Navy Warfare Development Command

13th Navy Technical Interchange

Chief Engineer
Director, Modeling and Simulation
Navy Warfare Development Command
MBGIE Technical Objectives

- Establish a Navy Continuous Training Environment (NCTE) Architecture and east/west coast baseline for Strike Group and Multi-Strike Group Training.
- Integrate the Battle Force Tactical Training Architecture and design in consideration of legacy limitations into the NCTE.
- Design with JNTC requirements, as we understand them, in mind. Develop and propose standards for the JNTC Architecture.
Technical Challenges

• 4 Months to design, engineer, install, contract, test, integrate, rehearse, document

• Solve key technology issues
  – Simulation Loading (2500 entity scenario to systems capable of 128 entities)

• Interface LOS radio capability among Fleet Concentration Areas

• Test with inconsistent availability of participants

• Reroute east coast SIPRnet and build new TDL path due to HREN failure

Required team of dedicated Professional Modeling and Simulation Engineers
One, common, geographic-centric environment
Simulation Data Management

JS AF

DDM

JS AF

DDM

JS AF

DDM

HLA/DIS GW

BFTT TDL NES Based DIS Broadcast Network

DIS/DIS GW

Geographic Filter

Geographic Filter

Theater - wide Area of Interest

Strike Force Area of Interest

Unit Sensor Determined Area of Interest

> 50K Entities

> 800 Entities

> 128/256 Entities
Simulation to C4I
Stimulating the War Fighter

Interphase C4I Generation Interface

HLA Environment

ASSET
AUTO SIGS
U2 TENCAP
C4I GW
Predator JSTARS MUSE
MLST3
HLA/DIS XFACE
IT Apps

Nat'l ELINT TAB 37
Nat'l Imagery NITF 2D SAR/I
OTM Gold USMTF ELINT MEDAL TACFIRE
Streaming Video/MTI Telemetry
TADIL J TADIL DIS Simulation
Voice/VTC Control

SIPR to NMCC
TDDS to Ships
SIPR to ONI JCA to Ships
DREN to TTGs BLII to Ships
DREN to TTGs SIPR to Ships
DREN to TTGs BLII to Ships
DREN to TTGs JTIDS to Ships
DREN to TTGs BLII to Ships
DREN to TTGs Radios to Ships

TDDS
TBMCS
PTW
IPL
CBTSYS
MIDS/IDB
GCCS-M
**MBGIE Architectural Concept**

**One, common, geographic-centric environment**

- **Bremerton**: Control Net to CVN
- **Everett**: TDL to Ship, VOIP to Ship
- **NAS Fallon**: EP-3 MAST, VoIP, M&S net
- **M&S Simulation Federation**: between Newport, San Diego, and Dam Neck
- **SIMS Hall, NWDC**: TTGL Gallery Hall and Train Hall

**Link**
- OTH-Gold
- TACEINT
- TACREP
- Voice Nets
- VTC
Addressing Standards

- Entrée to Navy Inport Training Architecture
- High Level Architecture simulation baseline
- HLA/DIS Interface Specification and Hardware
- H323 Voice and VTC Communications Standards and Specification (Not a simulation standard such as ASTi)
- Link 11 and Link 16 Interface Specification
- Network responsibilities and divisions
  - Simulation (dedicated)
  - Control (Voice, data, VTC) dedicated
  - Operations (SIPRnet)
Communications

Architecture and Standards

- Design and Architecture support future growth
- Support three required networks
  - Red Simulation Net
  - Red Voice, VTC and Data Net
  - Black Voice, VTC, and Data Net
- Layer 2 ATM Long Haul circuit
  - DATMS, DREN, DISN-LES
  - Fast ATM Encryption of all three networks required for simulation and VoIP
- Layer 3 Supports Multicast
  - Supports simulation subscription groups for simulation scalability issues
  - Supports bandwidth conservation of multicast applications
  - Supports MCU conferencing scalability issues
  - Isolates Simulation PIM Dense mode and data PIM Sparse modes
- Layer 3 and 4 Support of COS and QOS
  - Supports H323 VTC and VoIP
Design Incorporates

- Long Haul connectivity among central nodes at San Diego, Dam Neck, Newport, JFCOM
- Metropolitan connectivity between TTGs
- Ready for future connectivity to EWTGs and FITC/NMITC
- Uses VoIP as intercom and long haul voice and tie between LOS radios coast to coast
- Allows hundreds of “nets” to be setup via S/W and MCUs
- VoIP ties into uncovered radios and public phone switch on Black side
- VoIP ties into encrypted radios on Red Side
- Data ties into SIPRnet on Red Side
- Will support both H323 and H320 VTC coast to coast
- Simulation ties into pier side distribution on Red Side (places all controls for VTC in the hands of the trainers)
Inport Architecture

- Gateways and specifications maintain configuration management on each side
- Define Interface Specification to the Navy Training Architecture
NWDC M&S and Engineering Methodology

To create a simulated environment where war fighting concepts involving process (Doctrine & TTP), organizations, and technologies can be “end to end,” repeatedly stimulated in a robust, scalable manner in the field and laboratory.

High Fidelity, Immersive Simulation Technology
Synthetic Natural Environment

Integrated environmental models and databases to form a **Realistic, Tactically Significant Dynamic Battlespace**

- **Terrain**
  - STOW databases
  - World Wide TDB terrain generation process
- **Ocean**
  - Bathymetry
  - Integrated/coupled wind / waves / surf/water column
- **Atmosphere**
  - Real-time and historical weather
- **Dynamic environmental effects in each domain**
  - Dynamic terrain, dynamic METOC
JSAF: NWDC’s Modeling & Simulation System

- Environmental features include:
  - Topography
  - Bathymetry
  - Obstacles, roads, airfields, ports
  - Population centers
  - Environmental conditions with
    - ATLOS: Acoustic Transmission Loss
    - OASES: Ocean, Atmosphere, Space, Environmental System
  - Geographic areas
Adding Sonars to JSAF

**Evolutionary Lifecycle Approach Used**

- Initial Sonar Modeling - Global Wargame 2001
  - Passive Sonars Only; Static MIV Tables Pre-computed
- Second Spiral - FBE India
  - Passive and Active Sensors, Simple Sensor Nets
  - Limited set of ship radiated noise data files; specific sensor data
  - Static, Pre-computed Passive Prop Loss (MIV) and Active Prop Loss/Reverb
- Third Spiral - FBE Juliet
  - Passive and Active Sonars, Complex Sensor Nets; Weapon Sonars
  - Continued improvements in characterization of ship noise and sensor performance
  - Dynamic Passive Prop Loss; Static Active Prop Loss/Reverb
- Forth Spiral FBE Kilo
  - Passive/Active Sonars, Sensor Nets, Dynamic Passive and Active Prop Loss & Reverb Loss; LFA
  - Noise Interference Due to Local Shipping (Noise Masking); Active Ping Intercept
JSAF Approach to Sensor Modeling

• Collaborative Engineering among
  - NWDC
  - Navy Oceanographer
  - Naval Research Laboratory
  - Defense Modeling and Simulation Office
• Free play environment = no canned results
• Real-time calculation keeps sensor effects in-sync with war game.
• Real-time calculations change with environmental changes and geometry changes according to the environment
• Resolution equivalent to best available tactical decision aids (validated results with PCIMAT/NITES II).
• Model both the sensor effects and track reporting processes.
• Maximize re-use of existing Navy infrastructure.
Example: Real-Time Sonar Modeling

3-D Ocean Profile
Historical or Current Conditions

User Controlled Maneuvers and Operating Modes

Shallow Water Multi-path Effects

Target Tracking

Real-time calculation at sonar refresh rate

NIMA bathymetry and OAML bottom types

Signal Excess Calculation = SL - TL + ( NL - DI ) + DT
Passive Sonar Model

**Passive Sonar Parameters**
- Directivity Index
- Noise
- Frequency Bandwidth Length
- Max. Detection Range
- Sensor Duration
- Flow Noise (On/Off)
- Sonar Type
- Det. Threshold

**Radiated Noise Parameters**
- Narrowband Frequency / Source Level (4 sets)
- Broadband Frequency / Source Level
- Propulsion Source
- Propulsion Source Level
- No. of Propellers
- Propeller Turns per Knot
- Gear Contact Rate

**Environmental Parameters**
- ATLoS
- Passive Transmission Loss
- Bathymetry
- Precipitation Rate
- Distant Shipping Noise Level
- Ambient Noise

**JSAF Parameters**
- Ship/Sonar Position \((x,y,z)\)
- Target Position \((x,y,z)\)
- JSAF
- JSAF
- Ship Course, Speed

**Passive: \(SE = SL - TL - DT - NL\)**

**Italicized Text - User Modifiable via GUI**
Active Sonar Model

**Active Sonar Parameters**
- Directivity Index
- Frequency Bandwidth
- Max. Detection Range
- Det. Threshold Noise
- Det. Threshold Reverb
- Flow Noise
- Ping Cycle
- Transmit Power (SL)
- Pulse Length
- Sector Scale
- Coverage Area
- Sonar State

**Environmental Parameters**
- Active Transmission Loss
- Active Reverberation Loss
- Bathymetry
- Precipitation Rate
- Distant Shipping Noise Level
- Ambient Noise

**Contact Report**
- Target ID
- Position
- Classification
- Category

From JSAF

**Active: SE = SL + TS - 2TL - (NL + RL+DT + N+R)**

**Radiated Noise Parameters**
- Ship/Sonar Position (x,y,z)
- Target Position (x,y,z)
- Ship Course, Speed

**JSAF Parameters**
- Target Strength

Italicized Text - User Modifiable via GUI
JSAF Propagation Loss Modeling

- FNMOC In-Situ Forecasts
- MEL In-Situ Historical Climatology
- GDEM-V
- NIMA Terrain Databases
- OAML Bottom Loss
- OASES Environment Server
- ATLOS Sonar Propagation
- CTDB Terrain
- TL Request
- TL Response
- Atmosphere
- Inter-visibility
- EREPS Radar Propagation
**JSAF in Counter Small Boat Study**

- Analysis required adequate fidelity of environment coupled:
  - with sensors (sea state vs radar detections)
  - with mobility (sea state vs small boat movement)
  - with accurate modeling of weapon capabilities (Modeling of stabilized and un-stabilized weapons)

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**Sea Return Modeling**

**Weapons Ballistics**

**EREPS Propagation Ducting, OTH, Rough Sea Surface**

Obscuration by wave action

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**Joint Semi-Automated Simulation (JSAF) - Behaviorally Accurate, Autonomous Forces, Weapons & Sensors fully integrated into the Joint Synthetic Battlespace**
Example: Radar Detection in Rough Seas

EREPS Propagation
Ducting, OTH, Rough Surface

Sea Return Modeling

Obscuration by wave action
Track Data Fusion

DDG51

- SPY1 Radar
  - Sensed Contacts
- SPS67 Radar
  - Sensed Contacts
- Visual Lookout
  - Sensed Contacts
- SQR19 Sonar
  - Sensed Contacts
- SQS53 Sonar
  - Sensed Contacts

- Link Controller
- Link R2
- FOTC Model
- C4I Gateway
- GCCS
- MLST3
- Live Participants
- Link 16
- GCCS TDBM