Idaho National Laboratory "Defense Acquisition System" System of Systems Engineering

Abstract ID: #19736

For:
NDIA
20th Annual Systems Engineering Conference
23-26 October 2017

Prepared by:
Idaho National Laboratory (INL)
Larry Dean Harding
Systems Engineering

www.inl.gov

Idaho National Laboratory

INL Systems Analyses & Engineering Contacts

Mitchell Kerman
Division Director
(208) 526-3631
mitchell.kerman@inl.gov

Ron Klingler
Department Manager
(208) 526-0183
ron.klingler@inl.gov

NDIA Presenter

Larry Harding
Systems Engineer
(208) 526-6111
dean.harding@inl.gov

John Collins
Group Lead for
Energy & Environment
Projects
(208) 526-3372
john.collins@inl.gov

Jody Henley
Group Lead for
Nuclear Projects
(208) 526-1979
jody.henley@inl.gov

Shyam Nair
Group Lead for
Process & Data Sciences
(208) 526-3071
shyam.nair@inl.gov

INL Systems Analyses &
Engineering Web Page
https://systemsengineering.inl.gov

INL/MIS-17-42149

Core Functions – INL Systems Analyses & Engineering

1

- Concise Problem Definition
- Understanding Important Customer Needs
- Concise System/Project Boundaries
- Strategic Planning & Baselines
- "Concept" of Operations
- Stakeholder Buy-in
- Acquisition Strategy
- White Papers

2

- Technical, Functional, and Operational Analysis
- Requirements Elicitation, Clarification, Derivation, and Tracking
- Traceability, Change Control, and Impact Analysis
- Requirements Verification and Validation Planning

3

- Analysis of Alternatives
- Decision Metrics
- Organization Analysis & Visualization of Complex and Big Data
- Uncertainty Analysis & Probabilistic Risk Assessment
- Risk-informed Decision-making
- Integration of Viable Solutions
- Chemical Process Engineering & Analysis
- Chemical Process Control
- Computational Fluid Dynamics

4

- Risk Identification and Tracking
- Justification for Funding Contingency
- Risk Handling Strategy
- Risk Reduction Plan
- Risk-informed Path Forward

5

- Technology Maturity Analysis
- Technology Development Roadmap/Path Forward
- Roadblock Identification & Mitigation
- System Assessments (e.g., Energy Systems)

6

- Program & Project Integration
- Laboratory-wide R&D Integration
- Laboratories/Industries/ Universities Integration
- Integration of System Elements
- Systems of Systems Analyses

7

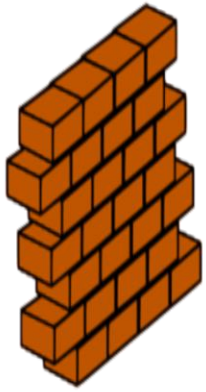
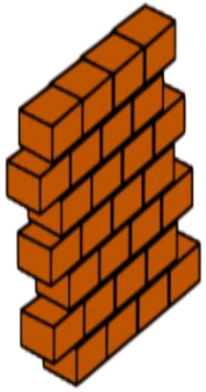
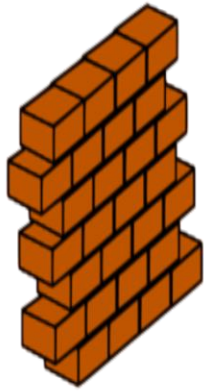
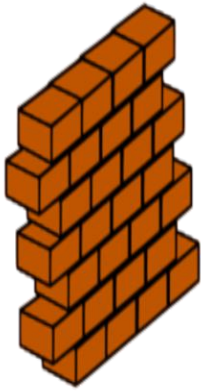
- Verification of System Performance and Functionality
- Validation of System Specification and Design Parameters
- Test Planning and Implementation

"Defense Acquisition System" System of Systems Engineering

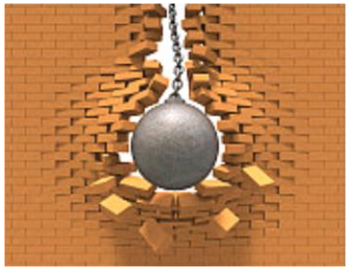
The Defense Acquisition System is a Joint Services process with the primary function to develop and provide DoD military capabilities. Because all branches of the military use this common system, by nature it is a very complex and lengthy process. The Integrated Defense Acquisition, Technology, and Logistics Life Cycle Management System, is composed of three major lanes of authority: (1) The Defense Acquisition System; (2) Joint Capabilities Integration & Development System (JCIDS); and (3) Planning, Programming, Budgeting & Execution Process. The purpose of this presentation is to introduce the Idaho National Laboratory's (INL) seven step process and a holistic approach of systems integration techniques directed at these three lanes of authority.

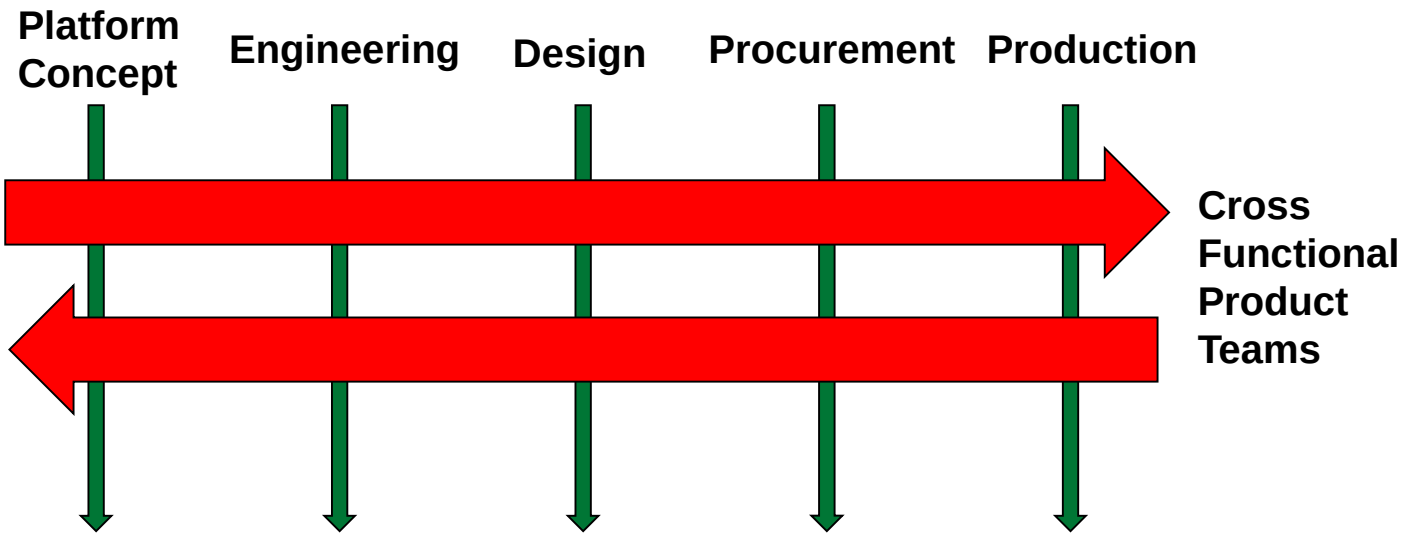
Chrysler's Mini Van Platform

Platform Concept → Engineering → Design → Procurement → Production

Chrysler's Mini Van Platform

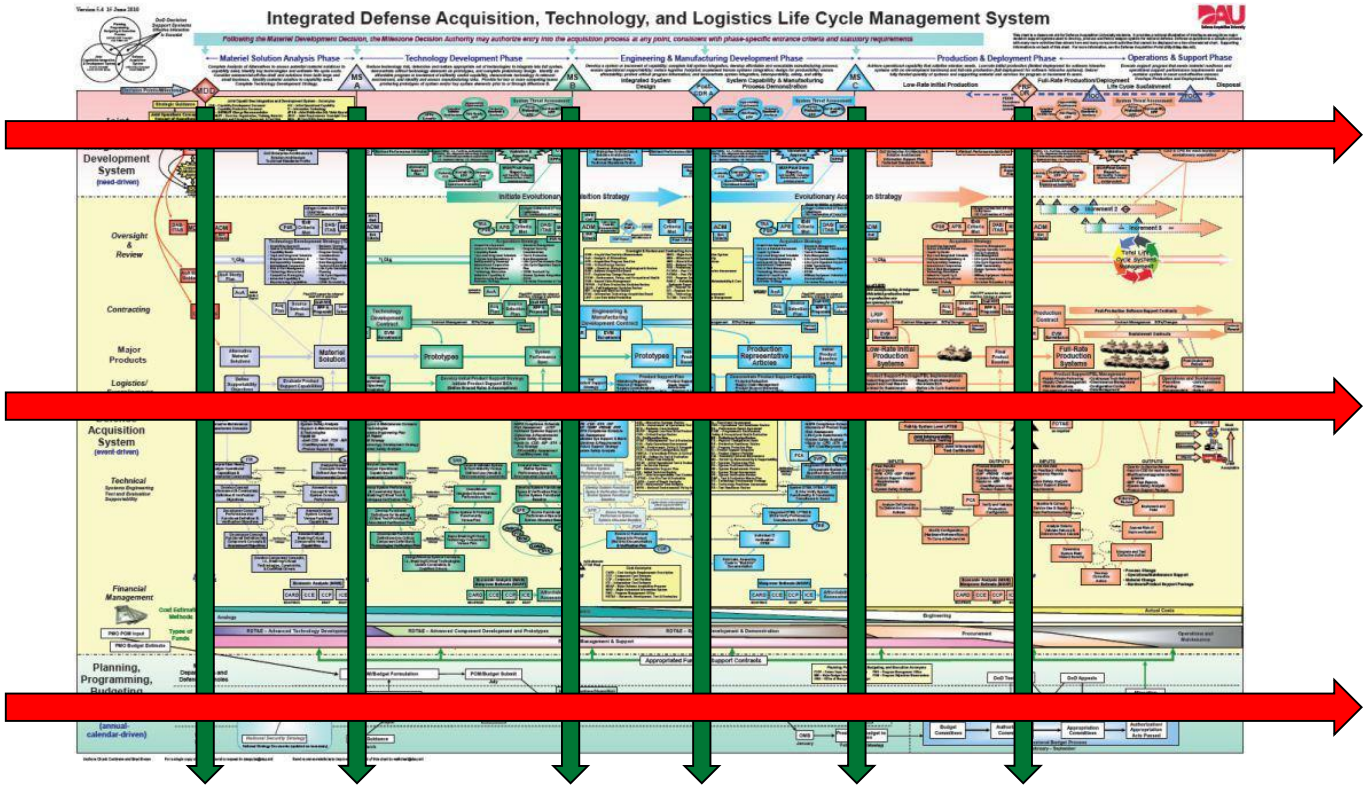


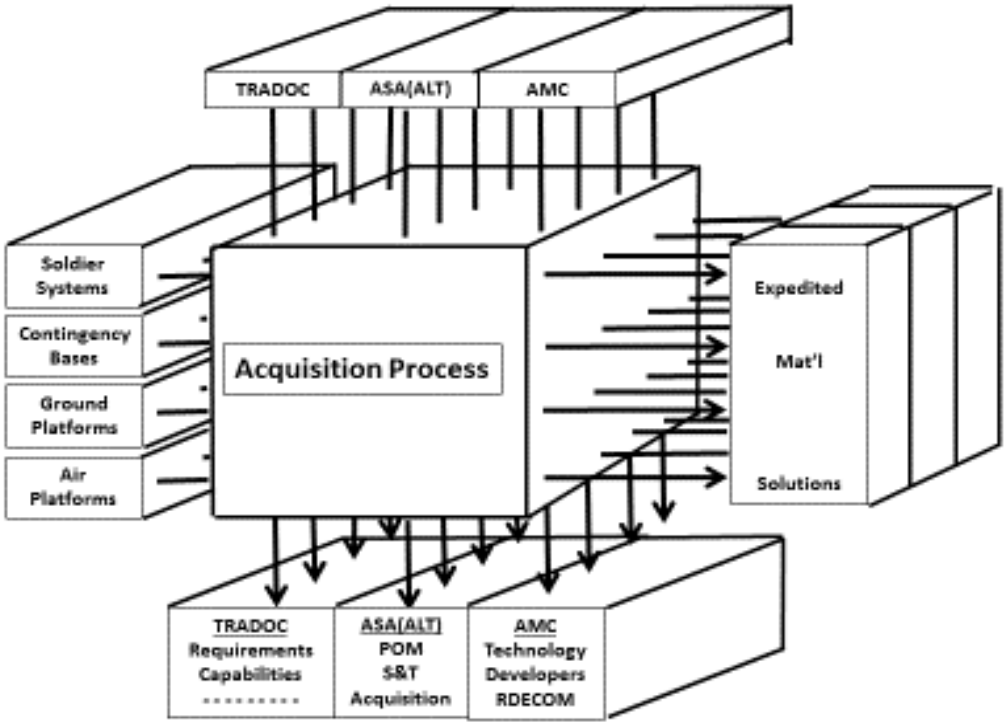


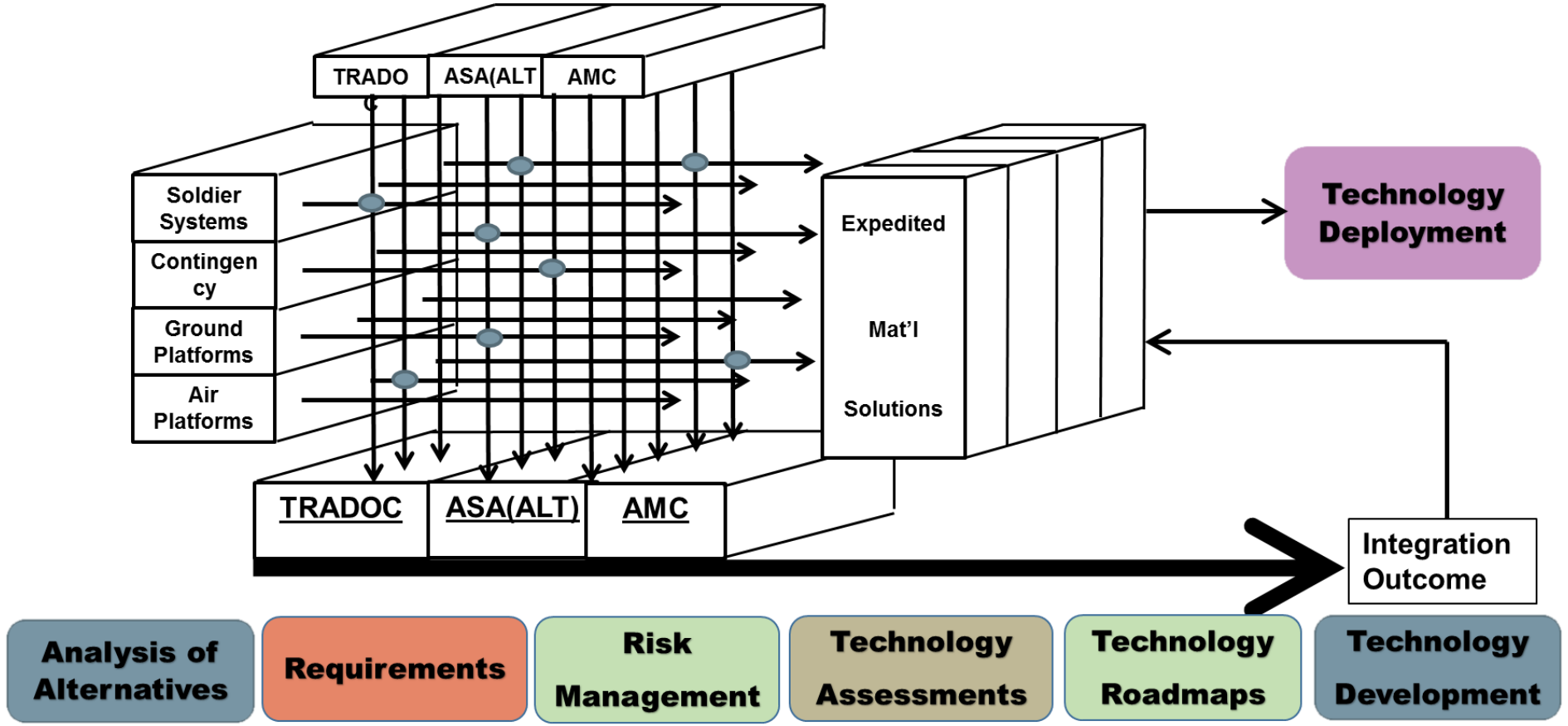
Keiretsu

- Enhanced Communications and Coordination
- Improve Efficiency
- Applicable to Several Vehicle Platforms

INL Seven Step Integration Methods




TRADOC
ASA(ALT)
AMC
Soldier Systems
Contingency Bases
Ground Platforms
Air Platforms
Acquisition Process
Expedited
Mat'l
Solutions
TRADOC
Requirements
Capabilities
ASA(ALT)
POM
S&T
Acquisition
AMC
Technology
Developers
RDECOM

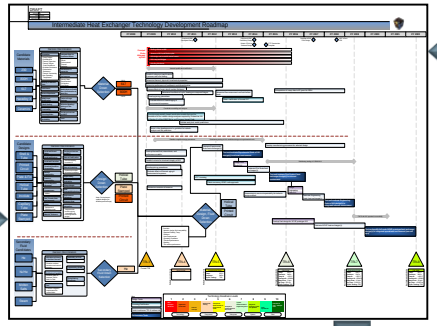

TRADO
ASA(ALT
AMC
Soldier Systems
Contingency
Ground Platforms
Air Platforms
Expedited
Mat'l
Solutions
Technology Deployment
TRADOC
ASA(ALT)
AMC
Integration Outcome
Analysis of Alternatives
Requirements
Risk Management
Technology Assessments
Technology Roadmaps
Technology Development

Assess Technology Maturity

NGNP Area / System	Min TRL
NGNP	3
Nuclear Heat Supply System (NHSS)	4
Reactor Pressure Vessel	4
Reactor Vessel Internals	4
Reactor Core and Core Structure	4
Fuel Elements	4
Reserve Shutdown System	5
Reactivity Control System	4
Core Conditioning System	4
Reactor Cavity Cooling System	4
Heat Transfer System (HTS)	3
Circulators	5
Intermediate Heat Exchanger	3
Cross Vessel Piping	4
High Temperature Valves - Flapper	6
High Temperature Valves - Iso, Relief	4
Power Conversion System (PCS)	4
Steam Generator	4
Balance of Plant (BOP)	3
Fuel Handling System - Prismatic	4
Fuel Handling System - Pebble Bed	5
Instrumentation & Control	3

- **Select Systems, Structures, Components**
- **Rate Technology Readiness Level**

Build the Roadmap & Define Path Forward

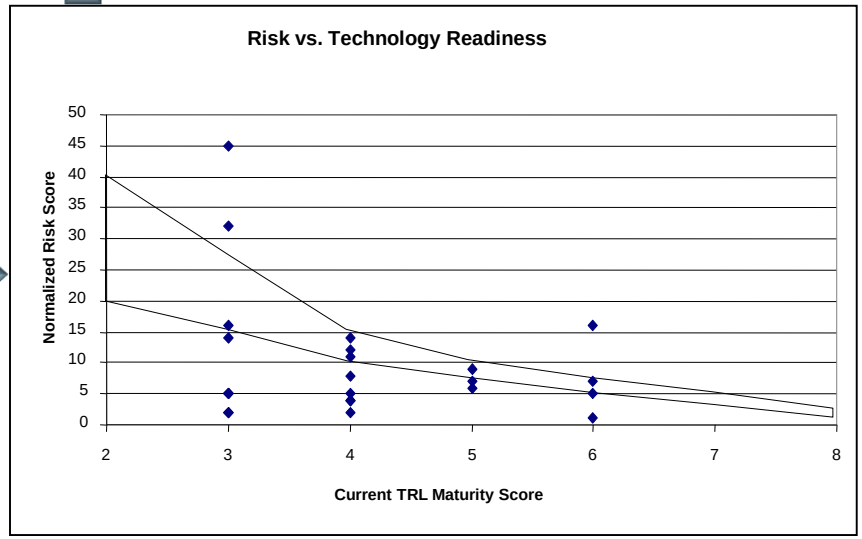


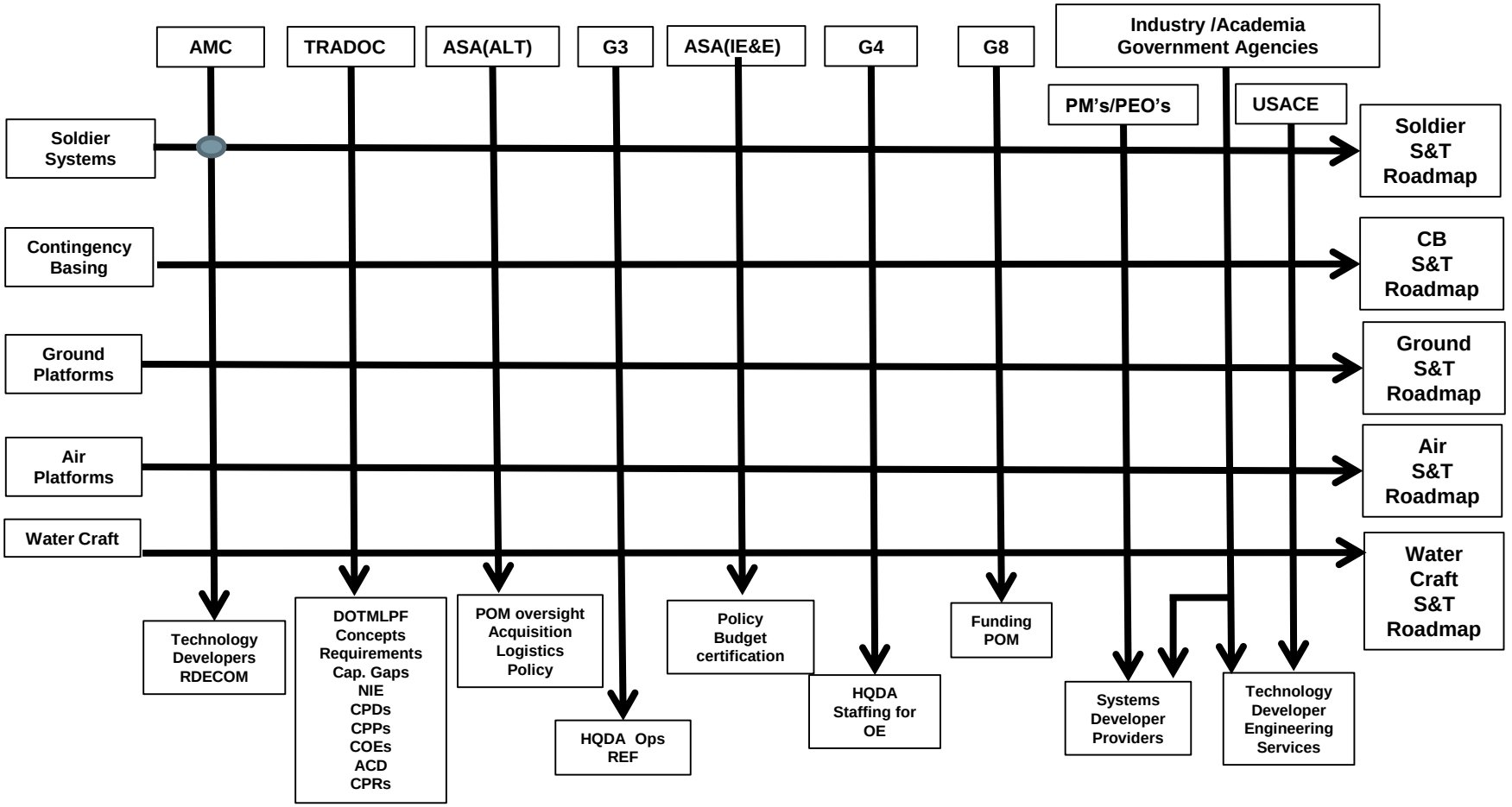
- **Develop Technology Maturation Steps**
- **Define Decision Points**
- **Establish Performance Metrics**

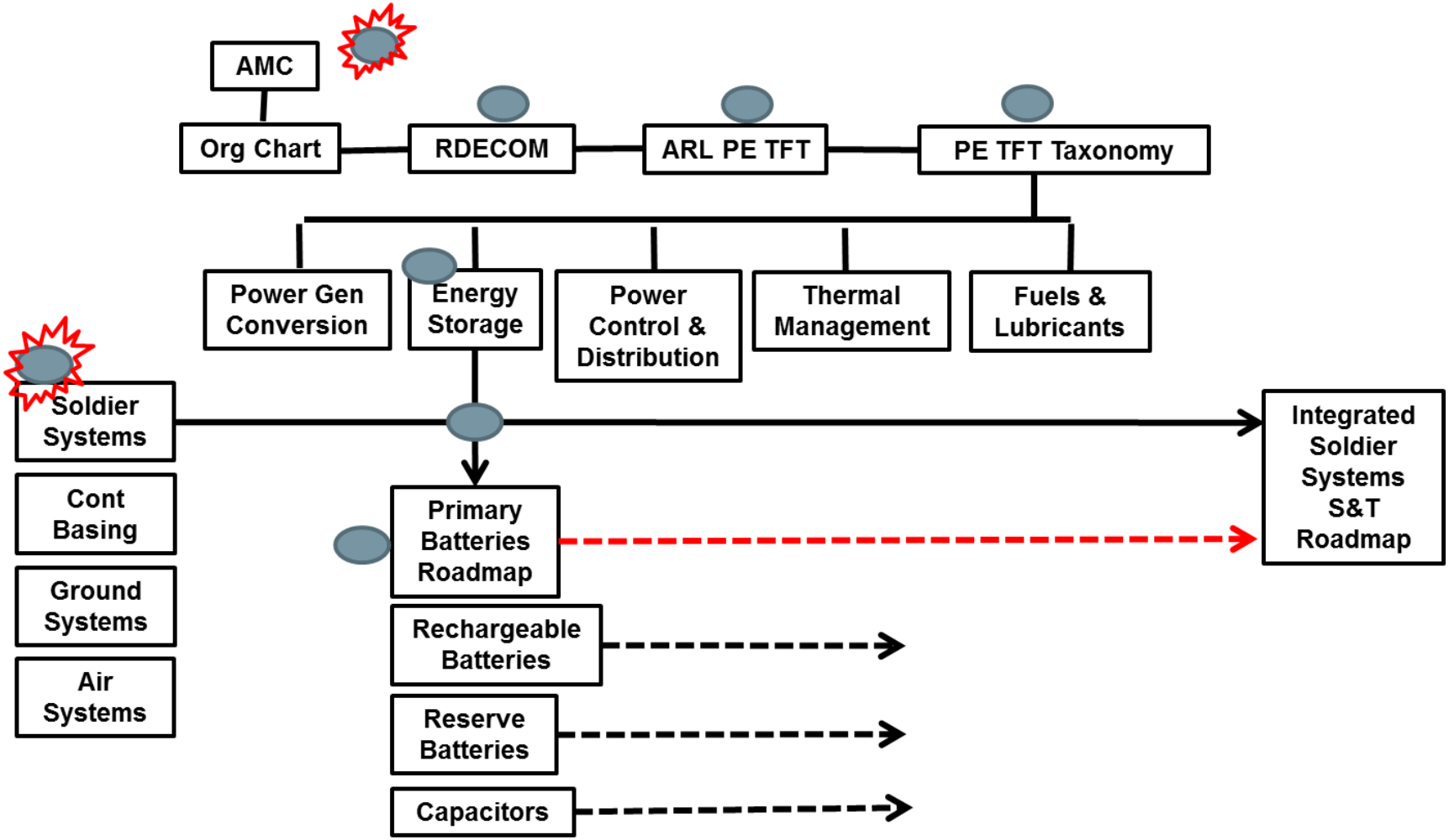
Execute the Roadmap & Refine Path Forward

Advance TRLs & Reduce Risk

- **Develop Risk Register**
- **Systematically Reduce Risk**
- **Execute to Risk – Work – off Metric**




AMC
TRADOC
ASA(ALT)
G3
ASA(IE&E)
G4
G8
Industry /Academia Government Agencies
PM's/PEO's
USACE
Soldier Systems
Contingency Basing
Ground Platforms
Air Platforms
Water Craft
Soldier S&T Roadmap
CB S&T Roadmap
Ground S&T Roadmap
Air S&T Roadmap
Water Craft S&T Roadmap
Technology Developers RDECOM
DOTMLPF Concepts Requirements Cap. Gaps NIE CPDs CPPs COEs ACD CPRs
POM oversight Acquisition Logistics Policy
HQDA Ops REF
Policy Budget certification
HQDA Staffing for OE
Funding POM
Systems Developer Providers
Technology Developer Engineering Services


AMC
Org Chart
RDECOM
ARL PE TFT
PE TFT Taxonomy
Power Gen Conversion
Energy Storage
Power Control & Distribution
Thermal Management
Fuels & Lubricants
Soldier Systems
Cont Basing
Ground Systems
Air Systems
Primary Batteries Roadmap
Rechargeable Batteries
Reserve Batteries
Capacitors
Integrated Soldier Systems S&T Roadmap

"Defense Acquisition System" System of Systems Engineering

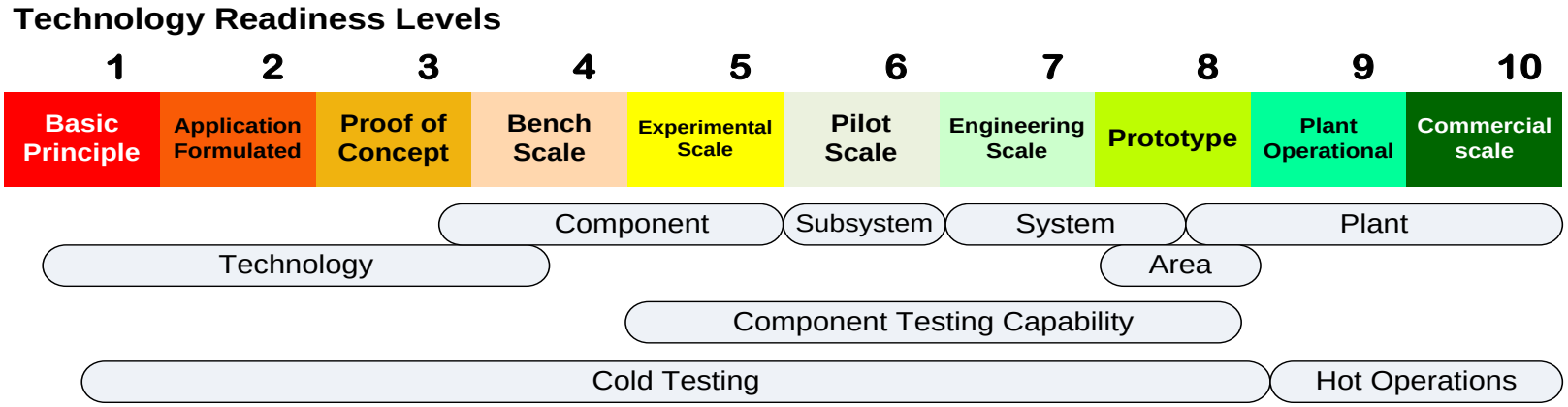
In general there are several hundred relationship nodes that are embedded in the Acquisition Process that presents numerous stopping points due to analysis, reviews, and approvals and in some cases contention due to stove pipe lines of authority and friction between organizations.

The construct provides three dimensional integration and applies the INL seven step integration methods to create technology roadmaps and expedited material solutions that could be directly applied to the Defense Acquisition Process and the JCIDS process.

- Early Development Planning
- Architecture
- Interoperability & Systems Integration
- Systems-of-Systems Systems Engineering
- Systems Engineering Effectiveness

INL/MIS-17-42149

Backup Slides



Technology Readiness Assessment

The structures, systems, and components (SSC) comprising the Defense Acquisition Process are synthesized and evaluated through a Technology Readiness Assessment and assigned Technology Readiness Levels (TRL) based on technical maturity. For lower TRLs, assessments typically occur at an individual technology or component level. To mature the technology or component, integrated testing or modeling must occur at increasingly larger scales, with integrated components, and in increasingly relevant environments, thus achieving higher TRL ratings as the project progresses. A validated TRL baseline is established for the proposed physical design and is periodically reassessed throughout the project life cycle. Validated TRLs provide project management one measure of the level of technological risk encountered by the project.

Technology Development Roadmaps

With the baseline TRLs in place, technology development roadmaps (TDRMs) can then be generated to define the decision discriminators, forecast down selection timeframes, and focus project research and development and engineering tasks on increasing levels of technical maturity. TDRMs provide the required structure and are the primary means to systematically perform risk-informed decision making, quantify uncertainty, down select technologies, and mature technologies in a cost-effective and timely manner. Tasks include modeling, testing, bench-scale demonstrations, pilot-scale demonstrations, and full integrated prototype demonstrations. TDRMs for critical SSC are developed to:

- Set the project vision for technology maturation and risk resolution
- Identify the key selection discriminators and drive uncertainty reduction to inform technology and design down selection
- Ensure technology readiness is demonstrated through testing, modeling, simulations, piloting, and prototyping
- Provide early identification and resolution of technical risks
- Avoid late project technical challenges, which manifest themselves as cost overruns and schedule delays

Risk-Informed Project Readiness Assessment

The tasks needed to mature the technologies, as documented in the TDRMs, also reduce the technical project risk. Technical and programmatic risks including political decisions, social acceptance, and market demand are reviewed and risk handling strategies developed to reduce the probability of the risk event and lessen its damage should the event occur. While advancing project readiness, and engineering design. The resulting RISK-Informed Project Readiness Assessment serves to:

- Identify the tasks that provide the most efficient risk resolution
- Provide a path forward for reducing risk over the life of the project
- Link risk to project schedule and integrated priority list
- Integrate multiple stakeholders viewpoints into risk-informed path forward
- Provide a “Risk Work-off Metric” for the project to track risk to acceptable levels

Questions?

Larry Harding
Systems Engineer
(208) 526-6111
dean.harding@inl.gov