Developing a Mission Solution: From Mission Gap Analysis to Preferred System Concept

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Outline

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- Development in the Acquisition Cycle
- Affordable Weapon System Study (AWS)
- Implementing JCIDS at RMS
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- Quality Functional Deployment / Preferred System Concept
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Introduction

- Mission analysis studies conducted per the Joint Capabilities Integration & Development System (JCIDS) process identified gaps in the Navy’s ability to provide accurate, responsive “Fire Support from the Sea”
  - Marine and Army forces operating ashore throughout conflict spectrum
  - Gaps defined in the Marines’ Joint Fires Initial Capabilities Document (ICD)
  - Included impact from use of MV-22 Osprey, which provides Marines ability to conduct vertical envelopment ops far beyond naval gunfire range

- Navy interested in developing a refined system concept for an Affordable Weapon System (AWS) as a ship- and/or air-launched material solution ” for the 2016 timeframe

- AWS Team employed RMS Mission System Engineering (MSE) Process
  - Mission Capability Analysis (MCA) used to identify relevant Mission Areas and Missions, and then determine the 2016 timeframe capability shortfalls
  - Solution Capability Analysis (SCA) used to identify, rank and rate solution options, and map options against defense strategies and mission shortfalls.
Development in the Acquisition Cycle: JCIDS and DoDI 5000.02

- Materiel Solution Analysis
- Technology Development
- Eng’g & Manufacturing Development

A: SRR
B: PDR
C: CDR

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One aspect of the AWS study was to determine the capabilities and associated tasks, conditions and standards required for Naval Surface Fire Support (NSFS) missions performed at standoff ranges.

MCA Identifies:
- Appropriate Mission Areas and Missions
- Scope of Mission Area / Military Problem
- 2016 timeframe capability shortfalls

MCA Maps:
- Capabilities to Defense Strategies
- Relevant objectives to capability gaps
- Example Scenarios to mission areas

Focus on Identifying the Gaps
Affordable Weapon System Study: Solution Architecture & Design Development

- MOEs → System Capabilities → System Requirements
- Use of Existing Navy Surface Fires Infrastructure
- Detailed Architecture Definition beyond M/S A levels
  - DoDAF AV-1, AV-2, OV-1 thru OV-7 SV-1 thru SV-9)

**Mission Capability Analysis**

**Solution Capability & Architecture Development**

**Affordable Concept Development**

**QFD**

**Solution Concepts**

**Military Utility**

**Analyses**

**Focus Areas**

Architecture Flexibility wrt Preferred System Concept
System of Systems Interoperability & Functionality
Priority on Affordable & Useful → Achievable SoS Design → Exceptional Value to the Warfighter

**Focus on Development of Solution Architecture & Concepts**

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Affordable Weapon System (AWS) Operational Concept OV–1

2016 Battle Space

Airborne ISR
National/Intel Asset Target and Position

SATCOM

Afordable Weapon System for Navy Surface Fires Support & Joint Fires Operation

Quality Attributes
Affordable
Usable
Easy to Integrate
Flexible
Interoperable

Naval Surface Fires

SAG
AEGIS

ZUMWALT
LHD/LHA

Strike Coordinator
FSCC/SAOC/TACC...

Ground Force

Call for Fires

Irregular GWQT

Strategic Mobile/Relocatable

Strategic Fixed

Threat Range
Implementing JCIDS at RMS: Mission System Engineering (MSE)

**DOD Milestones**
- Material Development Decision (MDD)
- Milestone A

**DOD Lifecycle Phases**
- DoD Strategic Guidance & Joint Concepts
- Mission Identification and Gap Analysis
- Identify and Assess DOT_LPFS Solutions
- Prepare ICD
- Best Materiel Approach(es)
- Analysis of Alternatives
- Preferred System Concept

**RMS Mission System Engineering (MSE) Activities**
- Mission Capability Analysis (MCA)
- Solution Capability Analysis (SCA)

**Methods**
- Doctrinal Research
- Warfighter Subject Matter Experts (SME)
- Mission/Operational Architecture
- First Principle Analysis (FPA)
- Constructive Analysis

- Constructive Analysis
- System Architecture
- Man-in-the-Loop Simulations
- SW/HW-in-the-Loop Simulations

**Analysis of mission areas and mission current and future capabilities**

**Analysis of solution space & capability gaps filled by candidate solutions**

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Implementing JCIDS at RMS: MSE Components

**Mission Capabilities Analysis (MCA)**
Analysis of mission areas and mission current and future capabilities

- **Identifies**
  - Mission Areas and Missions
  - Scope Problem
  - Relevant Timeframe
  - Capability Gaps

- **Maps**
  - Capabilities to Defense Strategies
  - Relevant Objectives to Capability Gaps
  - Example Scenarios to Mission Areas

- **Includes**
  - Mission Analysis
  - Capability Analysis
  - Gap Analysis

**Solution Capability Analysis (SCA)**
Analysis of solution space and capability gaps filled by candidate solutions

- **Identifies**
  - Solutions Ranked & Rated
  - Engagement Cost

- **Maps**
  - Options to Strategies
  - Solutions to Capability Gaps
  - Capability Gaps to Filled Gaps
  - Mission Weakness to Areas Fulfilled

- **Includes**
  - Tailored Analysis

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Customer Needs → MCA → Capability Gap → SCA
Implementing JCIDS at RMS: Mission to Solution Relationship

MISSION CAPABILITIES ANALYSIS (MCA)

- Mission Areas
- Missions & Scenarios
- Capability Attributes
- Current Capability Assessment
- Gap Identification
- Gap Descriptions and Weighting
- DOT_LPFI Analysis

SOLUTION CAPABILITY ANALYSIS (SCA)

- Solution Space Analysis
- Solution Concepts
- Concept Capability Assessment
- Concept Gap Analysis
- Rating/Ranking of Viable Concepts

MSE is tailored to project status and growth needs

Includes time frame and scope

Always keeping in Context of the Employment

Mission Architecting Begins

Consider “ilities” – feasibility, operational suitability, affordability

How do the concept capabilities fill the gaps?

What gaps still exist with the concept in place?

Architectures

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MCA Approach

- Perform Literature and Doctrinal Research
- Review with Subject Matter Experts
- Conduct Mission Analysis
- Summarize Findings
- Identify Capability Gaps
- Identify AWS Concept Trade Space

Review’s Purpose:
- Capture mission breakdown for Naval Strike and Fire Support from Warfighter perspective.
- Focus on Mission Operations, Capabilities, and Mission Execution Cost
- Utilize Warfighter Subject Matter Experts with broad spectrum of user perspectives. Subject

Subject Matter Experts Provide Key Input for Analysis
MCA Example

Missions Identified

Reference Scenarios Identified and Used to Assess Missions

Assessed Capabilities Using Reference Scenarios

Identified Gaps

Gap Analysis Report

Mission and Mission Characteristics Gaps drive System Level Concept Development and Analysis
SCA Approach

- Rank Options
- Rate Options vs Gaps uncovered in MCA
- Cost Engagements
- **Map Options, Capability Gaps and Mission Areas**
- Includes tailored analysis to cover identified Gaps

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**What gaps still exist with the concept in place?**

**What Kind of Item Meets the Warfighter’s Need?**

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**Mapping Purpose:**
- Options: determine extent to which Options are in line with Defense Strategies
- Capability Gaps: determine which Capability Gaps are fulfilled by other systems
- Mission Areas: determine extent to which Mission Area weaknesses are fulfilled

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**Solution Capability Analysis (SCA)**

- **Solution Space Analysis**
- **Solution Concepts**
- **Concept Capability Assessment**
- **Concept Gap Analysis**
- **Gap Descriptions and Weighting**
- **DOT_LP Federated Analysis**
- **Rating/Ranking of Viable Concepts**

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First Principle Analysis

• Purpose
  – Support decision making
  – Begin design space bounding
  – Begin analysis plan development

• Based on Top Level Understanding
  – Operating Concepts
  – System Components
  – Interactions

• What is it used for?
  – Quick response and understanding at early stages of system development
  – Qualitative input to early business decision points
  – Sanity check comparison with higher order models
  – Design space development
  – Military utility analysis
  – Requirements development, balancing, influence
  – Op Con Validation

• What it is not
  – High Fidelity Level Models
  – Detailed Analysis
  – The Final Answer

• How is it done?
  – Understand the problem/question and level of fidelity
  – Identify components
  – Describe the interactions/effects in a computationally efficient manner
     Mathematically
     Model the system
  – Design experiments
  – Conduct experiments
  – Analyze results
  – Iterate

Tools: Excel, Matlab, Pencil And Paper

Just Enough Fidelity to Provide Early Insight
The Solution Concepts are Assessed for Ability to Fill Capability Gaps
Quality Function Deployment / Preferred System Concept Methodology

Step 1 Airframe Options

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<thead>
<tr>
<th>Criteria</th>
<th>Weight</th>
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<tbody>
<tr>
<td>Affordability</td>
<td>5</td>
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<tr>
<td>Gap Coverage</td>
<td>4</td>
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<td>FPA</td>
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<td>Interoperability</td>
<td>2</td>
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<tr>
<td>Complexity</td>
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QFD Step 1 Results

Step 2 Subsystem Options

Sensor Rating
- Seeker / Sensor Type
- Warhead Rating
- Guidance Nav Rating
- Datalink Rating

Option Preferred Due to Ability to Affordably Fill Mission Characteristic Gaps

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Summary

- Raytheon uses Mission Analysis to Focus Selection of the Preferred System Concept on the Ability to Cover Gaps
  - Mission Capability Analysis
  - Solution Capability Analysis

- Mission Capability Analysis identifies Missions, Mission Gaps and Mission Characteristic Gaps

- Solution Capability Analysis bounds the Solution Space and assesses the Solutions Concepts for ability to fill the Capability Gap

- Results of the Affordable Weapon System Mission Analyses were key input to the QFD study and selection of the AWS Preferred System Concept – Airframe and Subsystems
Biographies

Elizabeth M. (Liz) O’Keefe is a Senior Principal Systems Engineer and Certified Architect at Raytheon Missile Systems, and has been with Raytheon and its legacy companies for 29 years. She has a BS degree from Clarkson University in Electrical Engineering (EE) - Communications and a MS degree in EE - Systems from California State University at Fullerton. Liz has worked in Radar Analysis, Systems Integration, Simulation, Engineering Processes, and Strategic Planning. She was Systems IPT lead for SM-3 Block I and then Chief Architect and Chief Engineer for SM-3 Strategic Architecture & Analysis (SA&A) and related Navy BMD programs, as well as Program Manager for the SM-3 SA&A and Low Cost Kill Vehicle programs. Liz was recently Chief Architect for the Affordable Weapon System and Net-Ready Key Performance Parameter Architecture Evaluator (NetRAE) Tool programs.

James G. (Jim) Sierchio is a Senior Principal Systems Engineer and Certified Architect at Raytheon Missile Systems. He has been with Raytheon for 11 years, developing mission architectures and CONOPS for such BMD-related programs as Exo-Atmospheric Kill Vehicle, Multiple Kill Vehicle, and Sea-Based Terminal, the latter as Chief Architect. Jim is a retired Air Force Lieutenant Colonel, with a career spent in directed energy, space systems and BMD R&D, and technical intelligence. Jim has a BSE degree from Princeton University in Aerospace & Mechanical Sciences, a MS degree in Aerospace Engineering from the University of Dayton, an Engineer degree in Aeronautics & Astronautics from New York University, a MBA degree from Averett University, and a DBA from California Coast University.
BACKUP
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