



Systems Engineering Technical Planning: Lessons Learned

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Outline

Technical Planning

- Establishing the Need and Urgency
- Recognizing the Stakeholders and Timing
- Understanding the Requirements



Top Five Systems Engineering Issues

- Lack of awareness of the importance, value, timing, accountability, and organizational structure of SE on programs
- Adequate, qualified resources are generally not available within government and industry for allocation on major programs
- Insufficient SE tools and environments to effectively execute SE on programs
- Poor initial program formulation
- Requirements definition, development, and management is not applied consistently and effectively

NDIA Study in January 2003



DoD Systems Engineering Shortfalls*

- Root cause of failures on acquisition programs include:
 - Inadequate understanding of requirements
 - Lack of systems engineering discipline, authority, and resources
 - Lack of technical planning and oversight
 - Stovepipe developments with late integration
 - Lack of subject matter expertise at the integration level
 - Availability of systems integration facilities
 - Incomplete, obsolete, or inflexible architectures
 - Low visibility of software risk
 - Technology maturity overestimated

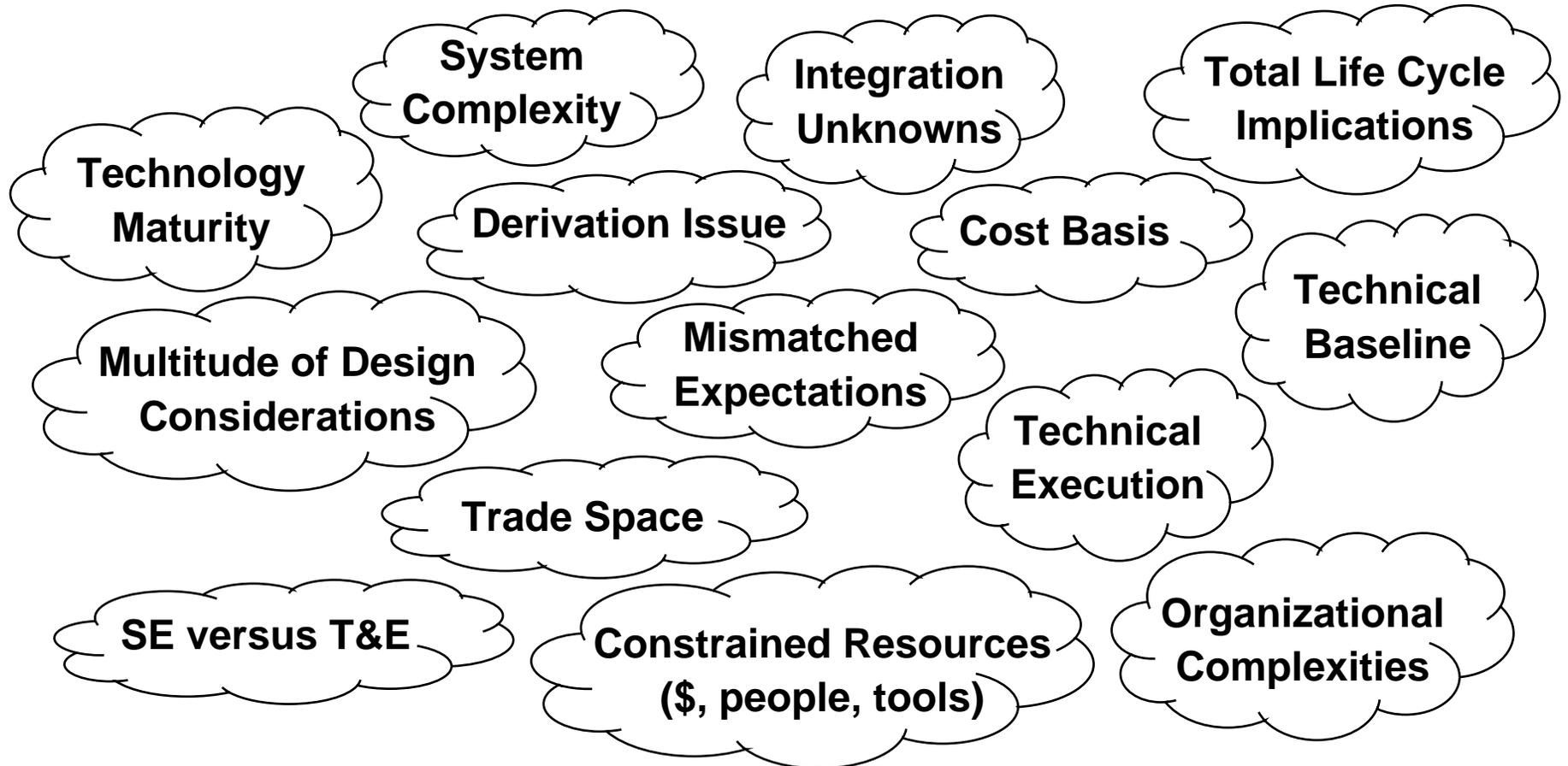
Major contributors to poor program performance



Why Plan?



Technical Planning Drivers



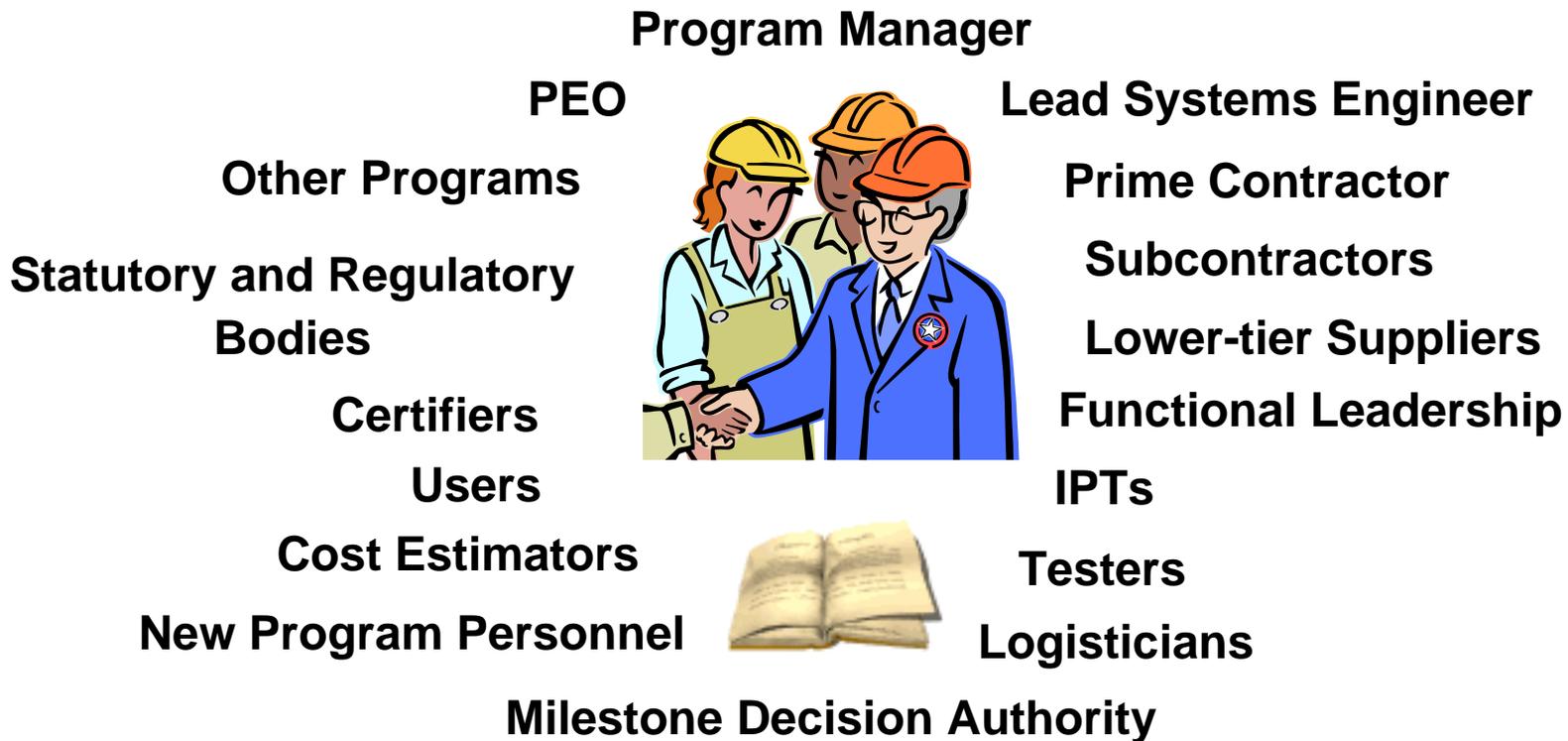
What does “SE” mean on your program?



Why Document the Plan?



SEP Stakeholders



A SEP Provides a Means for Collective Understanding Among All Stakeholders as to Program's Technical Approach



Driving Technical Rigor Back into Programs

“Importance and Criticality of the SEP”

- Program’s SEP provides insight into every aspect of a program’s technical plan, focusing on:
 - What are all the program requirements?
 - Who has responsibility and authority for managing technical issues— what is the staffing and organization to support the effort?
 - How will the technical baseline be managed and controlled?
 - What is the technical review process?
 - How is that technical effort linked to overall management of program?
- Living document with use, application, and updates clearly evident

The SEP is fundamental to technical and programmatic execution on a program



SEP Observations

- Descriptions vice plans
 - Regurgitated theory
 - Generic text, applicable to _____
 - Disconnected discussion
 - No numbers or specifics
 - No names
 - No timeframes or ordered relationships
- What
- How
- Why
- Where
- Who
- When
- Not reflective of known industry best practice
 - Technical baselines
 - Technical reviews
 - Entry criteria for technical reviews
 - Peer participation



Driving Technical Rigor Back Into Programs

“Emerging SEP Comments (First Drafts)”

(not systemic across all programs)

- Incomplete discussion of program requirements
 - Missing categories such as statutory, regulatory, or certifications
- Minimal discussion of program IPTs
 - Need to identify technical authority, lead systems engineer, and key stakeholders
 - Addresses part of SE organization, such as prime; no mention of government, subcontractors, or suppliers
- Incomplete technical baseline
 - How does the program go from CDD to product—traceability?
 - Linkage to EVM—not able to measure technical maturity via baselines
- Incomplete discussion of technical reviews
 - How many, for what (should tie to baselines and systems/subsystems/configuration items), and by whom (should tie to staffing)?
 - Lacking specific entry criteria
 - Peer reviews
- Integration with other management planning
 - Linkage with acquisition strategy, IMP, IMS, logistics, testing, and risk management
 - Schedule adequacy—success-oriented vice event-driven; schedule realism
 - Contracting for SE

**58 SEPs
reviewed
from 36
programs**

Compelling Need to Engage with Programs Early in Process



**When Should Technical
Planning Occur?**

Who Should do It?



Technical Planning Timeline

Milestone



- RFP Preparation
 - Acquirer's Technical Approach as Documented in Draft SEP
 - Written by Program Manager, Lead SE, Lead Tester, and Lead Logistician



- Source Selection
 - Offeror's Proposed Technical Approach based on Draft SEP
 - Evaluated by Source Selection Evaluation Board



- Post-Award Planning
 - Program Team's Technical Approach as Documented in Program SEP
 - Written by Program Manager, Lead SE, Lead Tester, and Lead Logistician from Government, Prime, Subs, and Suppliers

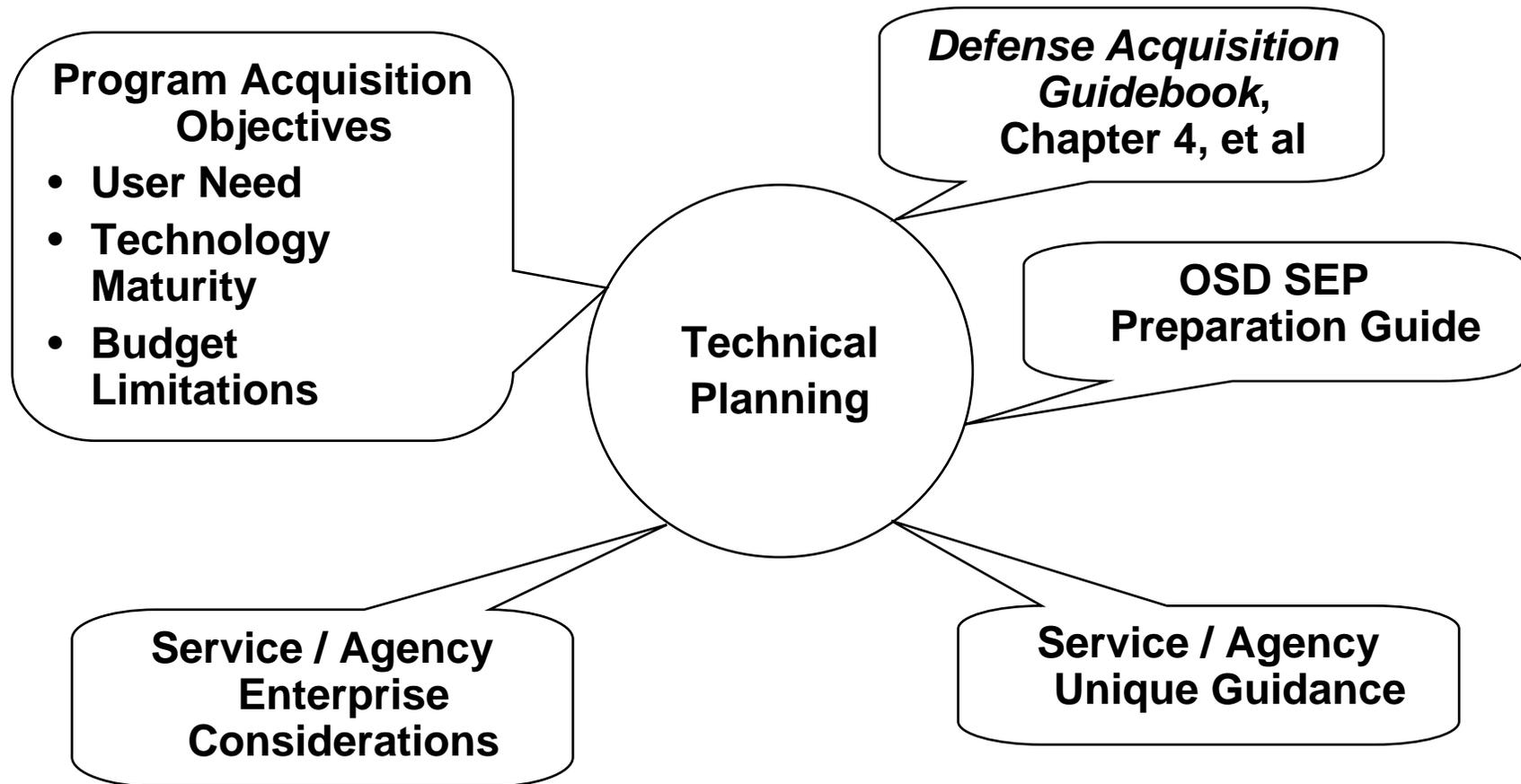


- Execution
 - Execute the Technical Approach
 - Updated by Program Team

A shared "vision" of SE on your program.



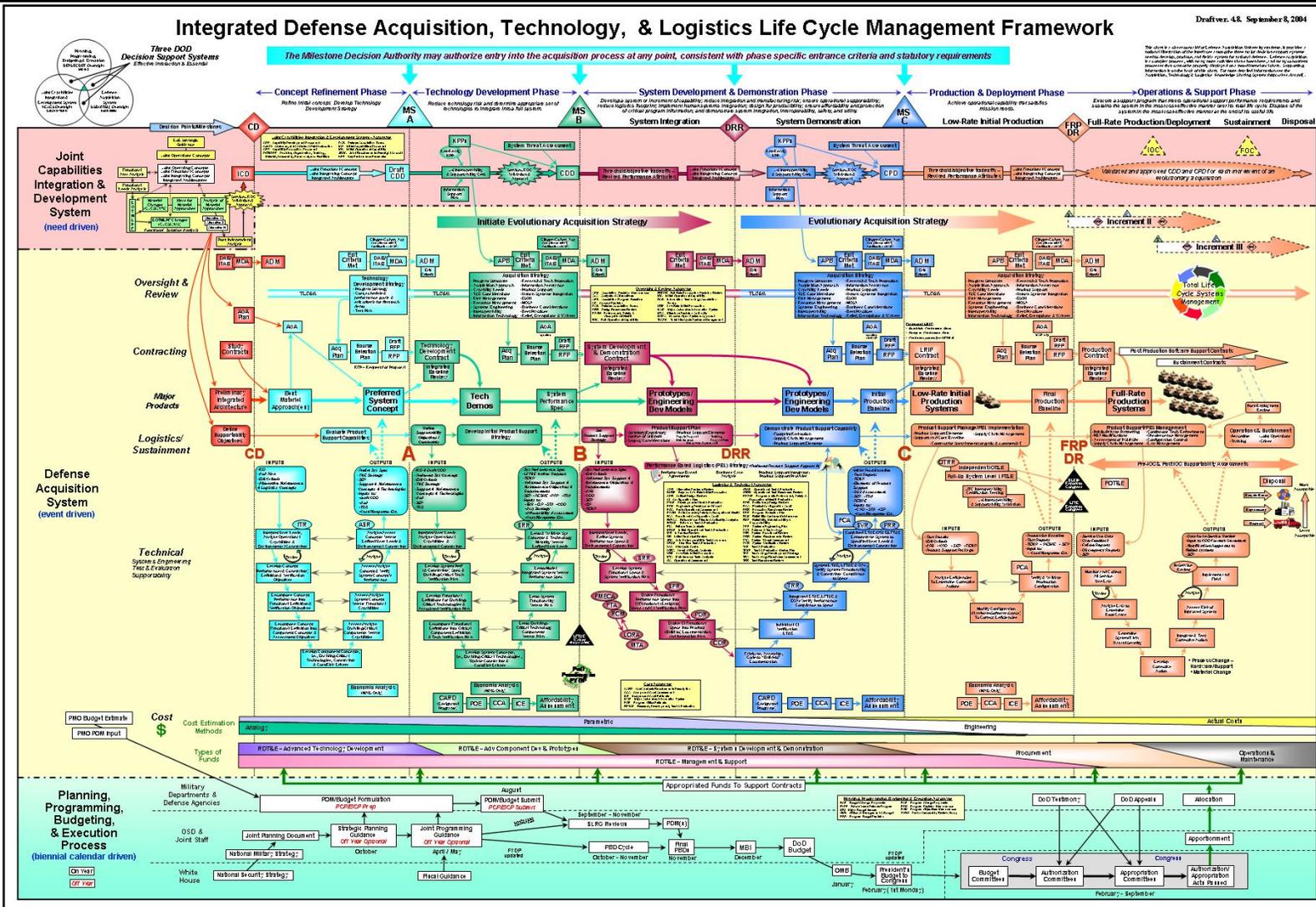
Technical Planning Considerations





SE in the System Life Cycle

"The Wall Chart"





SE in the *Defense Acquisition Guidebook*

- 4.1 SE in DoD Acquisition
- 4.2 SE Processes: How SE is Implemented
- 4.3 SE in the System Life Cycle
- 4.4 SE Decisions: Important Design Considerations
- 4.5 SE Execution: Key SE Tools and Techniques
- 4.6 SE Resources



Systems Engineering Plan Preparation Guide

- Program description, technical status, and approach for updating the SEP
- SE applied and tailored to life cycle phases
 - System capabilities, requirements, and associated design considerations to be addressed
 - SE organizational integration and technical authority
 - SE processes selected and rationale
 - Technical management and control, including technical baseline implementation / control and technical reviews planned
 - Integration with overall program management control efforts—linkage with other programmatic management efforts, such as acquisition strategy, integrated master planning and schedule, risk management, earned value management, and contract management

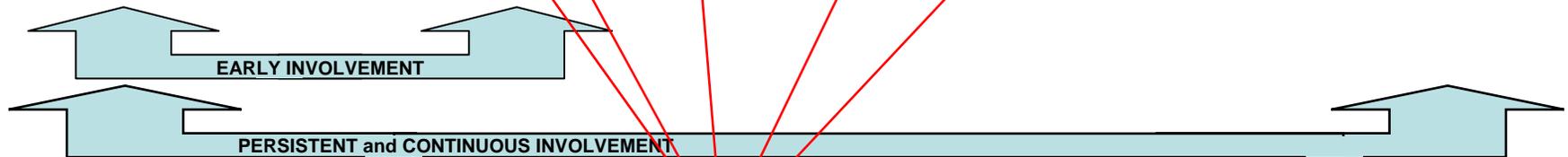
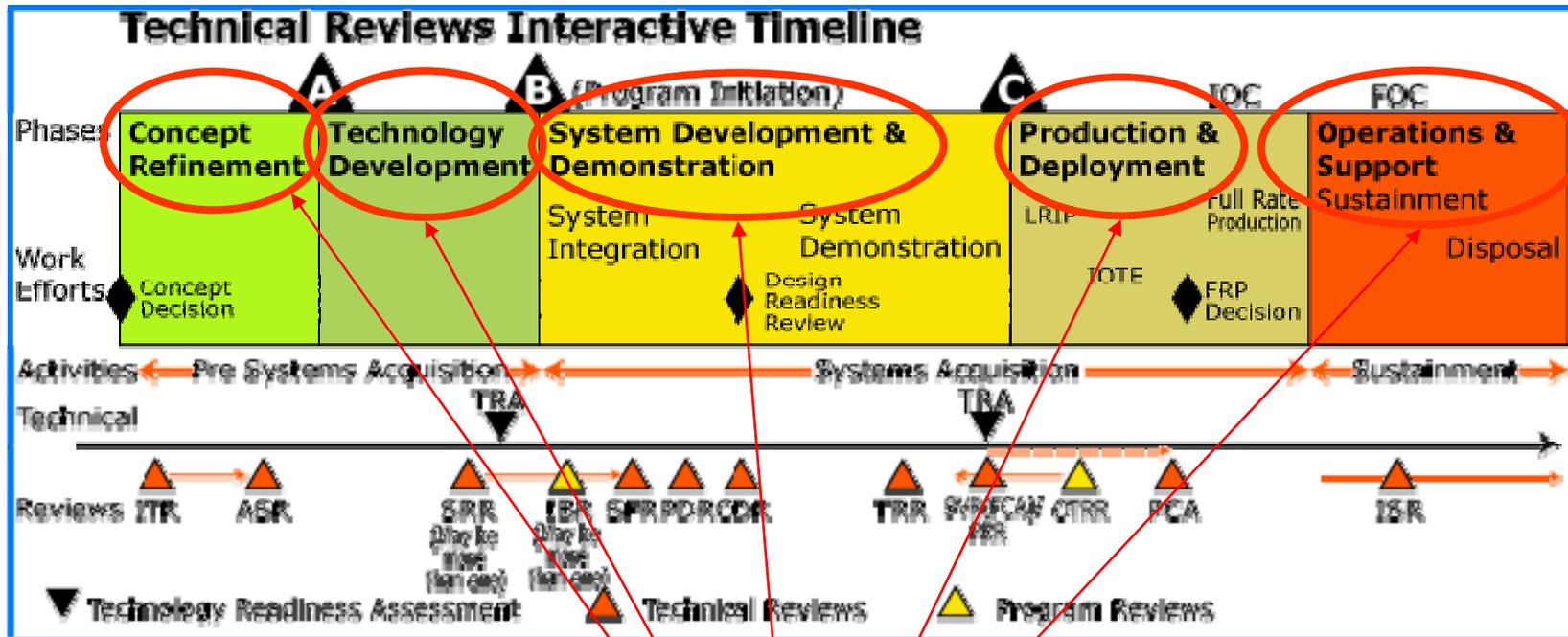
<http://www.acq.osd.mil/ds/se/index.html>



**What should be addressed
in a sound technical plan
for a program?**



Scope of Technical Planning



Sound technical planning is needed in EVERY acquisition phase

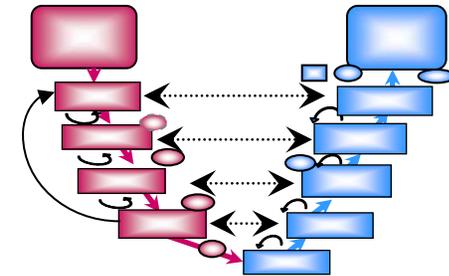


SE in the System Life Cycle

Defense Acquisition Guidebook

Chapter 4, Section 4.3

- By phase consideration of SE activities
 - Purpose of SE in the phase
 - Inputs to the SE process
 - Key SE activities during the phase
 - Technical reviews during the phase
 - Outputs of the phase's SE process
- Full life cycle coverage from Concept Refinement through Operations and Support





Driving Technical Rigor Back Into Programs

SEP Focus Areas for Milestone B

- Program Requirements
 - Capabilities, CONOPS, KPPs
 - Statutory/regulatory
 - Specified/derived performance
 - Certifications
 - Design considerations
- Technical Staffing/Organization
 - Technical authority
 - Lead Systems Engineer
 - IPT coordination
 - IPT organization
 - Organizational depth
- Technical Baseline Management
 - Who is responsible
 - Definition of baselines
 - Requirements traceability
 - Specification tree and WBS link
 - Technical maturity and risk
- Technical Review Planning
 - Event-driven reviews
 - Management of reviews
 - Technical authority chair
 - Key stakeholder participation
 - Peer participation
- Integration with Overall Management of the Program
 - Linkage with other program plans
 - Program manager's role in technical reviews
 - Risk management integration
 - Test and logistics integration
 - Contracting considerations



**How would technical planning
need to change to
accommodate programs Pre-
Milestone B and Post-
Milestone C?**



Driving Technical Rigor Back Into Programs

SEP Focus Areas for Milestone A

- Program Requirements
 - **Desired capabilities; required attributes**
 - **Potential statutory/regulatory, specified/derived performance, certifications, design considerations**
 - **Enabling technologies**
 - **Cost/schedule constraints**
 - **Future planning**
- Technical Staffing/Organization
 - Technical authority
 - Lead Systems Engineer
 - **SE role in TD IPT**
 - IPT organization and coordination
 - Organizational depth
- Technical Baseline Management
 - Who is responsible
 - Definition of baselines
 - **ICD/CDD traceability**
 - Technical maturity and risk
- Technical Review Planning
 - Event-driven reviews
 - Management of reviews
 - Technical authority chair
 - Key stakeholder participation
 - Peer participation
- Integration with Overall Management of the Program
 - Linkage with other program plans
 - Program manager's role in technical reviews
 - Risk management integration
 - Test and support strategy
 - Contracting considerations



Driving Technical Rigor Back Into Programs

SEP Focus Areas for Milestone C

- Program Requirements
 - **Technical surveillance approach**
 - **Tracking of actual vs. planned usage**
 - **Monitoring of system hazards, risks, certifications**
 - **Tracking of usage, corrosion-related maintenance and repair costs, and total ownership costs**
 - **Management of configuration changes and incremental modifications**
- Technical Staffing/Organization
 - Technical authority
 - Lead Systems Engineer
 - **Coordination of sustaining engineering with operational, maintenance, and repair domains**
 - **Sustaining support organization**
 - Organizational depth
- Technical Baseline Management
 - Who is responsible
 - Definition of baseline management
 - **Requirements and certification traceability and verification of changes**
 - Specification tree and WBS link
 - **Tracking of operational hazard risk against baseline**
- Technical Review Planning
 - **In-service reviews**
 - Management of reviews
 - Technical authority chair
 - Key stakeholder participation
 - Peer participation
- Integration with Program Management
 - **Linkage with overall sustainment**
 - **Program manager's role in in-service reviews**
 - Risk management integration
 - Logistics integration
 - Contracting considerations



Coordination and Approval Mechanics

- For ACAT ID and IAM programs, SEP is submitted to MDA:
 - By appropriate Component Acquisition Executive (CAE) or designated representative,
 - Not later than 30 days prior to milestone decision point or subsequent program initiation if PM must have an OSD-approved document by the decision date, and
 - Through the appropriate OUSD(AT&L) Defense Systems, Systems Engineering, Assessments and Support (OUSD(AT&L) DS/SE/AS) Program Support Team Lead (PSTL), who will forward SEP to appropriate Overarching Integrated Product Team (OIPT) leader for endorsement to MDA
- For non-ACAT ID or IAM (i.e., ACAT IC, II, III):
 - Component MDA will designate SEP approval authority and prescribe submittal instructions



Summary

- Sound technical planning is fundamental to program success
- A well-written, comprehensive SEP enables collective understanding of the program's technical approach across all program stakeholders

***“In preparing for battle I have always found that plans are useless, but planning is indispensable.”
Dwight D. Eisenhower***



BACK-UP



Technical Planning Area 1

- Program Requirements
 - Capabilities, CONOPS, KPPs
 - Statutory/regulatory
 - Specified/derived performance
 - Certifications
 - Design considerations



Capabilities, CONOPS, KPPs

- Most programs have KPPs, then what?
- What is the plan for how they will be managed?, Tested-to, traded against other requirements?
- How are they captured, analyzed, decomposed, and allocated?
- Who is responsible for the above?
- Who are the stakeholders?



Statutory/Regulatory

- What are all of the statutory and regulatory requirements?
- What is the plan for capturing and managing this set of requirements?
- Beyond the statutes and regulations themselves, how are the specific requirements identified, analyzed, decomposed, and allocated?
- How are these requirements to be managed in an integrated framework with KPPs, etc.
- Who is responsible for the above?
- Who are the stakeholders?



Specified/Derived Performance

- What is the plan for managing and integrating the totality of specified performance (per the applicable system spec or performance spec)?
- Who is responsible for derivation, decomposition, and allocation of requirements?
- What tools will be used and what organizational elements are responsible for ensuring requirements traceability?
- How will the program ensure that these requirements are managed across contractual boundaries (subsystem suppliers)?



Certifications

- What are all of the certifications to which the program is subject? How does the program ensure that all applicable certification are identified?
- Who are the stakeholder organizations responsible for certification requirements?
- How will the program ensure that all of the certification requirements find their way into the integrated set of requirements?
- How are the respective certification processes integrated with the program's own design, development, and test approach?



Design Considerations

- What is the program's approach to addressing and managing the ever-growing list of potentially applicable design considerations?
- How are these requirements integrated with the other requirements (both specified and derived)?
- Who is responsible for addressing these requirements that span a broad range of domains and subject matter areas?
- How will technical budgets be established, allocated, and managed (reliability, weight, etc.)?



Technical Planning Area 2

- Technical Staffing/Organization
 - Technical authority
 - Lead Systems Engineer
 - IPT organization
 - IPT coordination
 - Organizational depth



Technical Authority

- What technical authority (functional leads) is implied from the integrated set of Requirements (KPPs, statutory, regulatory, specified, certification, design considerations)?
- What organizations will be supporting the program in the role of technical authority?
- How will the program leverage tech authority resources and balance the need to support with the budgetary constraints?
- What is the program's approach to integrating technical authority on the appropriate IPTs?



Lead Systems Engineer

- Does the program have a lead systems engineer? Who is this person and how do they interact with SE technical authority?
- What is the LSE's role and authority on the program relative to SE processes and products (technical reviews, technical baselines, etc)?
- How will the LSE and the PM coordinate in technical management?
- What is the plan for how the LSE will manage SE activities vertically and horizontally across IPTs?



IPT Organization

- What is the program's approach to the IPT structure?
- How does the IPT structure relate to the program's products?
- What is the program's plan for alignment of the WBS with the IPT structure?
- How are the IPTs populated to integrate all stakeholders (users, developers, testers, technical authority, and design considerations)



IPT Coordination

- How are the systems engineering processes managed and controlled across the IPTs?
- How are the systems engineering products (requirements and technical baselines) managed and controlled across the IPTs?
- If there are functional as well as product IPTs, what is the program's approach to the respective roles?
- How does the program's IPT structure and operation provide for system integration?



Organizational Depth

- Does the SEP address overall organization of Government and contractor systems engineering tasks, activities, and responsibilities (requirements, technical baseline, technical reviews, etc) from prime contractor down to lowest level supplier?
- If a part of system-of-systems or family-of-systems, what is the interaction with higher and peer organizations and authorities regarding design trades?



Technical Planning Area 3

- Technical Baseline Management
 - Who is responsible
 - Definition of baselines
 - Requirements traceability
 - Specification tree and WBS link
 - Technical maturity



Who is Responsible?

- What is the program's approach to overall management of the technical baselines? Who are the participants across the program?
- How does this approach relate to the roles and responsibilities of the lead systems engineer, the IPT leads, and any functional IPTs assigned for requirements management?
- What is the plan for technical baseline management across IPTs and across the program office, prime, and sub-suppliers?



Definition of Baselines

- What is the program's approach to utilization of technical baselines as a technical management tool?
- How are technical baselines used to across the domains of functional, allocated, and product attributes?
- What is the program's approach to these baselines relative to the WBS? EVM? TPMs?
- How is the program using technical reviews to manage the technical baselines and assess technical maturity and risk?



Requirements Traceability

- How are requirements (KPP, statutory, regulatory, specified, derived, certification, design considerations, etc) tracked from source to (and throughout) the program technical baseline and specification tree?
 - What is the program’s plan to ensure that there are no “orphan” or “childless” requirements?
 - What tools will be used and by whom?
- Is this traceability addressed in the requirements management and configuration management planning?
- Does the traceability extend to the verification and validation requirements and planning?



Specification Tree and WBS Link

- What is the program's WBS and how does it relate to the end item configuration?
 - Is the plan reflective of an understanding as to how many CIs are planned?
 - What is the program's approach to technical baseline specifications (system spec(s), functional spec(s), subsystem specs(s), design spec(s) and is there alignment between the WBS and the planned technical baselines (specs)?
- What is the program's approach to managing against the WBS across contractual boundaries?
- How does the program plan to use the WBS and the specifications as a technical management tool across the SE tasks?
- What is the program's approach down to the CI level?



Technical Maturity

- What is the program's plan to measure technical maturity (as opposed to TPM tracking)?
- How is the program using the SE products of the technical baseline (functional, allocated, and product) to gauge technical maturity?
- Who is involved in this assessment from a stakeholder perspective?
- Has the program established maturity criteria and what is the plan for application of these criteria across the WBS and down to the CI level?



Technical Planning Area 4

- Technical Review Planning
 - Event-driven reviews
 - Management of reviews
 - Technical authority chair
 - Key stakeholder participation
 - Peer participation



Event-driven Reviews

- What is the program's approach to executing event-driven reviews?
 - Are best practice criteria being applied?
 - Is technical authority being engaged to develop criteria for specific reviews and who will assess readiness for the conduct of the review?
 - How many?
 - For what?
- Is the timing of the reviews in program plan reflective of the achievable technical maturity required (per best practice) for the review?
- What is the program's plan for ensuring that reviews are event vice schedule driven?



Management of Reviews

- What is the program's approach for oversight and conduct of all technical reviews?
- Who is responsible?
- How is technical authority involved / engaged?
- How is the program planning to ensure that technical products subject to the review are available prior and to the appropriate stakeholders?
- What is the plan for integrating the outcomes of the technical reviews into the program's plan forward?



Technical Authority Chair

- What is the program's approach to chairing of technical reviews?
- How will the program ensure that reviews are conducted to "best practice"?
- How is technical authority to be engaged and what is the approach for system-level and subsystem-level reviews?
- How will the program manager, lead systems engineer, and technical authority collaborate?



Key Stakeholder Participation

- What is the program's approach to attendance at reviews?
- What is the plan to ensure that stakeholders are involved at key decision points? Example: airworthiness certifiers at technical reviews)
- Are Users, Testers, and Logisticians involved in the execution of systems engineering?
- Are representative offices from "design considerations" areas involved?
- How is the program office reconciling resource realities with these technical needs?



Peer Participation

- What is the program's approach to addressing "peer" of third party insight to the program?
- Who are these peers and from where will they be attained?
- Are there provisions for cross-talk at the peer level at key points such as the technical reviews?
- What is the program's approach to the areas (subject matter areas) that peer insight is most critical?
- Peer participation at the SE leadership level? Beyond?



Technical Planning Area 5

- Integration with Overall Management of the Program
 - Linkage with other program plans
 - Program manager's role in technical reviews
 - Risk management integration
 - Test and logistics integration
 - Contracting considerations



Linkage with Other Program Plans

- What is the program's approach to linking and integrating SE (technical management) with other management efforts?
- Was the SEP the basis for the IMP/IMS?
- Was the IMS the basis for the IBR/cost account/EVM approach?
- Were the technical baselines (across the WBS) incorporated as products in EVM?
- Are the technical review risk assessments treated as inputs to the risk management approach?
- Is the independent cost estimate based on systems engineering?
- Does the PM's program management plan use SE as the technical management arm?



Program Manager's Role in Reviews

- Is the SEP indicative of the PM using the technical reviews as a technical product to him/her?
- Is the PM (acquirer and supplier) to be an active participant on the technical review board?
- Is the program manager planning to self-chair technical reviews?



Risk Management Integration

- How are risk and systems engineering linked in the program planning?
- Does the SEP reflect strong linkages between the technical reviews and the program's risk assessment process (i.e. risks of successful completion of the next technical review)?
- Does the plan reflect the decision-making process necessary to mitigate risks?
- Does the risk management plan refer to the SEP at an operational planning level?



Test and Logistics Integration

- What is the program's approach to integration of the T&E communities in the SE process?
- Are the verification and validation plans part of the technical baselines?
- Is supportability and the support systems part of the technical baseline?
- Are the testers and logisticians involved in the technical reviews?
- Does the TEMP and ILSP align with the SEP?



Contracting Considerations

- Are there provisions in the contract to incentivize best systems engineering practices as applied on the program?
- Are technical reviews used as a basis for progress payments? (BAD)
- Are there provisions in the prime and sub-supplier contracts for the execution of technical management across contractual boundaries (SE processes and products extend across the team)?
- Is systems engineering treated in the contract as an integral part of the development or as an overhead function with no product?
- Has the supplier's systems engineering approach been "piecemealed" or "edited" to remove seemingly non-value-added work?