The U.S. DoD Technology Transition
A Critical Assessment

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Overview

- **Defenition of Technology Transition**
- **Current Technology Transition at US DoD**
- **Knowledge-Based Acquisition**
- **Gaps and Recommendations for Improvement**
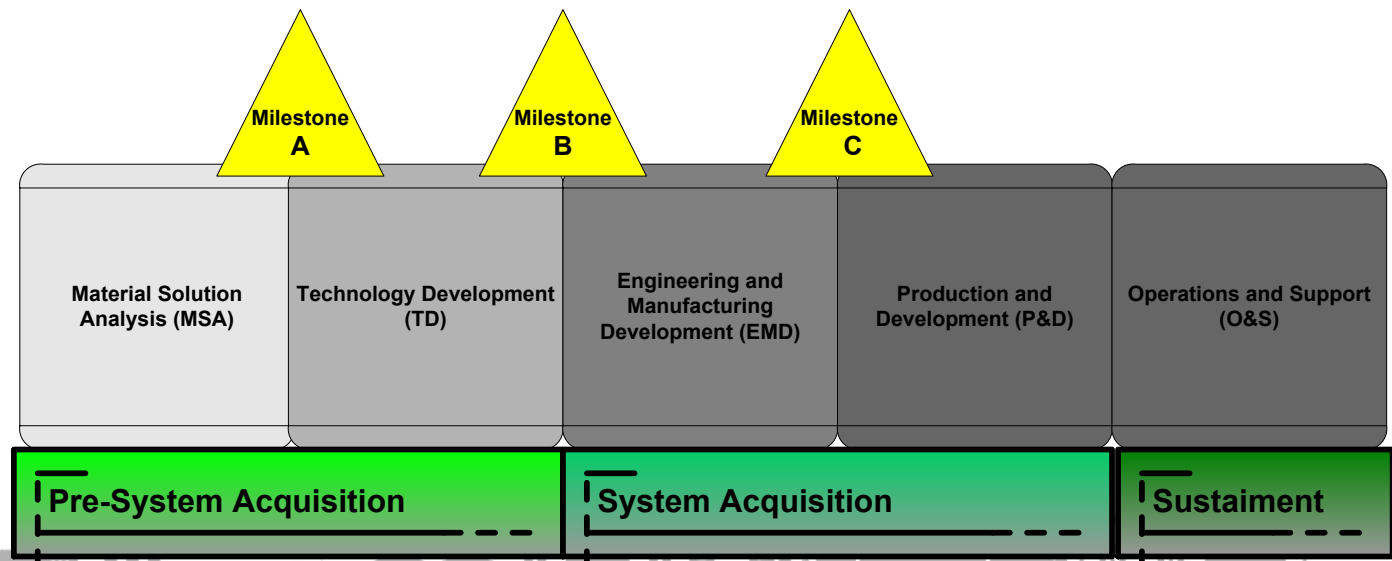- **New Research Direction**
- **Questions**
- **References**

Definitions

- *Technology Transition versus Technology Transfer*

- ***Technology Transfer:*** *Handing over at any stage of technology development life cycle*

- ***Technology Transition Life Cycle:*** *A process from research and development to new product development, and to adaptation and implementation*

Current Technology Transition
"The Technology Acquisition Life Cycle"

- **Consists of five time periods called phases and three decision points, called milestones**

- **Stages:**
  - *Pre- Acquisition Stage:* Materiel Solution Analysis (MSA) phase and Technology Development (TD) phase
  - *Systems Acquisition Stage :* Engineering and Manufacturing Development (EMD) phase and Production and Deployment (P&D) phase
  - *Sustainment Stage:* Operations and Support (O&S) phase

- **Decision Points:**
  - *Milestone A:* Technology Transition from MSA to TD
  - *Milestone B:* Technology Transition from TD to EMD
  - *Milestone C:* Technology Transition from EMD to P&D

Milestone A | Milestone B | Milestone C

Material Solution Analysis (MSA) | Technology Development (TD) | Engineering and Manufacturing Development (EMD) | Production and Development (P&D) | Operations and Support (O&S)

Pre-System Acquisition | System Acquisition | Sustainment

Major Risks in Technology Transition

- **The two major risk areas in acquisitions are**
  - Immature product technologies
  - Immature manufacturing capability

- **At DoD:**
  - The technology risk is addressed by Technology Readiness Level (TRL) metric
  - Manufacturing risk is addressed by Manufacturing Readiness Level (MRL) metric

Current Technology Transition
"Readiness Metrics: Technology Readiness Level (TRL)"

- Originally developed by NASA in 1970s
- Calculated through out the life cycle to determine the **maturity** of the technology and if it is ready to move forward to the **next phase**
- TRL is a number between 1 and 9 that describes the degree of maturity of a project
  - **TRL 1:** The idea is at early stage of scientific investigation
  - **TRL 9:** The technology is being successfully used in a system

Technology Readiness (maturity)	Definitions
TRL 1	Basic principles observed and reported
TRL 2	Technology concept or application formulated
TRL 3	Experimental and analytical critical function and characteristic proof of concept
TRL 4	Component or breadboard validation in a laboratory environment
TRL 5	Component or breadboard validation in a relevant environment
TRL 6	System or subsystem model or prototype demonstrated in a relevant environment
TRL 7	System prototype demonstration in an operational environment
TRL 8	Actual system completed and "flight qualified" through test and demonstration
TRL 9	Actual system "flight proven" through successful mission operations

Current Technology Transition
"Readiness Metrics: Manufacturing Readiness Metric (MRL)"

- **Assesses** manufacturing maturities and manufacturing risks of projects throughout the entire defense acquisition life cycle

- **10 MRLs**, 1 through 10, which are correlated with the 9 TRLs

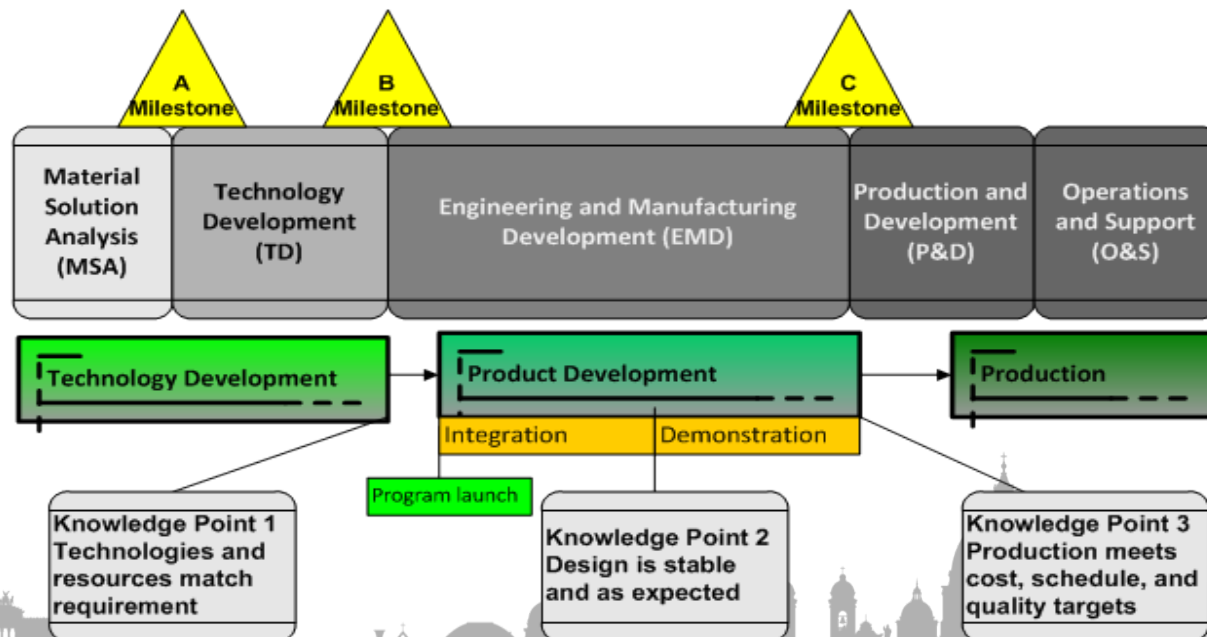| Manufacturing Readiness (Maturity)	Definitions	TRL Correlation
MRL 1	Basic Manufacturing Implications Identified	Must be TRL1
MRL 2	Manufacturing Concepts Identified	Must be TRL 2
MRL 3	Manufacturing Proof of Concept Developed	Must be TRL 3
MRL 4	Capability to Produce the Technology in a Laboratory Environment:	At Least TRL 4
MRL 5	Capability to Produce prototype Components in a Production relevant environment	At Least TRL 5
MRL 6	Capability to produce a prototype system or subsystem in a production relevant environment	At Least TRL 6
MRL 7	Capability to produce systems, subsystems, or components in a production representative environment	On a path to achieve TRL 7.
MRL 8	Pilot line capability demonstrated; Ready to begin Low Rate Initial Production	At Least TRL 7
MRL 9	Low rate production demonstrated; Capability in place to begin Full Rate Production	Must be TRL 9
MRL 10	Full Rate Production demonstrated and lean production practices in place	Must be TRL 9

Current Technology Transition
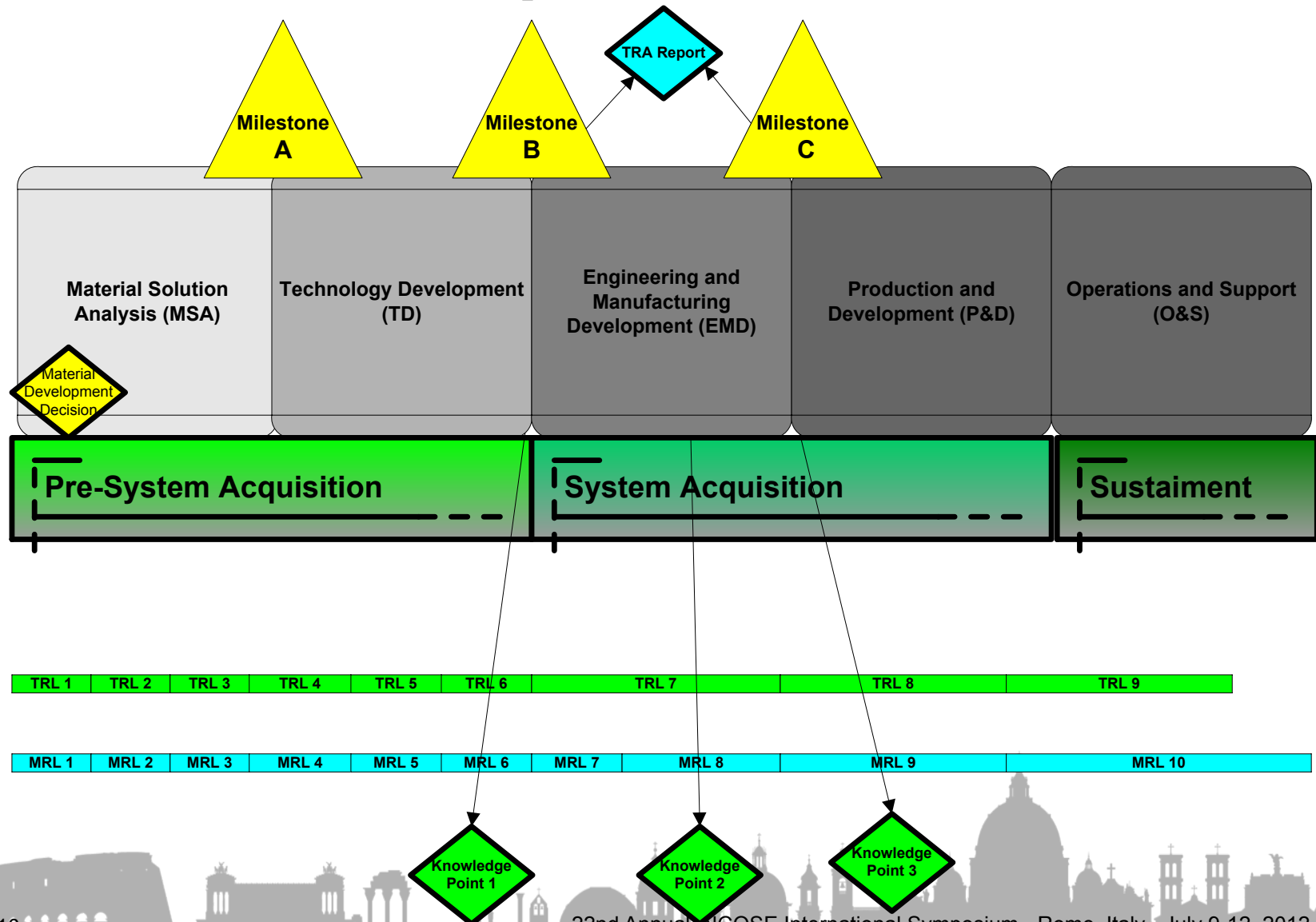## "Technology Readiness Assessment (TRA)"

- An official process to evaluate readiness level of technology transition at Milestones

- The TRA uses the Technology Readiness Level (TRLs) criteria to evaluate readiness level system elements

- TRA is conducted by an Independent Review Team (IRT) of subject matter experts (SMEs)

- TRA is a requirement at Milestone B and Milestone C

Knowledge-Based Acquisition

- Government Accountability Office recommended best practice for DoD Acquisition
- To have high knowledge about **critical** features of the project at **key points** in time during its development and delivery
- **Knowledge Point 1:** By the start of EMD, ensure technologies and resources match end user requirements; **TRL should be 7**
- **Knowledge Point 2:** Ensure design is stable and as expected; Completion of at least 90 percent of engineering drawings
- **Knowledge Point 3:** Ensure production meets cost, schedule, and quality targets

Summary of DoD's Technology Acquisition

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Major Problems

- **Main Issue: Non Optimal Investment**
  - The most promising technology is not always selected to fund

- **Valley of Death**
  - Many projects do not get transitioned from S&T to acquisition community and do not make it past TRL 6

- **Cost Overrun**
  - GAO (2011) Report: Half of DoD's major defense acquisition programs do not meet cost performance goals and that 80 percent of programs have experienced an increase in unit costs from initial estimates.

- **Schedule Delays**
  - Takes average of 10 years from basic research to implementation

- **Performance Mismatch**
  - Causes cancellation of programs: Waste of resources

Gaps and Recommendations for Improvement

- **Gap:** Lack of knowledge at key decision points
  - **Effect:** Leads to continuation of projects no longer meeting end user need
  - **Recommendation:** Implement **Knowledge Based Model** as used by the industry

- **Gap:** TRA certification is not required at Milestone A
  - **Effect:** Continuation of unnecessary projects past Milestone A
  - **Recommendation:** Mandate formal **TRA Certification** at Milestone A prior to moving forward form the material solution analysis phase to technology development phase.
    - Helps identify technologies no longer needed due to change in end-users requirements or emergence of more advanced technologies

Gaps and Recommendations for Improvement (cont.)

- **Gap:** MRL metric is not a requirement for TRA
  - **Effect:** A technology might meet the required TRL and move into the engineering and manufacturing development phase at Milestone B without meeting the manufacturing readiness criteria
  - **Recommendation:** Incorporate MRL assessment into the formal TRA certification to ensure the intended correlations between the TRL numbers and the MRL numbers are met

- **Gap:** S&T developers each have their own small area of focus
  - **Effect:** Many independent small projects do not integrate into a system suitable for Acquisition
  - **Recommendation:** Require more coordination of S&T project managers combine projects into a system suitable for effective transition
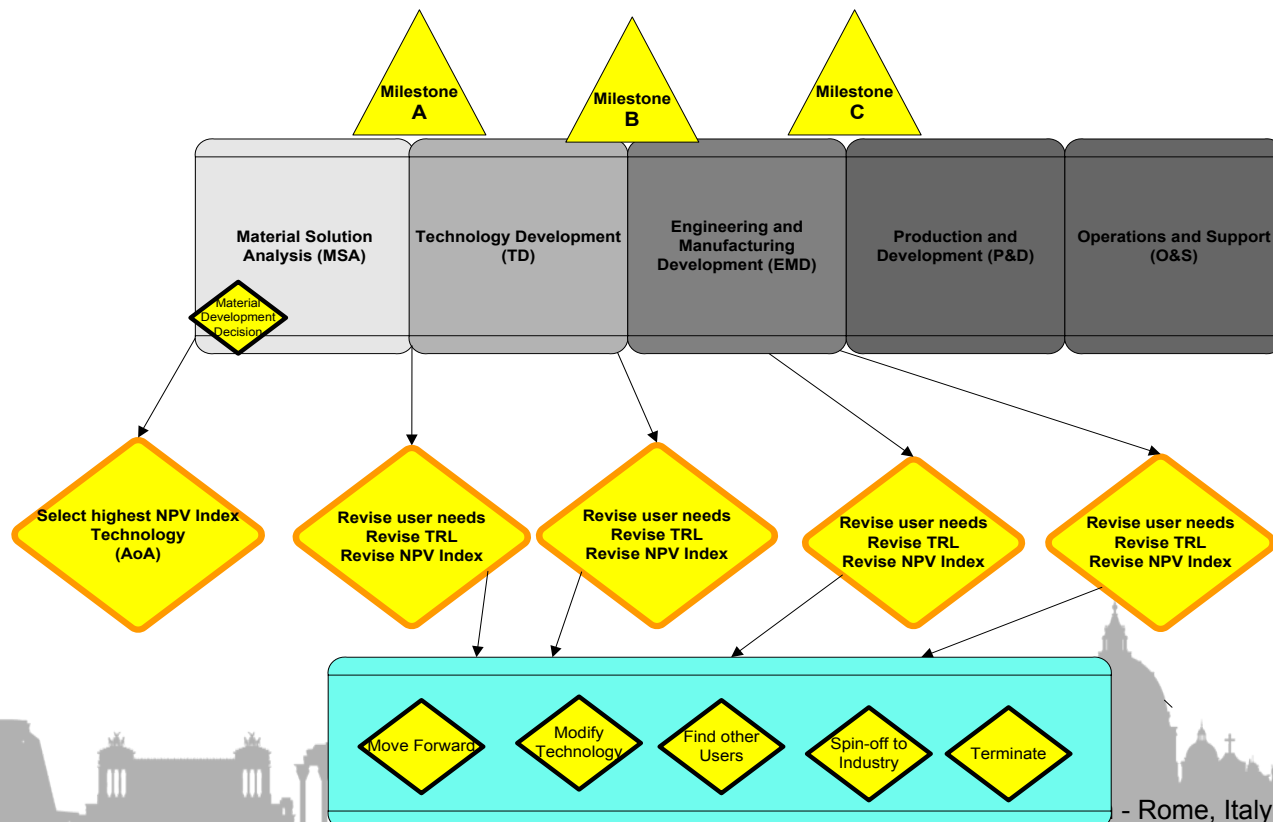
Gaps and Recommendations for improvement (cont.)

- **Gap:** S&T community does not have the budgetary authority for transition at Milestone B
  - **Effect:** Many projects fall into the so called *Valley of Death*
  - **Recommendation:**
    - Authorize S&T community for developing, maturing, and transitioning mature technologies to the acquisition community
    - Emphasize acquisition community to focus solely on product development activities and delivering weapon systems to the warfighter.

New Research Direction

Main Issue: Non Optimal Investment

- **Gap:** Lack of Dynamic Cost Benefit Analysis and TRL update
  - **Effect:** DoD projects are intended for specific missions and threats. When threats change, priorities and requirements change and the technology under development becomes irrelevant.
  - **Recommendation:**
    - **Update the TRL at Key Decision Points based on changes in end user requirements**
    - **Develop Dynamic Cost Benefit Analysis, such Net Present Value metric, to justify validity of continuation at each major decision point**

Questions

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