Regional Value Analysis at Threat Evaluation

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Agenda

- Overview of Air Defense
- Threat Evaluation & Weapon Assignment
- Problem
- Regional Value Analysis
- Formulation
- Conclusion

Overview of Air Defense

- Detection
- Identify
- Intercept
- Destroy

Threat Evaluation & Weapon Assignment

Threat Evaluation

As for air defense, threat is an aircraft, cruise missile or ballistic missile that aims to destroy, to defuse or to harm the functions of the targets. Threat evaluation is a process of prioritization and determination the enemy tracks with some specific methods.

Various decision support models for threat evaluation have been developed

Bayesian networks and fuzzy logic models come to the fore.

Weapon Assingment

Weapon assignment consists of finding an optimal assignment of a set of weapons of various types to a set of targets in order to maximize the total expected damage done to the opponent.

$$\prod_{k}^{T}\left(1-\omega_{jk}\prod_{i}^{M}(1-P_{ik})^{X_{ik}}\right)$$

ω_{jk} – Threat`s priority

X_{ik} – represents the assignment of as many weapons

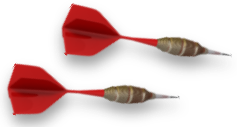
P_{ik} – probability of kill

Threat Evaluation

Liebhaber has identified 6 basic totally 18 parameters for threat evaluation.

Liebhaber & Feher

Basic	origin, IFF mode, intel, air route, altitude, radar and electronic
Other	airline, coordinated activity, speed, closest point of approach (CPA), feet wet/dry, maneuvers, number/composition, own support, range/distance, visibility, weapon envelope, wings clean/dirty

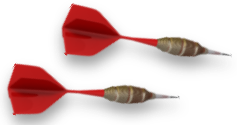


Threat Evaluation

Johansson divided same parameters into three groups

Johansson

Group	Parameters
Proximity Parameters	Range from Closest Point of Approach (CPA), Time to CPA, CPA in Units of Time, Time Before Hit and Distance
Capability Parameters	Target Type, Weapon Type, Fuel Capacity, Maximum Radius of Operation
Intent Parameters	Target's Kinematics, Number of Recent Maneuvers



Problem

Liebhaber & Feher

Basic	origin, IFF mode, intel, air route, altitude, radar and electronic
Other	airline, coordinated activity, speed, closest point of approach (CPA), feet wet/dry, maneuvers, number/composition, own support, range/distance, visibility, weapon envelope, wings clean/dirty

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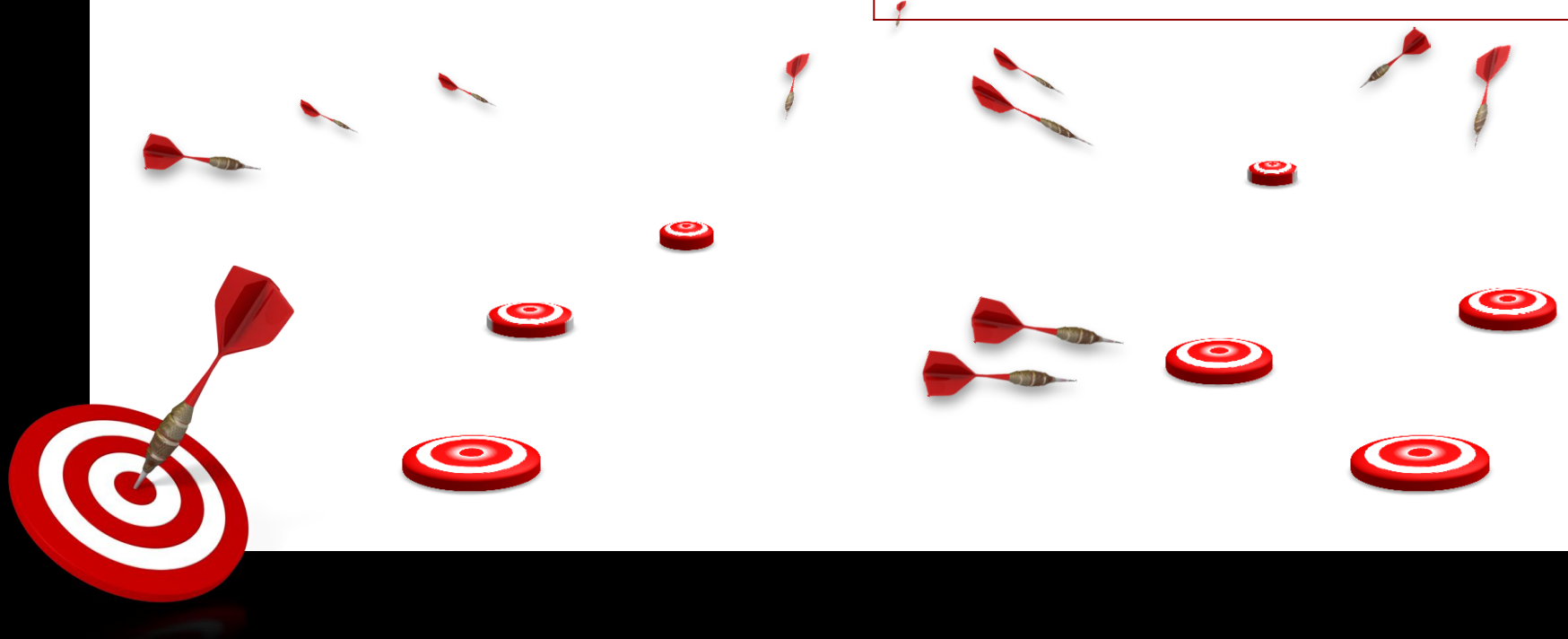
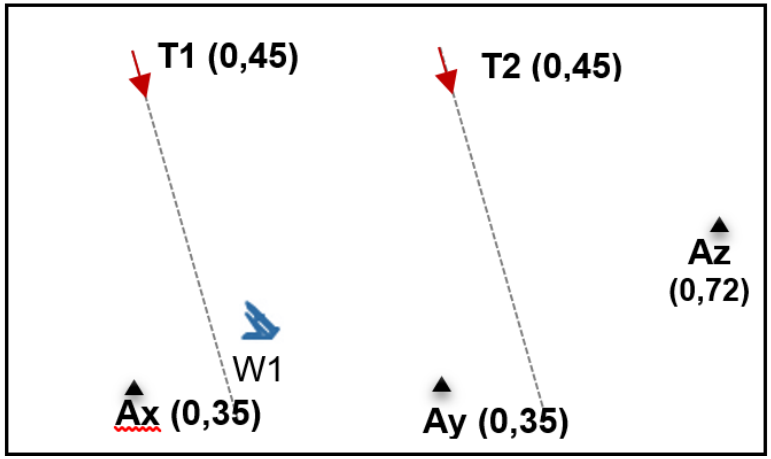
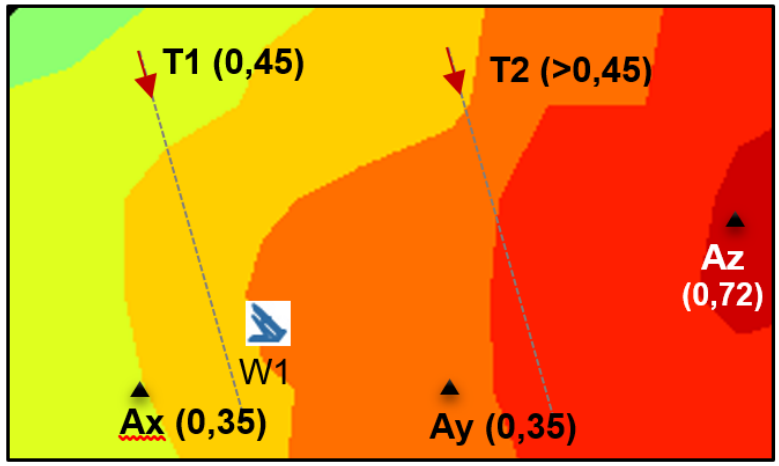


Regional Value Analysis

Classic Threat Evaluation



With Regional Value Analysis



Formulation (Target Values)

Set and Variables

A : Set of Assets,

a_j : Asset value, $j \in A$,

T_j : Asset priority

V_j : Vulnerability

R_j : Repairing capability

Alt_j : Alternate

D_j : Distribution

Rng_j : Range to threat

Lc_j : Land condition

Dl_j : Diagnosis Level

$Rdrc_j$: Radar coverage

$SAMc_j$: SAM coverage

$RngB_j$: Range to border

Formulas

$$a_j = T_j + V_j + R_j + Alt_j + D_j + Rng_j + Lc_j + Dl_j + Rdrc_j + SAMc_j + RngB_j$$

Formulation

Set and Variables

A : Set of Assets,

N : Set of Points,

a_j : Target value, $j \in A$,

b_{nj} : Point value,

u_n : Updated point value,

r_{nj} : Distance between target and point,

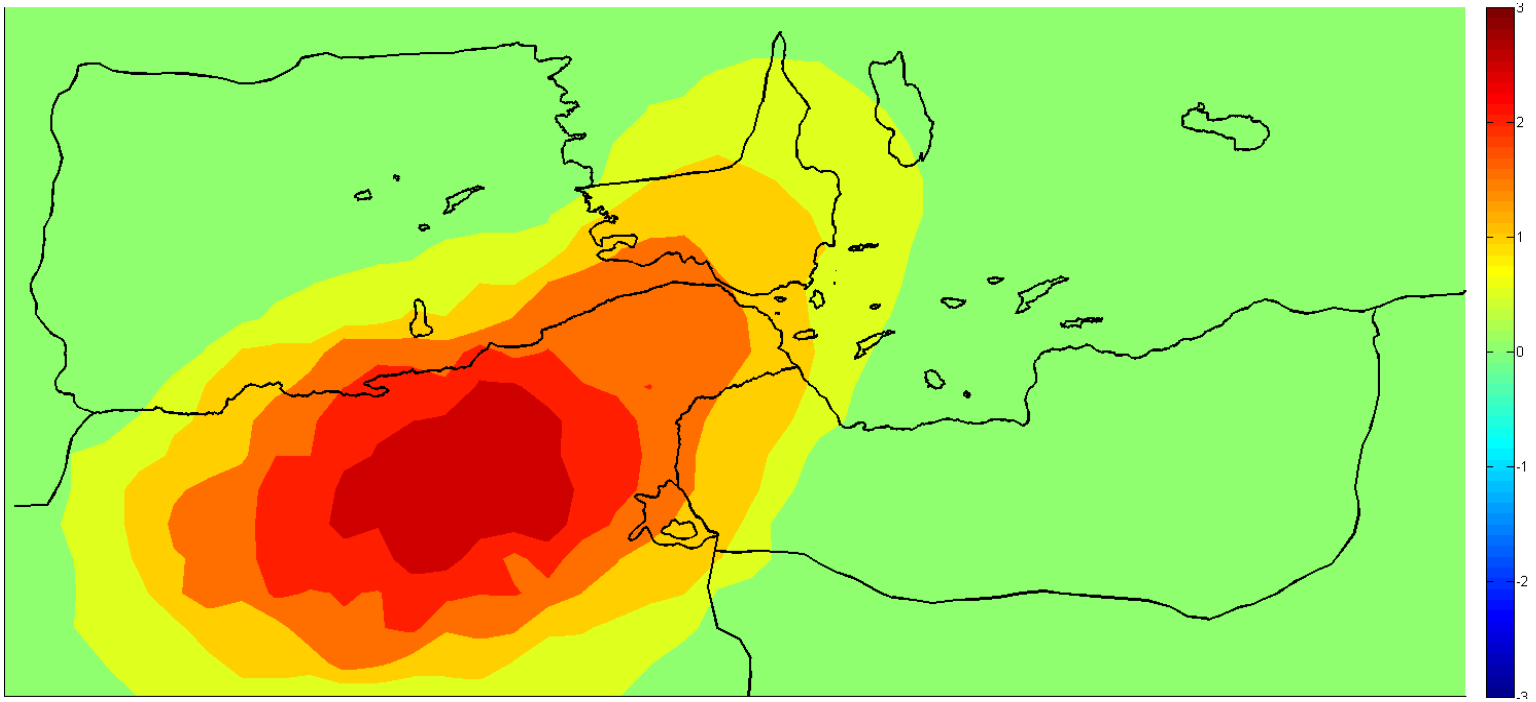
Rw : Most effective air to surface missile range,

Formulas

$$b_{nj} = \begin{cases} a_j & if\ r_{nj} \leq Rw, \\ 0 & if\ r_{nj} > Rw, \end{cases} \quad (1)$$

$$u_n = \frac{\sum_{j=1}^{|A|} b_{nj}}{\max_n b_{nj}} \quad \forall j \in A, \forall n \in N \quad (2)$$

Regional Value Map



Within the Scenario 66 targets including strategic, operative and tactical level have been generated consisting bases, radars, Surface to Air Missile (SAM) batteries and command and control centers.

Conclusion

- Regional Defense
- Minimize Unpredictability
- Efficiency
- Accuracy

QUESTıONS ?

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