Readiness Level Proliferation

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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

Technology Readiness Level (TRL)

10 USC 2366a, DoD 5000.1

Law: 10 USC 2366a

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

How Current is This?

Search this title: Search Title 10

Notes
1 Pending Update(s)
Parallel authorities (CFR)
PDF (5 pages)

(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 improvement 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.

DEPARTMENT OF DEFENSE

Technology Readiness Assessment (TRA) Deskbook

May 2005

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

This version of the TRA Deskbook accounts for policy and guidance provided by Directive DoDD 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	2,866 aircraft	$223.3 billion	2,458 aircraft	32.8
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: JSF Program Office; Program Manager, Future Combat Systems (BCT); V-22 Joint Program Office. (Left) © 2008 ILS/Lockheed Martin. (right) © 2003 The Boeing Company; Lockheed Martin Space Systems Company; General Dynamics Land Systems.

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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
- Human Readiness Levels
- Engineering & Manufacturing Readiness Levels

- Technical Readiness Levels
- Programmatic Readiness Levels
- Reuse Readiness Levels
- Demand Readiness Levels
- Funding Readiness Levels
- System Readiness Levels
- 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 need

- 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.

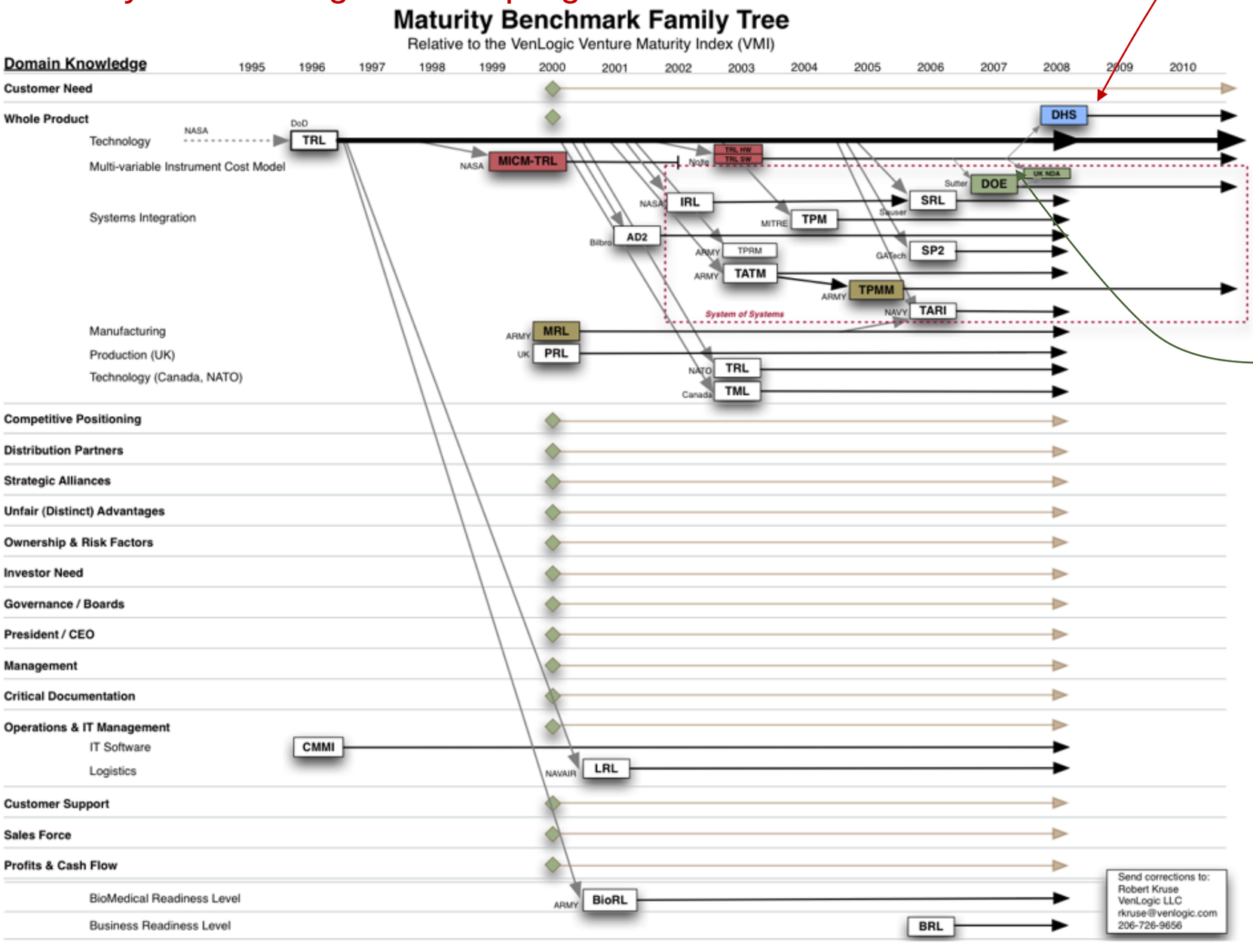
Issues are:

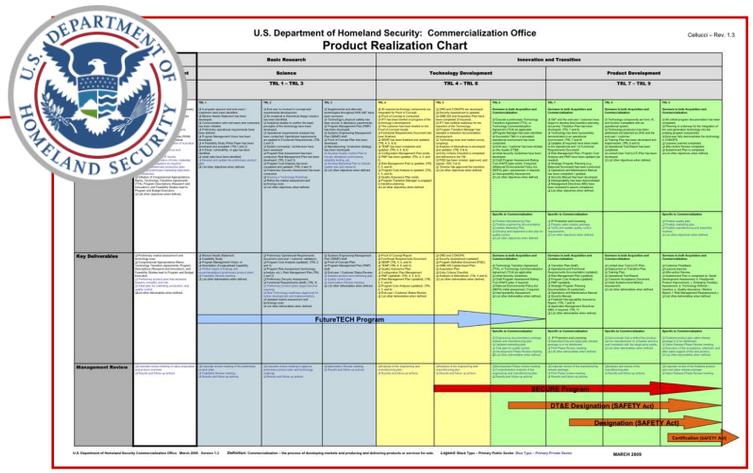
- Quality: Too many RL's of substandard quality design being used in programs.
- Question Alignment: Unable validate alignment: DoD TRL 6 = DHS TRL 6 = DOE TRL 6
- Data Sync: No easy way to sync 2 or 3 spreadsheets, which results in...
- Manual Re-entry: Requires re-input same data over again.

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.

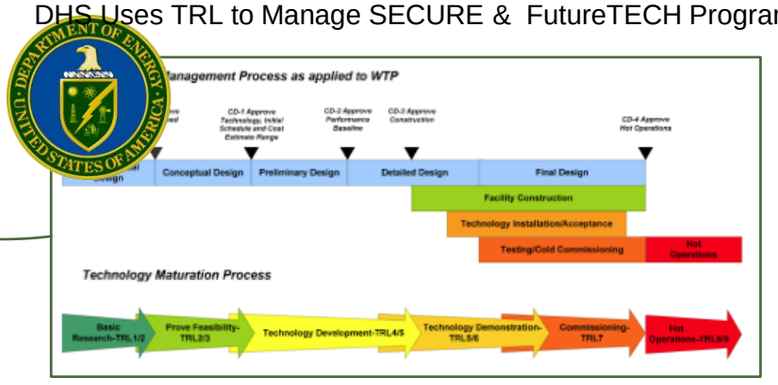
TRL Family Tree Out of Control!

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.

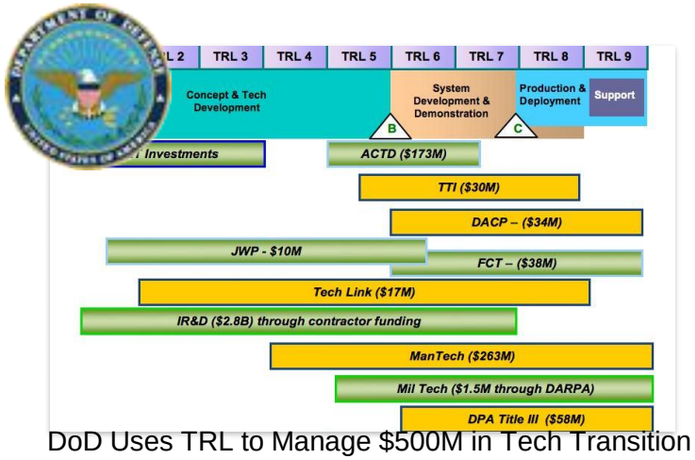




DHS Uses TRL to Manage SECURE & FutureTECH Programs



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



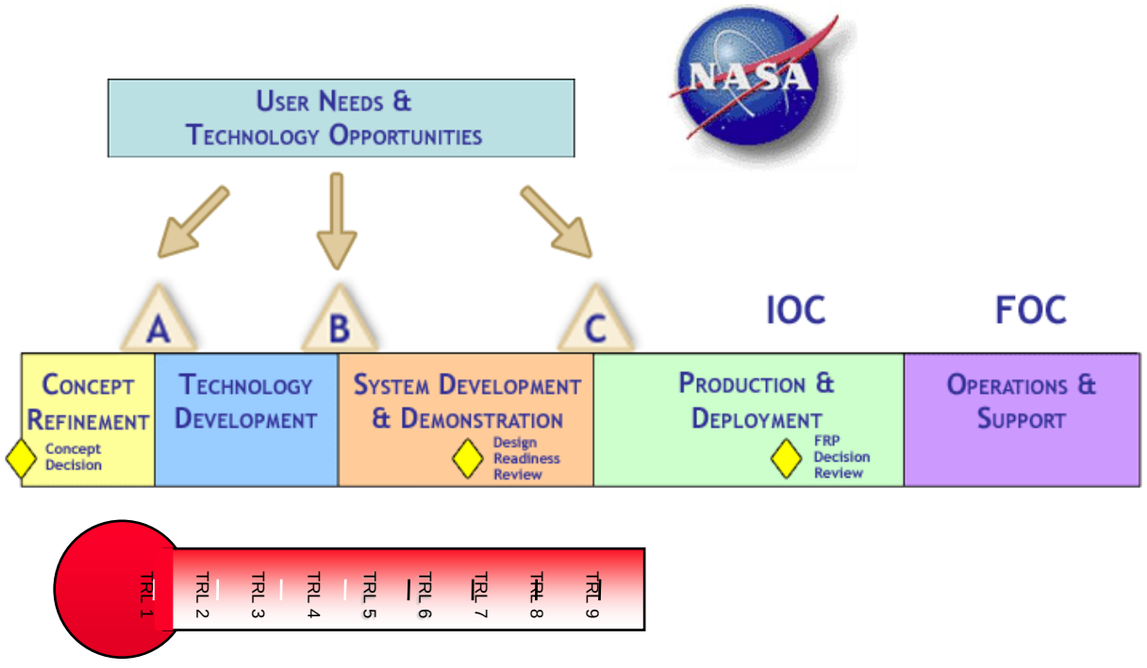
DoD Uses TRL to Manage $500M in Tech Transition Funds

TRL Flaw #1:

No Complex Systems

- DOD 5000.2
- Acquisition Milestones A, B, C

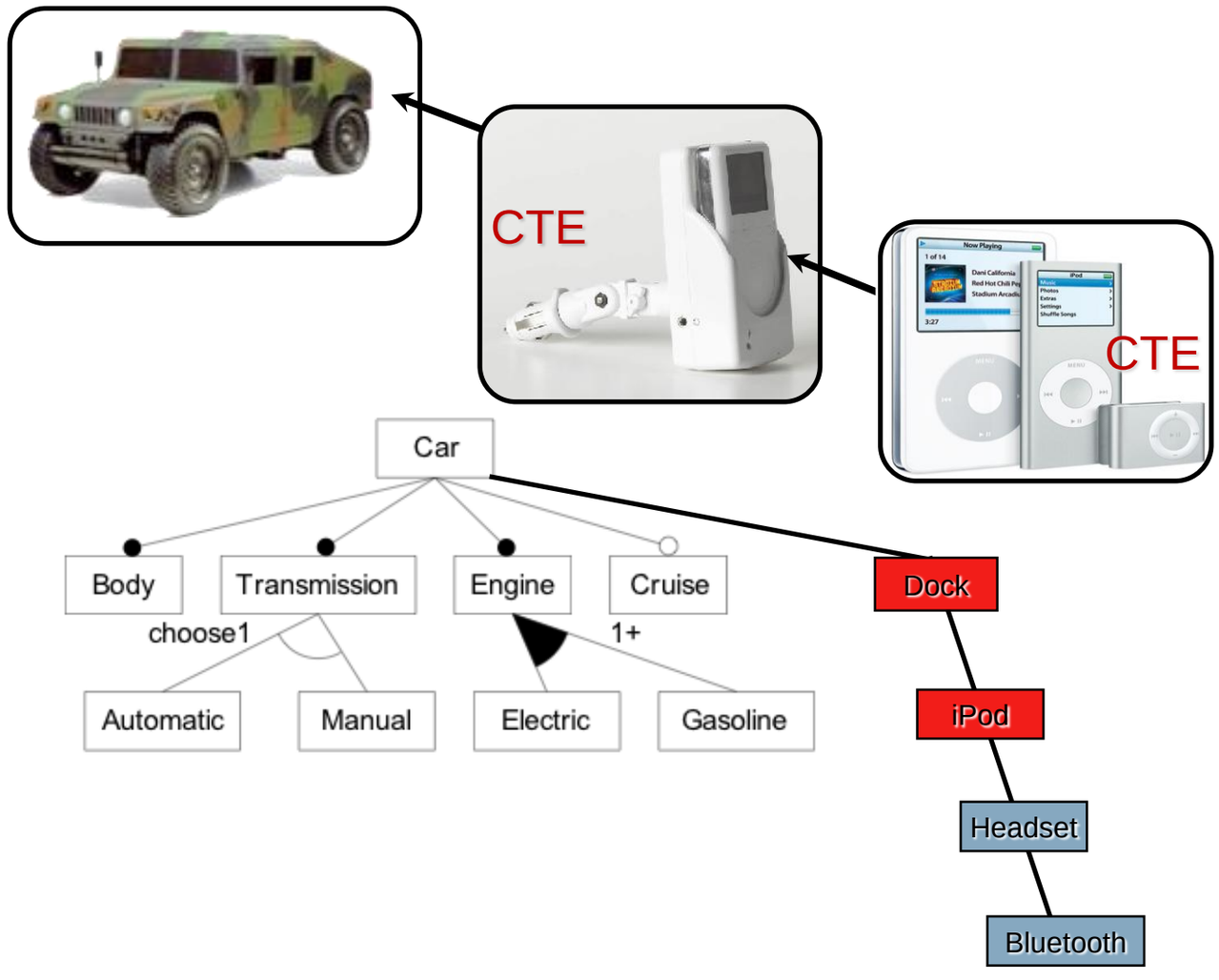
- NASA/DOD Technology Readiness (TRL)
- A BASIC Common Language Used Across ARMY, NAVY, AIR FORCE, and First Responder vendors.



Can the TRL Integrate my iPod?

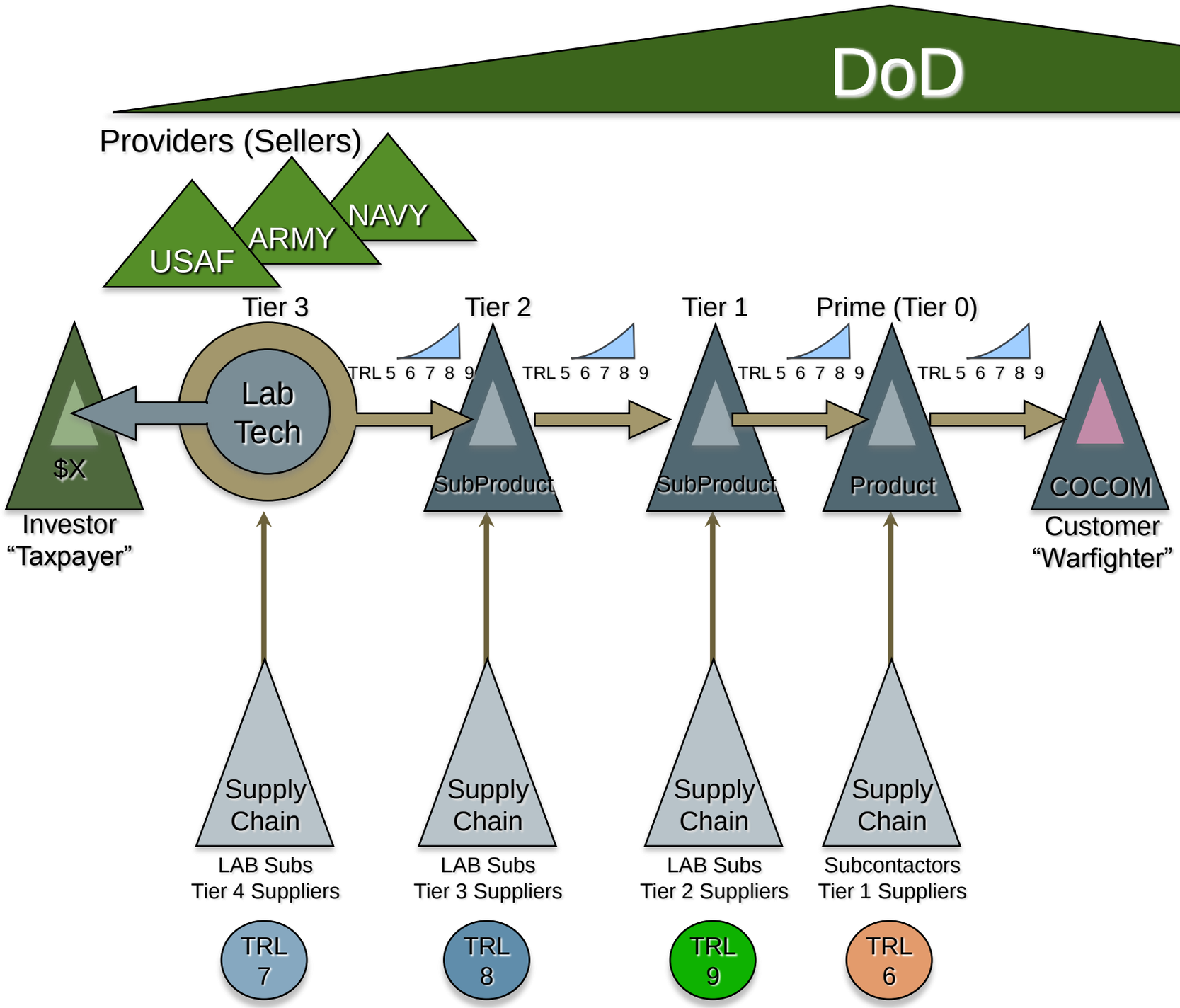
iPod is a Complex System that plugs into Another

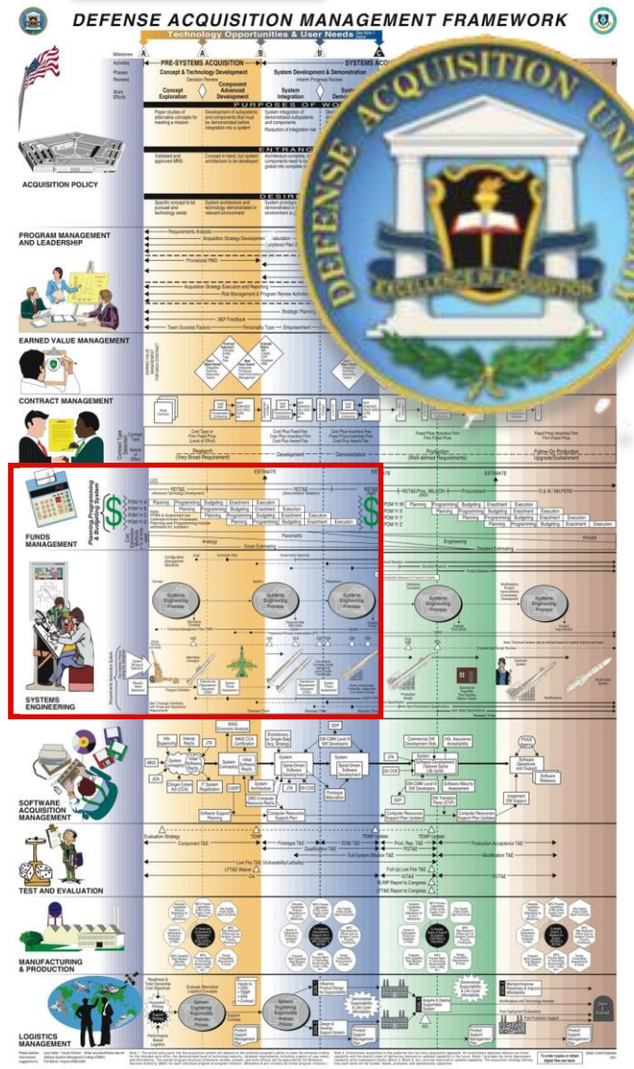
TRL does NOT provide guidance on Systems of Systems



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

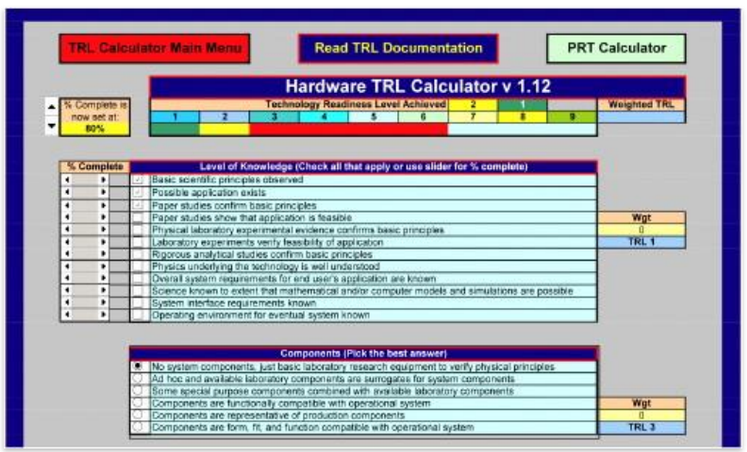
HARD Problem

- 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.

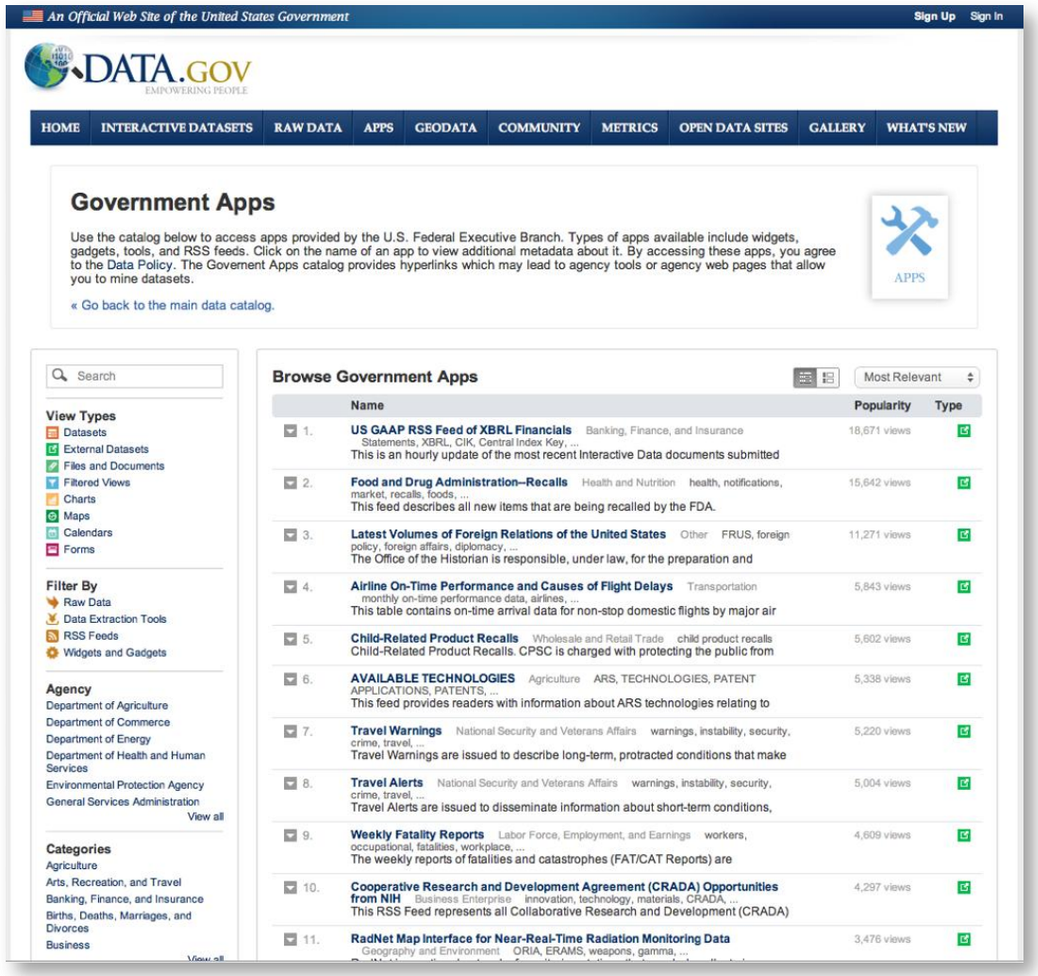


- RL Gets modified to address domain specific probs (silo)
- Now a new RL variant that can stray from the standard

All Readiness Levels Should Be Readily Available

Federal Data & Apps

DoD, DoE, DHS



NetCentric (Semantic) Interoperability Industry Meets Govt

How to Adapt

Solution: <u>Separate the TRL from the Technology</u>

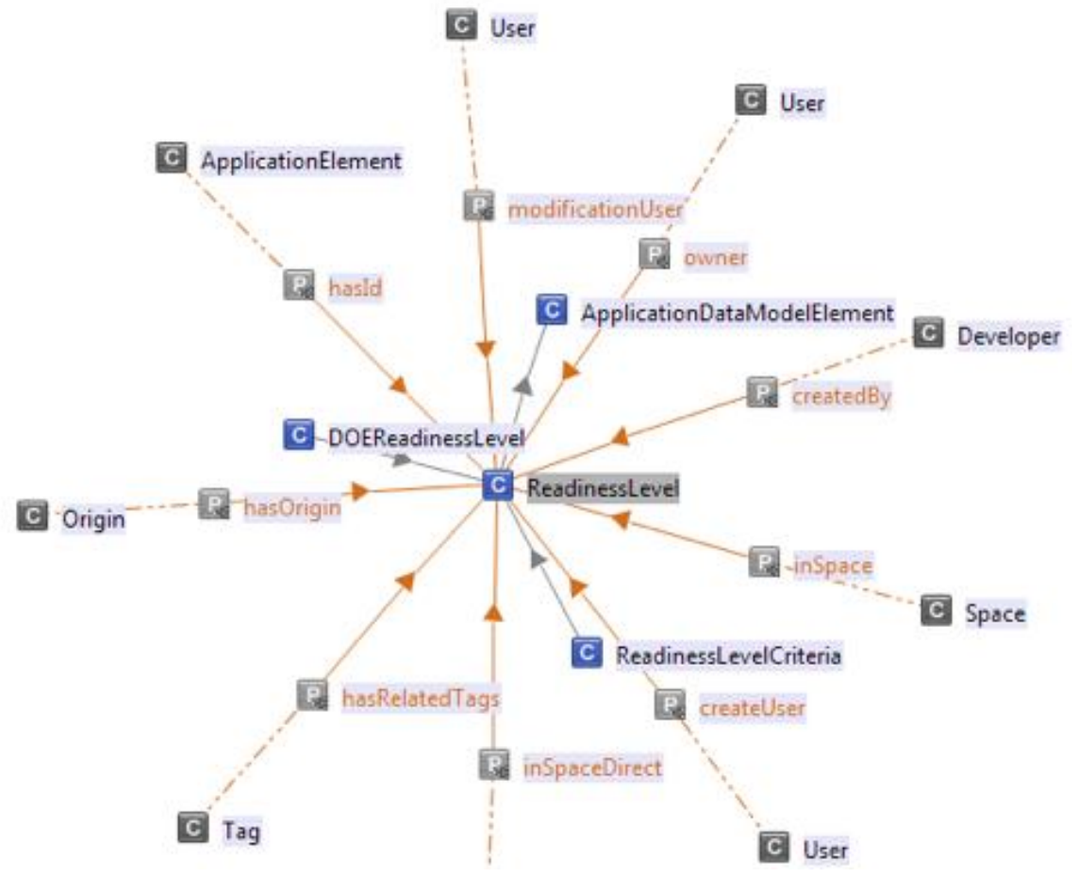
- Track RL's at an object level - as "objects" regardless of the "technology or RDBMS" limitations.
- Enables Alignment across any technology, anywhere
- W3C SemWeb Standards were developed and approved by Obama, Data.gov, etc

- **<u>Get Net Centric</u>**
  - Use Open W3C Standards (RDF, OWL RIF, SPARQL)
  - Get: Anywhere, anytime, platform independent, secure, RL Metrics

visit: W3.org

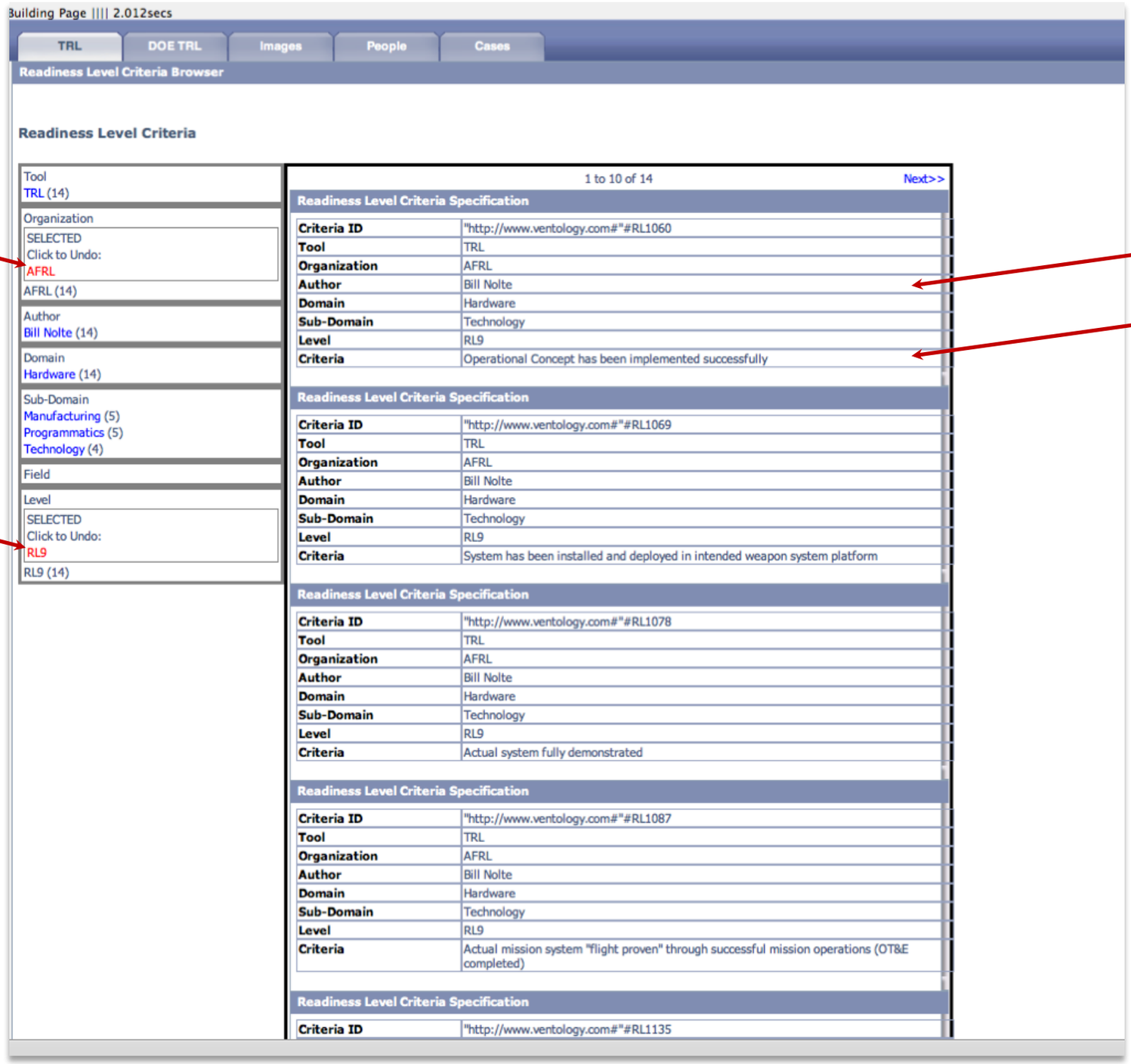
Semantic TRL

- 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

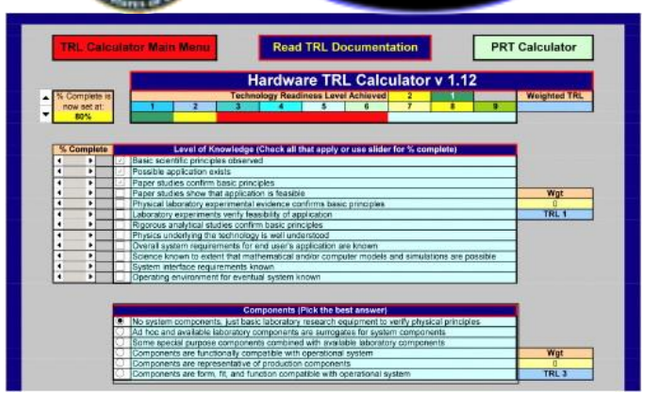


AFRL TRL Variant

TRL 9

Criteria Author

Criteria to Pass TRL9



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)

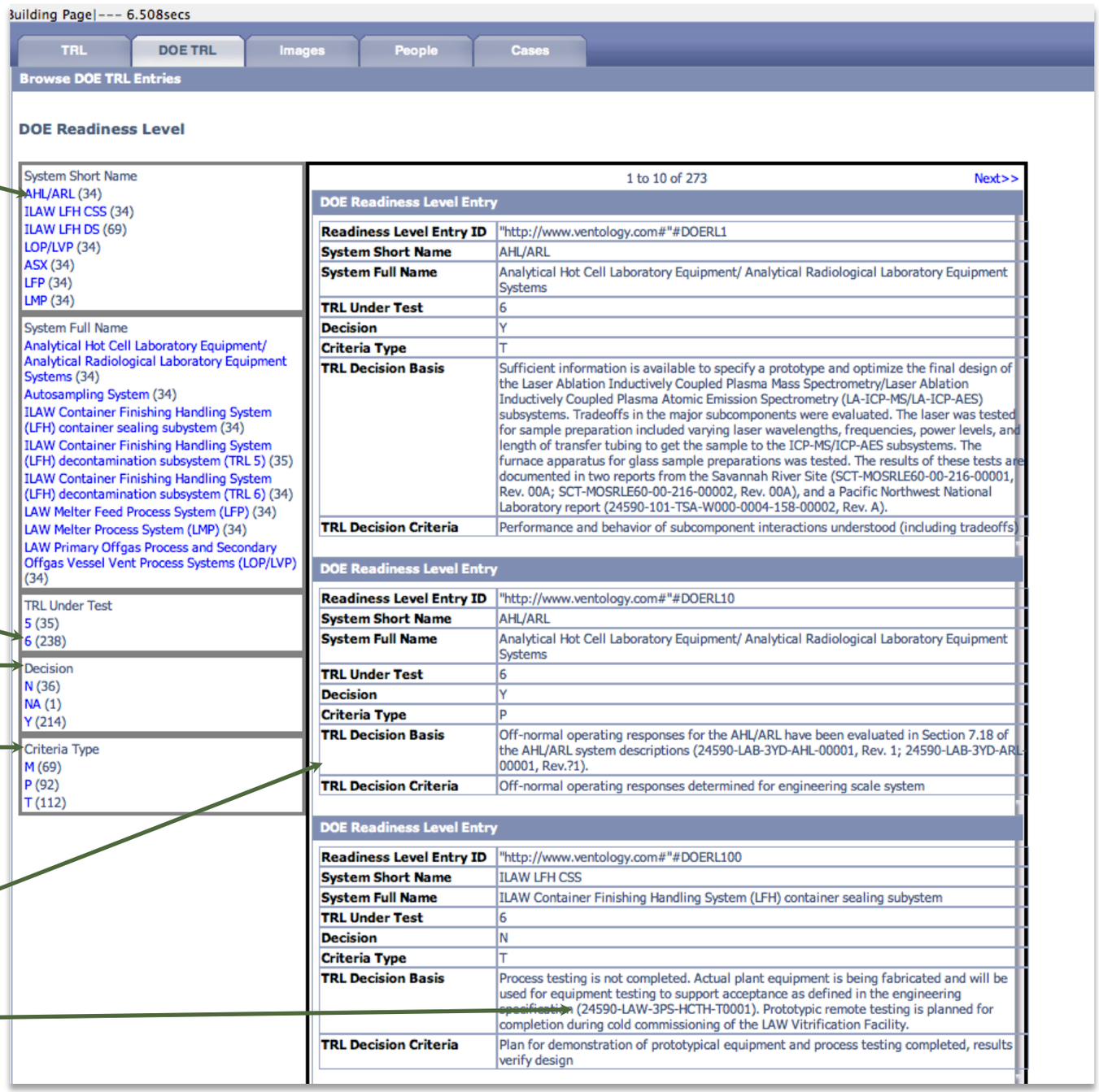
TRL 6

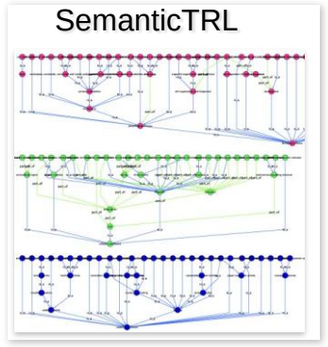
Assessment Result

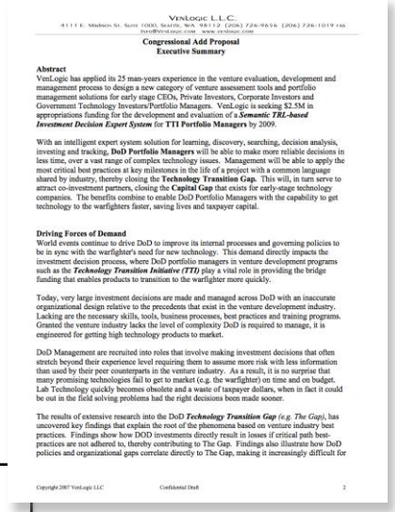
Criteria Type: Manufacturing Programmatic Technology

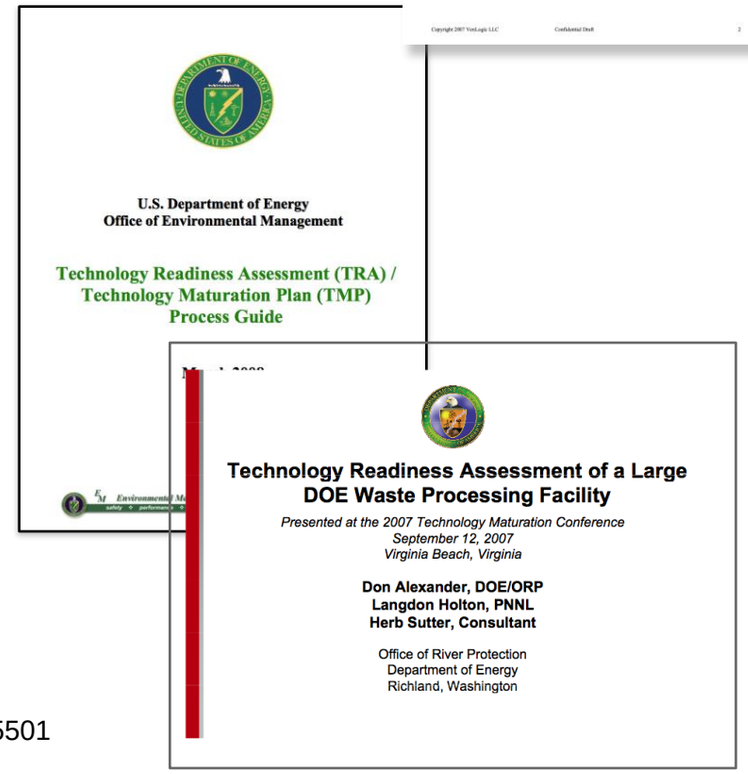
Decision Basis

Supporting Documents

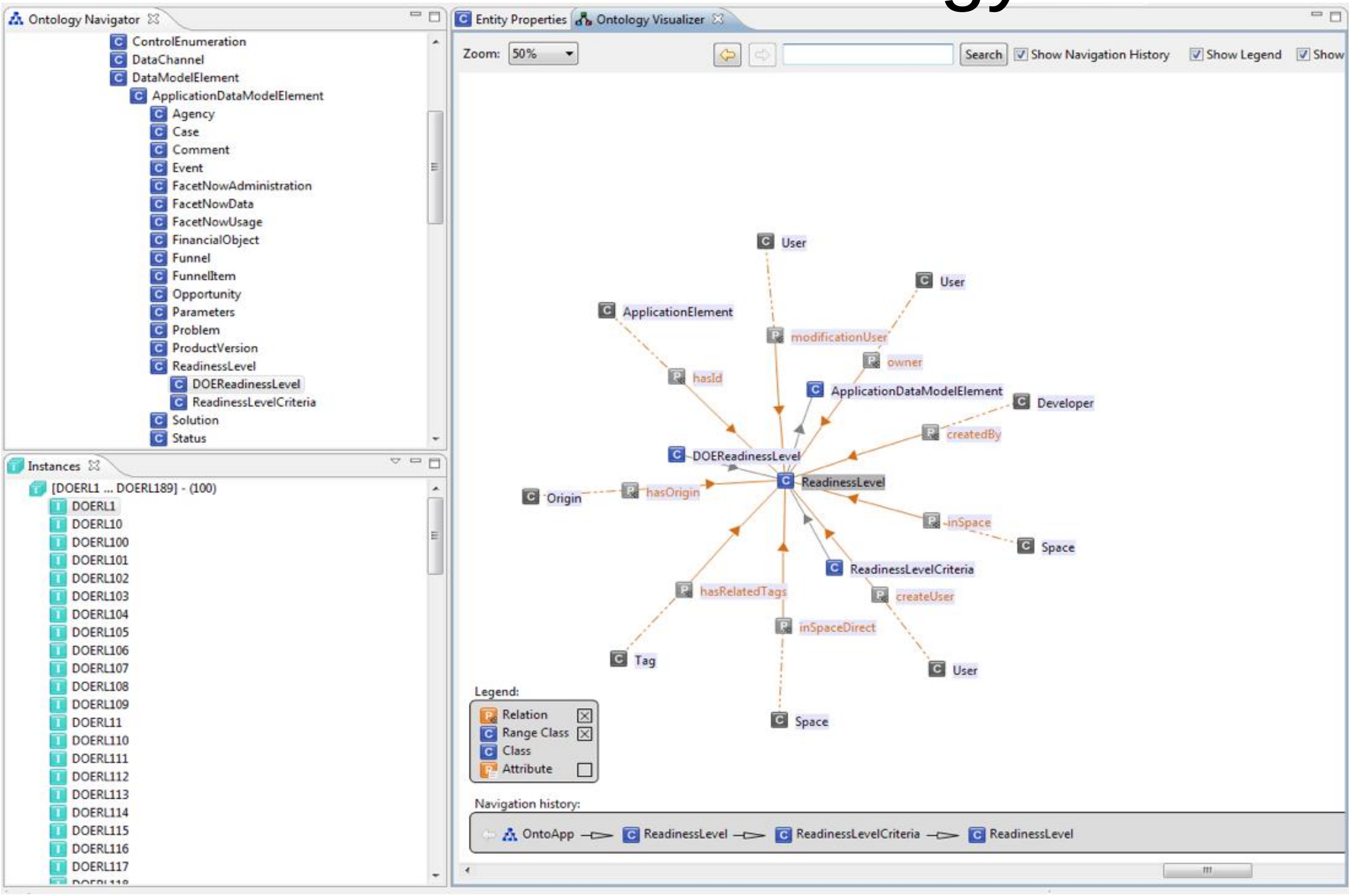








DoE TRL Ontology



DoE RL 6

Ontology Navigator

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

Instances

- [DOERL1 ... DOERL189] - (100)
  - DOERL1
  - DOERL10
  - DOERL100
  - DOERL101
  - DOERL102
  - DOERL103
  - DOERL104
  - DOERL105
  - DOERL106
  - DOERL107
  - DOERL108
  - DOERL109
  - DOERL11
  - DOERL110
  - DOERL111
  - DOERL112
  - DOERL113
  - DOERL114
  - DOERL115
  - DOERL116
  - DOERL117

Entity Properties | Ontology Visualizer

Identifier

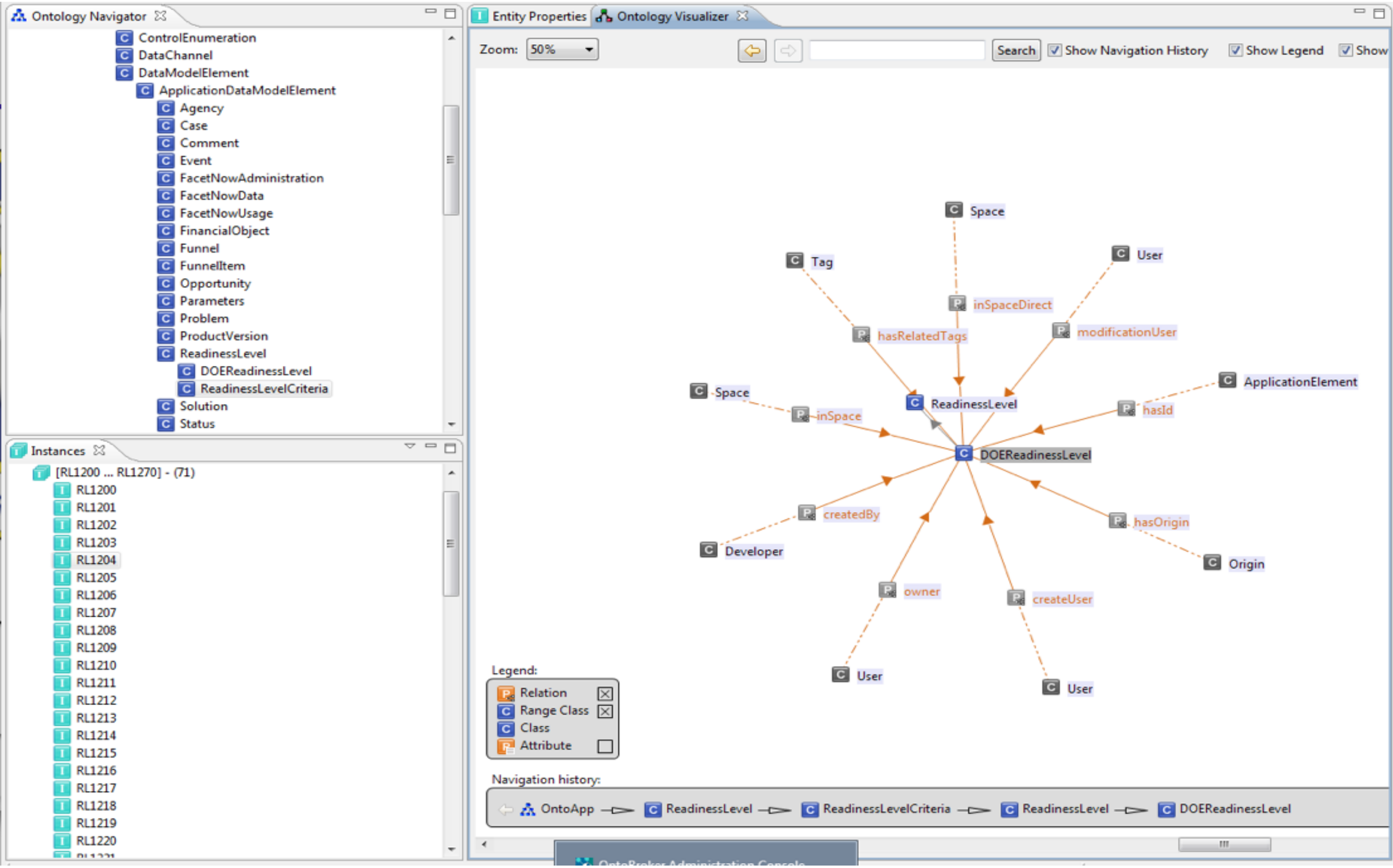
Local name: DOERL1

Properties

Identifier	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	

Properties | Comments & Labels | Synonyms

Map to DoD TRL



Map to MRL 5

Ontology Navigator

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

Instances

- [RL1000 ... RL1099] - (100)
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  - RL1001
  - RL1002
  - RL1003
  - RL1004
  - RL1005
  - RL1006
  - RL1007
  - RL1008
  - RL1009
  - RL1010
  - RL1011
  - RL1012
  - RL1013
  - RL1014
  - RL1015
  - RL1016
  - RL1017
  - RL1018
  - RL1019
  - RL1020

Entity Properties | Ontology Visualizer

Identifier

Local name: RL1011

Properties

Identifier	Value
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forLevel	
forLevel	RL5
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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	

Properties

DoD TRL 7

Ontology Navigator

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

Instances

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  - RL1103
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  - RL1105
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  - RL1110
  - RL1111
  - RL1112
  - RL1113
  - RL1114
  - RL1115
  - RL1116
  - RL1117
  - RL1118
  - RL1119
  - RL1120

Entity Properties | Ontology Visualizer

Identifier

Local name: RL1101

Properties

Identifier	Value
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createDatetime	
createProcess	
forLevel	
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hasCriteriaText	
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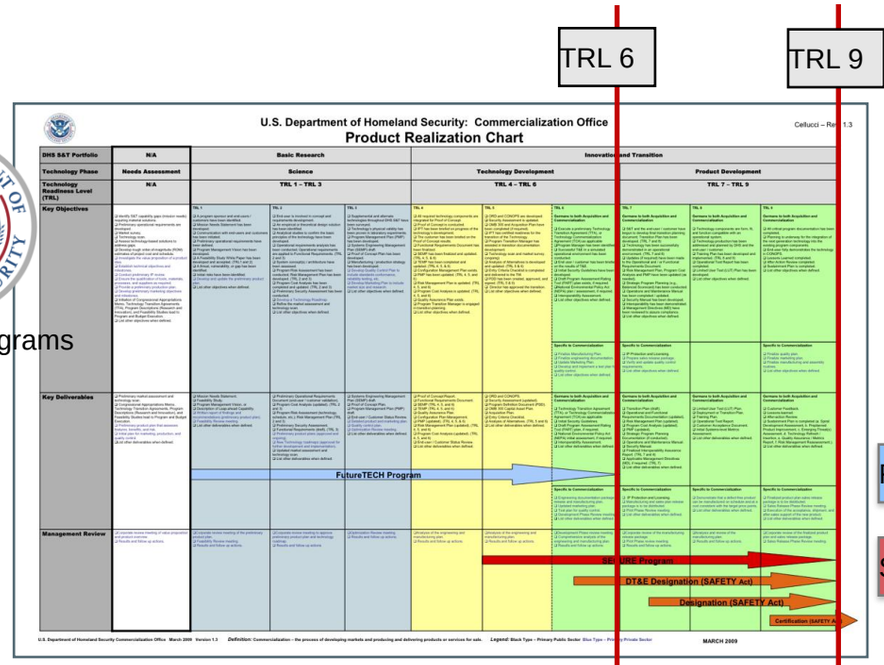
hasDescription	
hasLabel	
hasModelName	
hasSortName	
hasStatusV (DataSourceField,StatusType,string,string)	
hasText	
inDomain	
inDomain	Hardware
inField	
inPartitions	
inSubDomain	
inSubDomain	Technology
inTool	
inTool	TRL
isClass	
modificationDatetime	
modificationProcess	
createdBy	
createUser	
hasId	
hasOrigin	
hasRelatedTags	
inSpace	
inSpaceDirect	
modificationUser	
owner	

Properties

Many Benefits for Being in Sync

DHS Uses TRL to Manage SECURE & FutureTECH Programs



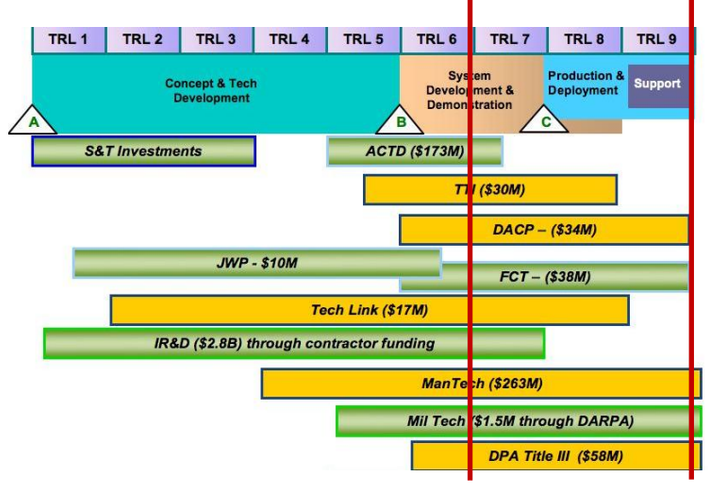
Gating Criteria

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



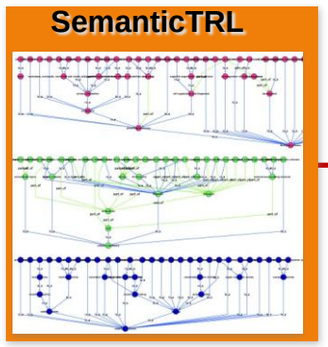
Does your TRL Sync up?

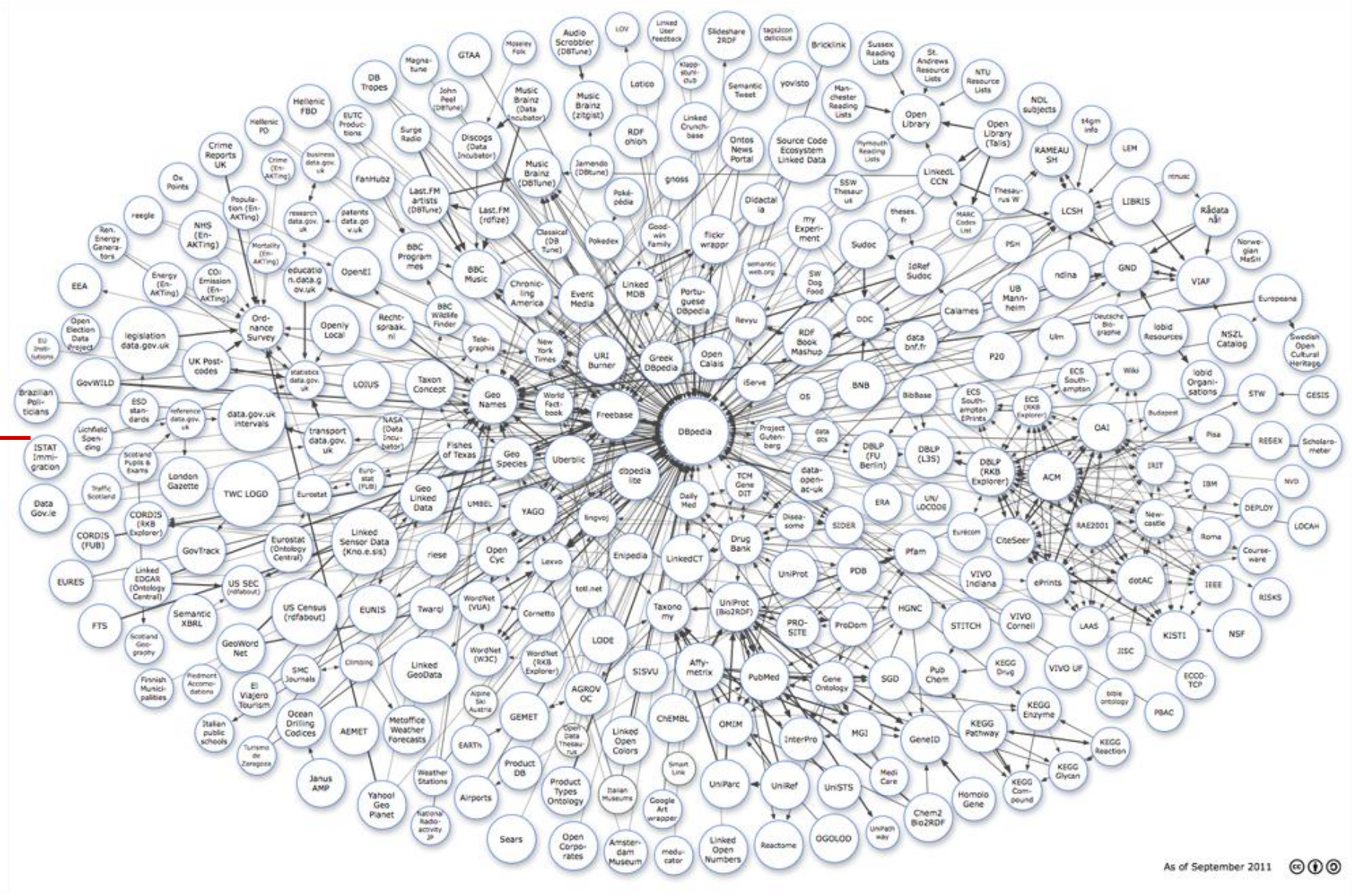
- Does **DHS TRL 6** = **DoD TRL 6 ?**

Benefits:

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

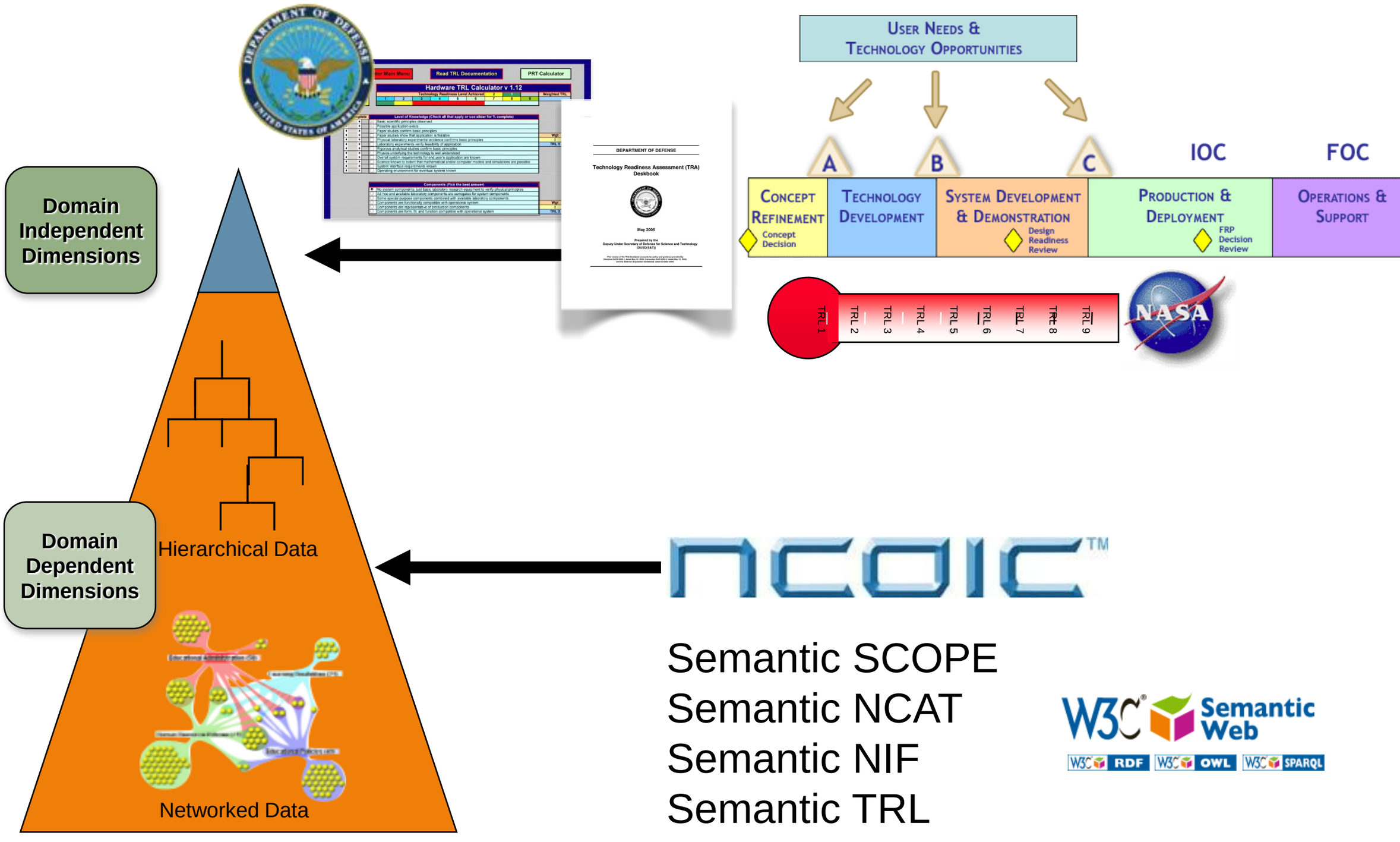
Goal: Access TRLs @ LinkedData.org





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: NCOIC™

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?