Soldier Systems TRM Visioning Workshop

Soldier Systems Technology Mindmap & Readiness/Maturity Levels

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Nato Land Ops Key Technologies

1. **Electrical Technologies**
   - Electrical Batteries
   - Electrical Power Cells
   - Conversion of Solar Energy to Electricity
   - High Energy Physics Techniques (including plasmas)
   - Transmissions/Powertrains

2. **Sensor, Directed Energy and Communications Related T**
   - Lasers (all types)
   - Power Sources (RF, micro and mm wave)
   - DEW Lasers
   - RF Sensors/Antennas - Active Radar
   - Very High Power Electronic Components
   - Electromagnetic Compatibility Simulation and Protection
   - Integrated Systems Design (incl. EMC)

3. **Computing Technologies**
   - Software Engineering
   - Protocols (incl. LANs & WANS)
   - Architectures
   - High Integrity Computing (incl. Safety Critical Software)
   - Secure Computing Techniques (Incl. MLS)
   - CIS Design
   - Software Programs for Complete Material, Modelling and th Implementation Processes
   - Database Design
   - Digital Signal Processing Techniques
   - Optical Signal Processing Techniques
   - Image/Pattern Processing Techniques
   - IKBS/AI/Expert Techniques
   - Data Fusion Techniques
   - Simulators, Trainers & Synthetic Environments

4. **Communications Specific Technologies**
   - Communications Design - RF
   - Encryption
   - High-Sensitivity Reception Technologies
   - Wide Bandwidth Networks

5. **Electronic/Information Warfare Technologies**
   - RF Sensors/Antennas - Active Radar
   - Very High Power Electronic Components IW Defence Techniques

6. **Electronic Devices**
   - IR Sensors (EO Systems)
   - Explosive Detection Systems
   - Explosives Detection Techniques (incl. bulk & trace)
   - Chemical & Biological Detection (CB Agents & Toxic Chemicals)
   - Rapid Microbiological Detection Methods

7. **Biotechnology**
   - Medical Materials Including Blood Products & Biomimetics
   - CB Countermeasures - Medical
   - Vaccines from Genetic Engineering

8. **Structural Materials Technologies**
   - Non-Destructive Evaluation & Life Prediction
   - IR Absorbing Materials
   - Radar Absorbing Materials
   - Smart/Functional Materials (Sensors/Actuators/Biomimetics)
   - Platform Protection Measures - Armour.
   - Aerodynamic Designs
   - Structural Designs
   - Stealth Designs
   - Manufacturing Processes/Design Tools/Techniques

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Nato Land Ops Key Technologies

9. Human Factors and Man-Machine Interface

Knowledge Management
Cognitive Performance
Decision Making
Human Behaviour
Human Performance
Social and Cultural Issues
Psychological Issues
Human Computer Interfaces/Man Machine Interfaces

10. Precision Attack Technologies

Low-Cost Inertial Components, Low-Cost GPS with Protection Against Jamming
Warheads (all types) including Insensitive Munitions
Navigation Systems
Weapon Guidance & Control (for Sea, Land, Air)
Dynamic Management Control of Traffic Flow
Brilliant Munitions

11. Automation and Robotics

Automation & Robotics
Intelligence Automated Systems
Unmanned Aerial Vehicles Control

12. Examples of systems which use 2/3 technologies from the Critical Technology List

Health Monitoring Systems (incl. HUMS)
IFF/NCTR/NIS
UAVs, Unattended Weapons

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Soldier System 2020 Mindmap

- **2004**
- **The following needs were identified:**
  - Determine technology developments that could influence the design of soldier systems out to 2020.
  - Describe technologies.
  - Reference source knowledge.
  - Determine technology readiness milestone dates.
- **Method:**
  - Literature review (NATO, TTCP, DARPA….)
  - Subject Matter Experts

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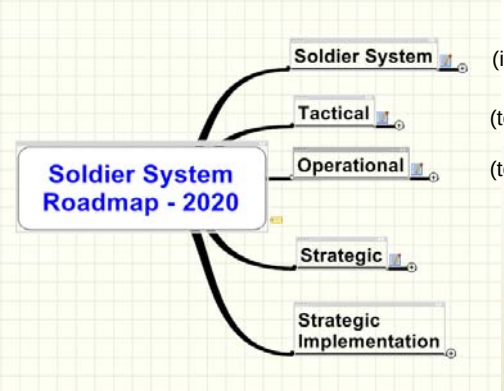
Mindmap Organization



(individual)

(team)

(team of teams)

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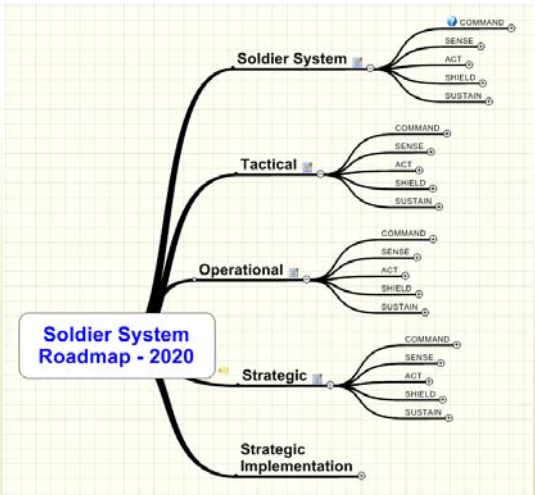
Capability-based Framework



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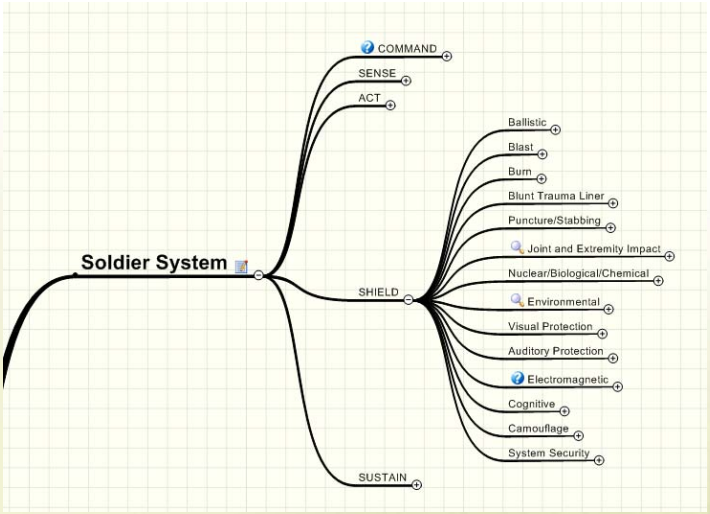
Mindmap - 1



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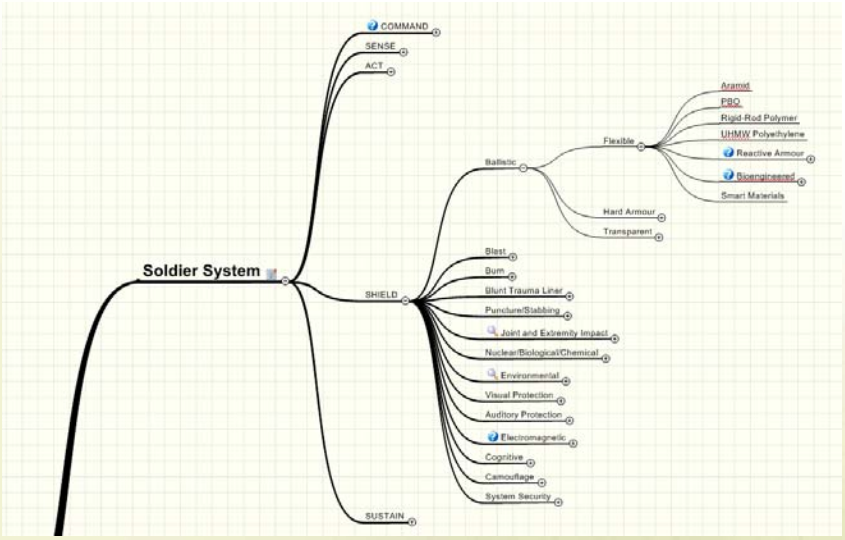
Mindmap - 2



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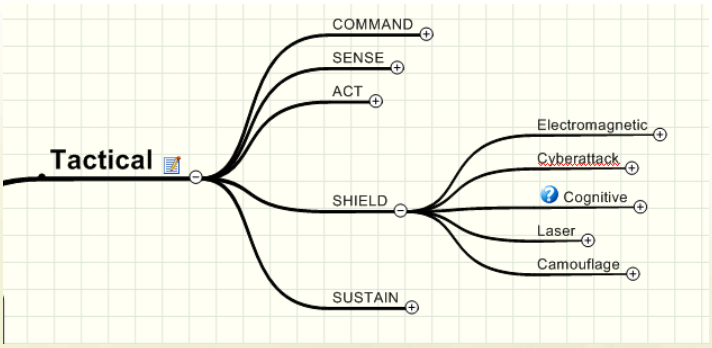
Mindmap - 3



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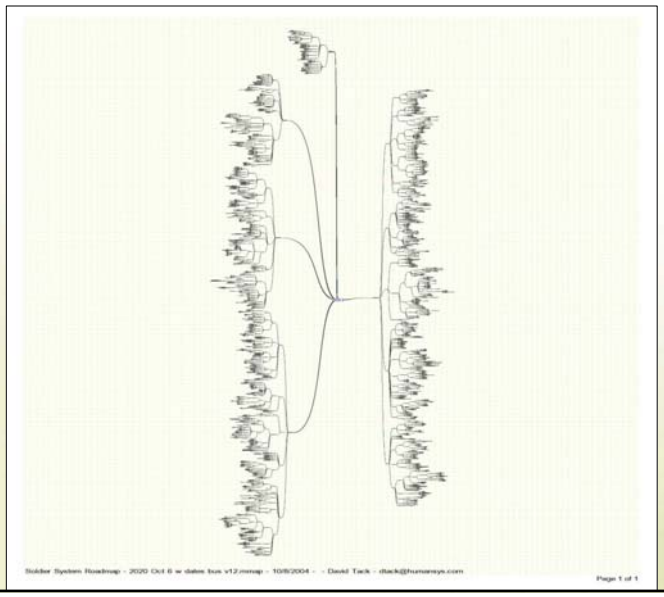
It’s quite big!



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New Consolidated Mindmap

More than 900 technology items

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Database

OPERATIONAL FUNCTIONS	DESIGN DRIVER	ENABLER	Technology Readiness Scale/Time Line	FACILITATORS	Notes	Reference
SHIELD		Confuse and Deceive Communications, Reconnaissance, Surveillance and Targeting Systems				
SHIELD		Chaff, Seduce Missile Seekers from Friendly Platforms and Distract Acquisition Radars				
SHIELD		NBCR Dissemination				IPCE Sys Design Doc March 98, table 6-1
SHIELD		Spider Silk	Nexia has already plans to market the material, dubbed BioSteel, for use as fine suture material + biodegradable fishing line by 2003 or 2004...[lightweight body armor made of artificial spider silk w/i 3-5 years... may also be used for safer suspension bridges]." (http://abcnews.go.com/sections/scitech/CuttingEdge/cuttingedge020118.html)		"Spider silk is 5-times stronger than steel+about 3 times tougher than man-made fibers such as Kevlar... Quebec-based Nexia w/ U.S. Army's Soldier Biological Chemical Command (SBCCOM) in Natick, Mass., have managed to create artificial spider silk by taking the genes responsible for creating spider silk into the cells of mammals, such as goats. The re-engineered goats are able to produce in their milk the same protein that makes up spider's silk." (http://abcnews.go.com/sections/scitech/CuttingEdge/cuttingedge020118.html)	Potter, N., Eng, P. ABCNEWS Here Comes Spider-Goat? http://abcnews.go.com/sections/scitech/CuttingEdge/cuttingedge020118.html (accessed February 23, 2004).
SHIELD		New Fibers				
SHIELD		Ceramics				
SHIELD		Eye protection Materials			"i.e. non-linear optics, energy absorbency materials, dielectric stacks, anisotropic structures and materials." (ITCP JSA-AG7-2000-01, p. 33)	ITCP: Technology Requirements for Soldier Modernization in the 2015 Timeframe, JSA-AG7-2000-01, p. 33
SHIELD		False Avatar and Holographic Surrogate			For training or for deception/PSYOPS	OFW "Another Look" p.30 (panel 2 vision)
SHIELD		Decoys, Obscurants, False Cues, Saturation Aids				OFW "Another Look" p.30 (panel 2 vision) IPCE Sys Design Doc March 98 ITCP: Technology Requirements for Soldier Modernization in the 2015 Timeframe, JSA-AG7-2000-01, p. 3_7)
SHIELD		Dissorientation Methods (i.e. Aerosol, multispectral smoke, flash, auditory)		Satellite network, radio comms, web based system, air/land/marine intermediary, SOP, policies, protocol, MEMS	Obscurants distributed usually by pyrotechnics or sub munitions. Obscurants to obscure IF/Thermal/Visibility. "Effective multispectral screening devices that operate in restricted terrain." (ITCP JSA-AG7-2000-01, p. 3)	OFW "Another Look" p.30 (panel 2 vision) IPCE Sys Design Doc March 98 ITCP: Technology Requirements for Soldier Modernization in the 2015 Timeframe, JSA-AG7-2000-01, p. 36
SHIELD		Means to Employ Deceptive Unit Locations/Activities				OFW "Another Look" p.22 (Panel 1 vision)
SHIELD		Directional and Amplified Acoustics			Obscurants distributed usually by pyrotechnics or sub munitions. Obscurants to obscure IF/Thermal/Visibility. Training or for deception/PSYOPS	OFW "Another Look" p. 26 (panel 4 vision)
SHIELD		Counter Sensors				OFW "Another Look" p. 25 (panel 3 vision)
SHIELD		Counter-Propaganda				
SHIELD		Counter-Deception				
SHIELD		Counter Intelligence		Media		Future Force (Can) p. 121
SHIELD	Diversion/Distraction/ Deception	Spoofing				ITCP: Technology Requirements for Soldier Modernization in the 2015 Timeframe, JSA-AG7-2000-01, p. 32

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Current Mindmap Challenges

- **Needed industry involvement.**
- **Difficult to keep current.**
- **Limited accessibility.**
- **Lacks accurate technology readiness dates.**

Hence, the new Soldier Systems TRM project and the ICee software.

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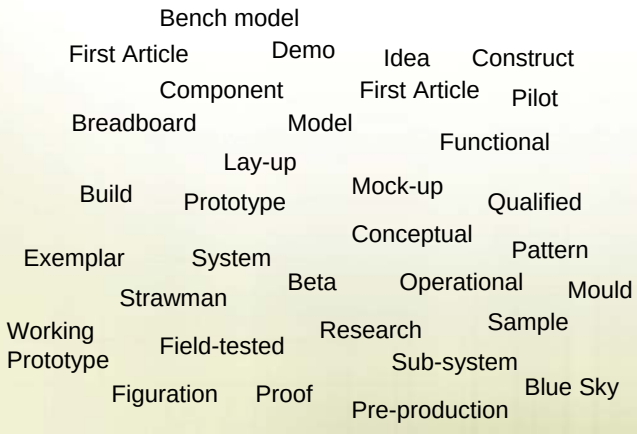
What is the maturity level of your technology?



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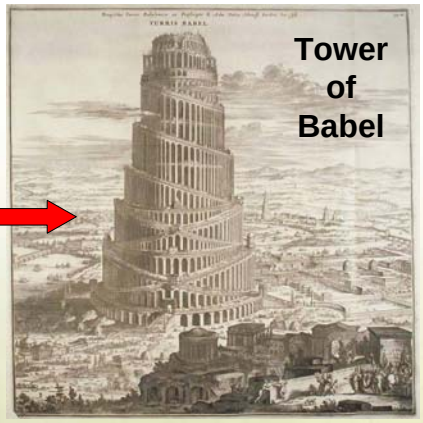
If no common scale….

- Different industries
- Different perspectives
- Different terminology
- Different processes
- Different concept of maturity
- Different cultures



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Many Maturity Measurement Methods

- Technology Readiness Levels (TRL)
- Integration Maturity Levels (IML)
- System Readiness Levels (SRL)
- Design Maturity Levels (DML)
- Manufacturing Readiness Levels (MRL)

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DND Solution

- **A common measurement system.**
- **A system that reflects readiness in:**
  - Technology readiness
  - Integration maturity
  - Design maturity
  - System maturity
  - Manufacturability
- **A system that reflects the state of maturity on several relevant dimensions at each level.**
- **A Technology Maturity scale that:**
  - Uses the TRL scale as a baseline
  - Adds criteria of Programmatics and Manufacturability

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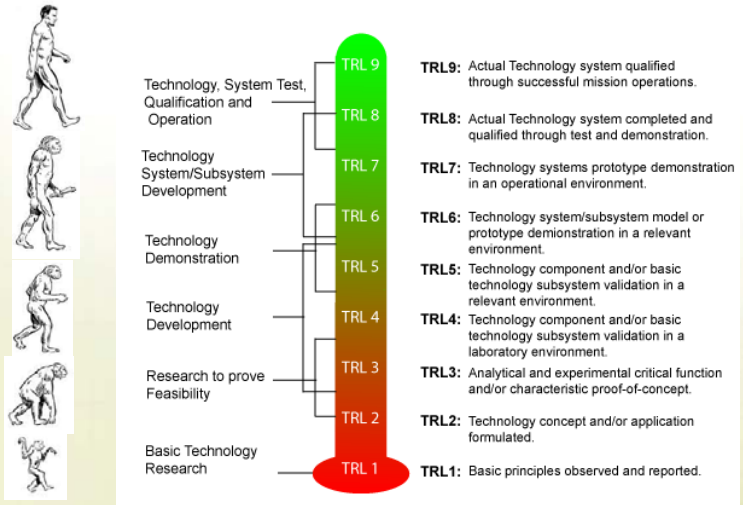
TRL scale is the baseline



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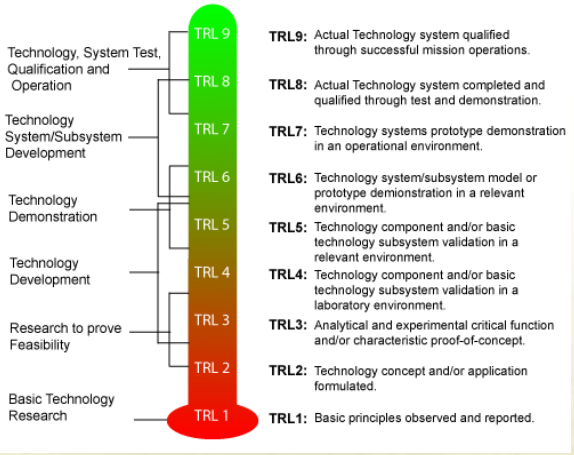
How mature is this item?



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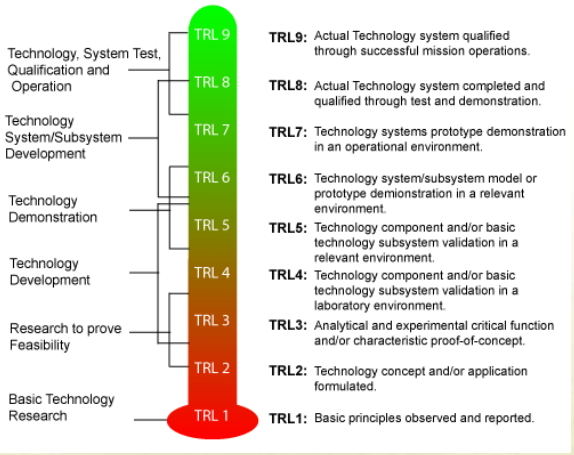
How mature is this item?



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Other Scales

Design Maturity

Stage	Level	Design Maturity Description
Concept	1/ 2/ 3	Design is advanced enough to support Initial Gate Operational Effectiveness and Investment Appraisal analysis, e.g. Draft URD, Outline SRD, Scheme Drawings, Outline Concepts, Product Architecture, Initial Cost estimates. Identify key design risks.
Assessment	4	Complete System Requirements Review Review.
	5	Complete Preliminary Design Review.
	6	Complete Critical Design Review for C Systems (e.g. Long Lead Time Items).
Demo	7	Complete Critical Design Review (all S
	8	Complete Critical Design Review (Syst Design Complete). Build and Test Pre-production model. Functional Configuration Audit. Production Readiness Review (Design I Aspects).
Manufacture	9	Physical Configuration Audit.

Manufacturing Readiness

MRL	Definition	Description	Acquisition Phase
1-3	Manufacturing concepts identified	Identification of current manufacturing concepts or producibility needs based on laboratory studies.	Pre Concept Refinement
4	System, component or item validation in laboratory environment.	This is the lowest level of production readiness. Technologies must have matured to at least TRL 4. At this point few requirements have been validated and there are large numbers of engineering/design changes. Component physical and functional interfaces have not been defined. Materials, machines and tooling have been demonstrated in a laboratory environment. Inspection and test equipment have been demonstrated in a laboratory environment. Producibility assessments have not been initiated.	Concept Refinement (CR) leading to a Milestone A decision.
5	System, component or item validation in initial relevant environment. Engineering application/bread board, brass board development.	Technologies must have matured to at least TRL 5. At this point all requirements have not been validated and there are significant engineering/design changes. Component physical and functional interfaces have not been defined. Materials, machines and tooling have been demonstrated in a relevant environment but most manufacturing processes and procedures are in development (or MANTECH initiatives ongoing). Inspection and test equipment have been demonstrated in a laboratory environment. Producibility assessments have not been initiated.	Technology Development (TD) leading to a Milestone B decision.
6	System, component or item in prototype demonstration beyond bread board, brass board development.	During the prototype demonstration phase requirements are validated and defined. However, there are still many engineering/design changes and physical and functional interfaces are not yet fully defined. Technologies must have matured to at least TRL 6. Raw materials are initially demonstrated in relevant environment. Similar processes and procedures have been demonstrated in relevant environment. At this point there are likely major investments required for machines and tooling. Inspection and test equipment should be under development. Producibility risk assessments should be initiated.	System Development & Demonstration (SDD) leading to Design Readiness Review (DRR).

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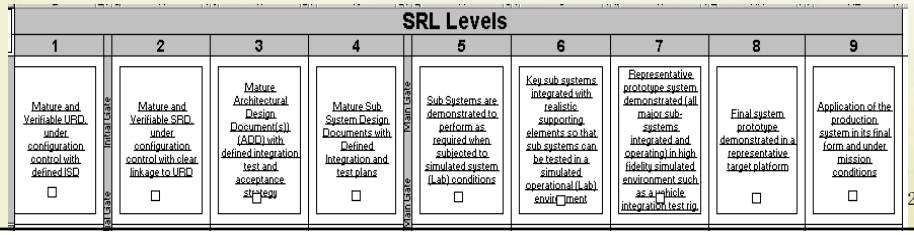
Other Scales

Integration Readiness

IRL	Definition [9]
7	The integration of technologies has been ***verified and validated*** with sufficient detail to be actionable.
6	The integrating technologies can ***accept, translate, and structure information*** for its intended application.
5	There is sufficient ***control*** between technologies necessary to establish, manage, and terminate the integration.
4	There is sufficient detail in the ***quality and assurance*** of the integration between technologies.
3	There is ***compatibility*** (i.e. common language) between technologies to orderly and efficiently integrate and interact.
2	There is some level of specificity to characterize the ***interaction*** (i.e. ability to influence) between technologies through their interface.
1	An ***interface*** (i.e. physical connection) between technologies has been identified with sufficient detail to allow characterization of the relationship.

System Readiness



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Cross System Readiness/Maturity Levels

Technology Readiness Level (TRL)	Design Maturity Level (DML)	Integration Readiness Level (IRL)	Manufacturing Readiness Level (MRL)	System Readiness Level (SRL)	System Maturity Level (SML)
1	1				1
2	2		1, 2, 3		2
3	3	1	4	1	3
4	4	2	5	2,3	4
5	5	3	6	4,5	5
6	6	4	7	6	6
7	7	5	8	7	7
8	8	6	9	8	8
9	9	7	10	9	9

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Medium TML

TM Level	Description T–Technical Readiness, P – Programmatics, M – Manufacturing Readiness
4	T - Component & / or "Breadboard" Validation in Laboratory/Field Environment - Basic technology components are integrated. This is relatively "low fidelity" compared to the eventual system. Examples of R&D results include integration and testing of "ad hoc" hardware in a laboratory/field setting. Often the last stage for R&D (funded) activity. P – Interfaces partially demonstrated - system/sub-system level in a high fidelity synthetic environment - Critical design review completed for critical sub-systems - Preliminary Safety/Environmental assessments complete - Supportability work breakdown structure completed - Sub-system R&M case developed for sub-systems. - Initial Human Machine Interface design completed - Key Sub-System schematics completed. - All Sub-System Specifications defined - Engineering and operational communities negotiated a formal commitment to use the results of the research. M – Laboratory Manufacturing Process demonstrated

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DND TML Reference

Defence Research and Development Canada | Recherche et développement pour la défense Canada

DEFENCE R&D DÉFENSE

A Technology Maturity Measurement System for the Department of National Defence

The TML System

Brent Hobson
Naval Engineering Test Establishment

Naval Engineering Test Establishment
Peacock Inc. Marine Engineering
9401 Wanklyn St.
LaSalle, Quebec H8R 1Z2

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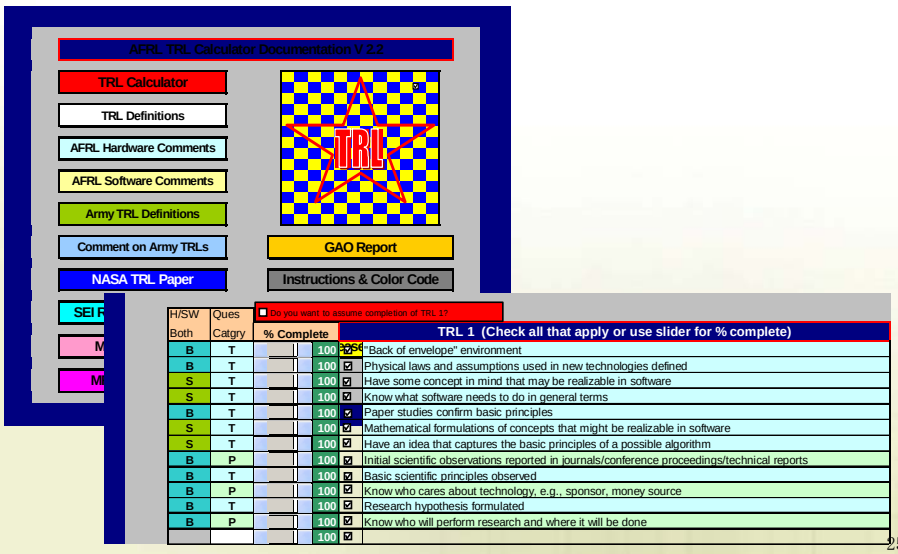
Established Area with Tools



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ICee – TRL & SML

System Maturity Level			
Level	**Current Year**	**+ 5 years**	**+ 10 years**
Technology readiness level (1-9)	6	9	9
Design maturity level (1-9)	Select ...	Select ...	Select ...
Integration readiness level (1-7)	Select ...	Select ...	Select ...
Manufacturing readiness level (1-10)	Select ...	Select ...	Select ...
System readiness level (1-9)	Select ...	Select ...	Select ...
Estimated system maturity level (1-9)	Select ...	Select ...	Select ...
System maturity level	**6**	**9**	**9**

Calculate

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Questions?

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