



Readiness Level Proliferation



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William Nolte

AFRL/XPQ

(937) 904-8070

Air Force Research Laboratory

William.Nolte@wpafb.af.mil

Robert Kruse

President

FacetApp LLC

rkruse@facetapp.com



Integrity ★ Service ★ Excellence



Problem

Readiness level proliferation is the tendency to add new undefined readiness levels as measures of program progress



Big Picture



- PROBLEM (1991)
 - Immature Technologies getting into acquisition programs (GAO)
- SOLUTION (1999)
 - Develop TRL's to measure tech maturity
 - Congress agreed, mandated into DoD & NASA
- PROLIFERATION
 - Additional RLs developed to meet specific needs
 - TRLs adapted to new purposes



Congress Mandate



Law: 10 USC 2366a

Cornell University Law School

U.S. Code collection

TITLE 10 > Subtitle A > PART IV > CHAPTER 139 > § 2366

§ 2366. Major systems and munitions programs: survivability testing and lethality testing required before full-scale production

(a) Requirements.—

(1) The Secretary of Defense shall provide that—

(A) a covered system may not proceed beyond low-rate initial production until realistic survivability testing of the system is completed in accordance with this section and the report required by subsection (d) with respect to that testing is submitted in accordance with that subsection; and

(B) a major munition program or a missile program may not proceed beyond low-rate initial production until realistic lethality testing of the program is completed in accordance with this section and the report required by subsection (d) with respect to that testing is submitted in accordance with that subsection.

(2) The Secretary of Defense shall provide that a covered product improvement program may not proceed beyond low-rate initial production until—

(A) in the case of a product improvement to a covered system, realistic survivability testing is completed in accordance with this section; and

(B) in the case of a product improvement to a major munitions program or a missile program, realistic lethality testing is completed in accordance with this section.

(b) Test Guidelines.—

(1) Survivability and lethality tests required under subsection (a) shall be carried out sufficiently early in the development phase of the system or program (including a covered product improvements program) to allow any design deficiency demonstrated by the testing to be corrected in the design of the system, munition, or missile (or in the product modification or upgrade to the system, munition, or missile) before proceeding beyond low-rate initial production.

(2) The costs of all tests required under that subsection shall be paid from funds available for the system being tested.



Technology Readiness Level (TRL) 10 USC 2366a, DoD 5000.1

DEPARTMENT OF DEFENSE

Technology Readiness Assessment (TRA)
Deskbook



May 2005

Prepared by the
Deputy Under Secretary for Science and Technology
(DUSD(S&T))

This version of the TRA Deskbook accounts for policy and guidance provided by Directive DoD 5000.1, dated May 12, 2003; Instruction DoDI 5000.2, dated May 12, 2003; and the Defense Acquisition Guidebook, dated October 2004.

Used to Govern Acquisition Across Numerous \$B Programs

GAO
Accountability • Integrity • Reliability

Outcomes Since Then: Reduced Buying Power For Major Programs

Program	Initial estimate	Initial quantity	Latest estimate	Latest quantity	Percentage of unit cost increase
Joint Strike Fighter	\$196.5 billion	2,666 aircraft	\$223.3 billion	2,458 aircraft	32.6
Future Combat Systems	\$85.5 billion	15 systems	\$131.7 billion	15 systems	54.1
V-22 Joint Services Advanced Vertical Lift Aircraft	\$36.9 billion	913 aircraft	\$50.0 billion	458 aircraft	170.2
Evolved Expendable Launch Vehicle	\$16.0 billion	181 vehicles	\$28.6 billion	138 vehicles	134.7
Space Based Infrared System High	\$4.2 billion	5 satellites	\$10.4 billion	3 satellites	311.6
Expeditionary Fighting Vehicle	\$8.4 billion	1,025 vehicles	\$11.3 billion	1,025 vehicles	33.7

Source: GAO analysis of DOD data. Images sourced in their respective order: JEF Program Office; Program Manager, Future Combat Systems (BGT); V-22 Joint Program Office; (Left) © 2005 IL5/Lockheed Martin; (right) © 2003 The Boeing Company; Lockheed Martin Space Systems Company; General Dynamics Land Systems.





Why Do We Care?



- GAO reports document the maturity problem
- DoD 2010 Acquisition portfolio grew by \$135B in 2 years
- \$70B not attributed to quantity change
- Half of DoD major defense acquisition programs do not meet cost performance goals
- 80% have experienced increase in unit cost

Changes in DOD's Fiscal Year 2010 Portfolio of Major Defense Acquisition Programs over the Past 2 Years (Fiscal Year 2011 Dollars in Billions)				
	Estimated portfolio cost in 2008	Estimated portfolio cost in 2010	Estimated portfolio cost growth since 2008	Percentage growth since 2008
Total estimated research and development costs	\$407	\$428	\$15	5%
Total estimated procurement costs	\$1,089	\$1,219	\$121	11%
Total estimated acquisition cost	\$1,531	\$1,680	\$135	9%

Source: GAO analysis of DOD data. GAO 11-233 SP, Assessments of Selected Weapon Programs, March 2011





Does Readiness Level Proliferation Really Happen?



- Technology Readiness Levels
- Manufacturing Readiness Levels
- Innovation Readiness Levels
- Integration Readiness Levels
- Strategic Readiness Levels
- Direct Manufacturing Readiness Levels
- Logistics Readiness Levels
- System Readiness Levels
- Supportability Readiness Levels

- Technical Readiness Levels
- Programmatic Readiness Levels
- Reuse Readiness Levels
- Security Readiness Levels
- Demand Readiness Levels
- Fuel Readiness Levels
- Funding Readiness Levels
- Fire Readiness Levels
- Reading Readiness Levels
- Community Readiness Levels
- Sustainment Readiness Levels



More Readiness Levels



- Software Readiness Levels
- Countermeasures Readiness Levels
- Operational Readiness Levels
- Condition of Readiness Levels
- Tropical Storm Readiness Levels
- Defense Readiness Condition (DEFCON) Levels
- People's "Task" Readiness Levels
- Football Readiness Levels

- Tactical Readiness Levels
- Risk Readiness Levels
- Problem Solving Readiness Levels
- Survival Readiness Levels
- Engineering & Manufacturing Readiness Levels
- Extreme Heat Readiness Levels
- Learning Readiness Levels
- Love Readiness Levels
- Internet Marketing Readiness Levels



Still More Readiness Levels



- Continuity Readiness Levels
- Accreditation Readiness Levels
- Follower Readiness Levels
- Business Readiness Levels
- University Technology Transfer Readiness Levels
- Physical Readiness Levels
- TQM Readiness Levels
- Defence Readiness Levels
- Change Readiness Levels
- Material Operational Readiness Levels

- E-Procurement Readiness Levels
- Venture Readiness Levels
- Entrepreneurship Readiness Levels
- Partner Readiness Levels
- Bilingualism Test Readiness Levels
- Performance Readiness Levels
- Disaster Readiness Levels
- Human Effects Readiness Levels
- Earthquake Readiness Levels
- Human Readiness Levels
- Primary Mental Abilities Readiness Levels



Only Levels Related to Technology Maturity



- Technology Readiness Levels
- Manufacturing Readiness Levels
- Logistics Readiness Levels
- Innovation Readiness Levels
- Integration Readiness Levels
- Direct Manufacturing Readiness Levels
- Sustainment Readiness Levels
- Software Readiness Levels
- Risk Readiness Levels
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- Supportability Readiness Levels
- Countermeasures Readiness Levels
- Accreditation Readiness Levels
- University Technology Transfer Readiness Levels



TRLs Have Been Adapted for



- Biomedical Systems
- Systems of Systems
- Modeling and Simulation Technologies
- Learning Systems
- Automated Manufacturing Technologies
- Healthcare

- Practice-based Technologies
- Families of Systems
- Software Intensive Systems
- Chemical Processes
- Alternative Fuels Technologies / Certification
- Platform Technologies



Is Readiness Level Proliferation a Problem?



- Only 3 of 21 related to Technology Maturity are widely accepted
 - Technology Readiness Levels, Manufacturing Readiness Levels, Logistics Readiness Levels
- 7 of 21, e.g., Integration & Programmatic Readiness Levels, are not pure technology maturity measures
- 9 of 21 may already be covered by some other readiness level
 - Some may also be better called adaptations of TRLs, e.g., Countermeasures & Risk Readiness Levels
- One, Technical Readiness Levels, may just be a typo
- Non-standard application of readiness levels may give illusion of attention to problems while masking underlying cause factors
- Proliferation in itself is not bad.
- Proliferation of RL's using tools that fail to integrate easily is a problem.



Solving the Readiness Level Proliferation Problem



- Ignore the problem
- Return to original maturity measurement purpose (throw out baby with bathwater)
- Make data accessible when and where needed
- Engineered Resilient Systems
 - Virtual Collaborative Environment
- Net-centric solutions, e.g., Semantic Web
(See Net-centric track presentations)
 - Track 1 - BayView 1 - Co-Chair Jack Zavin, DoD



Problem Summary

Robert Kruse
FacetApp LLC

Problem Statement

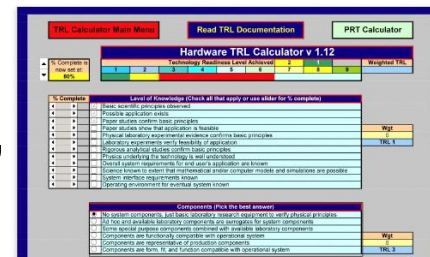
How do we proliferate RLs' that solve a real problem and integrate well and play well with others?

Point: We started with TRLs (1991)

TRLs solved the maturity measurement problem as defined by GAO at that time.

TRL Calculator simplified implementation of TRLs.

Because TRL Calculator was successful because a) free Excel distribution, b) simple to use to modify to individual needs because everyone has Excel.



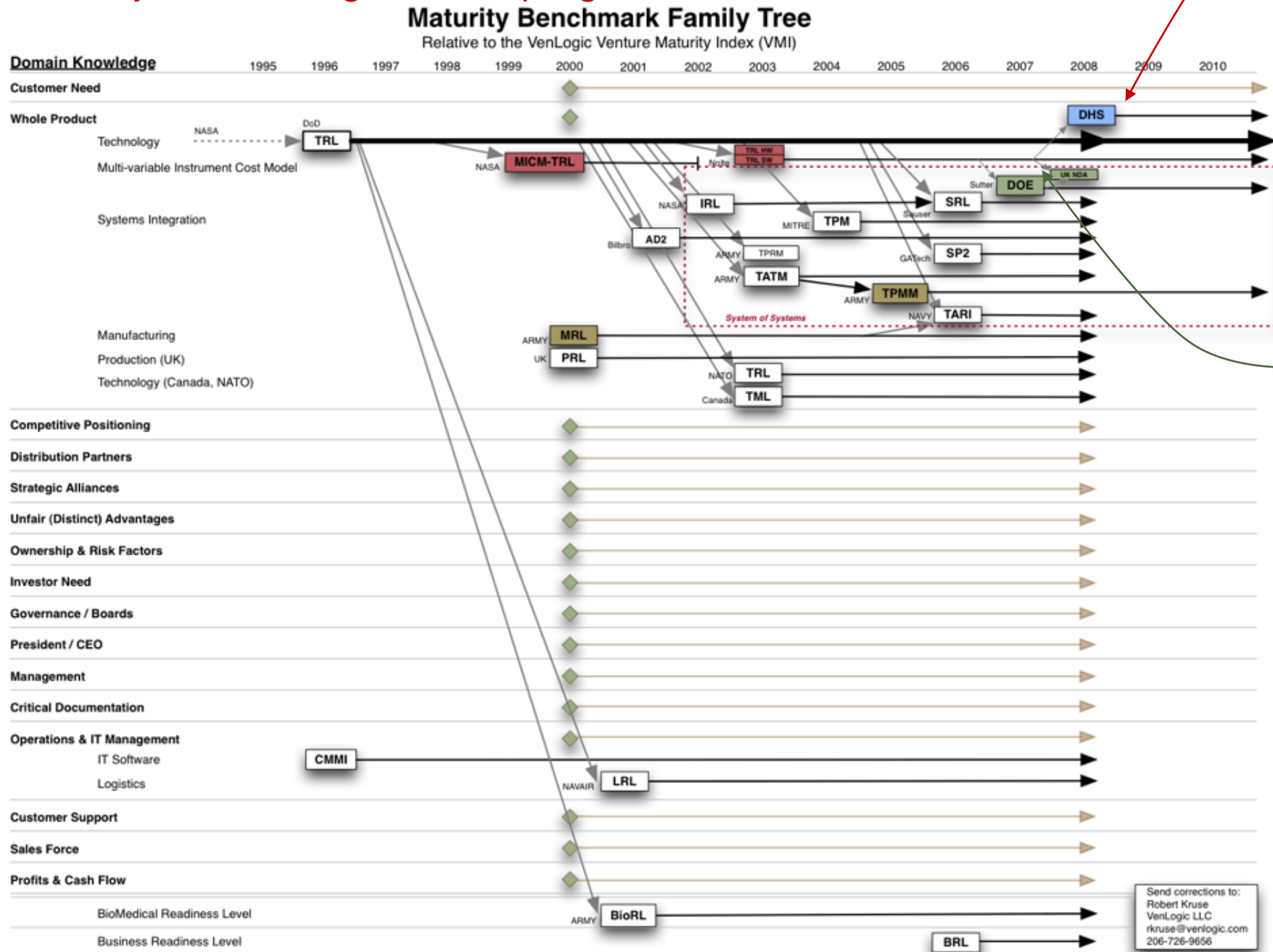
Issues are:

- Quality: Too many RL's of substandard quality design being used in programs.
- Question Alignment: Unable validate alignment: DoD TRL 6 = DHS TRL 6 = DOE TRL 6
- Data Sync: No easy way to sync 2 or 3 spreadsheets, which results in...
- Manual Re-entry: Requires re-input same data over again.

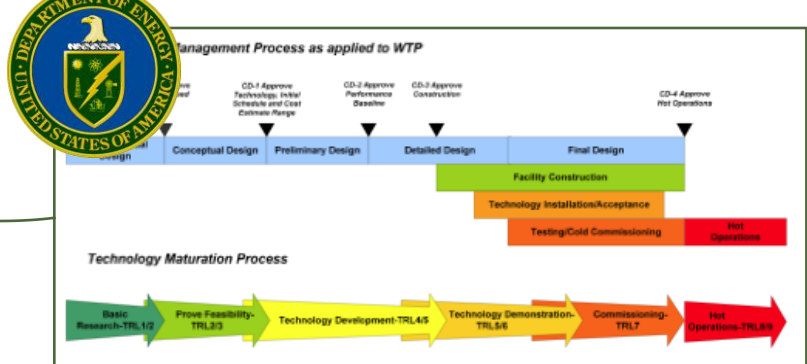
The community began adding new RLs using the **Excel-based TRL Calculator** and other similar tools. Many new RLs did not have the quality control in their construction as the original. As a result, many new RL's were under developed and are being used inappropriately.

TRL Family Tree Out of Control!

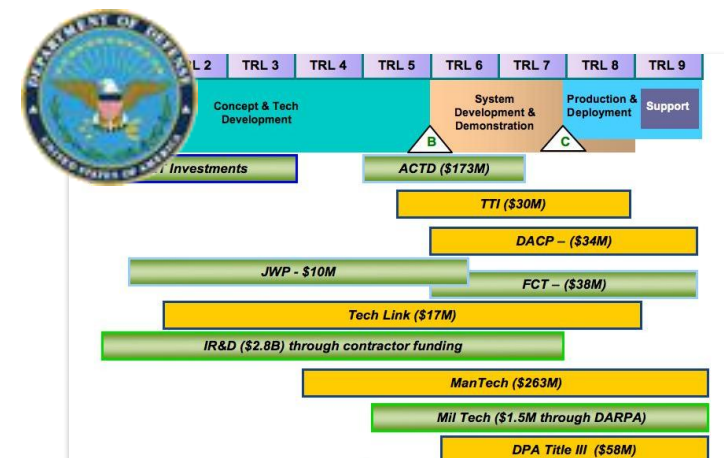
The result of many agencies taking a similar approach over 10+ years, has led to serious fragmentation of the TRL. TRL alignment is difficult to verify between agencies & programs.



DHS Uses TRL to Manage SECURE & FutureTECH Programs



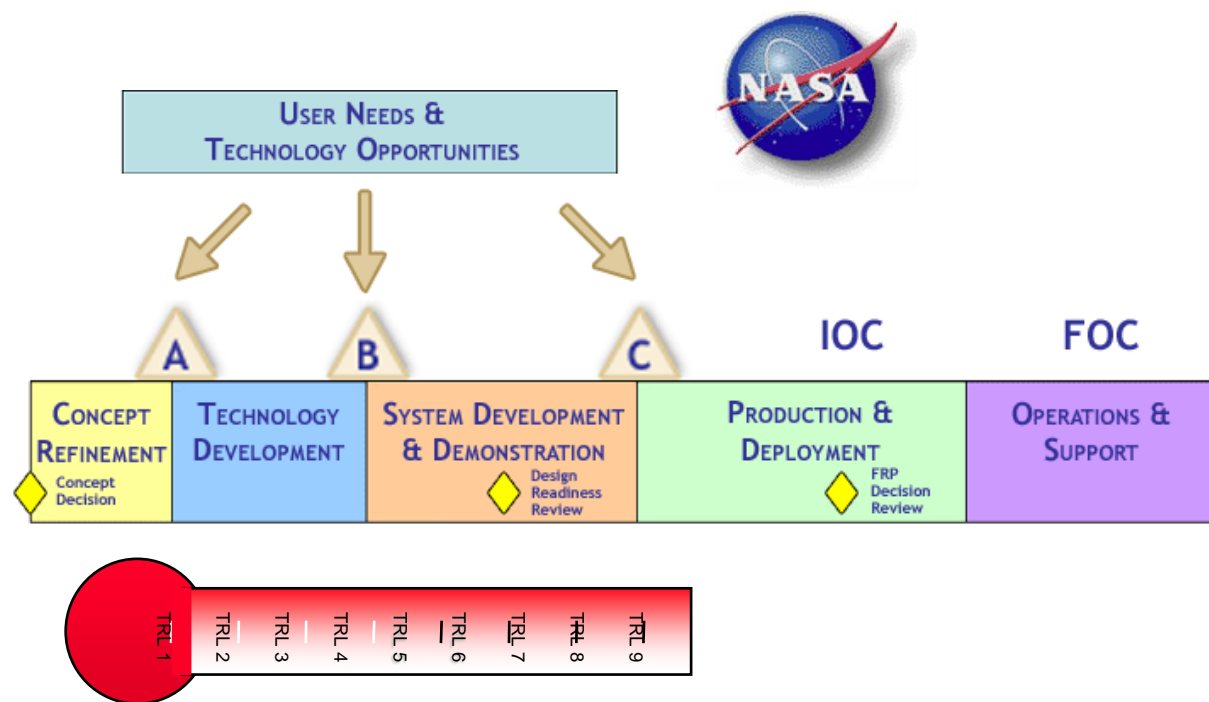
DoE Uses TRL to Manage \$20B Hanford Vit. Plant



DoD Uses TRL to Manage \$500M in Tech Transition Funds

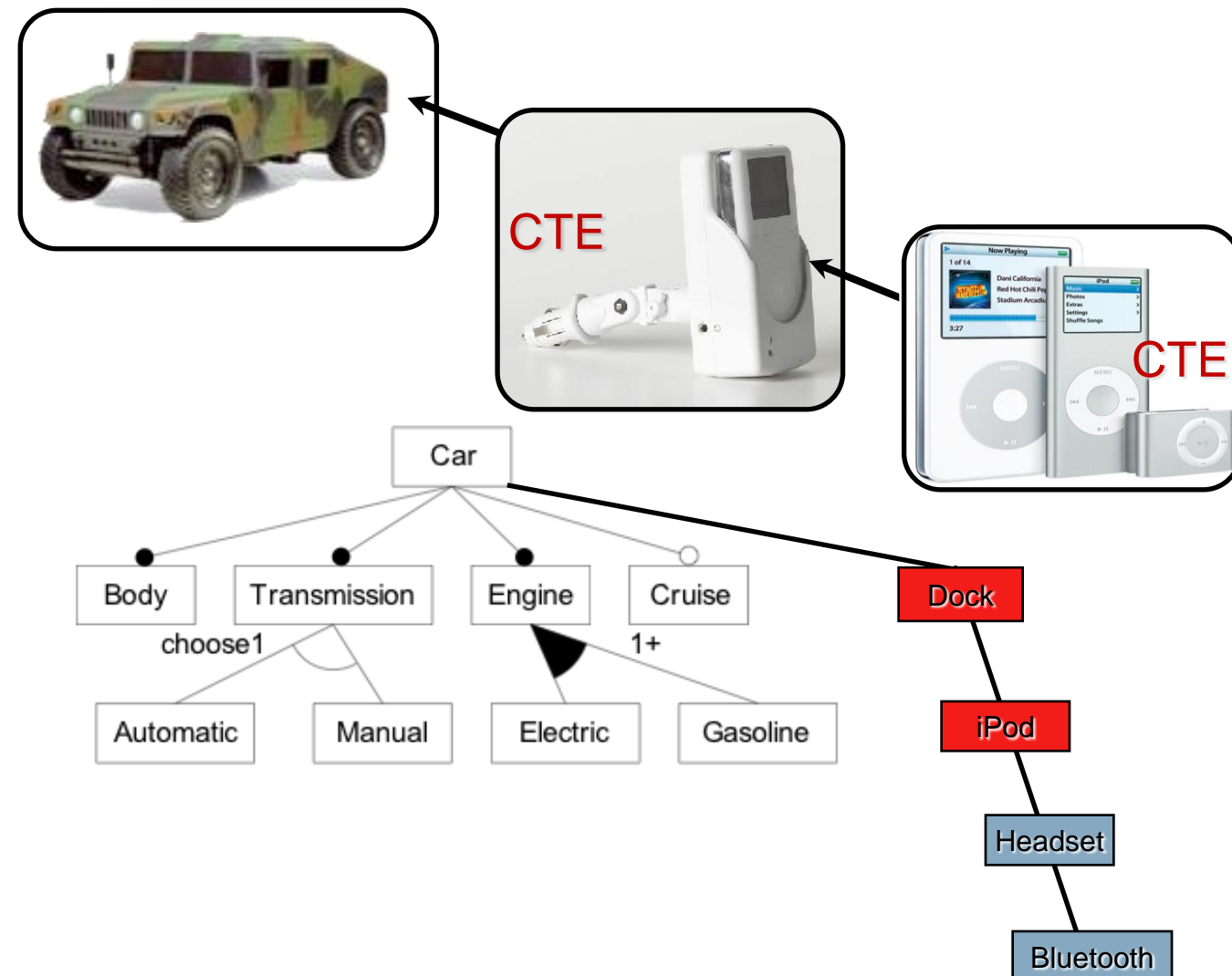
TRL Flaw #1: No Complex Systems

- DOD 5000.2
- Acquisition Milestones A, B, C
- NASA/DOD Technology Readiness (TRL)
- A **BASIC Common Language** Used Across ARMY, NAVY, AIR FORCE, and First Responder vendors.



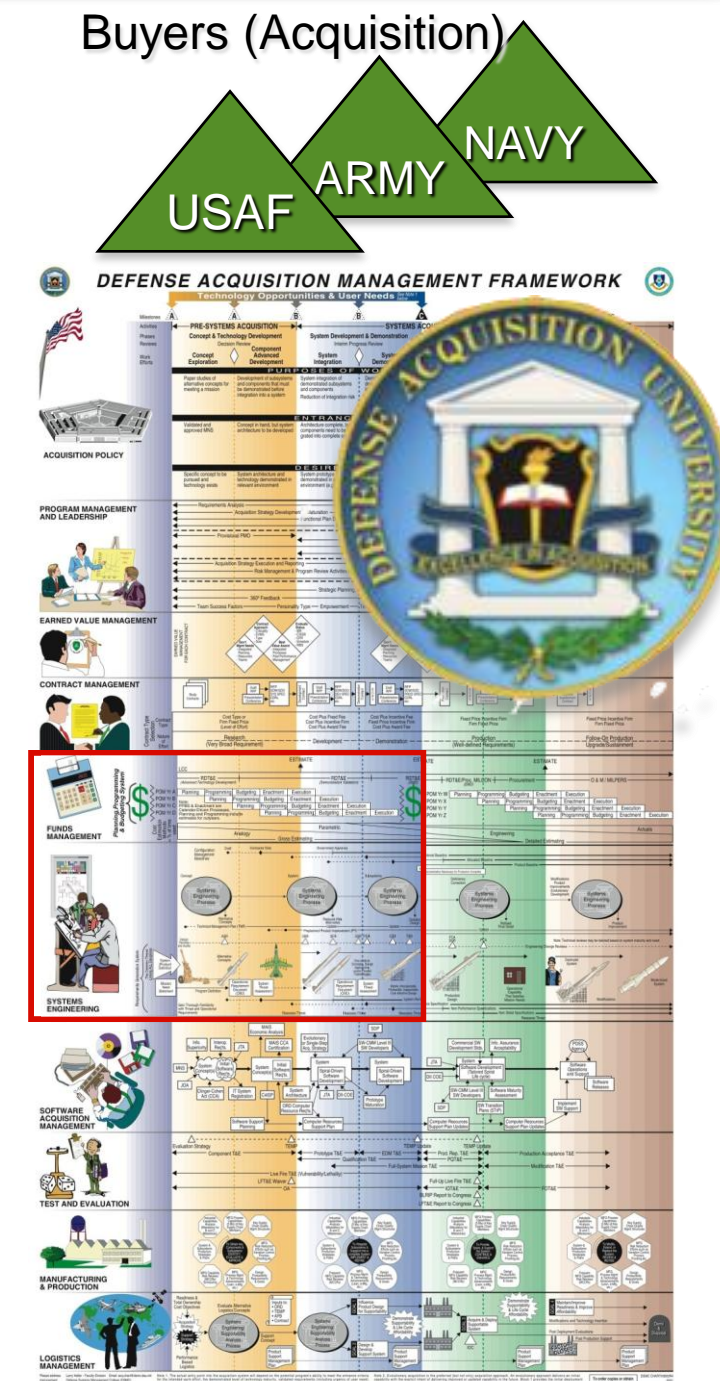
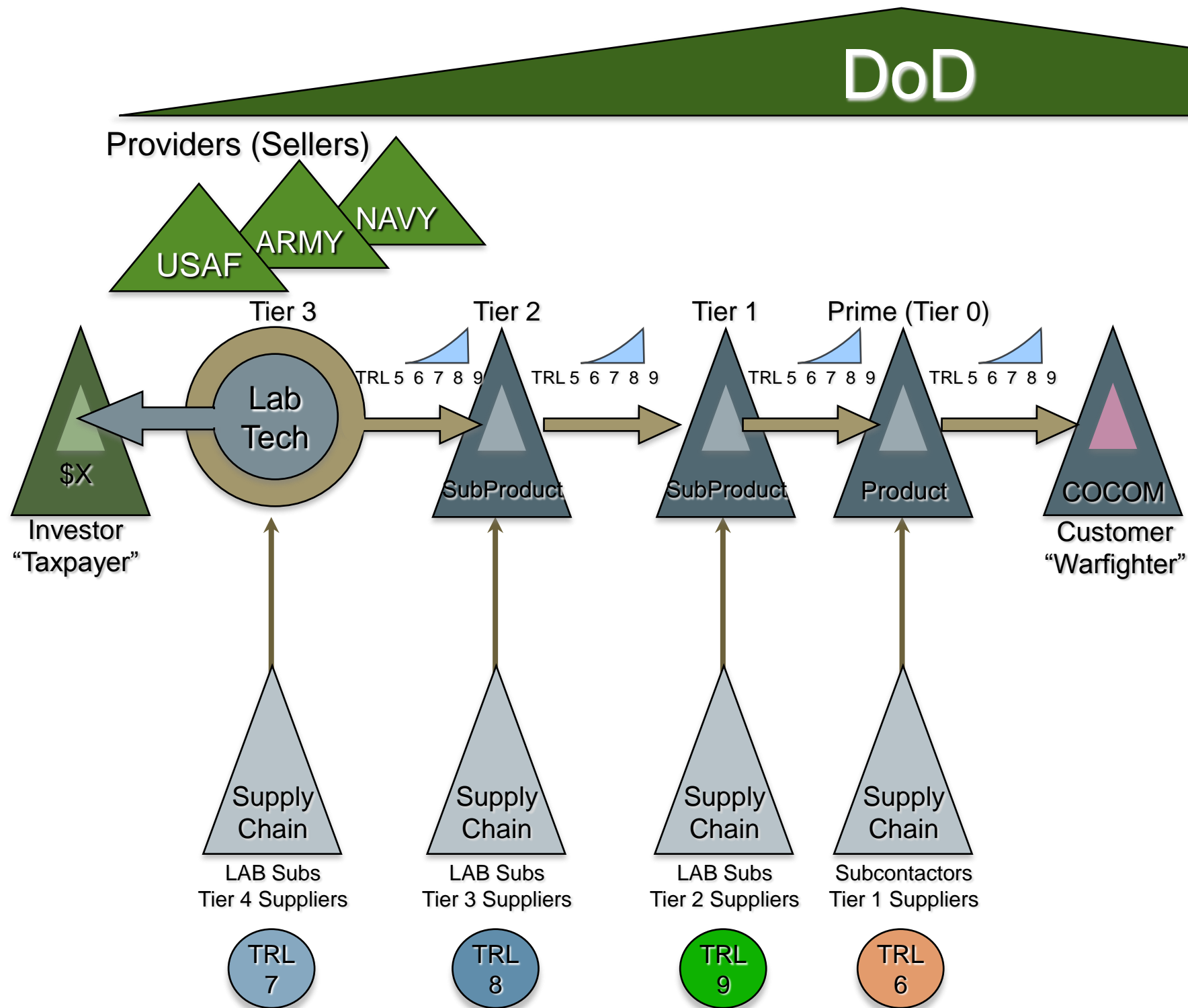
Can the TRL Integrate my iPod?

iPod is a Complex System that plugs into Another
TRL does NOT provide guidance on Systems of Systems



TRL Flaw #2: No Value Chains

TRL does NOT provide guidance on Supply Chain Critical Technology Elements (CTEs)



TRL Flaw #3:

Can't Sync Frameworks

Actual TRL to MRL Sync



TRL 1	TRL 2	TRL 3	TRL 4	TRL 5	TRL 6	TRL 7	TRL 9	
Basic Principles Observed	Concept Formulated	Proof of Concept	Breadboard in Lab	Breadboard in Representative Environment	Prototype in Representative Environment	Prototype in Operational Environment	Mission Proven	

		MRL 3	MRL 4	MRL 5	MRL 6	MRL 7	MRL 8	MRL 9	MRL 10
		Manufacturing Concepts Identified	Manufacturing Processes Identified	Manufacturing Processes Developed ----- Subsystem cost goals set; cost drivers identified	Critical Manufacturing Processes Demonstrated ----- Unit cost goal set	Prototype Manufacturing System ----- Unit cost estimated and in range of goal	Process Maturity Demo ----- Unit cost estimates meet goal	Manufacturing Processes Proven ----- LRIP actual unit cost meets goal	Lean Manufacturing Processes ----- FRP actual unit cost meets goal

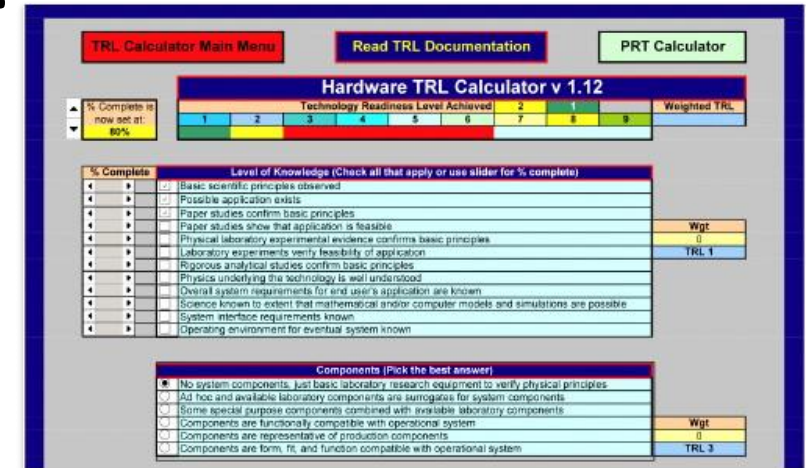


HARD Problem

- Readiness / Assessment Proliferation Continues (past 10 yrs)
 - Does Not work Across Value Chains (IT Systems)
 - Does not handle complex/SOS cases
 - Does not allow for sync among different frameworks/RLs
- Root Cause: RL Data & Rules need to be stored as objects
- Current Tools limit interoperability, which results in proliferation. Which in turn raises the cost for Industry and Govt to produce quality products and adhere to Laws (TRL)
- Point: How you implement the RL matters.
- Tools that exchange rules based on interoperable standards matter.

Problem Summary

- **RDBMS (Excel/Java MYSQL) does not:**
 - Handle hierarchical Data very well.
 - Is not object oriented.
 - Difficult to add and use metadata.



- RL Gets modified to address domain specific probs (silo)
- Now a new RL variant that can stray from the standard

All Readiness Levels Should Be Readily Available

Federal Data & Apps

DoD, DoE, DHS

The screenshot shows the DATA.GOV website interface. At the top, it says "An Official Web Site of the United States Government" and "DATA.GOV EMPOWERING PEOPLE". The navigation menu includes HOME, INTERACTIVE DATASETS, RAW DATA, APPS, GEODATA, COMMUNITY, METRICS, OPEN DATA SITES, GALLERY, and WHAT'S NEW. The main content area is titled "Government Apps" and includes a description: "Use the catalog below to access apps provided by the U.S. Federal Executive Branch. Types of apps available include widgets, gadgets, tools, and RSS feeds. Click on the name of an app to view additional metadata about it. By accessing these apps, you agree to the Data Policy. The Government Apps catalog provides hyperlinks which may lead to agency tools or agency web pages that allow you to mine datasets." Below this is a "Browse Government Apps" section with a search bar and a table of apps. The table has columns for Name, Popularity, and Type. The first few apps listed are: 1. US GAAP RSS Feed of XBRL Financials (18,671 views), 2. Food and Drug Administration--Recalls (15,642 views), 3. Latest Volumes of Foreign Relations of the United States (11,271 views), 4. Airline On-Time Performance and Causes of Flight Delays (5,643 views), 5. Child-Related Product Recalls (5,602 views), 6. AVAILABLE TECHNOLOGIES (5,338 views), 7. Travel Warnings (5,220 views), 8. Travel Alerts (5,004 views), 9. Weekly Fatality Reports (4,609 views), 10. Cooperative Research and Development Agreement (CRADA) Opportunities from NIH (4,297 views), and 11. RadNet Map Interface for Near-Real-Time Radiation Monitoring Data (3,476 views).



NetCentric (Semantic) Interoperability
Industry Meets Govt

The screenshot shows the NCOIC website interface. At the top, it says "NCOIC Network Centric Operations Industry Consortium". The navigation menu includes Home, About NCOIC, NCOIC Role in Technology, Calendar & Events, Press Room, Join NCOIC, Sign-In, and Contact Us. The main content area is titled "Member Organizations" and includes a description: "NCOIC Membership is organized in a tiered structure, each with a unique privileges and responsibilities." Below this is a grid of member organization logos, organized into three tiers. Tier 1 includes BOEING, CISCO, Deloitte, and EADS. Tier 2 includes HARRIS. Tier 3 includes ADIESA, AFEI, American Red Cross, aselsan, CACI, EVER VIGILANT, Carlo Business Technologies, Inc., NCPS, cien, DCNS, EIC, FacetApp, LLC, FINMECCANICA, Fraunhofer Institute for Open Communication Systems, GBL Systems Corporation, HAVELSAN, IDA, and Intelligent Intelligence.

How to Adapt

Solution: Separate the TRL from the Technology

- Track RL's at an object level - as "objects" regardless of the "technology or RDBMS" limitations.
- Enables Alignment across any technology, anywhere
- W3C SemWeb Standards were developed and approved by Obama, Data.gov, etc

Get Net Centric

- Use Open W3C Standards (RDF, OWL RIF, SPARQL)
- Get: Anywhere, anytime, platform independent, secure, RL Metrics



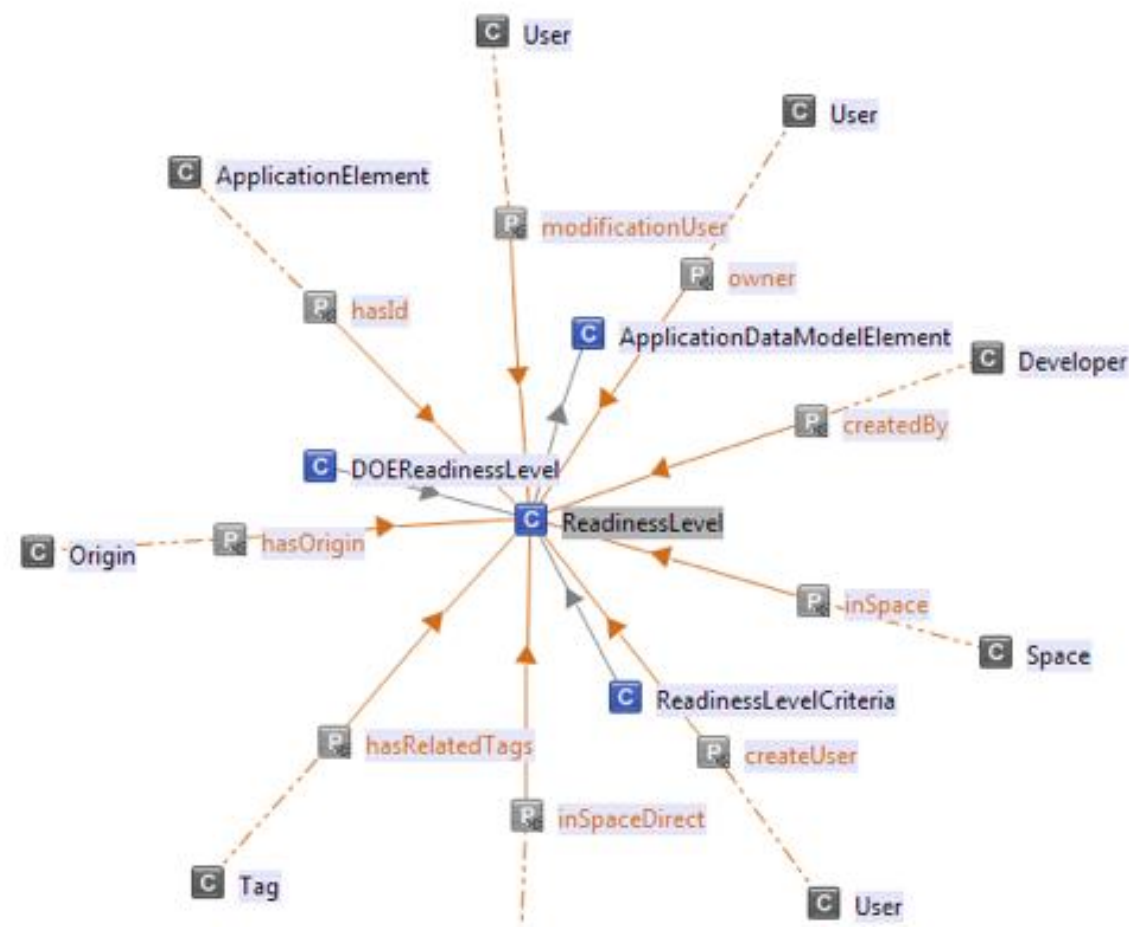
visit: W3.org



Semantic TRL



- Aligning DoD & DoE TRL Variants
- Using a Semantic TRL Ontology



This is the DoD Variant for AFRL, co-developed with their input since 2002, using advanced semantic web technology.

DoD AFRL TRL Screenshot

AFRL TRL Variant

TRL 9

Criteria Author

Criteria to Pass TRL9

Building Page |||| 2.012secs

TRL DOE TRL Images People Cases

Readiness Level Criteria Browser

Readiness Level Criteria

<p>Tool (14)</p> <p>Organization</p> <p>SELECTED</p> <p>Click to Undo:</p> <p>AFRL</p> <p>AFRL (14)</p> <p>Author</p> <p>Bill Nolte (14)</p> <p>Domain</p> <p>Hardware (14)</p> <p>Sub-Domain</p> <p>Manufacturing (5)</p> <p>Programmatics (5)</p> <p>Technology (4)</p> <p>Field</p> <p>Level</p> <p>SELECTED</p> <p>Click to Undo:</p> <p>RL9</p> <p>RL9 (14)</p>	<p>1 to 10 of 14</p> <p>Next>></p> <p>Readiness Level Criteria Specification</p> <table border="1"> <tr><td>Criteria ID</td><td>"http://www.ventology.com/#RL1060"</td></tr> <tr><td>Tool</td><td>TRL</td></tr> <tr><td>Organization</td><td>AFRL</td></tr> <tr><td>Author</td><td>Bill Nolte</td></tr> <tr><td>Domain</td><td>Hardware</td></tr> <tr><td>Sub-Domain</td><td>Technology</td></tr> <tr><td>Level</td><td>RL9</td></tr> <tr><td>Criteria</td><td>Operational Concept has been implemented successfully</td></tr> </table> <p>Readiness Level Criteria Specification</p> <table border="1"> <tr><td>Criteria ID</td><td>"http://www.ventology.com/#RL1069"</td></tr> <tr><td>Tool</td><td>TRL</td></tr> <tr><td>Organization</td><td>AFRL</td></tr> <tr><td>Author</td><td>Bill Nolte</td></tr> <tr><td>Domain</td><td>Hardware</td></tr> <tr><td>Sub-Domain</td><td>Technology</td></tr> <tr><td>Level</td><td>RL9</td></tr> <tr><td>Criteria</td><td>System has been installed and deployed in intended weapon system platform</td></tr> </table> <p>Readiness Level Criteria Specification</p> <table border="1"> <tr><td>Criteria ID</td><td>"http://www.ventology.com/#RL1078"</td></tr> <tr><td>Tool</td><td>TRL</td></tr> <tr><td>Organization</td><td>AFRL</td></tr> <tr><td>Author</td><td>Bill Nolte</td></tr> <tr><td>Domain</td><td>Hardware</td></tr> <tr><td>Sub-Domain</td><td>Technology</td></tr> <tr><td>Level</td><td>RL9</td></tr> <tr><td>Criteria</td><td>Actual system fully demonstrated</td></tr> </table> <p>Readiness Level Criteria Specification</p> <table border="1"> <tr><td>Criteria ID</td><td>"http://www.ventology.com/#RL1087"</td></tr> <tr><td>Tool</td><td>TRL</td></tr> <tr><td>Organization</td><td>AFRL</td></tr> <tr><td>Author</td><td>Bill Nolte</td></tr> <tr><td>Domain</td><td>Hardware</td></tr> <tr><td>Sub-Domain</td><td>Technology</td></tr> <tr><td>Level</td><td>RL9</td></tr> <tr><td>Criteria</td><td>Actual mission system "flight proven" through successful mission operations (OT&E completed)</td></tr> </table> <p>Readiness Level Criteria Specification</p> <table border="1"> <tr><td>Criteria ID</td><td>"http://www.ventology.com/#RL1135"</td></tr> </table>	Criteria ID	"http://www.ventology.com/#RL1060"	Tool	TRL	Organization	AFRL	Author	Bill Nolte	Domain	Hardware	Sub-Domain	Technology	Level	RL9	Criteria	Operational Concept has been implemented successfully	Criteria ID	"http://www.ventology.com/#RL1069"	Tool	TRL	Organization	AFRL	Author	Bill Nolte	Domain	Hardware	Sub-Domain	Technology	Level	RL9	Criteria	System has been installed and deployed in intended weapon system platform	Criteria ID	"http://www.ventology.com/#RL1078"	Tool	TRL	Organization	AFRL	Author	Bill Nolte	Domain	Hardware	Sub-Domain	Technology	Level	RL9	Criteria	Actual system fully demonstrated	Criteria ID	"http://www.ventology.com/#RL1087"	Tool	TRL	Organization	AFRL	Author	Bill Nolte	Domain	Hardware	Sub-Domain	Technology	Level	RL9	Criteria	Actual mission system "flight proven" through successful mission operations (OT&E completed)	Criteria ID	"http://www.ventology.com/#RL1135"
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TRL Calculator Main Menu Read TRL Documentation PRT Calculator

Hardware TRL Calculator v 1.12

Technology Readiness Level Achieved: 2

% Complete	1	2	3	4	5	6	7	8	9	10	Weighted TRL
80%											2

Level of Knowledge (Check all that apply or use slider for % complete)

- Basic scientific principles observed
- Possible application exists
- Paper studies confirm basic principles
- Paper studies show that application is feasible
- Physical laboratory experimental evidence confirms basic principles
- Laboratory experiments verify feasibility of application
- Rigorous analytical studies confirm basic principles
- Physics underlying the technology is well understood
- Overall system requirements for end user's application are known
- Science known to exist that mathematical and/or computer models and simulations are possible
- System interface requirements known
- Operating environment for eventual system known

Components (Pick the best answer)

- No system components, just basic laboratory research equipment to verify physical principles
- All key and available laboratory components are prototypes for system components
- Some special purpose components combined with available laboratory components
- Components are functionally compatible with operational system
- Components are representative of production components
- Components are form, fit, and function compatible with operational system

Data Source Courtesy:
DoD TRL Calculator (Bill Nolte, AFRL)

A prototype Web 3.0 solution is already available, based on years of research and validation. This is the DoE Variant.

DoE SemanticTRL Screenshot

Phase 1: 80% Complete

Items Remaining:

- Import the DHS Product Realization Chart Criteria
- Build Interview Screens, Workflows & Rules
- Build Analytical Reports
- Add DHS Branding
- Host on LinkedData Cloud

DoE AHL System Under Assessment (Hanford)

TRL 6

Assessment Result

Criteria Type: Manufacturing Programmatic Technology

Decision Basis

Supporting Documents

building Page|--- 6.508secs

TRL DOE TRL Images People Cases

Browse DOE TRL Entries

DOE Readiness Level

System Short Name
 AHL/ARL (34)
 ILAW LFH CSS (34)
 ILAW LFH DS (69)
 LOP/LVP (34)
 ASX (34)
 LFP (34)
 LMP (34)

System Full Name
 Analytical Hot Cell Laboratory Equipment/
 Analytical Radiological Laboratory Equipment
 Systems (34)
 Autosampling System (34)
 ILAW Container Finishing Handling System
 (LFH) container sealing subsystem (34)
 ILAW Container Finishing Handling System
 (LFH) decontamination subsystem (TRL 5) (35)
 ILAW Container Finishing Handling System
 (LFH) decontamination subsystem (TRL 6) (34)
 LAW Melter Feed Process System (LFP) (34)
 LAW Melter Process System (LMP) (34)
 LAW Primary Offgas Process and Secondary
 Offgas Vessel Vent Process Systems (LOP/LVP)
 (34)

TRL Under Test
 5 (35)
 6 (238)

Decision
 N (36)
 NA (1)
 Y (214)

Criteria Type
 M (69)
 P (92)
 T (112)

1 to 10 of 273 [Next >>](#)

DOE Readiness Level Entry

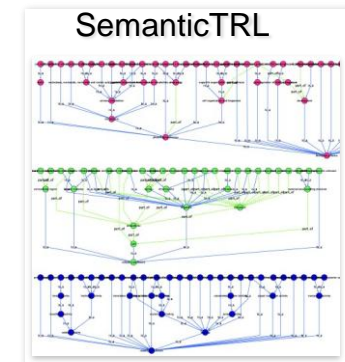
Readiness Level Entry ID "http://www.ventology.com/#DOERL1"
 System Short Name AHL/ARL
 System Full Name Analytical Hot Cell Laboratory Equipment/ Analytical Radiological Laboratory Equipment Systems
 TRL Under Test 6
 Decision Y
 Criteria Type T
 TRL Decision Basis Sufficient information is available to specify a prototype and optimize the final design of the Laser Ablation Inductively Coupled Plasma Mass Spectrometry/Laser Ablation Inductively Coupled Plasma Atomic Emission Spectrometry (LA-ICP-MS/LA-ICP-AES) subsystems. Tradeoffs in the major subcomponents were evaluated. The laser was tested for sample preparation included varying laser wavelengths, frequencies, power levels, and length of transfer tubing to get the sample to the ICP-MS/ICP-AES subsystems. The furnace apparatus for glass sample preparations was tested. The results of these tests are documented in two reports from the Savannah River Site (SCT-MOSRLE60-00-216-00001, Rev. 00A; SCT-MOSRLE60-00-216-00002, Rev. 00A), and a Pacific Northwest National Laboratory report (24590-101-TSA-W000-0004-158-00002, Rev. A).
 TRL Decision Criteria Performance and behavior of subcomponent interactions understood (including tradeoffs)

DOE Readiness Level Entry

Readiness Level Entry ID "http://www.ventology.com/#DOERL10"
 System Short Name AHL/ARL
 System Full Name Analytical Hot Cell Laboratory Equipment/ Analytical Radiological Laboratory Equipment Systems
 TRL Under Test 6
 Decision Y
 Criteria Type P
 TRL Decision Basis Off-normal operating responses for the AHL/ARL have been evaluated in Section 7.18 of the AHL/ARL system descriptions (24590-LAB-3YD-AHL-00001, Rev. 1; 24590-LAB-3YD-ARL-00001, Rev. ?1).
 TRL Decision Criteria Off-normal operating responses determined for engineering scale system

DOE Readiness Level Entry

Readiness Level Entry ID "http://www.ventology.com/#DOERL100"
 System Short Name ILAW LFH CSS
 System Full Name ILAW Container Finishing Handling System (LFH) container sealing subsystem
 TRL Under Test 6
 Decision N
 Criteria Type T
 TRL Decision Basis Process testing is not completed. Actual plant equipment is being fabricated and will be used for equipment testing to support acceptance as defined in the engineering specifications (24590-LAW-3PS-HCTH-T0001). Prototypic remote testing is planned for completion during cold commissioning of the LAW Vitrification Facility.
 TRL Decision Criteria Plan for demonstration of prototypical equipment and process testing completed, results verify design



VENTOLGY LLC
 8111 E. Madison St. Suite 1000, Seattle, WA 98112 (206) 728-9434 (206) 728-1019 fax
 info@ventology.com www.ventology.com

Congressional Add Proposal
 Executive Summary

Abstract
 VenLogic has applied its 25+ years experience in the venture evaluation, development and management process to design a new category of venture assessment tools and portfolio management solutions for early stage CEOs, Private Investors, Corporate Investors and Government Technology Investors/Portfolio Managers. VenLogic is seeking \$2.5M in appropriations funding for the development and evaluation of a **Semantic TRL-based Investment Decision Expert System for TTI Portfolio Managers** by 2009.

With an intelligent expert system solution for learning, discovery, searching, decision analysis, investing and tracking, **DoD Portfolio Managers** will be able to make more reliable decisions in less time, over a vast range of complex technology issues. Management will be able to apply the most critical best practices at key milestones in the life of a project with a common language shared by industry, thereby closing the **Technology Transition Gap**. This will, in turn serve to attract co-investment partners, closing the **Capital Gap** that exists for early-stage technology companies. The benefits combine to enable DoD Portfolio Managers with the capability to get technology to the warfighters faster, saving lives and taxpayer capital.

Driving Forces of Demand
 World events continue to drive DoD to improve its internal processes and governing policies to be in sync with the warfighter's need for new technology. This demand directly impacts the investment decision process, where DoD portfolio managers in venture development programs such as the **Technology Transition Initiative (TTI)** play a vital role in providing the bridge funding that enables products to transition to the warfighter more quickly.

Today, very large investment decisions are made and managed across DoD with an inaccurate organizational design relative to the precedents that exist in the venture development industry. Lacking are the necessary skills, tools, business processes, best practices and training programs. Granted the venture industry lacks the level of complexity DoD is required to manage, it is engineered for getting high technology products to market.

DoD Management are recruited into roles that involve making investment decisions that often stretch beyond their experience level requiring them to assume more risk with less information than used by their peer counterparts in the venture industry. As a result, it is no surprise that many promising technologies fail to get to market (e.g. the warfighter) on time and on budget. Lab Technology quickly becomes obsolete and a waste of taxpayer dollars, when in fact it could be out in the field solving problems had the right decisions been made sooner.

The results of extensive research into the DoD **Technology Transition Gap** (e.g. *The Gaps*), has uncovered key findings that explain the root of the phenomena based on venture industry best practices. Findings show how DoD investments directly result in losses if critical path best practices are not followed in, thereby contributing to The Gap. Findings also illustrate how DoD policies and organizational gaps correlate directly to The Gap, making it increasingly difficult for

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U.S. Department of Energy
 Office of Environmental Management

Technology Readiness Assessment (TRA) /
 Technology Maturation Plan (TMP)
 Process Guide

Technology Readiness Assessment of a Large
 DOE Waste Processing Facility

Presented at the 2007 Technology Maturation Conference
 September 12, 2007
 Virginia Beach, Virginia

Don Alexander, DOE/ORP
 Langdon Holton, PNNL
 Herb Sutter, Consultant

Office of River Protection
 Department of Energy
 Richland, Washington

DoE TRL Ontology

The screenshot displays the DoE TRL Ontology software interface, which is divided into several main sections:

- Ontology Navigator:** A tree view on the left side showing the hierarchy of classes. The classes listed include: ControlEnumeration, DataChannel, DataModelElement, ApplicationDataModelElement, Agency, Case, Comment, Event, FacetNowAdministration, FacetNowData, FacetNowUsage, FinancialObject, Funnel, FunnelItem, Opportunity, Parameters, Problem, ProductVersion, ReadinessLevel, DOEReadinessLevel, ReadinessLevelCriteria, Solution, and Status.
- Instances:** A list at the bottom left showing 100 instances of the DOEReadinessLevel class, labeled from DOERL1 to DOERL118.
- Entity Properties:** A panel at the top right showing the current entity being viewed, which is ReadinessLevel.
- Ontology Visualizer:** A central diagram showing the relationships between classes. The central node is ReadinessLevel, which is connected to several other classes via relationships:
 - ApplicationElement** (Class) is connected to ReadinessLevel (Class) via the relationship **hasId** (Property).
 - User** (Class) is connected to ReadinessLevel (Class) via the relationship **modificationUser** (Property).
 - User** (Class) is connected to ReadinessLevel (Class) via the relationship **owner** (Property).
 - ApplicationDataModelElement** (Class) is connected to ReadinessLevel (Class) via the relationship **createdBy** (Property).
 - Developer** (Class) is connected to ReadinessLevel (Class) via the relationship **createdBy** (Property).
 - Origin** (Class) is connected to ReadinessLevel (Class) via the relationship **hasOrigin** (Property).
 - Space** (Class) is connected to ReadinessLevel (Class) via the relationship **inSpace** (Property).
 - Tag** (Class) is connected to ReadinessLevel (Class) via the relationship **hasRelatedTags** (Property).
 - Space** (Class) is connected to ReadinessLevel (Class) via the relationship **inSpaceDirect** (Property).
 - User** (Class) is connected to ReadinessLevel (Class) via the relationship **createUser** (Property).
 - ReadinessLevelCriteria** (Class) is connected to ReadinessLevel (Class) via the relationship **createUser** (Property).

Legend:

- Relation: P (Property)
- Range Class: C (Class)
- Class: C (Class)
- Attribute: A (Attribute)

Navigation history:

OntoApp → ReadinessLevel → ReadinessLevelCriteria → ReadinessLevel

DoE RL 6

The screenshot displays the Ontology Navigator interface with three main panels:

- Ontology Navigator:** A tree view showing the class hierarchy. The path is: ControlEnumeration > DataChannel > DataModelElement > ApplicationDataModelElement > ReadinessLevel > DOEReadinessLevel.
- Instances:** A list of instances for the class DOERL1, ranging from DOERL1 to DOERL118.
- Entity Properties:** A detailed view of the DOERL1 instance. It shows a table of properties and their values.

Property	Value
createDatetime	
createProcess	
hasCriteriaType	
hasCriteriaType	T
hasDecision	
hasDecision	Y
hasDescription	
hasFullSystemName	
hasFullSystemName	Analytical Hot Cell Laboratory Equipment/ Analytical Radiological Laboratory Equipment Sy...
hasID	
hasID	"http://www.ventology.com/#DOERL1"
hasLabel	
hasModelName	
hasShortSystemName	
hasShortSystemName	AHL/ARL
hasSortName	
hasStatusV (DataSourceField, StatusType, string, string)	
hasText	
hasTRLDecisionBasis	
hasTRLDecisionBasis	Sufficient information is available to specify a prototype and optimize the final design of the
hasTRLDecisionCriteria	
hasTRLDecisionCriteria	Performance and behavior of subcomponent interactions understood (including tradeoffs)
hasTRLUnderTest	
hasTRLUnderTest	6
inPartitions	
isClass	
modificationDatetime	
modificationProcess	
createdBy	
createUser	
hasId	
hasOrigin	
hasRelatedTags	
inSpace	
inSpaceDirect	
modificationUser	
owner	

Map to DoD TRL

The image displays two windows from an ontology editor. The left window, 'Ontology Navigator', shows a tree view of classes. The right window, 'Ontology Visualizer', shows a network graph of these classes and their relationships.

Ontology Navigator (Left Panel):

- ControlEnumeration
- DataChannel
- DataModelElement
 - ApplicationDataModelElement
 - Agency
 - Case
 - Comment
 - Event
 - FacetNowAdministration
 - FacetNowData
 - FacetNowUsage
 - FinancialObject
 - Funnel
 - FunnelItem
 - Opportunity
 - Parameters
 - Problem
 - ProductVersion
 - ReadinessLevel
 - DOEReadinessLevel
 - ReadinessLevelCriteria
 - Solution
 - Status

Instances (Bottom Left Panel):

[RL1200 ... RL1270] - (71)

- RL1200
- RL1201
- RL1202
- RL1203
- RL1204
- RL1205
- RL1206
- RL1207
- RL1208
- RL1209
- RL1210
- RL1211
- RL1212
- RL1213
- RL1214
- RL1215
- RL1216
- RL1217
- RL1218
- RL1219
- RL1220

Ontology Visualizer (Right Panel):

Zoom: 50%

Legend:

- Relation (P)
- Range Class (C)
- Class (C)
- Attribute (P)

Navigation history: OntoApp → ReadinessLevel → ReadinessLevelCriteria → ReadinessLevel → DOEReadinessLevel

Ontology Graph (Center):

The graph shows a central class **DOEReadinessLevel** (C) with several outgoing relations (P) to other classes (C):

- inSpace** (P) to **Space** (C)
- hasRelatedTags** (P) to **Tag** (C)
- inSpaceDirect** (P) to **Space** (C)
- modificationUser** (P) to **User** (C)
- hasId** (P) to **ApplicationElement** (C)
- hasOrigin** (P) to **Origin** (C)
- createUser** (P) to **User** (C)
- owner** (P) to **User** (C)
- createdBy** (P) to **Developer** (C)

There are also relations between other classes:

- hasRelatedTags** (P) from **Tag** (C) to **ReadinessLevel** (C)
- inSpace** (P) from **Space** (C) to **ReadinessLevel** (C)
- inSpaceDirect** (P) from **Space** (C) to **ReadinessLevel** (C)
- modificationUser** (P) from **User** (C) to **ReadinessLevel** (C)
- hasId** (P) from **ApplicationElement** (C) to **ReadinessLevel** (C)
- hasOrigin** (P) from **Origin** (C) to **ReadinessLevel** (C)
- createUser** (P) from **User** (C) to **ReadinessLevel** (C)
- owner** (P) from **User** (C) to **ReadinessLevel** (C)
- createdBy** (P) from **Developer** (C) to **ReadinessLevel** (C)

Map to MRL 5

The screenshot displays the Ontology Navigator and Entity Properties windows. The Ontology Navigator shows a class hierarchy with 'ReadinessLevelCriteria' selected. The Entity Properties window shows the details for the instance 'RL1011', including its identifier, properties, and values.

Ontology Navigator Class Hierarchy:

- ControlEnumeration
- DataChannel
- DataModelElement
 - ApplicationDataModelElement
 - Agency
 - Case
 - Comment
 - Event
 - FacetNowAdministration
 - FacetNowData
 - FacetNowUsage
 - FinancialObject
 - Funnel
 - FunnelItem
 - Opportunity
 - Parameters
 - Problem
 - ProductVersion
 - ReadinessLevel
 - DOEReadinessLevel
 - ReadinessLevelCriteria
 - Solution
 - Status

Entity Properties for RL1011:

Identifier	Value
byOrganization	
createDatetime	
createProcess	
forLevel	
forLevel	RL5
hasAuthor	
hasCriteriaId	
hasCriteriaId	"http://www.ventology.com#"#RL1011
hasCriteriaText	
hasCriteriaText	Manufacturing Process Development. Trade studies and lab experiments define key manufa
hasDescription	
hasLabel	
hasModelName	
hasSortName	
hasStatusV (DataSourceField,StatusType,string,string)	
hasText	
inDomain	
inDomain	Manufacturing
inField	
inField	MRL Definitions
inPartitions	
inSubDomain	
inTool	
inTool	TRL
isClass	
modificationDatetime	
modificationProcess	
createdBy	
createUser	
hasId	
hasOrigin	
hasRelatedTags	
inSpace	
inSpaceDirect	
modificationUser	
owner	

DoD TRL 7

The screenshot displays an ontology editor interface with three main panes:

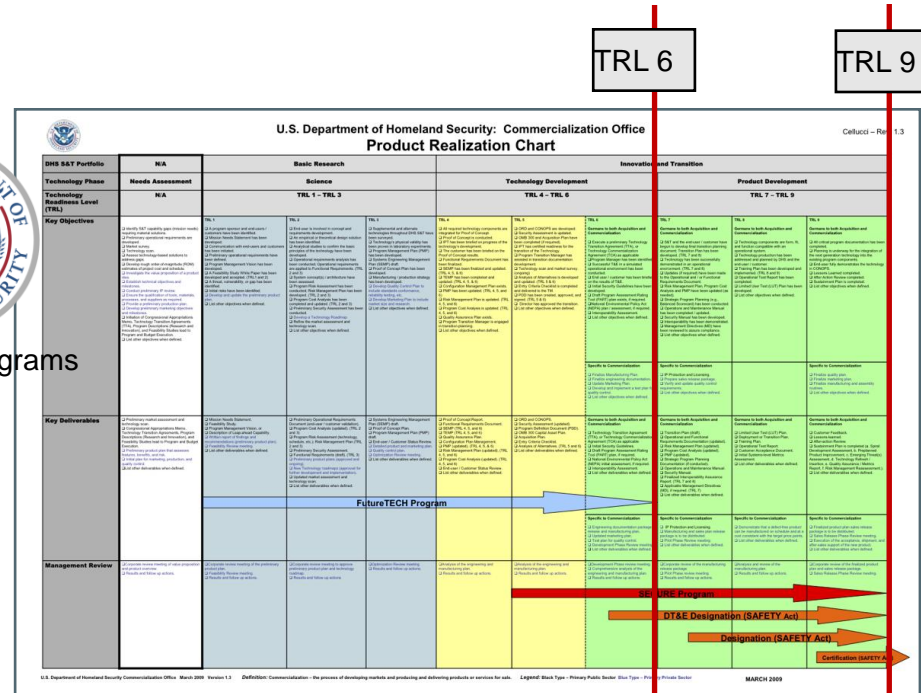
- Ontology Navigator:** A tree view of classes including ControlEnumeration, DataChannel, DataModelElement, ApplicationDataModelElement, Agency, Case, Comment, Event, FacetNowAdministration, FacetNowData, FacetNowUsage, FinancialObject, Funnel, FunnelItem, Opportunity, Parameters, Problem, ProductVersion, ReadinessLevel (with sub-classes DOEReadinessLevel and ReadinessLevelCriteria), Solution, and Status.
- Instances:** A list of instances from RL1100 to RL1120, with RL1101 selected.
- Entity Properties:** A detailed view for the instance RL1101, showing a table of properties and their values. Red 'X' marks indicate missing or invalid values for several properties.

Property	Value	Status
byOrganization	AFRL	✗
createDatetime		
createProcess		
forLevel	RL7	✗
hasAuthor	Bill Nolte	✗
hasCriteriaId	"http://www.ventology.com#"#RL1101	✗
hasCriteriaText	System prototype successfully tested in a field environment.	✗
hasDescription		
hasLabel		
hasModelName		
hasSortName		
hasStatusV (DataSourceField, StatusType, string, string)		
hasText		
inDomain	Hardware	✗
inField		
inPartitions		
inSubDomain	Technology	✗
inTool	TRL	✗
isClass		
modificationDatetime		
modificationProcess		
createdBy		
createUser		
hasId		
hasOrigin		
hasRelatedTags		
inSpace		
inSpaceDirect		
modificationUser		
owner		

Many Benefits for Being in Sync



DHS Uses TRL to Manage SECURE & FutureTECH Programs



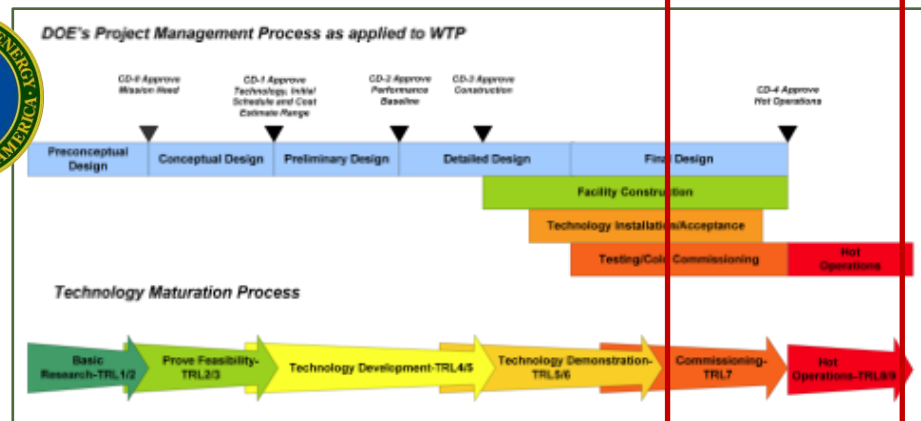
Gating Criteria

FutureTECH Program TRL 6

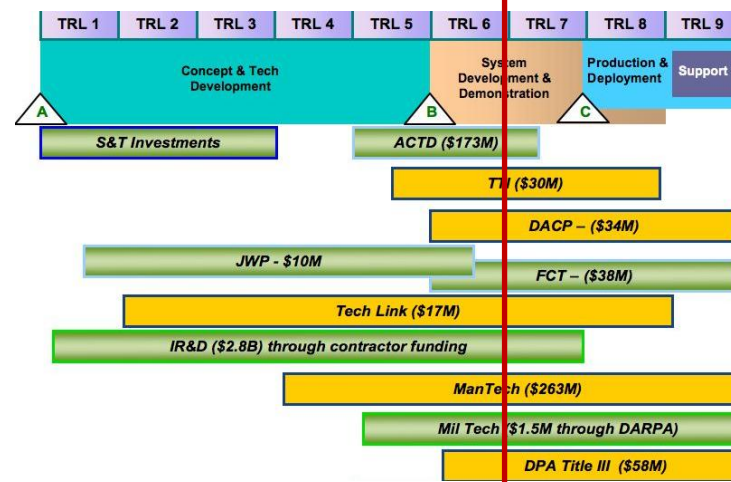
Secure Program TRL 9



DoE Uses TRL to Manage \$20B Hanford Vit. Plant



DoD Uses TRL to Manage \$500M in Tech Transition Funds



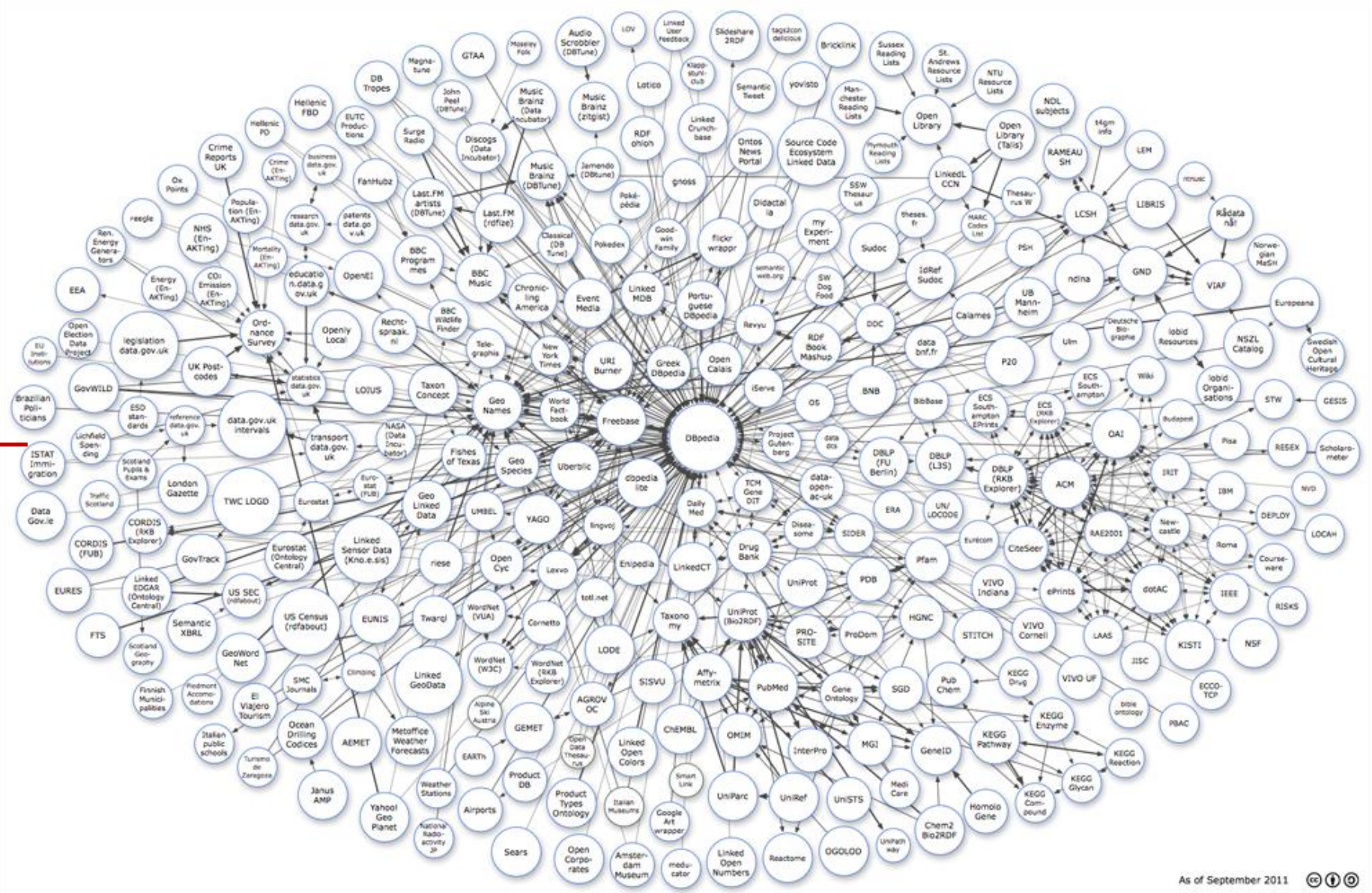
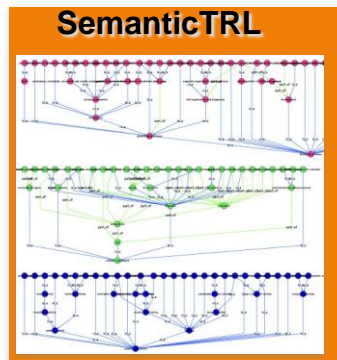
Does your TRL Sync up?

• Does DHS TRL 6 = DoD TRL 6 ?

Benefits:

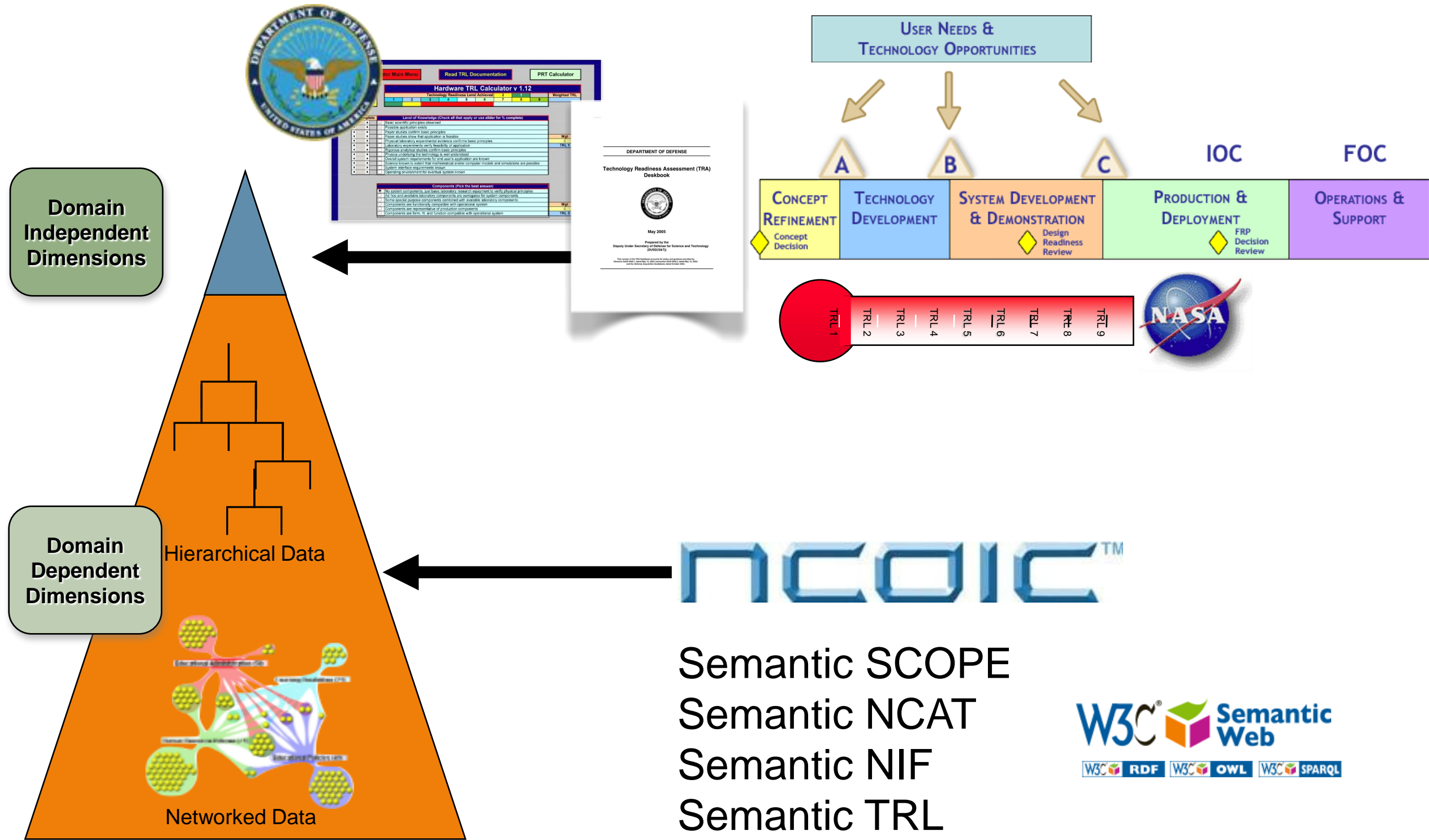
- Pool Cross-Agency Funds
- Interagency Coordination
- Assist Investor Syndicates
- Joint Venture Suppliers
- Reduce Confusion
- Communicate Clearly
- Track Spending in Detail
- TRL Criteria Collaboration

Goal: Access TRLs @ LinkedData.org



LinkedData.org

NCOIC Solution Partner



Learn More

Visit the NetCentric Interoperability Session
Bayview 2

5:15 – 5:50 Wednesday: Session 13618

**“Describing Value-Add of Semantic Web
Design Using a Practical Interoperability Scale”**

Mr. Robert Kruse, FacetApp LLC

Demo: Semantic TRL between DoD & DoE

JOIN:



Visit: NCOIC.org

Semantic Interoperability Working Group

SCOPE Working Group

In Summary

- PROBLEM
 - A lot of poorly defined RLs out there.
 - Growing at an increasing rate each year
- SOLUTION
 - To become NetCentric!
 - NCOIC DoD Endorsed Solutions for Interoperability
 - SCOPE leverages the idea of a semantic-enabled TRL.
- Closing:
 - Each year we wait, it's harder to address
 - Help the TRL become NetCentric. Join NCOIC.org



Questions?

