Technology Program Management Model (TPMM)

A Systems-Engineering Approach to Technology Development Program Management

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Dynetics
The Power of Solutions™

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Mission is to “Successfully *support the transition* of evolving and mature technologies to customers.”

Technology Program Management Model (TPMM)

Introduction

TPMM V2 applies a **systems engineering methodology** to Technology Program Management developed by the Space and Missile Defense Technical Center

This presentation will highlight how a model like the TPMM can provide the Defense S&T community as a whole with the following benefits:

- **A Systems Engineering Approach**
- **Improved Documentation Process**
- **Better Program Execution**
- **Management Decision Metrics**
- **Defensible Budgets**

Transitioning Technology To Programs

Technology Development		Technology Transition
ERINT	MISSILE UPGRADE	PAC III
Ground Based Interceptor	TECHNOLOGY DEMONSTRATION	EKV
THAAD Technology Program (HEDI)	TECHNOLOGY BASE	THAAD System
Radar Systems Technology	SENSOR TECHNOLOGY	Next Generation Radar
Satellite Early Warning System (SEWS)	SPACE AUGMENTATION	JTAGS
Solid State Laser Test Bed	HIGH ENERGY LASER TECHNOLOGY	Solid State Demonstrator
TCMP-3	SYSTEM INTEGRATION TEST	Critical Measurement & Countermeasures Program

SMDTC Had The Problem of Every S&T Executive

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 identification/involvement

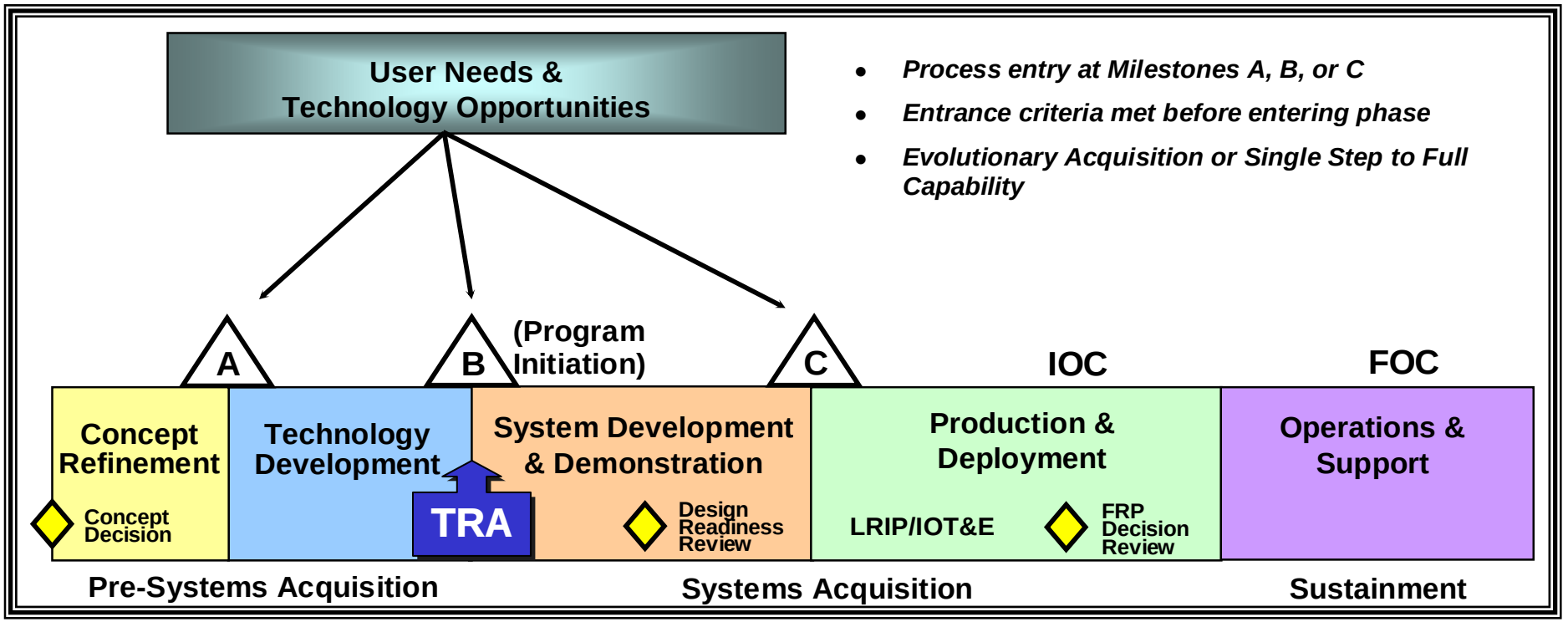
Quantifying the Effects of Immature Technologies

According to a GAO review 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

First TRA Requirement



DoD 5000 Metric

- Technology Readiness Assessment (TRAs) - Required at MS B
- TRAs using Technology Readiness Levels (TRLs)

Perspectives

Hey Buddy - I OWN The Requirements!

Gotta be small, lightweight, and 99.99% reliable

I Want it All!!
I Want it Cheap!
I Want it Now!

I'm governed by the JCIDS

- Threat Driven
- Soldier-Proof
- Fieldable
- Meets Mission Needs
- **DOTMLPF**

USER

Your next chance for funding is 5 years down the road – stud!

I NEED a REQUIRMENT (CDD)!

My prime can do that!!

I am governed by DoD 5000.

You forgot about the "illities"!!!

- Value Added
- Capability
- Probability of Success
- Acquisition Strategy
- Budget (LLC/POM)
- Schedule - WBS
- The System " approach"

PM

If you "Push" long enough – they will come!

You don't understand - This project is different from everyone else

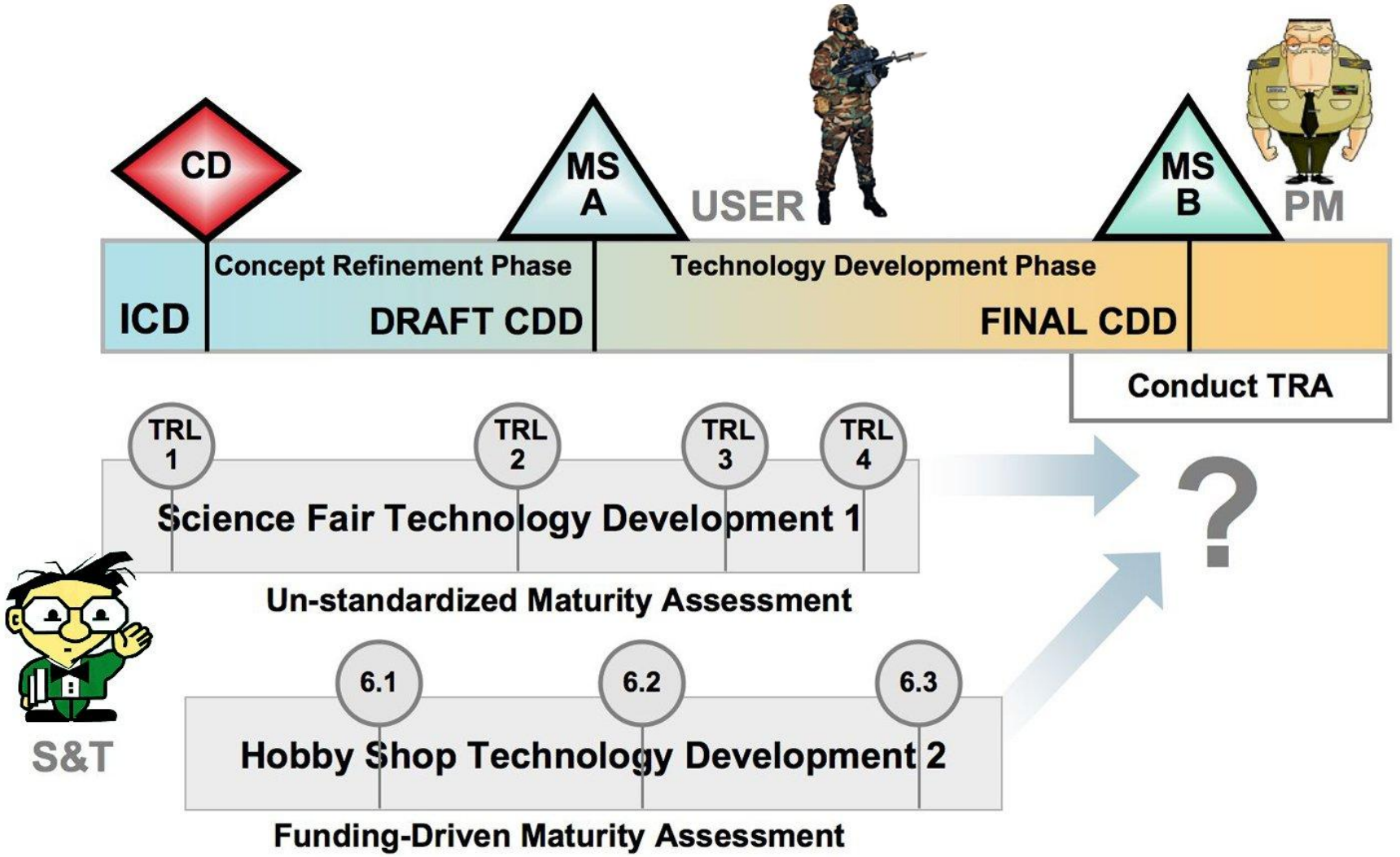
S&T does not require a process – I have been doing it for years

Customer role is to integrate

- Technical "break-thru"
- Performance Goals
- Risk
- Cost Estimate.
- Program Plan
- Build a prototype

S&T

Aligning Technology with the Acquisition DoD 5000 MS's



Transitioning Technology

Technology Management vs. Transition Management

Transition Management ••••••••••→

- **Transition an afterthought**
- **Technologist still tinkering**
- **Not knowing when you're finished**
- **Not knowing when technology is needed**

Typical Paradigm

Technology Management ——————————→

Technology Readiness Levels
Do

1. Basic prin… …st level … …egins to be translated into re… …y's ba…
2. T… …s. Once ba… …served, practical applications can be invented. The …eculative and th… …o proof or detailed an… …sumption. …l limited to pap… …dies.
3. A… …and developmen… initiated. This incl… …ory studies fu… …date analytical predictions of separate… …ples proof o… …that are… …rated or repre…
4. Component and/or breadboard validation … env… Basic technological c… …d to establish t… …together. This is relatively "low fid… …tual system. Examples include integration of "ad hoc" hardware in a labo…
5. C… …y of breadboard tech… …eases sig…ntly. The basic … …e …tegrated with reasonably … …pporting elemen… …mulated environment. Ex… …clude "high fidelity" labor…
6. Sys… prototy… relevant environment. Representative model or p… …stem, which is well beyo… tested in a relevant enviro… Represen… major step up … readi… Examples include testing a prototy… in a high fidelity … …ated operational envir… …ment.
7. System prototype demonstratio… an… Prototype near or at plan… operational system. … …sents a major step up from level 6, requiring the demonstration of a… …al system prototype in a… …ironment. Examples include testing the prototype … bed aircraft.
8. Techn… …k in its fina… …ons. In almost all ca… …ue sys… …de developmental te… …tende… …t meets design sp…
9. Actual system proven through successful mission operations. Actua… …n its final form and … …conditions, such as those encountered in … test and evaluation. Examples include using the system under operational mission conditions.

In what way will this technology Add Value to the End User?

What Programmatic & System Engineering tasks should be performed during each Stage of Development?

When should I know who my Customer is?

When should I know what the requirements for the technology are?

At what point will the technology be transitioned to a Customer?

How will my progress be measured?

What are the criteria for completing a TRL?

What is the definition of a success?

Quantifying the Effects of Immature Technologies

According to a GAO review of 54 DoD programs:

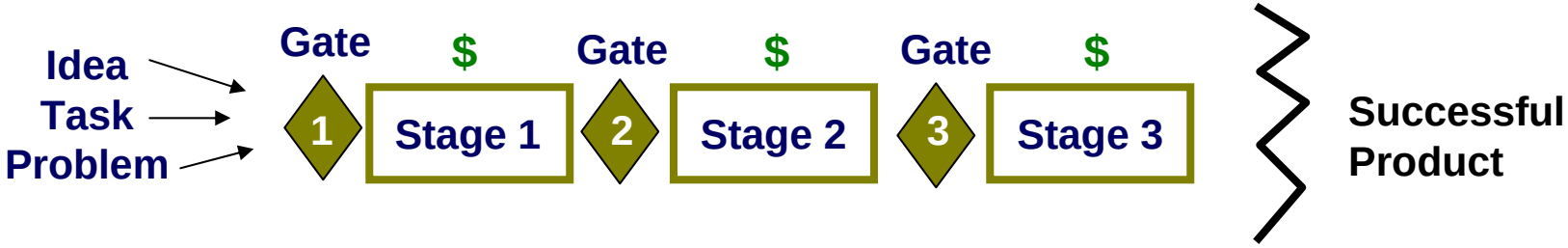
- Only 15% of programs began System Design Decision [post MS B] with mature
  - Pro… …logies ave…
- At Cr… desig…
  - ***Design stability not achievable with immature technologies***
  - Programs ***without stable designs at CDR*** averaged ***46% cost growth*** and a ***29 month schedule delay***

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

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

Basic Stage Gate Process

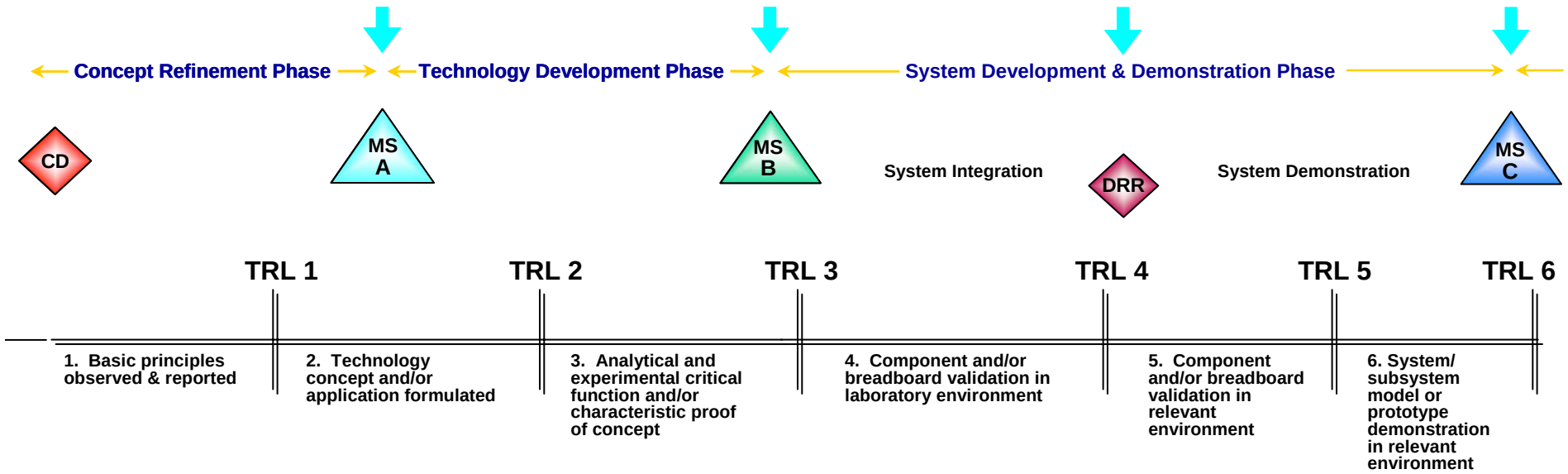
Stage – Gate Type Process – all businesses have "a process"



- Each Gate is a decision point for the program to move to the next stage.
  - Decision to Go / Kill / Hold / Recycle
- Each Stage is measured by:
  - Metrics Goals
  - (Exit Criteria)
  - Deliverables
  - Funding allocation

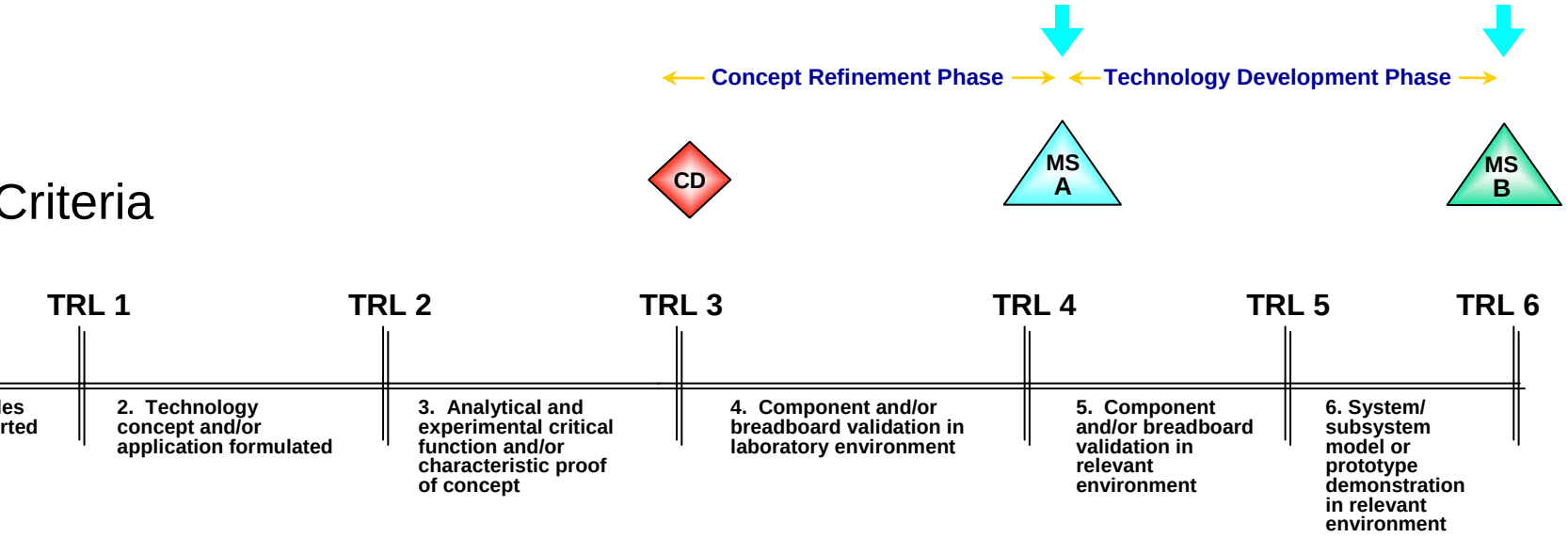
Everything We Do is a Process

Aligning TRLs & DoD 5000



S&T Community Activities

Aligning TRLs & DoD 5000

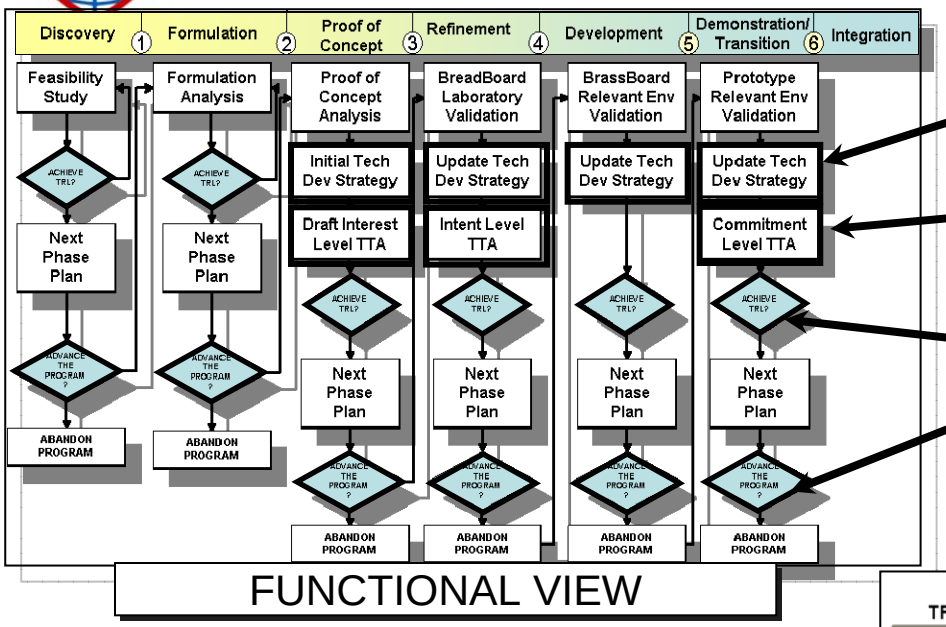


TPMM Criteria

Discovery	Formulation	Proof of Concept	Refinement	Development	Demonstration Transition
Develop an Idea Based on Threat, need, User Rqmt, Other	Develop a Concept	Proof of Concept and approach	Demonstrate Key Technologies Work Together	Demonstrate Components Work With/as System	Demonstrate Prototype Ready for Operations
Identify Pertinent Military Application & a Potential Customer(s)	Conduct Trade Studies	Develop General Technical Requirements	Refine Requirements	Finalize Requirements	Demonstrate Increased Capabilities
	Perform Military Utility Analysis	ID cross technologies	System Eng Plan	Develop Transition Plan and Gain Customer Approval	Develop Transition Agreement
	Perform Paper Studies	Develop Draft Tech Development Strategy	Update Tech Development Strategy		Acquisition Strategy
	Identify specific customer(s)	*TTA - Interest*	*TTA –Intent*		*TTA – Commitment*
	Analysis of Alternatives				

"Secure the High Ground"

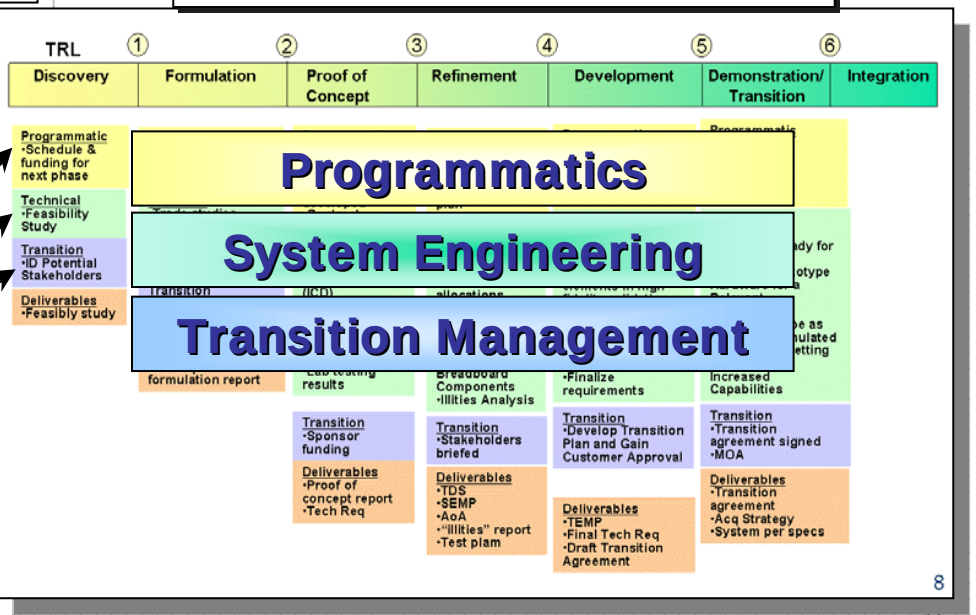
Functional View of a Systematic Development Process



FUNCTIONAL VIEW

- TDS establishes common language and vision
- DAU adopted TTA
- Program reviews include a TRA and a TAA

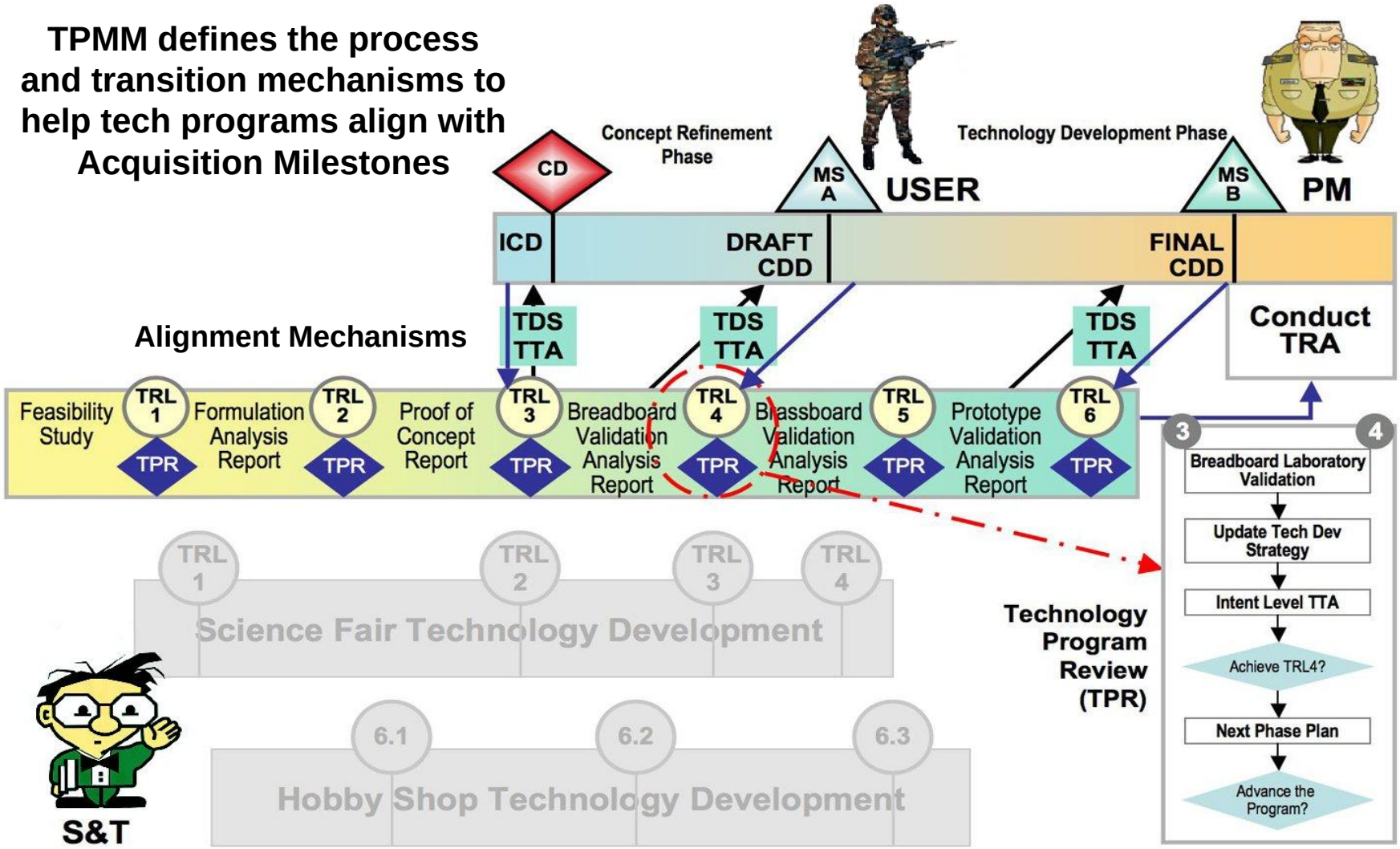
ARCHITECTURAL VIEW



- Multi-Dimensional criteria set provides a comprehensive TRL Assessment

Operational View - Aligning Technology with Acquisition Partners

TPMM defines the process and transition mechanisms to help tech programs align with Acquisition Milestones



Transitioning Technology

Technology Management vs. Transition Management

Transition Management

- Transition an afterthought
  - *Integrated Transition Management*
- Technologist still tinkering
  - *Technology Readiness Assessments*
- Not knowing when you're finished
  - *Technology Advancement Assessments*
- Not knowing when technology is needed
  - *Technology Transition Agreements*

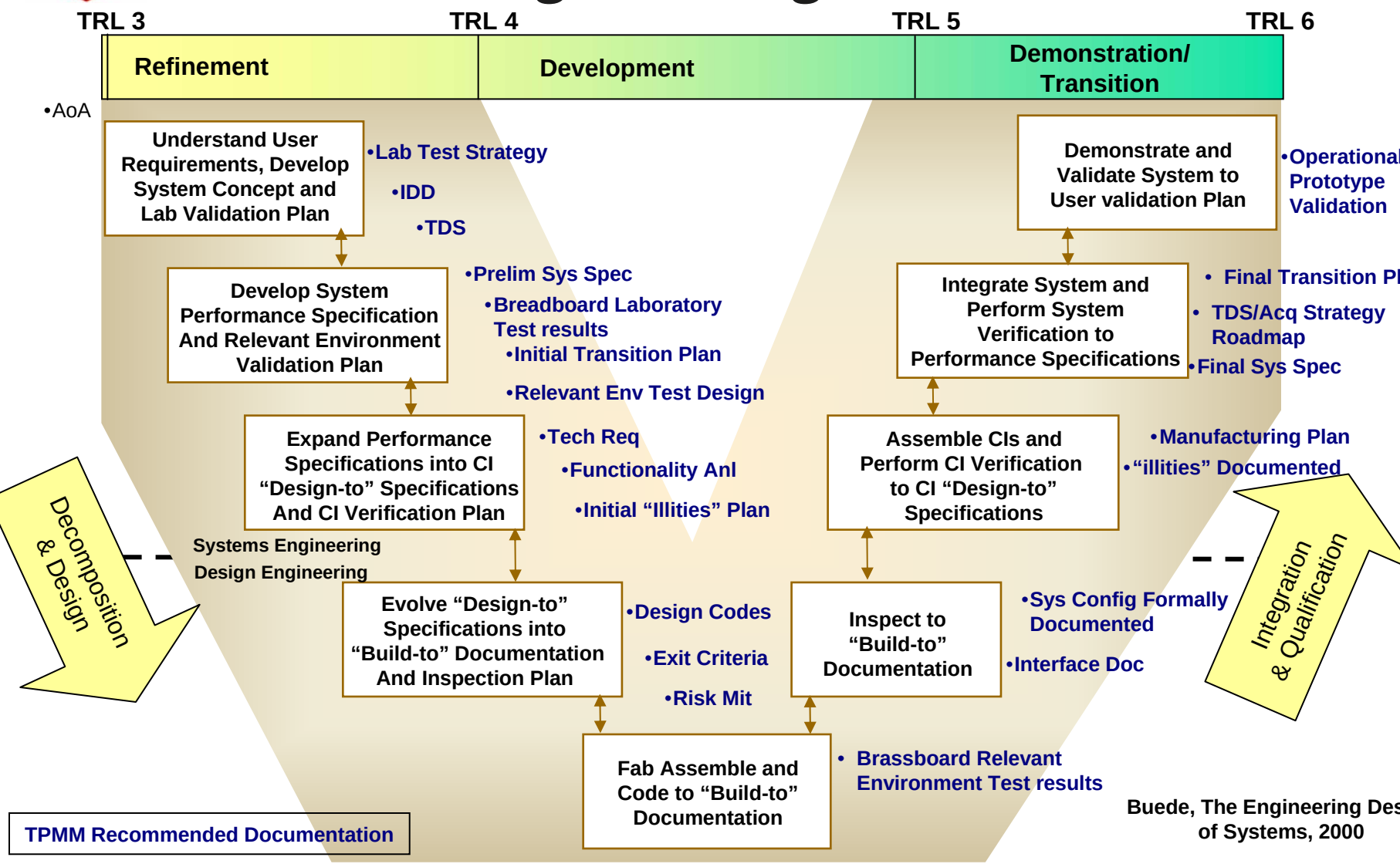
Balanced Paradigm

Typical Paradigm

Technology Management

A Systems Engineering Approach

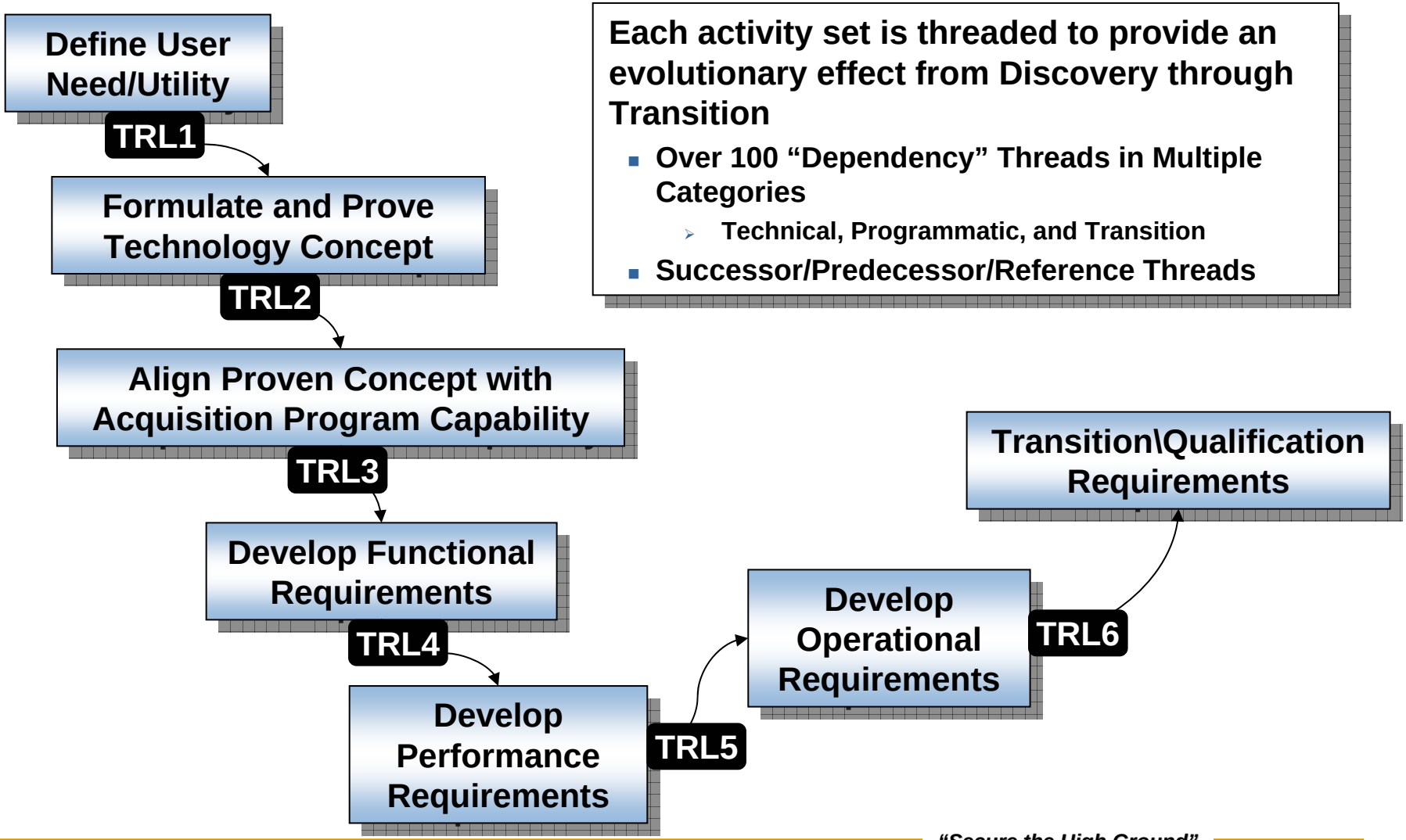
TPMM and the Systems Engineering "V"



TPMM Recommended Documentation

Buede, The Engineering Design of Systems, 2000

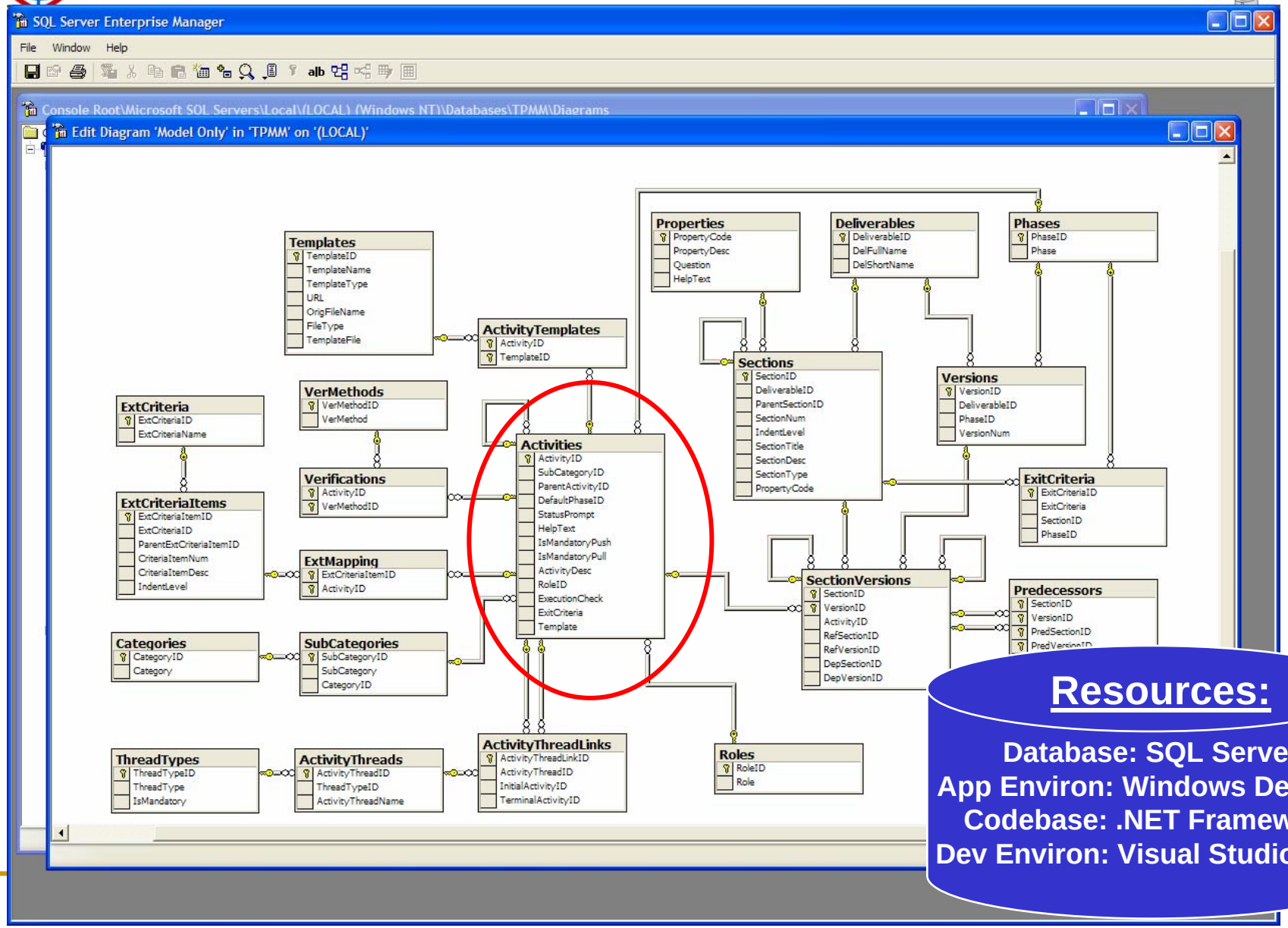
Example Thread - Capability/Requirement



Each activity set is threaded to provide an evolutionary effect from Discovery through Transition

- **Over 100 "Dependency" Threads in Multiple Categories**
  - **Technical, Programmatic, and Transition**
- **Successor/Predecessor/Reference Threads**

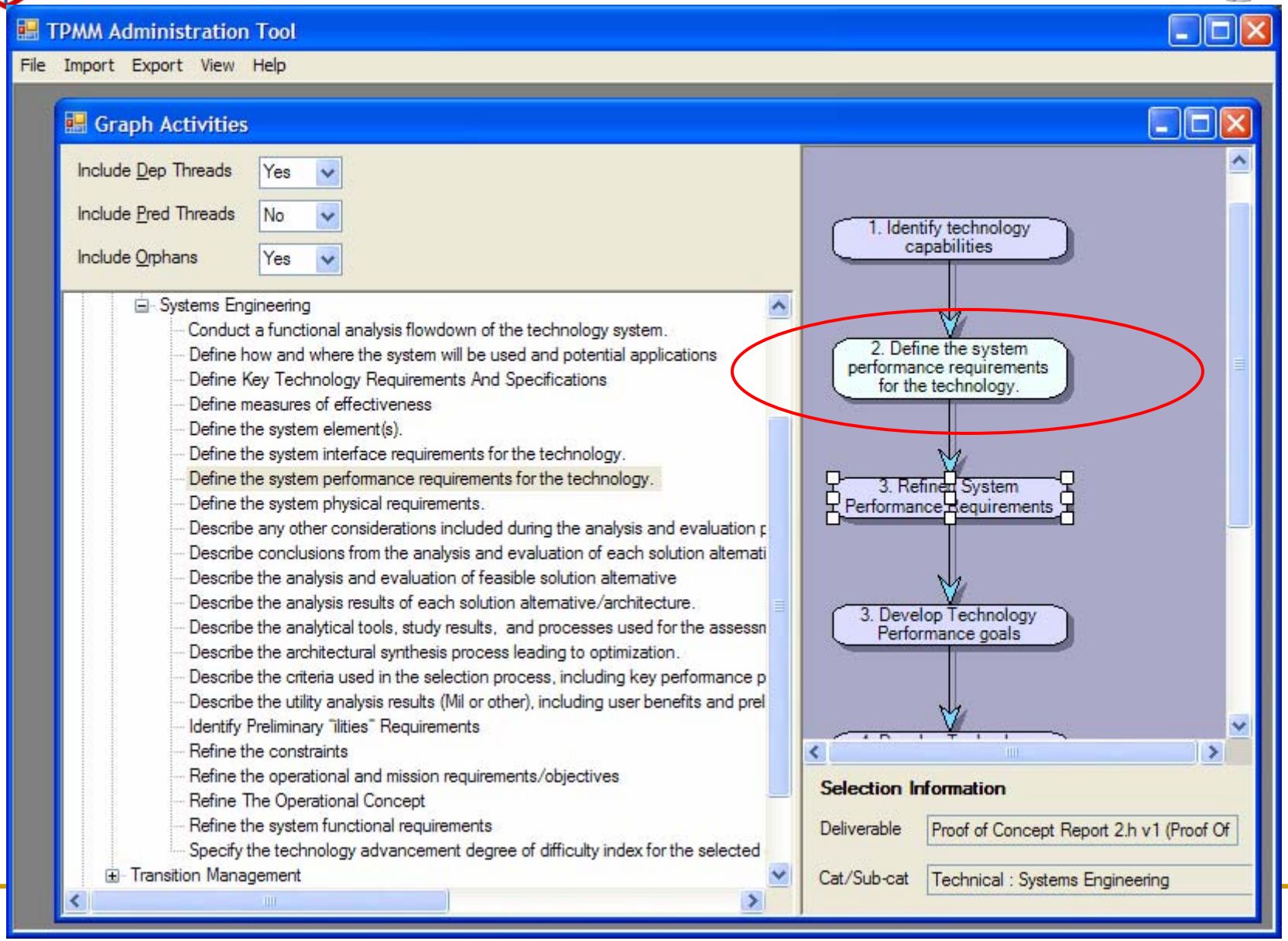
Physical View - Activity Centric Database



Resources:

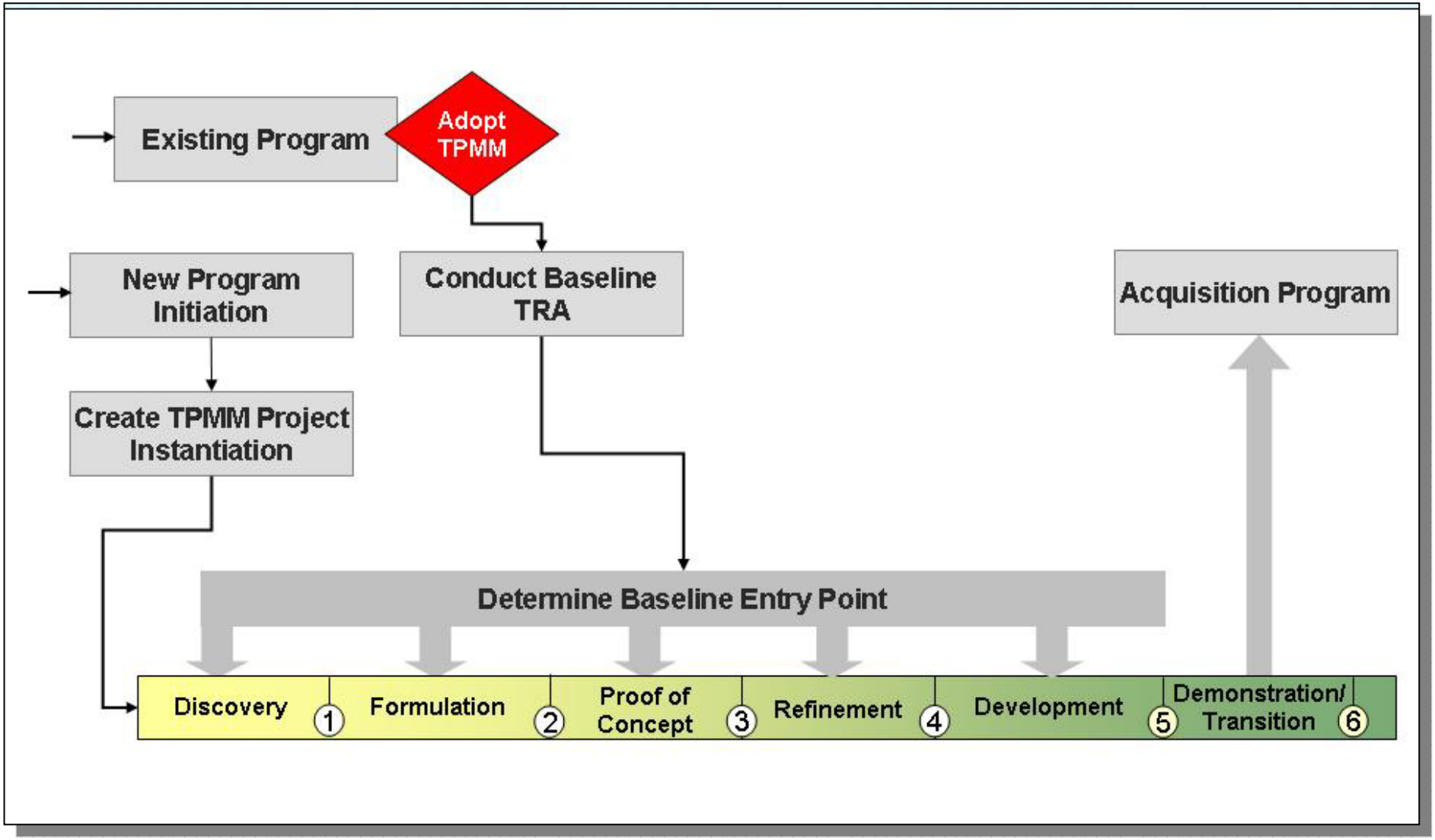
Database: SQL Server
App Environ: Windows Desktop
Codebase: .NET Framework
Dev Environ: Visual Studio 2005

System Engineering Threads

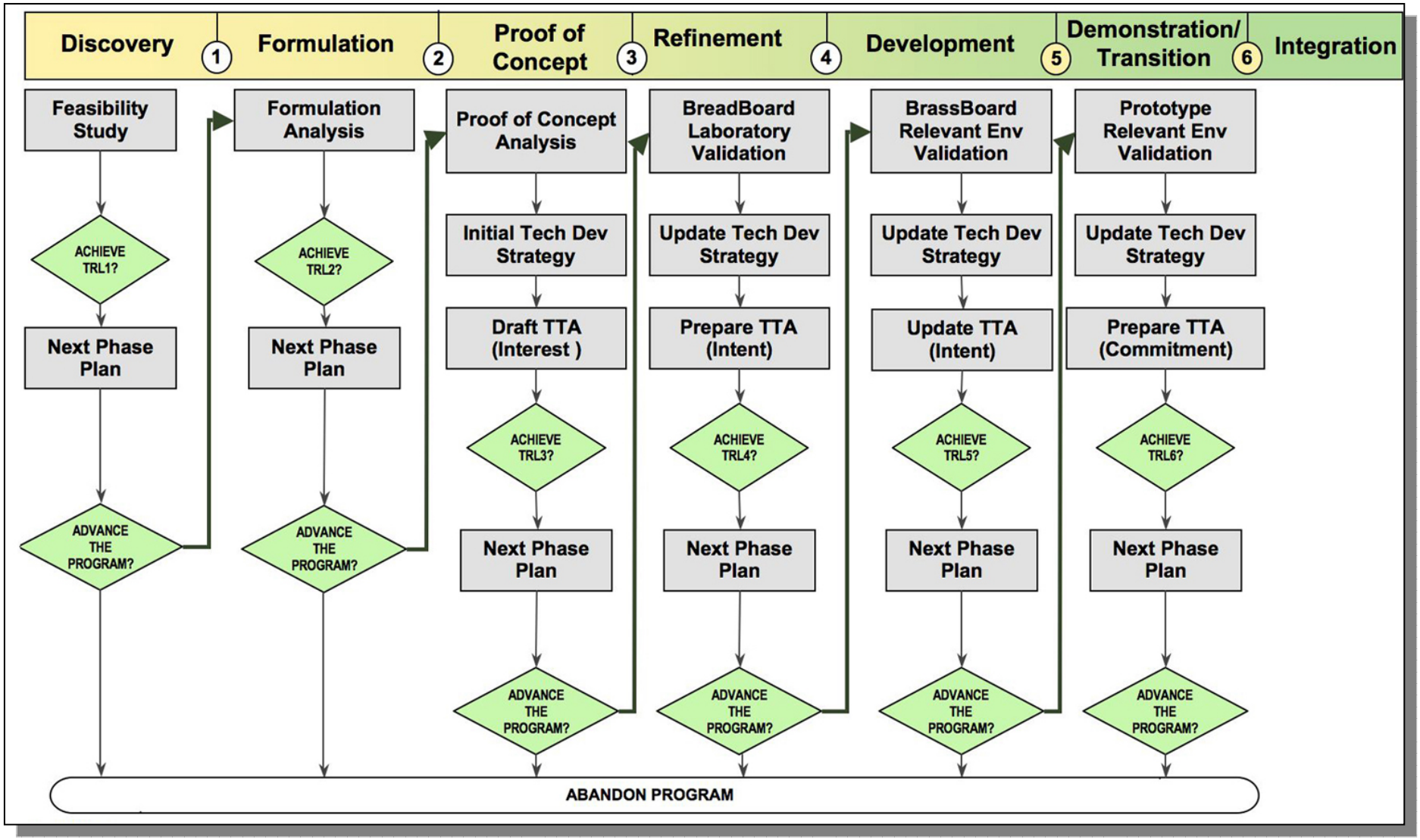


Improved Documentation Process

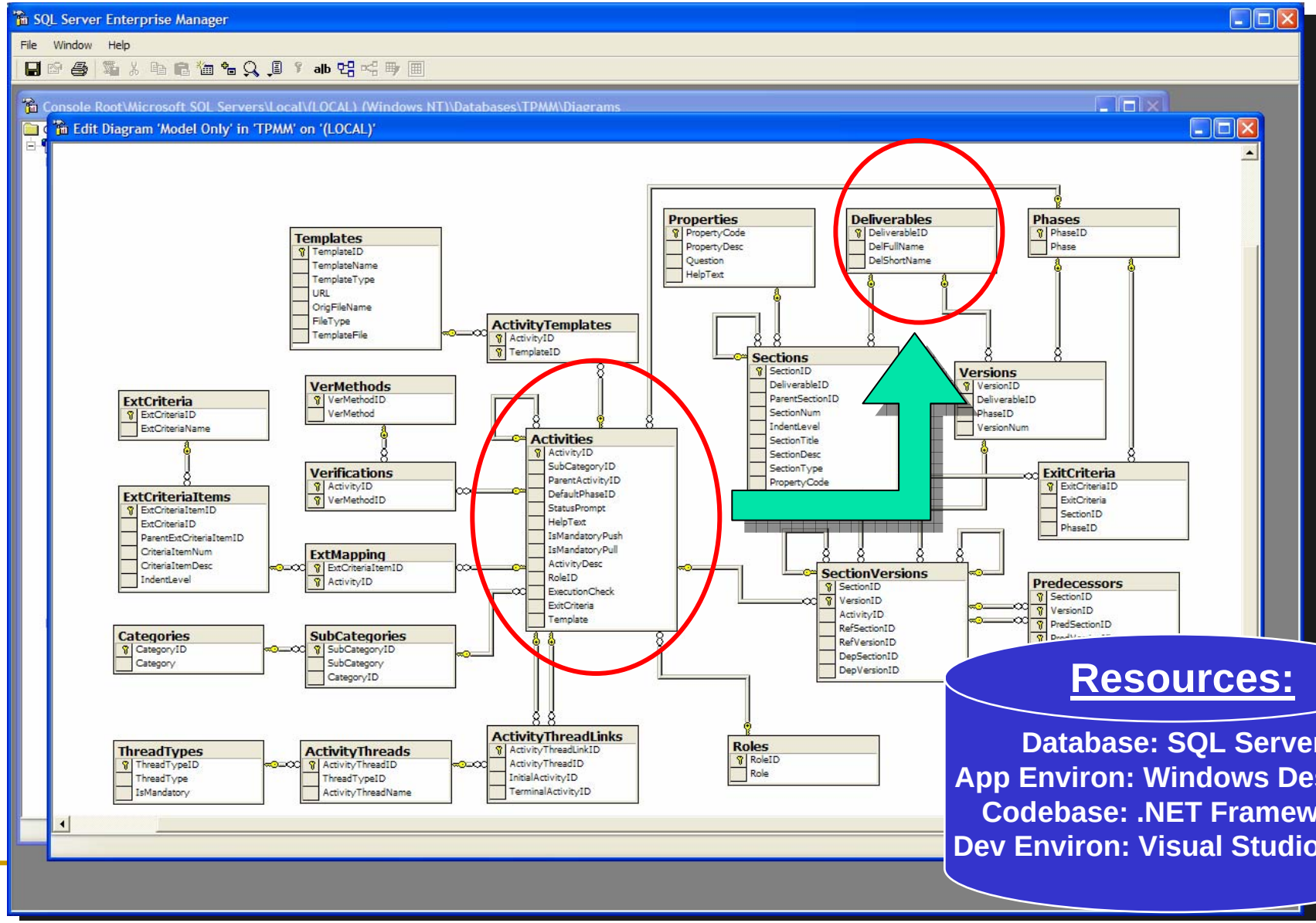
TPMM Entry Process



TPMM High-Level Process



TPMM Database – Activities Linked to Deliverables



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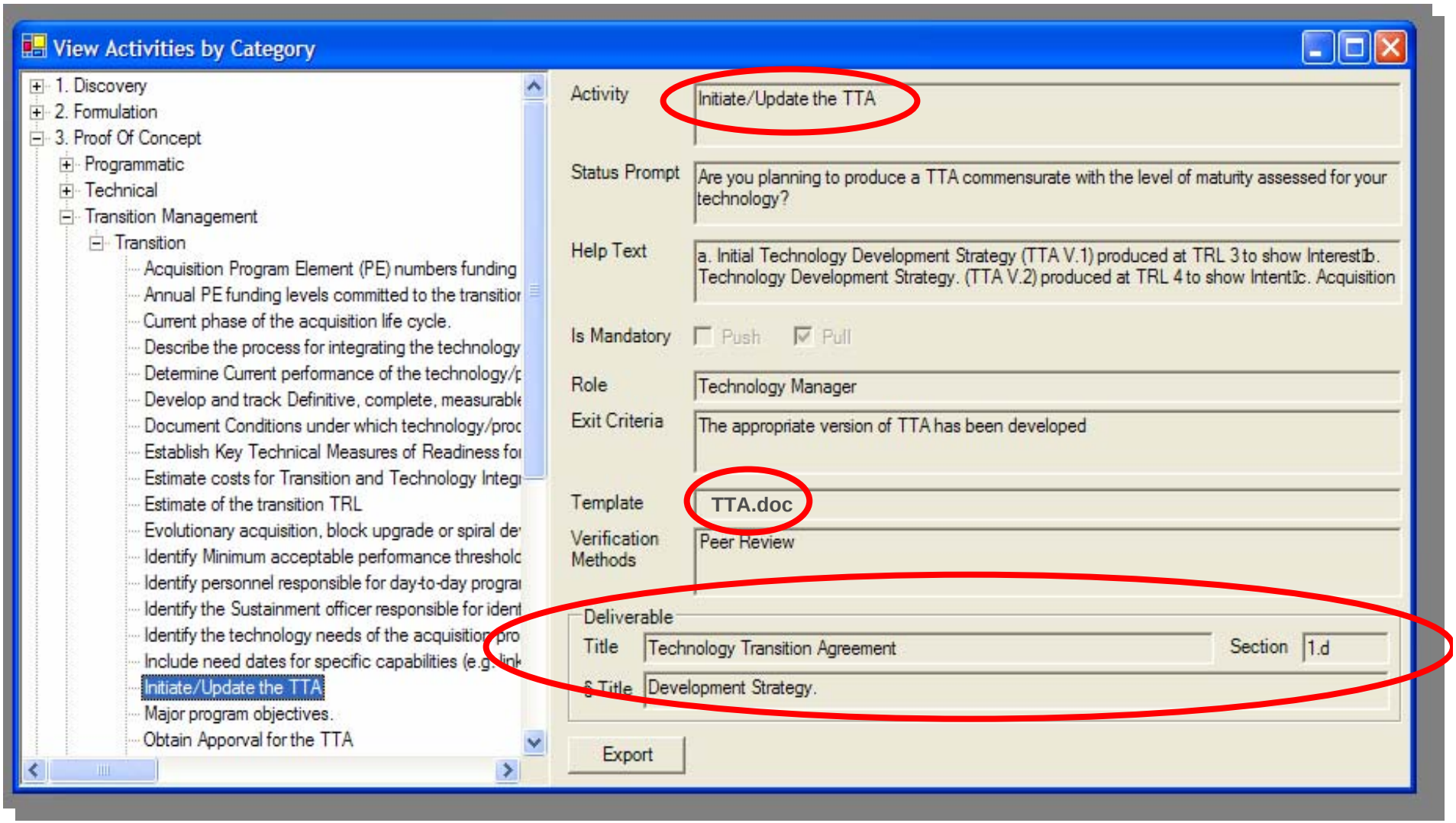
TPMM Database Administration

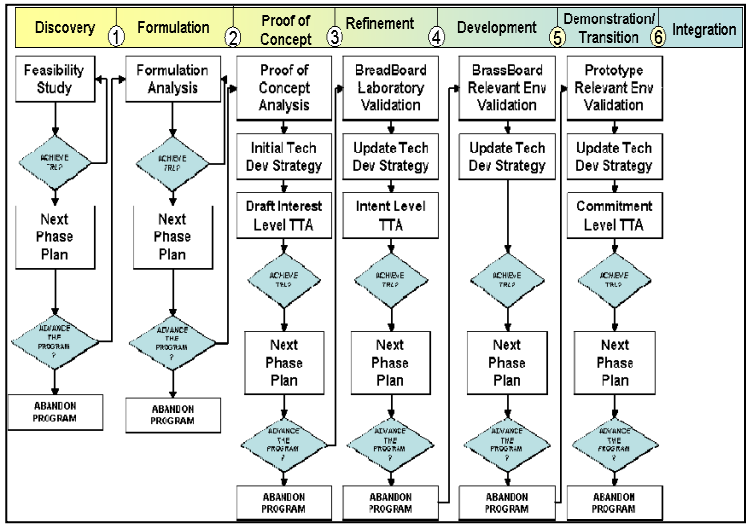


Better Program Execution

Standardizes Tech Development, Assessment, & Transition

A TRL-based, Systems Engineering Activity Model that Assists:

- **Technology Program Definition**
  - o Identify **Activities** that will be performed
  - o Identify **Documents** that will be produced
  - o Provide an Environment for **Tailoring** the Model
  - o Develop and Employ **"Best Practice" Tools**
- **Technology Transition Management**
  - o Technology **Transition**
  - o Technology **Transfer**
  - o Technology **Marketing**
- **Technology Maturity Assessments**
  - o Establishes **Entry/Exit Criteria** - Tailored for each Project
  - o Provides a Framework for Performing **Technology Readiness Assessments** (TRA)

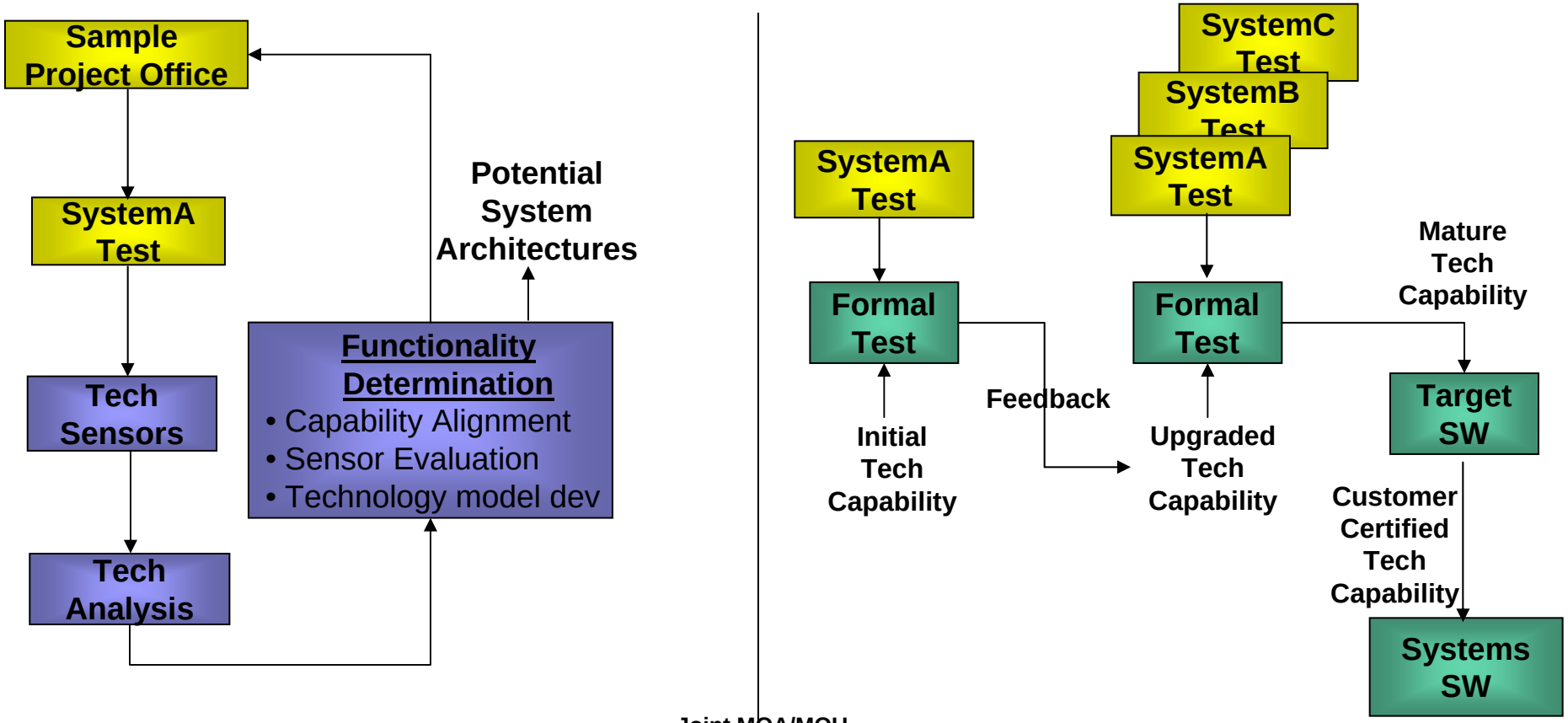


"TPMM: A Model for Technology Development and Transition"

Establish TDS as Focal Point for Development Planning

- Producing a Technology Development Strategy (required at TRL3), with a focus on Systems Engineering Principles, helps Technology Managers by:
  - ***Technology Goals*** aligning with Users, Capability Needs, and Performance Requirements
  - Accomplishing Technology Goals drives ***Program Schedules***
    - Focuses program efforts on ***technology insertion*** points
    - Develop and follow ***Transition Plan*** to execute TDS
    - Establish ***transition agreements***, even if informal, with transition partners
  - ***Budget/Funding*** questions drive alignment with Sponsors/Customers
  - ***Technology Readiness Assessment*** of the program instills confidence
  - Gaps identified in Technology Development planning are fed directly to ***Risk Management & Mitigation***

Incremental Capability Development (Excerpt from a TDS)



Management Decision Metrics

TPMM as SMDTC Enterprise level solution

Mgt Functions / Mgt Level	Technology Program Definition	Technology Maturity Assessment	Technology Transition Management

Tech Manager (Practitioner)	▪ ID activities performed by TRL
	▪ ID documents that will be produced /delivered
	▪ Develop and employ "Best Practice" Tools
		▪ Establishes Technology Readiness Assessment Criteria
		▪ Tailored to each program
		▪ ID Technology Mgt Risks
			▪ Early Customer/USER Involvement
			▪ TTA's
			  ▪ Interest
			  ▪ Intent
			  ▪ Commitment
			▪ Integration Opportunities
			▪ Tech Transfer Opportunities
			▪ Align DoD 5000 (Common Language)
			▪ Transition Focus – ***Doing The Right Things At The Right Time With The Right People***

Portfolio Manager (Director)	▪ Portfolio Tracking Data	▪ Standardized Measurements ▪ Aligns technologies for cross pollination ▪ ID Program Mgt Risks ▪ Supports Key Decision Points	

Executive Manager	▪ Provides Enterprise Level Program Management Data	▪ Enterprise Assessment
		  ▪ TRLs (Push / Pull)
		  ▪ Funding
		  ▪ Transition
		▪ Support s Key Decision Points	

Vision to have a Fully Automated Management Tool For All Managers

SMDTC TPMM Quad Chart (Notional)

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 Statement of Risk

Technology Development Strategy

- TPMM Requirement? (TRL3 or beyond)
- Status = Draft, Preliminary, Final
- Updated for Current Phase?
- Gap Analysis/Percentage Populated

Programmatic Progress

Transition Management

Customer/User/Sponsor ID'd

- TTA Version (Interest, Intent, Commitment)
- TTA Matrix Populated
- Signature Status

Transition Planning Progress

TRL Roadmap

- TRL Milestone Schedule to transition
- TPR Status

Program Vision to Transition

Executive Dashboard

Captures the Enterprise View of Technologies in S&T

Status of Programs

- Transition Agreements in place
- Successful Transitions over time
- Program Distribution by
  - TRL
  - Technology Domain
    - •Science Discipline
    - •Sponsor
  - Acquisition Customer
  - Funding

Facilitate Strategic Planning

- Technologies Distribution
- Technologies Gap Analysis
- Domain Analysis
  - Skill gaps / recruiting needs (Develop/Maintain TC skill set)
  - Diversified Portfolio Analysis
    - •Sponsor
    - •Science Discipline
- TTA Migration Status

Metrics-driven Executive Dashboard forms the basis of a Decision Support System (DSS)

Promotes Defensible Budgets

- ***Effectively Communicates*** the Developmental Process/Methodology is working
- ***Establishes Requirements*** for
  - Cost/Funding
  - Capabilities/Performance
- ***Instill Confidence*** in Funding Source
  - Documented Planning & Schedules
  - Established Deliverable Documentation
- Puts ***Program Execution*** into perspective
- ***Aligns Technology with Acquisition Partners*** for Tech Insertion

Summary

- TPMM is a ***technology development activity model***, partitioned into phases that are 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 OSD with the criteria for evaluating the ***Technology Development Strategy at MS A***.
- TPMM model provides ***a standard TRL criteria set*** for performing effective ***Technology Readiness Assessments at MS B***

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