Calhoun: The NPS Institutional Archive

DSpace Repository

Faculty and Researchers | Faculty and Researchers' Publications

2011-07

The Effect of Time Advance Mechanism (TAM) in Modeling and Simulation: DES & DTS Comparison Analysis, Case Study: Combat Simulation

Al Rowaei, Ahmed (Ali)

https://hdl.handle.net/10945/44367

This publication is a work of the U.S. Government as defined in Title 17, United States Code, Section 101. Copyright protection is not available for this work in the United States.

Downloaded from NPS Archive: Calhoun

http://www.nps.edu/library

Calhoun is the Naval Postgraduate School's public access digital repository for research materials and institutional publications created by the NPS community. Calhoun is named for Professor of Mathematics Guy K. Calhoun, NPS's first appointed -- and published -- scholarly author.

Dudley Knox Library / Naval Postgraduate School
411 Dyer Road / 1 University Circle
Monterey, California USA 93943

The Effect of Time Advance Mechanism (TAM) in Modeling and Simulation: DES & DTS Comparison Analysis

Case Study: Combat Simulation

Ali Al Rowaei

MOVES Student

MOVES R&E Summit 2011
Wednesday July, 13

Outline

- **Motivations and Concepts**
- **Emergent Effects of TAMs**

  Skipping Phenomenon

  – Scenario 1: Simple Agent Engagement

  – Scenario 2: The Littoral Combat Ship (LCS) Battle

- **Conclusion**

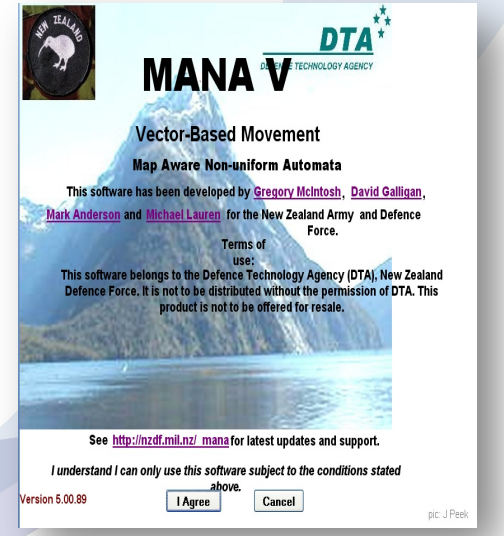
Motivations and Concepts

"All models are wrong, but some are useful." (Box 1979)

…but how wrong can a model be before its not useful?

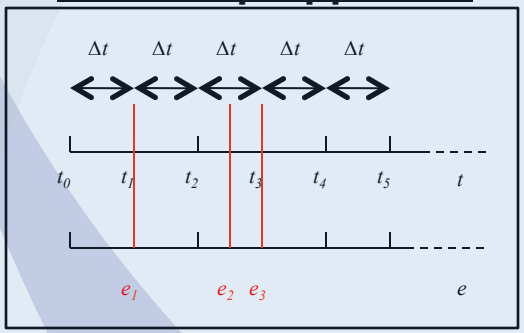
- The effects of TAM are not well understood.
- The effects of Δt are not well described in the literature.
- What are the limitations and strengths of each mechanism?

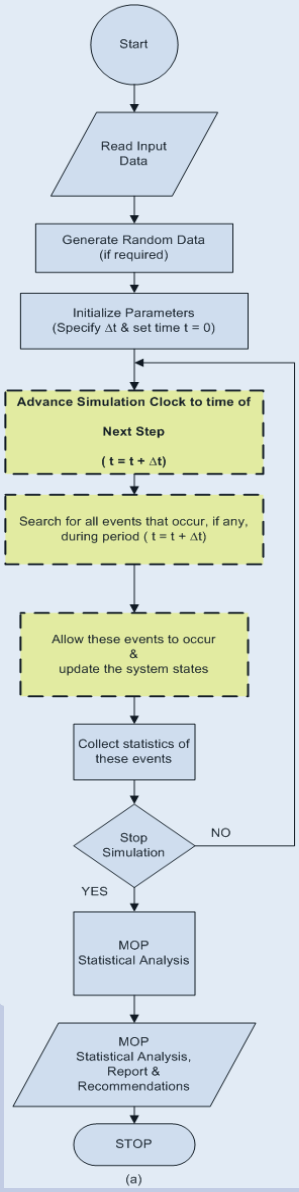
Discrete Event Simulation (DES) and Discrete Time Simulation (DTS)



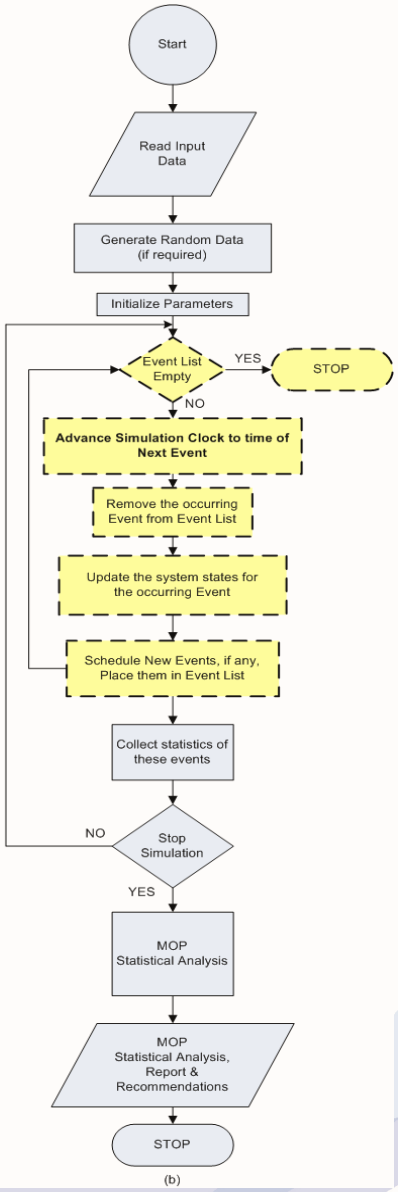
Discrete Time Simulation (DTS)

Time-Step Approach

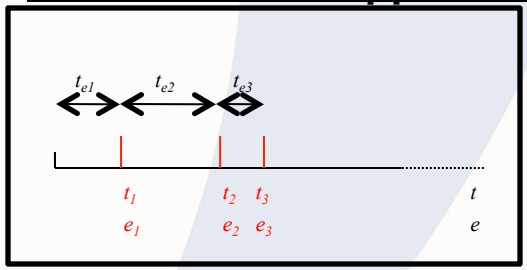




Discrete Event Simulation (DES)

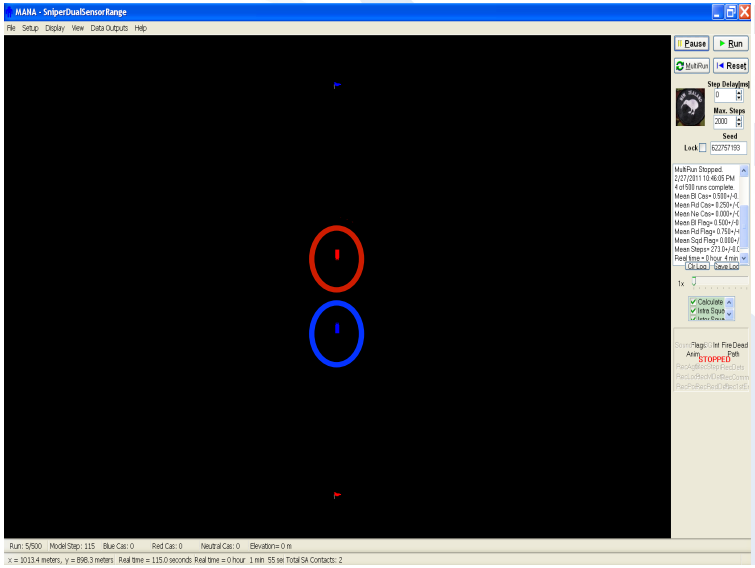


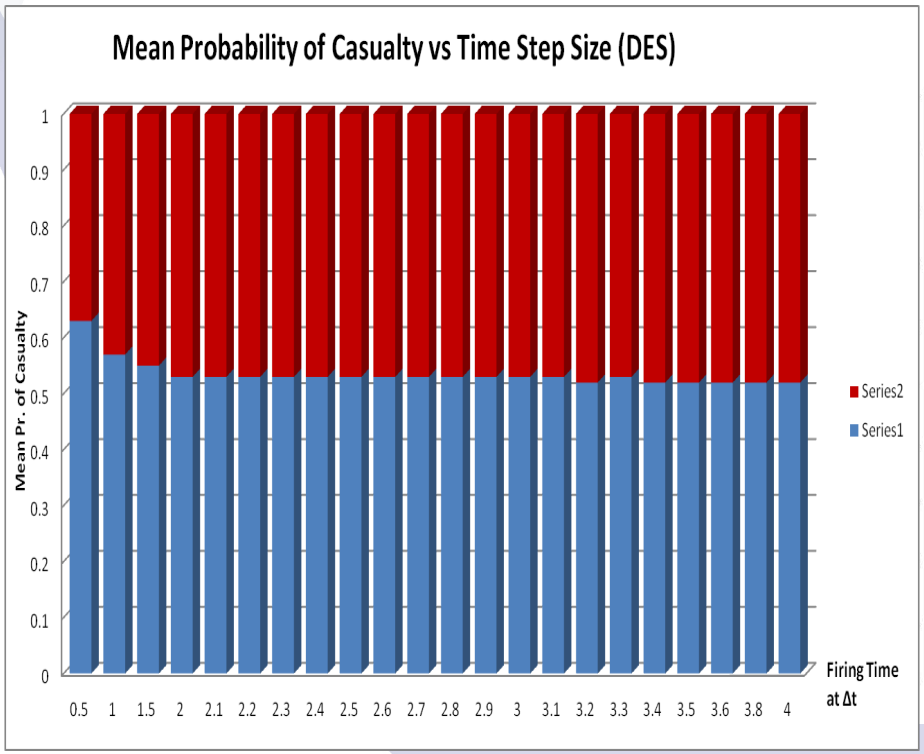
Discrete Event Approach

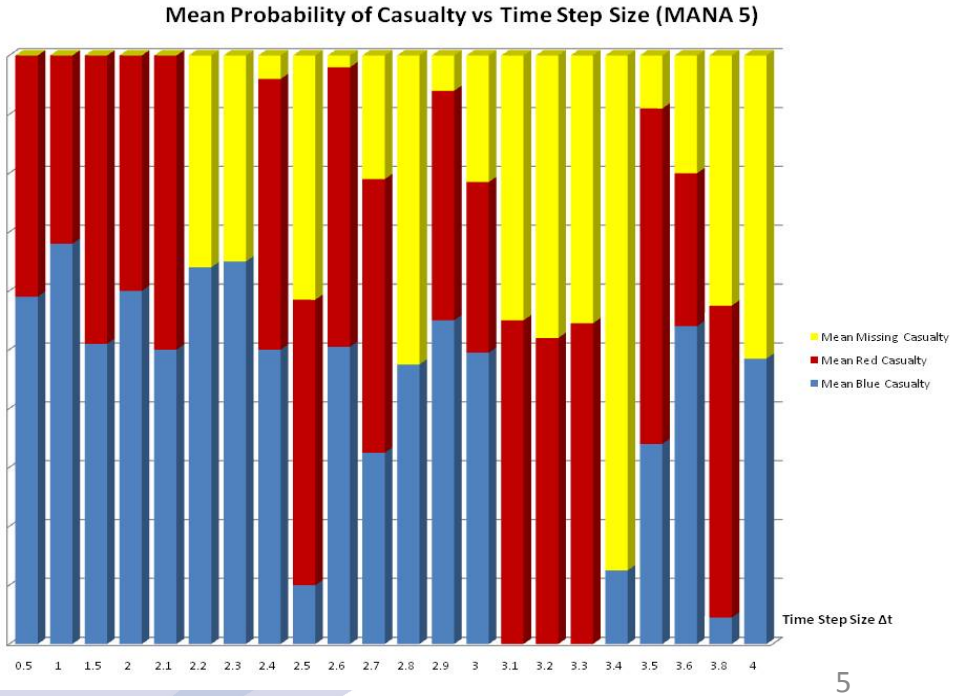


S 1.1: Simple Agent Engagement

Parameters	Red Agent	Blue Agent
Speed	15	10
Sensor Type	Cookie-Cutter	Cookie-Cutter
Sensor Range	17	13
Weapon Range	17	13
P_{kill}	1	1
MOE	Mean Casualty Percentage at 200 replications	







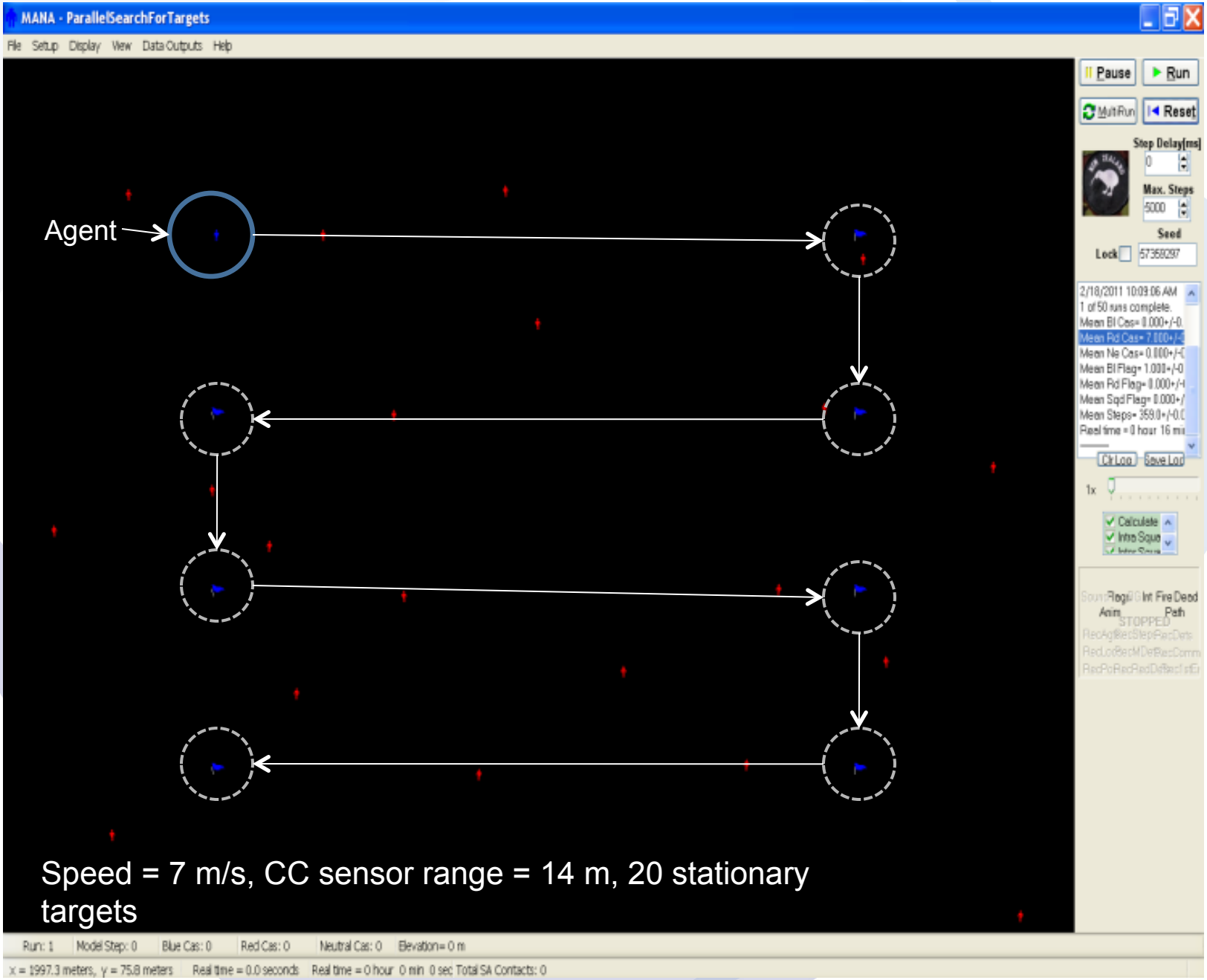
Single moving searcher looking for stationary targets.

Searcher:
speed: constant @ 7m/s
sensor type: cookie cutter
sensor range: 14m

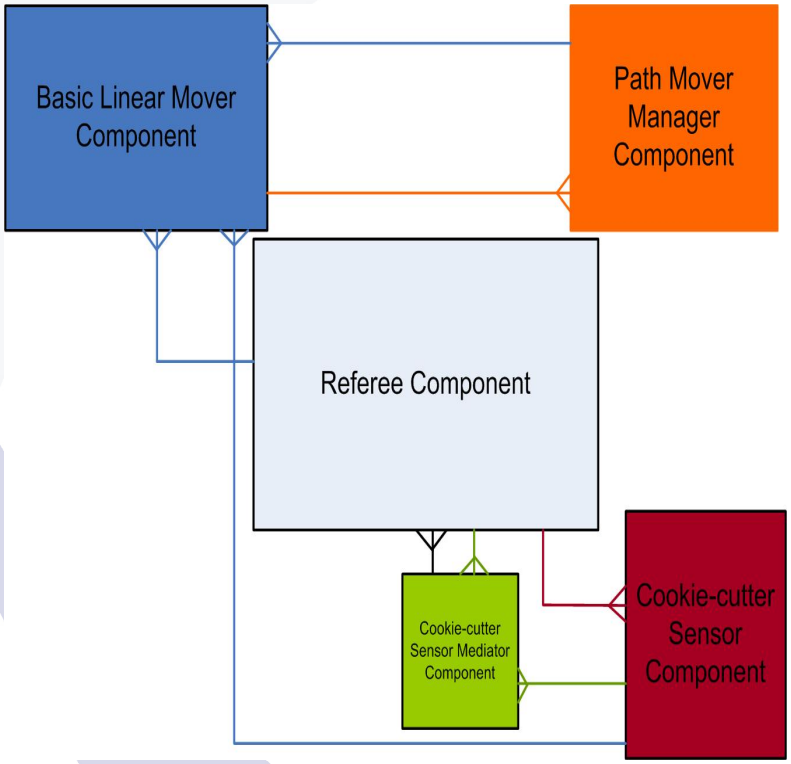
Targets: 20
distribution: randomly over combat area
search pattern: Parallel (Washburn 2009)

Set-up:
Grid: 2000 x 2000 m
Replications: 200
Measure: number of detected targets

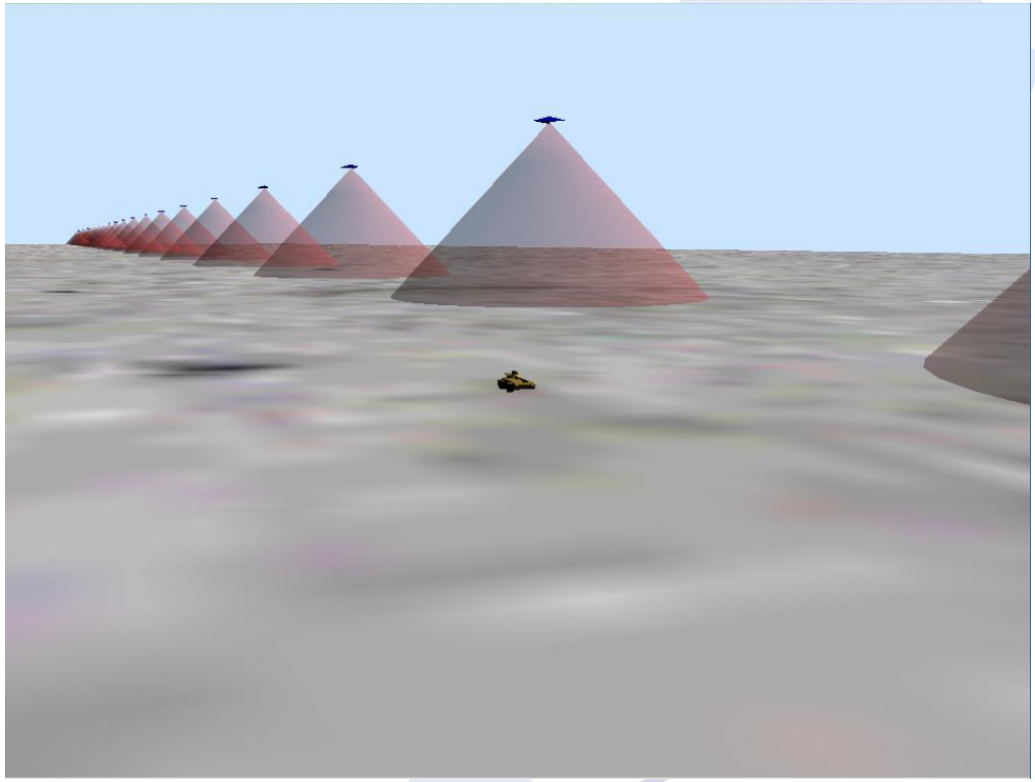
S1.2 Simple Search & Detection Operation



S1.2 Simple Search & Detection Operation



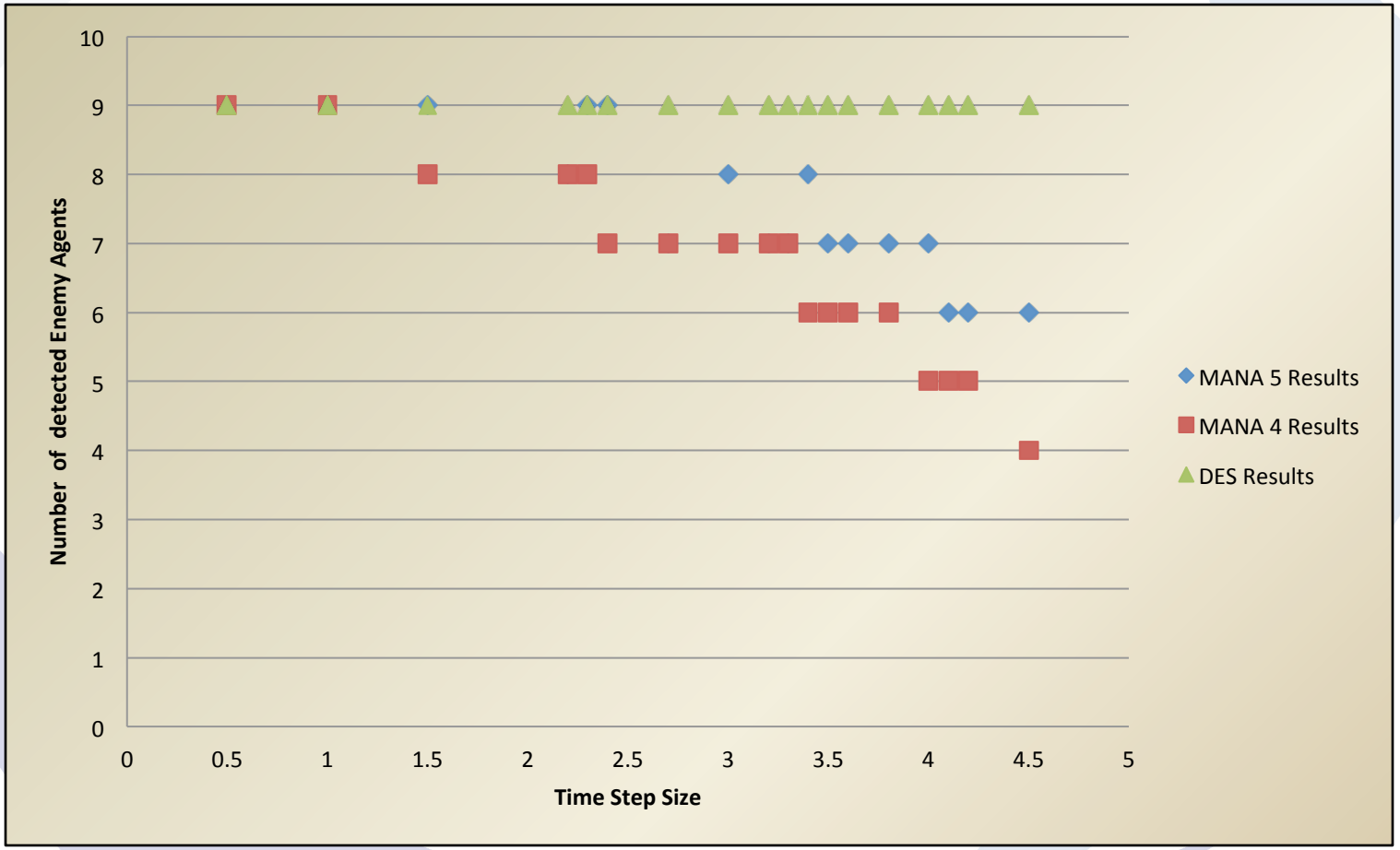
Sensor agent event graph modeled in DES



3D View from MARSS (Dickie 2002)

S 1.2: Results and Observations

- 200 replications were conducted in MANA 5 and Simkit.



- How to ensure this phenomenon is detected in complex simulations, or it is not affecting non-visible variables?

S 2: The LCS Battle

- Original scenario is the work of an NPS Master Thesis (*Jacobson 2010*).
- **Elements:**
  1) 1 LCS equipped with 2 types of missiles:
     a- NLOS b- Harpoon
  2) 1 Helicopter/UAV equipped with 4 types of missiles: a- Hellfire b- LOGIR c- APKWS d- DAGR
  3) 20 enemy boats equipped with only one missile type: C-802

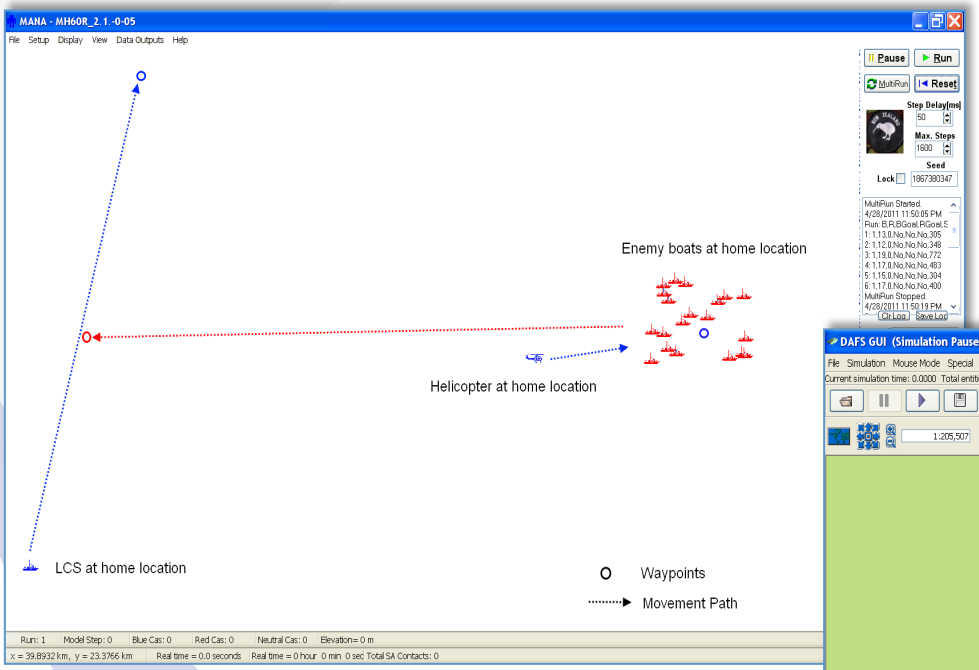
(Naval Warfare Development Command 2007)

- **Purpose:** investigate different weapons on the effectiveness of the LCS and Helicopter to neutralize enemy boats and essential engagement factors.

- **Original Study Results**: Firing rate is the most important factor, LSC missiles and capability need to be enhanced

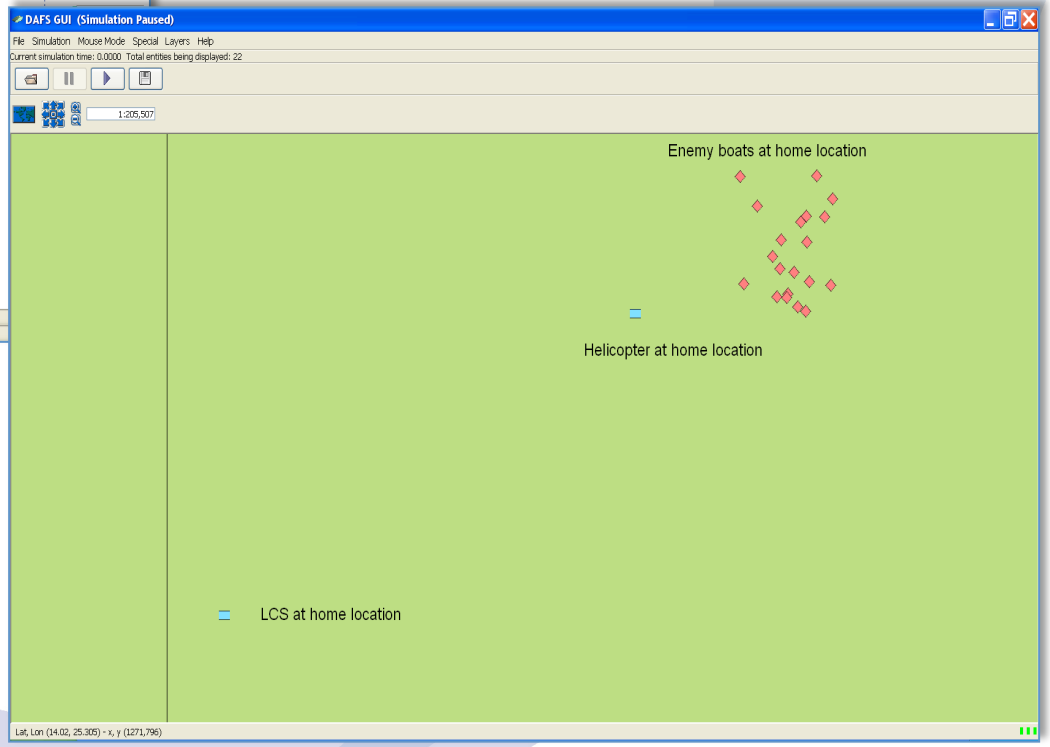
S 2: The LCS Battle

Our Study: Investigate the impact of TAM on the scenario results by comparing DES and DTS results.



LCS scenario in MANA 5 environment
Discrete Time Simulation (DTS)

LCS scenario in DAFS environment
Discrete Event Simulation (DES)



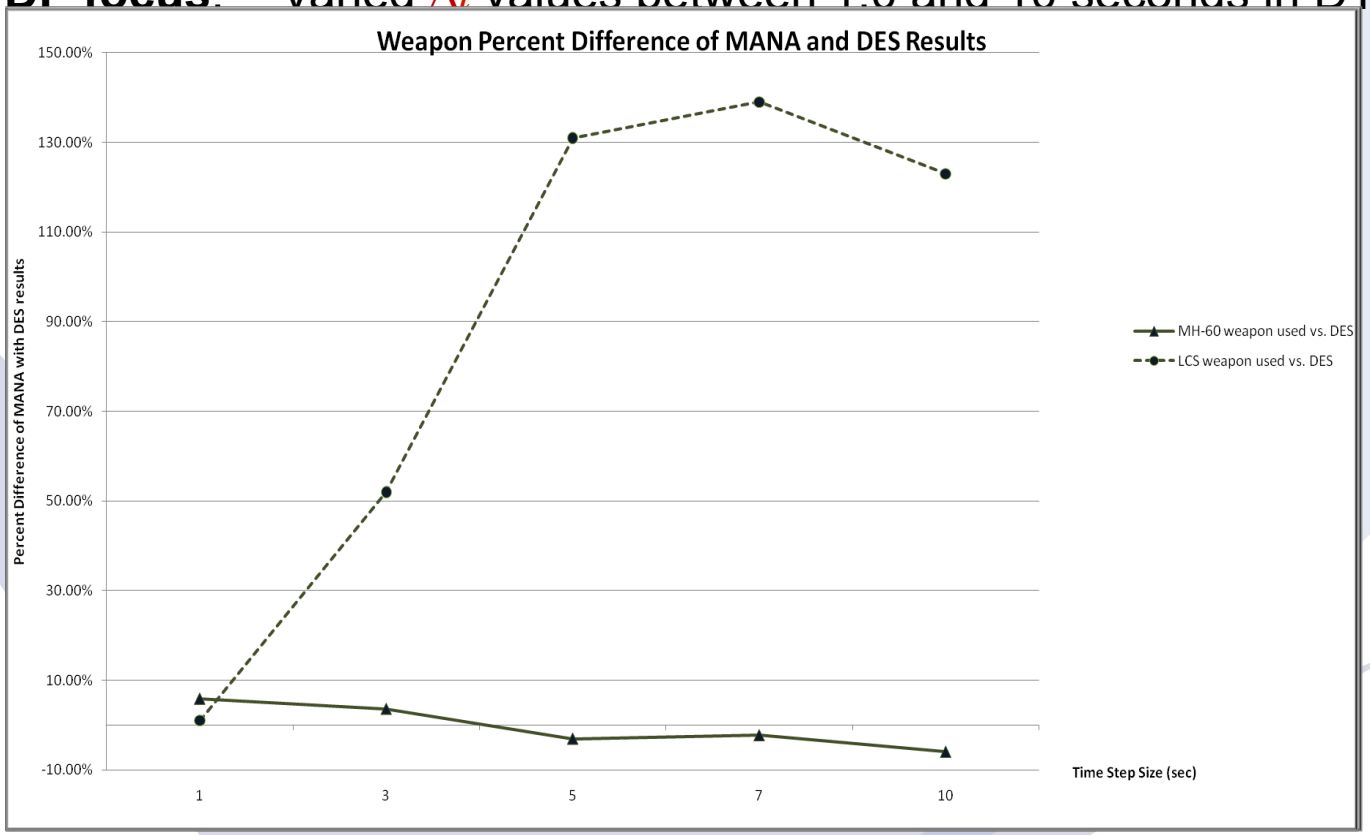
S 2: The LCS Battle

Results:

- Original study run 512 Design Points (DP) with 40 replications at Δt = **10** seconds.
- We found that more than 81 DPs can have significant change in outcome.
- **MOE**: 1. Number of kills (LCS and Enemy)

  2. Number of weapons fired (LSC and Helicopter)

- **One DP focus**: - Varied Δt values between 1.0 and 10 seconds in DTS



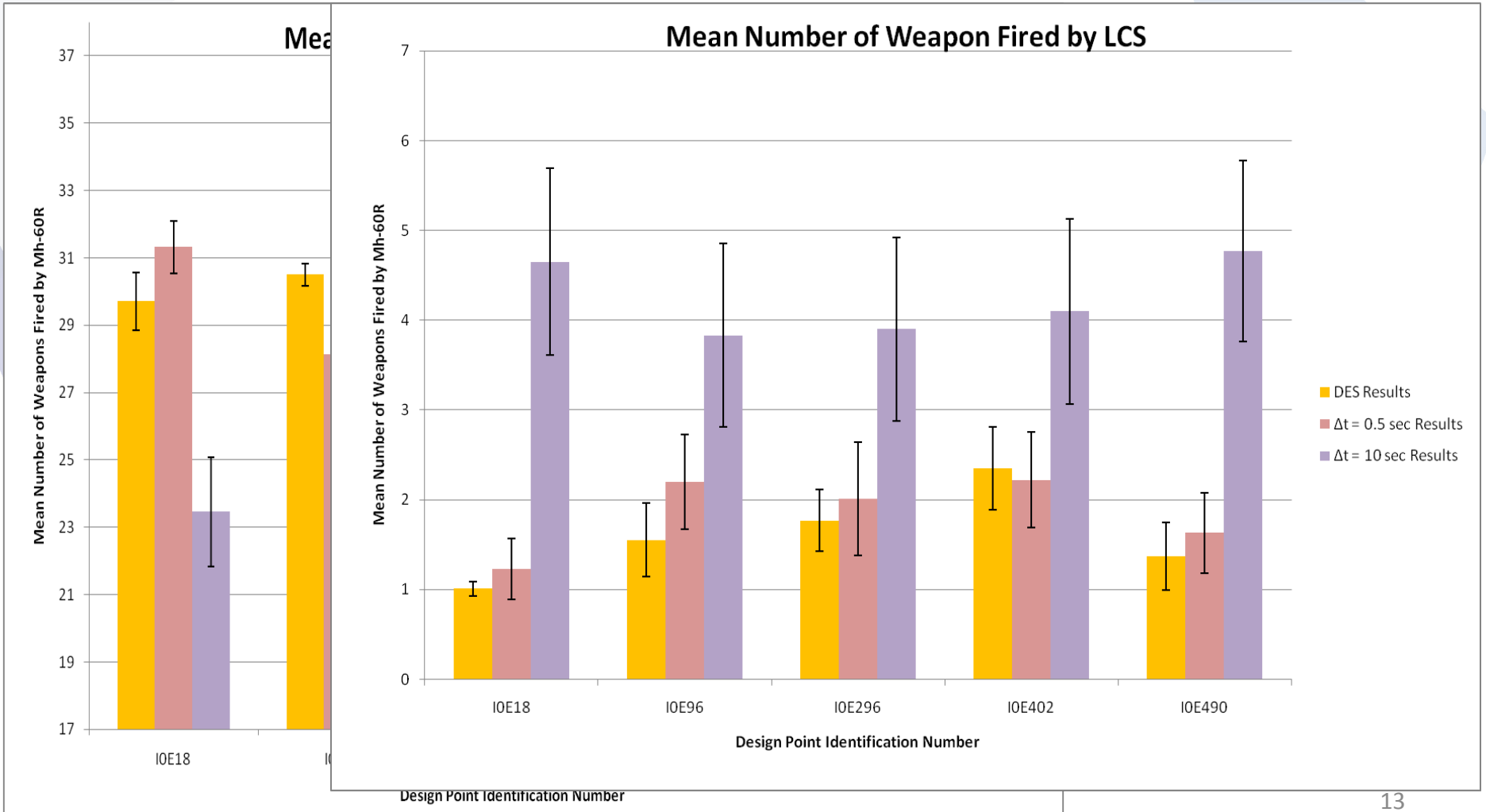
S 2: The LCS Battle

Results (cont…)

- Five DPs were tested in details for greater coverage.

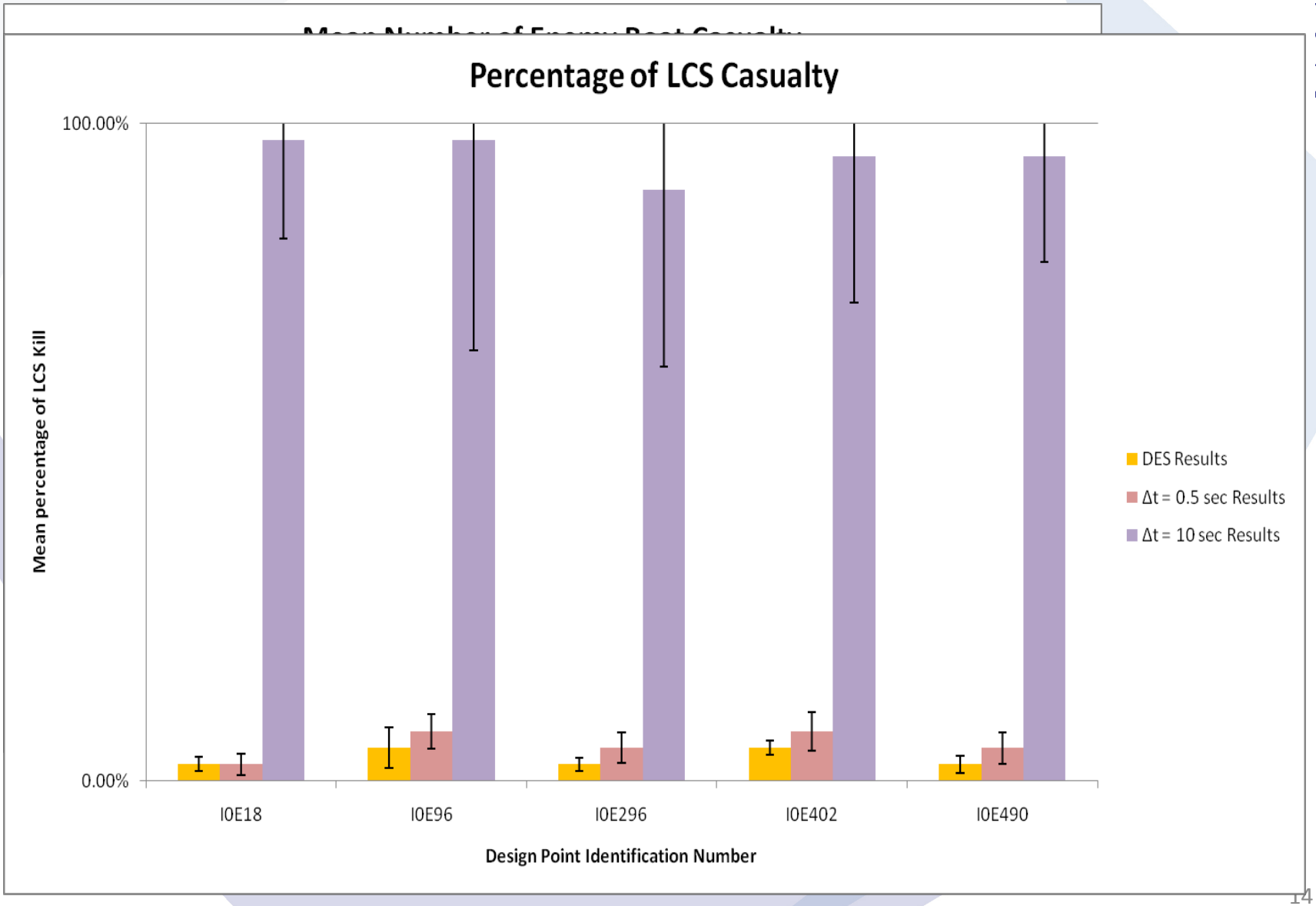
i. MANA 5 (DTS) environment with Δt = 0.5 and 10 seconds at 40 replications

ii. DAFS (DES) environment

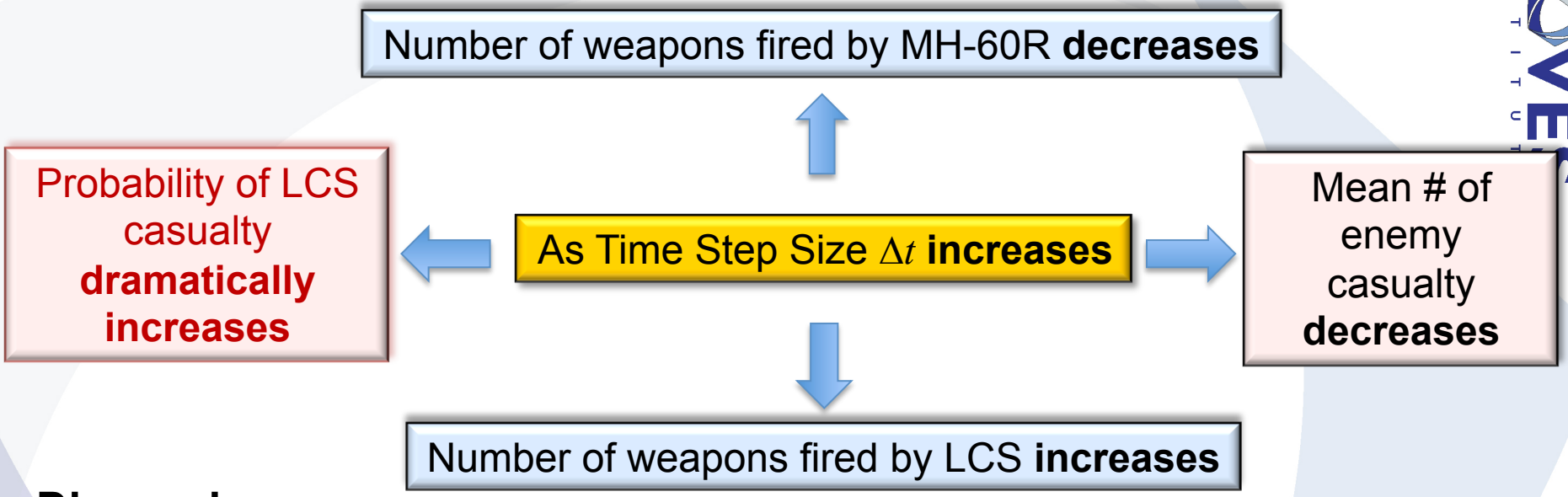


S 2: The LCS Battle

Results (cont….)



S 2: The LCS Battle



Discussions

- At large Δt large number of enemy boats were not detected and "skipped" MH-60 sensor range.
- State transition update allowed only at the end of time intervals,
  - ➢This introduces delays in rate of fire that leads to missing the enemy
- Difficult to notice these phenomena in complex/constructive simulations.
- **Recommendations**

Large Δt *(DTS)*	Firing rate, LCS capability/weapons
DES and small Δt *(DTS)*	Helicopter capability/weapons

Conclusions

- The choice of TAM impacts the simulation results.
- There are differences between approaches can leads to different results, outcomes and recommendations.
- The choice of Δt can also introduce significant qualitative anomalies.
- There is no accepted methodology in M&S for selecting Δt.
  - *Cannot separate time effects from system inherent properties*
- DES models tend to produce less (or no) anomalous behavior.

Questions?

aalrowae@nps.edu

Back-up Slides

Typical Combat Simulation Environments

Discrete Time Simulation	Discrete Event Simulation
MANA	Simkit
Pythagoras	JDAFS – DAFS
IWARS	Combat XXI
ISAAC	NSS
PSOM	OneSAF
JCATS	
THUNDER	
VIC	
WARSIM	
EADSIM	
JICM	