Headquarters U.S. Air Force

Integrity - Service - Excellence

USAF Implementation of Recommendations from National Research Council "Pre-Milestone A and Early-Phase Systems Engineering" Study Committee

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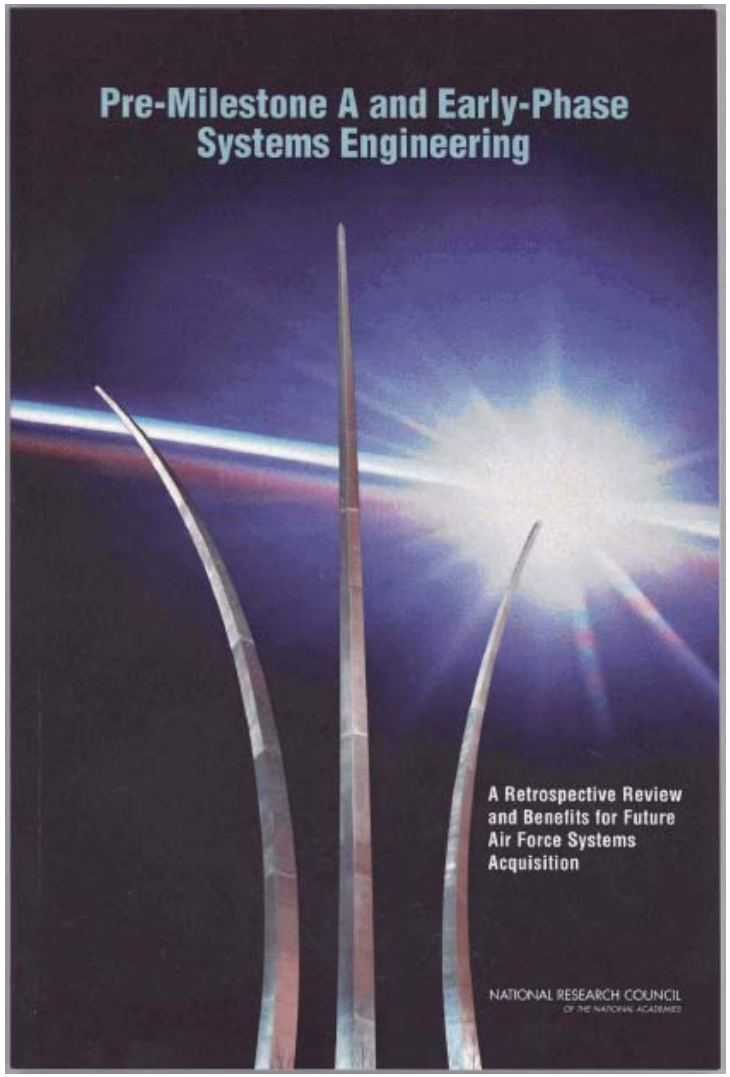
NRC Study Committee Report



"Pre-Milestone A and Early-Phase Systems Engineering: A Retrospective Review and Benefits for Future Air Force Systems Acquisition"

December 2007

http://books.nap.edu/catalog.php?record_id=12065

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Findings and Recommendations

- **Finding #1**

  Attention to a few critical systems engineering processes and functions particularly during preparation for Milestones A and B is essential to ensuring that Air Force acquisition programs deliver products on time and on budget.

- **Recommendation #1**

  Air Force leadership should require that Milestones A and B be treated as critical milestones in every acquisition program and that … the "Pre-Milestone A/B Checklist" … be used to judge successful completion.

Findings and Recommendations

- **Finding #2**

  Creating a robust SE process requires experienced SEs with domain knowledge

- **Recommendation #2**

  Assess career field needs and develop a program to address

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Implementation Approach - 2

- Established Program Systems Engineer (PSE) shred under SPRDE
- Active engagement with SPRDE FIPT to influence DAU STM courses
  - Subject matter focus has been realigned
  - Provide additional emphasis on technology transition techniques and tools
- Provided 70+ SMEs to support competency assessments
- "Science, Mathematics, & Research for Transformation" (SMART) –funded by OSD; managed by NPS and ASEE
  - Akin to an undergraduate co-op program
  - Also used to provide opportunities for graduate students
  - Trying to change to automatic hire after award of degree rather than having to compete

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Implementation Approach - 2 Organic S&E Development

- **Update Apr 01 S&E Strategic Plan**

Current & Future Requirements	Goal Areas
Recruitment and retention initiatives	Math
	S&T
Education and training	Acquisition
Individual growth paths	Test
Awards and recognition	Sustainment

- **NRC STEM Study (kicked off Aug 08; 15-month duration)**
  - **Determine STEM needs of 26 functionals**
  - **Fold recommended implementation strategy into S&E Strategic Plan update**
- **RAND S&E Study (SAF/AQXD initiated)**
  - **Estimating changes in S&E skills for emerging technical needs**
  - **Two time horizons: near term (5 years), mid-term (10-15+ years)**

Findings and Recommendations

- **Finding #3**

  Government, FFRDCs, and industry all have important roles throughout the life cycle

- **Recommendation #3**

  Pre-A decisions should be supported by rigorous SE processes and analyses involving teams of acquirers, users, and industry

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Implementation Approach – 3 Continuous Capability Planning

- **Informed Time-Phased Requirements Development (ITPRD)**
  - **Identify sponsoring MAJCOM personnel for collaborative requirements development**
  - **Insert acquisition (AFMC/AFSPC/AFRL) personnel into pre-MS/KDP-A/B process far enough in advance of the HPT to absorb context of program, execute SE processes, and affect content of KPP/KSAs and requirements that go into AoA planning and ICD/CDD/etc.**
- **Life Cycle Risk Management**
  - **Comprehensive definition of risk and risk management; should begin at the earliest stages of capability/program planning (pre-MS/KDP-A capability planning effects), and continue throughout the total life cycle of the program**
- **Modeling, Simulation, and Analysis**

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Implementation Approach – 3 Life Cycle Management

- **High-Confidence Criteria**
  - **Strategy should document multiple, viable trade space options for cost, schedule, capability-based performance requirements and technology**
  - **Strategy should support proper phasing/synchronization of requirements with on- and off-ramps**
  - **Requirements prioritized and properly time phased (cost/schedule)**
  - **Pre-M/S-B Risk Management plans complete, accurate, current and being followed**

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Implementation Approach – 3 Technology Development

- **Technology Development and Transition Strategy**
  - **Extends the scope of quantitative criteria beyond TRLs**
  - **Includes broader processes and cross-command forums to improve the rigor of early SE and contribute to "doable" requirements**
  - **Increases the probability that highest-priority shortfalls/gaps are addressed**
  - **Results in closer alignment between technology investments and system / capability needs**
- **Transition Stage-Gating**
  - **Provides a CONOPS for total technology insertion into the Acquisition & Sustainment Plan**

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Implementation Approach – 3 Technology Transition

- AF Tech Transition Office (TTO) continues support to JCTD, QRF, TTI and other Tech Transition programs
- Tech Transition Program Initiative funded in FY10 POM ($10M/yr)
  - Hardware prototyping
  - Bridge funding from Tech Demo to Program POM
  - Enterprise interface management / configuration control
- Developing R&D Strategic Framework to coordinate AF policy, programs and processes to transition technology through 6.1-6.8 to new program of record or change to existing program

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Findings and Recommendations

- **Finding #4**

  The organic development planning function that applied pre-A SE to a number of successful programs was allowed to lapse

- **Recommendation #4**

  A development planning function should be established in the military departments to coordinate the concept development and refinement phase of all acquisition programs to ensure that the capabilities … as a whole are considered and that unifying strategies such as … interoperability are addressed.

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Implementation Approach - 4

- **Secured FY10 POM funding ($37M/yr) for new PE for Requirements Analysis & Maturation (RAM) ("Development Planning")**
- **Concept Development**
- **Requirements Analysis Support**
- **Establishing DP/RAM governance structure; single point of entry for MAJCOM DP requests**
- **Early SE Guide to be published 4Q CY08**
- **Institutionalize CCTD and ConSEP in policy**

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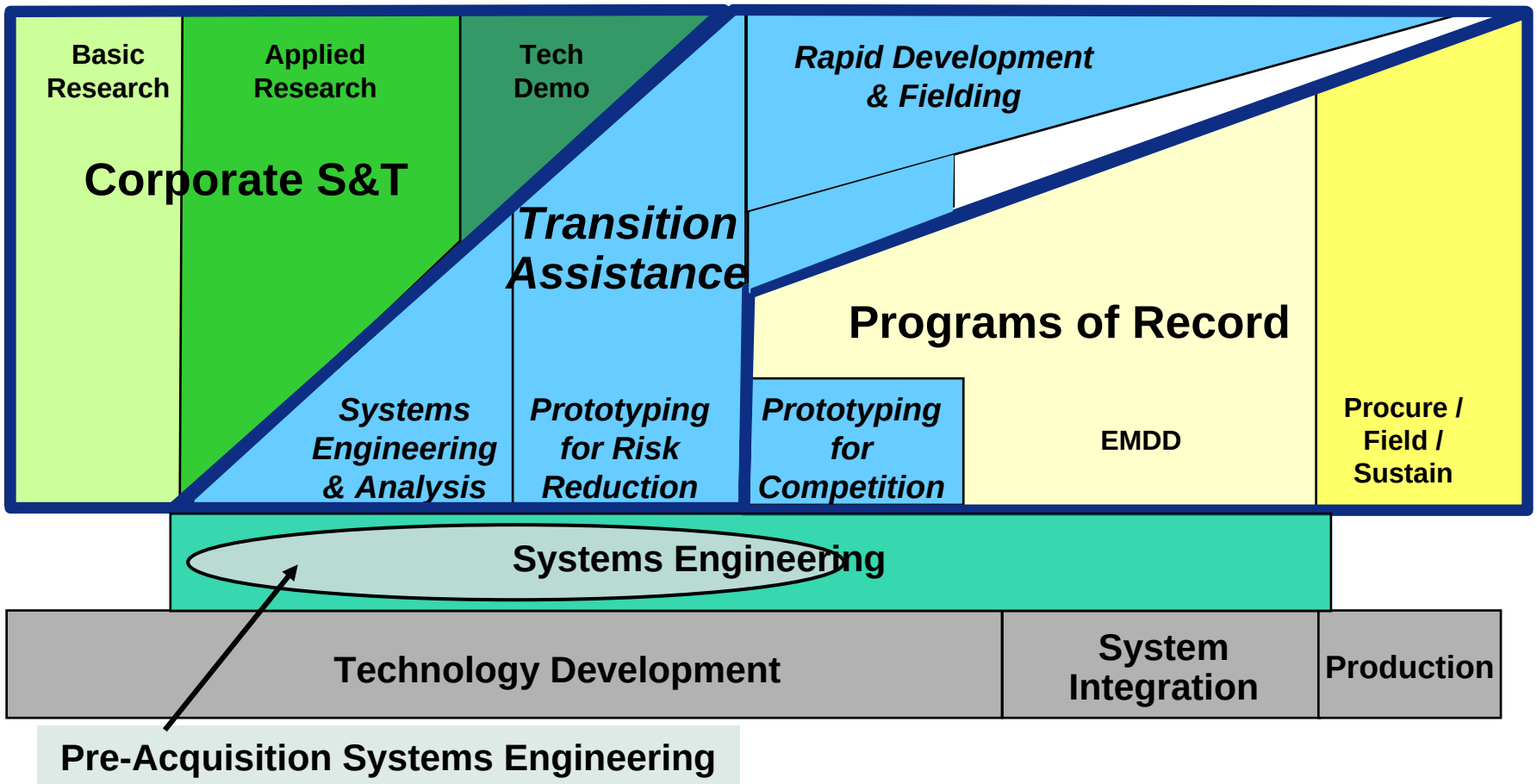
Implementation Approach – 4
RD&E Investment Framework

Transition Assistance -- filling the "Valley of Death"



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Implementation Approach - 1

- Checklist identifies 20 items in 7 principal areas
- Coverage for 16 of 20 exists in current policy and guidance
- Conducted informal order-of-magnitude assessment of current compliance across practitioner community
- In process of identifying process owners and key linkages for each item needing action

Checklist – Concept Development

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		CURRENT PROCESS	SUPPORTING DOCUMENTATION	PROCESS OWNER(S)	OPR(S)	KEY LINKAGE(S)
1	**Have at least two alternative concepts been evaluated?**	AoA policy in AFI 10-601	• PASEP (pre-AoA) • ASC process (post-AoA) • Early SE Guide	• OAS, A2/5 • AQR, AFMC/EN	Center XRs	• AoA and DP • ESE guide • SoS stds / practices
2	**Can an initial capability be achieved within ~5 years from MS/KDP B? If not, can critical subsystems (or a key subset) be demonstrated within that timeframe?**	New MAIS programs now require IOC within 5 years of MS A, per FY08 NDAA Section 811. No rqmt for non-MAIS programs.	• Concept SEP (ConSEP) • Transition Plan • 5000.2 update (PDR ahead of MS B)	A2/5 for DP/RAM and attestation process	Center XRs	• DT&E initiative • Risk Assessment • Cost estimating • Other enduring/ std processes • CCP Guide
3	**Will high-risk new technologies have been matured prior to MS/KDP B? If not, is the risk mitigation plan adequate?**	10 USC 2366a requires TRL ~6 (defined by AF Policy Memo) at MS B	• Transition Plan • ConSEP • Competition & prototyping (Young memo, 5000.2 update)	• A2/5 • DP efforts and process leading to acq strategies	Center XRs with AFRL	• TD initiatives (RI3, TDTS) • CCP Guide
4	**Have external interface complexities (incl. dependencies on other programs) been identified and minimized? Is there a plan to mitigate risks?**	Part of JCIDS process; SoS SE guide	• Concept Characterization & Technical Description (CCTD) • CCP process for developing options • SoS engr (in Early SE Guide)	• AQR Guidance Memo mandates CCTD • A2/5 – process for developing option sets • AQR, AFMC/EN	Center XRs	• Early SE Guide • CCP Guide • AFMC/EN SoS eng practices • All enduring processes incl analysis • TD (RI3)

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Checklist – KPPs and CONOPS

		CURRENT PROCESS	SUPPORTING DOCUMENTATION	PROCESS OWNER(S)	OPR(S)	KEY LINKAGE(S)
5	**At MS/KDP A, have KPPs been identified in clear, comprehensive, concise, understandable terms?**	AFI 10-601 (JCIDS implementation) (at early stages, MOEs are more appropriate than solution-focused KPPs)	• ConSEP • CCTD • I-CDD (to support system rqmts refinement and PDR prior to MS B)	• AFMC/CC attestation point • DP/RAM process	Center XRs	• ITPRD initiative • Attestation process • SE activities • LCM
6	**At MS/KDP B, are major system-level requirements (including all KPPs) sufficiently well defined to provide a stable basis for system development?**	AFI 10-601 (JCIDS implementation) (at early stages, MOEs are more appropriate than solution-focused KPPs)	•ConSEP •CCTD •CDD	AFMC/CC attestation process	SPM and center XRs	• DT&E initiative • All enduring processes including analysis • LCM
7	**Has a CONOPS been developed showing that system operation can handle expected throughput and meet response time requirements?**		• ConSEP • CCTD • I-CDD	A2/5 DP/RAM process	SPM and center XRs	• Analysis framework • SoS practices and standards • Early SE – all enduring processes

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Checklist – Cost & Schedule, Performance Assessment

COST & SCHEDULE SCOPING						
8	**Are major cost and schedule drivers and risks explicitly identified, and is there a plan to track and reduce uncertainty?**	• Evaluated within JROC process per JROCM 06-261. • Part of Acq strategy	Pre-A • ConSEP • Transition Plan Pre-B • SEP • RMP	• A2/5 for DP/RAM • Individual process owners for risk & cost assessment	SPM and center XRs depending on phase	• Early SE • Risk and integrated assessments • Other std/enduring processes
9	**Have principal stakeholders accepted the confidence level (risk assessment) associated with cost estimates?**	Cost Estimating policy & guidance (POE, ICE, etc.)	• CCTD • SEP • RMP	• Risk process (ACE-AFMC/EN) • Sufficiency Rvw (best of breed from Risk Team) • CE methodology	SPM and center XR depending on effort/phase	• Risk process • Cost estimating methodology
PERFORMANCE ASSESSMENT						
10	**Are models and simulations adequate and appropriate to validate the selected concept and CONOPS against the KPPs?**	• Operational Context rather than "CONOPS" per se • MOEs at earliest "checkpoints"	•ConSEP •CCTD •SEP	• A2/5 (DP); M&S owner as enabler • A2/5 from attestation perspective	SPM and/or center XRs depending on effort/phase; also need M&S owner	• DT&E initiative • Analysis Team products (M&S activity)
11	**At MS/KDP B, do the requirements consider likely future mission growth over the life cycle?**	SE/SEP guidance (Address in updates)	•SEP •Transition Plan	• AFMC/CC attestation • DP/RAM • SE	SPM with insights from earlier XR efforts	• ICD and I-CDD (validation)

Checklist – Architecture, Risk

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		CURRENT PROCESS	SUPPORTING DOCUMENTATION	PROCESS OWNER(S)	OPR(S)	KEY LINKAGE(S)
ARCHITECTURE DEVELOPMENT						
12	**Has the system been partitioned to define segments that can be independently developed and tested?**	Architecture views required per JCIDS	• ConSEP • CCTD • SEP	SE and DP/RAM	Center XRs and XPM depending on effort/phase	• DT&E initiative • SoS SE • ICD and I-CDD to validate approach • CCP Guide
13	**By MS/KDP A, is there a plan to have information exchange protocols in place by MS/KDP B?**	Architecture views required per JCIDS (OV-3, OV-5 and SV-6 should address)	• ConSEP • CCTD • SEP	• A2/5 for DP/RAM process • SE process including SoS	Center XRs and SPM	• SoS practices and standards • early SE • DP/RAM
14	**At MS/KDP B, is the program plan structured to ensure that the contractor addresses rqmts decomposition / allocation to hardware, software, and human elements sufficiently early in development?**	• SE guidance in MS B RFP • WBS	• Acquisition Strategy • IMP/IMS	• SE • AFMC/CC attestation	SPM	Attestation

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Checklist – Risk Assessment, Program Implementation

		CURRENT PROCESS	SUPPORTING DOCUMENTATION	PROCESS OWNER(S)	OPR(S)	KEY LINKAGE(S)
RISK ASSESSMENT						
15	**Are all key risk drivers (including but not limited to critical technologies) identified?**	10-6 series?	• ConSEP • CCTD • SEP • TDTS	SoS engr processes; risk process (must begin early)	Center XRs and SPMs depending on effort/phase	• TD initiatives • Linkage betw risk, SE and SoS eng, Cost
PROGRAM IMPLEMENTATION						
16	**Does the program implementation plan account for necessary and sufficient # and skill levels of organic (military and civilian), FFRDC, and support contractor personnel to manage the program?**	• SEP should be a resource-constrained plan • LCMP should address.	• Acq strategy • Transition Plan	A1 – should be accounted for in Mission Assignment process as well as during transition to a SPO – all functionals (including A2/5 for DP) need to be included in the assessment process	SPO Cadre and SPM (Center XR, EN, other functionals as needed)	In work (HCC definitions)
17	**At MS/KDP A, is there a plan in place that identifies all necessary activities and resources to reach MS/KDP B?**	LCMP	Early SE Guide	• A2/5 for DP/RAM • SE and SoS processes	Center XRs and SPMs w/resource allocation process	• SoS • SE • DP/RAM resource allocation • All enduring processes

Checklist – Program Implementation (2)

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		CURRENT PROCESS	SUPPORTING DOCUMENTATION	PROCESS OWNER(S)	OPR(S)	KEY LINKAGE(S)
18	**Is there a top-level system integration and test plan?**	SEP and TEMP	• ConSEP • CCTD • Transition Plan	A2/5 (DP & attestation), PM, SE, SoS	TE Contractor	DT&E and TD initiatives, SoS practices
19	**At MS/KDP B, are the necessary and sufficient program management and systems engineering management personnel in place? Have they been empowered to tailor processes and enforce requirements stability through IOC?**	Usually based on PM and CE judgment and then articulated in SEP and LCMP. They are empowered to tailor processes. EMA instituted to add/improve discipline for requirements stability.	• ConSEP • Transition Plan	A1 (Mission Assignment Process)	SPO Cadre and SPM (Center XR, EN, other functionals as needed)	In work (HCC definitions)
20	**Has the government attempted to align the duration of the program manager's assignment with key milestones and deliverables?**	New policy memo forthcoming	Transition Plan	Mission assignment process with senior officer moves	OSD	In work (OSD)

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Prototyping and Early SE

- **Basic tenets of prototyping can help a program-to-be directly address 10 of the 20 checklist items -- at least one in each of the 7 areas**
- **A well-crafted prototyping plan can impact most if not all other items**

PROTOTYPING AND EARLY SE CHECKLIST "BOX SCORE"			
Concept Development	*2/4*	*Architecture Development*	*2/3*
KPPs and CONOPS	*1/3*	*Risk Assessment*	*1/1*
Cost and Schedule Scoping	*2/2*	*Program Implementation Strategy*	*1/5*
Performance Assessment	*1/2*		

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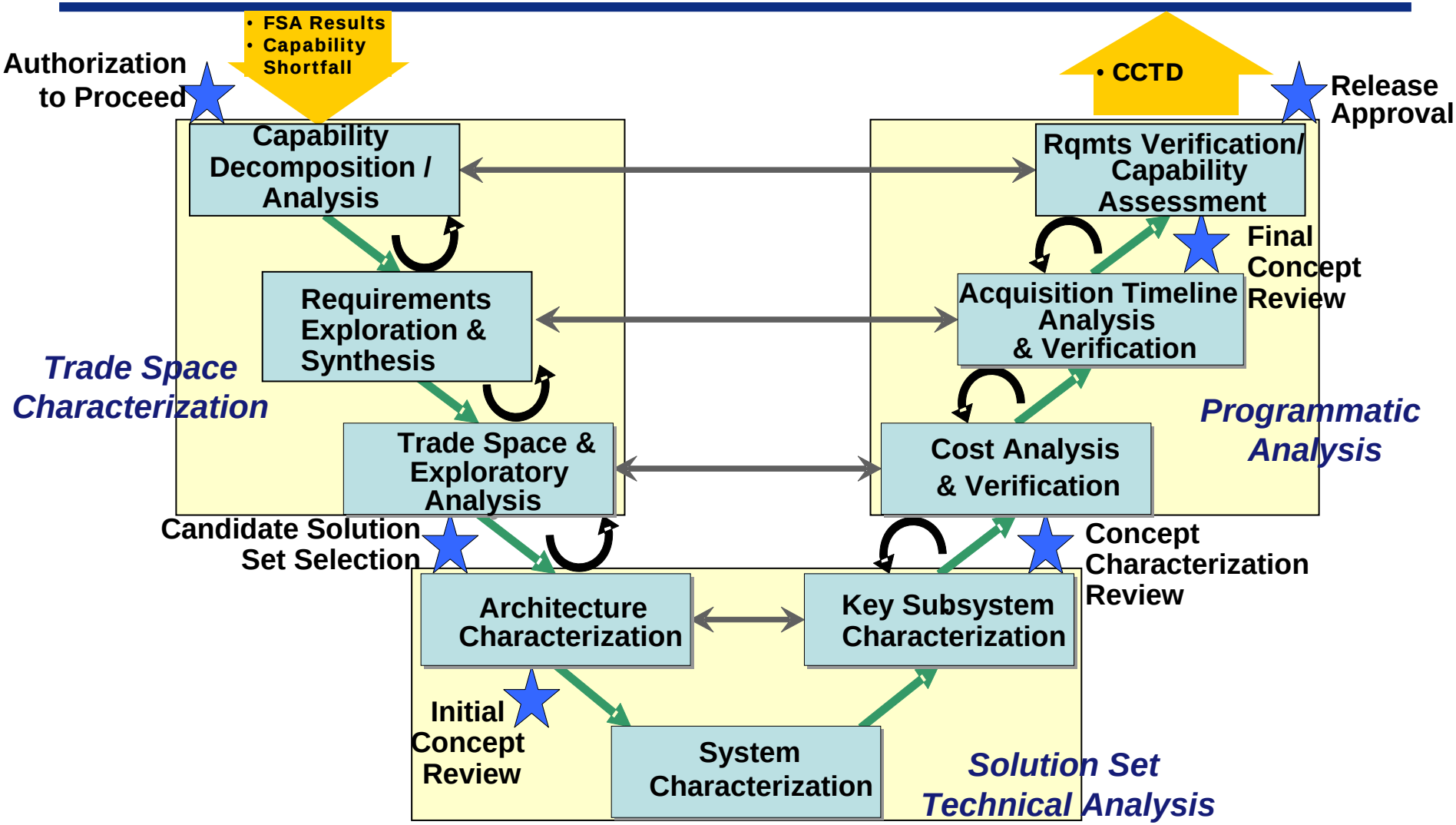
Concept SE Process



CCTD Content

Attachment 1: Concept Characterization and Technical Description Format

Concept Characterization and Technical Description (CCTD)

for

Concept Name

DATE

Prepared by:

Name of Source (e.g. Concept Development Organization, AFRL, Corporation, etc)

NOTE: Subjects **in boldface type** listed in this Table of Contents are mandatory. Design and performance parameters (e.g. "weight, power, cooling, throughput") for identified studies, analyses, and/or experiments should be selected on the basis of relevance to the concept, mission description, etc. Approaches and assumptions should reflect the anticipated purpose of the technical planning (e.g. strategic planning, AoA, weapon system technology demonstration). Descriptive detail should be consistent with the concept's level of maturity/fidelity and the purpose for which the concept is being developed. This document is not expected to be at the level of a formal submittal such as a milestone review product.

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Root Folder » 7. Draft Working Misc Files

Type	Title	Counts/ Versions	Owner	Date Modified	Email This	Reserved	Functions
	Briefings presented	=0, =5		6/25/2008			
	Draft Checklists	=0, =6		6/26/2008			
	Draft Policy	=0, =1		6/25/2008			
	Draft process briefs	=0, =1		6/25/2008			
	Draft RAM Strategic Plan	=0, =1		9/18/2008			
	Estimating Guide/Templates	=0, =1		9/17/2008			
	Prioritization	=2, =0		7/24/2008			

"Everything has been said before, but since nobody listens we have to keep going back and beginning all over again."
-- Andre Gide, Le traite du Narcisse

on Support Center