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Original title on 712 A/B: Investigation of advanced ISR and Weapon Systems in Missions against TBM Targets Employing Deceptive Tactics

Revised title: Investigation of CONOPS for ISR and Weapon Systems in Missions against Targets Employing Deceptive Tactics

Presented in (input and Bold one): (WG__5, CG___, Special Session ___, Poster, Demo, or Tutorial):

This presentation is believed to be:
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<th>01 JUN 2005</th>
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<td>3. DATES COVERED</td>
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<td><strong>Investigation of CONOPS for ISR and Weapon Systems in Missions against Targets Employing Deceptive Tactics</strong></td>
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<td><strong>The Aerospace Corporation</strong></td>
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<td><strong>Approved for public release, distribution unlimited</strong></td>
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*Standard Form 298 (Rev. 8-98)*

*Prescribed by ANSI Std Z39-18*
Investigation of CONOPS for ISR and Weapon Systems in Missions against Targets Employing Deceptive Tactics

W. Maillard
The Aerospace Corporation
June 2005
Study Objectives

- Survey Concealment, Camouflage and Deception (CCD) techniques and approaches to modeling them
- Represent characteristics and first order effects of CCD techniques in the SEAS theater level model
- Support training in Military Utility Analysis methods and tools as part of IR&D project

- Investigate the potential contributions of advanced ISR and weapon systems to the engagement of TBM target elements employing CCD tactics
Survey of CCD Techniques
Survivability Moves

• Summary of tactic
  – Move units to new locations frequently and covertly
  – Disrupt Blue targeting process

• Modeling of tactic in SEAS
  – Code Red units and agents with orders to move periodically in some specified or reactive manner
  – Differentiate detection probability of sensors against targets in open, in hide, or on the move

• Metrics:
  – Detection rate and engagement rate

Reduce Cycle Times

• Summary of tactic
  – Minimize time required to conduct operations and for movement cycles
  – Decrease vulnerability by limiting exposures within sensor-to-shooter timeline

• Modeling of tactic in SEAS
  – Decrease timelines for setup, teardown, and movement for selected units
  – Shorten move distances to next hide

• Metrics
  – Rate of detection, engagement, and kill vs. these targets
  – Loss in effectiveness of these targets (if any)
Engagement of TBM TELs difficult because of short exposure cycles

Alternatives: 1) attack TBM support elements (C2, weapon supply)  
2) attack TBMs while in hide positions  
3) patrol regions where TBMs last seen
Mobile Camouflage

• Summary of tactic
  – Install camouflage systems that reduce signatures while a vehicle is in motion
  – Reduce the probability of detection for valuable assets while they are mobile

• Modeling of tactic in SEAS
  – Distinguish which units can be equipped with camouflage and represent appropriate delays
  – Decrease $P_D$ for Blue sensors operating in bands of the camouflage treatment

• Metrics
  – Detection rate against camouflaged targets
  – Rate of engagement and kill vs. there targets

Vehicle equipped with mobile camouflage
(photo courtesy of Saab/Barracuda)
Static Camouflage

• Summary of tactic
  – Install deployable camouflage systems that reduce signatures for stationary objects
  – Reduce the probability of detection for valuable assets while they are stationary

• Modeling of tactic in SEAS
  – Model use of camouflage by agents
  – Use factors to decrease PD for Blue sensors operating in bands affected by the camouflage treatment

• Metrics
  – Time to first detection of object
  – Rate of target kill

Camouflage netting covering amphibious assault vehicle

Decoy Operations

• Summary of tactic
  – Employ objects that realistically mimic signatures of valuable assets
  – Distract attackers away from real equipment and facilities

• Modeling of tactic in SEAS
  – Create decoy agents and employ them with tactics and behaviors similar to real objects

• Metrics
  – Probabilities of detection and identification vs. real and decoys
  – Kill ratio vs. real and decoys

(photos courtesy of USAF, - www.af.mil)
Battle Damage Assessment Confusion

- **Summary of tactic**
  - Make intact targets appear damaged or destroyed and destroyed targets appear to be repaired or undamaged.
  - Draw attacks away from undamaged equipment and facilities

- **Modeling of tactic in SEAS**
  - Lower the BDA probability for some sensors against targets employing these tactics

- **Metrics**
  - BDA success ratio
  - Rate of false attacks
  - Length of time for correct BDA and attack on undamaged target

Removal of damaged and destroyed vehicles from the battlefield can prevent accurate BDA.

(photography courtesy of USAF, www.af.mil)
Study Description
Approach

• Scenario:
  – Extensive modifications to Aerospace/SEAS contractor scenario to emphasize TBM missions and CCD usage
  – TBMs posed significant early threat to Blue air operations

• Methodology:
  – SEAS theater level campaign model with simple representation of CCD tactics
  – Parametric system performance estimates

• Metrics:
  – TBM losses (TELs, SOCs, weapon supply), ratio of TELs losses to decoys, TBM launch rate
  – Blue airbase losses and closures, Blue aircraft losses on the ground, Blue aircraft sorties
SEAS Theater Level Simulation

“Systems Effectiveness Analysis Simulation”

• Military Utility Analysis of Space, Air, Ground and Sea Systems

• Inputs
  – Military Scenario
  – Military Units & Platforms
  – Sensor & Weapon Performance
  – C4ISR Architectures

• Outputs
  – Scenario Outcomes
  – Military Utility Metrics
  – “Killer-Victim” Scoreboard
  – 2D Situational Display

• Features
  – Object-Oriented Simulation
  – Monte Carlo Combat Simulation
  – Autonomous Agent Behaviors

The SEAS Simulated Environment

SEAS Structure

Units and platforms
Agents and Behaviors
Comm
Weapons
Sensors
Terrain and Weather
Environment

SEAS is a time stepped simulation
Δt = 1 minute (typically)

Units and vehicles
Satellite
Weather region
Command
Target Object Sightings

Sensors
UCAV
Range error
Velocity error
Sensor Field of Regard
Range
Jamming region
Location error

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Experiment 1 - TBM TELs in Open

Blue ISR and attackers attempt to discriminate TELs and decoys

- TBM TELs in Hide (2-24 hrs)
- Weapon Supply
- TBM TEL Move (15-45 min.)
- TBM Decoy Ops.
- TBM Launch and Move Preparation (<15 min.)
- C2 Support (SOCs)
Blue CONOPS - Experiment 1
(Engaging TELs in Open)

CONOPS options:
1) Cue sensors on overhead platforms (air or space) to help discriminate TELs and decoys;
2) Divert strike missions when available with proper ordnance

UCAVs sent to patrol areas based upon observed TBM activity

UCAVs react to TBM sightings by own search sensor or off board

UCAVs attack TBMs based upon discrimination with onboard sensor
Utility of Sensor Discrimination versus TBM Decoys

Discrimination Ratio of UCAV Sensor
(PD vs. TEL/PD vs. Decoy)
Experiment 2- TBM TELs in Hide

Blue employs advanced sensors to locate and verify TELs in Hide

C2 Support (“SOCs”)

TBM TELs in Hide (2-24 hrs)

TBM Launch and Move Preparation (<15 min.)

TBM Decoy Ops.

Weapon Supply

TBM TEL Move (15-45 min.)
Blue CONOPS - Experiment 2
(Engaging TELs in Hide)

CONOPS options:
1) Cue sensors on overhead platform (air or space) to help locate TBM TELs in hide;
2) Attack TELs in hide with standoff weapons
Operations vs. TBM TELs in Hide

- 50% TELs deep hide, total losses
- 50% TELs deep hide, losses in hide
- 100% TELs deep hide

Detection Range of Sensor on UCAV (km)

TBM TEL Losses
Experiment 3 - Concealed C2 and Weapon Supply Sites

- Blue fuses multiple INTs to locate concealed targets
- TBM TELs in Hide (2-24 hrs)
- TBM Launch and Move Preparation (<15 min.)
- TBM TEL Move (15-45 min.)
- TBM Decoy Ops.
- C2 Support (SOCs)
- Weapon Supply
Responsive Blue CONOPS - Experiment 3

• Multiple ISR sources (e.g., SIGINT, HUMINT, GMTI, including IPB) detect and nominate “concealed” Red C2 and weapon supply sites

• Advanced overhead sensors cued to collect imagery for target confirmation

• Advanced weapon systems quickly prosecute attacks
  – Stealthy strike aircraft (JSF, B-2, F-22)
  – UCAV
  – “HyStrike”
Utility of Red Deceptive Tactics and Responsive Blue CONOPS

Rate of Detection of C2/HE by Multi-INT Sources

(Note: no C2 replacement within scenario)
Study Findings

- SEAS agent-based model well suited for representing CCD methods and associated CONOPS for both sides
- Exploratory study ideal vehicle for analyst training
- Choice of utility metrics important for understanding operational and system effects observed in study

- C2 and weapon supply critical for TBM operations
- CCD significantly improves the impact of these threat systems within the scenario
- CONOPS with multiple sources for detection and timely cueing of overhead imagery for target verification can help to counter CCD employment
Backup Slides
Aerospace Military Utility Analysis 
Roles and Responsibilities

• Assist program offices in assessing the utility impact of alternative concepts, requirements, and design choices
• Explore CONOPS and architecture alternatives for space systems operating together with ground, air, near-space and other space assets
• Participate in operationally based studies to evaluate the contributions of space systems in scenarios for DoD, NRO and Homeland Defense
Primary Sources

- "Camouflage, Concealment, and Decoys", Army Field Manual FM 20-3, Headquarters, Department of the Army, 1999
- FAS ("Federation of American Scientists"), www.fas.org, for weapon system and target information, 2003-04
- "SEAS 3 Training Presentation", E. Frisco, SPARTA, 2001-02
- "Hyperspectral Imaging", M. Christensen, Lt., USAF, SMC/XREE, 2001
- "Hyperspectral Imaging from Space ", www.afrlhorizons.com, Dr. J. Schummers, AFRL, Space Vehicles Directorate, 2003
Some Acronyms

• CCD - Concealment, Camouflage and Deception
• BDA - Battle Damage Assessment
• TBM - Theater Ballistic Missile
• TEL - Transporter-Erector-Launcher
• C2, SOC - Command and Control, Sector Operating Center
• ISR - Intelligence, Surveillance and Reconnaissance
• HSI - Hyper-spectral Imaging
• P_D, P_ID, P_K - Probability of Detection, Identification and Kill
• UCAV - Unmanned Combat Air Vehicle
• CONOPS - Concepts of Operations
• SEAS - System Effectiveness Analysis Simulation
• TAO - “Tactical Area of Operation”
SEAS Object Types

**Forces**
(Are groups of Units)

**Unit Agents**
(Are groups of Sub-units, Vehicles, Sensors, Comm Gear and Weapons)

**Platform Agents**
Ground Vehicles
Ships
Satellites
Aircraft (UAVs)

**Sensors**
Passive
Active
Designator

**Comm Gear**
Comm Channels
Jammers

**Weapons**
Direct Fire, Missiles

**Locations, TAOs, Events, Weather, Terrain, etc.**

**Force objects** provide initial unit and vehicle spacing, stopping criteria and macro scale movement.

**Unit objects** provide meso scale movement and command hierarchy for subordinate units and vehicles.

**Vehicle objects** provide movement in space time for objects that they carry.

**Sensor objects** provide vehicle and unit detection, position, velocity.

**Comm Gear (Comm Channels)** objects provide target sighting connectivity between vehicles, units and forces.

**Weapon objects** provide vehicle and unit kill capability.
Operate in Urban or Residential Areas

- **Summary of tactic**
  - Conduct military ops in urban or residential areas
  - Decrease effectiveness of Blue ISR and comm
  - Reduce tempo of Blue operations

- **Modeling of tactic in SEAS**
  - Create “TAOs” for urban areas where Blue Force sensors have reduced $P_D$
  - Add delays to Blue C2 decisions for targets located in urban “TAOs”
  - Model civilian entities (optional)

- **Metrics**
  - Rate of detection and kill against these targets
  - Potential collateral damage

(photos courtesy of USAF, Air Force Magazine)
Sensitivity to Constellation Size

(Note: baseline scenario modified to permit C2 replacement within 12-24 hours)
Sensitivity to Sensor Range

(Note: baseline scenario modified to permit C2 replacement within 12-24 hours)