Developing a Mission Architecture: From Mission Analysis to Executable Model

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Outline

- Introduction
- JCIDS Mission Capability Analysis process
- Solution Architecture and Design development
- “PF2T2EA” Kill Chain Architecture
- Critical Architecture DoDAF products
- Key Architecture analysis results
- Architecture executable model
- Summary

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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"
  - For 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
- Development of a mission solution necessitated developing an in-depth knowledge of the entire naval fire support "kill chain", and building an architecture expressing a comprehensive view of that kill chain
  - Architecture described AWS mission at the operational and system levels
- Team employed Raytheon Enterprise Architecture Process (REAP)

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Development in the Acquisition Cycle - JCIDS and DoDI 5000.02

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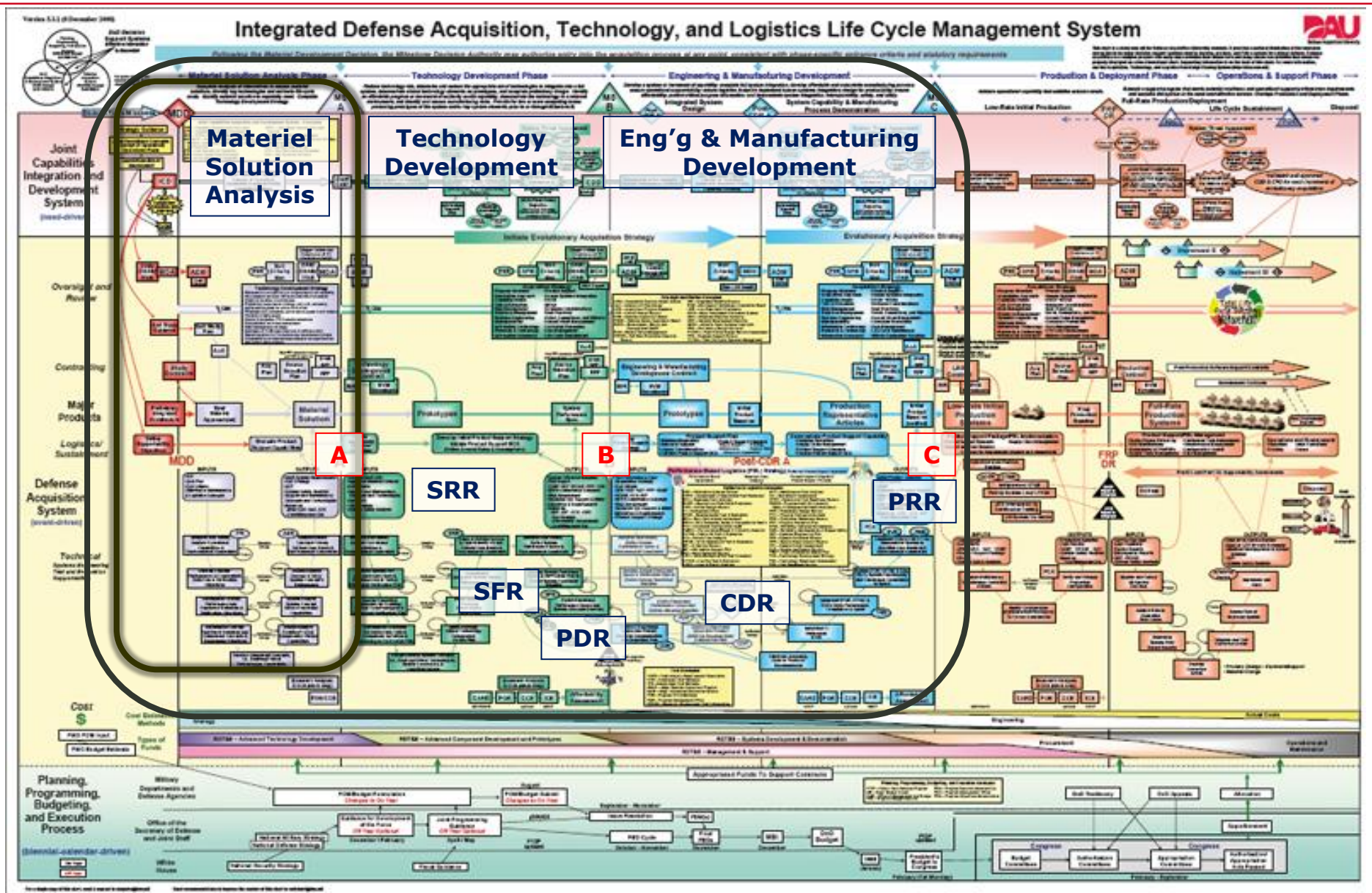


Mission Capability Analysis Process

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

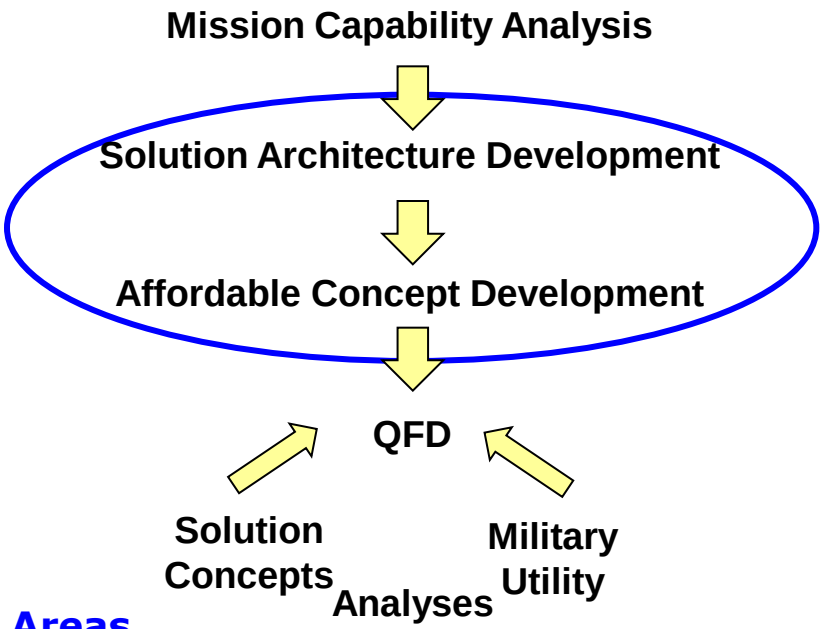
MCA Maps:

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

Focus on Identifying the Gaps

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)



Capabilities (CDD)
- KPPs, Mission Effectiveness

Requirements (SDS, EDD)
- Definitions of KPPs, KSAs, Other Targets, Environments

Operational Architecture
- Kill Chain & Operational Model

System Architecture
- Networks, Interfaces, Datalink, Systems, Functions, Function to Activity Mapping

Weapon System (WCS & Missile)
- Functionality
- Timeline
- End Game

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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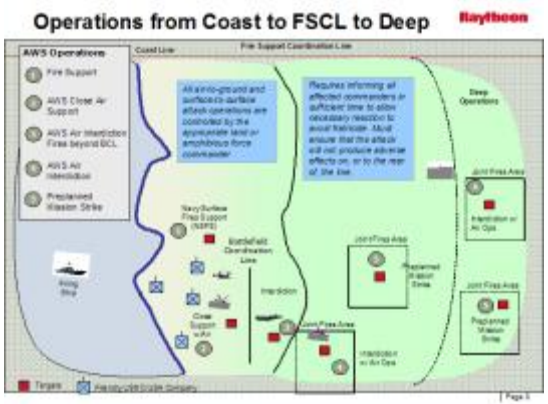
Architecture Development - Methods of Discovery

AWS Operations & Control

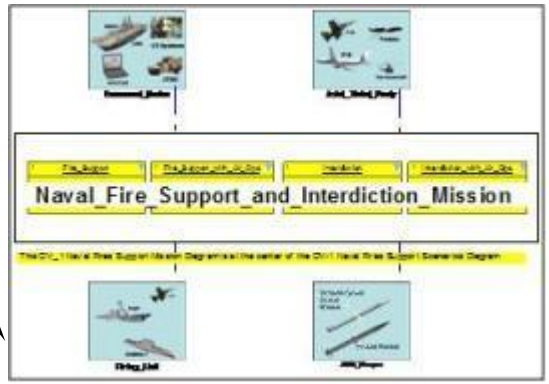


"Where"

Military Situations "When"

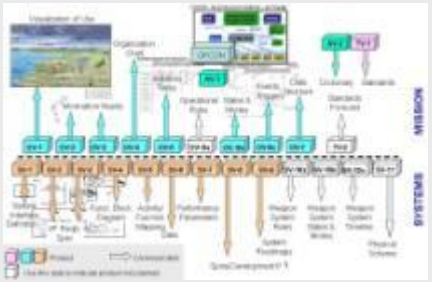
Categories				
Support to National Level Special Operations	Noncombatant Evacuation Operations / Humanitarian Assistance / Disaster Relief	Gain Access and Shape the Battlespace	Forcible Entry	Sustained Operations Ashore
Irregular Warfare	Stability Operations	Gain Access	Decisive Operations	
SSSP Military Operations Other than War		MCO Wartime Operations		

AWS Nodes "Who" "What"



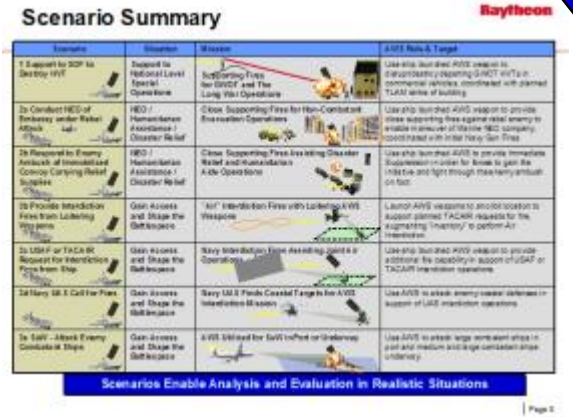
Process & Documentation

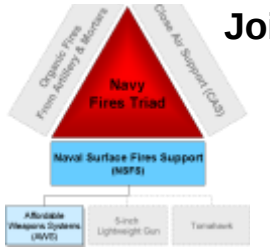
Raytheon Enterprise Arch Process



DoDAF

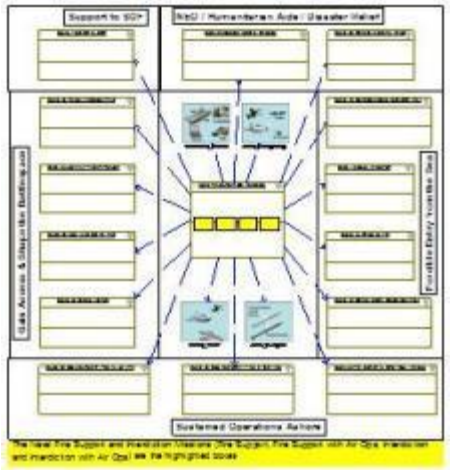
Scenario Summary





Joint Fires Scenarios "Why"

AWS Use Cases "How"



Discovery of "Where, When, Why, Who, What & How" for AWS

Defining the role of AWS and discovery of the Architecture

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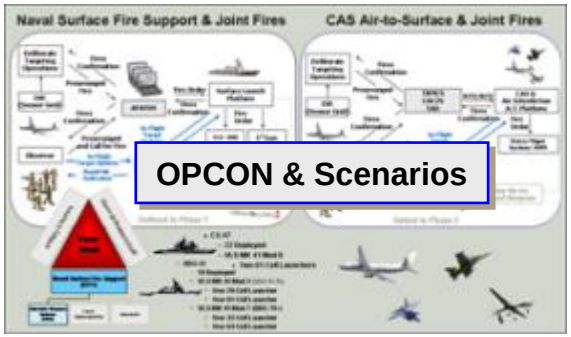
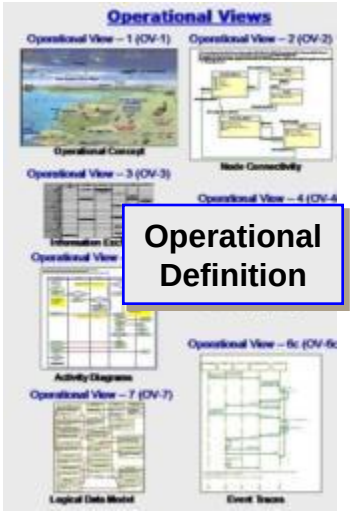
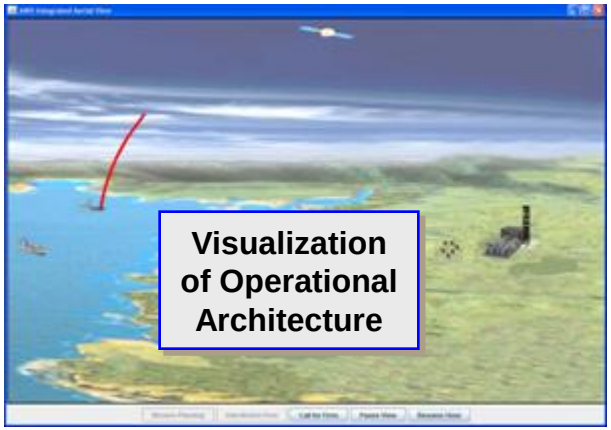
Architecture Development - Methods of Refinement



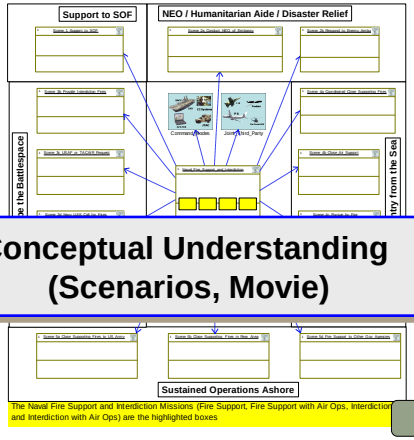
OPCON & Scenarios



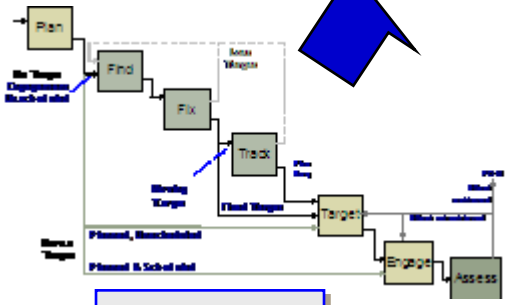
Operational Definition



Visualization of Operational Architecture



Conceptual Understanding (Scenarios, Movie)



Kill Chain Operations

System Definition

ICD

CDD

SDS

Capabilities Development

AFATDS/NFCS S/W Specs | NFCS/TTWCS Interface Specs | TTWCS/VLS/ MK-25/AWS Interface & Software Specs | MK-25 mod X Canister Spec | AWS Missile Spec

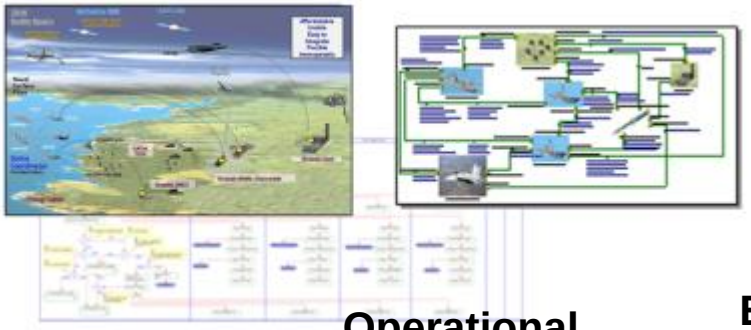
Notional Specification Tree

Requirements & Future Detailed Design

Operational understanding → System Development

“PF2T2EA” Kill Chain Architecture

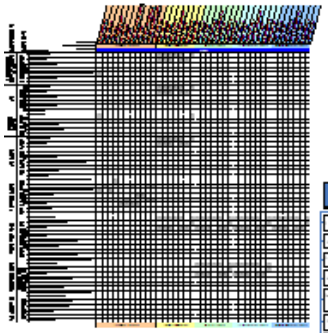
Operational Kill Chain

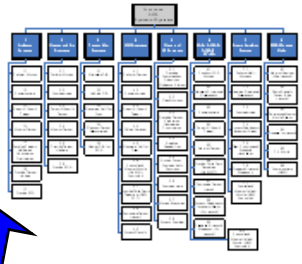


Executable Model

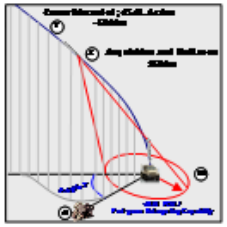
Studies & Design Decision Notebook

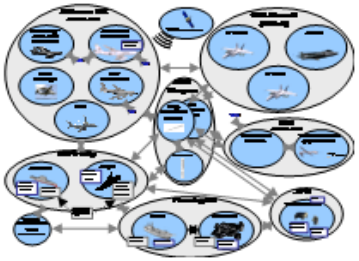
Operational Activities Mapping to System Functions

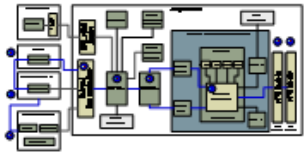




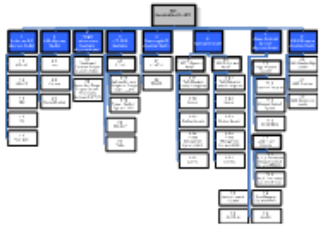
End Game



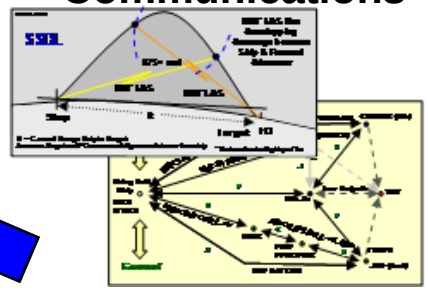




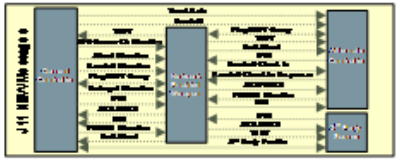
System Definition



Networks & Communications



Interfaces & Messages



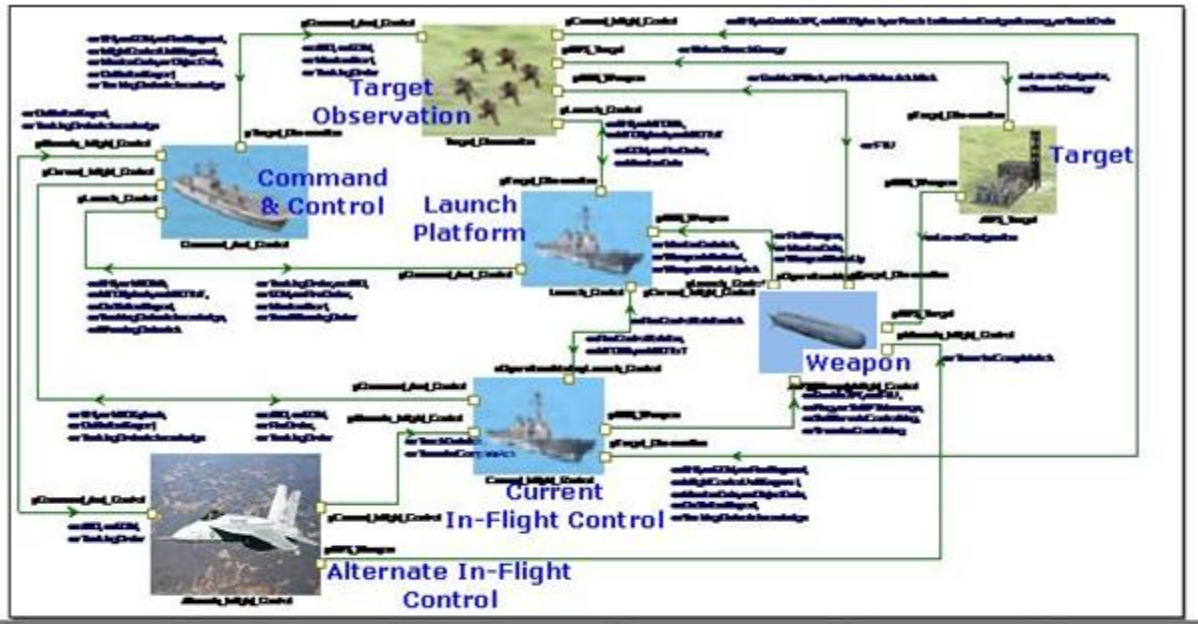
System Operation → System Definition → System Design

AWS "To-Be" Operational Concept OV– 1

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

Operational Nodes & Info Exchange OV-2

Definitions of Node Swim Lanes Used for OV-5, 6b, 6c



Command & Control	Target Observation	Launch Control	Current In-flight Control	Alternate In-flight Control	Weapon	Target
• Cmd Centers • Coord.Centers • Headquarters • FSCC, SACC …	• FO/JTAC/ FAC(A) • Joint Intell. • NEW 3rd Party Target Source	• Aegis • Zumwalt • Maritime Air • LCS, UAV	• Net-Enabled Weapon In-Flight Controller	• Net-Enabled Weapon Alternate Controller	• AWS Missile	• Target of Interest
responsible for C2 functions	provides target information before, during and after the engagement	responds to CFF by preparing and launching missile	controls AWS missile during flight per NEW concept	different planned node that can become Current In-flight Control during flight	causes intended effect to battlefield	intended aimpoint object in Fires Mission

Operational Nodes perform activities of AWS Fires Kill Chain

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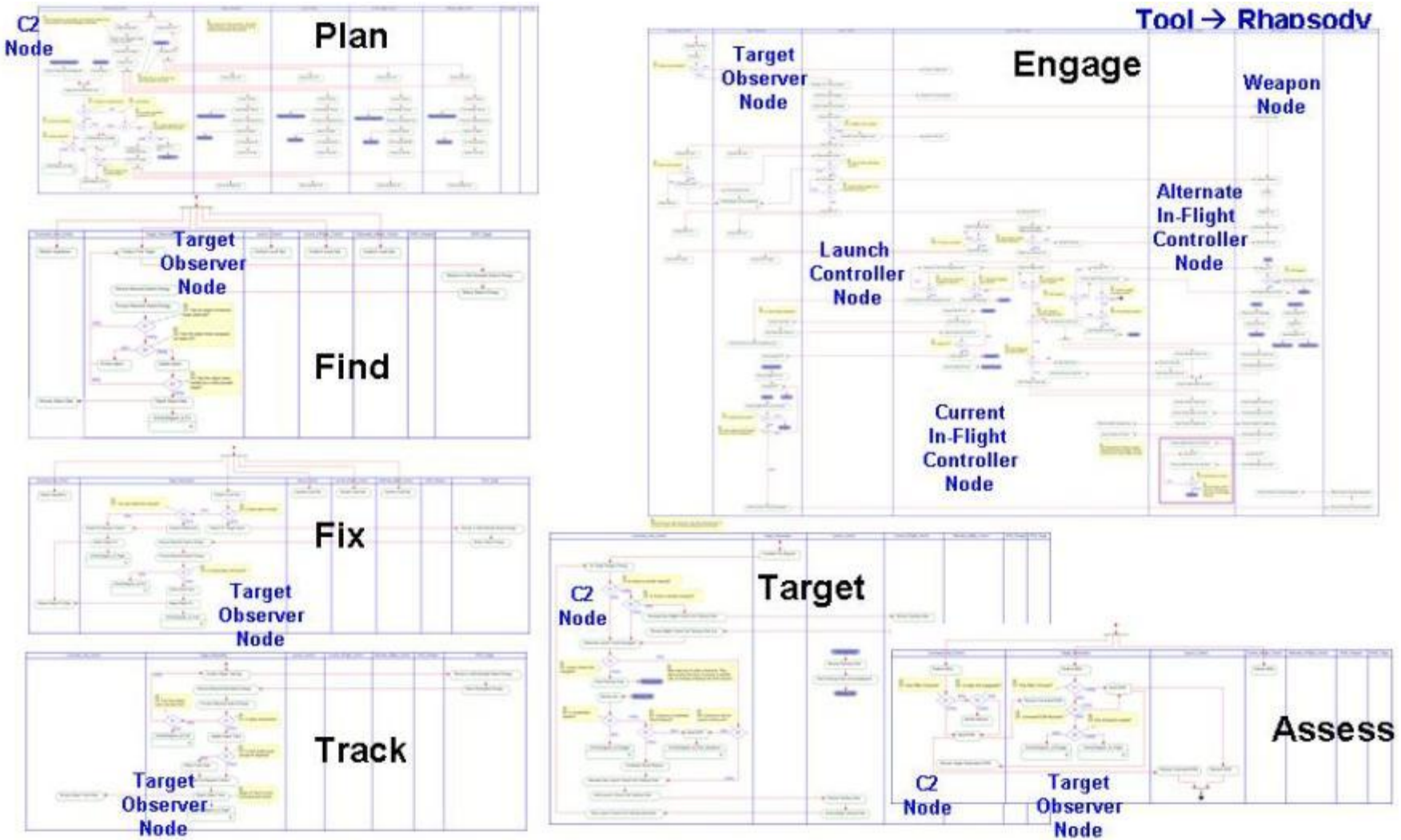
Activity Diagrams OV-5s



Activity Diagrams show the Node participation in the AWS Kill Chain operations

Paths through the Kill Chain - Issues

Definitions

Planned – Specifically in the ATO (if required) and supporting relationships defined

Scheduled – Specific launch time defined

Plan

No Target

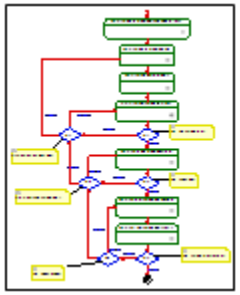
Find

Lost Target

Fix

Track

Engagement Unscheduled



Moving Target

Fixed Target

Target

Planned, Unscheduled

Have a Target

Planned & Scheduled

Response Time

Launch Platform Operations

C2

Missile Flight

Fire Req

Fire Order

Launch

EOM

Effect achieved

Effect not achieved

Engage

Assess

Call-For-Fire Supporting Fires focuses on Target & Engage

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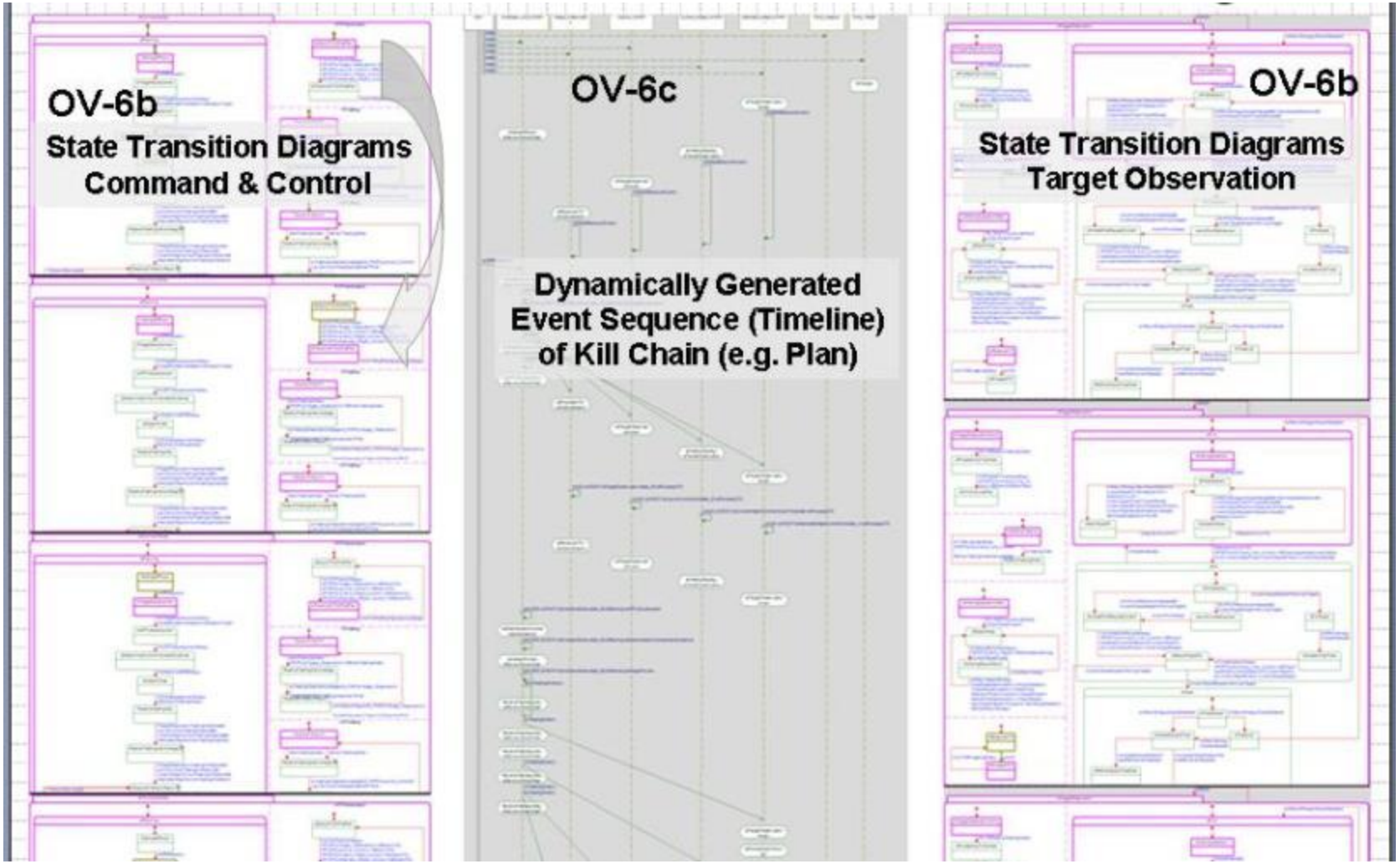
Execution of Kill Chain Operational Views



State Transitions and Event Sequences show dynamic interaction of AWS operations

Visualization of Operational Views

Enables Visualization and Verification of "what if" variations in AWS operations

Summary

- Described use of REAP to develop a Joint Fires and Naval Fire Support architecture based on P-F2T2EA kill chain model that emphasized:
  - Usability of the AWS
  - Affordability of development and deployment
  - Infrastructure and integration complexity
  - Desire for Net-Enabled Weapons (NEW) capability
- Showed operational- and system-level architecture products developed using IBM “Rhapsody” architecting tool, including an executable DoDAF model for sequencing, timeline analysis and mission visualization.
- Noted architecture analysis-derived mission and system requirements, and recommended C2 and fire support doctrine changes

Architecture available for use by other system developers

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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