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

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Jim Walsh, Jeff Roberts, Wayne Thompson
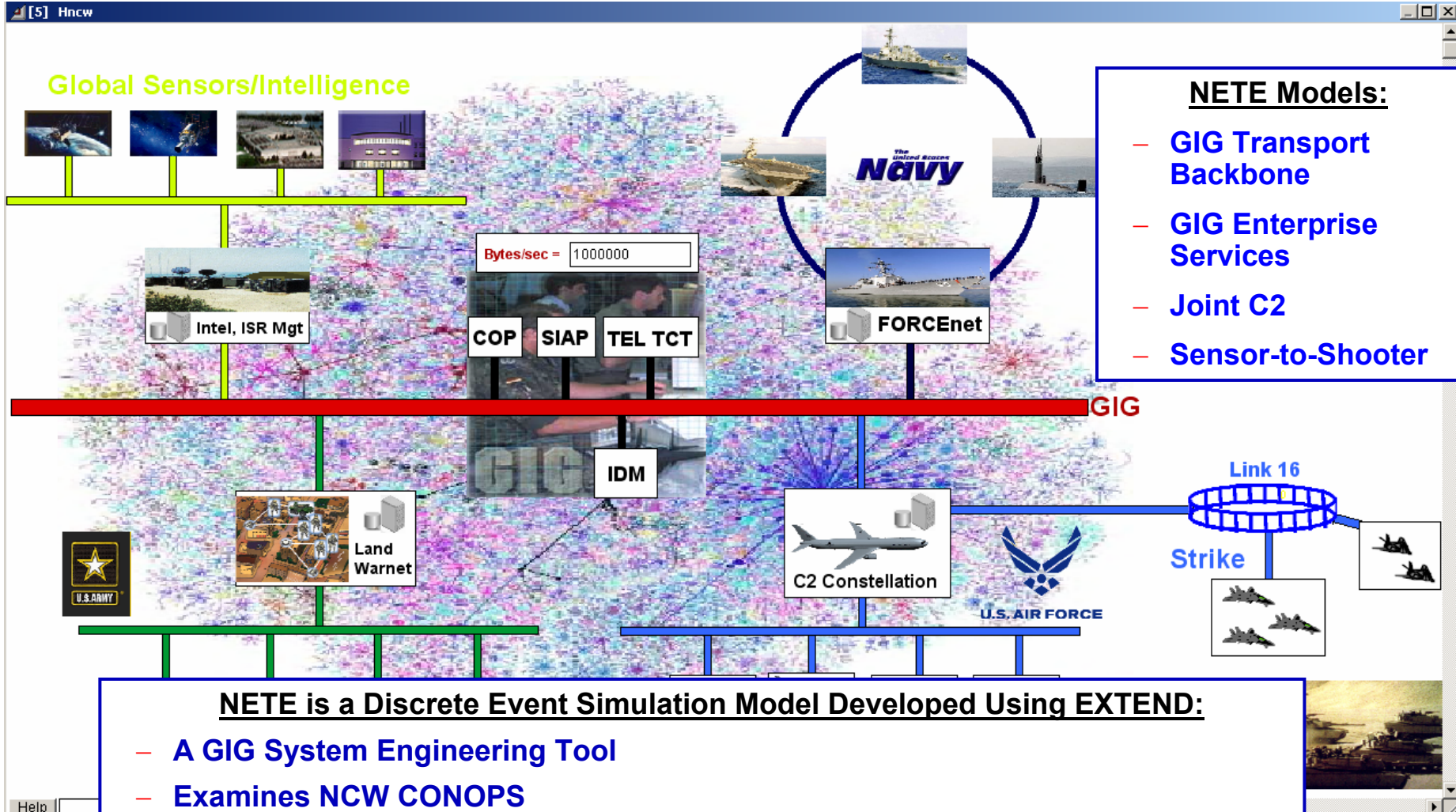
SPARTA, Inc.
4901 Corporate Drive NW   Ste 102
Huntsville,   AL   35805-6208
(256) 837-5282, X1203
jim.walsh@sparta.com

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…**
  - **N**et-Centric **E**nvironment for **S**ystem **T**esting and **O**perational **R**esearch
  - 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

SPARTA

NESTOR

Global Sensors/Intelligence

Bytes/sec = 1000000

Intel, ISR Mgt

COP | SIAP | TEL TCT

FORCEnet

The United States **Navy**

GIG

IDM

Land Warnet

U.S.ARMY

C2 Constellation

U.S. AIR FORCE

Link 16

Strike

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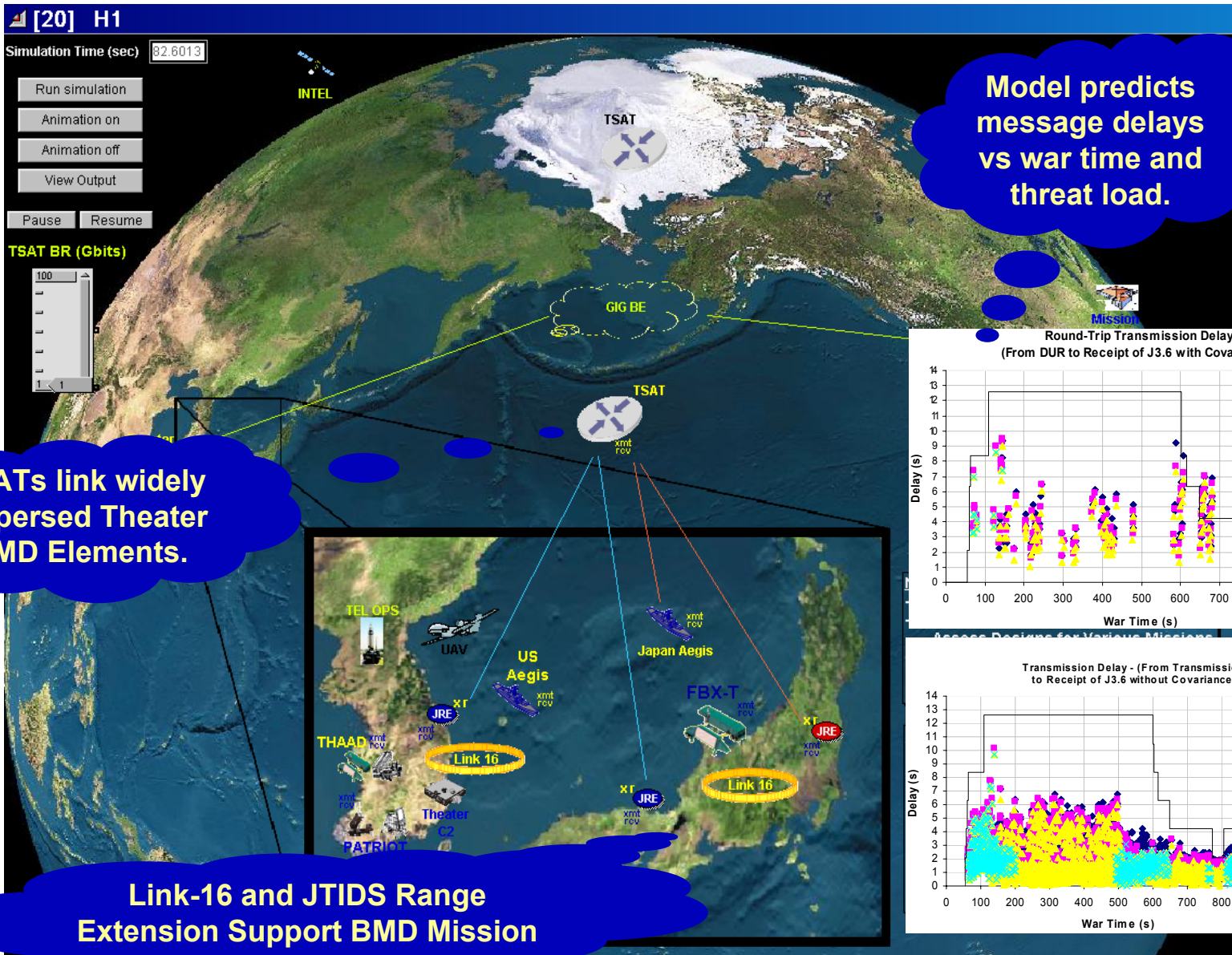- **Joint C2**
- **Sensor-to-Shooter**

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**
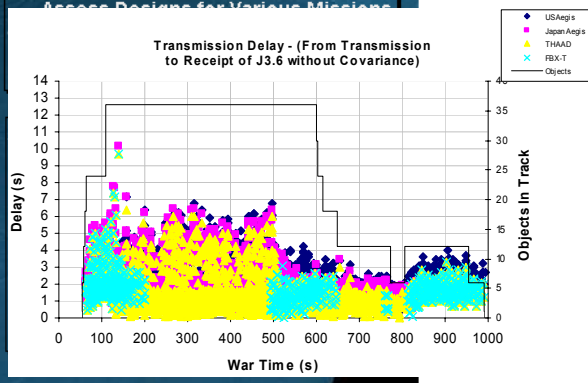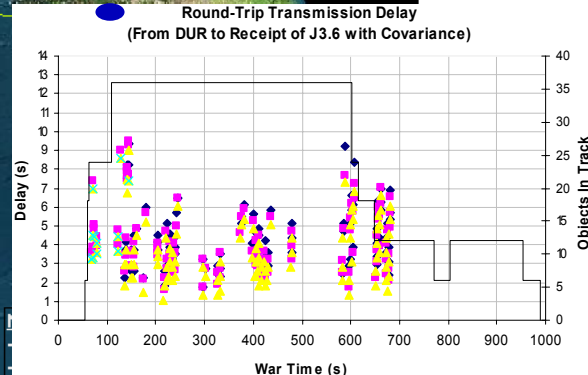
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NETE Model
(Homeland Defense Scenario)
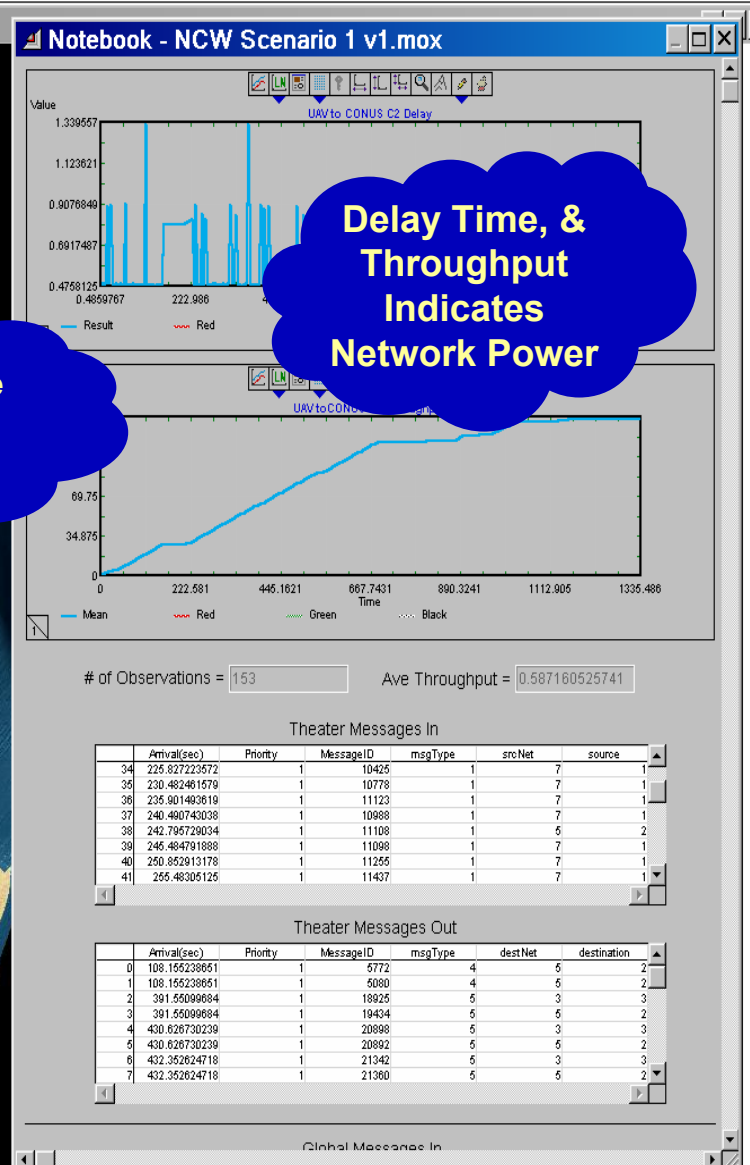
NETE Model
(Force Protection Scenario)

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

SEAS
Campaign

NETE
Mission
EXTEND

MOOSE
Engagement
ENG

System Engineering
UML

CERA   CAPS
Physics-Based Modeling
OPNET   *Radar Basing Opt*

Levels of Abstraction

Increasing Abstraction

Increasing Fidelity/Complexity

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EXTEND → OPNET Tool Relationship

EXTEND™

Simulation Time (sec) 273.662

- Run simulation
- Animation on
- Animation off
- View Output

TSAT BR (Gbits)

100

1 1

MESSAGE TYPE	ID
Observation	1
Track	2
Sensor Tasking	3
1st Responder Tasking	4
Coordination	5
Status Report	6

Message Traffic Legend
- Nominal
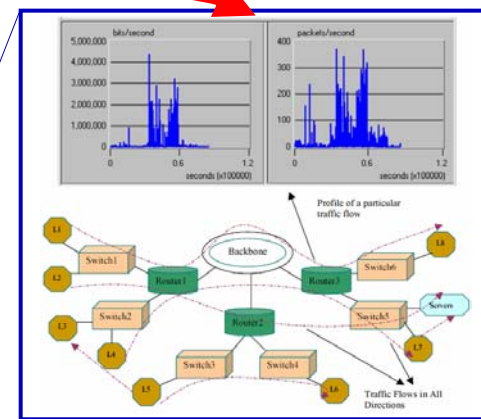- Acknowledgment
- Resend Request

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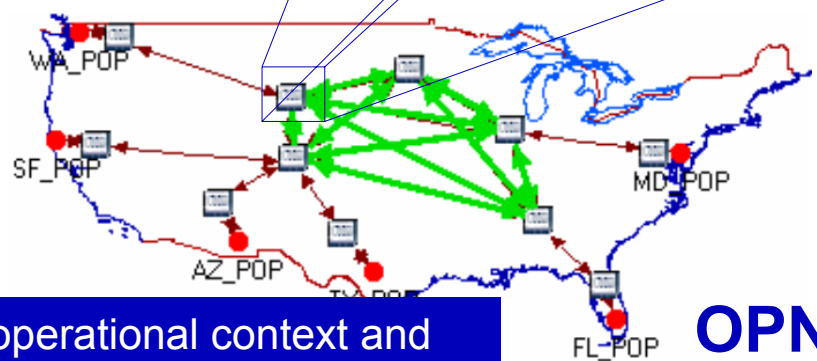- Comm Nets
- Sensor Platforms
- Weapon Platforms

Comprehensive but Medium Fidelity

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

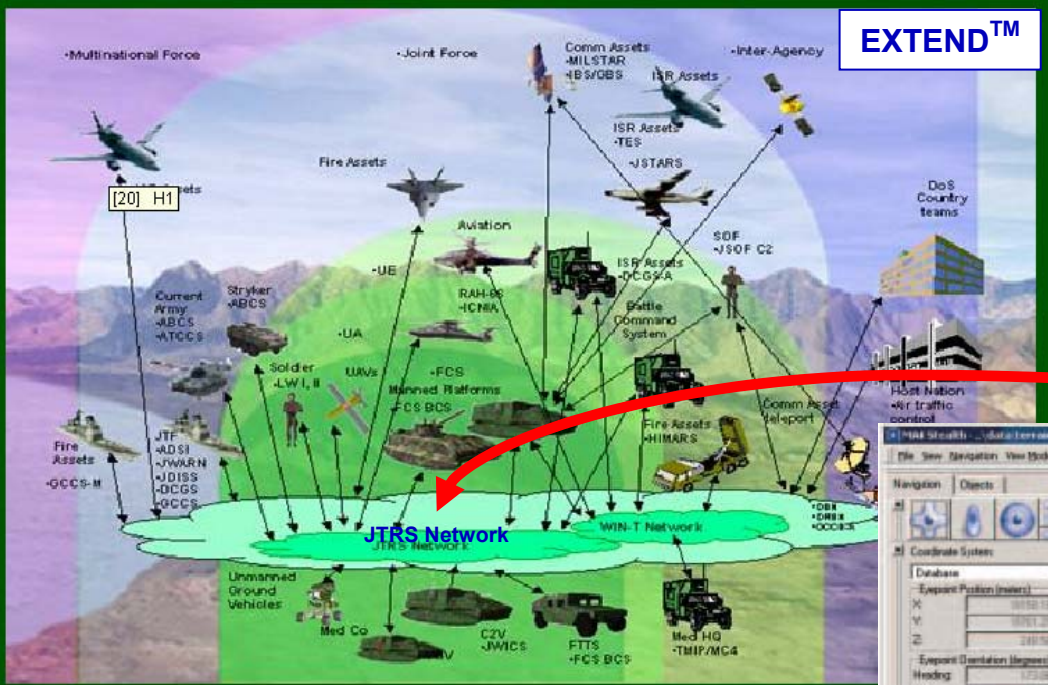**High fidelity representation of Comm Networks**

OPNET™

EXTEND describes the C4ISR concept in the operational context and provides CONOPS/C2BM Processes & Elements to OPNET

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OPNET → EXTEND Tool Relationship

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
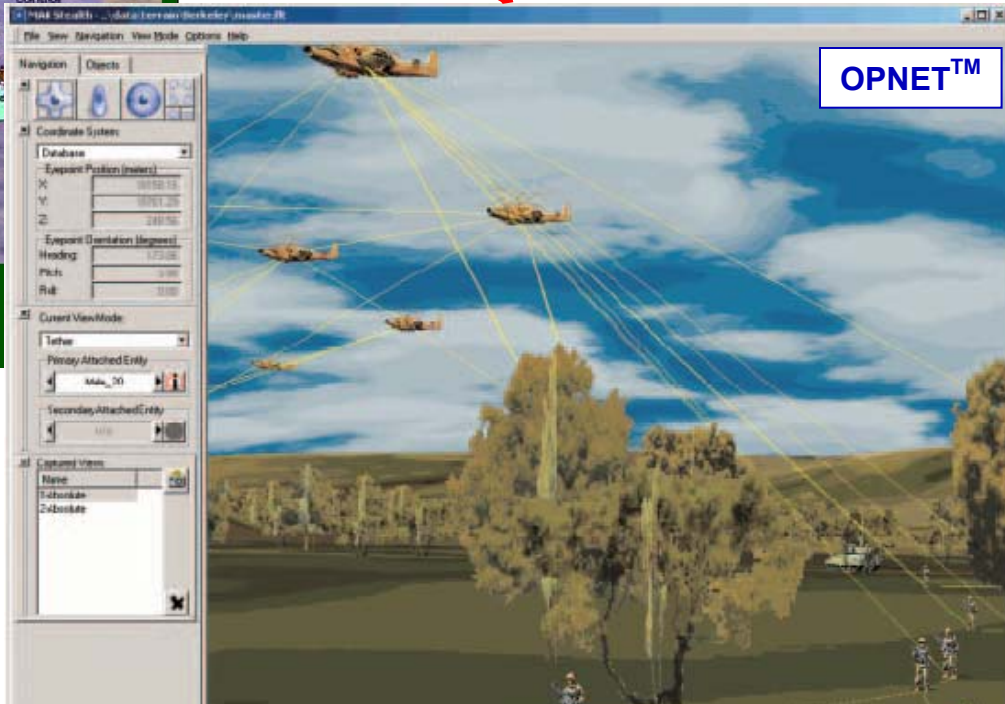
OPNET Provides Higher Fidelity Network Assessment And Parameters For EXTEND COMM Model To Use In End-to-end Analysis And Assessment

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

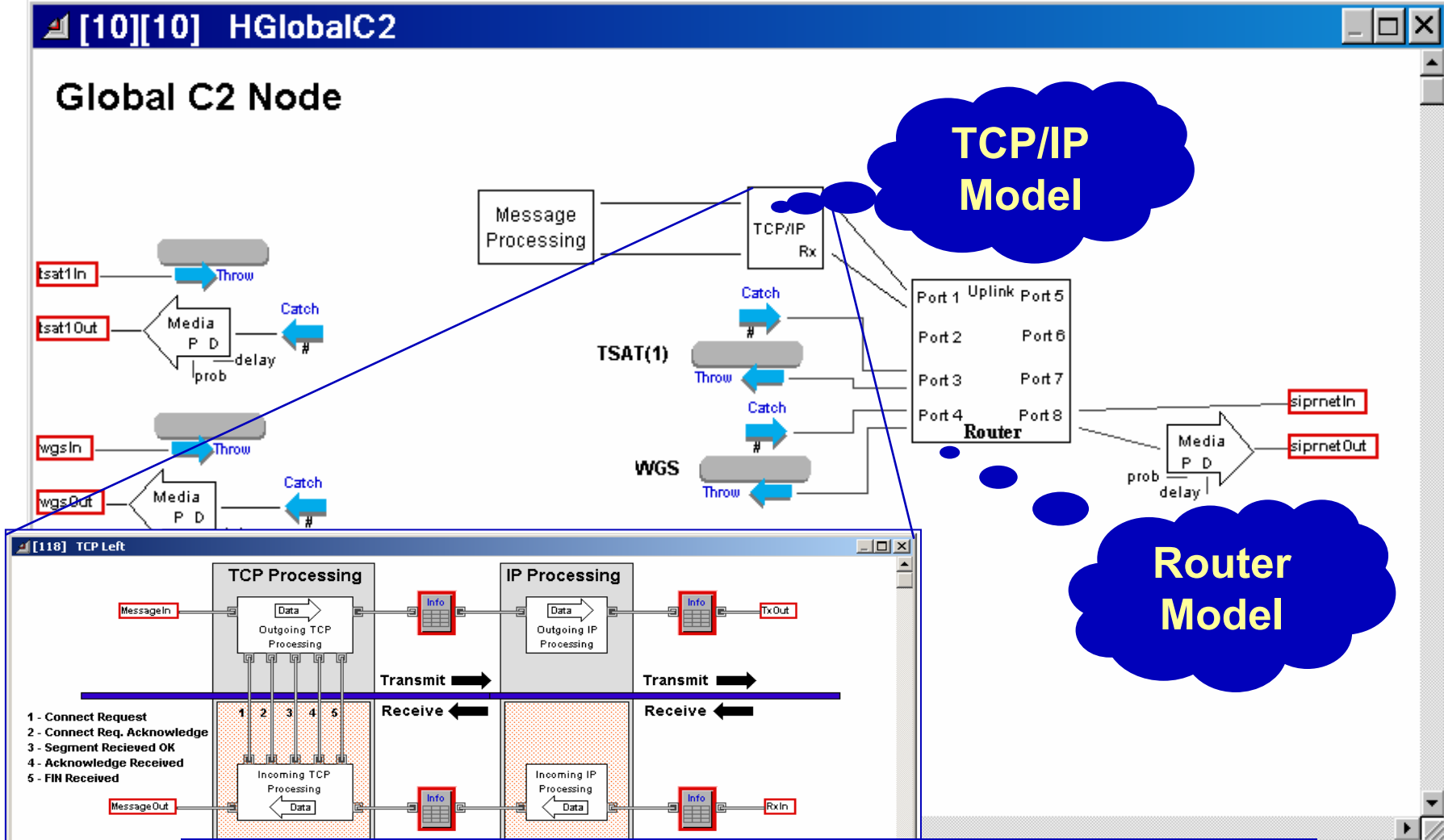- **Current Router Capability**
  - IPv6 Headers
  - IPv6 packet processing
- **Upgraded Network Identification Method**
  - Makes for easy "Plug-And-Play" construction of network models.
- **Planned Router Upgrades**
  - Dynamically constructed routing tables
    - Based on presence of network participants
    - 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
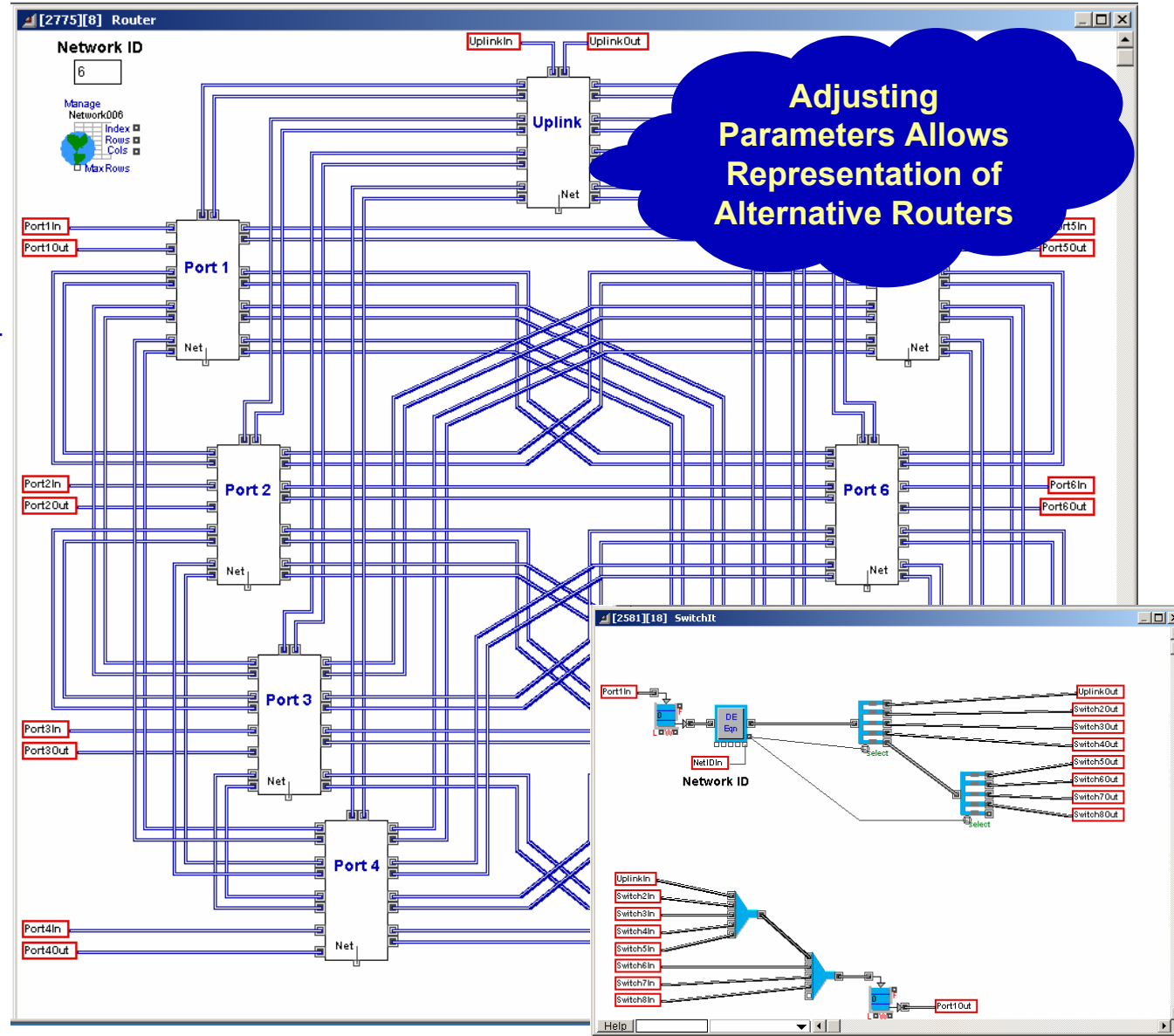
NETE Status and Plans

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

Transport Layer

Sensor/ Weapon Element

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

NETE Status and Plans

Enterprise Services

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

C2BM

Function	Current Capability	Future Capability
Sensor Management	Scripted 'Trigger Events' Cause Sensor Tasking; Integrated BBN for VOI Based Tasking	Decision Architecture Approach-Sensor Policy Generation
Weapon Management	Engagement Events (Available Battle Space) Internally Derived	Ditto for Weapon Policy Generation
Fusion	CID Fusion Model (Integrated NETE with BBN Modeling Environment-NETICA)	Decision Architecture Performs Levels 1-4 Fusion (Focus on 1 and 4); Includes CID Fusion

EXTEND Catalog

POC: Herschel Melton — EXTEND™ Model/Library Catalog

Models

POC: Jeff Roberts — EXTEND™ Model/Library Catalog

Models

Model Name	Description	Organization(s)	Program(s)	Supporting Libraries	Functional Area(s)	Market Area
NCW Demo	NCW demonstration of GIG/TC timing analysis and service connectivity	DPO	Marketing, NESTOR	NA	Communications, Threat Operations, Sensor Operations	TC, NCW, FCS
NCW End-To-End Model (ETEM)	Demonstrates end-to-end (sensor-to-shooter) simulation of GIG/TSAT in an operational context. Includes C2 nodes, detailed comm/networking, TEL operations.	DPO	NG TSAT Conference (marketing), NESTOR	NetLib	C2,Communications,TEL Operations,	TC, NCW, FCS
Aegis-To-GFC	Comm model for analyzing message delays/throughput between Aegis and GFC	DPO	MDA - NTZ	NA	Communications	GMD, MDA

Libraries

Library Name	Description	Organization(s)	Program(s)	Functional	Block Listing	Market/Support Area
NetLib	Contains detailed communications components	DPO	Marketing, NG TSAT, NESTOR	Transport Control and Internet protocols with routing capabilty	TCP, IP, Router	TC, NCW, FCS, GMD, MDA, other Net specific areas
UtilityLib	Currently under development, but will inlcude Blocks that define general physics based and geo-reference funcionality	DPO	NESTOR, MDA-NTZ	Coordinate Transformations	Coord Trans, Coord Trans (State Vectors)	Model Development Support

User Defined Blocks

Block Name	Description	Organization(s)	Program(s)	Functional	Library	Market/Support Area
TCP	Detailed Transport Control Protocol functional representation	DPO	NG TSAT, NESTOR	Comm/Network	NetLib	TC, NCW, FCS, GMD, MDA, other Net specific areas
IP	Detailed Internet Protocol functional representation	DPO	NG TSAT, NESTOR	Comm/Network	NetLib	TC, NCW, FCS, GMD, MDA, other Net specific areas
Router	8-Port Router with Source/Source Network and Destination/Destination Network Routing Table representation	DPO	NG TSAT, NESTOR	Comm/Network	NetLib	TC, NCW, FCS, GMD, MDA, other Net specific areas
Coord Trans	Performs transformations between various coordinate systems.	DPO	NESTOR	Geo-reference	UtilityLib	Model Development Support
Coord Trans (State Vectors)	Performs transformations between various coordinate systems (state vectors).	DPO	NESTOR	Geo-reference	UtilityLib	Model Development Support

Chandler, AZ / Colorado Springs, CO \ **Huntsville, AL** / Orlando, FL / El Segundo, CA /

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