

An Architecture Analysis Model Developed for the Evaluation of Forward-Based Sensors



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Outline

- ➔ • **Background and Problem Statement**
 - **Missile Defense Agency Mission Statement**
 - **Role of MDSET (Missile Defense System Engineering Team)**
 - **Driving Requirements for Forward-Based Sensor Modeling**
- **Overview of Architecture Analysis Model**
 - **Event-Driven vs. Time-Stepped Modeling**
 - **Modeling Environment**
 - **Interface Description**
- **Notional Scenario**
 - **Scenario Setup and Visualization**
 - **Utilizing Architecture Analysis Model**
 - **Sample Analysis and Results**
- **Summary**



Missile Defense Agency

- Role of MDSET -

- **Missile Defense Agency (MDA) Mission Statement– “To develop and field an integrated, layered BMDS to defend the United States, deployed forces, allies and friends against all ranges of enemy ballistic missiles in all phases of flight”**
- **MDSET explores advanced concepts and performs trade studies of components, elements, and architectures not yet clearly defined**
 - **Architecture-level models are ideal for high-level performance assessments of various combinations of systems**
- **MDSET must incorporate all elements of the BMDS to provide a system-of-systems analysis**
 - **Ballistic missile threat launches**
 - **Interceptor launch, commit, and engagement timelines**
 - **Sensor performance and threat coverage**
 - **Command and control system and operating concept development**



Role of MDSET requires ability to develop and utilize innovative and flexible tools



Analysis Problem

- Driving Requirements for Forward-Based Radar Modeling-

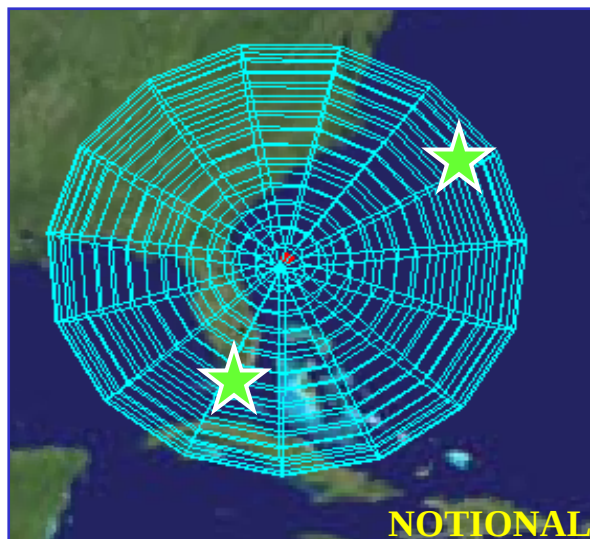
Driving Requirements

Analysis Problem

Model Forward-Based
Radar Functionality

- Radar Slewing Capability

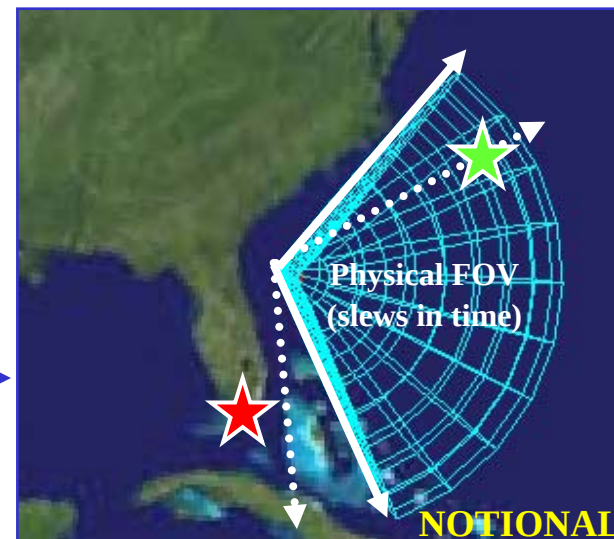
Fixed (360°) FOV



Both
threats in
360° FOV

Only one
threat in
physical FOV

Mechanically Steered FOV





Analysis Problem

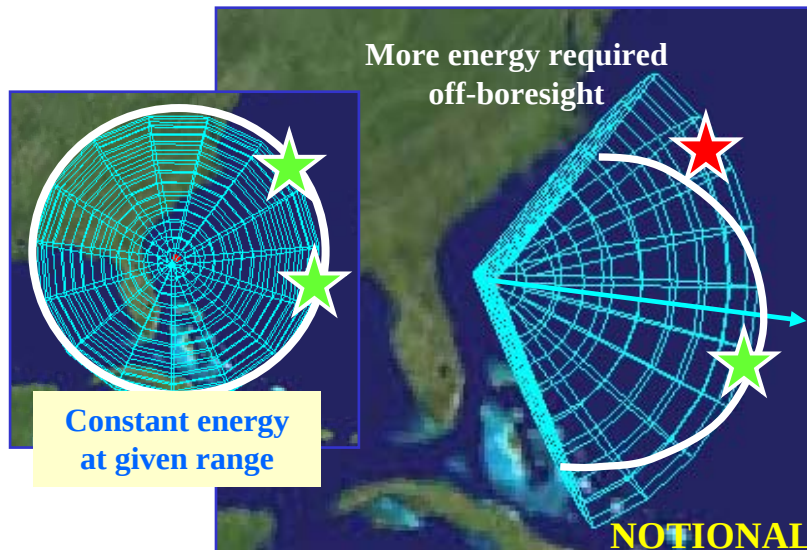
- Driving Requirements for Forward-Based Radar Modeling-

Analysis Problem

Model Forward-Based
Radar Functionality

Driving Requirements

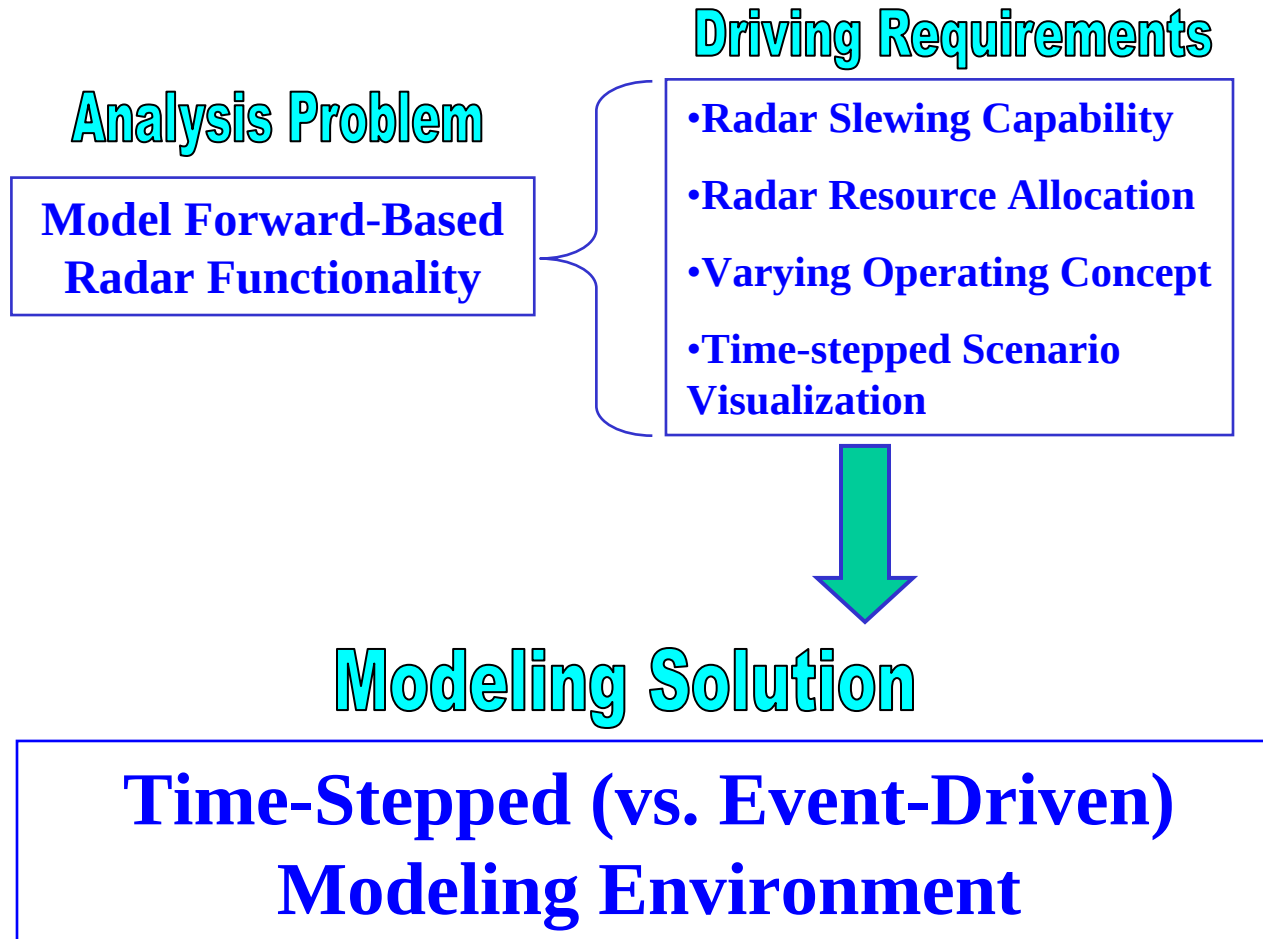
- Radar Slewing Capability
- Radar Resource Allocation





Analysis Problem

- Driving Requirements for Forward-Based Radar Modeling-



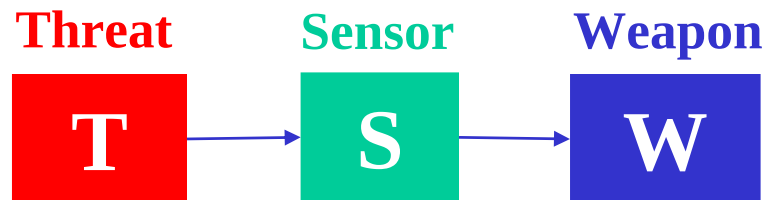


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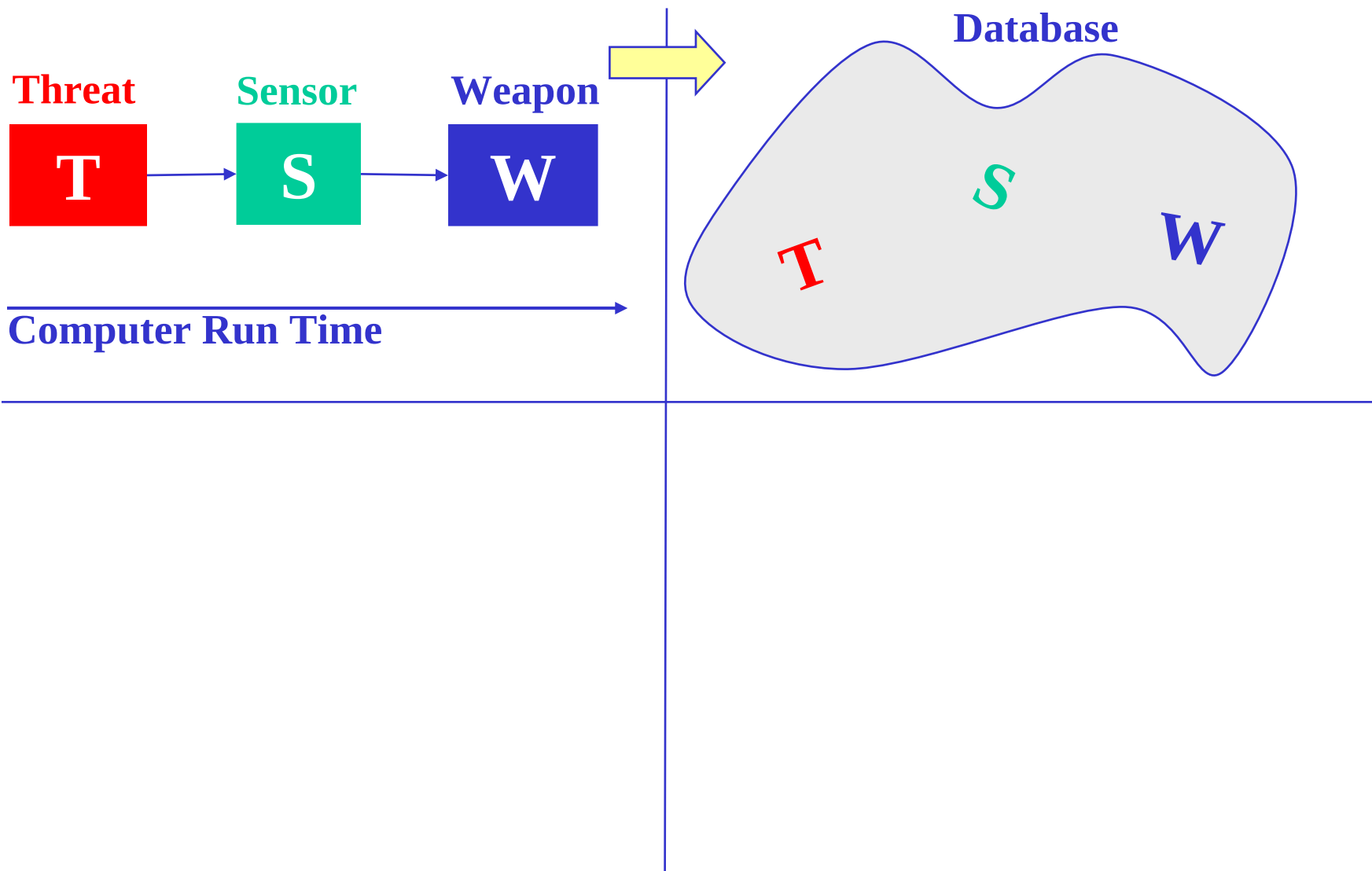
Event-Driven vs. Time-Stepped Model



Computer Run Time →

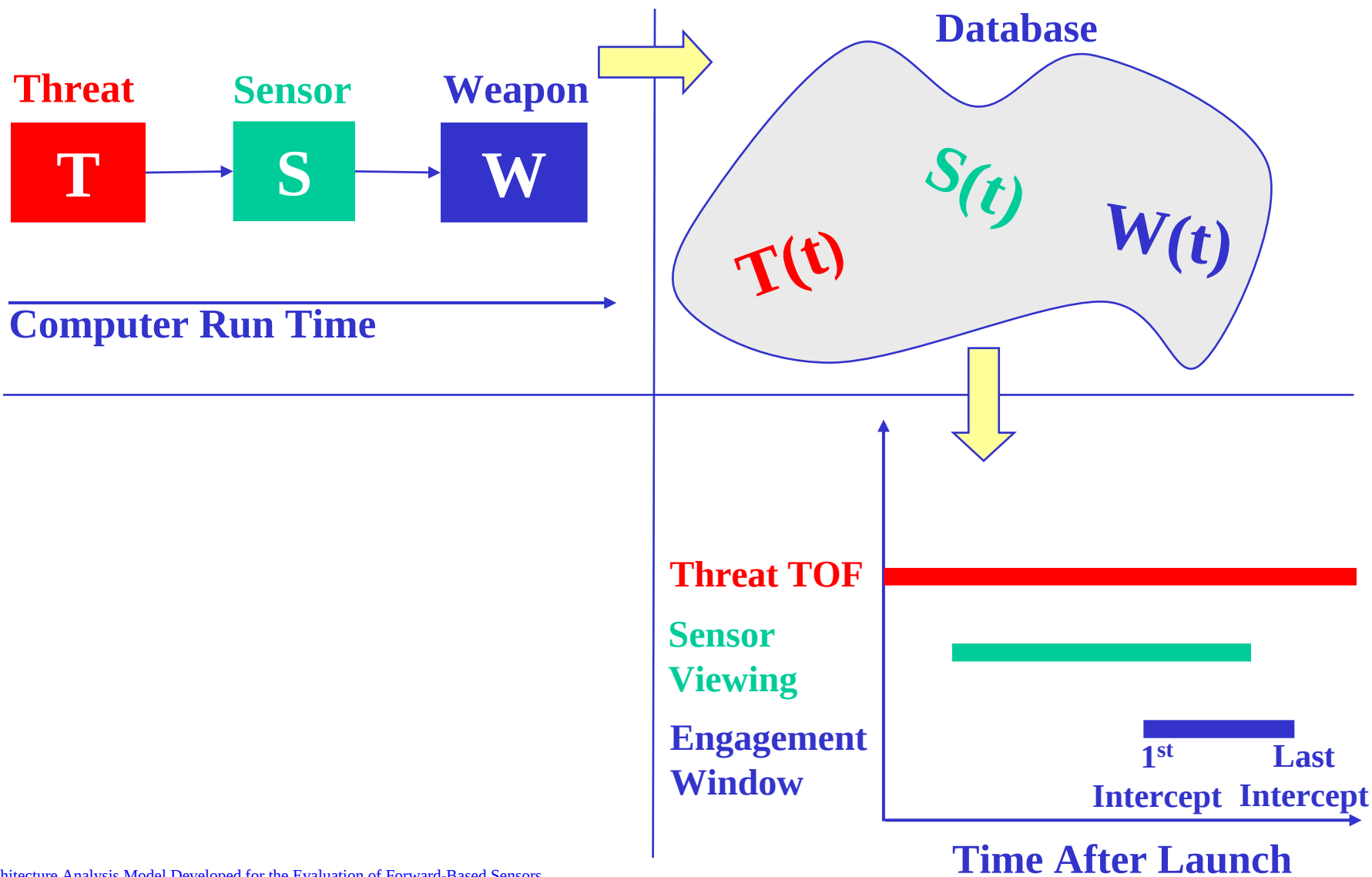


Event-Driven vs. Time-Stepped Model



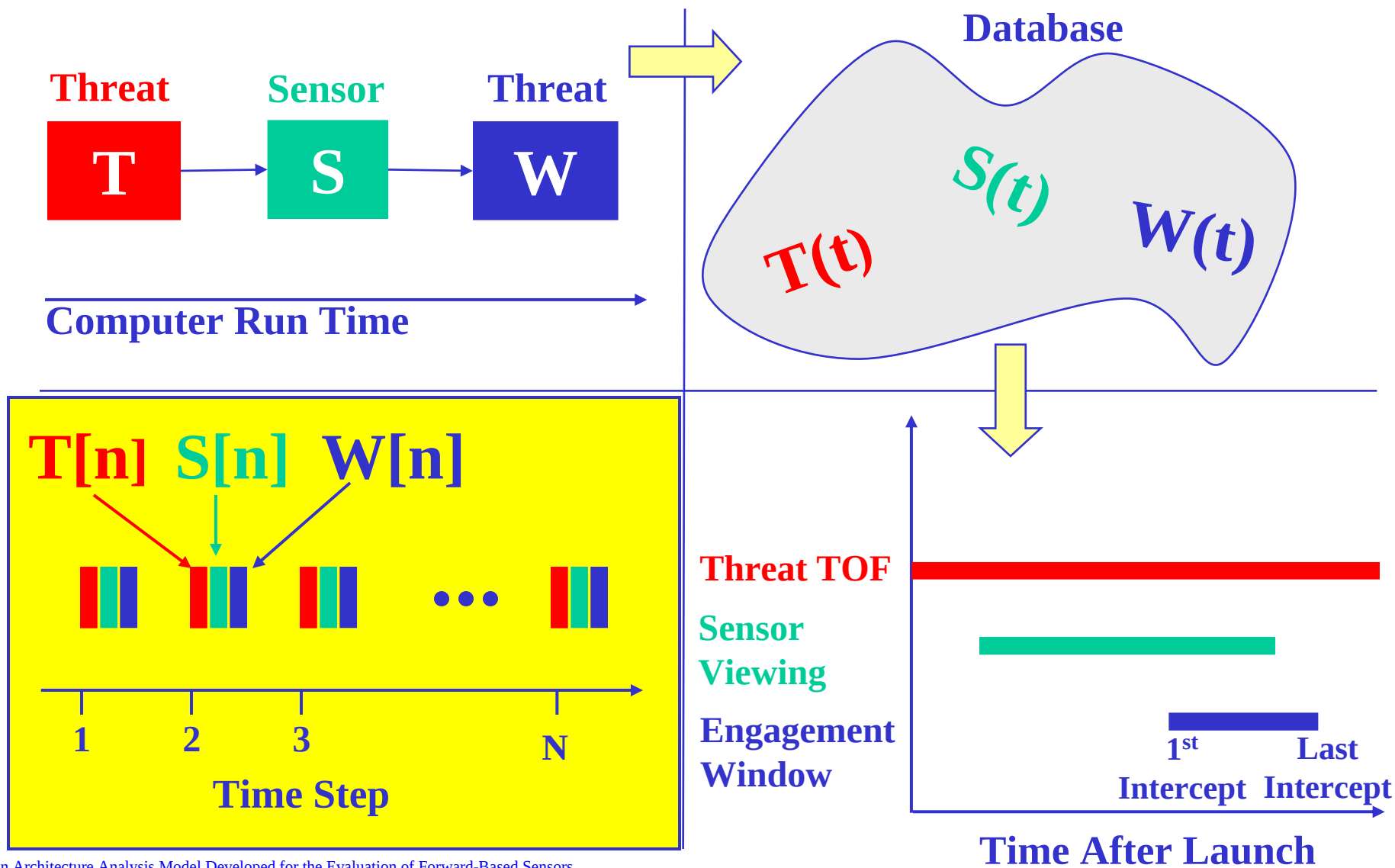


Event-Driven vs. Time-Stepped Model



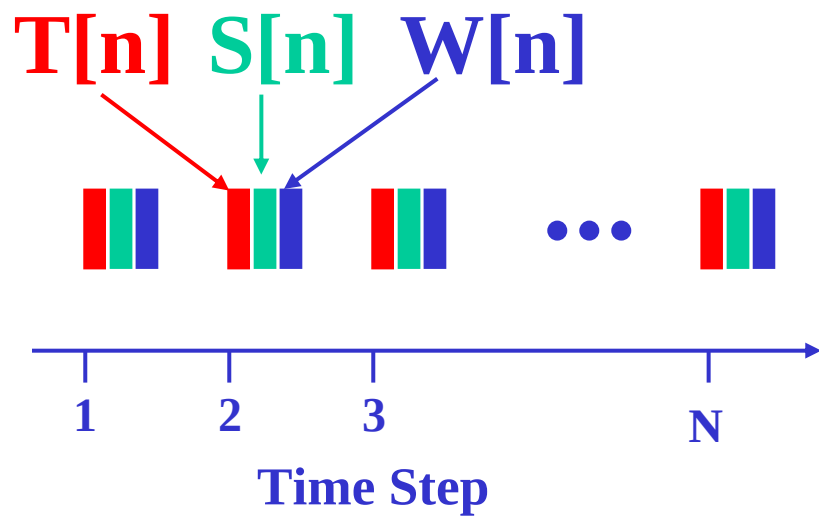


Event-Driven vs. Time-Stepped Model



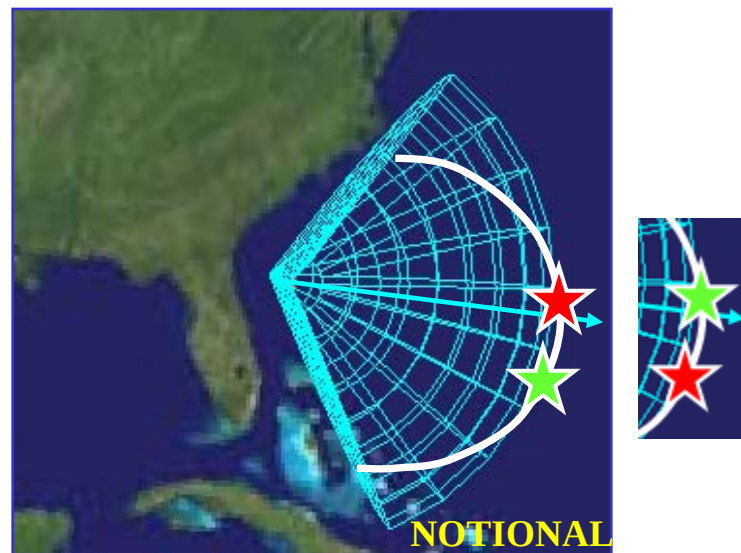
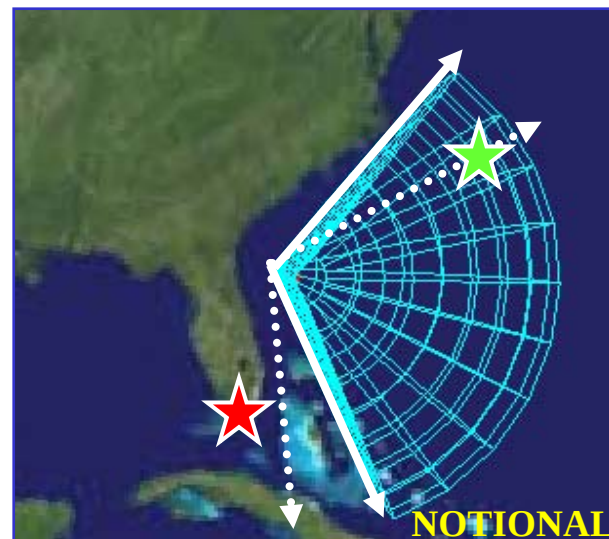
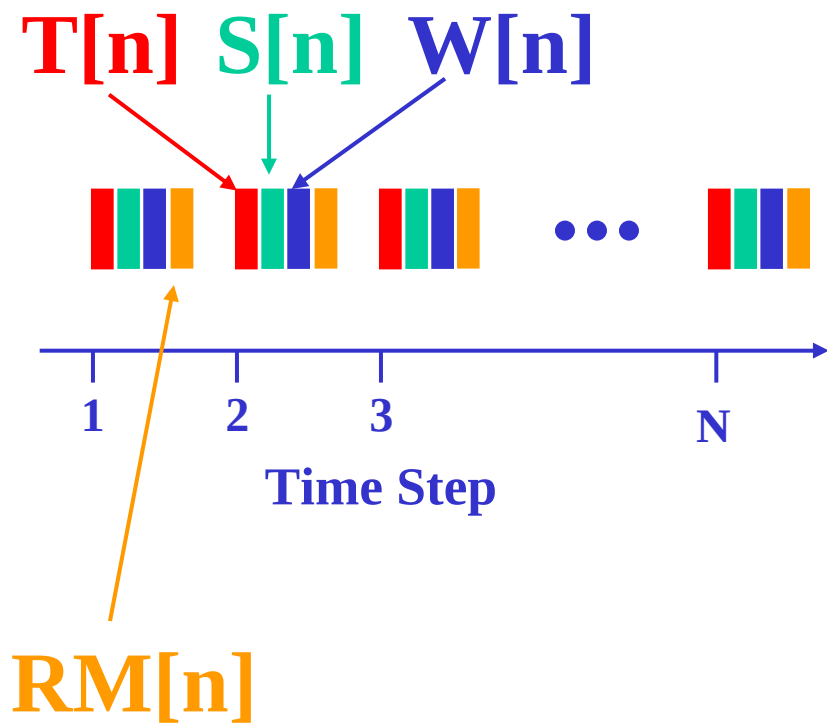


Time-Stepped Model





Time-Stepped Model

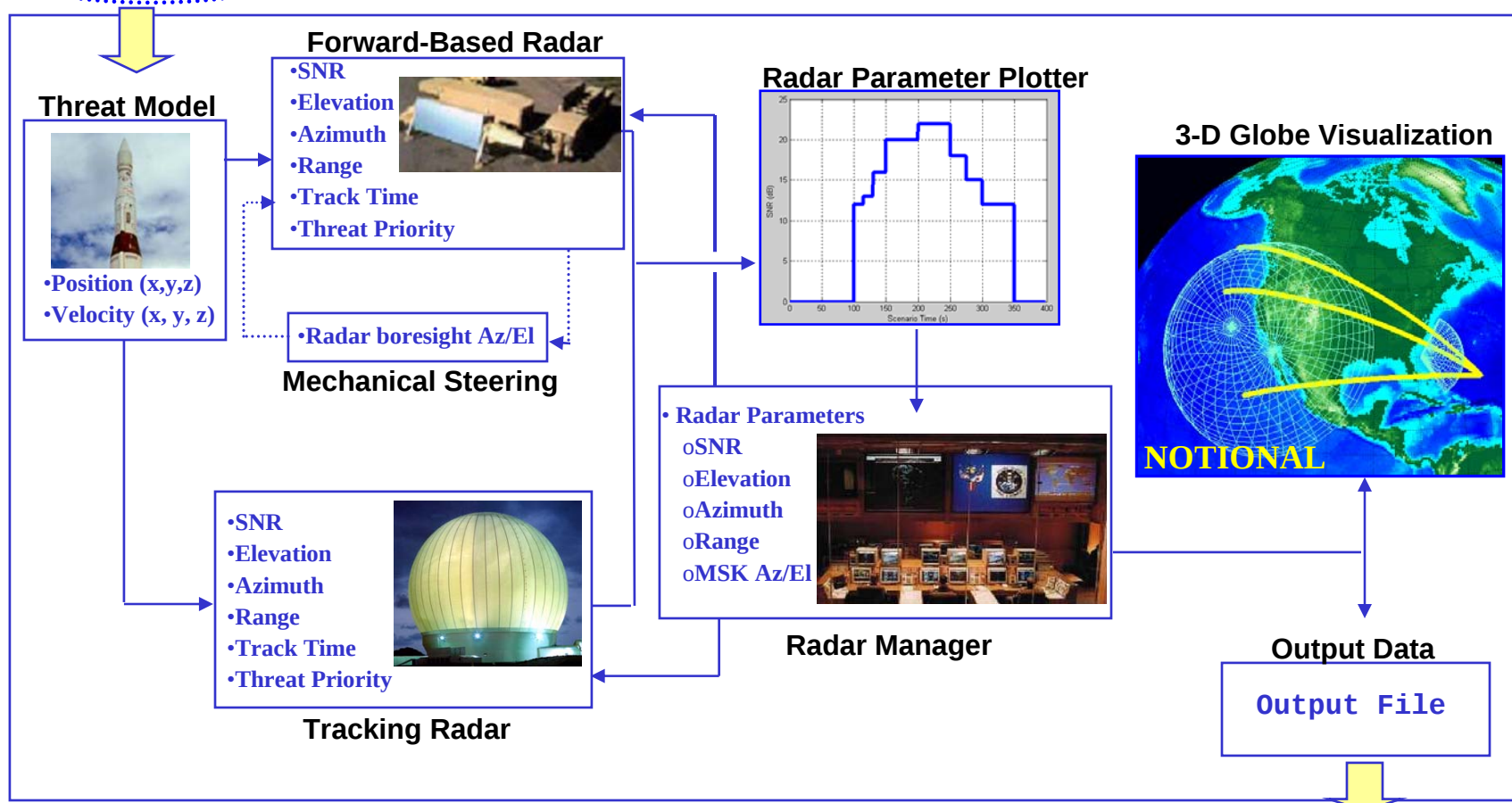




Overview of Architecture Analysis Model

- Modeling Environment-

Threat Trajectory Generation



Post-Process Output File



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Notional Scenario

- Scenario Setup -



HEADLINE NEWS

Country Orange has developed the capability to launch long-range threats from sea-based platforms and is poised to strike from the Atlantic. Possible threat to Country Blue's Pacific Assets. Country Blue's military leaders respond with a defense system involving two sea-based radars.



Notional Scenario

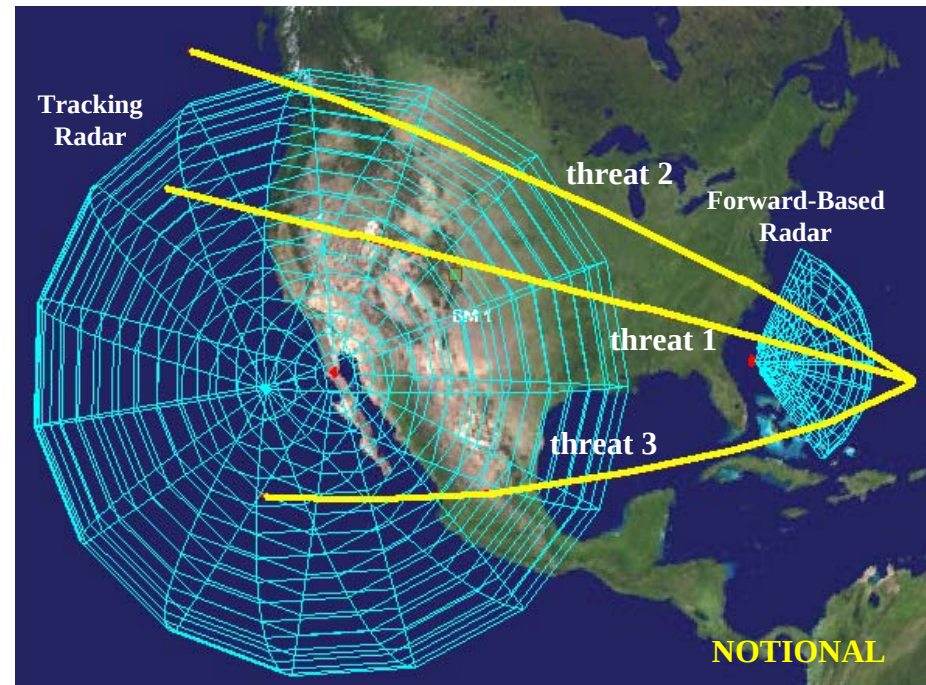
- Scenario Visualization -

Adversary: Country Orange

- Three long-range threats
- Atlantic Ocean launch points
- Pacific Ocean aimpoints

Friendly Forces: Country Blue

- Two defense sensors
 - Forward-based radar
 - Tracking radar
- Forward-based radar tasked to view and track each threat for a portion of ballistic flight



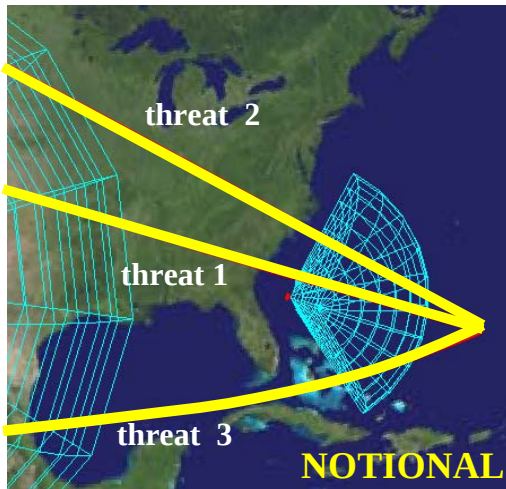


Notional Scenario

- Modeling of Radar operating concept -

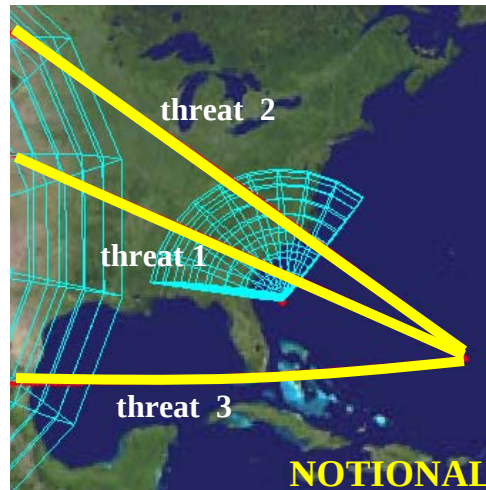
Radar boresight is at nominal azimuth location when it receives a Launch Alert

1) Radar starts at nominal boresight



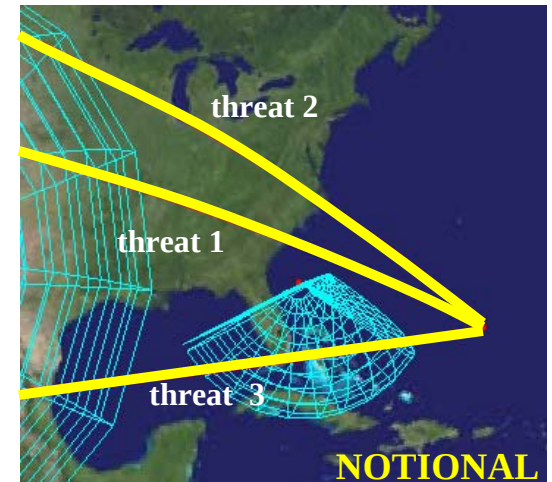
In a raid, radar slews to track threats in current FOV in sequential order (of received Launch Alerts)

2) Radar slews left to track threats 1 and 2



Radar will slew to follow and finish tasks on all raid threats if possible

3) Radar repositions to track threat 3



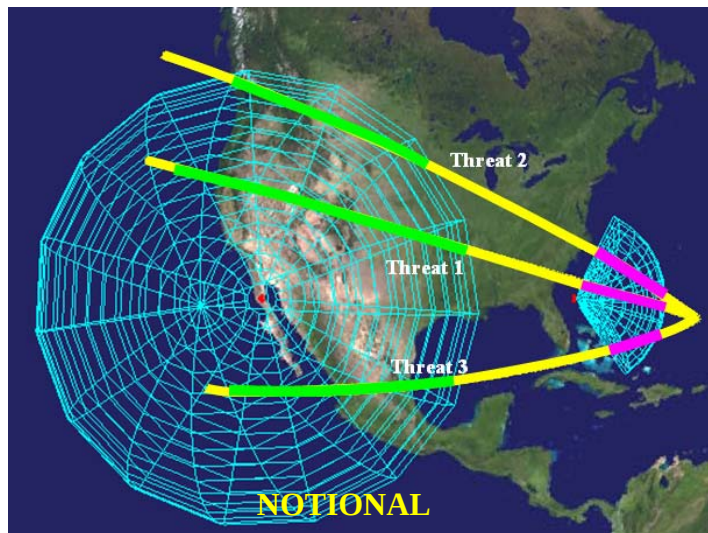
Scenario Time



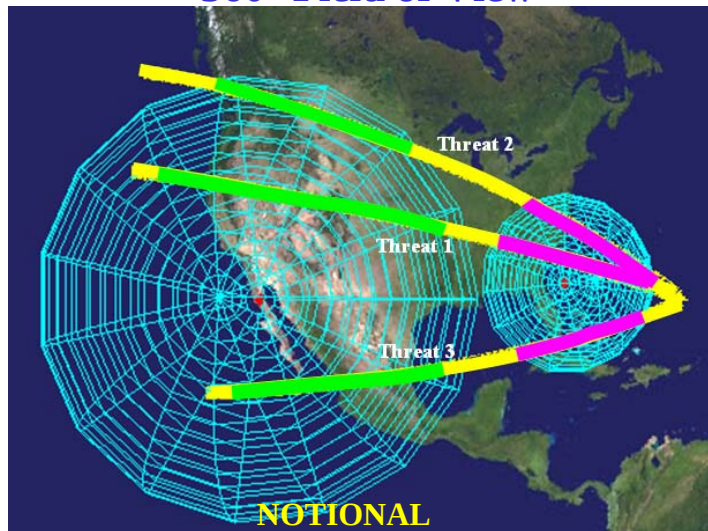
Notional Scenario

- Forward-Based Radar Coverage -

Fixed Field of View



360° Field of View



Time-stepped model
can show coverage
for dynamically
slewing FB Radar

Graphics Legend

Threat Time of Flight	Yellow
FB Radar Coverage	Magenta
Tracking Radar Coverage	Green

360° Field of Regard





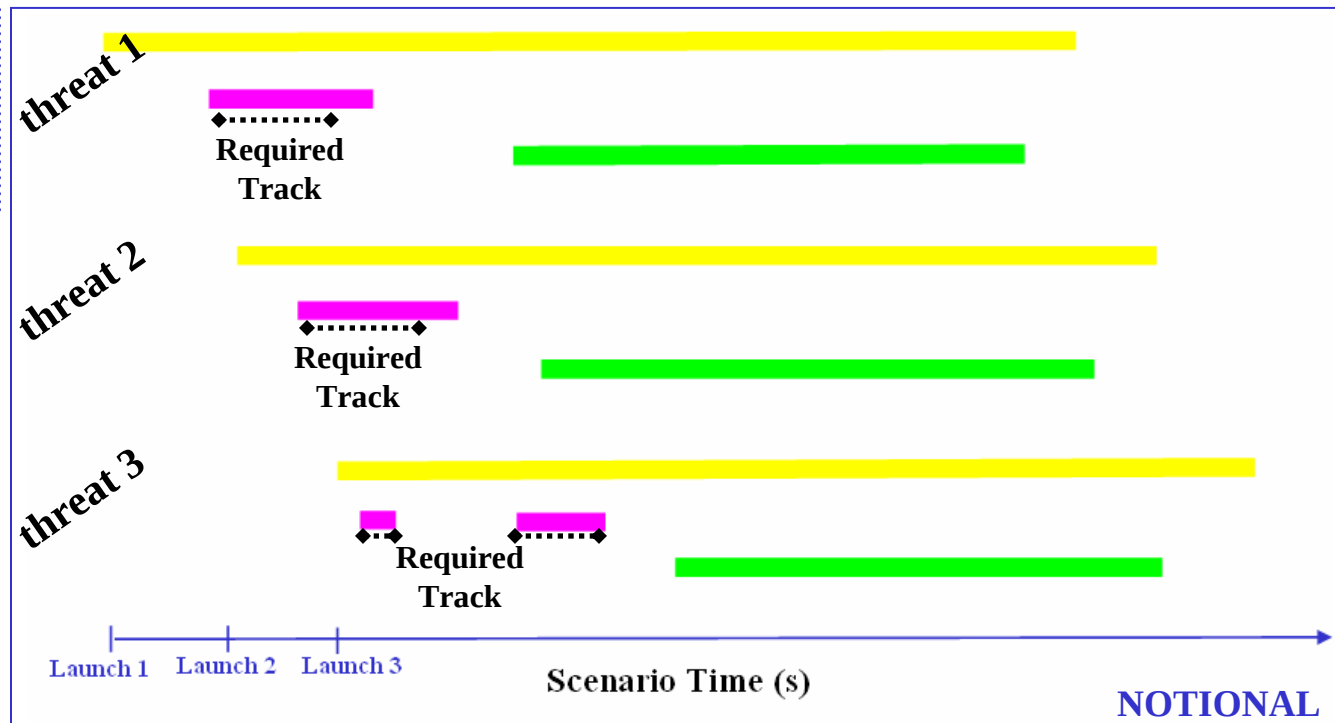
Notional Scenario Results

- Radar Coverage Timelines -

- The output file from the model can be used to extract data that is useful for assessing the radar's performance in a raid
 - Timelines can be used to validate handover between radars and determine length of track
 - This notional scenario shows no radar handover capability, but forward-based radar does complete tasks on all threats

Timeline Legend

Threat Time of Flight	
FB Radar Coverage	
Tracking Radar Coverage	



NOTIONAL

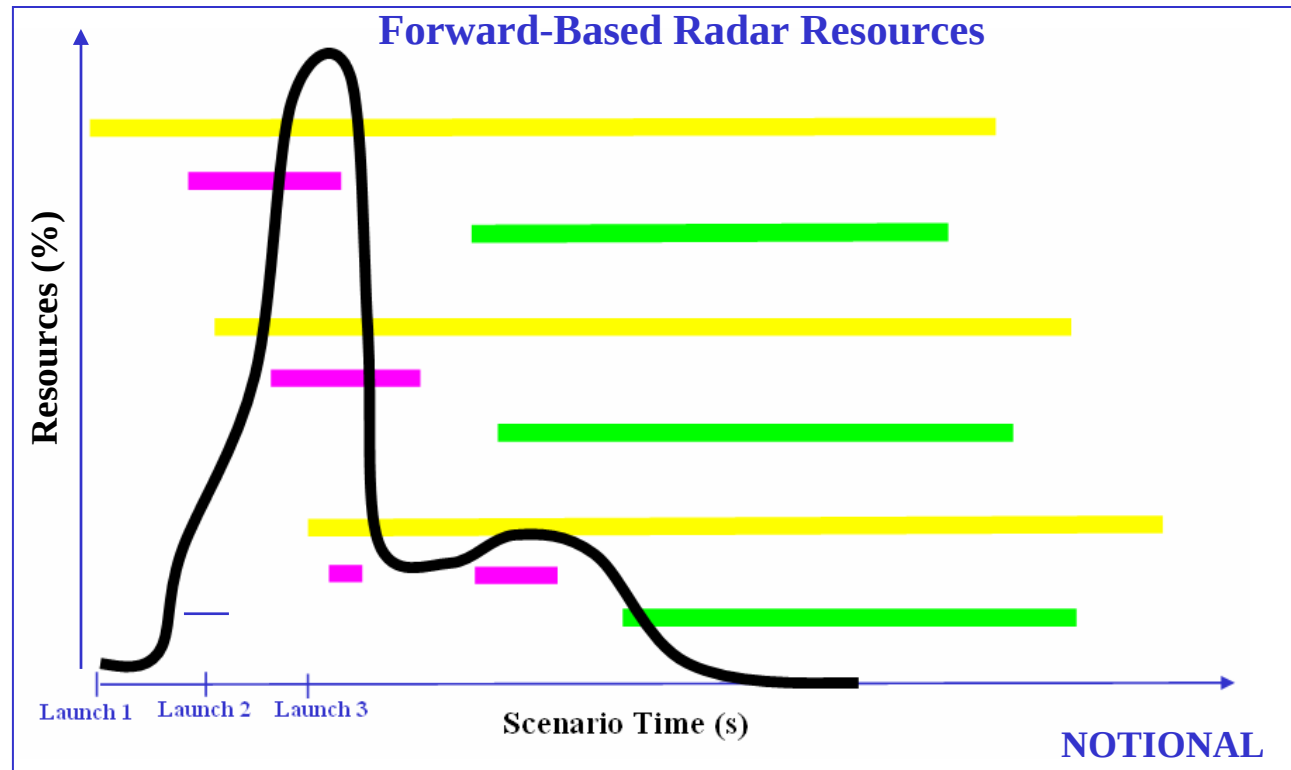
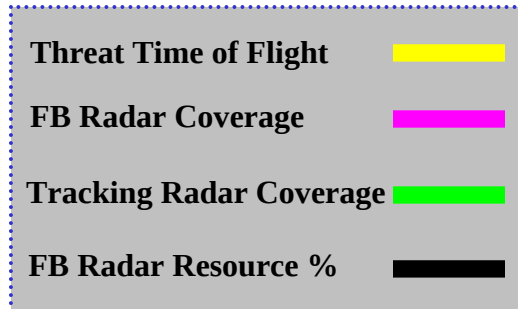


Notional Scenario Results

- Radar Resource Loading -

- When forward-based radar is tracking threats far in range, at far edge of FOV, or on multiple threats simultaneously, radar resource loading will be affected

Timeline Legend





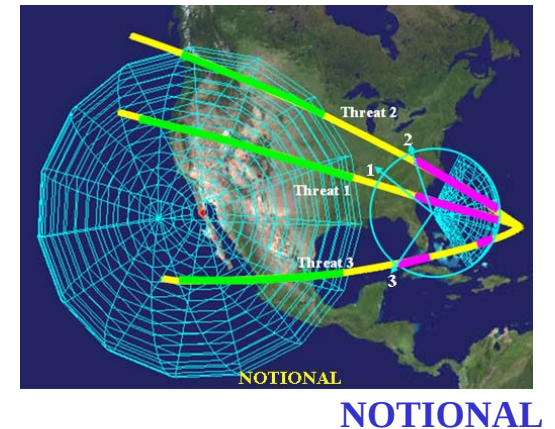
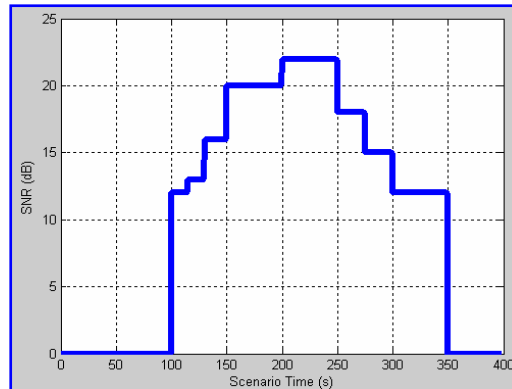
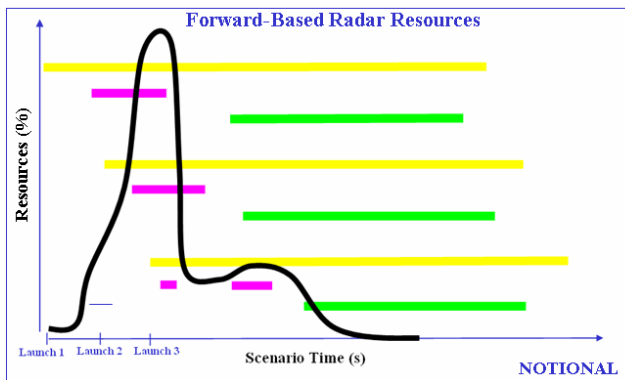
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Summary

- MDSET is tasked to solve analysis problems for MDA
 - Requires innovative and flexible tools
- Time-based vs. event-based model provides solution to current analysis problem
 - More accurate representation of a mechanically steered forward-based radar
 - Dynamic viewing of radar slewing and performance parameters



Time-Stepped Analysis Models Allow Dynamic Interactions Between Components and Increase Accuracy When Modeling Dynamically Driven Events

