Generic Sensor Model

Stanley N. Hack, D.Sc.
Keith Josef, Ph.D.
Philip Nation
Vinay Shah
Paul Juckiewicz
Yena Park
Jeri Anne Moses
Bradly Pietras
Walter Osadciw

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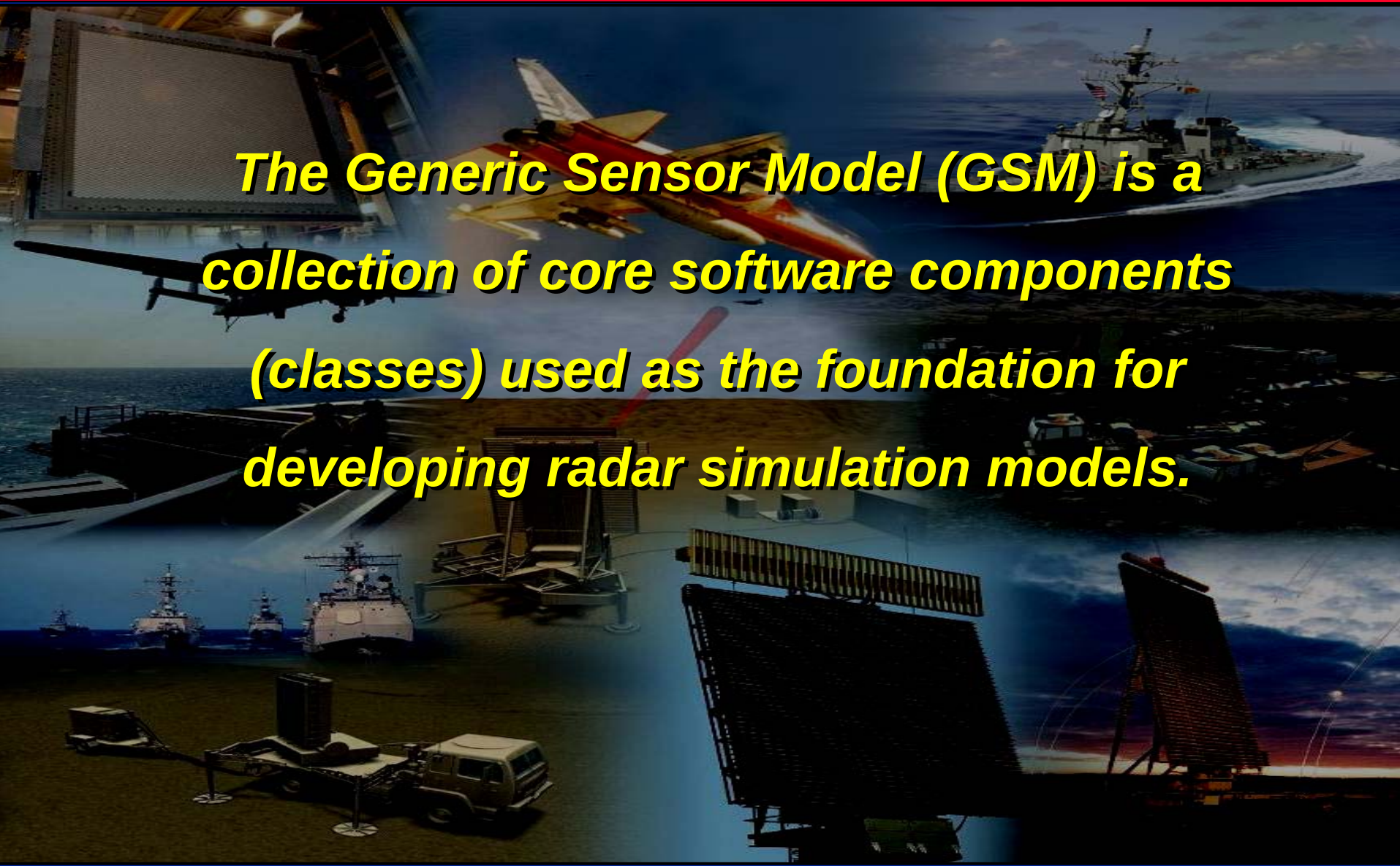
LOCKHEED MARTIN

MS-2 Radar Systems
Syracuse, New York

Generic Sensor Model (GSM)



Generic Sensor Model (GSM)

OVERVIEW

- *Model Description*
- *Operating Modes*
  - *Stand-Alone*
  - *System-of-Systems*
- *Model Components*
- *Model Flow*
- *Model Flexibility*
  - *Extensibility*
  - *Changeable Components*
  - *System Adjustable Parameters*
- *Analyses*

Generic Sensor Model (GSM)

The Generic Sensor Model (GSM) is a collection of core software components (classes) used as the foundation for developing radar simulation models.

MODEL UTILITY

- ***Scenario Testing***
- ***Algorithm Testing and Comparison***
- ***Interoperability Evaluation***
- ***Mission Planning***

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FEATURES

- ***Event Driven***
- ***Parameter Based***
- ***Scalable***
- ***Modular***
- ***Extensible - Uses Object Oriented Design (C++ based)***
- ***Can Incorporate Tactical Software***
- ***Can be Incorporated into system-of-systems environment (High Level Architecture (HLA) interface)***
- ***Fidelity - configurable from low to high***
- ***Unclassified***

Generic Sensor Model (GSM)

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COMPONENTS

- *HLA Interface*
- *Beam Scheduling*
- *Ray Trace Beam Propagation*
- *Detection Processing*
- *Tracking*
- *Cueing*
- *Communications*
- *Data Logging*
- *Dynamic Environment (Atmosphere, Weather, clutter)*
- *Terrain maps (DTED)*

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OPERATING MODES

Stand-Alone Mode

- *All inputs via XML and data files*
- *All outputs to log files*
- *Operates on a single Windows™-based platform*

System-of-Systems Mode

- *HLA federated configuration*
- *Operates in Lockheed Martin's Integrated Missile Defense Testbed (IMDT)*

Generic Sensor Model (GSM)

Integrated Missile Defense Testbed (IMDT™)

IMDT Addresses All Phases of BMDS Mission

1. *Plan the Battle* – *Integrated Defense Planner (IDP)*
2. *Fight the Battle* – *IMDT Federation*
3. *Assess the Battle* – *Post-Simulation Analyses*

IMDT Provides Accurate BMD Planning, Performance And Evaluation Support

Generic Sensor Model (GSM)

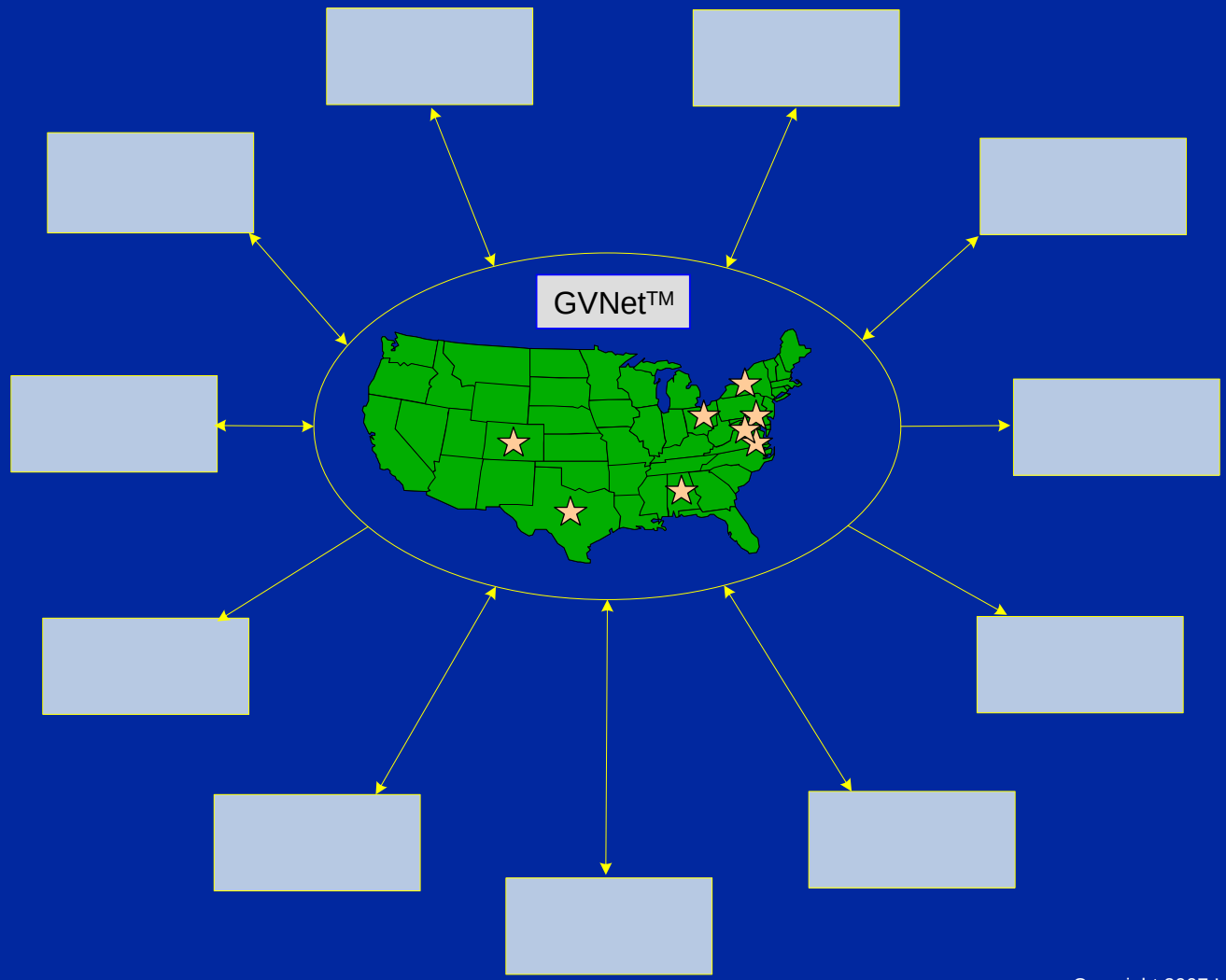
Integrated Missile Defense Testbed (IMDT™)

IMDT Federation

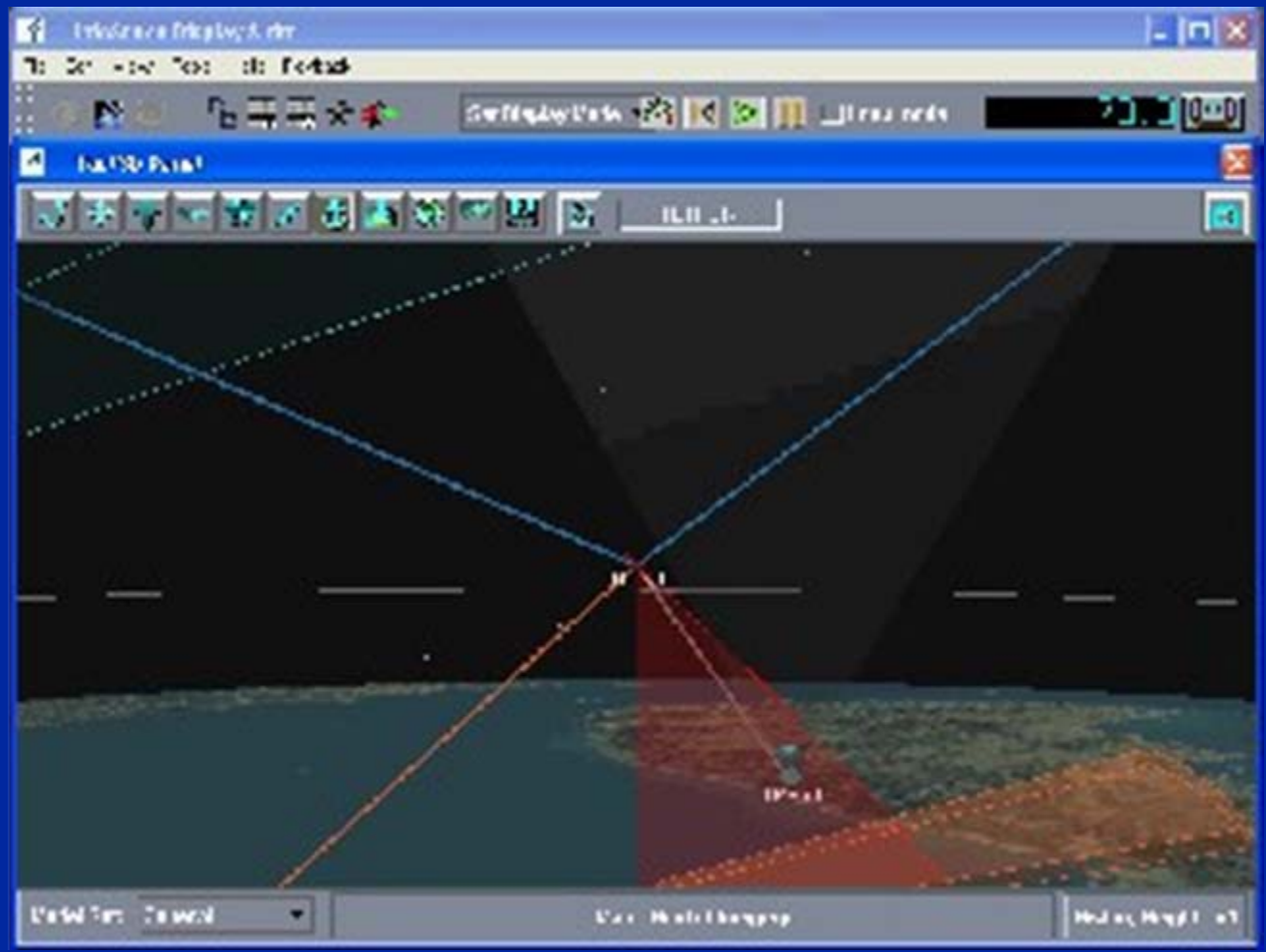
- *Distributed high-fidelity system-of-systems modeling and simulation testbed for BMD*
- *HLA and the GV-Net™ allow distribution of the simulation models to their developers' (subject matter experts') locations*
- *Includes sensor, weapon systems, communications, and C2BMC high-fidelity models. System controller, analysis suite, and visualization.*

Generic Sensor Model (GSM)

IMDT™ Distributed Network

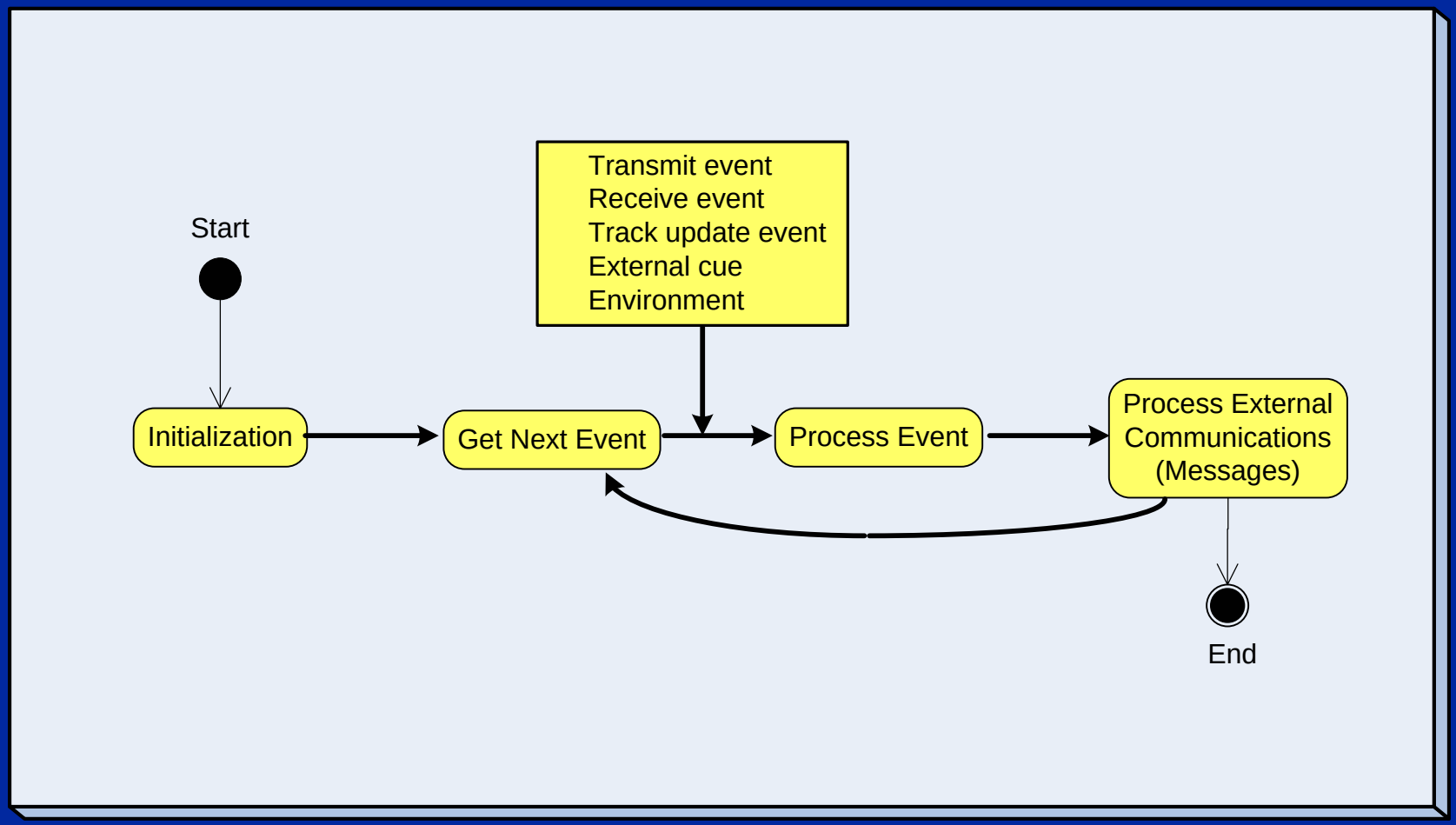


IMDT Video



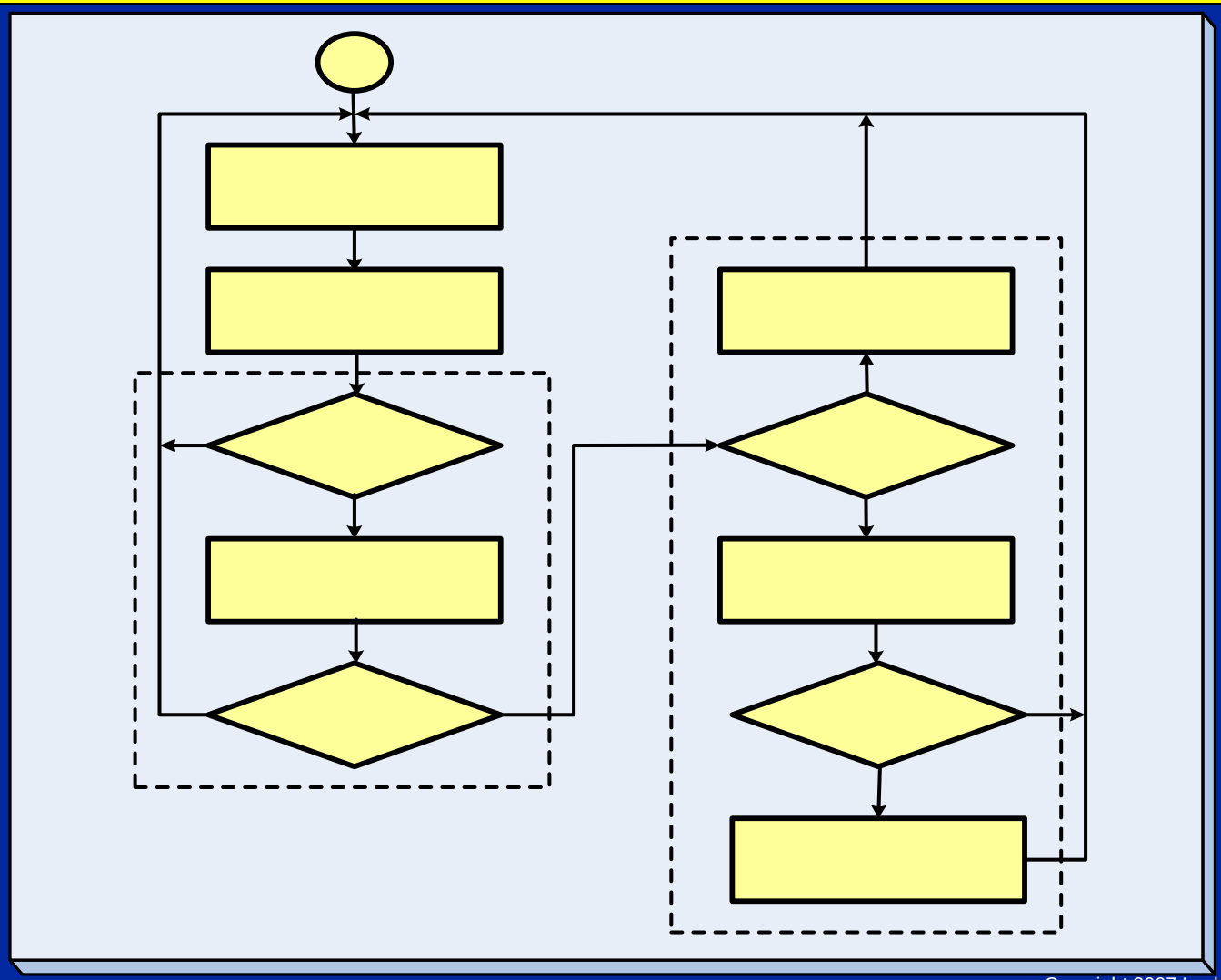
Generic Sensor Model (GSM)

Generic Sensor Model Flow



Generic Sensor Model (GSM)

Generic Sensor Model Transmit Event Flow



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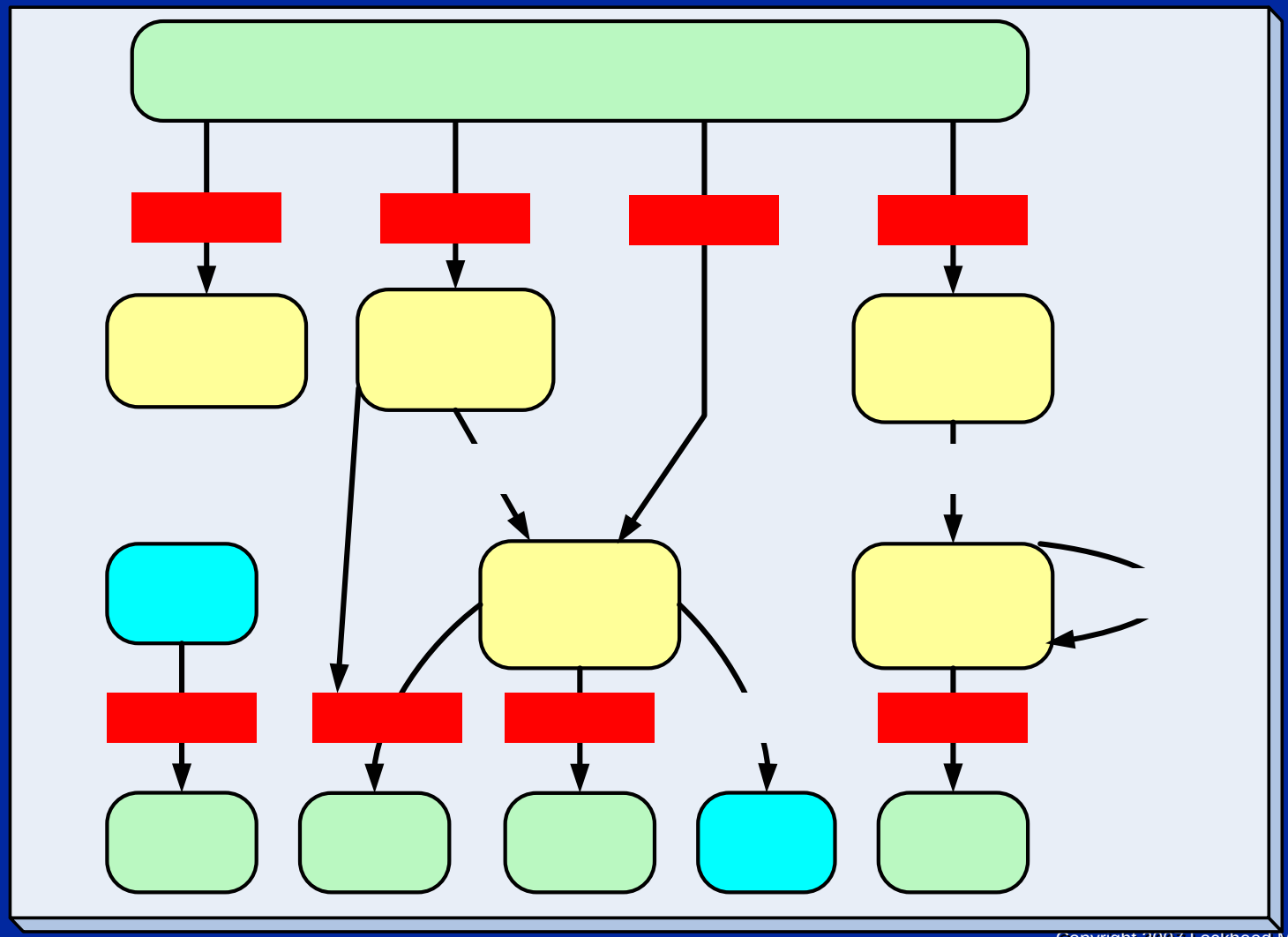
Generic Sensor Model Event Processing



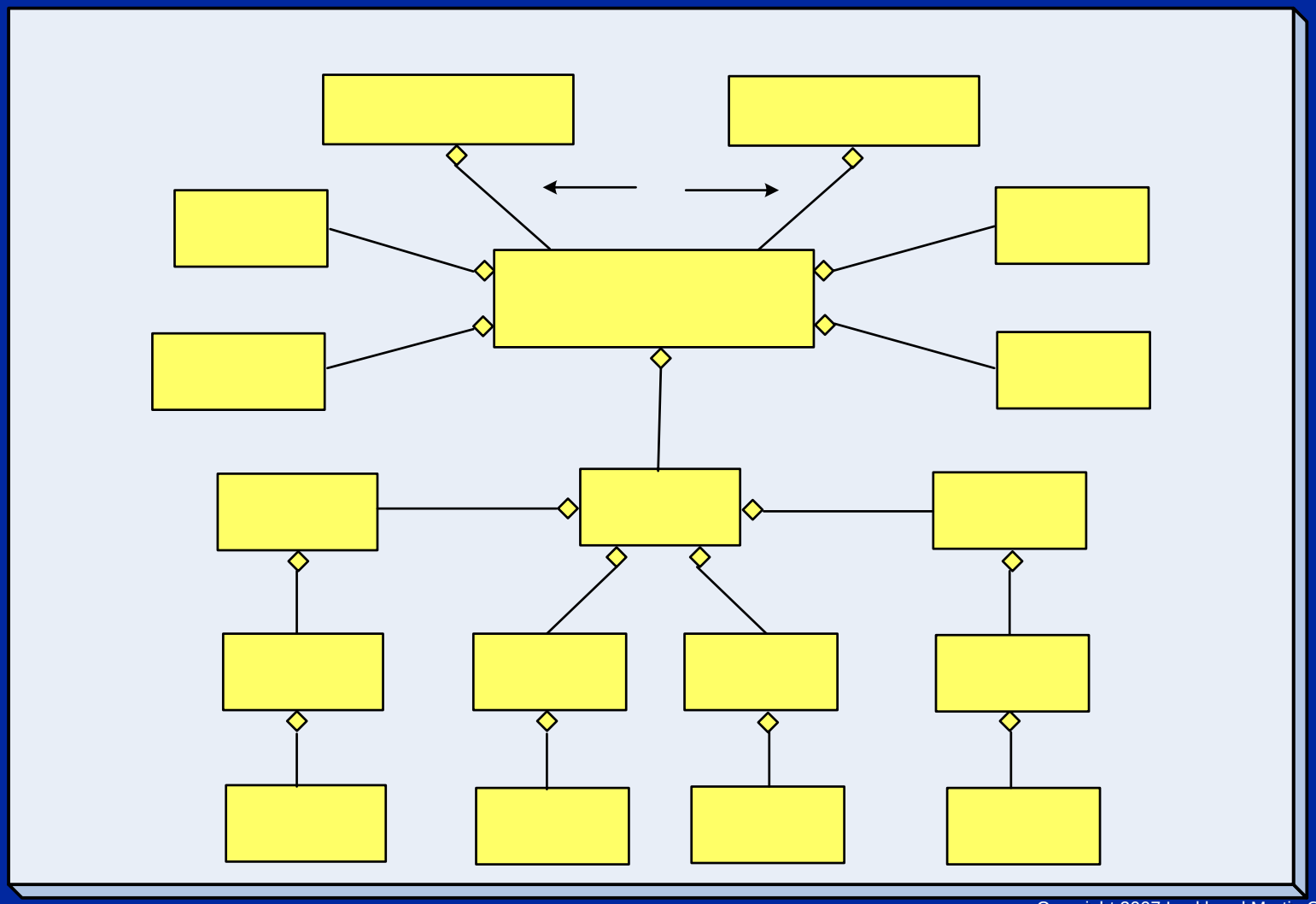
Generic Sensor Model (GSM)

Generic Sensor Model Components

- ***Physics-Based Components***
  - ***Beam scheduling***
  - ***Beam propagating***
  - ***Signal calculations***
  - ***Tracking***
- ***Effects-Based Components***
  - ***Measured state***
  - ***Single-scan correlation***
  - ***Multi-scan correlation***

Generic Sensor Model (GSM)

Generic Sensor Model Components

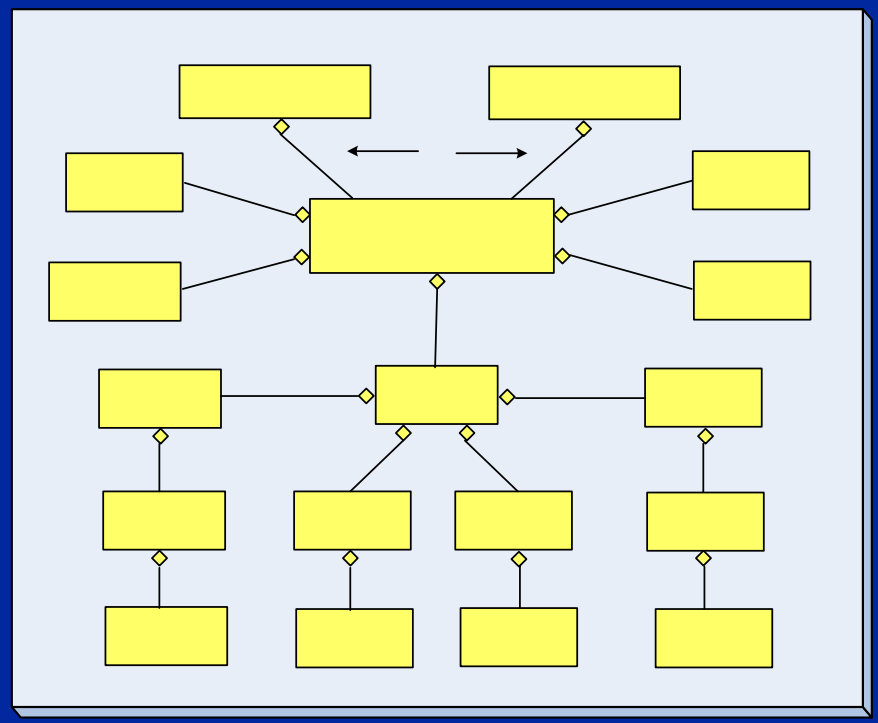


Generic Sensor Model (GSM)

Generic Sensor Model Components

Flexibility and Extensibility

- **Beam Scheduler**
  - Phase / Rotate
  - Phase / Phase
  - Phase / Phase / Rotate
  - Track Filter
- **Kalman Filter**
  - Interacting Multi-Model (IMM)
  - Non-Linear Ballistic Model
- **Model Extensions**
  - External Cue
  - IFF



Generic Sensor Model (GSM)

Generic Sensor Model Parameter Examples

- **Sensor**
  - Transmitter – power, duty cycle, …
  - Antenna – size, element count, …
- **Waveforms**
  - Selection
  - Beam Parameters – frequency, bandwidth, …
- **Tracker Characteristics**
  - Initial Conditions – weights, …
  - Operating Parameters – time constants, …
- **Threats**
  - Number
  - Characteristics
  - Trajectories

Generic Sensor Model (GSM)

Generic Sensor Model Analyses

- **Component Performance Analyses**
  - Detections – SNR, P_D, …
  - Tracker – initiate track, drop track, …
- **Algorithm Analyses**
  - Baseline updates
  - Extended functionality
- **Mission Planning**
  - Assumption verification
  - Parameter development
- **Scenario Analyses**
  - Targets – number, location, type, …
  - Assets - number, location, type, …
  - Communications – latency, availability, …

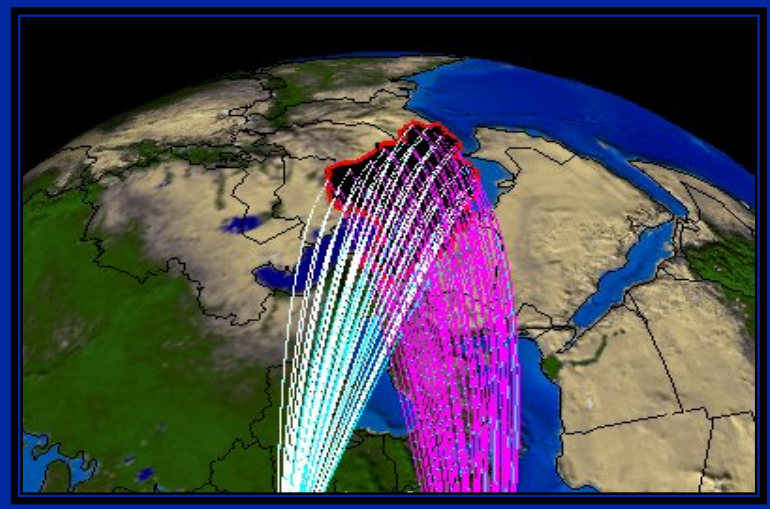
Generic Sensor Model (GSM)

Generic Sensor Model Analysis Examples

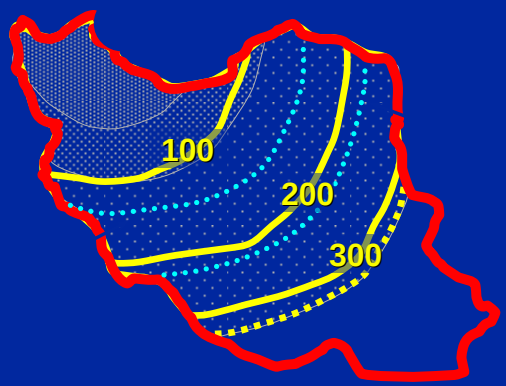
- Stand-Alone Operating Mode
  - Performance assessment
    - Track initiation
    - Coverage
    - Detection probability
  - Enhanced/Modified Capability evaluation
    - Tracking
- System-of-Systems Operating Mode
  - Interoperability

Stand-Alone Mode Performance Example

- *Individual missiles launched throughout the region of interest*
- *Missiles impact one of two cities (white, pink)*
- *Radar at a specified location*



Track initiation Time

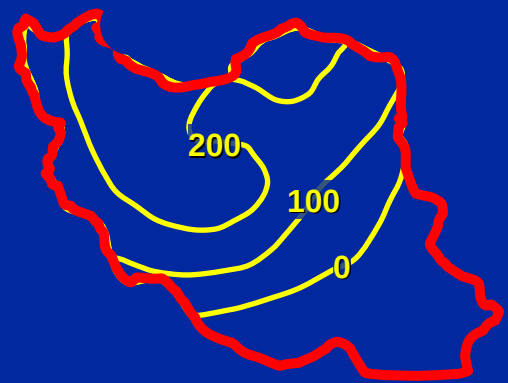


Pd A

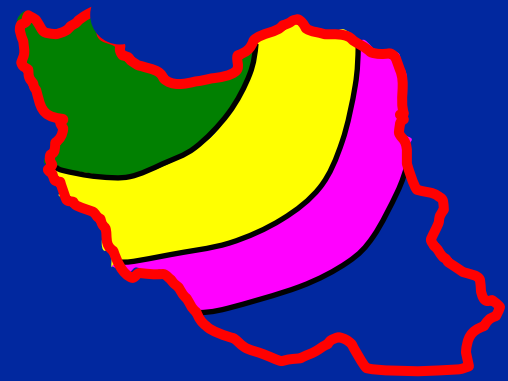
Pd B

Pd C

Track Duration



Track Coverage

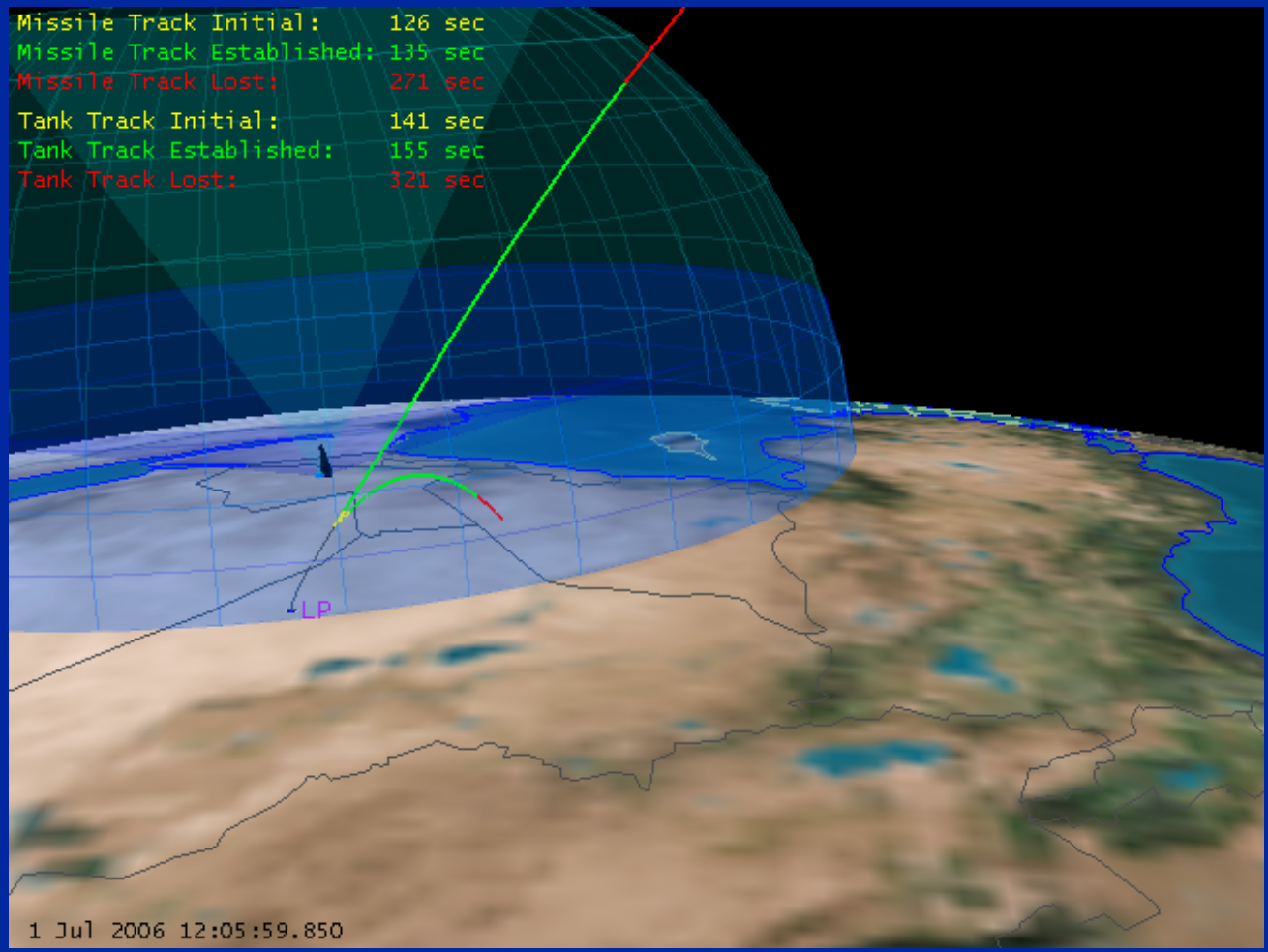


Track boost and midcourse phases
Track boost phase only
Track midcourse only

NOTE: All data are notional.

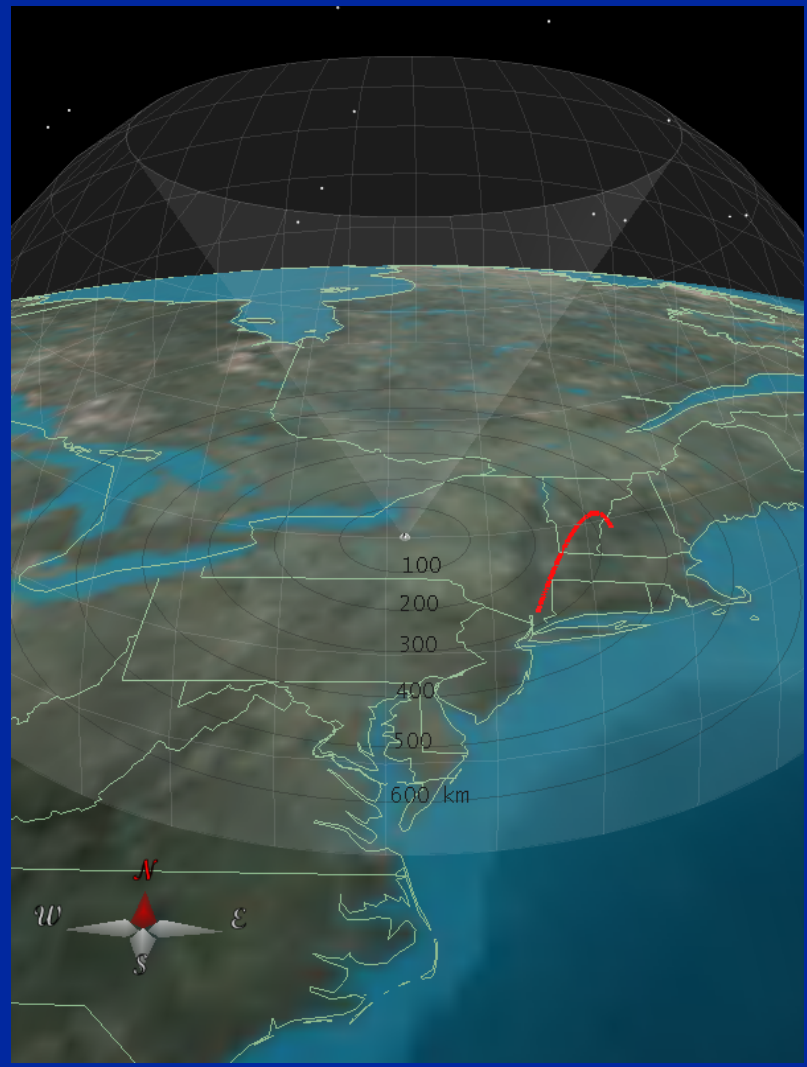
Stand-Alone Mode Performance Example Video

NOTE: All data are notional.



Stand-Alone Mode Enhanced Capability Example

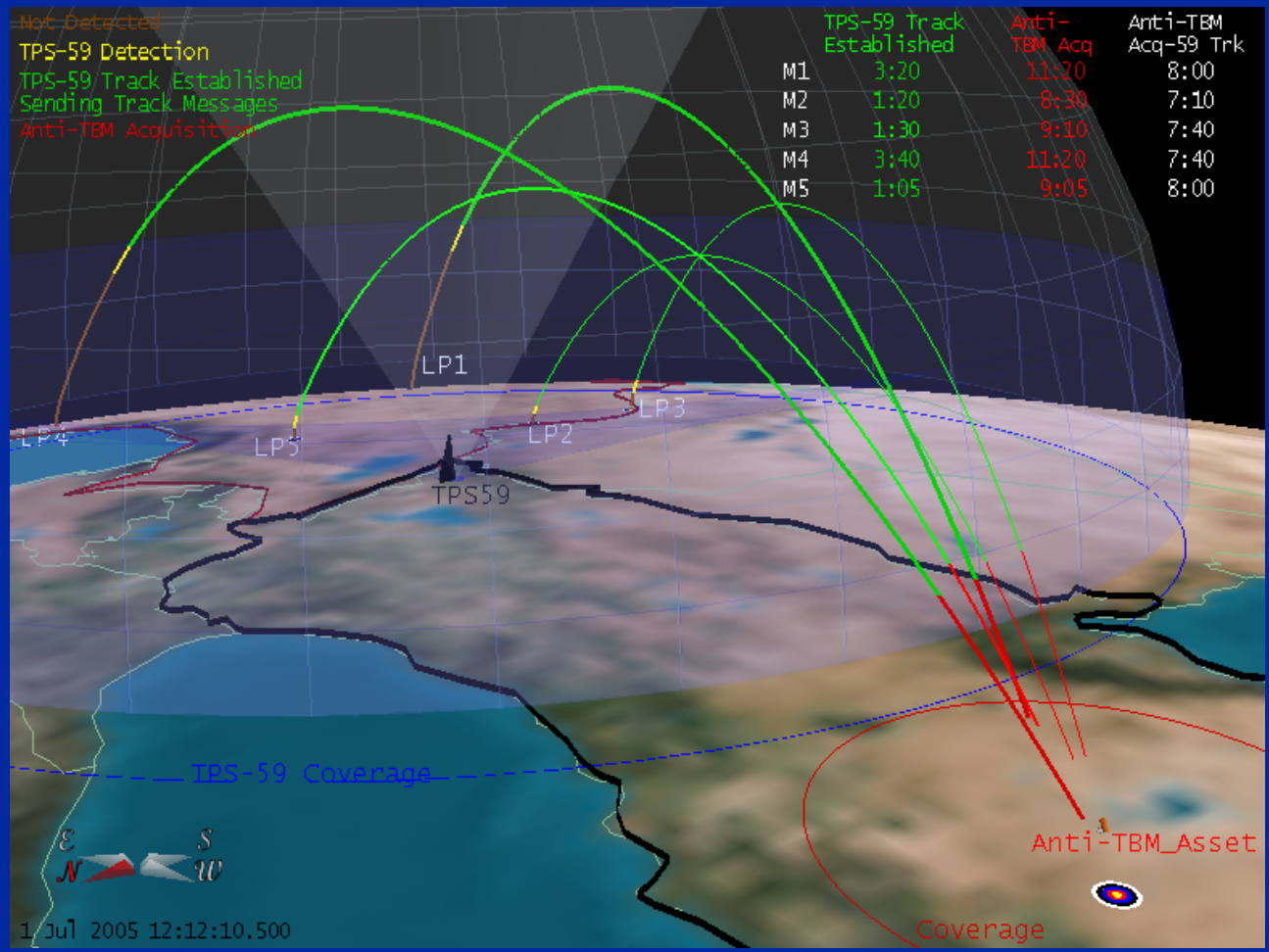
- *N Monte-Carlo runs using Tracker 1*
- *N Monte-Carlo runs using Tracker 2*
- *Evaluate*
  - *Probability of track initiation*
  - *Track initiation time*
  - *Track duration*
  - *Track drop time*
  - *Track quality*
  - *…*



NOTE: All data are notional.

Interoperability Video

NOTE: All data are notional.



Generic Sensor Model (GSM)

Summary

- ***Generic Sensor Model (GSM) provides a flexible, extensible framework for instantiating sensor models***
  - *Object-Oriented design*
  - *Parametrically driven*
  - *Stand-Alone mode*
  - *Federated mode*
- ***Integrated Missile Defense Testbed (IMDT) provides a distributed system-of-systems environment***
  - *High-Level Architecture (HLA)*
  - *Global Vision Network (GV-Net™)*
  - *Addresses all phases of the BMD mission*
    - *Plan the Battle*
    - *Fight the Battle*
    - *Assess the Battle*

Lockheed Martin MS2, Syracuse, NY