Early Systems Engineering to Achieve MS B

Michael Gaydar
Deputy Director Air Platforms, Systems Engineering
Early Systems Engineering Ground Rules

- Begins With MDD Decision
- Product Focused Approach
- Must Involve Engineers
  - Requirements Stability Is Outcome Of Early SE
- Must Demonstrate Achievable Technology
  - Requires TRL 6 Prior To MS B
  - Engineering Theory Pushed To Real World Capability
- Achieve Low Technical Risk
  - Medium Cost & Schedule Risk Environment
- Must Balance Cost, Schedule, & Performance
- Must Identify Sub-Systems Prior To MS-B
- CDD Finalized Just Prior To MS-B
CJCSI 3170.01G Enclosure A

... When a materiel solution is required by an approved ICD, the milestone decision authority (MDA) determines the scope of the subsequent analysis of alternatives (AoA), the appropriate entrance milestone, and designates the lead component(s) in a Materiel Development Decision (MDD). The purpose of the Materiel Solution Analysis (MSA) phase is to assess potential materiel solutions and to satisfy the entrance criteria for the next program milestone as designated by the MDA. If the next phase per the MDA is Milestone (MS) A, then the ICD along with the results of the AoA form the basis for the MS A decision.
NAVAIR 4 Phase SE Process

• **Phase I – Materiel Solution Analysis (MSA)**
  – Establish initial set of Operational Capabilities and resolve to a Candidate Materiel Solution (aviation, ship, ground)
  – Broad focus to ensure all types of solutions receive appropriate consideration
  – Maximize leverage of gov’t and industry knowledge base

• **Phase II – System Requirements & Technology Development (SRTD)**
  – Establish system performance requirements and detailed CONOPS
  – Develop critical technologies to support engineering final product
  – Relatively broad focus to maximize leverage of emerging technologies (stay ahead of the threat)

• **Phase III – System Architecture & Technology Demonstration (SATD)**
  – Complete the system architecture – requirements derivation and decomposition to subsystems
  – Demonstrate maturity of critical technologies
  – Narrowing focus down to a complete system architecture and preliminary design while allowing for optimization against cost and schedule

• **Phase IV – Engineering and Manufacturing Development (EMD)**
  – Complete the design, development and verification
  – Deliver the compliant weapon system to Operational Test/IOC
Phase I: MSA

- Assess State Of Current Technology
  - Lessons Learned From Current Systems
    - Government
    - Industry
    - Historical TOC for Similar Systems
- Assess Emerging Technology
  - Government S&T Projects
  - Industry Proprietary Investment
- Begin Bounding Of AOA
- DODAF Architecting

- Kill Chain Analysis and Mission Threads
- Validated Models Identified
- SOS Interoperability
  - External Requirements
  - Network Interfaces
- Potential CTEs
- Initial Technical/Program Baseline
- Initial TOC Focus Areas

SYSCOM Analyses and Assessments
Requests for Information From Industry
Joint Concept Technology Demonstrations

• Approved ICD
• AOA Guidance

GATE 1
• AOA Plan
• Draft SEP
• Draft TDS

ITR
Phase I: AOA

- Analysis Of Alternatives
- Define Initial Suite Of Analysis Models
- Continued Development Of Emerging Technology
  - Government JCTD
  - Industry Investment
- Establish Program Office & Engineering IPT
  - Non-Tailorable Design Standards
- Identify Test, Certification And T&E IPT
- Continue Systems of Systems Analysis
  - Establish ICD And Network Requirements

Joint Concept Technology Demonstrators

Risk Reduction Contracts

Request For Information

Industry Investment

- AOA Report On PSCs
- Draft KPPs
- Measures of Effectiveness (MOEs)
- MS-A SEP
- CTEs, TRAs, And TDS
- Initial Modeling & Simulation (M&S)
- Draft Tier I Specification
- TOC Design Drivers

Acquisition & Requirements Process

- Approved ICD
- Mission Threads
- AOA Plan

Government Industry Engagement

- Joint Concept Technology Demonstrators
- Risk Reduction Contracts
- Request For Information
- Industry Investment
Phase II: TD Phase RFP

**SYSTEMS ENGINEERING PROCESS**

- Translation Of Draft CDD Into Tier I Specification By SMEs
  - Clearly Identify Design Standards
  - Define Certification Standards
- Technology Development Of CTEs
  - Required To Set Performance Thresholds
  - Establish Prototype Demo Requirements
- Establish Draft MS B Source Selection Criteria
  - Criteria For Design Evaluation In TD Phase

**GOVERNMENT INDUSTRY ENGAGEMENT**

- Joint Concept Technology Demonstrators
- Risk Reduction Contracts
- Request For Information
- Industry Investment

**ACQUISITION & REQUIREMENTS PROCESS**

- SEP
- TDS
- Draft
- CDD
- CONOPS
- TES

**SRR-I**

- Tier I Specification
- Draft CDD To Specification Traceability
- MOEs and MOPs
- Non-Tailorable Design Requirements
- Certification Requirements Defined
- Objective Trade Space Defined

**Joint Concept Technology Demonstrators**

- Translation Of Draft CDD Into Tier I Specification By SMEs
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  - Establish Prototype Demo Requirements
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Phase III: Tailored PSCs

**Systems Engineering Process**

- Industry Interpretation Of Government Tier I Spec
  - Company Specific System Proposed
  - Tailorable & Objective Req's Documented
- CTE Demonstration Methodology Documented
- Establish Draft MS B Source Selection Criteria
  - Criteria For Design Evaluation Of TD Phase
- Design Focused To Specific Physical Architectural Approach

**Government Industry Engagement**

- Competitive Prototyping Contracts
- Systems Engineering Technical Reviews
- Earned Value Contract Oversight

**Acquisition & Requirements Process**

- TD Contract
- Tier I Spec
- SEMP
- Draft
- CDD
- CONOPS

**SRR-II**

- Development & Traceability
  - Industry Tier I Spec
  - Tailorable Requirements
- MOEs and MOPs
- Initial T&E RVM
- Trade Space Narrowing
- System Constraints Being Defined
- Alternate Design Paths (CTEs)
Phase III: Finalize CDD

- Functionality Derived From CONOPS
- Maintainability & Logistics Requirements Flowed Into Design
- Functionality Partitioned Between System Segments
- Potential Subsystems Identified
  - Preliminary Architecture Defined
  - Subsystem Constraints Identified
- CDD Traceable To Candidate Subsystems

- Tier II Specification
  - Functional Traceability
  - CONOPS
  - CDD
- CDD Thresholds Evaluated
- CONOPS Finalized
- Preliminary Subsystems TPMs Identified
- TOC Design Drivers Identified

Competitive Prototyping Contracts
Systems Engineering Technical Reviews
Earned Value Contract Oversight

• TD Contract
• Tier I Spec
• SEMP
• Draft
• CDD
• CONOPS

• CDD
• CONOPs
• TOC Drivers
Phase III: Pre-MS B PDR

- Complete the System Architecture
- KPPs → MOEs → MOPs → TPMs for Allocated Sub-System Acceptance Criteria
- Balance TOC with Development Cost in Proposed System Design
- Demonstration of CTEs to TRL-6 (competitive prototyping)
- Demonstrated Engineering Management During TD Phase Contract

Competitive Prototyping Contracts
Systems Engineering Technical Reviews
Earned Value Contract Oversight

- SDS Complete
  - Subsystem Specs Finalized
  - Design TOC Drivers
- KPP Thresholds Traceable To Subsystem TPMs
- KSA Compliance Evaluated
- Technology Readiness Assessment (TRA)
- Management Systems Assessment (MSA)
Controlling Program Inertia

• Recognize MS B As True Decision Point
  – Only 3-5% Of TOC Expended By MS B
  – 95% Of System Money Leveraged At MS B

• Not All Sunk Costs Are Wasted
  – Technology Developed And Demonstrated
  – Potential Weapon Systems Architectures Explored
  – Demonstrated Performance vice Previous CPRs

• Underlying System Engineering Approach Sound

“If you find yourself in a hole, the first thing to do is stop digging”

– Will Rogers
Summary

• Early Systems Engineering Is The Front End Of The Traditional Tried & True SE Process

• Aligning Business And Acquisition Decisions
  – Decisions Are Based On Depth Of Knowledge
  – Stability Is Output Of Systems Engineering Not The Input
  – PDR Is The First Physical Manifestation Of A System In Development

• Evolving Guidance
  – To Shorten Post MDD Development Move Engineering Timeline To Left
    • MDD “the old MS-A?”
  – Technology Development Timelines Unpredictable
    • Existing Technology Deploys Quicker