Integrated Representation of the Natural Environment

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Motivation

- In many cases, a simulation’s fidelity depends on interaction with the environment
  - Aircraft tactics based on clouds and visibility
  - Naval tactics based on acoustic performance
  - Troop movement rate determined by ground wetness

- Environment must be realistic and consistent
  - Should see ground get wet if it rains
  - Should see ocean response to high winds
Integrated Natural Environment

Processes
- Climate
- Weather
- Hydrologic Cycle
- Sea State
- Surface and Subsurface Flows
- Terrain surface and Features
- Ocean Parameters
- Transmittance
- Illumination

System Performance
- Flight Routes
- Route Selection
- Weapon Effects
- Mobility
- Line of Sight
- Visibility
- Acoustic Tracking
- Course of Action

Natural
- Dynamic Terrain
- Weather Models
- Hydrologic Modeling
- Elevations
- Features
- Bathymetry
- Climate
- Physical Parameters

Synthetic
- Decision Makers
- Behavior Models
- The Same
- Sensor
- Course of Action
- Line of Sight
- Acoustic Tracking
Environment Representation for M&S

- **Real vs. Realistic Data** - The complexity of today’s simulations and training events demand physically consistent environment representations however…

  - Live forecast data is not the answer
    - No control over the conditions at game time

  - Climatology data is not the answer
    - Can’t run physics based models against “average”

  - Historical Re-analysis provides the right mix
    - Build the underlying “ground-truth” representation to the best of your abilities
    - Control the conditions by selecting the right scenario
    - Derive all other products
    - Bounded by realism (if it never happened …)

All weather parameters match customer objectives
The Challenge

Create a physically consistent, cross-domain authoritative “ground truth” environmental representation that meets user requirements.

Integrated Natural Environment Authoritative Representation Process (INEARP)

DoD Production Centers
Environmental Scenario Generator (ESG)
- Identifies historical scenarios that provide relevant conditions
- Provides the Integrated Environment Representation
- Common Open Services for Integrated Natural Environment (COSINE)

Space Environment Impact System (SEIS)
- NGDC Developed Space domain overlay to ESG / EDCSS

Environmental Data Cube Support System (EDCSS)
- Provides consistent views of the Environment Representation to the C4I, Control Group, and Simulation domains
- Efficient runtime distribution and inject of data and effects
Environmental Scenario Generator

- Scenario Search Mechanism
  - Rapidly searches historical archives
  - Fuzzy-Logic Classification
  - Weapon System Impacts
  - Interactive Data Analysis

- Produce Realistic Data Sets
  - High-Quality data and models
  - Recreate historic scenarios
  - Customized post-processing
  - Standard/Custom formats
ESG and SEDRIS

- ESG offers delivery of gridded (2D) data in SEDRIS V4.1.1
  - Content limited to that supported by EDCS
  - Current capability developed specifically for FCS support
- ESG utilizes SEDRIS technology components
  - EDCS for terminology definitions and mappings
  - Write API for the generation of V3.x STF
  - Grb2stf conversion tool for generation of V4.x STF
- Additional SEDRIS technology could have been used in ESG/COSINE for internal processing
  - SEDRIS offered no Java bindings at time of development
  - ESG metadata could have been based on SEDRIS DRM if XML schema elements defined
  - ESG internal terminology maintained neutral of any one standard
Environmental Data Cube Support System (EDCSS)

National Repositories
- DoD Ops/R&D Centers
- NOAA Data Centers
- Other Domain CoE

Integrated Environment Representation Production

Product Generation

Distribution

Integration

Simulation

White Cell or Analyst

COP (C4ISR)
**EDCSS Correlated Products**

FTUS80 KWBC 110300
RKJK TAF 110303 04006KT 9999 SKC QNH3005INS
BECMG 1107/1109 35007KT 9999 SKC QNH2988INS
BECMG 1113/1115 09010KT 9999 SKC QNH2991INS
BECMG 1119/1121 04009KT 9999 SKC QNH2986INS
BECMG 1201/1203 03011G25KT 9999 SCT270 QNH2969INS
BECMG 1207/1209 33017G37KT 9999 SKC QNH2967INS

METAR RCMQ 110300Z 31016KT 10SM BKN140 30/25 Q0970

Consistent Integrated Representation EDCSS
Communities of Interest
Environmental Representation Integration Projects

Acquisition  Analysis  Planning  Testing  Training  Experimentation

Common and Cross-Cutting M&S Tools
Common and Cross-Cutting M&S Data
Common and Cross-Cutting M&S Services

ASNE

ASNE Goals: Interoperability, Reuse, Efficiency
LPD-17
Probability of Raid Annihilation (PRA)

- Integrated air/ocean data set for use in Radar simulation
  - Delivered test data set containing atmospheric parameters and sea heights
  - Created data for Mediterranean Sea play boxes
- Provided NRL Stennis with 10 year archive of ACMES data used to create 10 year wave model archive that can be used ISO of future LPD 17 efforts and others
Army Special Operations Training and Rehearsal System (ASTARS)

- H-60 Helo simulator
- Used ESG to find scenario for Ft Campbell KY
  - Produced and delivered high resolution (5 km) data set based on ACMES data
  - Produced higher resolution data set for entire CONUS (reuse)
- ASTARS PM selected ESG as the data provider of choice for the initial training data sets
# OSD/Service Programs Leveraging Environmental Data

<table>
<thead>
<tr>
<th>LEAD</th>
<th>FLAGSHIP COMMUNITY PROGRAMS</th>
<th>Integration Level</th>
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<tbody>
<tr>
<td>Army</td>
<td>Future Combat Systems (FCS)</td>
<td>Started, Partial</td>
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<td>One Semi-Automated Forces (ONESAF)</td>
<td>Partial, Fully</td>
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<td>Army SOF Aviation Training and Rehearsal System (ASTARS)</td>
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<td>Air Force Modeling and Simulation Training Toolkit (AFMSTT)</td>
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<td>Air Force</td>
<td>Talon SHU</td>
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<tr>
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<td>Storm</td>
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<td>Joint Expeditionary Force Experiment (JEFX)</td>
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<tr>
<td>Joint National Training Capability</td>
<td>Joint Live-Virtual Constructive (JLVC) Federation</td>
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<td>Terminal Fury</td>
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<td>Austere Challenge</td>
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<td>Joint Conflict and Tactical Simulation (JCATS)</td>
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<td>Urban Resolve 2015</td>
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<td>Unified Endeavor/Horn of Africa MRX</td>
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<tr>
<td>Analysis</td>
<td>Unified Engagement</td>
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<td>Next Generation [aircraft] Messaging System (NexGEN)</td>
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<td>Hazard Prediction and Assessment Capability (HPAC)</td>
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<td>National Warfare System (NWARS)</td>
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Benefits and Impacts

- **Benefits of continued investment in environmental representation:**
  - The use of interoperable environmental representations and their effects will increase within the DoD
  - DoD will have the capability to produce scalable, deployable environmental scenarios;
  - DoD will have the ability to integrate EDCSS capabilities into other DoD and Inter-Governmental agencies
  - DoD will have the ability to provide access to environmental M&S capabilities in support of emerging requirements for various DoD systems.

- **Negative impacts if no longer available:**
  - All of the benefits noted above are lost
Summary

- Realistic M&S requires high-fidelity, consistent, and relevant multi-domain environment representations

- The INEARP provides the roadmap. ESG and EDCSS are two key enabling technologies
  - National data and modeling assets provide the content

- The ASNE MSEA is working with the Ocean and Terrain MSEA’s to realize the full INEARP vision