

System Readiness Level

14TH Advanced Development for Security Applications Workshop (ADSA14)
Development and Deployment of Fusible Technologies for the Checkpoint
May 10-11, 2016 Northeastern University, Boston, MA

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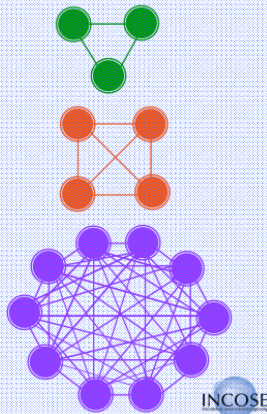
System Readiness Assessment

holistic evaluation of system maturity

TECHNOLOGY READINESS LEVEL

- Does **not give a holistic** picture of system's readiness
- Assessments of several technologies rapidly **becomes very complex**
- Does **not provide insight into integrations** between technologies nor the maturity of the resulting system

Metcalfe's Law



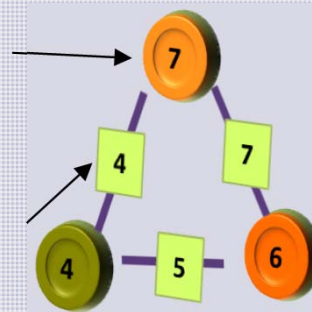
INCOSE

SYSTEM READINESS LEVEL

- Provide a **systemic view** of system maturity with opportunities to drill down to element-level contributions
- Gives managers the capability to take **proactive measures** on systems maturity and risk mitigation.
- Allows for **methods, processes and tools** adapted for a wide array of system engineering development efforts.

Technology
Readiness
Level (TRL)

Integration
Readiness
Level (IRL)



SYSTEM READINESS ASSESSMENT

- **Combining multiple** technologies and integrations in a state of evolving maturity.
- Overcoming the **inherent limitations** of using applicable experience with similar technology systems.
- Reaching **consensus** on the advisability of investments.
- Understanding how progress in technology development **influences** development of systems (e.g. phased development)

*DoD DoE US Navy US Army
Lockheed Martin Boeing SAIC
Honeywell KeyLogic Acadmia*

<http://www.ISRACOI.org>

Why GAO is Developing a Technology Readiness Assessment Guide

- **Raise awareness about the importance of technology readiness outside of the DOD and NASA.**
- **Give program managers and decision makers tools to put them in a better position to assess technology maturity and manage risk.**
- **Provide a common language on how to talk about technology readiness-related issues.**
- **Improve technology investment decisions and outcomes in light of budget constrained environment and decreased federal spending.**
- **Increase likelihood that science and technology projects are successfully transitioned from the lab to acquisition programs.**
- **Provide a tool for GAO analysts and others examining these issues.**



Guides for Implementation - SRL

- **Use the SRL as an indicator of current system readiness rather than for predictive analysis**
- **Incorporate the SRL with other metrics in making program decisions**
- **Compare SRLs of the same system throughout its life cycle. Compare “your system” as it matures, not two different arbitrary systems**
- **Let the SRL approach “work for itself”. Avoid interim or nodal comparison of TRLs and/or IRLs that result in setting an expectation for what the aggregate or composite readiness should be**

Lessons Learned - SRL

- **Programs tend to minimize the importance of system and subsystem integration and thus overestimate the maturity of their development**
- **Widespread familiarity with TRL makes acceptance and utilization of TRL and IRL easier**
- **Methodology is highly adaptable and can be quickly applied to a wide variety of development efforts**
- **TRL and IRL evaluation process brings about insightful discussions across the team**
- **Formulating the system architecture early in development is a key step and leads to an enhancement of the overall systems engineering effort**
- **The more development efforts the SRL methodology is applied to the more we learn**

International System Readiness Assessment Community of Interest

The ISRACOI is a worldwide collaborative community of individuals who have an interest in integration planning and measurement, system readiness metrics, and reducing program risk through comprehensive system thinking.

<http://www.ISRACOI.org>

To create and maintain a collaborative environment for systems readiness information and relevant research and to share, disseminate, and maintain relevant artifacts.

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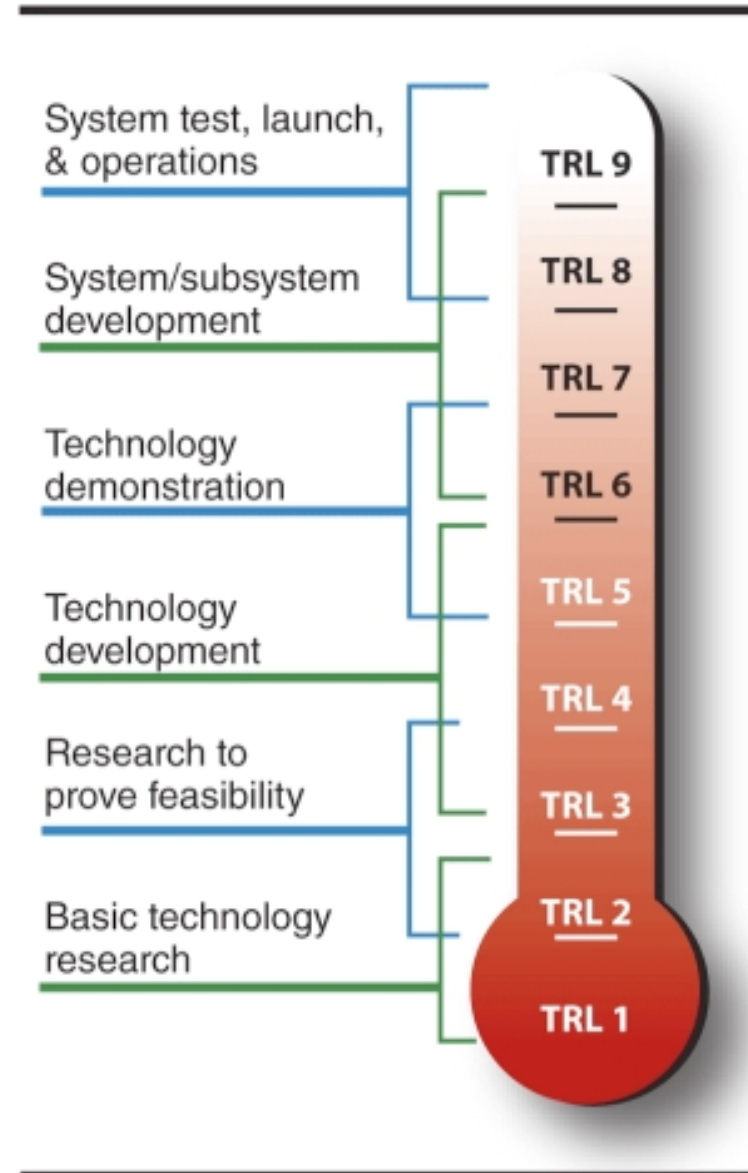
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BACK UP SLIDES TO SUPPORT ANY DISCUSSION

Technology Readiness Level (strengths)

- Effectively (and accurately) provides component technology readiness assessment
- Stakeholders coming together to evaluate component TRLs initiates the considerations of other important factors
- Assessment using TRL is an iterative process that can be easily repeated during development



- **The challenge...**

- There are few metrics used within the DoD to gauge the impact of investments or the effectiveness of processes used to develop and transition technologies (1999)
- Additional metrics in technology transition are needed (1999)
- DoD needs to enable success through demonstration of value and the credibility of new processes through the use of metrics (2002)

- **The solutions...**

- DoD began implementing the TRL as a metric to assess the maturity of a program's technologies before its system development begins (1999)
- Assuring a weapon system's technologies are demonstrated to a high level of maturity before beginning its program (2002)
- Using an evolutionary or phased approach to developing such systems (2002)

TRL Shortcomings

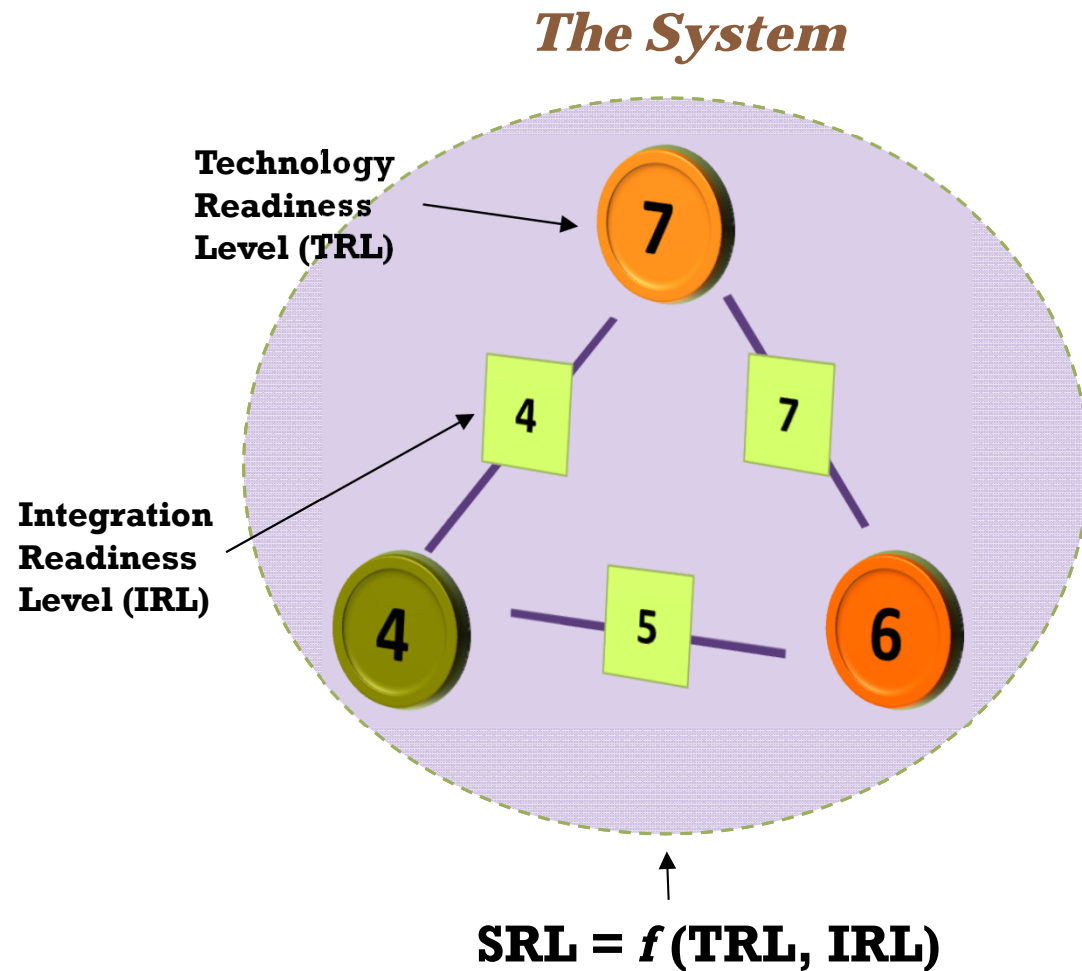
- **Application of TRL to systems of technologies is not sufficient to give a holistic picture of system readiness**
 - TRL is only a measure of an individual technology
- **Assessments of several technologies rapidly becomes very complex without a systematic method of comparison**
- **Multiple TRLs do not provide insight into integrations between technologies nor the maturity of the resulting system**
 - Yet most complex systems fail at the integration points

“Technology Readiness Levels at 40: A Study of State-of-the-Art Use, Challenges, and Opportunities” (A. Olechowski, S.D. Eppinger, N. Joglekar, MIT, April, 2016) details an important limitation with the go-to standard for gauging technology development.

System Maturity Assessment - SRL

Value Proposition:

- To provide a **systemic view of developmental maturity** with opportunities to drill down to element-level contributions
- To allow managers the capability to **evaluate system development** so as to take proactive measures
- To create **highly adaptive methods, processes, and tools** to use on a wide array of system engineering development efforts



System Readiness Assessment

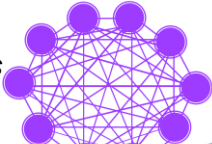
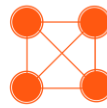
holistic evaluation of system maturity

STATUS QUO

Technology Readiness Level

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Metcalfe's Law



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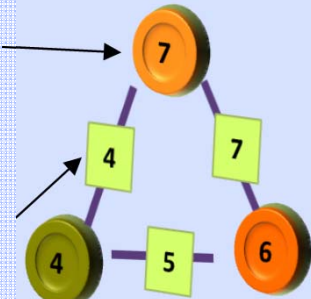
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NEW INSIGHTS

System Readiness Level SYSTEMIC VIEW OF MATURITY

Technology Readiness Level (TRL)

Integration Readiness Level (IRL)



$$SRL = f(TRL, IRL)$$

MAIN ACHIEVEMENT:

- Provide a **systemic view** of system maturity
- Creative **methods, processes and tools** adapted for independent assessment
- System maturity assessment resulting in **proactive risk mitigation** measures

HOW IT WORKS:

Understand & Bound System

Obtain Project Information

Decompose & Map System

Identify Components/ System Change
Develop/Update Mapping

Perform Iterative Evaluations

Evaluate Components and Interfaces
Determine / Update TRLs and IRLs
Determine / Update SRL

Re-eval/
No System
Change

Design or
Configuration
Change

IMPACT

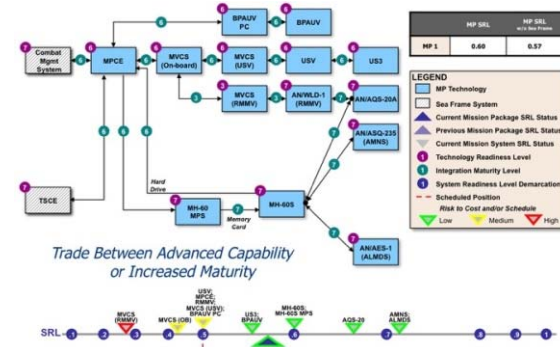
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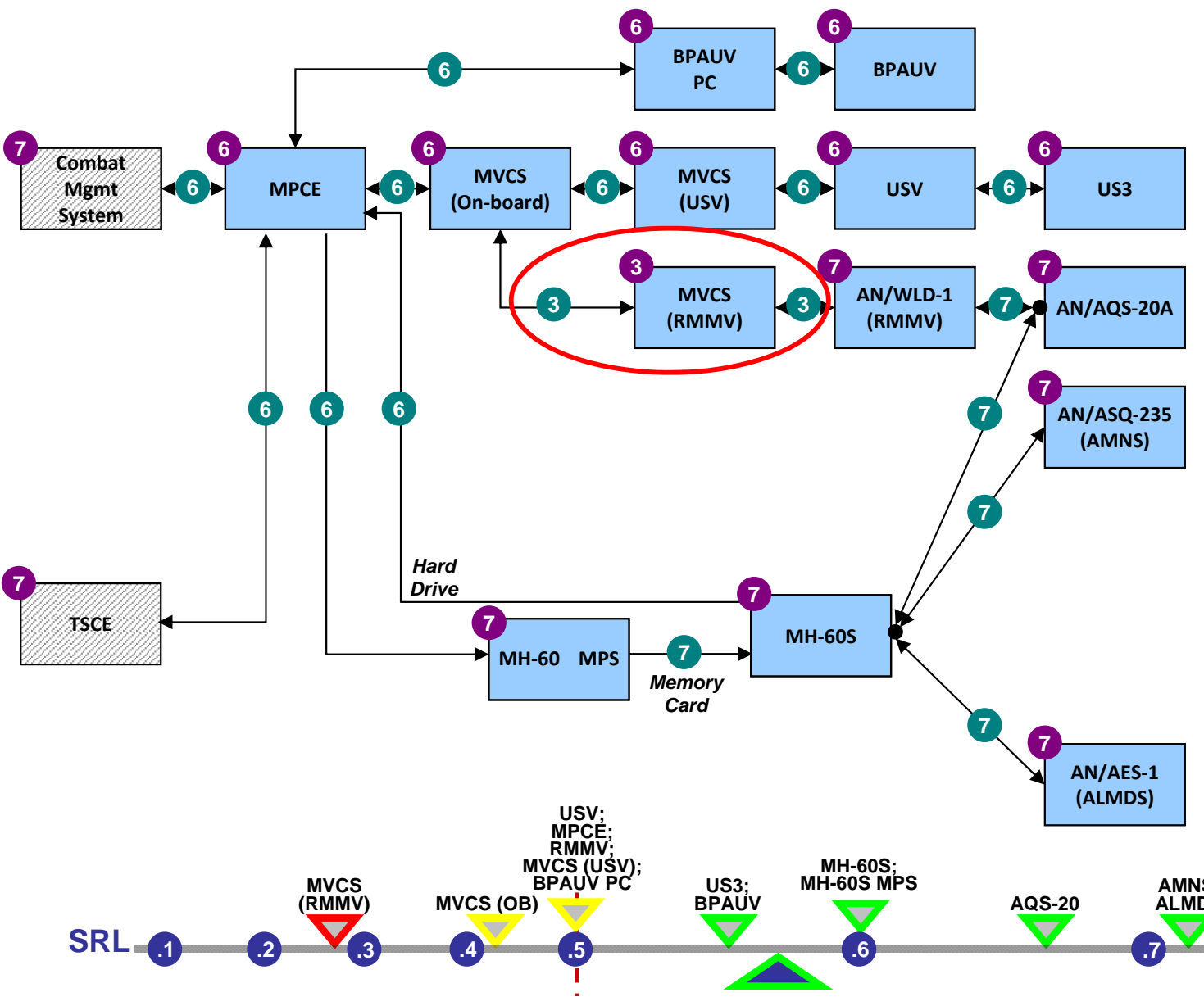
DoD DoE US Navy
US Army Lockheed Marin
Boeing Academia SAIC
Honeywell KeyLogic

GOAL

Methods, Processes, Tools



Trade Between Advanced Capability or Increased Performance



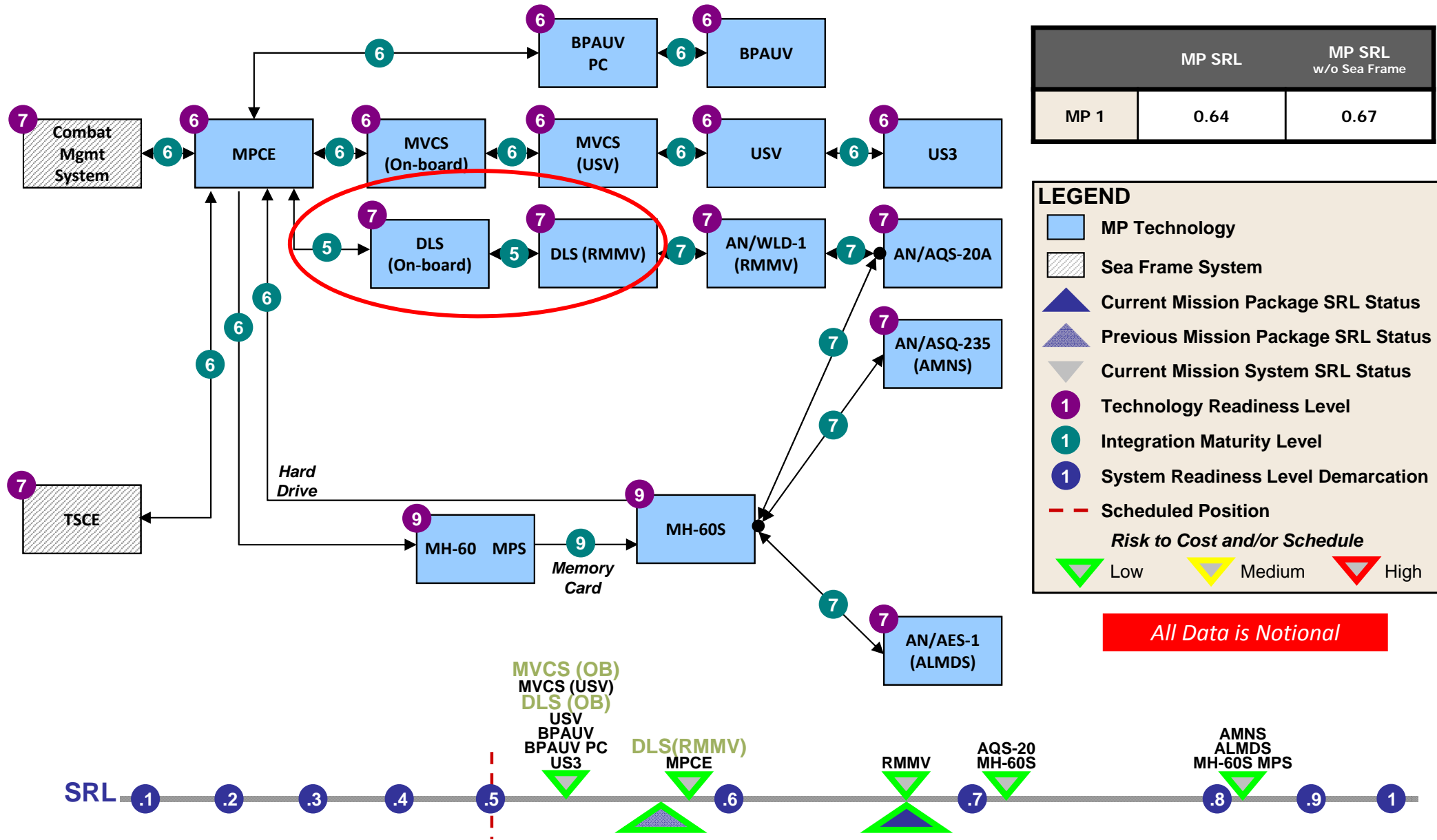
	MP SRL	MP SRL w/o Sea Frame
MP 1	0.60	0.57

LEGEND

- MP Technology (Blue box)
- Sea Frame System (Hatched box)
- Current Mission Package SRL Status (Blue triangle)
- Previous Mission Package SRL Status (Hatched triangle)
- Current Mission System SRL Status (Grey triangle)
- Technology Readiness Level (Purple circle)
- Integration Maturity Level (Green circle)
- System Readiness Level Demarcation (Blue circle)
- Scheduled Position (Red dashed line)
- Risk to Cost and/or Schedule:
 - Low (Green triangle)
 - Medium (Yellow triangle)
 - High (Red triangle)

All Data is Notional

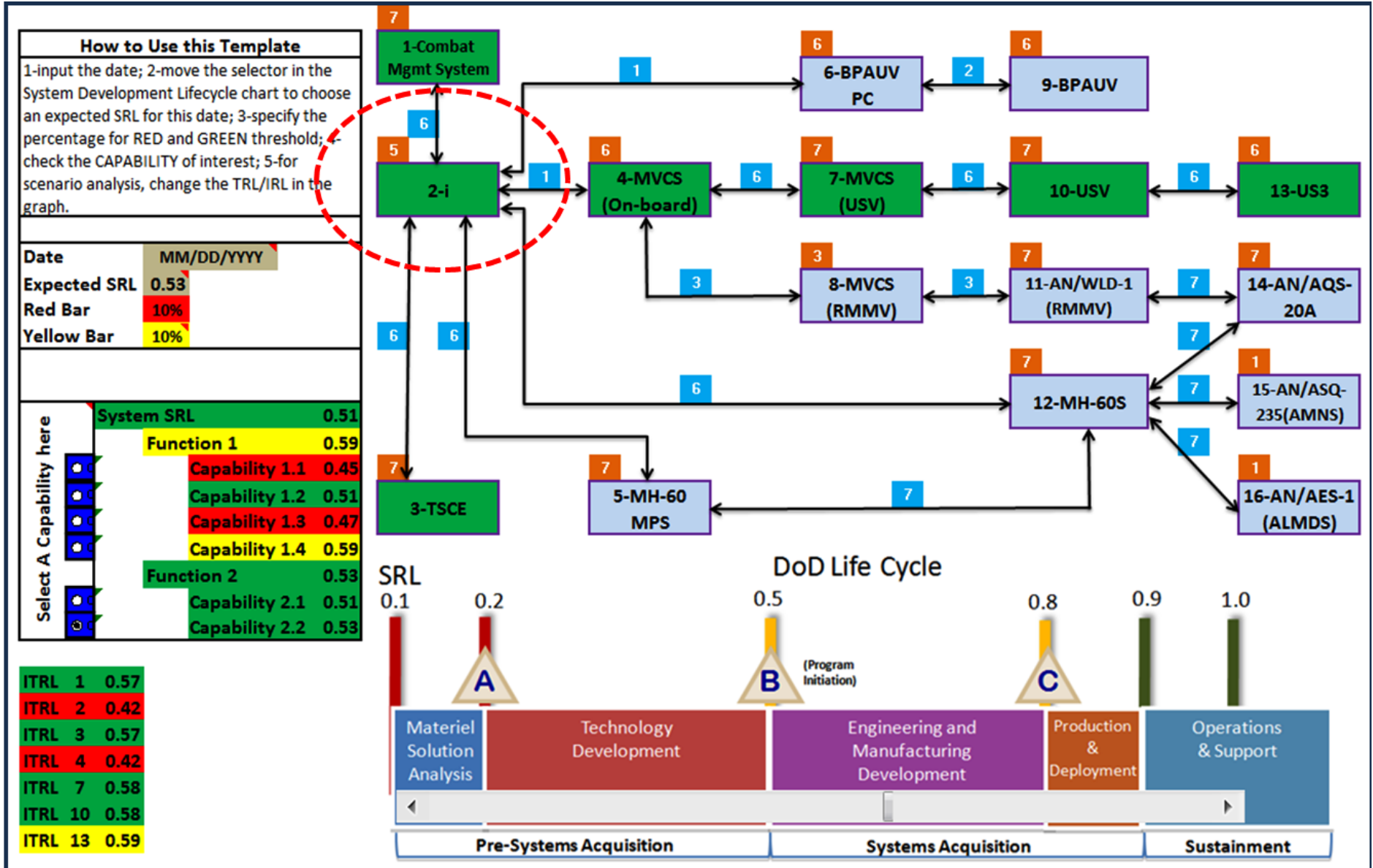
Trade Between Advanced Capability or Increased Performance



Integration Readiness Level

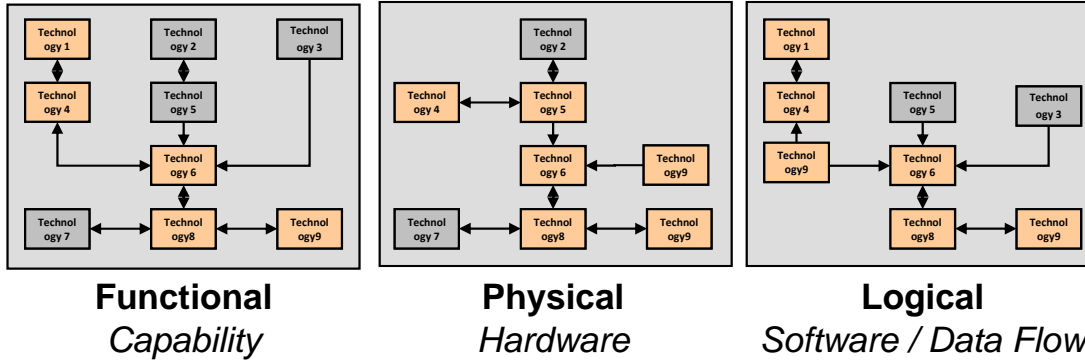
	IRL	Definition
Pragmatic	9	Integration is Mission Proven through successful mission operations.
	8	Actual integration completed and Mission Qualified through test and demonstration, in the system environment.
Syntactic	7	The integration of technologies has been Verified and Validated with sufficient 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.
Semantic	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 between technologies has been identified with sufficient detail to allow characterization of the relationship.

The Value of Systemic



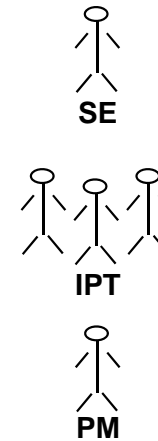
System Readiness Assessment

1.0 SoS Architectures Defined



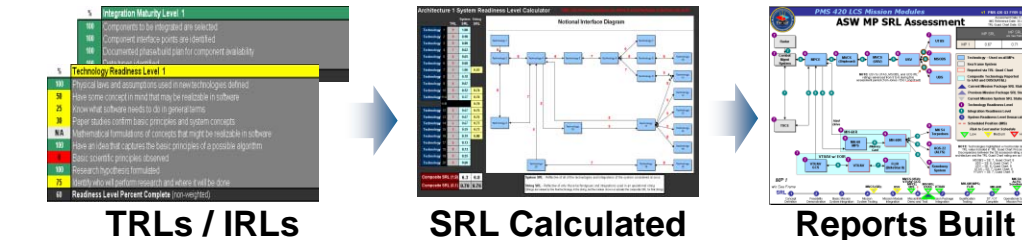
System architectures are defined along with identification of operational threads and the critical technology elements and interfaces

2.0 Assessment Framework Developed



- Select applicable TRL / IRL criteria
- Build SRL advancement schedule
- Tie scale to program test events / milestones
- Review proposed criteria, schedule, and milestones
- Approves assessment framework

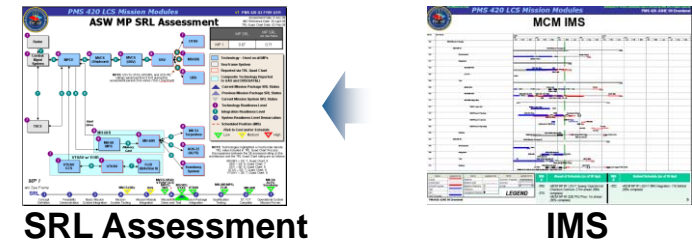
3.0 Quarterly SRL Assessment



Risks Identified Against Schedule

- *SRL assessment and test events / milestone gates are at or in advance of schedule*
- *SRL assessment is at or in advance of schedule, but test events / milestone gates remain to be closed*
- *SRL assessment and test events / milestone gates are behind schedule*

4.0 Cost Evaluated



Cost required to meet each SRL increment can be calculated from the test events / milestone gates scheduled to be achieved each increment

