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THE OPPORTUNITY TO MAKE A DIFFERENCE HAS NEVER BEEN GREATER

Blue SLAACM: a Stochastic Lanchester Air-to-Air Campaign Model for Blue Attack



Jeremy Eckhause, Robert Hemm, David Lee
in support of OD/PA&E TACAIR

MORS Symposium
June 10-12, 2008

Outline

- What is SLAACM?
 - “Air Defense” or “Classic” SLAACM
 - “Attack” or “Blue Attack” SLAACM
- SLAACM Features
 - Inputs & knobs
 - What the inputs reflect
 - What the knobs affect
 - Analysis protocol
 - Outputs
- Demo



SLAACM Summary

- The **Stochastic Lanchester Air-to-Air Campaign Model** determines statistics of day-by-day attrition and destruction, for a two-sided campaign.
 - Each “day” the attacking side launches its forces in optimal attack packages.
 - Defensive counter-air forces respond. Certain defender aircraft respond with optimal sets of defending flights, while others encounter attack packages randomly and may encounter no opponents. Defender forces may include local air defenders, with different optimization rules from the other defense forces.
- SLAACM does not simulate; rather, it calculates engagement outcome statistics analytically, with parsimonious probabilistic models.

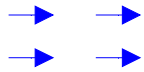


Campaign Analysis - Current Air Defense SLAACM Capabilities

- Extended list of Red and Blue aircraft options with calculation and use of full engagement statistics for all feasible attack and defense packages
- Integer programming optimization of Red attack and Blue defense that considers full engagement statistics
- Objective functions that include bomb effectiveness and user-adjustable aircraft kill and loss values
- Adjustable time phasing of Red and Blue supply to model attack and defense build-up
- Battle Management parameter to model AWACs impact
- Smart Blue optimization to model self-contained surveillance and battle management
- CAP factors to model remote basing
- Fully modeled classified scenarios



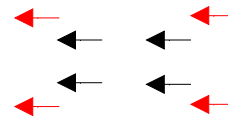
Air Defense SLAACM Scenario



Defenders

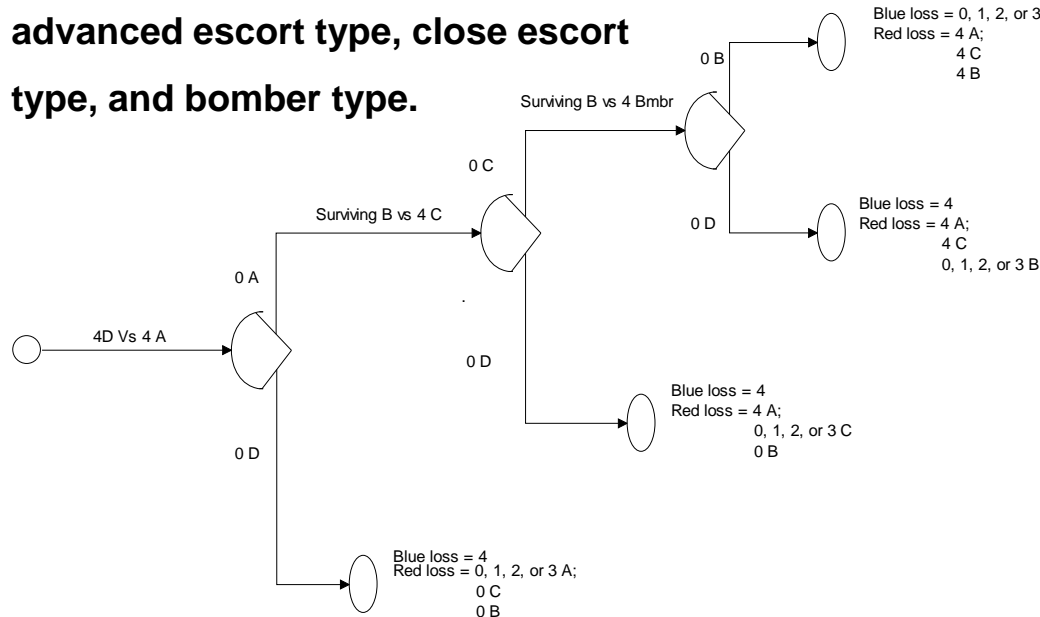


Advanced Escort



Close Escort ()
and Bombers ()

Package type is triple [a, c, b],
advanced escort type, close escort
type, and bomber type.



Probabilities of these outcomes
give Red and Blue loss distributions,
and bombs delivered

Absorbing States

	A	C	B	D
1	4	4	4	0
2	4	4	4	0
3	4	4	4	0
4	4	4	4	0
0	1	4	4	0
0	2	4	4	0
0	3	4	4	0
0	4	4	4	0
0	0	0	0	1
0	0	0	0	2
0	0	0	0	3
0	0	0	0	4
0	0	0	1	0
0	0	0	2	0
0	0	0	3	0
0	0	0	4	0

Calculations: 4 D vs 4 A; surviving D vs 4 C; surviving D vs 4 B



Attack (Blue) SLAACM Campaign Model

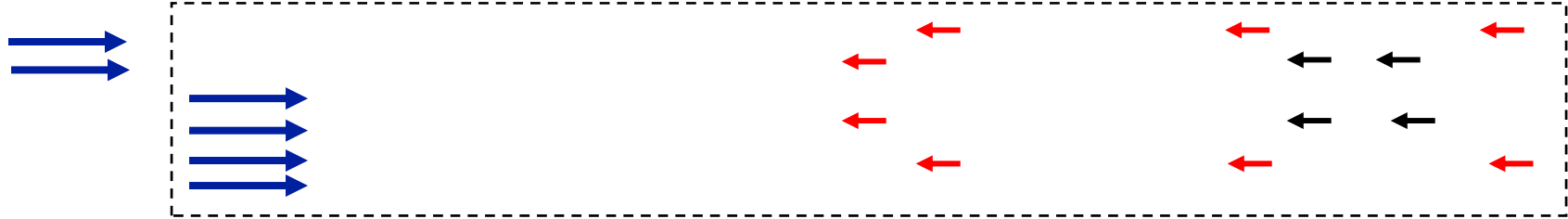
Purpose and Features

- Extends bomber types include low observable aircraft
- Allows new multiple engagement scenarios including
 - Additional fighter defense M vs. N options
 - SEADs and SAMs
 - Stand-off jamming
- SLAACM software converted to object-oriented programming structure allowing flexible selection of
 - Attack package structure
 - Defender flight structure
 - Engagement model
 - Scenarios

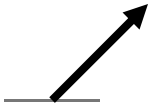
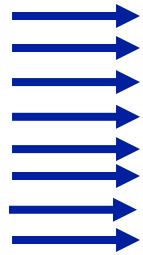


Attack SLAACM Example Modules

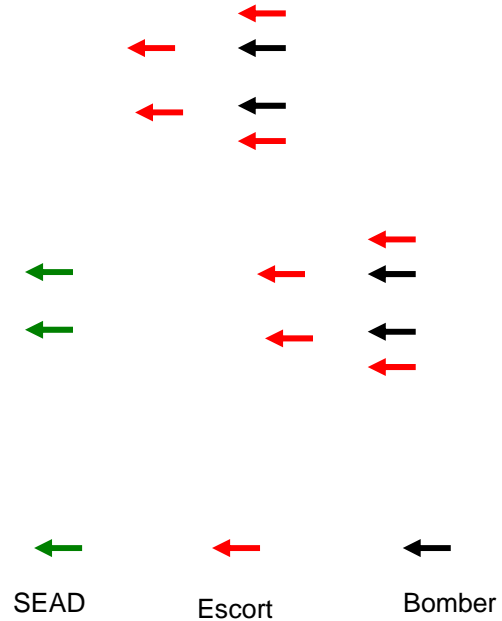
Defender Options



Attacker Options



SAM Site



Classic SLAACM Inputs

- Engagement Scenario
 - Attacker vs defender loss ratios
 - $\langle \text{mean time of Blue killing bomber} \rangle / \langle \text{mean time bomber escape} \rangle$
 - At user's choice, escaping bombers either abort or complete mission
 - Bomber payloads and delivery accuracies
 - Blue break point; Red break point
- Numbers of opposing forces
 - Includes day-by-day reinforcements
- CAP factor reflecting defenders flying combat air patrol
- Battle management factor reflecting C⁴I effectiveness
 - “Smart” defenders do their own battle management
- Attacker value of defender loss, bomber mission, and attacker loss
- Defender value of attacker loss, bomber mission kill, and defender loss



Attack SLAACM Inputs

- Engagement Scenario
 - “Classic” Air Defense
 - SEAD
- Defense
 - 2, 4, or 8-ship defender flights
 - SAM/No SAM
- Engagement model
 - M-Vs-N probabilistic model with assigned breakpoints

Defense SLAACM feature Attack SLAACM feature



SLAACM's Analysis Protocol

- Calculate outcomes for all feasible engagements using a unique, fast algorithm.
- Calculate bomber effectiveness based on payload and CEP
- Use engagement outcomes and bomber effectiveness to generate attacker and defender payoff functions for optimizations
- Calculate optimal attacks and defenses using either a sorting heuristic or an integer programming solver
- Run campaign day-by-day and display results



SLAACM Calculations

- Day-by-Day, solution of IP problem for Red's optimal attack
 - At user's choice, fast greedy heuristic or full IP solution
- Smart Blues mount optimized response
 - Other Blues encounter Red packages at random
- Full statistics of engagements calculated

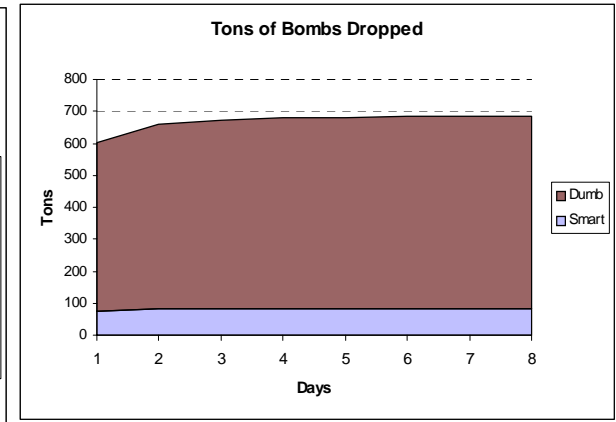
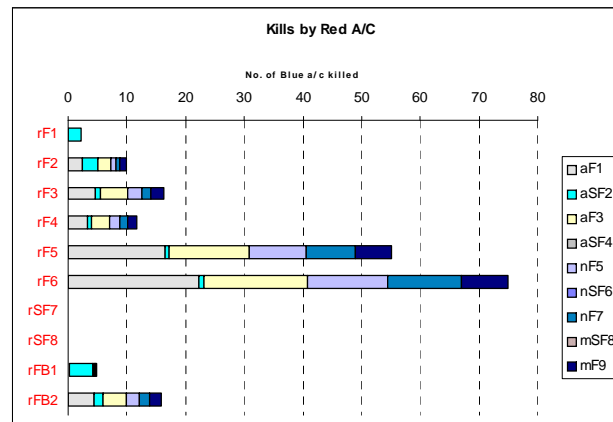
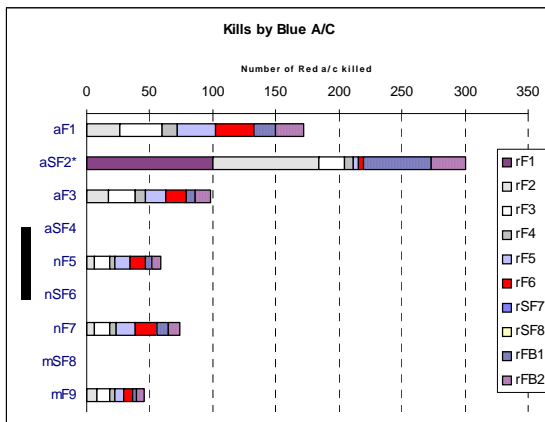
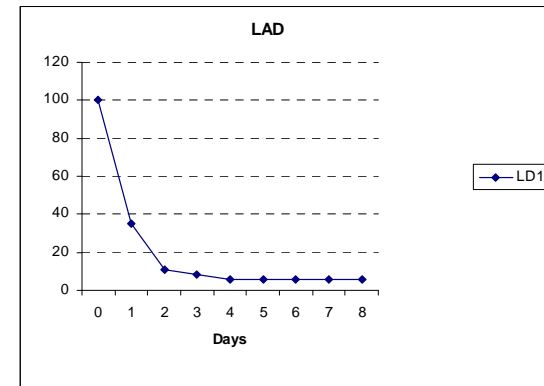
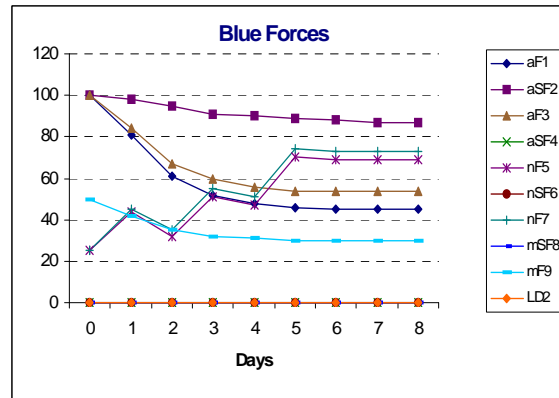
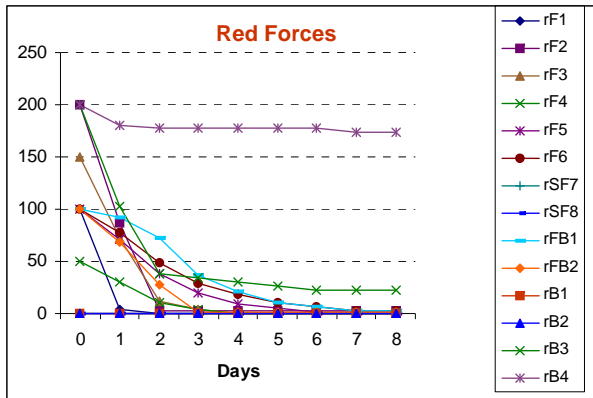


SLAACM Tabular Output

- Losses day-by-day
 - Central tendencies for Red and Blue
 - Dispersion measure for Blue
- “Who killed whom”
- Tons of bombs delivered day by day



SLAACM Graphical Output



SLAACM Summary

- Air Defense SLAACM is a powerful, flexible analytical tool, that thoroughly meets all the requirements of a useful campaign model.
- Attack SLAACM has demonstrated the ability to analyze complex attack scenarios, and is far beyond Air Defense SLAACM in power and flexibility
- New software design supports the ultimate plan for an integrated defense/attack campaign optimization model that is fast, flexible, comprehensive, repeatable and traceable.



Demo



Attack SLAACM – Sample Scenario

- Base Scenario
 - Attack Packages: 2 Bombers, 4 Escorts, 2 SEAD
 - Defense Packages: 8 Interceptors, 1 SAM site
 - SAM site engaged by SEADs; if survives, has time to fire 3 ready missiles while bombers in range
- Engagement Logic
 - Interceptors must defeat all escorts to attack bombers
 - SEADs engage SAMs in fight to death; SAMs only engage bombers if SEADs destroyed
 - Escorts and SAMs do not engage each other
 - Bombers escape interceptors based on a probability of escape-to-loss, rather than a kill-rate-ratio (but fighter-bombers fight)
 - Escaping bombers continue mission or abort; user choice



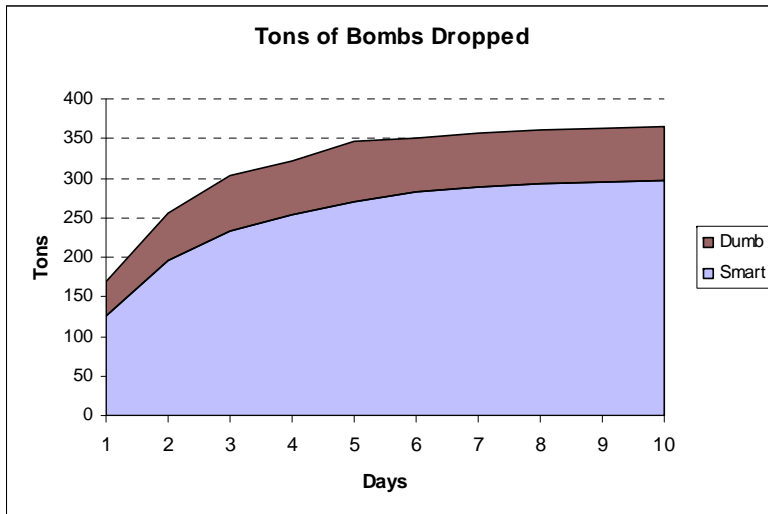
Attack Demo Campaign Scenario

- Order of Battle
 - Attacker types: 3 fighters, 1 SEAD, 3 fighter-bombers, 3 bombers
 - Defender types: 4 interceptors, 1 SAM site with 3 missiles
 - Time phasing of quantities: All available on first day (both sides)
 - CAP factors: 1 for all interceptors
- Rules of Engagement
 - Escaping bomber options: Bombers escape without dropping bombs
 - Battle management factor: 0.9
- Attacker and Defender Objective Function Coefficient Values
 - Attacker value of Attacker/Defender Loss: 2 / 20
 - Defender value of Defender/Attacker Loss: 5 / 20
- Campaign Duration – 10 days



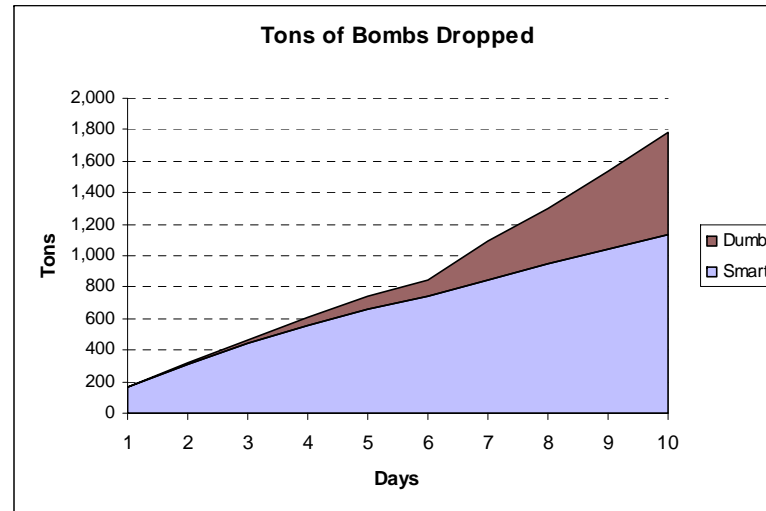
Attack Demo Campaign Results

No SEAD



Totals (tons)
 Dumb: 68
 Smart: 296

SEAD



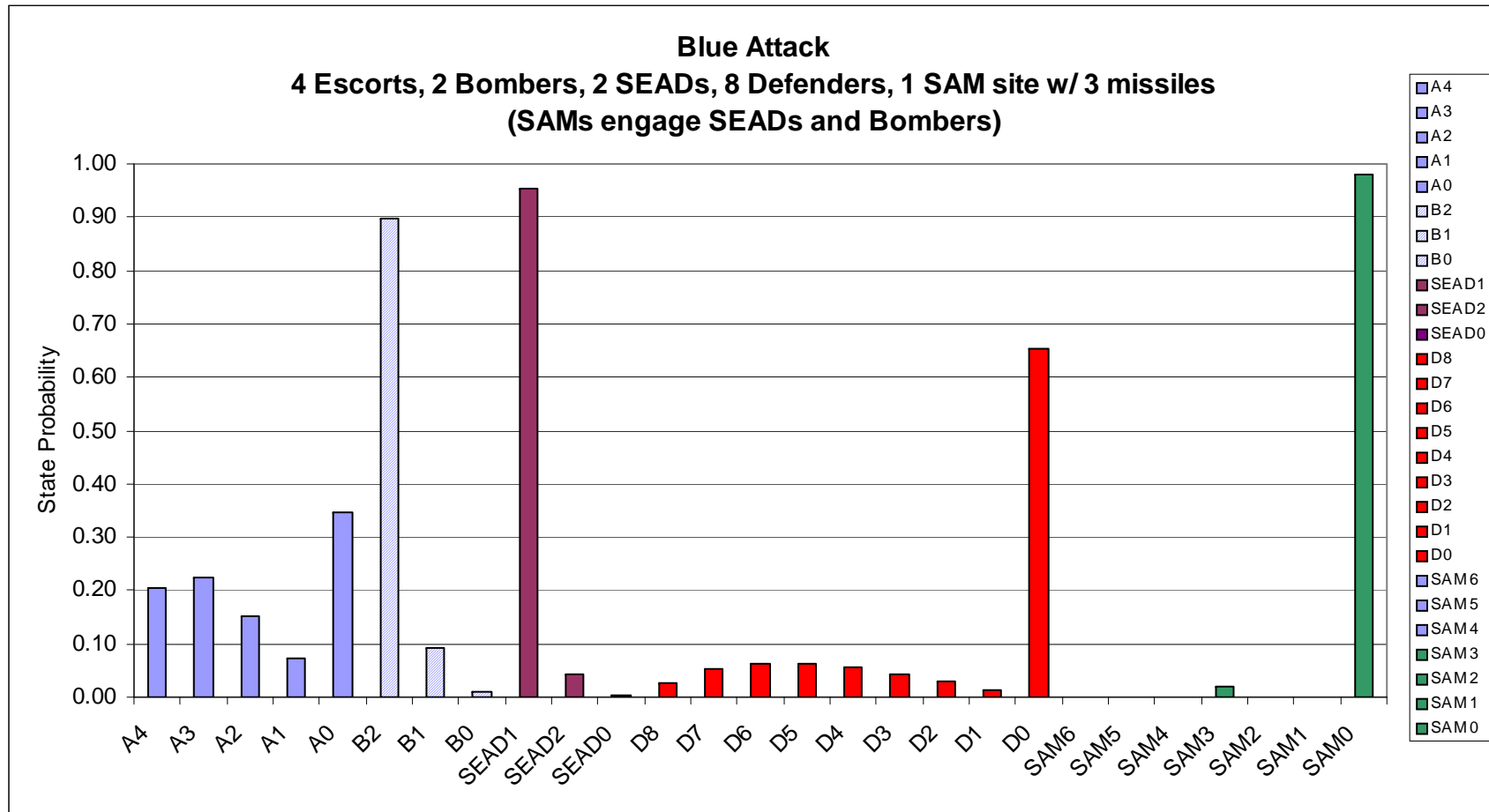
Totals (tons)
 Dumb: 650
 Smart: 1,138



Back-up



Attack Engagement Example – 2 SEADs



Attack Engagement Example - 0 SEADs

