NCW END-TO-END (NETE) MODEL FOR FUTURE C2 ARCHITECTURE ASSESSMENTS

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Introduction

- **Purpose:** Describe the Current Capabilities of Our NCW IRAD Program (NESTOR) in the Area of End-to-End Modeling
  - Illustrate NCW Operations on the GIG
  - Solicit Feedback on Future Direction

- **NESTOR is...**
  - Net-Centric Environment for System Testing and Operational Research
  - SPARTA’s Distributed Testbed for the Design, Implementation and Quantitative Evaluation of
    » NCW Concepts
    » NCW Infrastructure
  - SPARTA’s scale-model of the GIG
NCW End-to-End (NETE) Model

NETE Models:
- GIG Transport Backbone
- GIG Enterprise Services
- Joint C2
- Sensor-to-Shooter

NETE is a Discrete Event Simulation Model Developed Using EXTEND:
- A GIG System Engineering Tool
- Examines NCW CONOPS
- Models NCES Processes
- Supports Agent/Algorithm Development in Areas Such as Fusion, QoS and IA
NETE Model
(Homeland Defense Scenario)

This Global C2 Node is Connected to IP Network Supported by TSAT.

Delay Time, & Throughput Indicates Network Power
NETE Model
(Force Protection Scenario)

TSATs link widely dispersed Theater BMD Elements.

Model predicts message delays vs war time and threat load.

Link-16 and JTIDS Range Extension Support BMD Mission
NETE is a Mission Level Model, Supported by Engagement, SE and Physics Modeling

M&S Primary Uses:

• M&S Tools for Allocating Operational & System Requirements to Elements
  – Must Support Design Trades

• Models For Performance Analysis with respect to KPPs and related MOEs and MOPs
  – Must Show Military Utility of the Network & C4ISR Elements

• Models appropriate for incorporation in Real-Time, System-Level Federated Live-Virtual-Constructive environments
  – Must Support: Exercises; User Evaluation; Training

Increasing Abstraction

Increasing Fidelity/Complexity
EXTEND → OPNET Tool Relationship

EXTEND End-to-End Model Represents:
- CONOPS/C2BM Processes
- Comm Nets
- Sensor Platforms
- Weapon Platforms

OPNET Model Represents:
- Networks
- Protocols Stacks
- Net Management
- RF Propagation

EXTEND describes the C4ISR concept in the operational context and provides CONOPS/C2BM Processes & Elements to OPNET.
EXTEND End-to-End Model Represents:
- CONOPS/C2BM Processes
- FCS and Joint Interoperability
- Comm Nets
- Sensor Platforms
- Weapon Platforms

OPNET Model Represents:
- 3D Visualization
- Terrain Interference
- Masking
- RF Propagation

OPNET Provides Higher Fidelity Network Assessment And Parameters For EXTEND COMM Model To Use In End-to-end Analysis And Assessment
Global C2 Node: Model ‘Drill Down’

Separate TCP and IP processing: Modular design permits easy integration of additional Comm protocols (e.g. UDP) as they are built.
NETE: Router Model

- **Current Router Capability**
  - IPv6 Headers
  - IPv6 packet processing

- **Upgraded Network Identification Method**
  - Makes for easy “Plug-And-Play” construction of network models.

- **Planned Router Upgrades**
  - Dynamically constructed routing tables
    - Based on presence of network participants
    - Will require inter-router com and additional processing logic.
  - Dynamic message routing based on route availability & loading
    - Will require inter-router com and additional processing logic.

Adjusting Parameters Allows Representation of Alternative Routers
NETE: Communication Processing

- Hi fidelity representation of handshaking protocols
  - Link initiation
  - Link termination
## NETE Status and Plans

<table>
<thead>
<tr>
<th>Function</th>
<th>Current Capability</th>
<th>Future Capability</th>
</tr>
</thead>
<tbody>
<tr>
<td>IP</td>
<td>TCP/IPv4, IPv6 (selectable), Link-16</td>
<td>UDP; Multicast</td>
</tr>
<tr>
<td>Routers</td>
<td>Parametric Router</td>
<td>Contingency Routing</td>
</tr>
<tr>
<td>SAT COMM</td>
<td>EXTEND FTP Import/Export Feature (Off-Line use of CERA and ‘Real Time’ Access to CERA Server using SOAP)</td>
<td>Use of CERA for Dynamic Satellite Coverage and Routing</td>
</tr>
</tbody>
</table>

### Sensor/Weapon Element

<table>
<thead>
<tr>
<th>Function</th>
<th>Current Capability</th>
<th>Future Capability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensor</td>
<td>UAV Waypoints; Simple Sensor Representation (Probabilistic); Import Sensor and Events From Off-Line Models</td>
<td>Incorporate Simple Imagery and Radar Models; Tracking Math Model</td>
</tr>
<tr>
<td>Weapon</td>
<td>CAP Station; Import Weapon and Events From Off-Line Models Simple Process with Delays and Pk Draw</td>
<td>Decision Architecture to Develop Weapon Policy</td>
</tr>
<tr>
<td>Geo Reference/Math Models</td>
<td>Coordinate Transforms; Math/Vector/Matrix Routines;</td>
<td>Internal FOV, Line of Sight Models; Threat Objects Carry Signature; Environment Models (Simple)</td>
</tr>
</tbody>
</table>
# NETE Status and Plans

## Enterprise Services

<table>
<thead>
<tr>
<th>Function</th>
<th>Current Capability</th>
<th>Future Capability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Information Distribution</td>
<td>Scripted Publish-Subscribe; Developed Off-line CID VOI Model</td>
<td>Incorporate VOI as ‘Smart Pull’ Mechanism</td>
</tr>
<tr>
<td>Information Assurance (IA)</td>
<td>Scripted Net Attack</td>
<td>Incorporate GSAKMP for Group Security Key Management</td>
</tr>
<tr>
<td>Quality of Service (QoS)</td>
<td>Trades to Understand Quality of Service Capability/Issues</td>
<td>QoS Monitoring/Algorithms</td>
</tr>
</tbody>
</table>

## C2BM

<table>
<thead>
<tr>
<th>Function</th>
<th>Current Capability</th>
<th>Future Capability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensor Management</td>
<td>Scripted ‘Trigger Events’ Cause Sensor Tasking; Integrated BBN for VOI Based Tasking</td>
<td>Decision Architecture Approach-Sensor Policy Generation</td>
</tr>
<tr>
<td>Weapon Management</td>
<td>Engagement Events (Available Battle Space) Internally Derived</td>
<td>Ditto for Weapon Policy Generation</td>
</tr>
<tr>
<td>Fusion</td>
<td>CID Fusion Model (Integrated NETE with BBN Modeling Environment-NETICA)</td>
<td>Decision Architecture Performs Levels 1-4 Fusion (Focus on 1 and 4); Includes CID Fusion</td>
</tr>
</tbody>
</table>
# EXTEND Catalog

## Models

<table>
<thead>
<tr>
<th>Model Name</th>
<th>Description</th>
<th>Organization(s)</th>
<th>Program(s)</th>
<th>Supporting Libraries</th>
<th>Functional Area(s)</th>
<th>Market Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>5G Demo</td>
<td>Demonstrates INETC in an operational context.</td>
<td>DPO</td>
<td>Marketing, NESTOR</td>
<td>NA</td>
<td>Communications</td>
<td>TC, NOW, FCS</td>
</tr>
<tr>
<td>5G End-to-End Model (ETEM)</td>
<td>Demonstrates end-to-end (data-plane) simulation of INETC in an operational context.</td>
<td>DPO</td>
<td>NISTSAT Conference</td>
<td>NESTOR</td>
<td>CS, TEL Operations</td>
<td>TC, NOW, FCS</td>
</tr>
<tr>
<td>Angle-to-GRC</td>
<td>Common model for analyzing message delay throughout the angle and GRC.</td>
<td>DPO</td>
<td>MDA, NTZ</td>
<td>NA</td>
<td>Communications</td>
<td>BMG, MDA</td>
</tr>
</tbody>
</table>

## Libraries

<table>
<thead>
<tr>
<th>Library Name</th>
<th>Description</th>
<th>Organization(s)</th>
<th>Program(s)</th>
<th>Supporting Libraries</th>
<th>Functional Area(s)</th>
<th>Market/SUPPORT Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>NetLib</td>
<td>Contains detailed communications components</td>
<td>DPO</td>
<td>Marketing, NISTSAT, NESTOR</td>
<td>NetLib</td>
<td>TCP, IP, Router</td>
<td>TC, NOW, FCS, MDA, WDM, other Net specific areas</td>
</tr>
<tr>
<td>UtilityLib</td>
<td>Currently under development, but will include models that describe general performance and functionality.</td>
<td>DPO</td>
<td>NESTOR, MDA, NTZ</td>
<td>Coordinate Transformations</td>
<td>Coord Trans, Coord Trans (Byte Vector)</td>
<td>Model Development Support</td>
</tr>
</tbody>
</table>

## User Defined Blocks

<table>
<thead>
<tr>
<th>Block Name</th>
<th>Description</th>
<th>Organization(s)</th>
<th>Program(s)</th>
<th>Supporting Libraries</th>
<th>Functional Area(s)</th>
<th>Market/SUPPORT Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>TCP</td>
<td>Detailed Transport Control Protocol functional representation</td>
<td>DPO</td>
<td>NISTSAT, NESTOR</td>
<td>CommNetwork</td>
<td>NetLib</td>
<td>TC, NOW, FCS, MDA, WDM, other Net specific areas</td>
</tr>
<tr>
<td>IP</td>
<td>Detailed Internet Protocol functional representation</td>
<td>DPO</td>
<td>NISTSAT, NESTOR</td>
<td>CommNetwork</td>
<td>NetLib</td>
<td>TC, NOW, FCS, MDA, WDM, other Net specific areas</td>
</tr>
<tr>
<td>Router</td>
<td>6FonFeuer with Source/Source Network and Destination/Destination Network</td>
<td>DPO</td>
<td>NISTSAT, NESTOR</td>
<td>CommNetwork</td>
<td>NetLib</td>
<td>TC, NOW, FCS, MDA, WDM, other Net specific areas</td>
</tr>
<tr>
<td>Coord Trans</td>
<td>Performs transformations between various coordinate systems</td>
<td>DPO</td>
<td>NESTOR</td>
<td>Geo-reference</td>
<td>UtilityLib</td>
<td>Model Development Support</td>
</tr>
<tr>
<td>Coord Trans (State Vectors)</td>
<td>Performs transformations between various coordinate systems (state vectors)</td>
<td>DPO</td>
<td>NESTOR</td>
<td>Geo-reference</td>
<td>UtilityLib</td>
<td>Model Development Support</td>
</tr>
</tbody>
</table>
NETE Summary

• **Current Library of Model (Blocks) Supports Many Relevant Mission Areas in NCW**
  – Force Application: Sensors, Weapons and Networks for Strike
  – Force Protection: C2BMC Timeline for Missile Defense
  – Intelligence: Collectors (Surface, Air and Space), Messaging Routing and End-User Receipt
  – GIG Core Services: Transformational Comms, IA, Messaging, Discovery

• **Additional Fidelity Being Added to NETE in CY05**
  – Modular IP: UDP
  – TMOS: TSAT; Policy Based Network Management; QoS/VOI
  – Fusion/Decision Architecture Integration
  – Continue Development:
    » Discovery and Interface with Agents (Discovery/VOI)
    » Physics-Based Sensor Interface (CERA)
    » Information Assurance (IA) with Firewalls, IPSEC-IP, IDS