



# **Broad Area Maritime Surveillance (BAMS) Unmanned Aircraft System (UAS) Modeling and Simulation (M&S)**

**presented to**

**National Defense Industrial Association (NDIA)**

**August 17, 2010**

**Stephen C. O'Day, Ph.D.  
AIR 5.4.2 Battlespace M&S  
BAMS M&S IPT Lead, PMA-262**



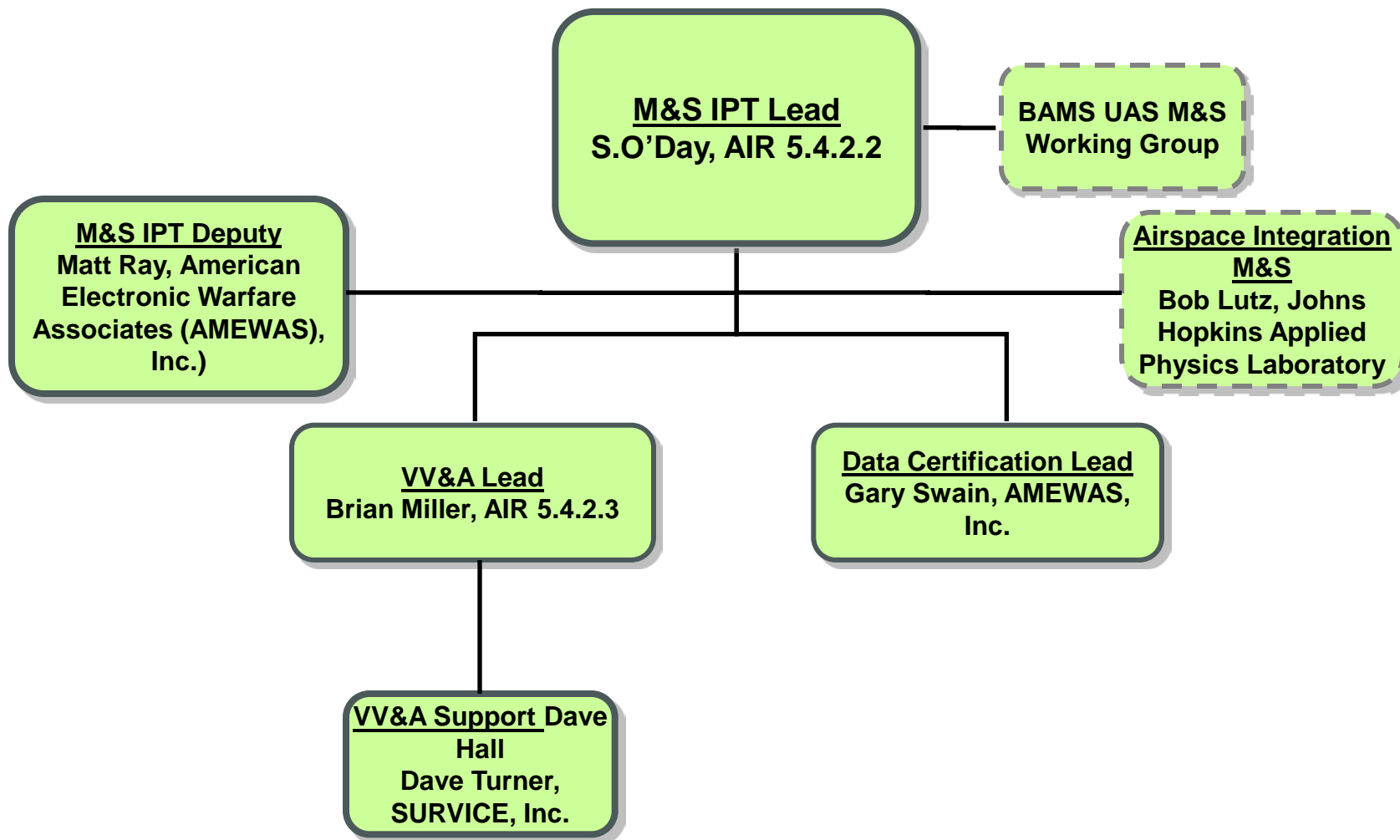
# Brief Overview

The purpose of this brief is to provide information about the approach of the BAMS program to M&S. The topics that will be covered are:

- M&S IPT organization and processes
- M&S and Verification, Validation, and Accreditation (VV&A) Contract Data Requirements List (CDRL) items
- Other contributing CDRLs
- Accreditation Support Packages
- Models proposed to satisfy system specifications
- Summary

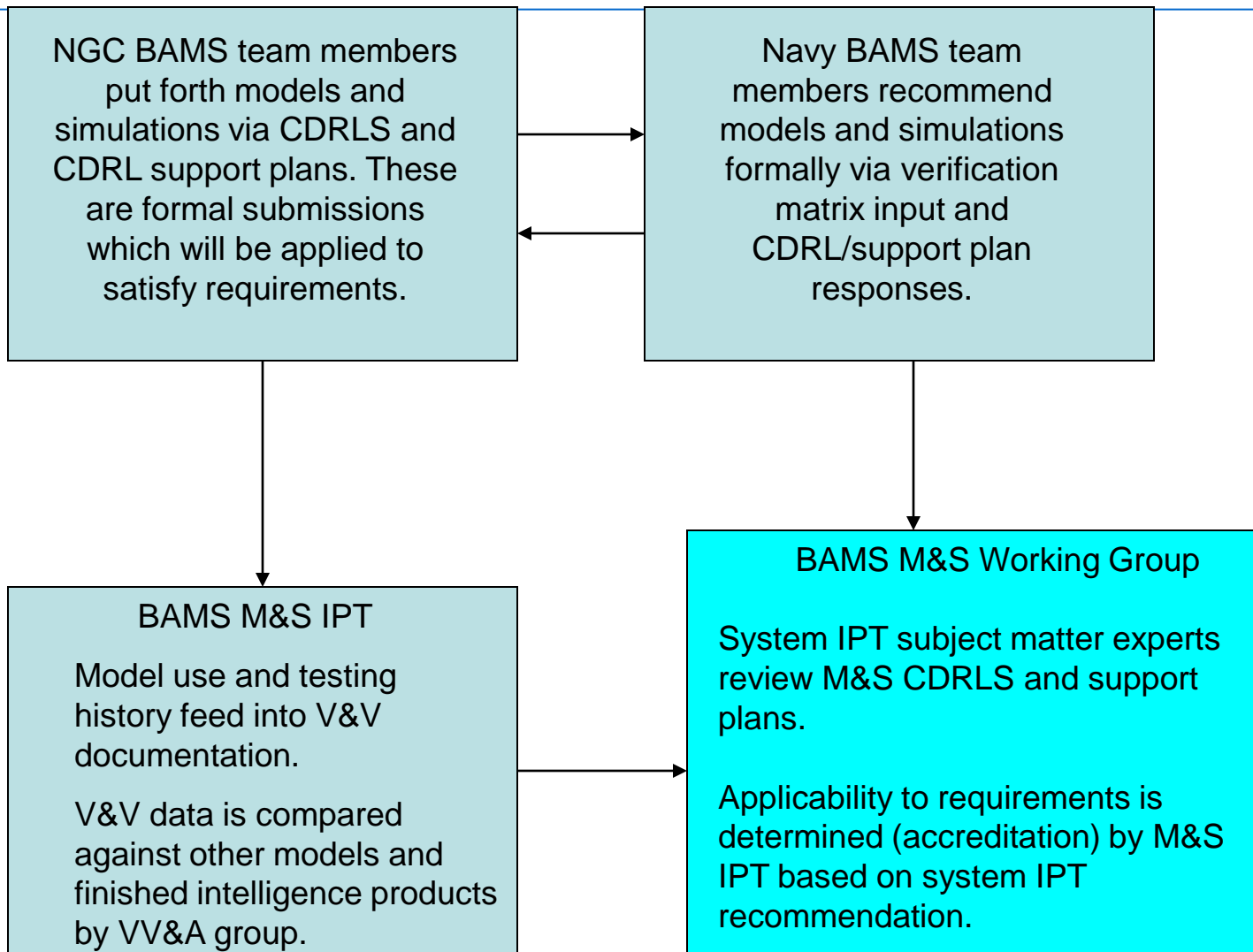


# BAMS M&S IPT Organization



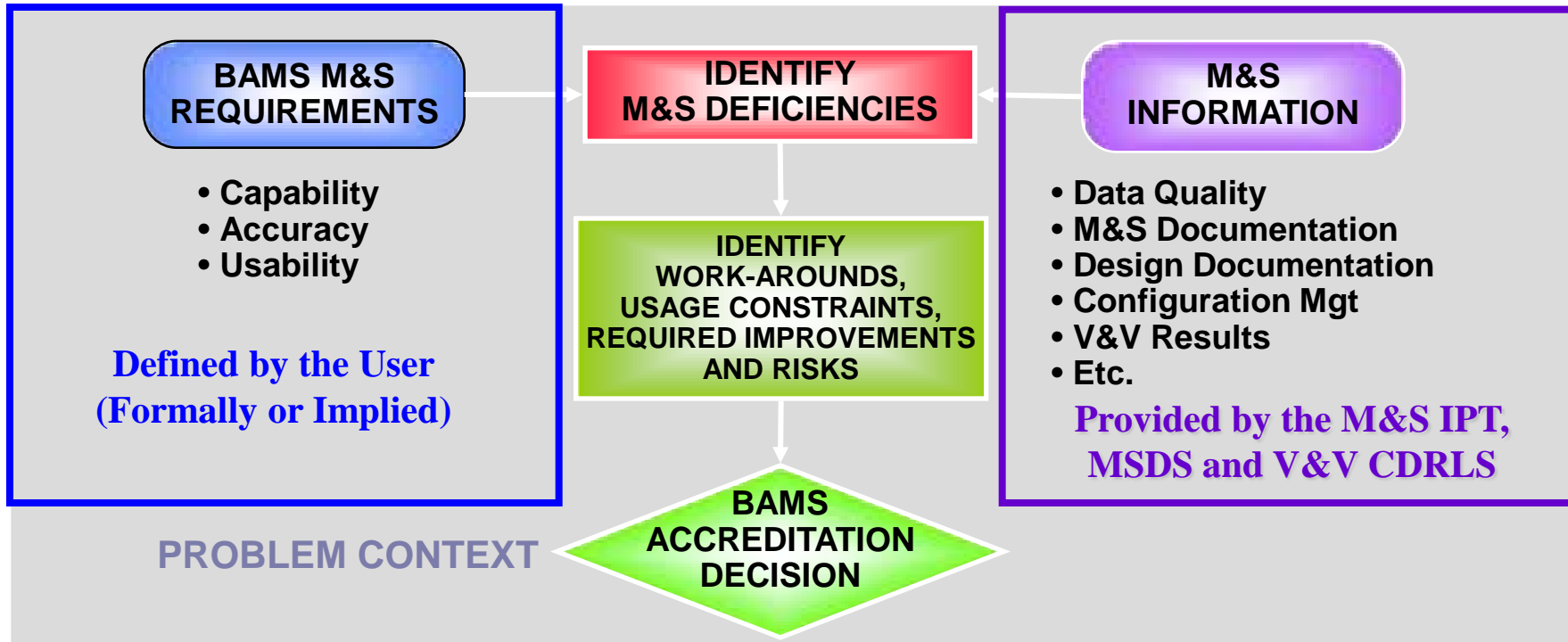


# M&S IPT Charter Work Flow





# The BAMS Accreditation Process



**TO PROVE THE M&S IS SUITABLE FOR THE NEED**

REQUIRES AN **OBJECTIVE COMPARISON**  
OF M&S REQUIREMENTS WITH M&S INFORMATION  
WITHIN THE CONTEXT OF THE PROBLEM



# The M&S Top Level CDRL



## Modeling and Simulation Design Specification (MSDS) CDRL

- This CDRL describes the M&S packages that will address groups of related requirements
- Only M&S that satisfies or supports system specifications (e.g. SW Level III test, ground test, and pre-flight test planning) is included in the MSDS CDRL
- VV&A is conducted on only the M&S in the MSDS



# V&V CDRLs

## V&V Plan CDRL

- Provides essential information that contributes to simulation credibility
- Problem statement
- intended use (satisfy system spec.)
- proposed simulation
- input data
- Outputs
- model history
- Subject Matter Expert (SME) credentials



# V&V CDRLs Continued



## V&V Report CDRL

- Satisfaction of capability and usability requirements
- Functional and fidelity capability limitations
- Estimate of errors
- Evidence of correct M&S use
- Configuration Management
- Documentation, test and simulation data



# Other BAMS CDRLs with M&S Information



- Software (SW) Program Management
- SW Test Description
- SW Development Plan
- Systems Engineering Management Plan
- Human Engineering Task Analysis Allocation Report
- SW Metrics
- SW Program Measurement Plan
- Human Engineering Program Plan
- Integrated Master Schedule
- Contract Work Breakdown Structure
- System Specification
- Communications M&S Plan
- Communications M&S Data/Analysis



# Other BAMS CDRLs with M&S Information Continued



- Mission Effectiveness Plan and Analysis
- Data Fusion Plan and Report
- Interface Control Documents/Drawings
- UAS Command and Control Performance Specification Document
- Segment Specifications
- Mission Systems Trainer (MST) Math Model
- Simulation Object Model
- SW Requirements Specification
- System Engineering Master Plan
- Verification Matrix
- 6DOF Model
- SW Architecture Design
- MCS Hardware Qualification
- Airborne Sense and Avoid V&V Plan



# NAVAIR Accreditation



## Accreditation Support Package (ASP)

- The BAMS M&S IPT generates an ASP for each M&S package in the MSDS that addresses a group of related requirements satisfying a specific intended use statement
- The ASP is generated from CDRL data delivered to the government and data from independent sources

## Letter of Accreditation

- There are NAVAIR PMA-262 requirements owners that will have to sign off on the risks documented in the ASP for their package in order for the M&S to go forward



# The BAMS MSDS M&S Packages



<b>M&amp;S Package</b>
Effective Time on Station (ETOS) Simulation
Operational Availability
Loss-of-Life Rate
Linear Air Vehicle
6DOF Air Vehicle Models
Air Traffic Models
Collision Avoidance



# MSDS M&S Packages Continued



<b>M&amp;S Package</b>
Radar CAD
EO/IR Performance
Radar Performance
Track
Communication Connectivity
Multi-UA Control
Payload Control
MP Flight Model
MP Sensor Model
MP Flight and Sensor Model
Mission System Trainer
Test/Demonstration Supporting M&S



# MSDS Candidate M&S Models



- **ETOS Package**

ETOSCalc

Naval Aviation and Maintenance Supply Model (NAMSM)

Multiple Aircraft Penetration Environment Simulation (MAPES)

- **Operational Availability Package**

NAMSM

- **Loss of Life Rate Package**

NAMSM

MAPES

- **Linear Air Vehicle Package**

Native Matlab-based Linear Air Vehicle Models



# MSDS Candidate M&S Continued



- **Six DOF Air Vehicle Package**

Native C/C++-based 6 DOF Nonlinear Air Vehicle Models

Closed Loop Simulator (CLS) (C-based)

Wind tunnel test data

Atmospheric disturbance models

Dryden turbulence model



# MSDS Candidate M&S Continued



- **Air Traffic Models Package**

Simulators/stimulators for sensors (e.g., Due Regard Radar, Electro-Optical/Infrared (EO/IR))

Simulators/stimulators for cooperative air traffic (Traffic Collision Avoidance System (TCAS), Automatic Dependent Surveillance - Broadcast (ADS-B), Identification Friend or Foe (IFF), Inertial Navigation System (INS))

MAPES

MIT Lincoln Laboratory air traffic models and traffic simulator/generator

Historical air traffic models/data from Federal Aviation Administration Mission Control System (MCS) operator interface or surrogate simulator



# MSDS Candidate M&S Continued



- **Collision Avoidance Package**

Air Traffic Models Package

Live/Virtual/Constructive Distributed Environment (LVC-DE)

Simulation Analysis Facility Extensible M&S Environment

Massachusetts Institute of Technology CA Models

Collision Avoidance System Safety Assessment Tool (CASSATT)



# MSDS Candidate M&S Continued



- **Radar Computer-Aided Design (CAD) Package**  
Solidworks  
Radar Computer Aided Design (CAD) models



# MSDS Candidate M&S Continued



- **EO/IR Performance Package**

MODerate spectral resolution atmospheric  
TRANsmittance (MODTRAN)

Night Vision and Electronic Sensors Director/Directorate  
(NVSED) Sensor Performance Models

Night Vision Thermal (NVTherm) models

Solid State Camera and Image Processing Model  
(SSCamIP) models



# MSDS Candidate M&S Continued



- **Track Package**

Mission Control System Testbed

Modeling and Simulation Systems Integration Laboratory (MSSIL)

- **Radar Performance Package**

Radar candidate model & tool update available after Supplier Preliminary Design Review

- **Communication Connectivity Package**

Joint Communications Simulation System (JCSS)

- **Multi-UA Control Package**

UA Hot Bench

JCSS



# MSDS Candidate M&S Continued



- **Payload Control Package**

UA and Sensor/Payload Hot Bench

JCSS

- **Mission Planning (MP) Flight Model Package**

Simplified 6DOF or Linear Air Vehicle  
performance/dynamic model (or envelope)

Closed Loop Simulator

- **Mission Planning Sensor Models Package**

Sensor parametric performance models (or envelopes)

General Image - Quality Equation (GIQE)

National Imagery Interpretability Rating Scale (NIIRS)



# MSDS Candidate M&S Continued



- **Mission System Trainer Package**  
Native MST being developed at NGC  
Vega Prime
- **Test/Demonstration Supporting Package**  
Identified by the BAMS Critical Design Review



# Summary



- The M&S IPT is a coordinating IPT in that it facilitates contractor cooperation with the Navy System IPTs determine which models and simulations to use.
- A structure has been put in place to facilitate VV&A of models and simulations which is straightforward (document, evaluate, accredit).
- Accredited M&S supports the risk-aware satisfaction of BAMS system specifications
- Any design or implementation problems that can be found and fixed early will lead to greater BAMS program safety and success