A Methodology for Network-Centric Electronic Attack Evaluation

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Agenda

• Background

• Network Centric (NC) EA Evaluation Methodology
  – ITT Network-Centric EA Model
  – Extended Air Defense Simulation (EADSIM) Model

• Applications of NC-EA and EADSim Models
  – Assessment of Jamming Effectiveness
  – Re-alignment of Jamming Assets
  – Trade Study of Radar Cross Sections

• Summary
Network-Centric Electronic Warfare

- **Network Centric Architecture:**
  - An operational architecture that closely couples the capabilities of sensors, command and control, and shooters to maximize the effects of geographically dispersed resources in electronic warfare

- **Network Centric Electronic Attack:**
  - Optimum control and utilization of a network of dispersed electronic attack (EA) assets to provide a wide area suppression of enemy integrated air defenses (IADS) in a dynamic manner
Network-Centric Electronic Attack Evaluation

- Evolution from Platform-Centric to Network-Centric (NC) EA Requires New Methodology to Develop and Evaluate Systems:
  - Uses NC-EA Simulator and EADSim Model
- ITT Interactive NC-EA Simulator
  - Implements radar jamming equation
  - Generates jamming effectiveness contour map in area of interest
  - Allows selection of optimum EA for Stand-off, Stand-in, Escort and Close-in systems based on J/S contours and “protected area”
- Extended Air Defense Simulation (EADSim) Model
  - Includes all IADS radars (3-D patterns) and detailed C²
  - Uses NC-EA Simulator results to quantify jamming effectiveness in aircraft protection (reduction in number of missiles launched)
NC-EA Elements (Notional)
ITT Interactive NC-EA Simulator

- Inputs:
  - IADS Laydown (Radar Locations)
  - Threat Radar Characteristics (ERP’s, Antenna Patterns,..)
  - Jamming Platform Locations
  - Jammer Characteristics (ERP’s, Allocations,…)
  - Attack Aircraft Flight Path
  - Attack Aircraft RCS

- Outputs:
  - Jam/Signal Ratio Contour Plots
    - One-on-One: One jammer vs one radar
    - Composite: “N” jammers vs “M” radars
  - Percentage of “Blue Zone” in Area of Interest
  - 1 NM x 1 NM Cell Resolution illustrating Mainbeam Effect in Support Jamming
Extended Air Defense Simulation (EADSim) Model

- Extended Air Defense Simulation - U.S. Army Space and Missile Defense Command Model
- A DoD standard mission-level stochastic model
- Focuses primarily on
  - Events occurring within an Integrated Air Defense System (IADS) including:
    - C² decision logic
    - SAM and AI operations
    - Intelligence, Surveillance and Reconnaissance
    - Electronic Attack and Suppression of Enemy Air Defense (SEAD)
  - Ballistic and Cruise missile employment & defense
EADSim Electronic Attack Modeling Capability

• Ability to model EA systems to a high level of fidelity
  – Platforms (Stand-off, Stand-in, Close-in, Self Protection)
  – Techniques (Deception, Noise, Decoys)

• Calibrated to match NC-EA model
  – Radar coverage defined by detailed antenna pattern diagram
  – Calibrated J/S and burn-through range with NC-EA jammers

• Graphical Outputs
  – Vertical coverage plots displaying radar antenna pattern with and w/o jamming
  – Intervisibility plots displaying detection area with and w/o jamming

• Analytical Outputs
  – Denied/delayed detection by EW/Acquisition/Fire Control radars
  – Reduced number of SAM shots due to EA
Jamming Effectiveness Assessment
## Interactive Simulation Model

### Table 1: IADS Example

<table>
<thead>
<tr>
<th>Target</th>
<th>Cross Range, NM</th>
<th>Down Range, NM</th>
</tr>
</thead>
<tbody>
<tr>
<td>R1, SAM 1, Tracking Radar</td>
<td>0</td>
<td>-8</td>
</tr>
<tr>
<td>R2, SAM 1, Acqu Radar</td>
<td>0</td>
<td>-8</td>
</tr>
<tr>
<td>R3, SAM 2, Tracking Radar</td>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td>R4, SAM 2, Acqu Radar</td>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td>R5, Early Warning Radar</td>
<td>-36</td>
<td>0</td>
</tr>
</tbody>
</table>

### Table 2: NC-EA Assets Example

<table>
<thead>
<tr>
<th>Stand-off</th>
<th>Cross Rng (NM)</th>
<th>Down Rng (NM)</th>
<th>Jamming vs R1</th>
<th>Jamming vs R2</th>
<th>Jamming vs R3</th>
<th>Jamming vs R4</th>
<th>Jamming vs R5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stand -In</td>
<td>40</td>
<td>80</td>
<td>50 KW</td>
<td>25 KW</td>
<td>50 KW</td>
<td>25 KW</td>
<td>1 KW</td>
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<tr>
<td>Close-In 1</td>
<td>7</td>
<td>-7</td>
<td>100 W</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Close-In 2</td>
<td>7</td>
<td>-7</td>
<td></td>
<td></td>
<td></td>
<td>100 W</td>
<td></td>
</tr>
<tr>
<td>Close-In 3</td>
<td>9</td>
<td>9</td>
<td></td>
<td></td>
<td>100 W</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Close-In 4</td>
<td>9</td>
<td>9</td>
<td></td>
<td></td>
<td></td>
<td>100 W</td>
<td></td>
</tr>
<tr>
<td>Close-In 5</td>
<td>-37</td>
<td>7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>50 W</td>
</tr>
</tbody>
</table>

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NC-EA Model Calibration
Jamming Effects on Individual Threats (A/C RCS = A dBsm)

- Target
- SAM (Acq / Track)
- Early Warning

- Attack A/C
- Standoff Jammer
- Stand-In Jammer
- Close-In Jammer

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NC-EA Model Results
(Attack Aircraft  RCS = A dBsm)

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EADSim Scenario and Laydown Description

- Threats (consistent with NC-EA model)
  - One Early Warning Radar
  - Two SAMs (Acquisition & Target Track Radar)

- Blue Systems
  - Four Attack Aircraft
    - Speed = 350 Knots
    - Altitude = ~ 27K ft.
    - Flight path: South to North
    - Two – 2 ship flights
  - Seven Jammer Aircraft
    - Altitude = ~ 27K ft.
    - Flying short orbit legs
EADSim Results
Elevation Coverage Plot for Acquisition Radar

• Modeling Radar in EADSim
  – Basic parameters (frequency, beam dimensions, scan parameters, power, losses, etc.)
  – Ability to input complex antenna pattern to define radar coverage in detail
EADSim Results
(Intervisibility Plot Coverage for Attack A/C RCS = A dBsm)

Concentric rings appear due to radar lobing structure

Penetration Flight Path

Target

Electronic Attack opens corridors for ingress by limiting detection capability of SAM acquisition radars
EADSim Results
Impact of Assets on Attack Aircraft

Average Number of Valid Shots per Aircraft

- No Jamming
- Jamming

A dBsm
Radar Cross Section

[Graph showing the impact of radar cross section on average number of valid shots per aircraft with and without jamming]
Re-Alignment of NC-EA Assets
NC-EA Model Results
(Attack Aircraft RCS = A dBsm)

Re-assigning locations of Stand-off, Stand-In and close-in jammers

"Blue" = 76.2%
Re-aligning assets results in complete overflight of SAM acquisition radars.
Trade Study of Radar Cross Sections
NC-EA Model Results
(Attack Aircraft RCS = B dBsm)

(J/S) Contour Plot for Network Centric EA

(J/S) Ratio (dB)

Target
SAM (Acq / Track)
Early Warning
Attack A/C
Standoff Jammer
Stand-in Jammer
Close-In Jammer

“Blue” = 90%
EADSim Results
(Intervisibility Plot Coverage for Attack A/C RCS = B dBsm)

Reduced ingressor RCS combined with EA assets ensure complete overflight of IADS threats.
EADSim Results
Impact of Realigned Assets and Lower RCS on Attack Aircraft

Average Number of Valid Shots per Aircraft vs Radar Cross Section

- **No Shots**
- **With Jamming**

EADSim Results
Impact of Realigned Assets and Lower RCS on Attack Aircraft

Average Number of Valid Shots per Aircraft vs Radar Cross Section

- **No Shots**
- **With Jamming**

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Summary

• NC-EA Evaluation Methodology Can Support:
  – Development of system requirements for EA system development
  – Pre-mission planning
  – Real-Time jammer assets tradeoff, re-alignment and reaction

• Lessons Learned from NC-EA and EADSim Modeling:
  – Close-In Jammers Can Be a Significant Factor but Need Dynamic and Accurate Control
  – Stand-in Jammers Need to Be Accurately Located or Use High ERP for Network Centric Electronic Attack (NC-EA) Operation