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SECURITY



LAWRENCE LIVERMORE NATIONAL LABORATORY

# Joint Conflict and Tactical Simulation (JCATS)

## Quantitative Analysis

2023 JCATS International Users Conference

PRESENTED BY:

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*Conflict Simulation Laboratory APL*

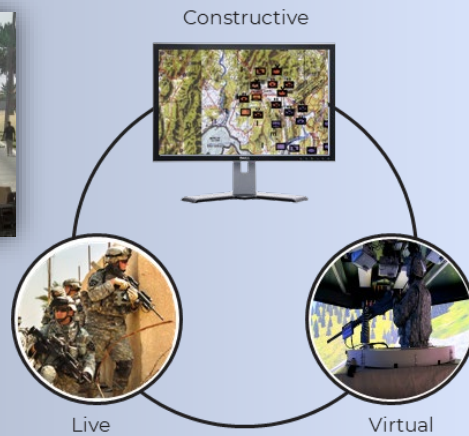
05 July 2023

# JCATS can be used in two modes: Interactive (training) and Batch (analysis)



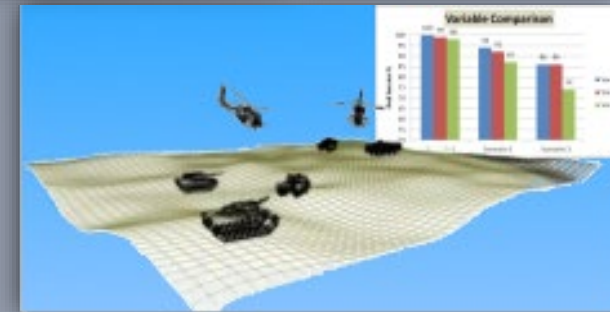
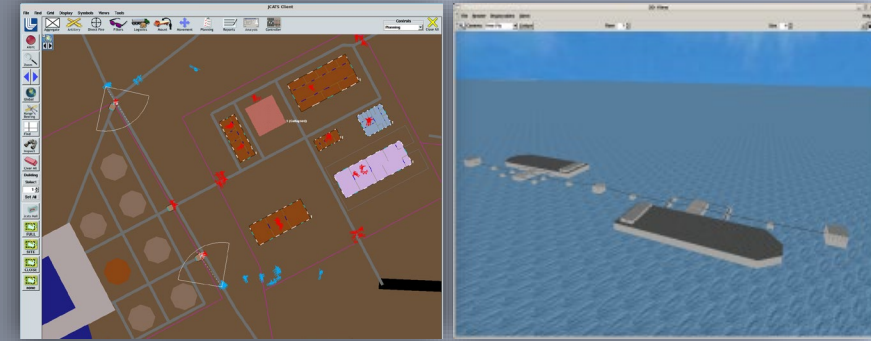
## Training & Mission Rehearsal

Joint and Multinational Exercises  
Stand Alone, Federated, Live-Virtual-Constructive  
Facility and Border Security

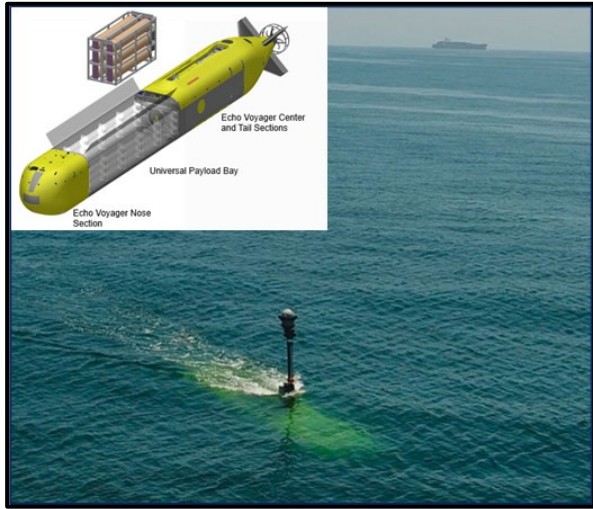


## Quantitative Analysis

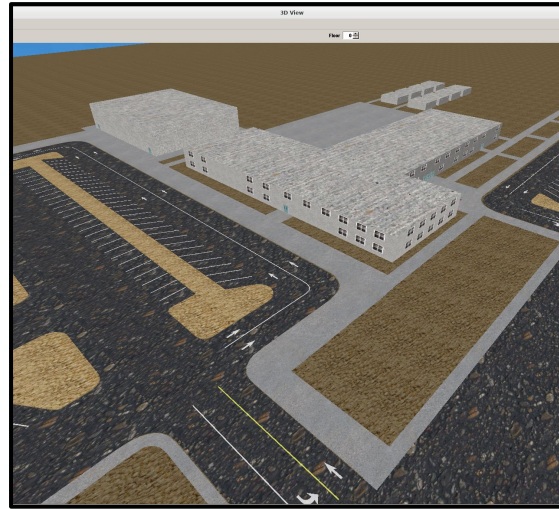
Military and Non-Military Scenarios  
Batch Mode  
Pre-planned Scenario Analysis



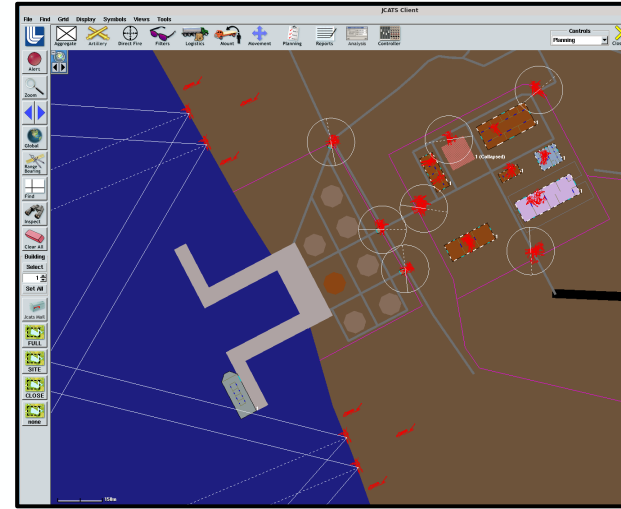
# Analyses with JCATS can support single system to large force-on-force scenarios



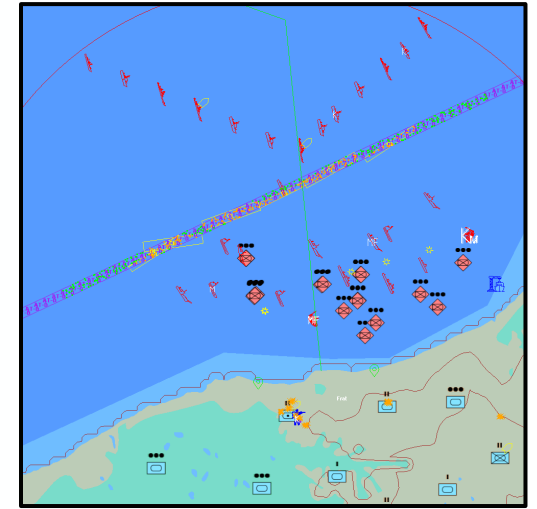
Unmanned Underwater Vehicle (UUV)



School Safety Study



Special Forces Operations



Force on Force Conflict

# Batch mode Executive controls and Batch Analyzer



## Batch Executive

File Time Range Help

Scenarios

#bugs/work/wilson252/Data/JCATS\_PRIVATE/scenario/NSW\_CONTROL\_UNCLASS.setup Remove

Output prefix: NSW\_CONTROL\_UNCLASS #Runs: 500  Log JDUs  
Seed Start: 10000 Delta: 1

Started:  27% Status ▾  
Completed:  26%

#bugs/work/wilson252/Data/JCATS\_PRIVATE/scenario/NSW\_UNMANNED\_UNCLASS.setup Remove

Output prefix: NSW\_UNMANNED\_UNCLASS #Runs: 500  Log JDUs  
Seed Start: 20000 Delta: 1

Started:  0% Status ▾  
Completed:  0%

Add Scenario... Add Node Start Abort

Nodes

Hostname: bugs Status ▾ #Processes: 7 Remove

## Batch Analyzer

File Time Range Help

Input Files

Setup File: JCATS\_PRIVATE/scenario/NSW\_CONTROL\_UNCLASS.setup Browse...  
Event Dir: k/wilson252/Analysis/msw/NSW\_CONTROL\_NO\_FLYOUT/DAT Browse...  
Event Prefix: NSW\_CONTROL\_UNCLASS

Read

Read Files  
Scenario files read: NSW\_CONTROL\_UNCLASS.setup, NSW\_CONTROL\_UNCLASS.fplan, MontereyBay\_4\_Night.DAF  
Event files read (496): View

Report

Choose Report Files...  
Reporting on 496/496 Sim Runs

Unit: SEALS #Systems: 36 #Aggs: 0

Total kills & damage dealt by selected entities <Select cell for additional info - not all cells have info>

|                       | Direct Fire % Runs KKill | Direct Fire % Runs FKill | Direct Fire % Runs MKill | Direct Fire % Runs MFKill | Direct Fire % Runs Any Kill | Indirect Fire % Runs KKill | Indirect Fire % Runs FKill | Indirect Fire % Runs MFKill | Indirect Fire % Runs Any Kill |
|-----------------------|--------------------------|--------------------------|--------------------------|---------------------------|-----------------------------|----------------------------|----------------------------|-----------------------------|-------------------------------|
| KAM M4_57             | 64.5161%                 | 1.00806%                 | 4.03226%                 | 9.67742%                  | 79.2339%                    | 0%                         | 0%                         | 0%                          | 0%                            |
| KAM M4_58             | 59.6774%                 | 1.6129%                  | 5.84677%                 | 27.621%                   | 94.7561%                    | 0%                         | 0%                         | 0%                          | 0%                            |
| KAM M4_59             | 59.679%                  | 1.00806%                 | 4.83871%                 | 16.129%                   | 81.8548%                    | 0%                         | 0%                         | 0%                          | 0%                            |
| KAM M4_60             | 33.0645%                 | 2.21774%                 | 7.25806%                 | 50.6048%                  | 93.1452%                    | 0%                         | 0%                         | 0%                          | 0%                            |
| KAM M4_61             | 69.9597%                 | 0.604839%                | 4.6371%                  | 13.3065%                  | 88.5061%                    | 0%                         | 0%                         | 0%                          | 0%                            |
| KAM M4_63             | 93.9516%                 | 0%                       | 2.82258%                 | 2.21774%                  | 98.9919%                    | 0%                         | 0%                         | 0%                          | 0%                            |
| KAM M4_64             | 76.8145%                 | 0.403226%                | 2.41935%                 | 5.44355%                  | 85.0806%                    | 0%                         | 0%                         | 0%                          | 0%                            |
| KAM M4_65             | 63.1048%                 | 1.00806%                 | 2.01613%                 | 15.7256%                  | 81.8548%                    | 0%                         | 0%                         | 0%                          | 0%                            |
| KAM K9_66             | 62.0968%                 | 0.403226%                | 2.62097%                 | 21.9758%                  | 87.0968%                    | 0%                         | 0%                         | 0%                          | 0%                            |
| KAM K9_67             | 51.0081%                 | 1.81452%                 | 5.04032%                 | 38.3065%                  | 96.1694%                    | 0%                         | 0%                         | 0%                          | 0%                            |
| OBJECTIVE_1           | 88.3065%                 | 0.201613%                | 0.403226%                | 10.8871%                  | 99.7984%                    | 0%                         | 0%                         | 0%                          | 0%                            |
| OBJECTIVE_2           | 67.1371%                 | 1.41129%                 | 2.62097%                 | 16.9355%                  | 88.1048%                    | 0%                         | 0%                         | 0%                          | 0%                            |
| KAM PISTOL MAKAROV_70 | 71.7742%                 | 0%                       | 3.02419%                 | 7.45968%                  | 82.2561%                    | 0%                         | 0%                         | 0%                          | 0%                            |
| KAM PISTOL MAKAROV_72 | 56.6532%                 | 1.41129%                 | 5.24194%                 | 31.0484%                  | 94.3548%                    | 0%                         | 0%                         | 0%                          | 0%                            |
| KAM PISTOL MAKAROV_73 | 35.6855%                 | 2.01613%                 | 6.45161%                 | 43.1452%                  | 87.2984%                    | 0%                         | 0%                         | 0%                          | 0%                            |
| KAM PISTOL MAKAROV_74 | 73.9919%                 | 0.201613%                | 1.6129%                  | 5.24194%                  | 81.0484%                    | 0%                         | 0%                         | 0%                          | 0%                            |
| KAM PISTOL MAKAROV_77 | 49.1935%                 | 0.403226%                | 2.01613%                 | 19.3548%                  | 70.9677%                    | 0%                         | 0%                         | 0%                          | 0%                            |
| KAM PISTOL MAKAROV_78 | 66.3306%                 | 0.604839%                | 2.41935%                 | 18.129%                   | 85.4839%                    | 0%                         | 0%                         | 0%                          | 0%                            |

Find

Row/Col Titles

Multiple Run scenarios (e.g., 500 times each)

Review statistical data

# Example Analysis Study: Special Forces amphib operations



**Overview:** BLUFOR nighttime naval assault. BLUFOR objective to find and destroy outdoor and one indoor objective.

**Analysis Objective:** Understand the impact of using MQ-8 drones for target lasing and for ISR to support on-shore operations.

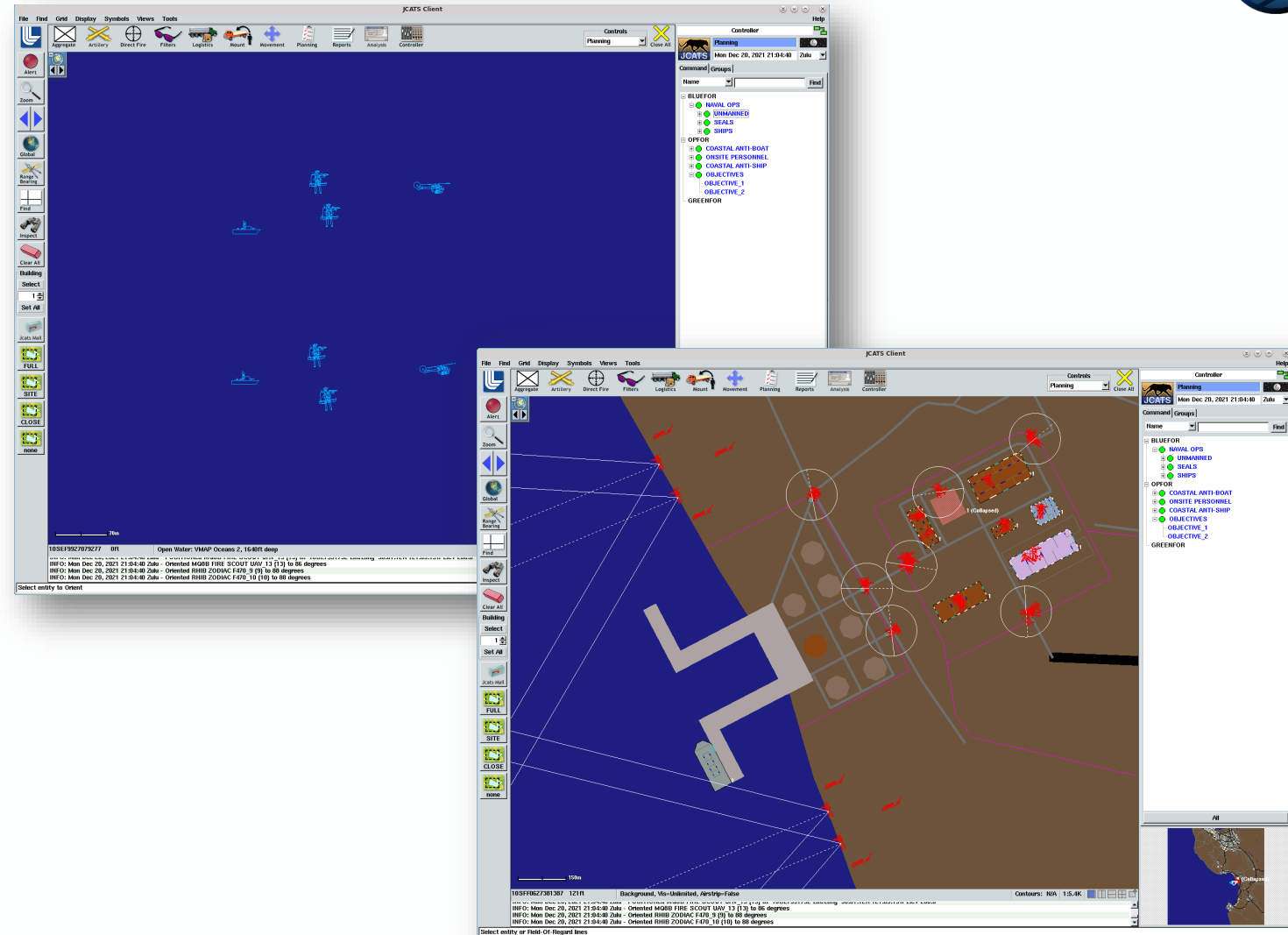
## BLUFOR:

- (2) Cyclone-class patrol ships
- (4) Zodiac CCRCs
- (2) MQ-8 Fire Scouts
- (32) Navy dismounts



## OPFOR:

- Small fenced military site
- (3) 155MM anti-ship defenses
- (3) 105MM DPICM small craft defenses
- (32) armed on-site personnel



# Baseline vs. Excursion scenarios



## Baseline scenario:

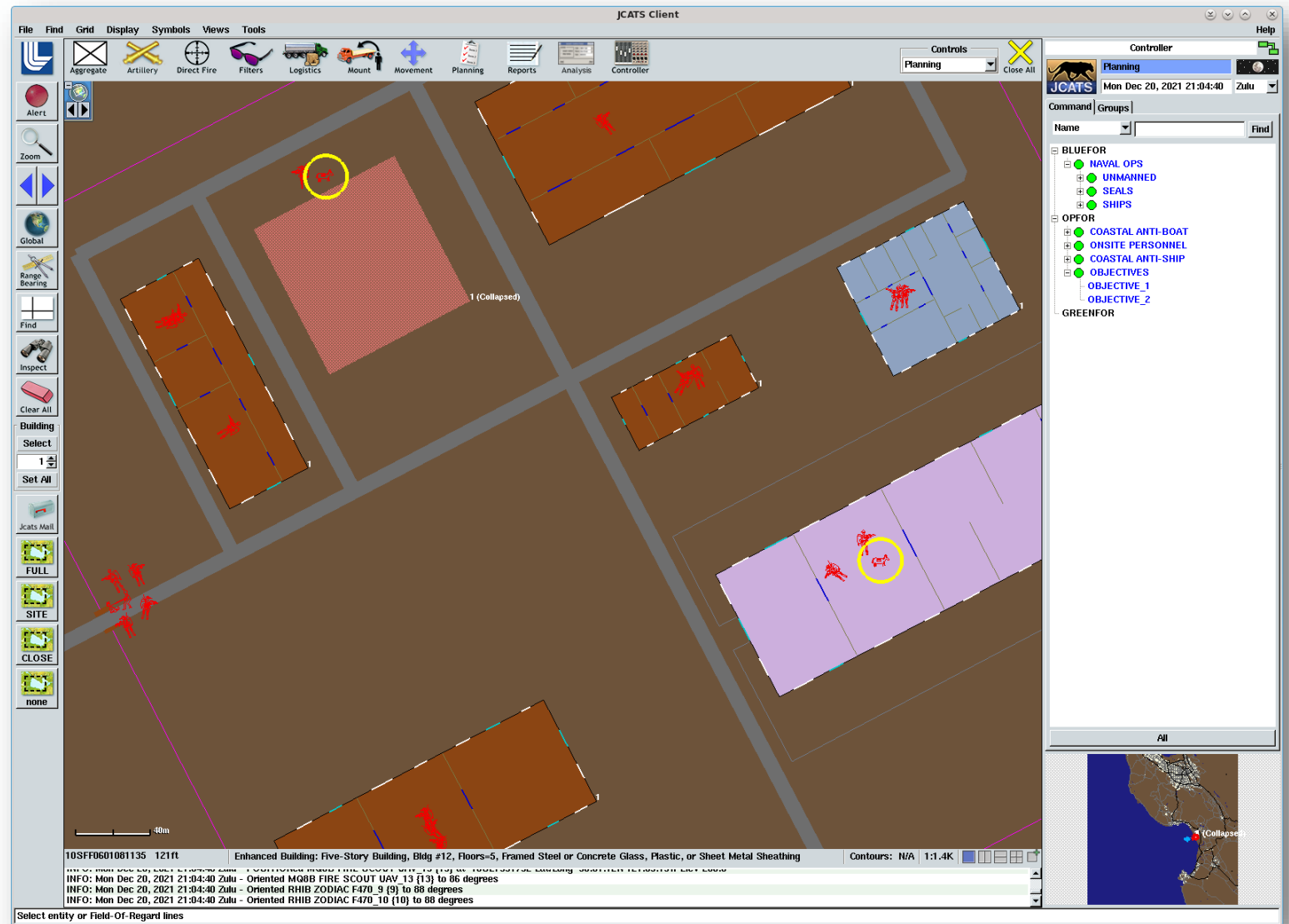
- BLUFOR patrol ships position outside range of OPFOR coastal defenses.
- BLUFOR patrol ships deploy two Zodiacs each with FO (Forward Observer) and LD (Laser Designation) capabilities.
- BLUFOR Zodiacs move in and lase coastal defenses.
- BLUFOR patrol ships destroy coastal defenses with laser-guided munitions.
- BLUFOR Zodiacs move to coast and deploy dismounts.
- BLUFOR dismounts breach and secure site.

## Excursion scenario with unmanned systems:

- BLUFOR patrol ships position outside range of OPFOR coastal defenses.
- BLUFOR patrol ships deploy a single Fire Scout each with FO (Forward Observer) and LD (Laser Designation) capabilities.
- BLUFOR Fire Scouts lase coastal defenses.
- BLUFOR Patrol ships destroy coastal defenses with laser-guided munitions.
- BLUFOR patrol ships deploy two Zodiacs each to deploy dismounts on the coast.
- BLUFOR Fire Scouts position over site to observe enemy forces.
- BLUFOR dismounts breach and secure site with UAV ISR of enemy forces.

# Mission objectives

- Destroy one outdoor objective
- Destroy one indoor objective
- UAV aids in finding outdoor objective and allows BLUEFOR to avoid unnecessary outdoor engagements



# Baseline scenario



- Navy dismounts under fire while they lase coastal defenses.
- Fewer dismounts make it to the coast resulting in less effective securing of site.
- Lack of UAV ISR results in less optimal infiltration of site and completing mission.
- **This is a random run. System effectiveness and results vary per run.**





# Excursion scenario (use of UAVs)



- Navy dismounts under less or no fire while they approach the coast.
- More dismounts make it to the coast resulting in more effective securing of site.
- UAV ISR results in more effective execution of mission.
- **This is a random run. System effectiveness and results vary per run.**



# Example results

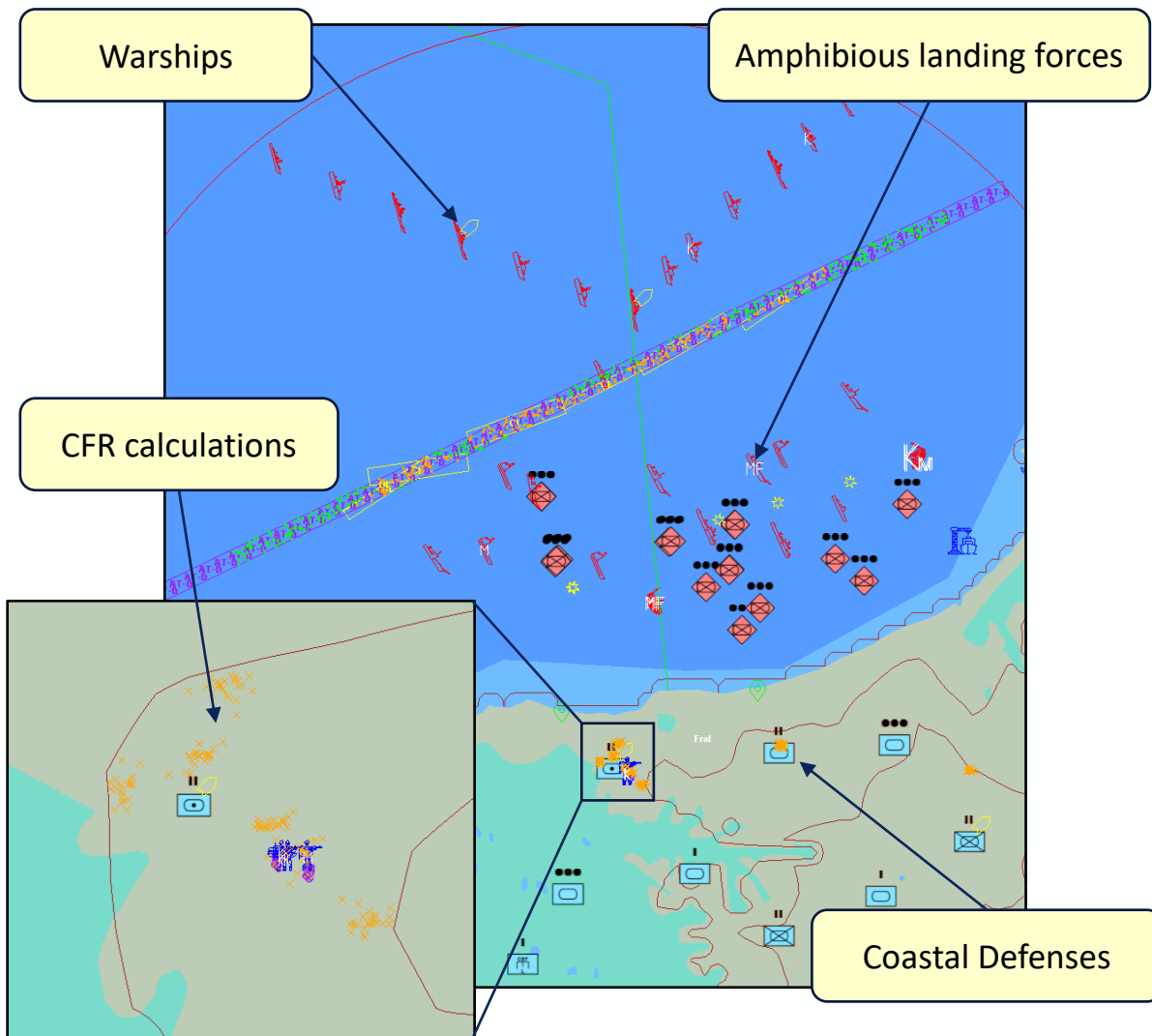


|  | Baseline |         | Excursion with UAV |         |
|--|----------|---------|--------------------|---------|
|  | Average  | Std Dev | Average            | Std Dev |
| BLUEFOR Dismount Casualties (on water) | 11.60    | 5.98    | 7.20               | 6.07    |
| BLUEFOR Dismount Casualties (on land)  | 3.40     | 2.51    | 2.39               | 2.36    |
| OPFOR Personnel Killed                 | 13.59    | 4.13    | 10.20              | 2.01    |
| OPFOR Artillery Rounds Fired           | 90.85    | 51.18   | 49.39              | 44.65   |
| Outdoor Objective Secured              | 99.60%   | -       | 99.20%             | -       |
| Indoor Objective Secured               | 86.90%   | -       | 99.60%             | -       |

Incorporation of the MQ-8 Fire Scouts in this sample Naval assault scenario resulted in:

- Significantly fewer BLUEFOR casualties on the water.
- Quicker destruction of OPFOR coastal defenses reducing OPFOR shots fired.
- Fewer engagements and BLUEFOR casualties on land.
- Outdoor objective success rate is statistically equivalent, but is achieved with fewer casualties.
- Indoor objective success rate was improved.

# Force on Force example with coastal defense artillery/counter fire



|               | Cruise Missile #1 |         | Cruise Missile #2 |         |
|---------------|-------------------|---------|-------------------|---------|
|               | Ave. per run      | Std Dev | Ave. per run      | Std Dev |
| Trigger Pulls | <b>1352</b>       | 0       | <b>504</b>        | 0       |
| Detonations   | 1102.35           | 14.56   | 445.62            | 10.68   |
| <Hit Results> |                   |         |                   |         |
| KKills        | <b>86.02</b>      | 7.62    | <b>31.32</b>      | 5.11    |
| FKills        | 7.96              | 3.09    | 4.66              | 2.43    |
| MKills        | 16.34             | 4.83    | 6.38              | 3.11    |
| MFKills       | 51.44             | 8.20    | 19.17             | 6.06    |
| MountKks      | <b>6,113.79</b>   | 974.19  | <b>3,867.68</b>   | 782.91  |
| Tot Kills     | 6,275.55          | 985.95  | 3,929.21          | 793.44  |
| NoEffects     | 88.21             | 11.23   | 29.61             | 7.60    |
| Suppresses    | 160.21            | 83.1    | 24.41             | 27.67   |

# IADS Study - Problem Description



## Background

This unclassified study uses entity-based simulations to quantitatively analyze proposed high, medium and low-cost solutions to destroy enemy IADS in a simulated region of interest.

## Study Objectives

- Analyze behavior of fully integrated air defense system of six long-range sites and two mid-range sites each with two short-range point defense systems.
- Identify possible force sizing constructs required to destroy long-range and mid-range IADS tracking radars and point defense transporter erector launcher and radar (TELAR) systems
- Explore force sizing changes due to anticipated near and long-term enemy capabilities

# Scenario Laydown



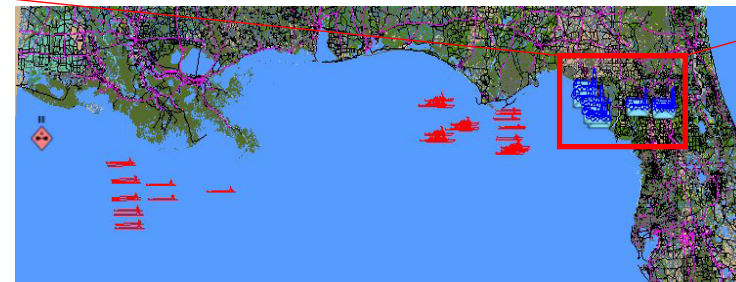
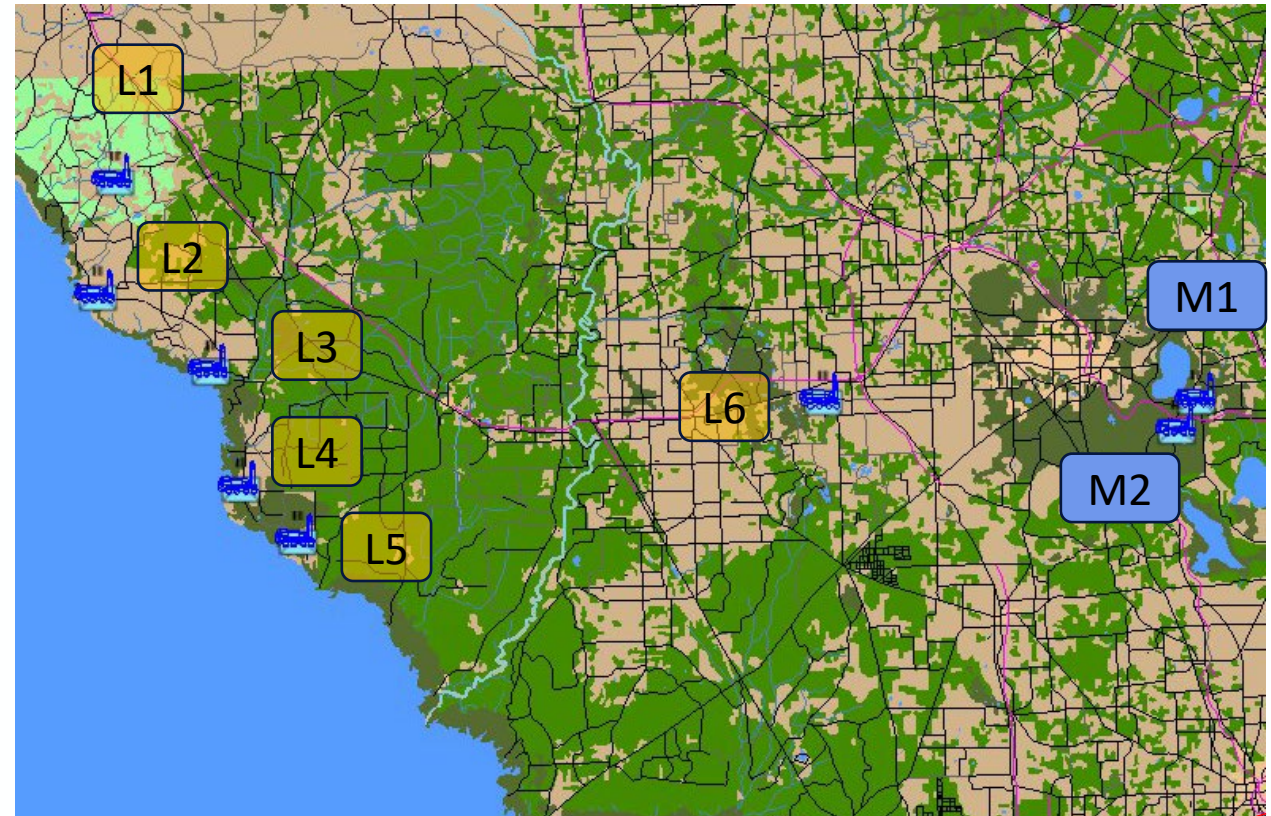
## ➤ Air Defense layout

- L1 - L6 are similar **Long-Range** SAM sites
  - Totals: (6x) 12 TELs x 4 tubes = 288 missiles
  - Each has 1 acquisition radar and 1 tracking radar
- M1 and M2 are similar **Mid-Range** SAM sites
  - Totals: (2x) 12 TELs x 4 tubes = 96 missiles
  - Each has 1 acquisition radar and 1 tracking radar
- Each SAM site is defended by two **Short-Range** point defense TELARs
  - Totals: (8x) 2 TELARs x 12 tubes = 192 missiles
  - Each TELAR can receive acquisition feeds and can independently acquire and track

## ➤ Terrain nearly flat with no terrain masking

## ➤ Attacking Forces

- Cruise Missiles
- Tactical Ballistic missiles
- Hypersonic Glide Vehicles



# Scenario Assumptions



## ➤ Assumptions for IADS

- **Fixed SAMs** – All elements are stationary during the scenario
- **No Decoys** – No Decoys will be used in the scenario
- **No Air Support** – Air will not be part of the scenario
- **No Munition Reloading** – No sufficient time to reload in engagement window
- **No Counter Attack** – IADS will defend in place

## ➤ Assumptions for Attackers

- **Perfect ISR** – All element positions are known during the scenario
- **Pre-planned Attack** – No Dynamic tasking will occur
- **IADS Focused** – No Tasking or concern for other targets
- **No Jamming** – No attempt to Jam Surveillance or Tracking Radars or inject faux tracks
- **No Cyber** – No attempt cyber aspect in the scenario
- **Full Fly-over Permissions** – No attempt to limit routes

# Results

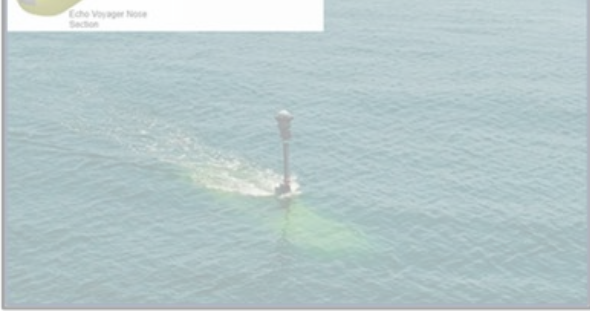


## ▶ Best Force Sizing Constructs

- 479 Cruise Missiles
  - Cheaper than other combination of weapon systems
  - Result is insensitive to the improvement of the enemy tracking radar capabilities
  - Potential for dynamic re-tasking, reducing the required number of missiles
  - 99.2% destruction of tracking radars and TELARs
- 172 Short Range Ballistic Missiles (SRBM) and 205 Cruise Missiles
  - Long and mid range sites on average have 20% unused missiles
  - Improved enemy tracking radars will require 25% more SRBMs to achieve similar results
  - 99.6% destruction of tracking radars and TELARs
- 24 Hypersonic Glide Vehicle, 131 SRBMs and 205 Cruise Missiles
  - Most expensive combination of weapon systems
  - Improved enemy tracking radars will require more attack missiles
  - 95.2% destruction of tracking radars and TELARs



# Questions ?





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