Enhanced Systems Engineering - Starting Programs Right

NDIA 11th Annual Systems Engineering Conference

October 23, 2008

Ceasar D. Sharper
Systems and Software Engineering/Enterprise Development
Office of the Deputy Under Secretary of Defense
(Acquisition & Technology)

Outline

Enhanced Systems Engineering (SE)

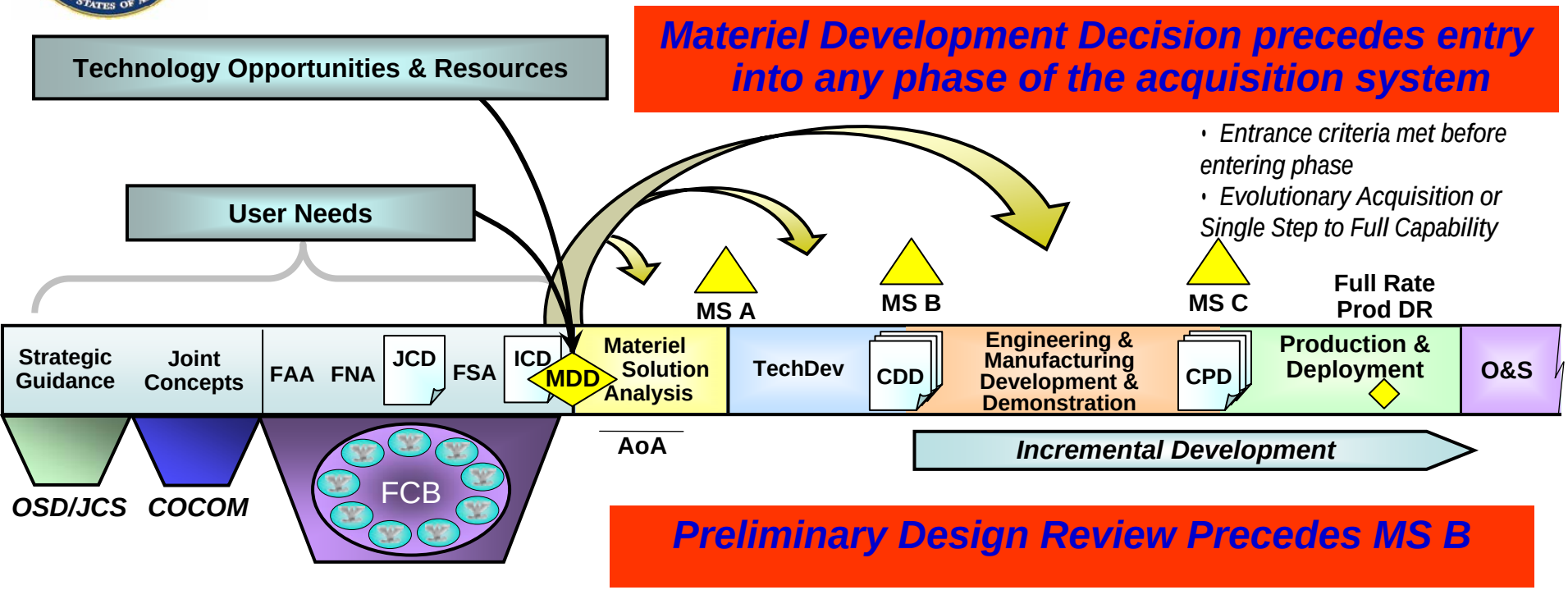
- SE Context: Background / Framework
- Early SE: "… right activities at the right time …"
  - Materiel Solution Analysis Phase
  - Technology Development Phase
- Emphasis on SE ".. the right time in the right way"
  - Competitive Prototyping
  - SE Design Consideration - Reliability, Availability, and Maintainability
  - Preliminary Design Review (PDR)

"Implementing the right activities at the right time in the right way"

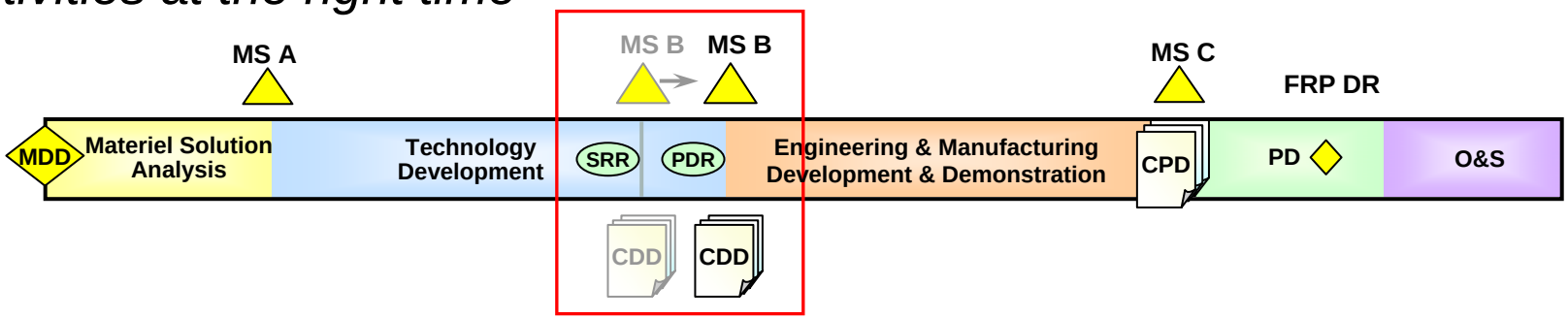
Background
Program Roles & Activities

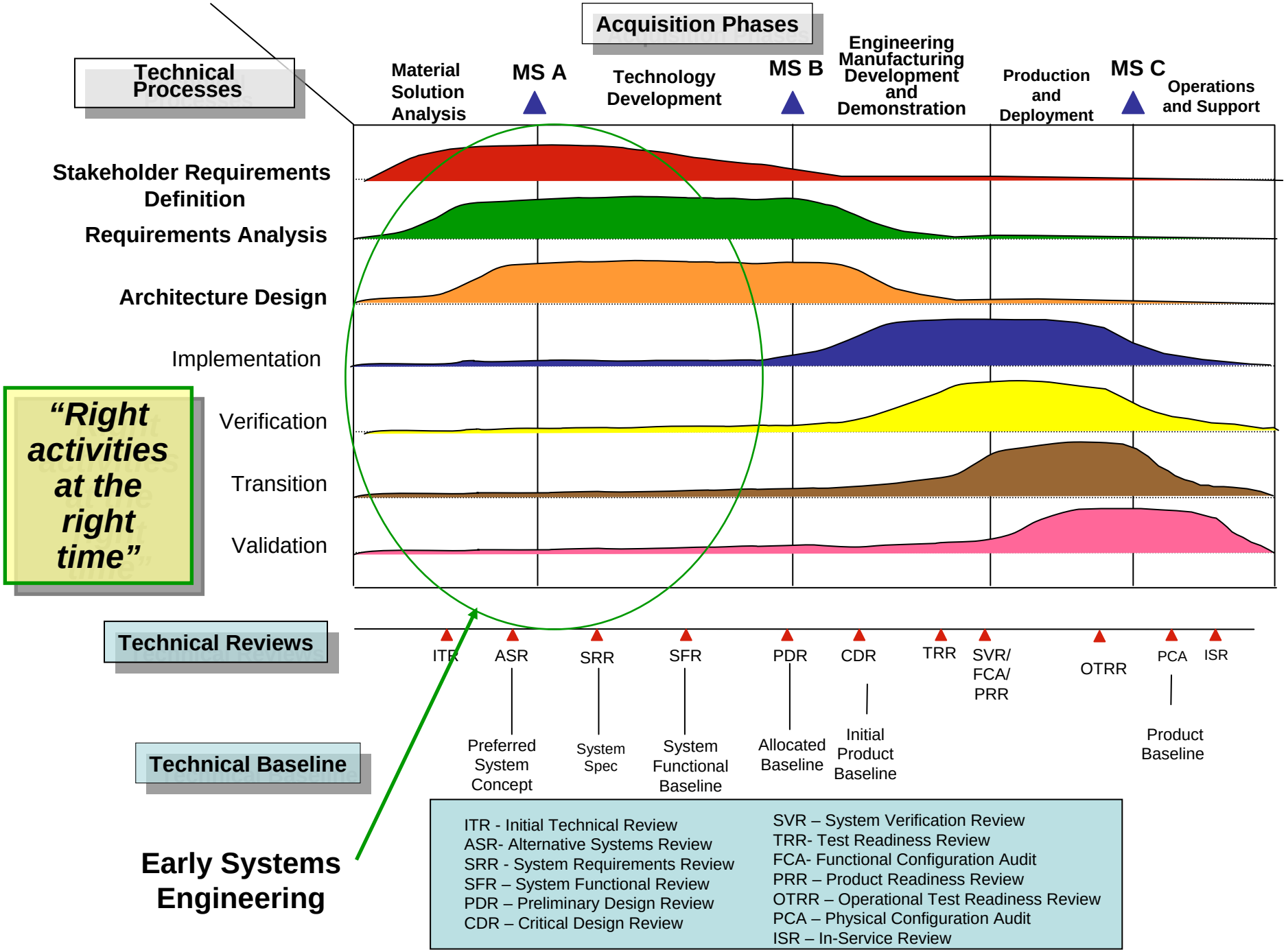
	Project Manager	Systems Engineer
Stakeholder Management	Primary	Support
Planning	Primary	Support
Cost Management	Primary	Support
Schedule Management	Primary	Support
Configuration Management	Primary	Support
Contract Management	Primary	Support
Concept Selection	Shared	Shared
Architecture Development	Support	Primary
Requirements Baseline	Support	Primary
Technical Risk Management	Support	Primary
Interface Control	Support	Primary
Integration	Support	Primary
Verification	Support	Primary
Validation	Shared	Shared

"Proposed DoDI 5000.02 Changes" Framework for Enhanced SE

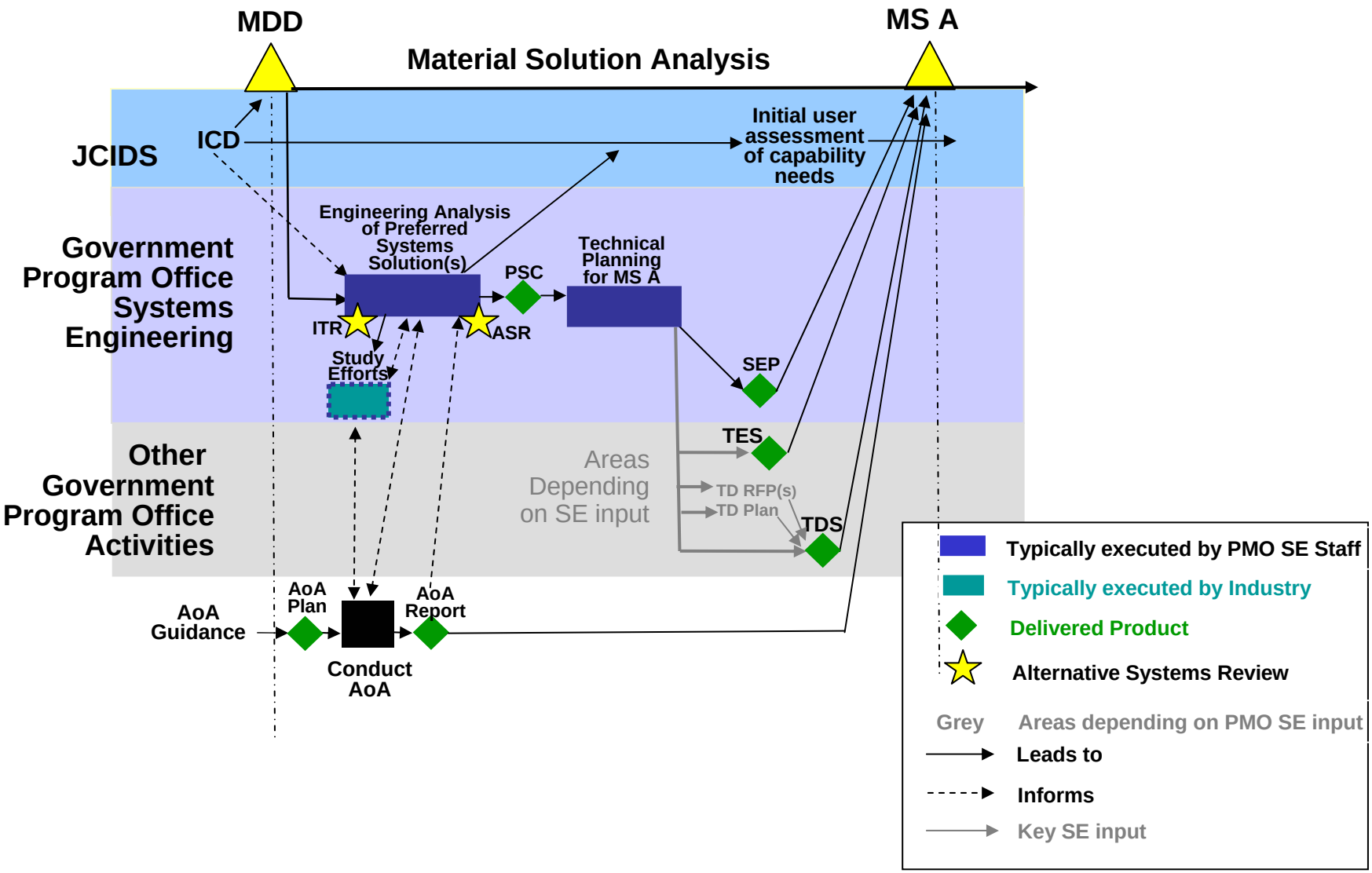


"Right activities at the right time"




Acquisition Phases
Technical Processes
Material Solution Analysis
MS A
Technology Development
MS B
Engineering Manufacturing Development and Demonstration
Production and Deployment
MS C
Operations and Support
Stakeholder Requirements Definition
Requirements Analysis
Architecture Design
Implementation
Verification
Transition
Validation
"Right activities at the right time"
Technical Reviews
ITR
ASR
SRR
SFR
PDR
CDR
TRR
SVR/ FCA/ PRR
OTRR
PCA
ISR
Technical Baseline
Preferred System Concept
System Spec
System Functional Baseline
Allocated Baseline
Initial Product Baseline
Product Baseline
Early Systems Engineering
ITR - Initial Technical Review
ASR- Alternative Systems Review
SRR - System Requirements Review
SFR – System Functional Review
PDR – Preliminary Design Review
CDR – Critical Design Review
SVR – System Verification Review
TRR- Test Readiness Review
FCA- Functional Configuration Audit
PRR – Product Readiness Review
OTRR – Operational Test Readiness Review
PCA – Physical Configuration Audit
ISR – In-Service Review

Materiel Solution Analysis Phase



SE Activities During MSA Phase

Systems Engineering Processes/Documents/Plans

- Key Technical Processes
- Systems Engineering Plan (SEP)
- Test and Evaluation Strategy (TES)
- Analysis of Alternatives (AOA)
- Input to the Technology Development Strategy
- Input to the Cost Estimate

Assessments

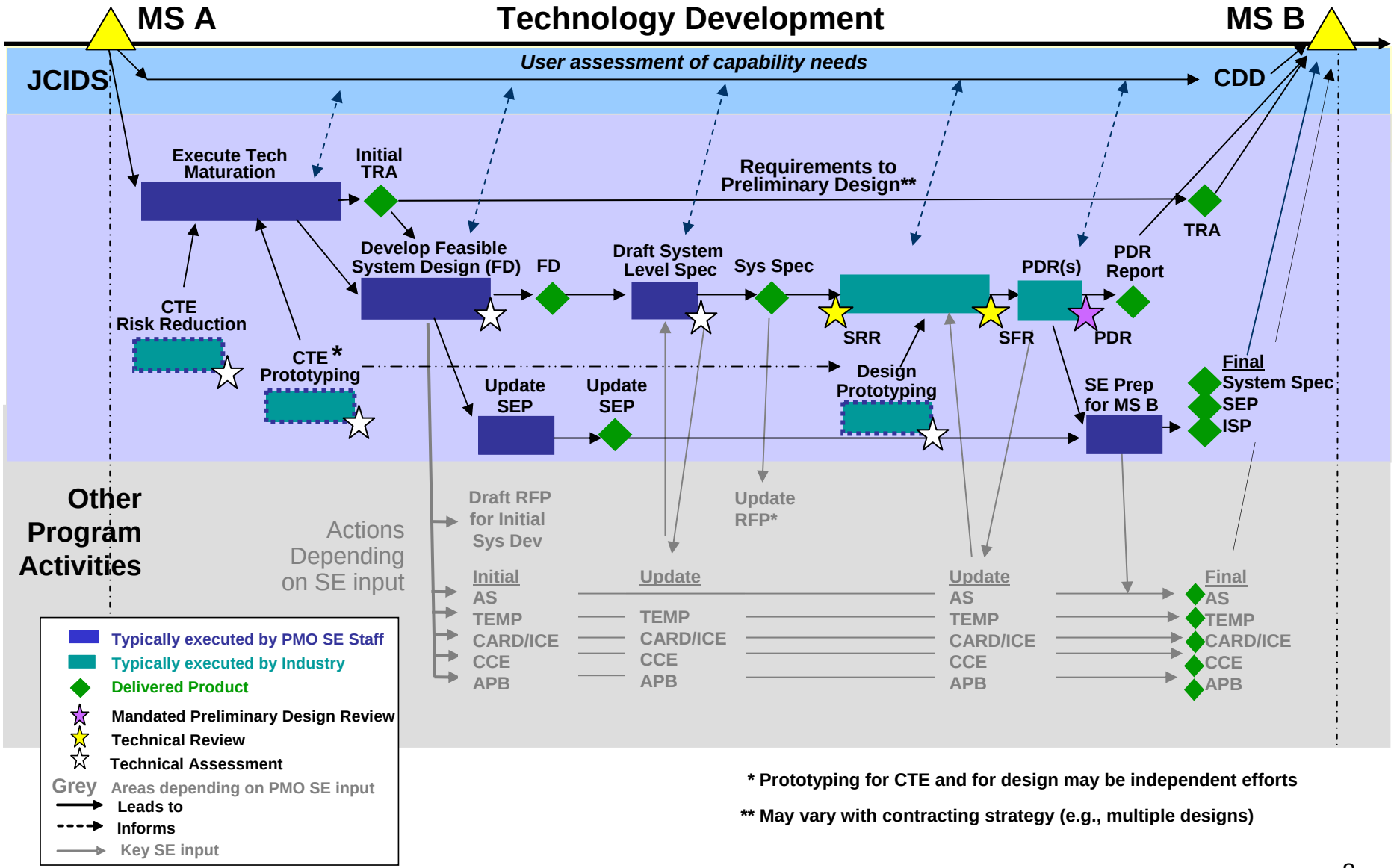
- Program Support Review (PSR)

Technical Reviews

- Initial Technical Review (ITR)
- Alternative System Review (ASR)

SE COP **(**https://acc.dau.mil/TechRevChklst**).**

Technology Development Phase



* Prototyping for CTE and for design may be independent efforts

** May vary with contracting strategy (e.g., multiple designs)

SE Activities During TD Phase

Systems Engineering Processes/Documents/Plans

- Key Technical Processes
- Competitive Prototyping
- Technology Maturation
- Test and Evaluation Master Plan (TEMP)
- Cost Analysis Requirements Description (CARD)
- Input to the Acquisition Program Baseline (APB)

Assessments

- Technology Readiness Assessment (TRA)
- Program Support Review (PSR)

Technical Reviews

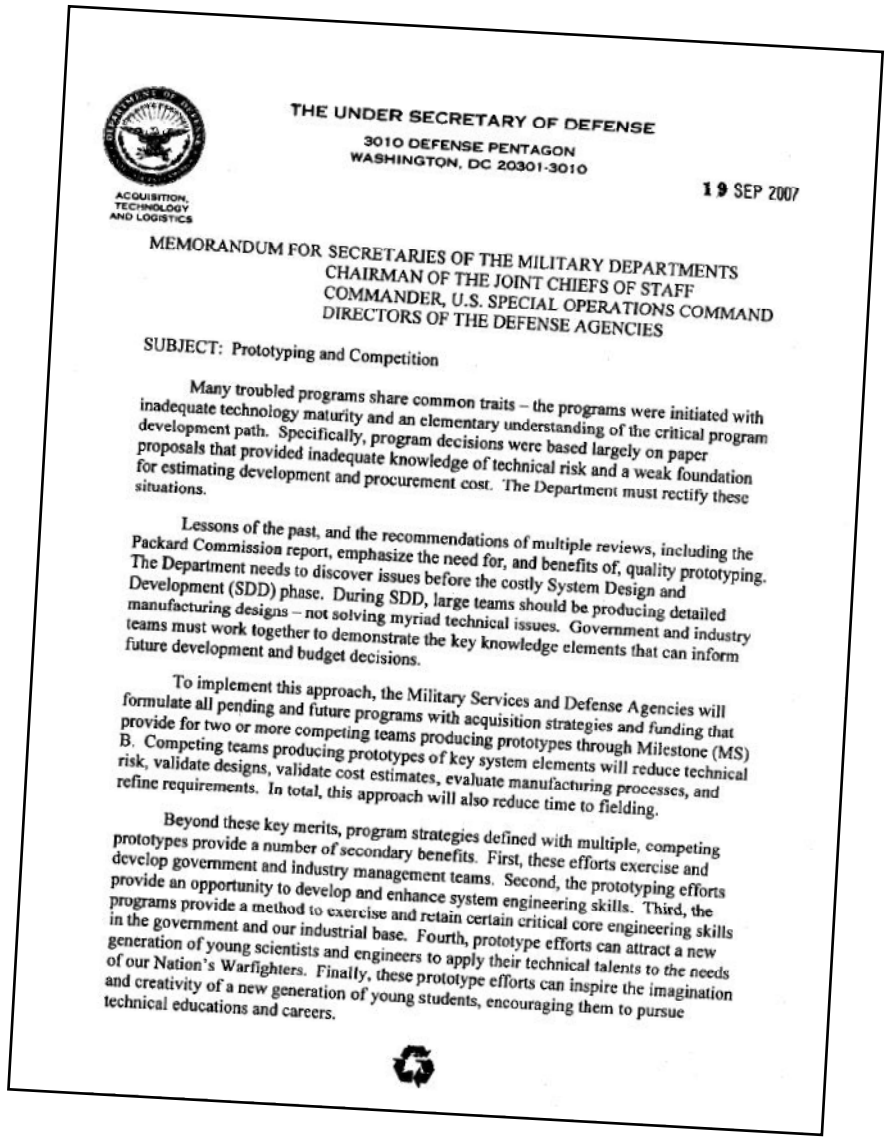
- Systems Requirements Review (SRR)
- Systems Functional Review (SFR)
- Preliminary Design Review (PDR)

Prototyping and Competition
"… in the right way"

Systems and Software Engineering

"Evolutionary acquisition requires . . . Technology development preceding initiation of an increment shall continue until the required level of maturity is achieved, prototypes of the system or key system elements are produced, and a preliminary design is completed. . . ."

"The TDS and associated funding shall provide for two or more competing teams producing prototypes of the system and/or key system elements prior to, or through, Milestone B. The prototypes shall be representative platforms reflecting the maturity of technologies and integrated system performance consistent with expected capability."



THE UNDER SECRETARY OF DEFENSE
3010 DEFENSE PENTAGON
WASHINGTON, DC 20301-3010

ACQUISITION, TECHNOLOGY AND LOGISTICS

19 SEP 2007

MEMORANDUM FOR SECRETARIES OF THE MILITARY DEPARTMENTS
CHAIRMAN OF THE JOINT CHIEFS OF STAFF
COMMANDER, U.S. SPECIAL OPERATIONS COMMAND
DIRECTORS OF THE DEFENSE AGENCIES

SUBJECT: Prototyping and Competition

Many troubled programs share common traits – the programs were initiated with inadequate technology maturity and an elementary understanding of the critical program development path. Specifically, program decisions were based largely on paper proposals that provided inadequate knowledge of technical risk and a weak foundation for estimating development and procurement cost. The Department must rectify these situations.

Lessons of the past, and the recommendations of multiple reviews, including the Packard Commission report, emphasize the need for, and benefits of, quality prototyping. The Department needs to discover issues before the costly System Design and Development (SDD) phase. During SDD, large teams should be producing detailed manufacturing designs – not solving myriad technical issues. Government and industry teams must work together to demonstrate the key knowledge elements that can inform future development and budget decisions.

To implement this approach, the Military Services and Defense Agencies will formulate all pending and future programs with acquisition strategies and funding that provide for two or more competing teams producing prototypes through Milestone (MS) B. Competing teams producing prototypes of key system elements will reduce technical risk, validate designs, validate cost estimates, evaluate manufacturing processes, and refine requirements. In total, this approach will also reduce time to fielding.

Beyond these key merits, program strategies defined with multiple, competing prototypes provide a number of secondary benefits. First, these efforts exercise and develop government and industry management teams. Second, the prototyping efforts provide an opportunity to develop and enhance system engineering skills. Third, the programs provide a method to exercise and retain certain critical core engineering skills in the government and our industrial base. Fourth, prototype efforts can attract a new generation of young scientists and engineers to apply their technical talents to the needs of our Nation's Warfighters. Finally, these prototype efforts can inspire the imagination and creativity of a new generation of young students, encouraging them to pursue technical educations and careers.

Competitive Prototyping "Done in the Right Way"

- Need to know earlier on what will make the program successful and prototype that (i.e. challenges)
- Decide what is important – cost, integration, technology, etc – and determine how to measure / assess success
- Cost in prototyping should be a factor but the not dominant decision point
- Get domain experts to assist in determining what needs to be prototyped
- Do proof of concept but also to fill in the other holes
- Achieved at any level – system or key system elements (sub-system, assembly, or component)
- Prototype the critical path items first
- Need to spend money smartly up front – get smart at low burn rate

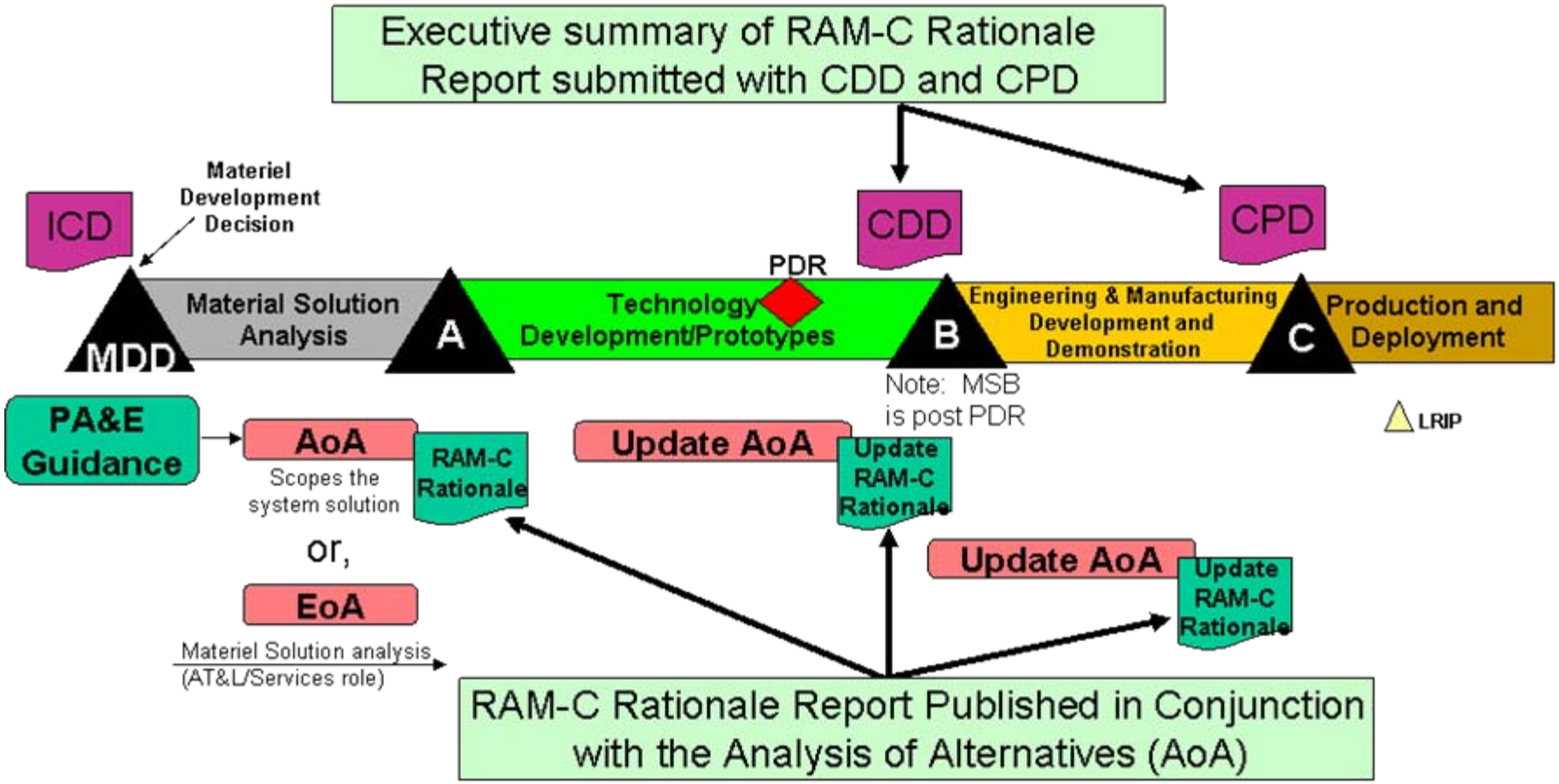
Enhanced Systems Engineering
SE Design Consideration - RAM

Reliability, Availability, & Maintainability (RAM)

- Defense Science Board Report on DT&E (dtd May 08) recommended to improve RAM
- DoD Working Group formed to implement recommendations
- Reliability, Availability, and Maintainability Policy (dtd 21 Jul 08); Directs Components to set policy actions to ensure:
  - Collaboration in the establishment of RAM requirements
  - Development contracts and acquisition plans evaluate RAM during system design
  - Maturation of RAM throughout the acquisition life cycle
  - Use of contract incentives to achieve RAM goals

(http://www.acq.osd.mil/sse/dte/docs/USD-ATLMemeo-RAM-Policy-21Jul08.pdf)

Implementing RAM-C
"… right activities at the right time …"



Implementing RAM-C "… in the right way"

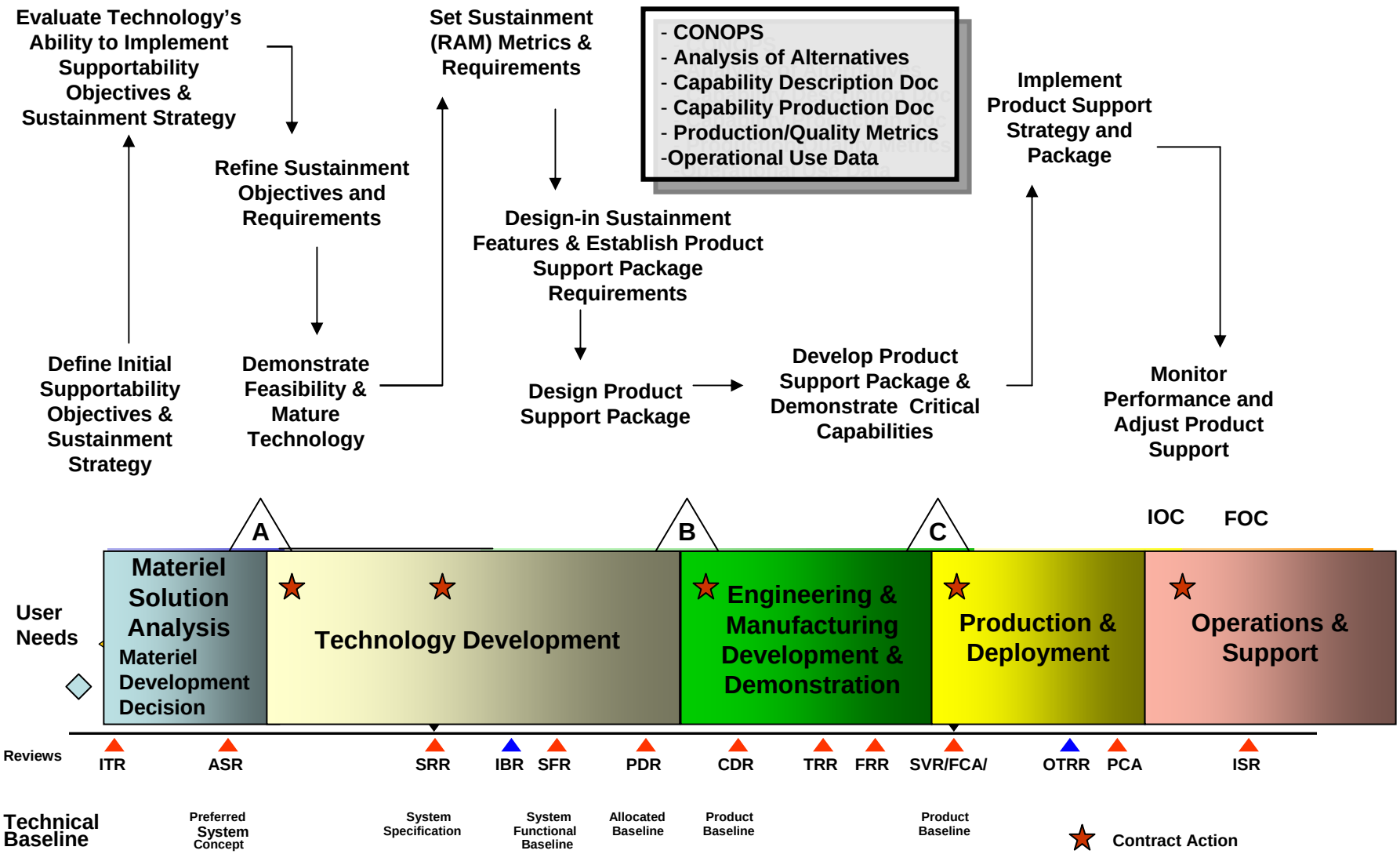
SE Design consideration "… in the right way"

- Template for Reliability Contract Language
  - Sections C, L, and M
  - Guidance on Performance Incentives for Reliability
- GEIA-STD-0009, Reliability Program Standard for Systems Design, Development, and Manufacturing
- RAM Planning Template by each Technical Review
- Evaluation Criteria (Reliability Program Detailed Scorecard) to assess a program
- Early T&E Involvement in RFP Development
- DoD Reliability, Availability, Maintainability and Cost Rationale Report Manual, October XX, 2008

(http://www.acq.osd.mil/sse/dte/spec-studies.html)

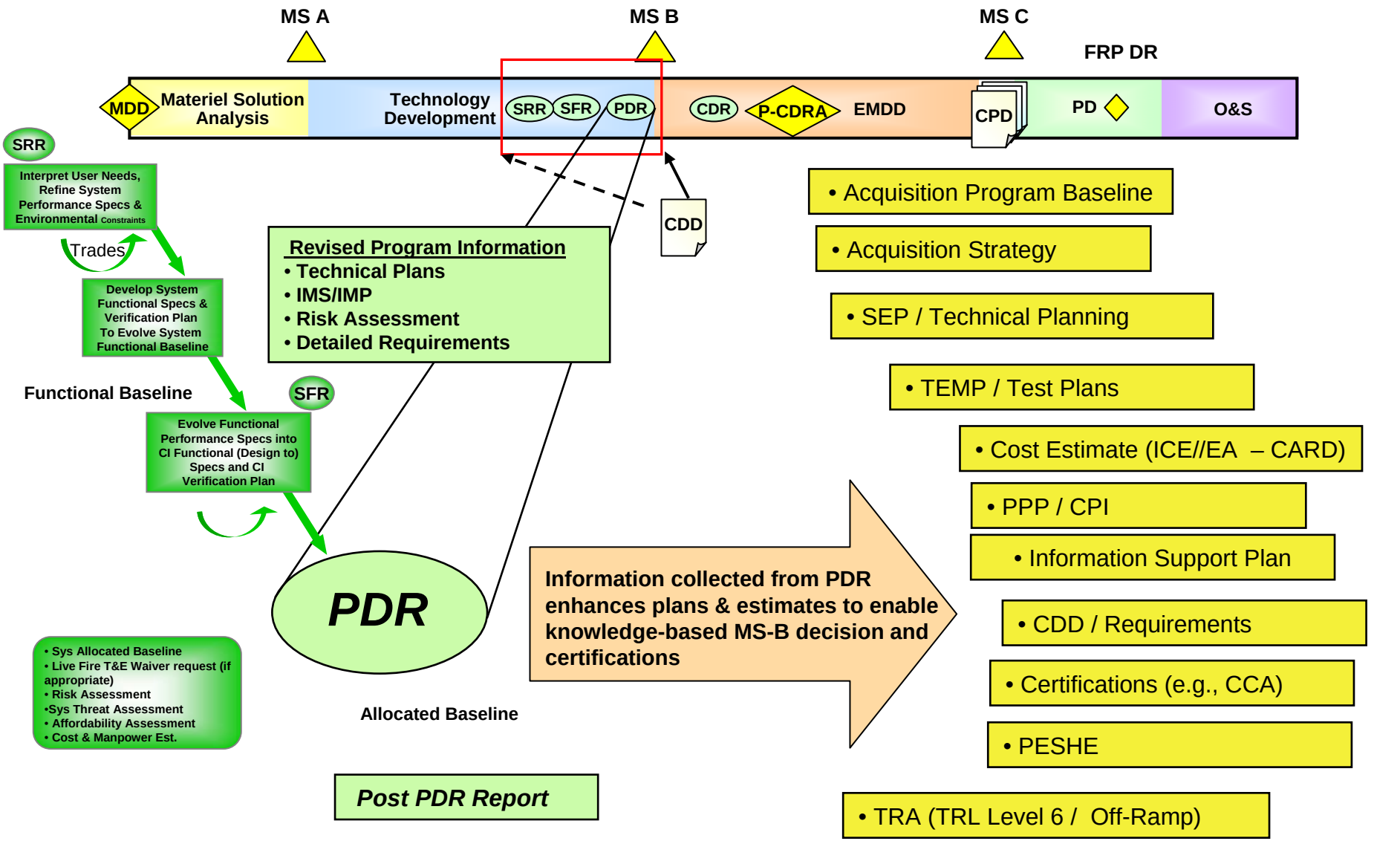
"Having performance is important, but not as important in most cases, as having reliability"

Life Cycle Logistics Flow (RAM)



RAM included in Systems Engineering Tech Reviews

Enhanced Role of PDR



PDR – "… in the right way"

- Certification and Accreditation activities scoped and identified
- Configuration Management Plan and procedures scoped and implemented
- Integrated Master Schedule showing Critical Path through Critical Design Review
- Software Development Plan scoped and documented at the Configuration Item level
- FMECA scheduled to support System Hazard Analysis
- Modeling and Simulation role in testing and life cycle planning scoped
- Representative mission profiles finalized

PDR – "… in the right way"

(Continued)

- Engineering data requirements needed from testing identified
- Data element identification procedures established – IDE procedures established
- Test Verification Matrix covering subsystem allocations
- Physical properties (i.e., weight, power, cooling, etc.) allocated to subsystems
- Human Systems Integration design standards flowed to subsystems
- R&M diagnostics addressed in design allocations
- Interface Control Documents between subsystems completed

PDR Report to MDA

DRAFT PDR Report Guidance to require the following:

- A comprehensive list of the systems engineering products that make up the Allocated Baseline, per the PDR review,
- A list of the participants in the review. including the independent (of the program) chair, applicable technical authorities, independent subject matter experts, membership of the Technical Review Board, and other key stakeholders,
- A summary of the Action Items and their closure status/plan
- A resulting risk assessment using a PDR risk assessment checklist and readiness to commit to full detail design,
- A recommendation from the PDR as to the approval of the program's system Allocated Baseline to support detail design.

Proposed Source: DAG para 4.3.2.4.2.3

Enhanced SE Provides key information for the MS B Decision

Enhanced SE contributes to key MS B prerequisites

- Acquisition Strategy (including core logistics analysis/source of repair; cooperative opportunity; etc.)
- Independent Cost Estimate
- Cost Analysis Requirements Description (CARD)
- Manpower estimate
- Acquisition Program Baseline
- Analysis of Alternatives
- System Threat Assessment
- Technology Readiness Assessment (TRA)
- Affordability Assessment
- Selected Acquisition Report (SAR)
- SEP, TEMP, Program Protection Plan, and PESHE
- Clinger-Cohan Act compliance

Enhanced SE Summary

Enhanced Systems Engineering is the lynchpin to start programs right!

- Early SE in support of MDD, MS A, and B
- SE activities in support of Technical Reviews and essential program planning efforts
- Implementing SE ….in the right way
  - Competitive Prototyping
  - Reliability, Availability, Maintainability – Cost implementation

"Implementing the right activities at the right time in the right way"

Defense Acquisition Guidebook (DAG) (http://akss.dau.mil/dag/)
The Systems Engineering Community of Practice (https://acc.dau.mil/CommunityBrowser.aspx?id=17608);

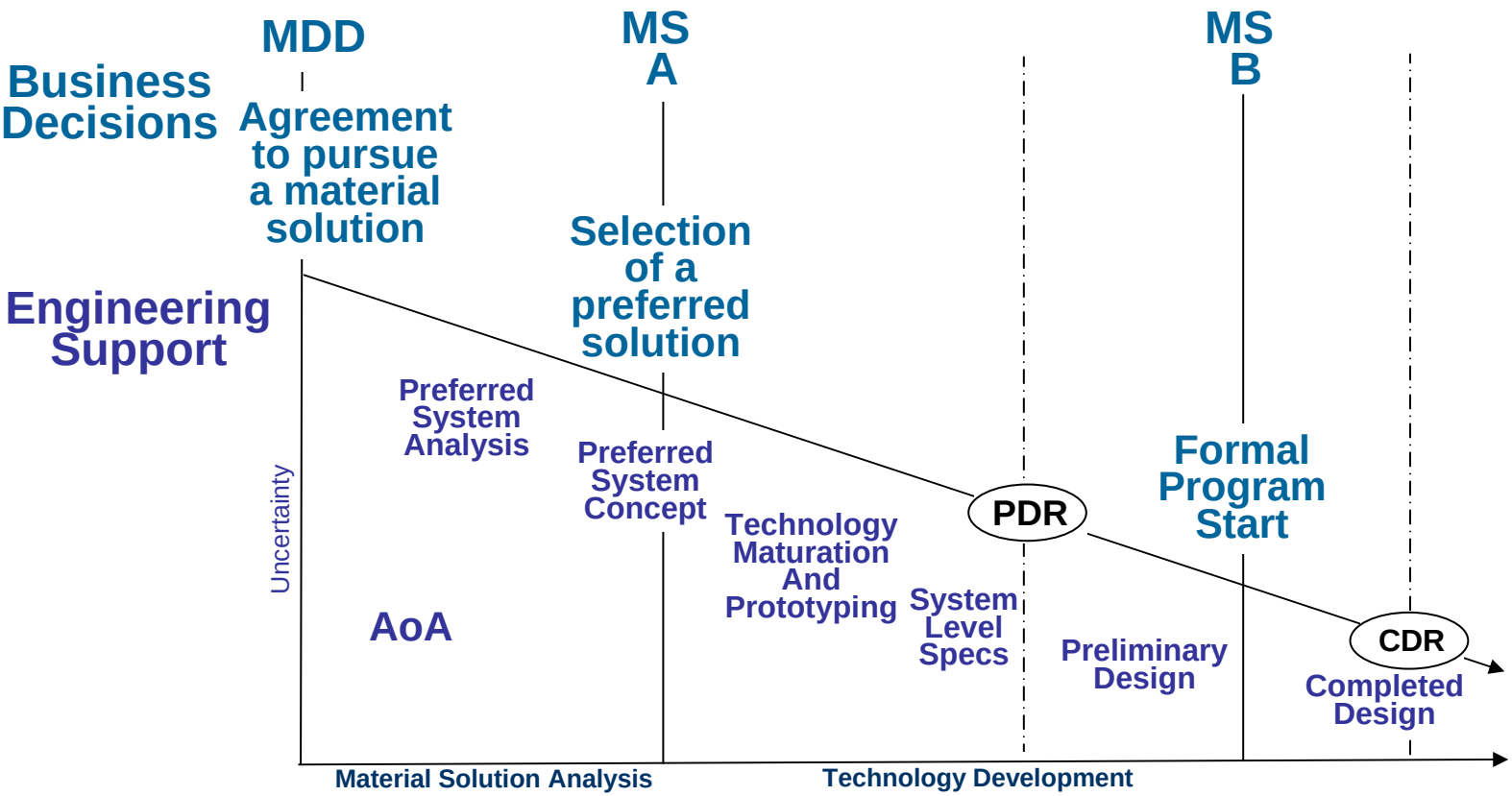
Systems and Software Engineering

Backup

RAM Improvement Efforts

- Some RAM Pitfalls to avoid when executing a sound systems engineering process include:
  - Inadequate planning for reliability and maintainability
  - Failure to identify mission context or intended use profile when stating RAM requirements
  - Failure to design-in reliability early
  - Reliance on predictions instead of design analysis
  - Inadequate lover level testing
  - Lack of proper planning, managing, and executing reliability growth activities, and
  - Lack of reliability incentives

SE Provides a Technical Foundation for Acquisition

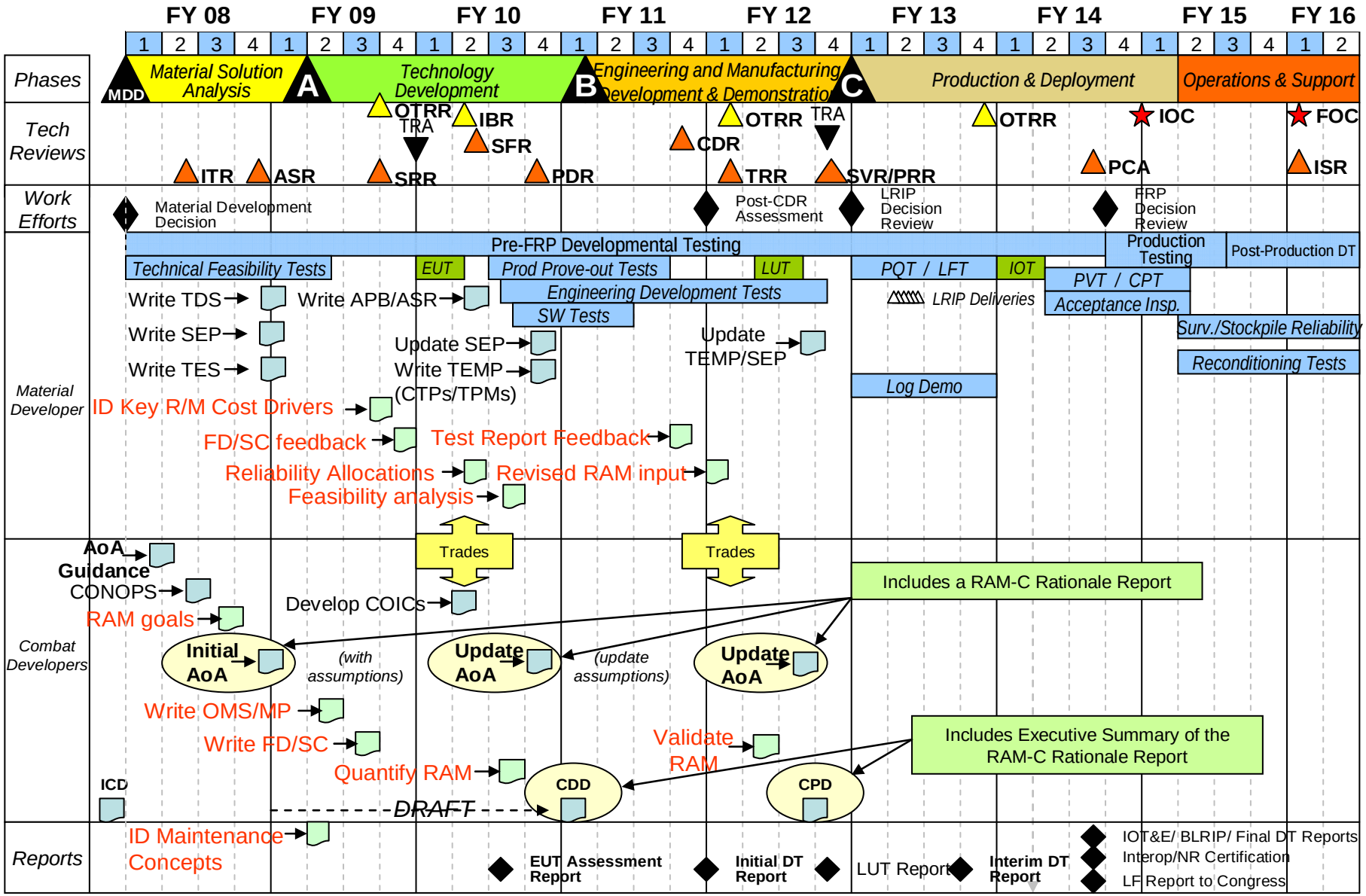


National Research Council

"Pre-Milestone A and Early-Phase Systems Engineering" Jan 2008

Systems Engineering is most effective when it initiated early to start a program right!

RAM-C Activities



Pre-Milestone B Sustainment Requirement Process