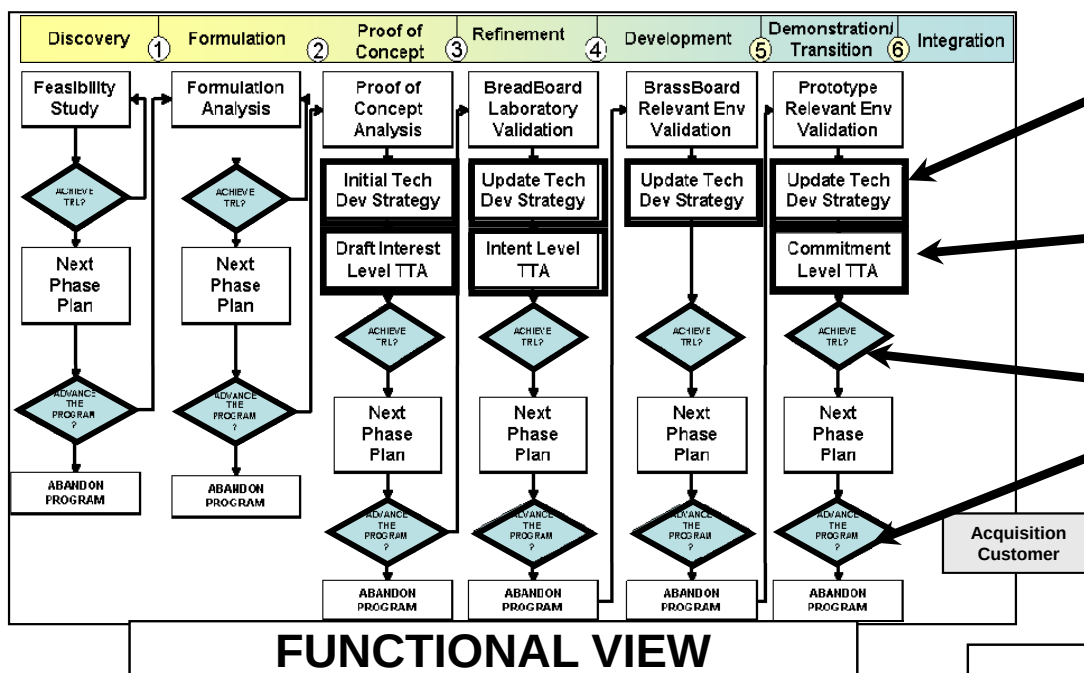
- Establishes Entry/Exit Criteria - Tailored for each Project
- Provides a Framework for Performing Technology Readiness Assessments (TRA)



***“TPMM: A Model Designed for
Technology Development and Transition”***



Key Features of the Multi-Dimensional TPMM



TDS establishes common language and vision

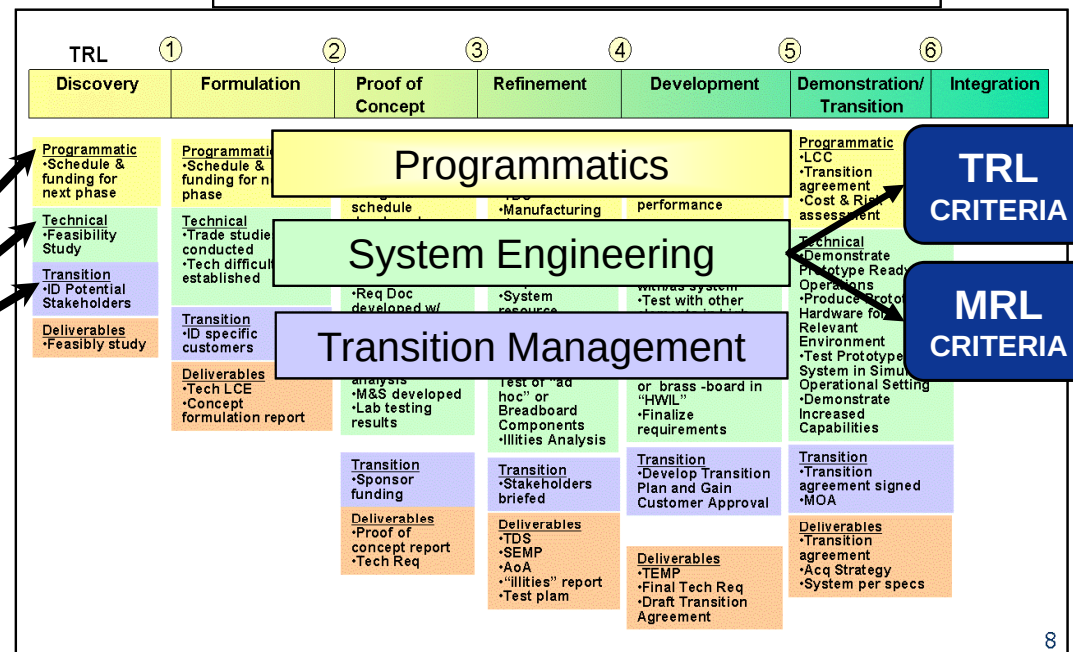
DAU adopted TTA

Program reviews include a TRA and a TAA

Acquisition Customer

ARCHITECTURAL VIEW

Multi-Dimensional criteria set provides a comprehensive TRL Assessment



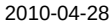
TRL CRITERIA

MRL CRITERIA





TPMM facilitates Technology Transition into Acquisition Programs





TPMM Support to Decision-makers





TPMM Strategic Value



Captures the Enterprise View of Technologies in S&T

Status of Programs

- Standardizes Progress in Meeting TRL Maturity Goals
- Transition Agreements in place
- Successful Transitions over time
- Program Distribution by
 - TRL
 - Technology Domain
 - Science Discipline
 - Sponsor
 - Acquisition Customer
 - Funding



Facilitate Strategic Planning

- Technology Distribution and Prioritization
- Technology Development Gap Analysis
- Domain Analysis
 - Skill gaps / recruiting needs (Develop/Maintain TC skill set)
 - Diversified Portfolio Analysis
 - Sponsor
 - Science Discipline
- TTA Migration Status
- Develop POM/Budget Inputs
 - Substantiates Technology maturity and value



TPMM Provides a Metrics-driven Process that Supports Strategic Decision Making





Program/Project Status Quad Chart (Notional Tech Program Metrics)



Program Description

Description

- Executive summary
- Validated Need
- Significance to End User

Current Technical Status

TRL Rating Based on TPMM

- TPMM Phase
- Required Criteria Met/Not-Met
- Gap Analysis (on Un-Met)

Cost & Schedule Progress

Technology Development Strategy

- Schedule Milestone Items
- Cost vs. schedule

Risk

- Risk Assessment on Gaps

Program Vision to Transition

TRL Roadmap

- TRL Milestone Schedule to transition

Transition Management

- Customer/User/Sponsor ID'd
- TTA Version (Interest, Intent, Commitment)





Government Agency/ Program TPMM Users



Missile Defense Agency

- Kill Assessment Technology Program used TPMM to broker the inclusion of their technology concept into the C2BMC Element of the BMDS.

Department of Homeland Security

- Provided Basic Research technology maturity data (Entry/Exit Criteria, Phase Deliverables, and Activities) used to populate the Exploratory portion of their draft S&T RDT&E Process.

Air Force (AFMC at Wright-Patterson AFB)

- Supporting TD-1-13 Initiative: High Confidence Technology Transition Planning Through the Use of Stage-Gates (More later)

U.S. Army Space and Missile Defense Command/Army Forces Strategic Command (USASMDC/ARSTRAT)

- Vertical/horizontal Integration of Space Technologies and Applications (VISTA) Program
- Distributed Imaging Radar Technology (DIRT)
- All Weather RF Launch Detection (AWRFLD)

Defense Acquisition University (Huntsville Campus)

- Developing an interface between Technology Assessment and Transition Management (TATM tool used at PEO Aviation) and TPMM.

Defense Threat Reduction Agency (NTD Ft. Belvoir)

- Providing Engineering Analysis to initiate collaboration on a Technology Management Process Improvement effort designed to implement the TPMM in their Division S&T.





DTRA RD TPMM Implementation Pilot

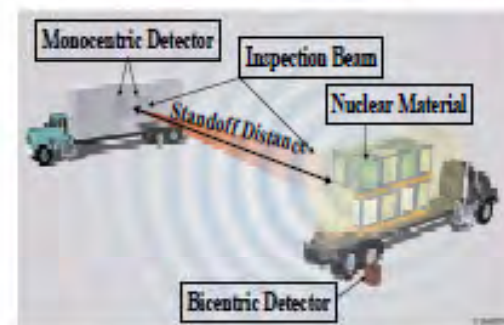




Defense Threat Reduction Agency



Making the world safer...

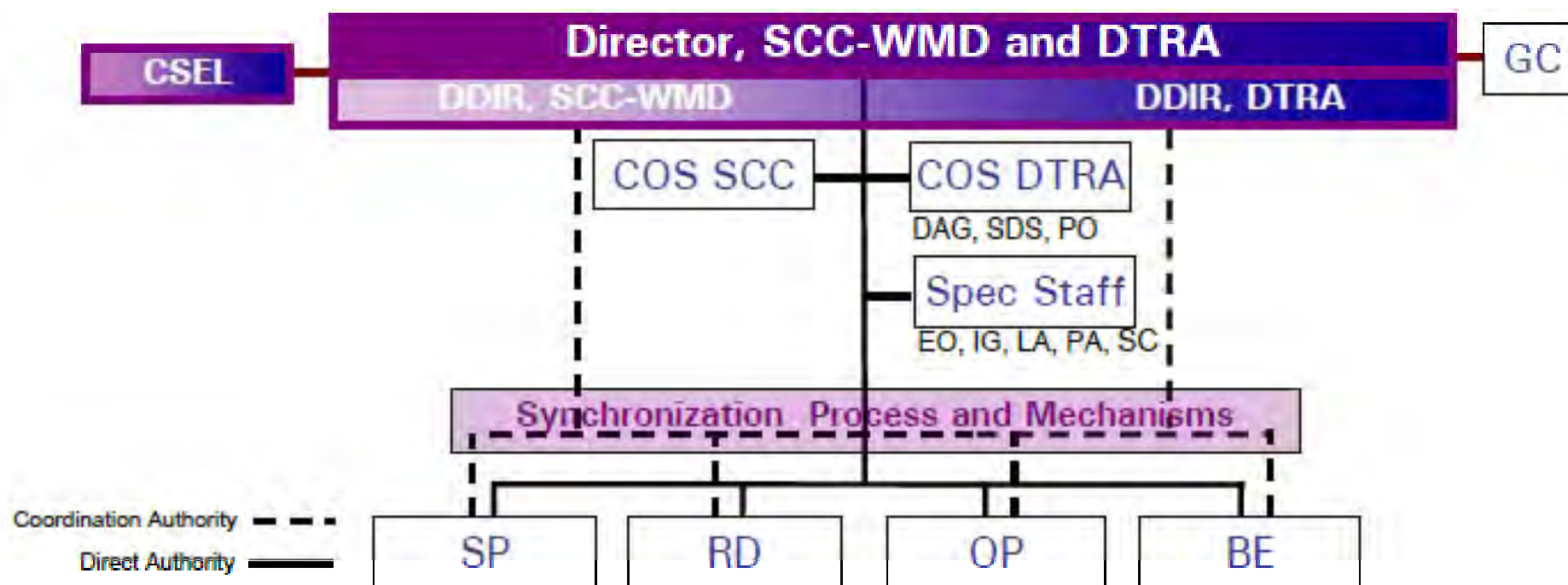


...by countering weapons of mass destruction





DTRA Organization





Challenges Facing an RD-NT Tech Director



Effectively managing technology development

- Programmatic problems
- Lack of Systems Engineering Principles

Successfully transitioning technologies

- Transition not considered as part of Tech Dev
- Lack of Customer/User identification/involvement

*Establish “a management methodology that balances the portfolio by **Imposing Structure and Rigor** through the use of clear, well-defined and **Measurable Metrics!**”*

J. Heusmann DTRA-RD-NT (7 May 09)

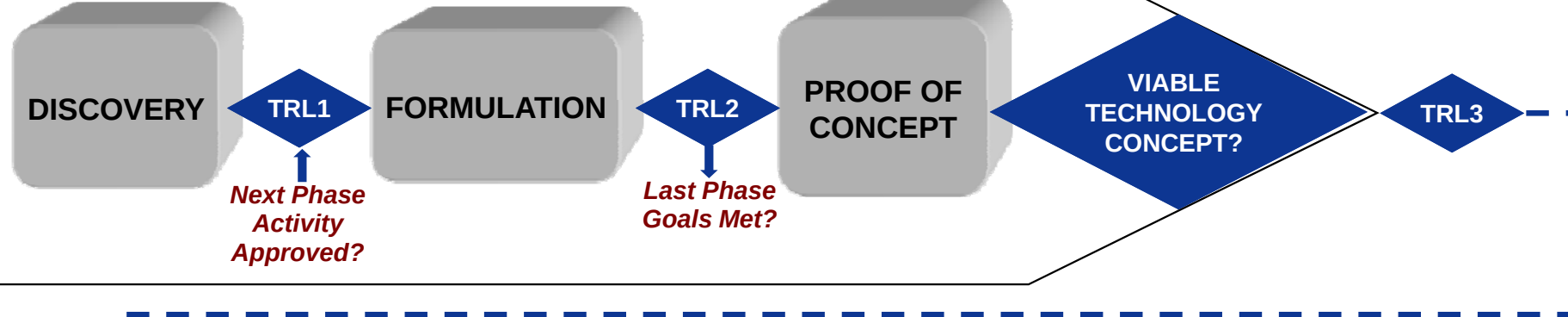




Introducing Stage-Gate

STAGES OF BASIC RESEARCH (Conceptual)

IDEA



STAGES OF TECHNOLOGY PROJECT DEVELOPMENT (Operational)

TECH
PROJECT
INITIATION

REFINEMENT

TRL4

DEVELOPMENT

TRL5

DEMONSTRATION
to TRANSITION

TRL6

CUSTOMER
/USER

LAUNCH

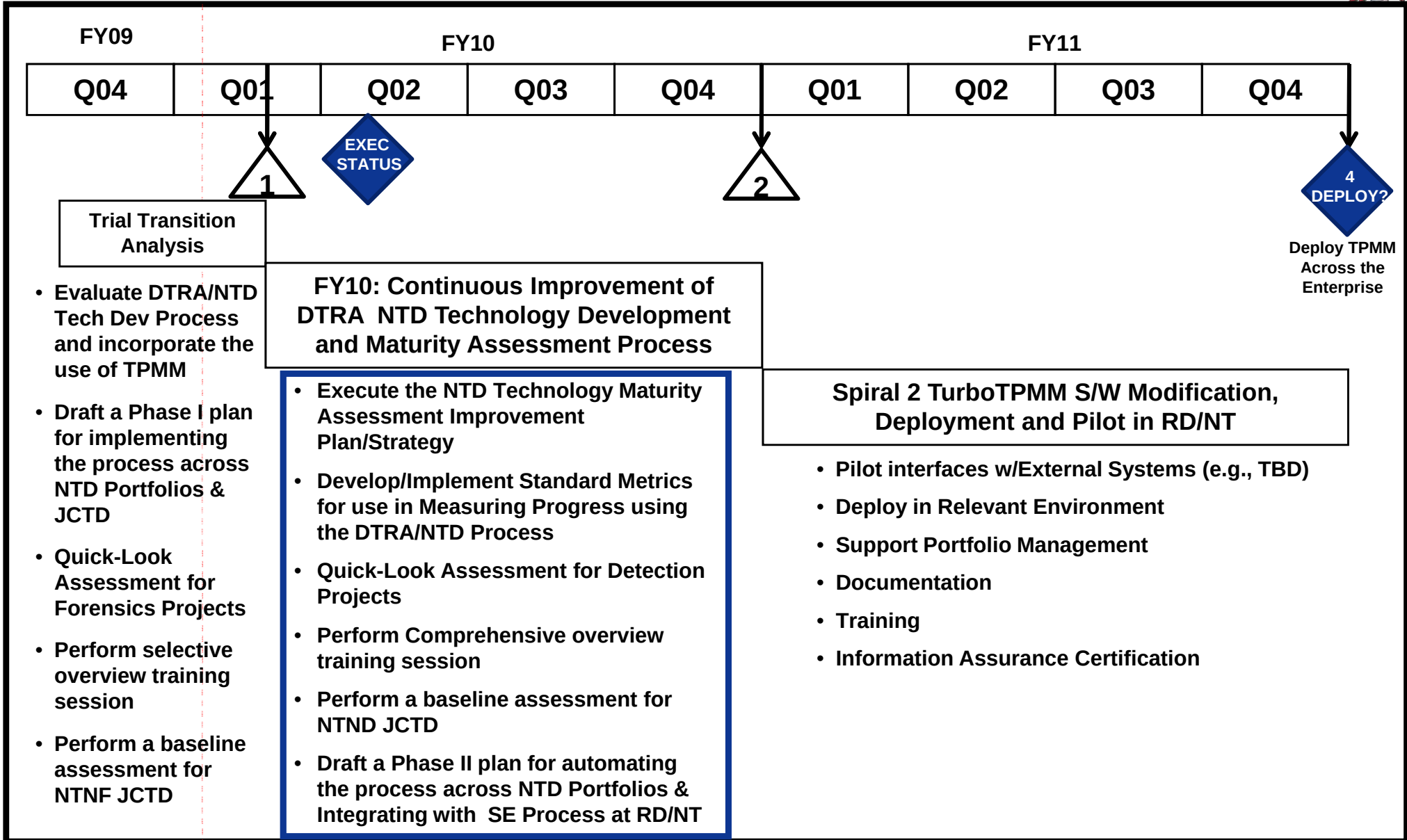
Process Represented by:

- Distinct Blocks for Conceptual and Operational development paths that when combined, traverse from Idea to Launch.
- Managed process of Defined Stages composed of Activities/Tasks that are evaluated as input criteria for planning/approval to proceed to the next stage.
- Stages culminate in Decision Gates of measurable Exit Criteria used to evaluate technical accomplishment and technology readiness/maturity (TRL).





Current Plan for TPMM Implementation in DTRA/RD-NT



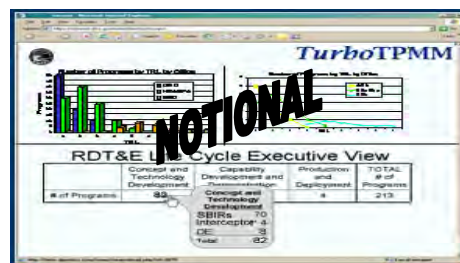


TPMM Implementation Process



Organizational Policy/Standards

Executive Dashboard



KBS

Program Sponsor
or Technology
Portfolio Mgr

QSR

TRL Rating Based on TPMM - TPMM Phase - Required Criteria Met/Not Met - Gap Analysis (on Un-Met) - Risk Assessment on Gaps - Current TRL, confidence and submission or none	Technology Development Strategy - TPMM Requirement? (TRL3 or beyond) - Status - Draft, Preliminary, Final - Updated for Current Phase? - Gap Analysis/Percentage Populated
Transition Management - Customer/User/Sponsor ID'd - TTA Version (Interest, Intent, Commitment) - TTA Matrix Populated - Signature Status	TRL Roadmap - TRL Milestone Schedule to transition - TPR Status

Technology
Maturity
Assessment

Primitive
Data
(as needed)

Gap
Analysis

Technology
Programs

TRL RM

TDS

TRA

TTA

Standards-Based
Training Courses

Performance Quad Preparation Workshops

Deliverables / Lessons-Learned

LEGEND:
Infrastructure:
Status Review:

TPMM
TECHNOLOGY
PROGRAM
MANAGEMENT

TRL Exit
Criteria

KBS

DMD



TPMM Implementation Process



After the TMA, the Technology Maturity Level is available to be posted in its for Executive

Policy/Standards

KBS

Program Sponsor or Technology Portfolio Mgr

LEGEND:
Infrastructure:
Status Review:

At the same time, a critical review of Project Deliverables by subject matter experts will be conducted to verify that agreed-to Exit Review Criteria are met and that identified Risks have been mitigated.

Organizational Policies and Standards:

is-based behavior forms the basis of the ns' Knowledge Base which grows over time as v Project adds their artifacts and experience.

the TRL

a you will use to Assess Technology Maturity and Progress:

- The TPMM contains entry and exit criteria to guide Systems Engineering, Programmatic, and Transition technology development activity

Gap Analysis

TPMM
TECHNOLOGY
PROGRAM
MANAGEMENT

TRL Exit Criteria

KBS

TPMM v.2
Standards-Based
Knowledge
Training Courses
- Based -
System

Technology Programs

TRL RM

TDS

TRA

TTA

Performance Quad Preparation Workshops

Deliverables / Lessons-Learned

DMD



Planned TPMM Pilots at DTRA-NT in FY 10/11



Basic Research

- BA to identify TRL 2/3 opportunities (1 or 2 projects) that BA and NTD will develop a transition plan for FY11 execution .

NTD TPMM Pilot

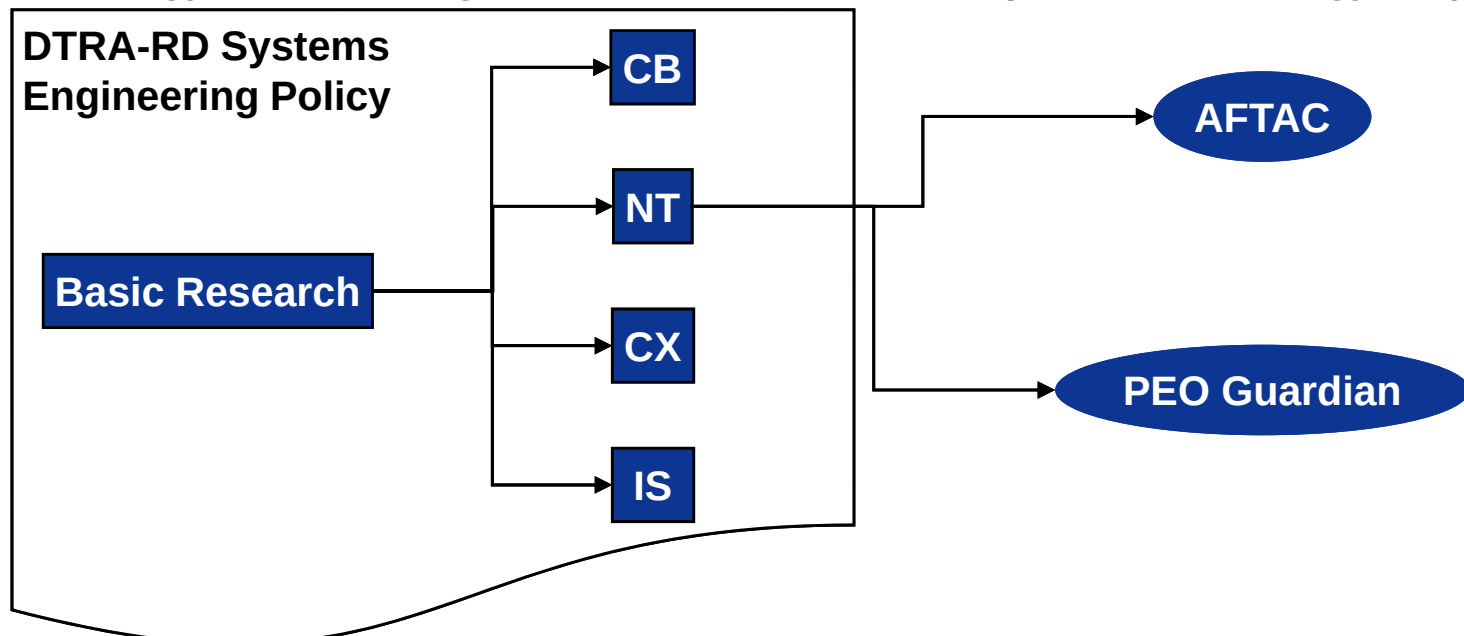
- Develop/Implement Standard Metrics for use in Measuring Progress using the DTRA/NTD Process. Perform Quick-Look Assessment for Detection Projects and Baseline in TPMM.

Systems Engineering

- Drafting DTRA-RD Systems Engineering Policy and developing strawman Technology Maturity Assessment Process for use as Formal Gate Review.

Transition to Customer Pilot(s)

- Developing Generic Transition Process between PEO Guardian and DTRA-RD including Pilots
- Executing Technology Transition Agreement with AFTAC on a specific Technology Project





Overview Summary



- TPMM is an **activity model** for technology development that is partitioned into phases and gate-qualified using **TRL's**.
- TPMM is a **best practice standard** that expands TRL understanding to include **detailed activities, exit criteria, and deliverables**.
- TPMM is a **toolset** used by the Tech Manager to **plan, guide and measure** a technology program's development maturity.
- TPMM is an **alignment mechanism** that promotes early focus on **transitioning the technology** to Acquisition Program Customers.
- TPMM acts as a **common yardstick** and provides the criteria for evaluating the **Technology Development Strategy** earlier.
- TPMM model provides **a standard TRL criteria set** for performing effective **Technology Readiness Assessments** at MS B





Contact/Consultation Information



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US Government Personnel can request a copy of TPMM V2.pdf file at:
<http://www.tpmm.info>





QUESTIONS?





BACKUP





DTRA-RD Systems Engineering Policy [DRAFT]



DTRA DIRECTIVE XXXX.X

SUBJECT: Defense Threat Reduction Agency (DTRA) Research and Development (RD) Enterprise Systems Engineering (SE) Process Model

- References:
- (a) DoD Directive 5000.1, "The Defense Acquisition System," May 12, 2003
 - (b) DoD Instruction 5000.2, "Operation of the Defense Acquisition System," April 5 2002
 - (c) AT&L Memorandum, "Policy for Systems Engineering in DoD," February 20, 2004
 - (d) AT&L Memorandum, "Implementing Systems Engineering Plans in DoD - Interim Guidance," March 30, 2004
 - (e) AT&L Memorandum, "Policy Addendum for Systems Engineering in DoD," October 22, 2004
 - (f) Technology Program Management Model (TPMM) Version 2 dated September 2006
 - (g) DoD Instruction 3210.1, September 16, 2005

TPMM Added as a Reference to the DTRA-RD Systems Engineering Policy

A. PURPOSE

This Instruction establishes Defense Threat Reduction Agency (DTRA) Research and Development Enterprise (RD) policy, prescribes procedures, and assigns responsibility for Systems Engineering development and execution.

B. APPLICABILITY

This Directive applies to all RD Directorates responsible for managing programs beyond the Basic Research level for developing technology solutions to validate operational requirements.

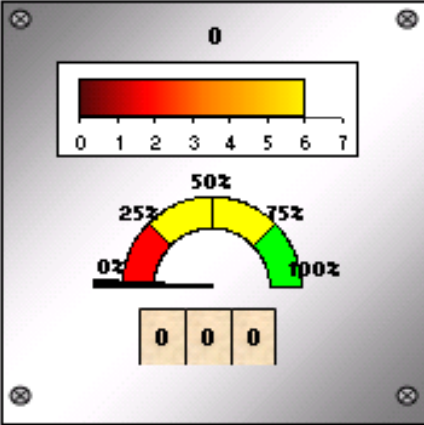
C. DEFINITIONS





TRL 6 Quick-Look Assessment Checklist [DRAFT]



Project:	TRL: 6
	

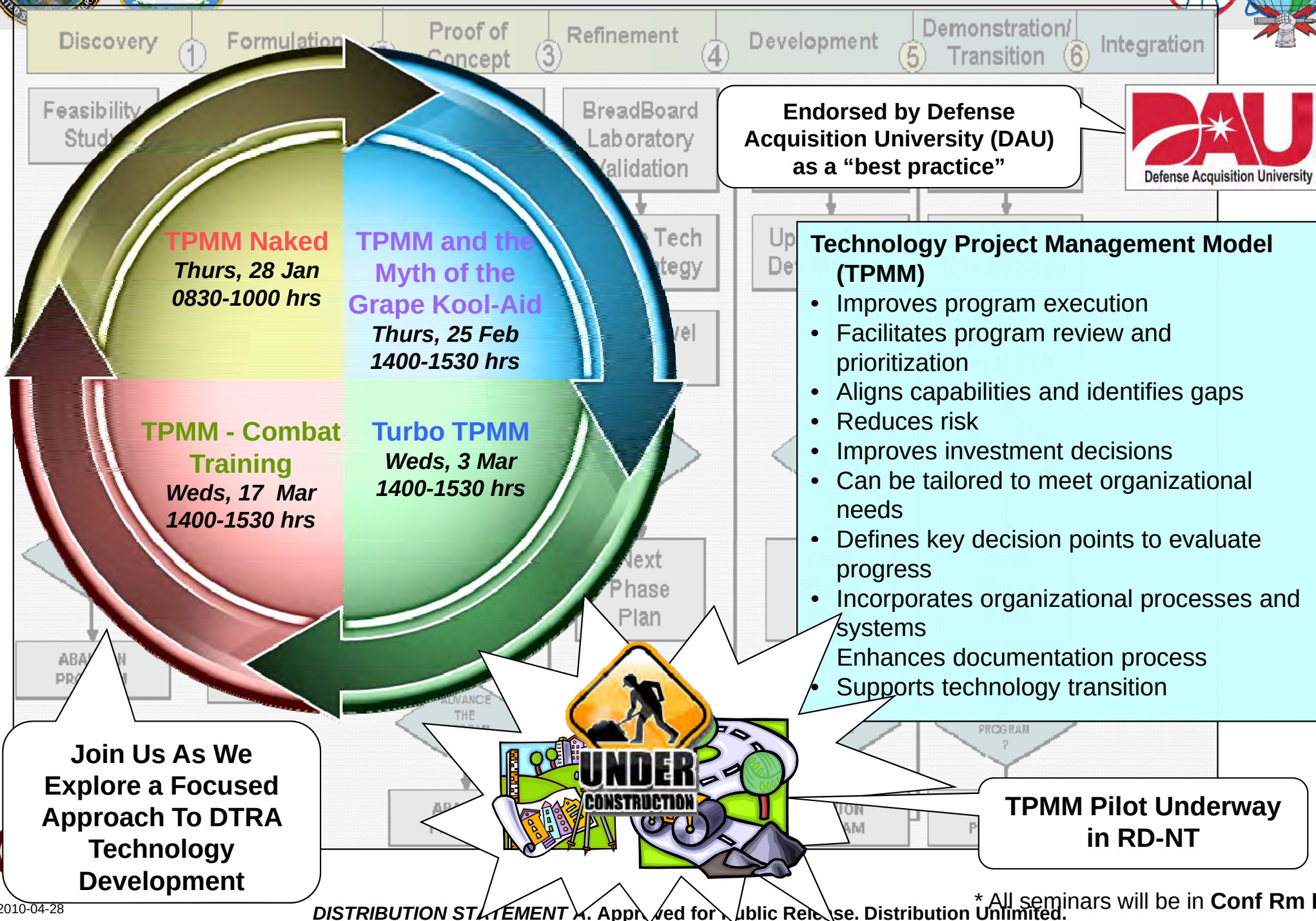
TRL 6 Quicklook Worksheet

Mnemonic	Description	Yes	No	N/A	Comments	Response
Program Management						
66211	Technology has been assessed at TRL 6.	☐	☒	☐		
56017	The technology program development strategy has been Finalized	☐	☒	☐		
66047	Provide an estimate of the costs for Transition and Technology Integration into Acquisition Program	☐	☒	☐		
66048	A realistic estimate total life-cycle costs have been documented	☐	☒	☐		
66035	A Risk Mitigation plan has been documented and reviewed by the Programmatic	☐	☒	☐		
13040	The Technology Advancement Degree Of Difficulty has been revised based on the validation process.	☐	☒	☐		
	The Delivery Baseline is established and under formal Configuration control	☐	☒	☐		
	All Corrective Actions are closed or resolved for closure	☐	☒	☐		
	Software Development Cost projections for the Transition phase are updated in the TDS	☐	☒	☐		
Technical Management						
35009	Refined Operational And Mission Requirements/Objectives were finalized	☐	☒	☐		
35015	System Functional Requirements were finalized	☐	☒	☐		
66030	Specific performance goals and exit criteria that must be met before exceeding number of prototypes were met	☐	☒	☐		





TPMM Seminar Series





DTRA TPMM IPT

[NOTIONAL]



Director's Staff (DIR)

Security & Counter Intel

TPMM SMEs

Research & Development (RD)

Chem Bio Technologies

Counter WMD
Technologies

Systems Engineering

Nuclear Technologies

Plans and Programs

Contracting

Information Operations

Acquisition Mgmt

Contingency Operations

DTRA
Core Integrated Product Team

RD TPMM Pilot

Business (BE)

Operations (OP)

DMD



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Risk

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Program Vision to Transition

TRL Roadmap

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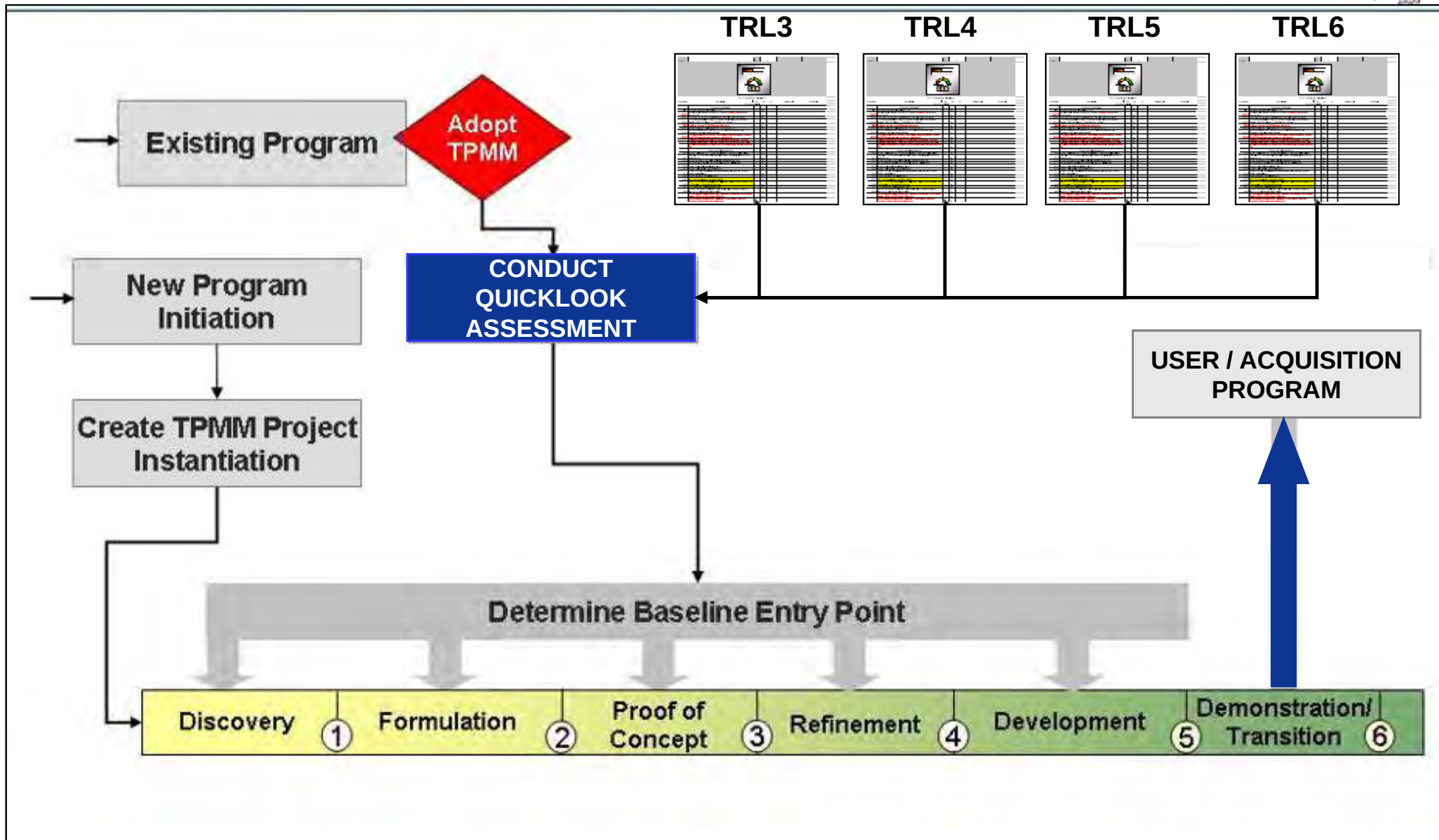
Transition Management

- Customer/User/Sponsor ID'd
- TTA Version (Interest, Intent, Commitment)





TPMM Entry Process





Tech Project Gap Report [DRAFT]



Demonstration/Transition Phase Planning			
<i>Mitigated Risks</i>			
<u>Category</u>	<u>Exit Criteria</u>	<u>Justification Type</u>	<u>Justification Status</u>
Demonstration/Transition Phase Planning			
Program Management Planning			
Systems Engineering Planning	The threats to the warfighter addressed by the technology were accurately documented	Justification Applicable Future	Date: 1/15/2010
Requirements Update Planning			
Design Update Planning	Document the electrical and mechanical interfaces for this spiral or increment of development	Justification Applicable Future	Date: 12/15/2009
	Provide the detailed design drawings necessary for this spiral or increment of development	Justification Applicable Future	Date: 12/15/2009
	Provide updated design techniques and codes to be used during this spiral or increment of development	Justification Applicable Future	Date: 12/15/2009
Manufacturing Planning			
Relevant Environment Validation Planning	Document the overall test plan for this phase of development	Justification Applicable Future	Date: 1/15/2010
	Identify Test instrumentation required	Justification Applicable Future	Date: 1/15/2010
	Identify and briefly describe and special test equipment required for a specific test	Justification Applicable Future	Date: 1/15/2010





TPMM Strategic Value



Status of Programs

- Standardizes Progress in Meeting TRL Maturity Goals
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TPMM Phase Deliverables

