System Effectiveness Analysis Simulation (SEAS) Overview

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Overview

- Need for credible, quantitative military worth analysis is a given
- SEAS:
  - Proper modeling of C4ISR as Prerequisite to Space Worth Analysis
    - Force planning centers around C4ISR issues (eg., Sim Based Acquisition)
    - Non-linear conceptual model of combat is essential
    - Conceptual model framework bridges gaps in DoD community
    - SEAS data model supports non-linear combat
    - Comparison of SEAS “vertical slice” to aggregated, legacy models: very different results
  - Quick Reaction Analysis (QRA) approach—existence proofs of sensitivity to C4ISR
    - Processing, Exploitation, Dissemination (Comm) delay
    - Comm outage
    - Concealment & Deception (SATRAN phasing, decoys)
    - Sensor Cuing
    - Model behavioral/functional validation
  - In detail
    - SEAS unique features
    - Where SEAS fits in DoD set of models
SEAS Unique QRA Features

- Balanced representation of C4ISR functions & “Information War” with weapons effects
  - Dynamic “Tactical Pictures” for each Blue & Red force element
    - Explicit sensor geometries and sensor platform revisit/gap times
    - “On the Fly” Air Tasking Order–diversion with in-flight update
    - Decoy/Deception for high value targets
  - Explicit end-to-end C-3 connections & time lines
    - Modeling of future weapons follows JMEM logic but not limited by historical data (eg., ATCAL tables)
    - Processing delay
    - Commander’s perception vs decision threshold (doctrine/rules)
    - Commander’s orders to field units–planning cycle delay
    - Maneuver warfare via automata rules–emergent behavior
  - Interaction of tactical doctrine & new system capabilities
    - Permits new CONOPs & doctrine to optimize exploitation of space

SEAS Unique QRA Features (2)

- Explores broad scope of outcome space consistent with high risk nature of warfare
  - Multi-run stochastic model for Exploratory Analysis
  - Interface to COTS analysis tools (eg., JMP) for visualizing probabilistic outcomes
  - Feeds response surface method to link architecture MOPs to campaign MOEs

- Architecture consistent with Military Worth Framework
  - Based on widely accepted “Strategy-to-Task” method
  - Interface to Strategy-to-Task MOEs & C4ISR & space system MOPs
  - Balanced context for credible space–air–ground ISR comparison
## SEAS Data Model

<table>
<thead>
<tr>
<th>Observe</th>
<th>Orient</th>
<th>Decide</th>
<th>Act</th>
<th>Killed?</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SURVEY</strong></td>
<td><strong>ASSESS</strong></td>
<td><strong>COMM</strong></td>
<td><strong>MOVE</strong></td>
<td><strong>SUPPLY</strong></td>
</tr>
<tr>
<td>TLE</td>
<td>Delay</td>
<td>Delay</td>
<td>Delay</td>
<td>Delay</td>
</tr>
<tr>
<td>TVE</td>
<td>BDA Delay</td>
<td>(msg loss &amp; link outage determined by MOPs below)</td>
<td>(loc &amp; delay determined by motion MOPs below)</td>
<td>(determined by logistics MOPs below)</td>
</tr>
<tr>
<td>Pd tgt (<em>Dwell</em>)</td>
<td></td>
<td></td>
<td></td>
<td>Aim Point</td>
</tr>
<tr>
<td>Pd decoy (<em>Dwell</em>)</td>
<td></td>
<td></td>
<td></td>
<td>Ballistic CEP</td>
</tr>
<tr>
<td>BDA Prob (TYPE I)</td>
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<td></td>
<td></td>
<td>Effect Radius</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>True Tgt Locus</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Pk</td>
</tr>
</tbody>
</table>

### Info Quality
- Range
- BrkRange (Pd rolloff)
- FOV Shape/Orient.
- Revisit (Orbit & Scan)
- Cued Pd & Range incr.
- Tgt Type
- MTI/SAR
- Active/Passive Sensor
- Day/Night
- Cloud Deck
- Hide State 0-2
- Hide State 3

### SEAS MOPS

### ConstrainTS
<table>
<thead>
<tr>
<th>Designator time</th>
<th>Range</th>
<th>AIR</th>
<th>GND</th>
<th>AIR</th>
<th>GND</th>
<th>AIR</th>
<th>GND</th>
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</thead>
<tbody>
<tr>
<td>Max tkt tracks</td>
<td>Msg rate</td>
<td>JIPTL</td>
<td>Speed</td>
<td>Wpn Range</td>
<td>Rate-of-Fire</td>
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<td></td>
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<tr>
<td>Launch detect</td>
<td>Queue size</td>
<td>Tgt Ptry</td>
<td>Speed</td>
<td>-Normal</td>
<td>Use Limit</td>
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<td>MaxHops</td>
<td>Wpn Load</td>
<td>Interval</td>
<td>-Base Atk delay</td>
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<td></td>
<td>Jammer Rng</td>
<td>Tgt Priority</td>
<td>Deploy</td>
<td>Loiter</td>
<td></td>
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<td></td>
<td>Reliability</td>
<td>Loiter</td>
<td>MoveTo</td>
<td>Latency Limit</td>
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<td>CommOn/Off</td>
<td>Latency Limit</td>
<td>Latency Limit</td>
<td>Wpn left</td>
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<td></td>
<td>Patrols</td>
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</tbody>
</table>

### AIR
- Divert Rng
- SetEvent
- WaitUntil
- WaitEvent
- OnB Sensr
- OnB Sensr
- Save Wpn
- Coord Fire
- Coord Fire
- Hide State 3

### GROUND
- Rearm/Refuel

**Blue Font** = Info elements propagated via comm links to shooters where effect on attrition occurs

**Black Italic Font** = Continuously variable MOP constraints which control the flow info elements

**Black Regular font** = 2 or 3 valued logical constraints which control flow of info elements

**Pink Bold font** = variables which generate reactive/adaptive behaviors
Simulation Domains

EXPRESSIVENESS

- abstract theories
- conceptual models
- concrete models
- observed world

APPLICATION

- real-world
- small: Ops analysis for exercise support
- medium: NSS, EADSIM
- large: SEAS

SCALE

- high fidelity investigation of specific options
- medium
- large

- abstract mapping of local option-space with cellular automata
- Exploratory Analysis for acquisition planning
- Ops analysis for force sizing
- System & Ops Eval
- Syst. & Ops Concept Expl.
Bottom Line

- SEAS developed for over 5 yrs to meet goals of next generation combat models
  - Guided by Sante Fe Institute Complex Adaptive System concept
  - Consistent with MORS SIMTECH 2007 & "New Sciences" Symposium

- SEAS provides capabilities for C4ISR and Info War analysis not possible with aggregate combat models

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