Improving T&E Participation in the Requirements Generation Process

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"The Role of the T&E Community in the Requirements Process"

Requirements Generation

- **The Government regularly conducts analysis to determine requirements, select system capability parameters, perform cost-benefit trade-offs, etc.**
  - **Analysis is a critical element in providing capable, cost effective solutions suitable to requirements**
- **To support this analysis, the analytical community maintains several models and simulations of future warfighting threats and capabilities**
  - **Most studies are tied to legacy Service models**
  - **Threat and System data sets are updated regularly**

Requirements Analysis & Simulation

- **Typically, for an OSD sponsored study of capabilities, each Service or major DoD Agency provides one or more simulations of preference. For example:**
  - Thunder/STORM for the Air Force,
  - ITEM for the Navy,
  - JICM for the Army
  - EADSIM for Missile Defense
  - COSMOS/SEAS for Intel
  - ELIST for Logistics
  - MIDAS for Strategic Lift
  - Pythagoras for SOF

- **These simulations are readily available, but obtaining the data for representing friendly forces, threat forces, and the situation 10 or 20 years out for each of the models has been a challenge**

- **To address this, the OSD Analytical Community* has developed the Analytical Agenda, a collaborative analytical framework, to examine Defense Strategy and Capabilities requirements along with a common source of credible data, the Joint Data Support (JDS) Office**

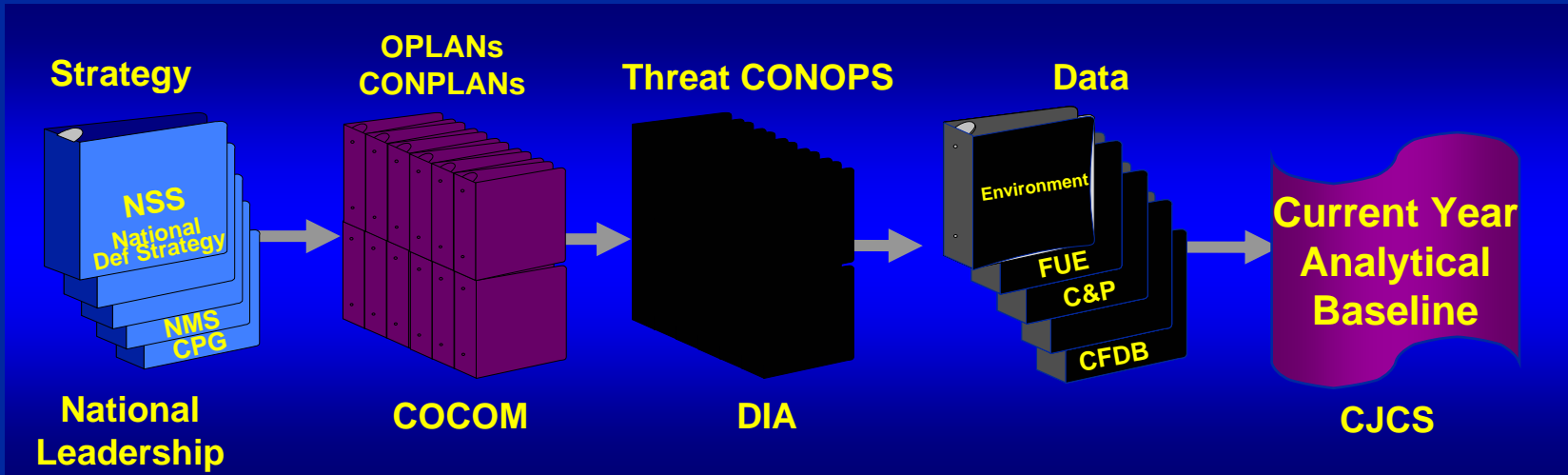*** Office of the Sec of Def (Policy), JCS J8, and OSD PA&E**

Analytical Agenda Tenets

- **Make analyses more effective and relevant for decision-making**
  - Focus debate on assumptions and issues
  - Help synchronize strategic planning activities throughout DoD
- **Provide a common starting point for joint analyses**
  - Scenarios characterize the range of defense challenges
  - Future joint warfighting CONOPS are developed/examined
  - Analytic assessments (baselines, data, and studies) are accessible and well documented
- **Support a collaborative, transparent, and continuously ongoing analytical process with the Services, COCOMS, Joint Staff, and OSD involved**
  - Train and sustain a critical mass of analysts
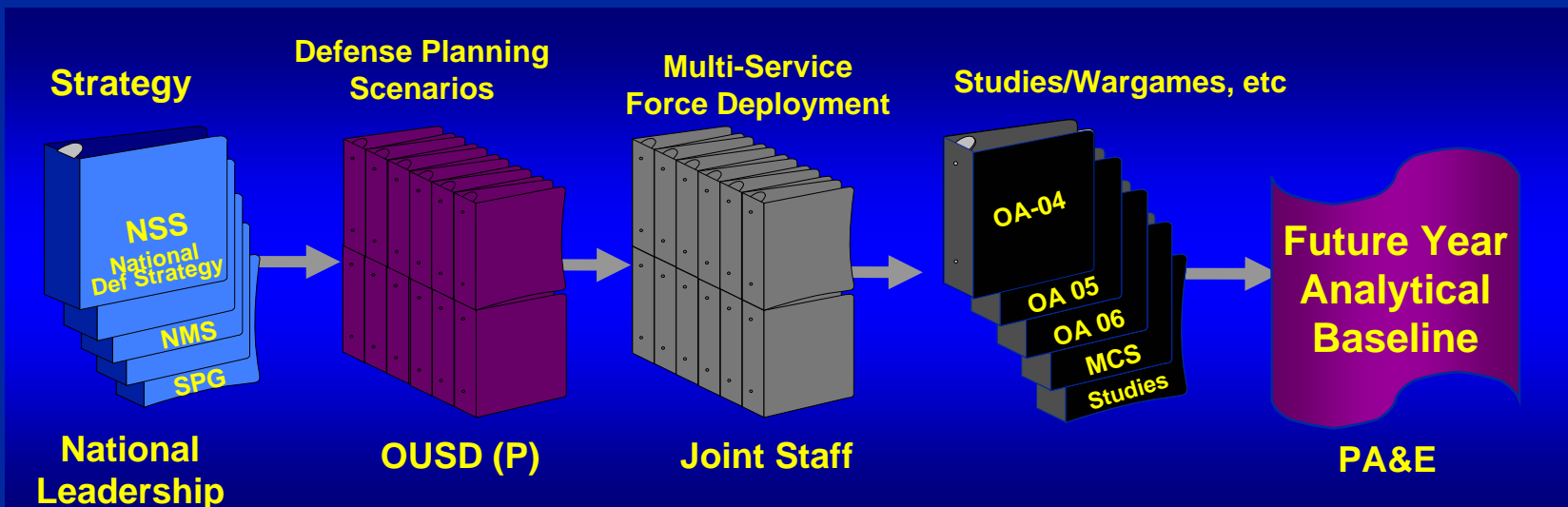 - Managed by OSD Policy, Joint Staff, and PA&E

Create a Common Simulation Environment for Planning, Programming, Acquisition, Testing, Experimentation, and Training
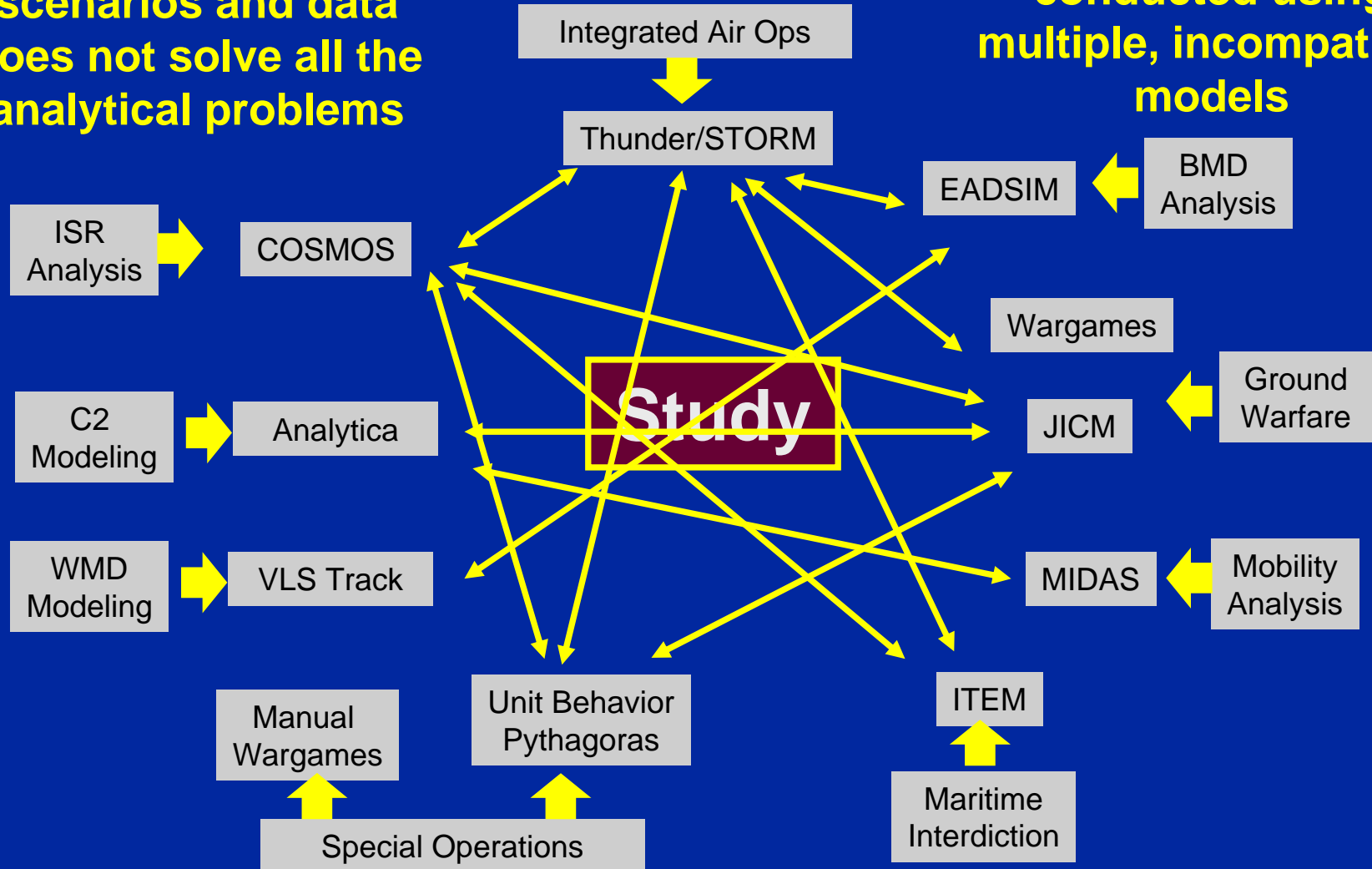
Analytic Community Models

C/Blue is Campaign-level, M/Green is Mission-level, and E/Brown is Engagement-level of detail

Only one model currently stretches across the M&S Toolkit

Alternative Analytical Modeling Methodology

Study Plan

Feeder Area	Model
Integrated Air Ops	→ Thunder/ Storm
BMD Analysis	→ EADSIM
Ground Warfare	→ JICM & Wargames
ISR Analysis	→ COSMOS
C2 Modeling	→ Analytica
Mobility Analysis	→ MIDAS
Special Operations	→ Pythagoras
Maritime Warfare	→ ITEM

Joint Analysis System

Integrated Campaign Analysis
- Integrated Warfight
- Integrated C3ISR
- Integrated Logistics
- Dynamic Behaviors

Common Metrics

Rapid Excursions

Once all the data is in a single model, excursions or new analysis can be conducted without reactivating all the feeder models

Integrated Joint Campaign Modeling

Analysis Paradigm: All input *integrated* into a single, joint environment

J A S

Theater Logistics

Operations

Strategic Mobility

Response

Supplies

"Integrated"

"Integrated"

Continuous Interaction

International Shipping

Local & Regional Infrastructure

Intel, Comms, TBMD, WMD, Warfighting

Requirements

Sustainment

Requirements

Destruction of assets, disruption of deployment network, fact assessments
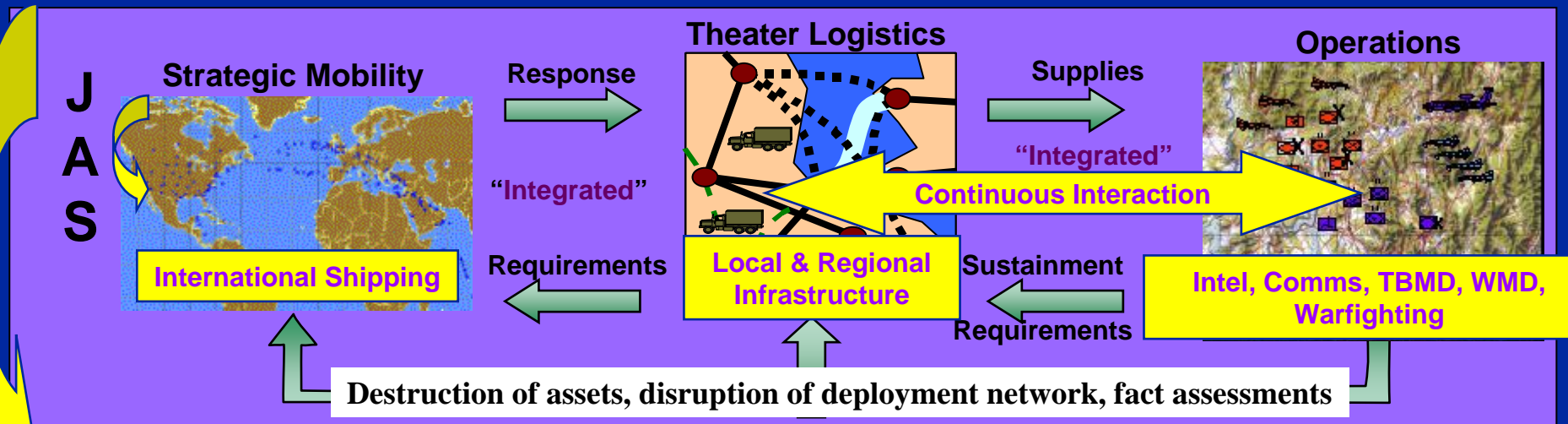
JAS Paradigm:

All CAPABILITY areas *integrated* in a single, operational environment

Basic Scenario Entities: Forces (US Military, Allies, Neutrals, Adversaries, Terrorists, US Government & Host Nation, Civil Agencies, NGOs/PVOs, Populations)

Intelligence, Perception, and Knowledge Base: Multi-source Collection, prior knowledge, rule sets

Organization, Directives & orders, Communications) - C2: Multi-actor Info sharing/ tiered dissemination, Rules of Engagement, Decision Process, Communications Interoperability

Response Plans (CONOPS): Range from Facility –> Port –> Region –> National -> Coalition, entities with both common & unique capabilities

Logistics & Support: Support for Civil Authorities; constrained transportation, food, fuel, and shelter

Agent-Based Operations

- BSE -- a friendly unit, enemy unit, or major system operating in the battle space. Examples:

  - Operational Headquarters   - Land: Units, Neighborhoods
  - Support Headquarters   - Air: Flights, military & civil
  - Airbases and seaports   - Maritime: Ships, small craft
  - Infrastructure: Power, H_2O - Space: Sensors & Comms
  - Civilians
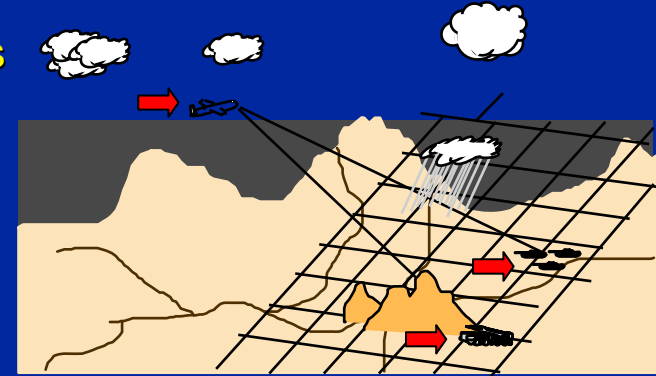
**Effects-based and much
faster than Real Time**

**Basic Scenario Entity
(BSE)**

**Owns or
Controls**

**Command
& Control**

Sensor

**Resource
Account**

Platform

**Communications
Manager**

BSE

"Thinking,"
Planning,
Decision Making

Detecting,
recognizing,
identifying

Tracking the
BSE's assets
and
consumable
resources

Location,
speed,
direction

Communications-
based interface to
other BSEs

**Event-based, stochastic model
providing detailed cause and
effect outcomes**

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JAS C4ISR is Unique

SENSORS → **Explicit COMMS** → **Updated Perception** → **Decisions*** → **Actions**

- **Every Sensor input, including Human Intelligence is recorded**
- **Ground Truth is simultaneously recorded for comparison**

- **Over 70 types of operational messages currently employed (could be increased)**
- **Uses explicit networks with capacities and delays**

- **Simulates information fusion**
- **Common Operational Picture maintained**
- **Sources of all information recorded**

- **Decisions & Actions are traceable to their underlying information**

***
- **Every BSE has a basic Command & Control capability appropriate to the BSEs purpose, e.g. explicit headquarters units, artillery unit, supply and transportation unit, etc.) giving a set of allowable decisions.**

- **A BSE's C2 capabilities are further enhanced by plug-ins which give specific new functionality to either a single BSE or a class of BSEs, e.g. a Supply Planner**

- **Knowledge Bases are assigned to individual BSEs or classes of BSEs to allow them to employ user-selected facts, rules, and actions.**

Joint Data Inputs

Synthetic Environment
- *Solar/Lunar*
- *Atmospheric*
- *Sea/Sub Surface*
  - *Transmission Loss*
  - *Ambient Noise*
- *Terrain*
  - *Movement*
  - *Line of Sight*

CONOPS
- Orders & Plans
  - Land/Air/Maritime
  - ISR Collection
  - Any Other Object
- Formations & Positioning
- Logistics
- Intelligence
- Doctrine

Behaviors/Soft Factors
- *Training Level*
- *Country Of Origin/Side Changing*
- *Morale/Cohesion/Level of Commitment*
- *Degradation of Unit*

Basic Scenario Entities
- Forces/Population Centers
- Units/Civil Groups
- Equipment
  - Characteristics
  - Interactions
  - Performance

Raw Data

Feeder Model   *Feeder Model*

Raw Data   Raw Data

Feeder Model
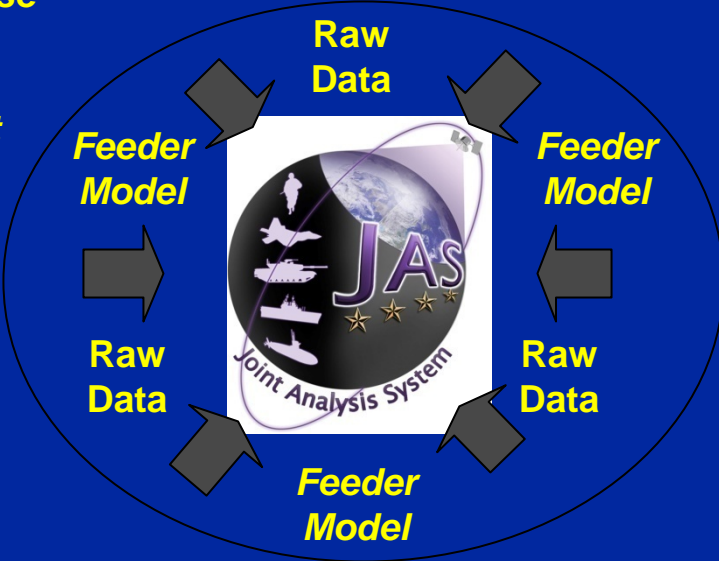
Deployment
- *Origin*
- *Port of Embarkation*
- *Port of Debarkation*

Federation "Hooks" (as req'd)
- HLA Certified/DIS capable
  - JSAF Demonstrated
  - Air Defense Demonstrated

JAS Scenario Levels of Effort

Time (months) — vertical axis (1, 3, 5, 7)

Staff Members/Subject Matter Experts — horizontal axis (1, 3, 5, 7, 9)

MCO – 1 (from scratch)

MCO – 2 (from scratch)

Studies/Scenarios reusing MCO Scenarios

MCO – 2 (QVI Excursion)

HLD Vignette

MCO-1 mini-Excursions

Balanced Joint Domains
Air
Maritime
Land
SOF
Space
with
Communications
ISR
Logistics

- Large Analytical Baseline Scenarios builds are data intensive and require ~ 9 persons 6 months to build whether in a set of legacy models or in JAS
- However, excursions are quick using existing JAS scenarios
- Reusing an existing scenario to conduct studies and evaluate plans requires much less effort
- The concept is to maintain the major scenarios in a status where they can be provided in executable format to any interested (and approved) user

Why Test in a Complex Environment

- **T&E Community can quickly perform rigorous constructive simulations with known data sets**
  - **Enables an "Apples to Apples" comparison**
  - **JAS covers a wide range of realistic, cross-functional scenarios**
- **Provides the ability to Test, Remodel, and Retest Prior to first LRIP in a credible analytic scenario**
  - **Cuts production *and* pre-production costs**
  - **Allows the T&E Community to identify flaws early**
    - » Recommend vital changes to design, and rerun the simulation
- **Offers opportunity to apply early test results to the original National Planning Scenarios**
  - **Assess operational implications of shortfalls or expanded capabilities**

Cost of Change
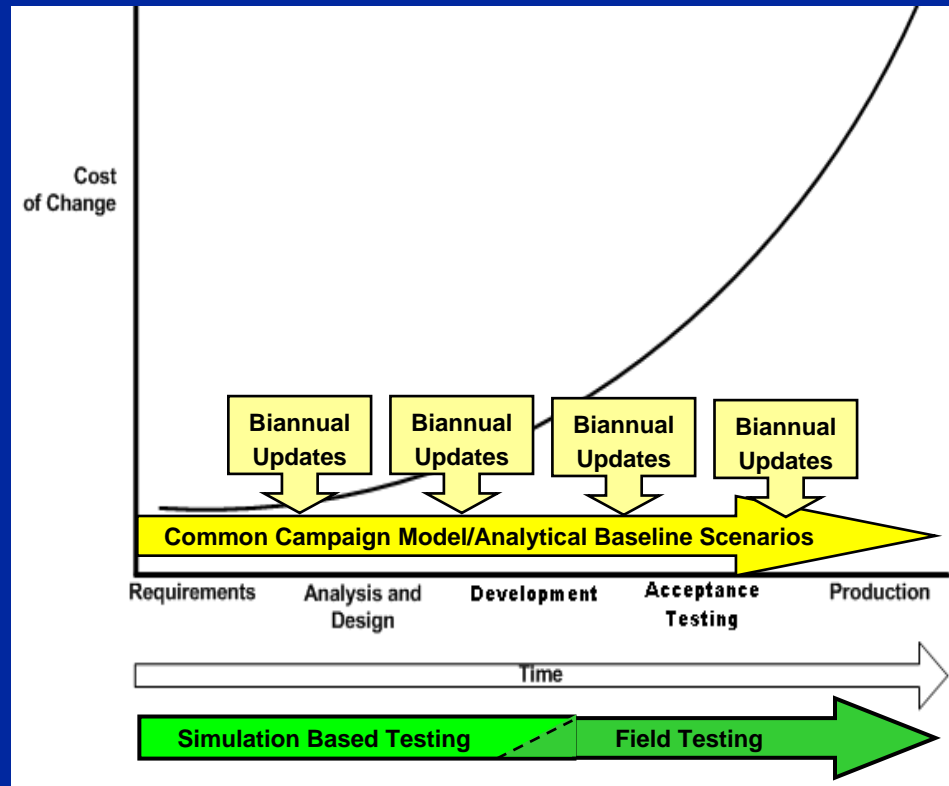
- **Cost of change rises exponentially with time**
- **JAS provides ability to efficiently model the system under test during Analysis & Design phase**
  - **Lowers the cost of change**
  - **Increases the likelihood of successful acceptance test**
- **Enables engineering community to create best of breed solutions**

# Regional Geography Used in the Trident Warrior Wargames
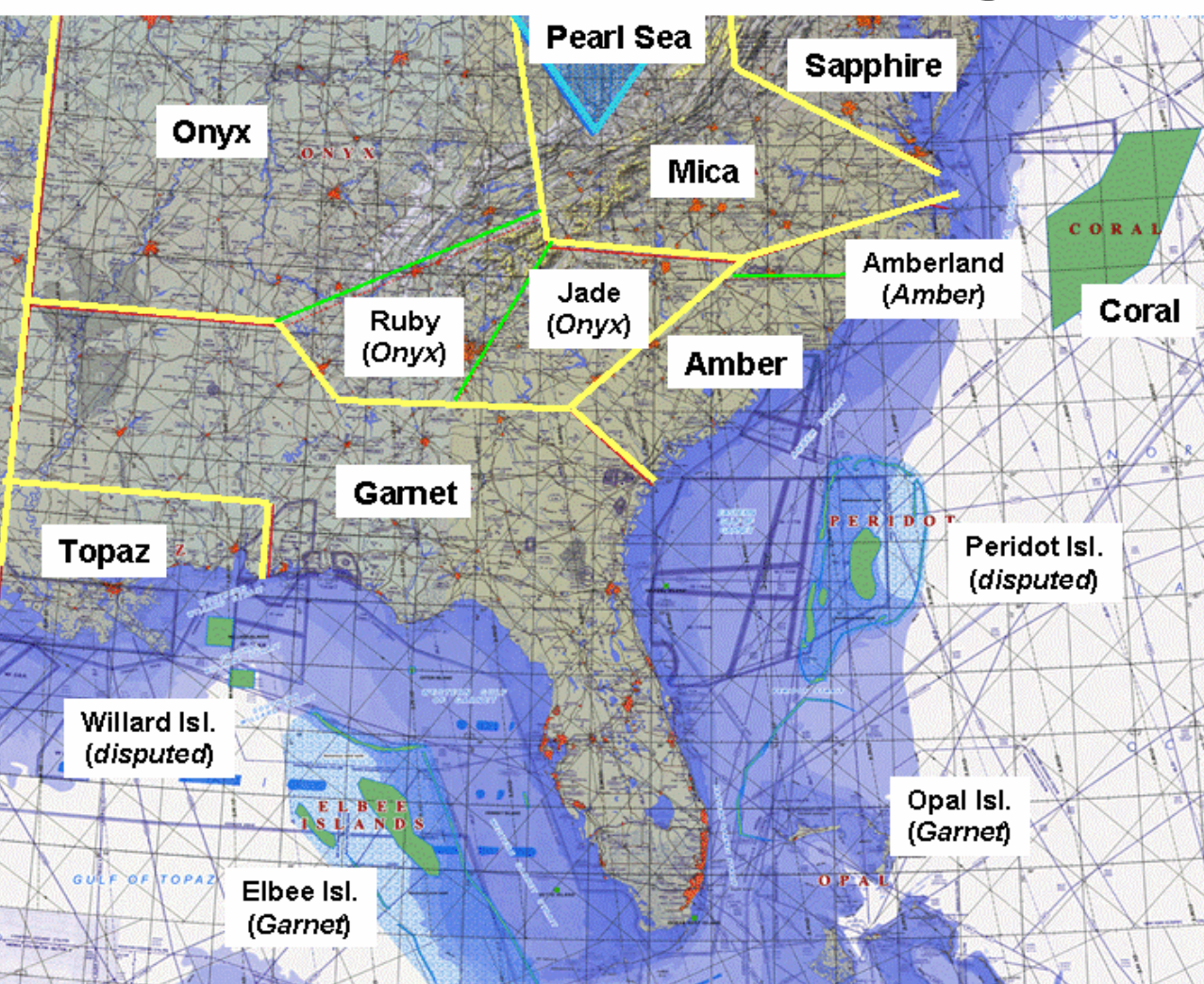
- **Multiple sides,**

- **Countries and non-state BSEs can change sides,**

- **Considerable coordination and communication of military and civilian law enforcement**
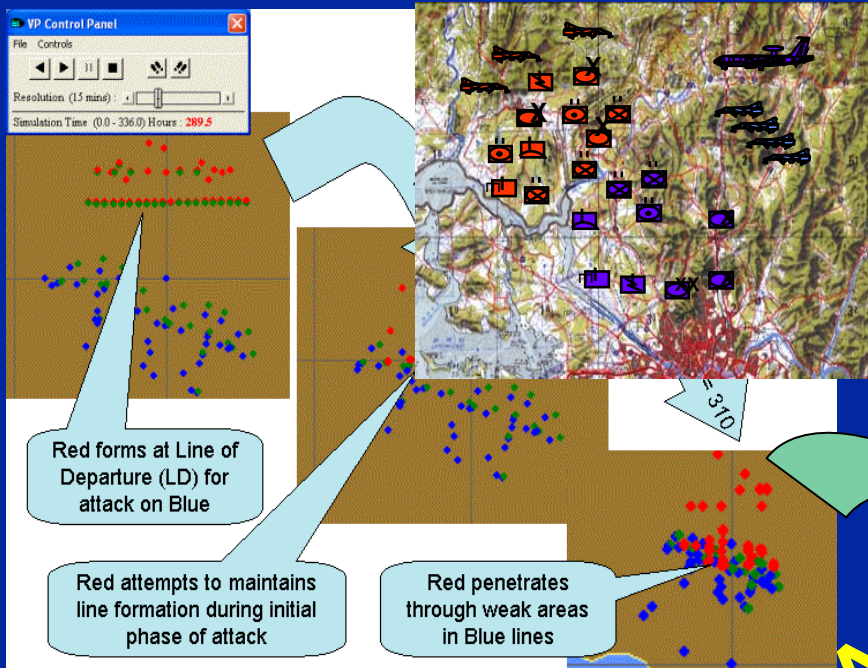
Illustrative Findings
- **Initial level of Alert critical to outcome**
- **Most plans do not address an adaptive opponent**

Humanitarian Support Scenario

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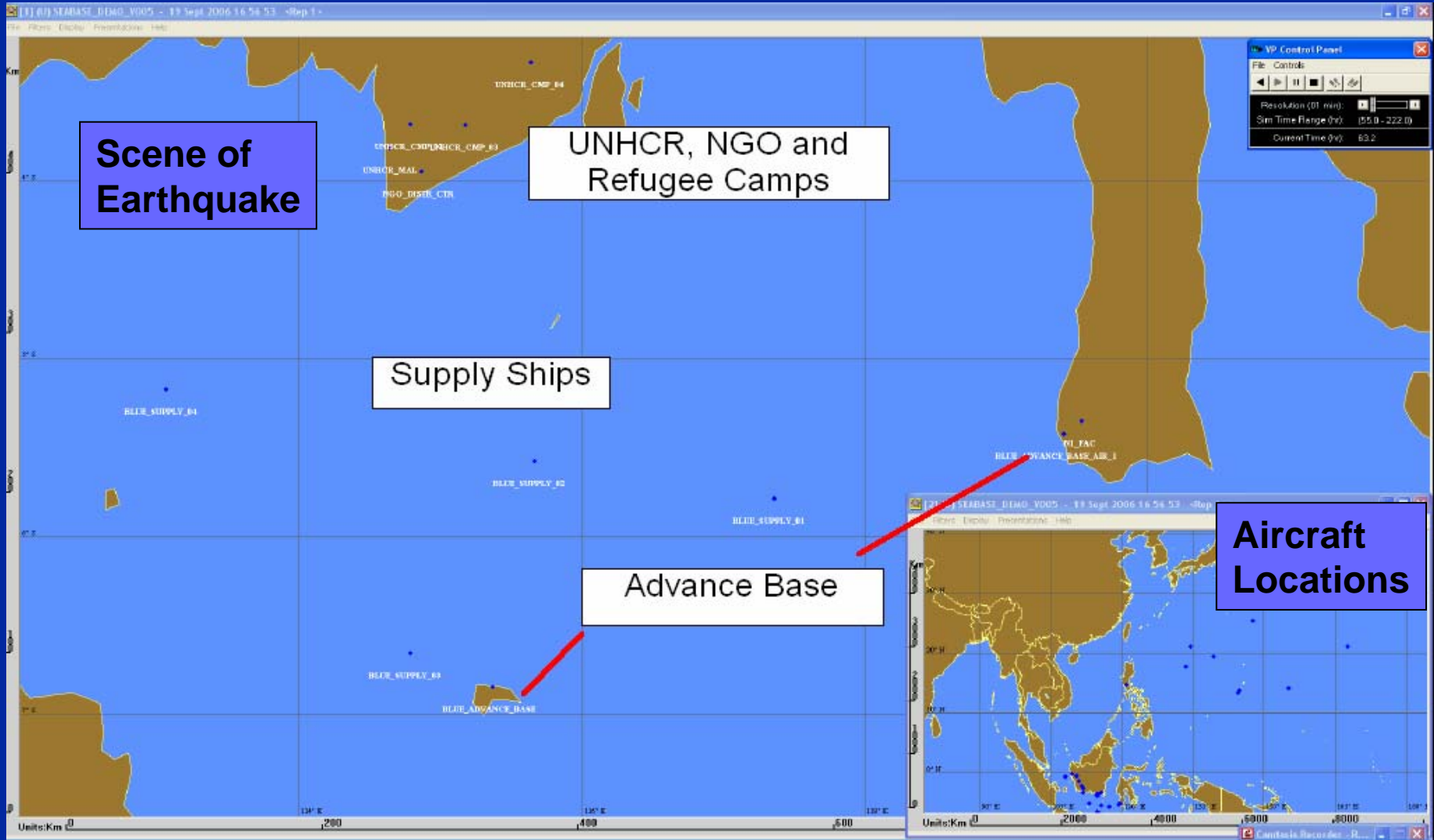
JAS Can Federate with Mission-Level Models

JAS

- • **Campaign-level**
- • **Aggregate units**
- • **Measures of Effectiveness**

Red forms at Line of Departure (LD) for attack on Blue

Red attempts to maintains line formation during initial phase of attack

Red penetrates through weak areas in Blue lines
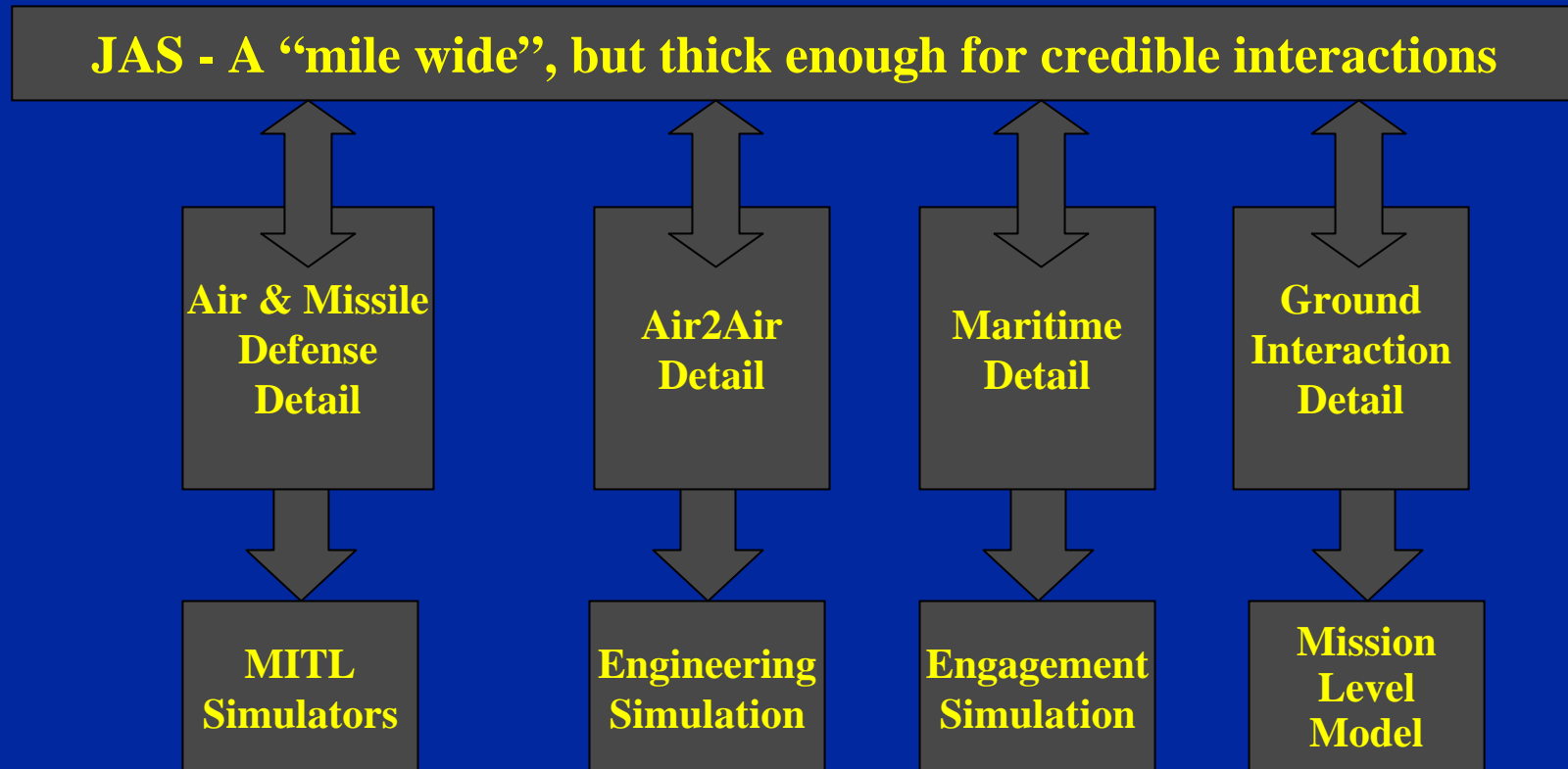
HLA Federation

JSAF

- • **Mission, in a Campaign context**
- • **Views of Individual Platforms**
- • **Measures of Performance**

JAS as a Test Context Generator

- **Covers the full breadth of the Theater and its external support elements**
- **Uses executable scenarios from the Analytical Baseline for credibility**

JAS - A "mile wide", but thick enough for credible interactions

Air & Missile Defense Detail	Air2Air Detail	Maritime Detail	Ground Interaction Detail
MITL Simulators	Engineering Simulation	Engagement Simulation	Mission Level Model

Federating with various models involves some effort, but once completed, other users can employ the same interface

Summary

- **The T&E Community has the opportunity to participate in using a common analytical simulation framework and scenario context to potentially unify the basis of requirements generation, acquisition, and testing. This automatically links early test simulation effort to the Defense Planning Scenarios and the OSD Analytic Baselines**

- **JAS is executable GFE software and comes populated with data and scenarios (currently 10 available)**

  - **While scenario development from scratch is hard, excursions from existing scenarios are relatively easy to run. A mix of both Analytical Baseline (MCO-1 and MCO-2) and Title 10 scenarios are available for immediate execution and instant credibility with minimum effort. Focus can be on the proposed tests and evaluation, not on building scenarios.**

  - **Cost of ownership is low. Replications generally run on PCs in the Windows, Unix, or Linux operating system. The larger, more complex scenarios require considerable data storage and servers to capture all the output.**

  - **HLA federation capability allows straight-forward access to more detailed models and human-in-the-loop simulators that can represent proposed systems to be tested in high detail in a full theater context.**

BACK-UP

What are the Products
of an Analytical Baseline?

- **Scenario description**

- **Concept of Operations (CONOPS)**

- **Joint, Service, and Threat Data**

- **Initial assumptions, methodology, analytical results, insights, and challenges**

- **Documentation, usually in paper or electronic format**

- **With the addition of JAS to the family of analytical models, an analysis can also produce an executable and maintainable simulation of the specific Scenario, Plan, or Exercise of interest. This can form the basis for further studies or excursions using the same validated scenario.**

  - **Over a dozen major scenarios are either completed as the basis for analytical baselines or are in development.**

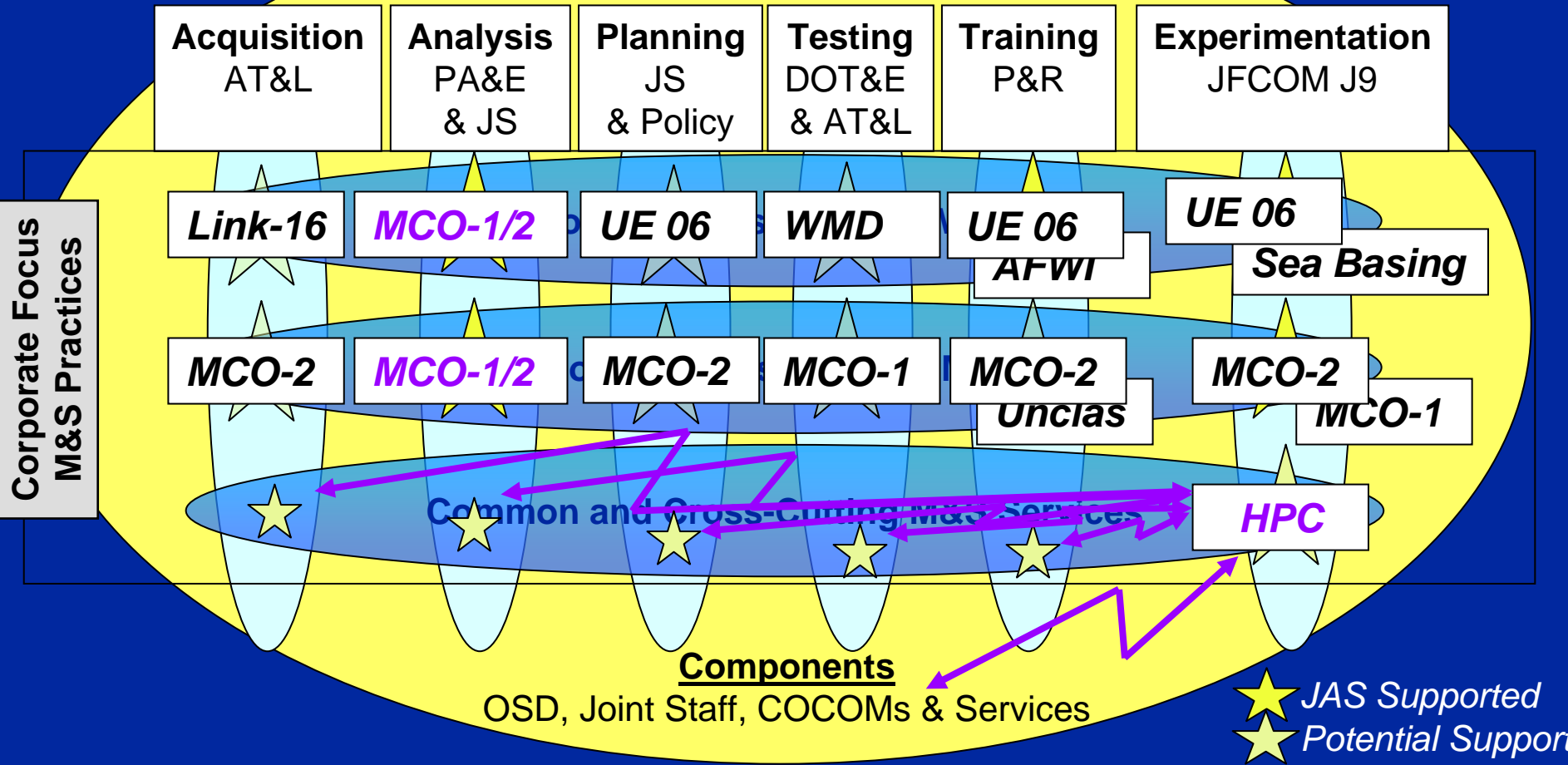 - **Three of these MCO's have been translated into JAS.**
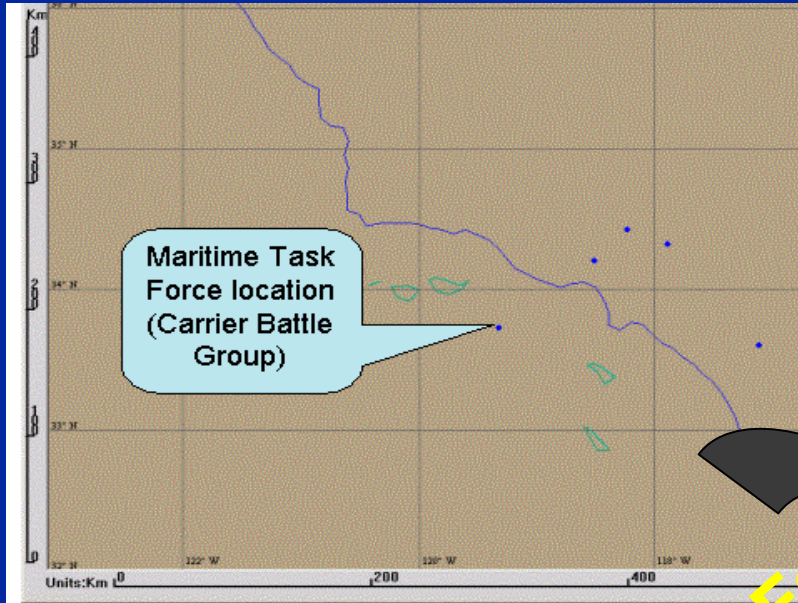
Analytic Agenda Future
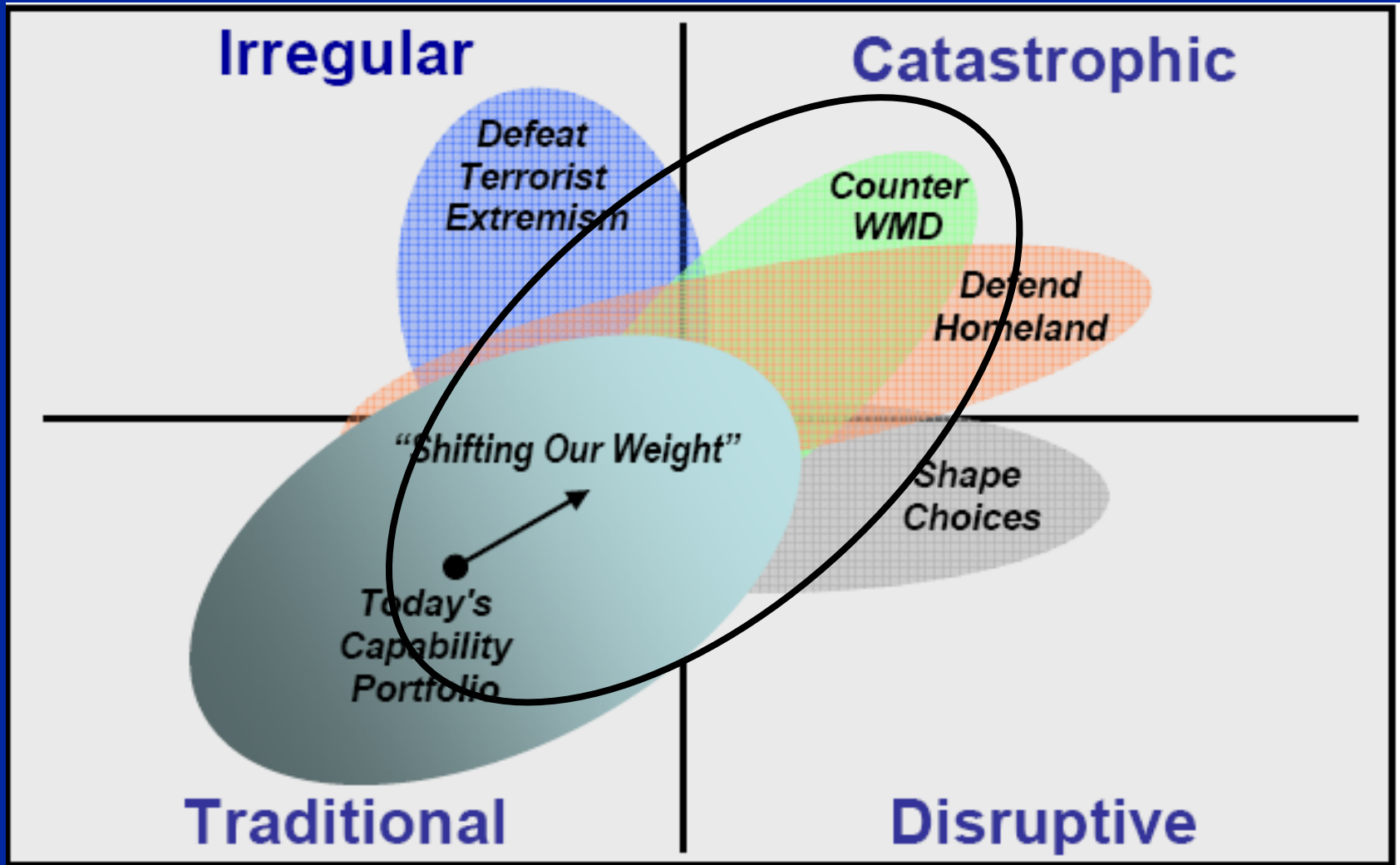
DoD M&S Framework and JAS

- Organized by Communities
- DoD M&S coordination structured to support the Communities

Corporate Focus M&S Practices

Acquisition AT&L	Analysis PA&E & JS	Planning JS & Policy	Testing DOT&E & AT&L	Training P&R	Experimentation JFCOM J9
Link-16	MCO-1/2	UE 06	WMD	UE 06 / AFWI	UE 06 / Sea Basing
MCO-2	MCO-1/2	MCO-2	MCO-1	MCO-2 / Unclas	MCO-2 / MCO-1

Common and Cross-Cutting M&S Services

HPC

Components
OSD, Joint Staff, COCOMs & Services

★ JAS Supported
★ Potential Support

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Maritime HLA Example from a Common Scenario

Maritime Task Force location (Carrier Battle Group)

JAS Aggregated Campaign Level
- **Combatant locations and interactions**
- **C4ISR interactions**
- **Weather/Sea Conditions**

HLA Federation

JSAF Disaggregated Mission Level Representation