SEA-13/TDSI Final Presentation

SEA-13
MARITIME
INTERDICTION
OPERATIONS

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What's MIO about?

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US/Coalition Sailors boarding vessels to search for illicit cargoes.

What's MIO about?

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Here, everyone is compliant.

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What’s MIO about?

but, just in case

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What’s MIO about?

Get the target crew mustered in one place

What's MIO about?

Sweep the ship for any stragglers

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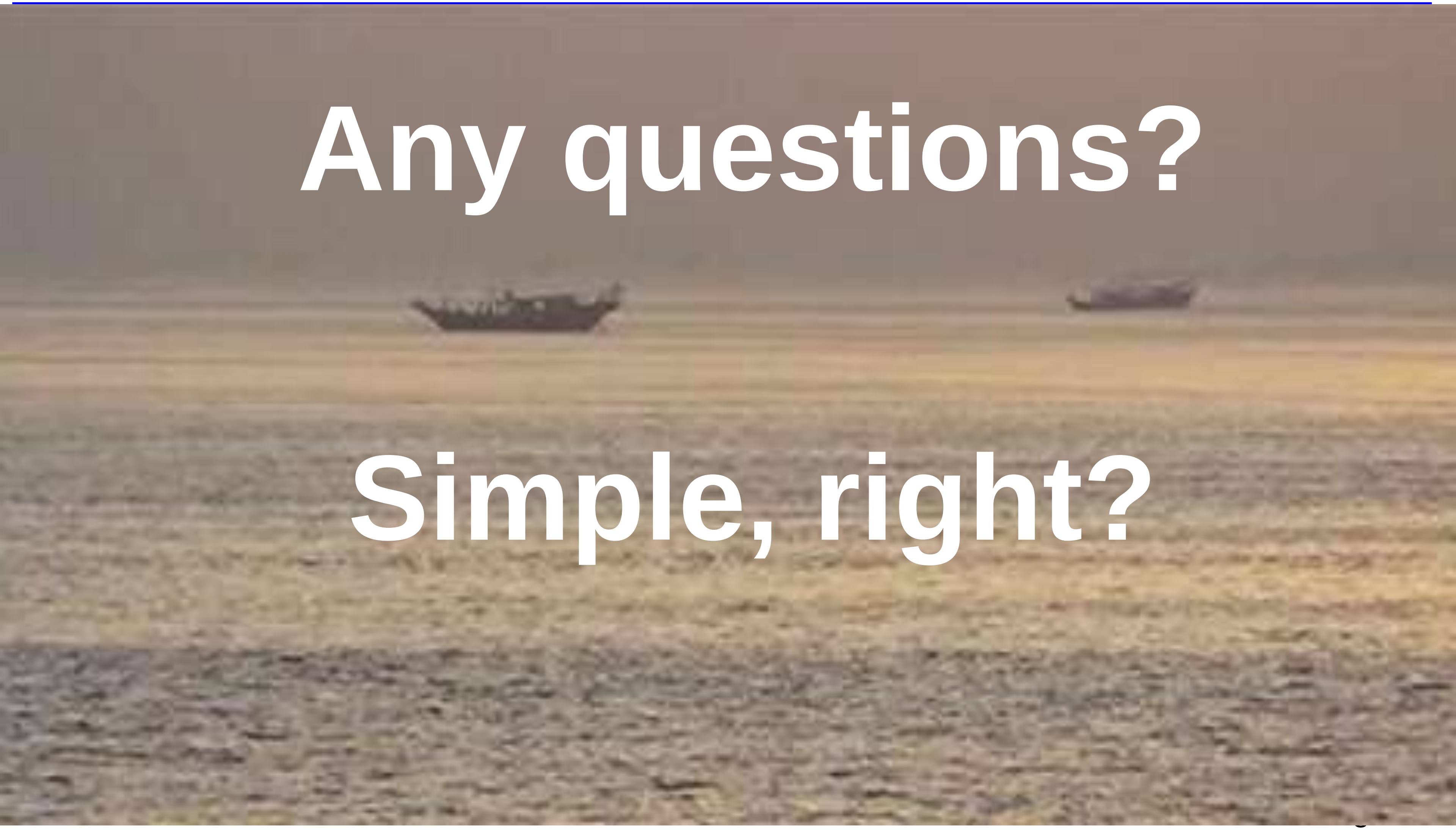
What’s MIO about?

Now, search
the ship.

What's MIO about?



Agenda

- Intro to MIO & Systems Engineering process
  - Tasking
  - Key definitions
  - Scope
  - Needs
  - Stakeholders
  - Functional analysis
  - Architectural analysis

Agenda (contd)

- Scenarios and Operations Mgmt
- Boarding and Recovery
- Search
- Information Superiority
- Intercept
- Logistics and Costing
- Modeling and Simulation
- Conclusions

BLUF

- Recommended approach as follows:
  - ESG force composition
  - Surface launched boarding teams with HVBSS capability
  - Employ augmented sensors during the MIO
  - Employ UAV’s for macroscopic surveillance
  - Employ biometric collection
  - Employ WETNET/Trellisware comms architecture
  - Utilize armed UAV, armed USV and non-lethal weapons as is appropriate for non-compliant/opposed MIO’s and deterrent for compliant MIO’s
  - Utilize a push based logistics approach

Intel Utilization

- Macroscopic intelligence (regarding the identification/location of all vessels in the maritime environment) is collected by organic or inorganic assets.
- The ESG staff onboard the LHD fuses this with the microscopic intelligence collected by boarding teams.
- Decisions are made based on their analysis as to who to board next. Could witch from phase 1 to phase 0 based on intel collected during boarding operations.

Conduct of a Typical MIO

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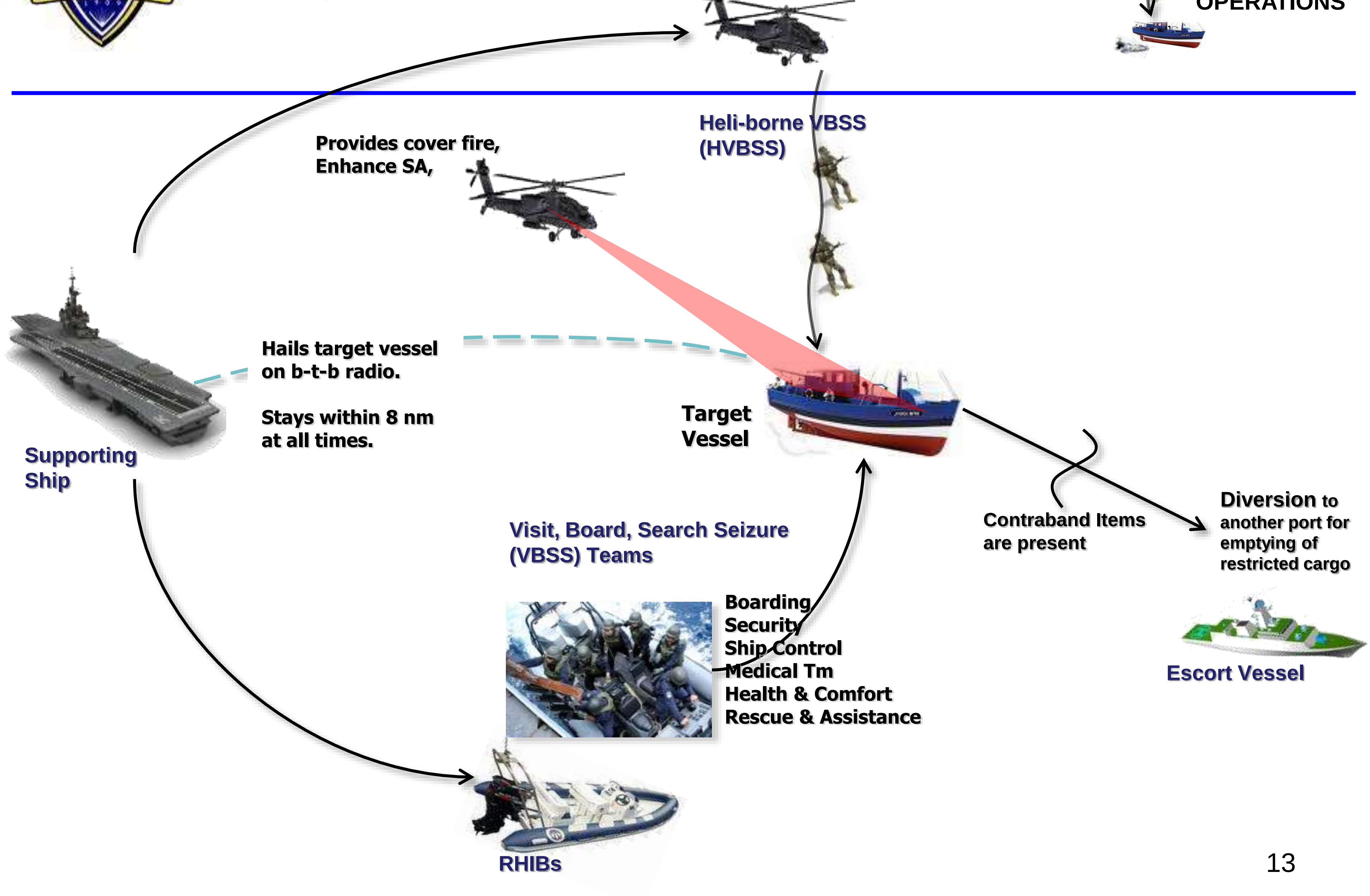

Tasking - Definitions

- Design a **system of systems** to employ a regional Maritime Interdiction operation in a logistically barren area.
  - Implies no centralized control
  - Multiple interacting components.

Tasking - Definitions

- Design a system of systems to employ a regional Maritime Interdiction operation in a logistically barren area.
  - "Regional" implies multiple MIO's on a large area
  - Maritime Interdiction Operation (MIO): Taking targeted cargo from ships at sea. (short version)

Levels of MIO's

- Design a system of systems to employ a regional Maritime Interdiction operation in a logistically barren area.
  - 1: Compliant
  - 2: Non-compliant – low freeboard
  - 3: Non-compliant – high freeboard
  - 4: Opposed

Reference Naval Tactics Techniques and Procedures publication 3-07

Tasking - Definitions

- Design a system of systems to employ a regional Maritime Interdiction operation in a logistically barren area.
  - You can have anything you want, but you had to define how you got it.
  - The time of arrival of items is not guaranteed.
  - Things present at every location on Earth are fair use for this analysis (consider satellites in low Earth orbit)

Tasking - Definitions

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- Design a system of systems to employ a regional Maritime Interdiction operation in a logistically barren area.

- The system should be capable of collecting maritime intelligence and conducting rapid intercepts based on that intelligence to execute theater security, crisis response, and law enforcement missions in a coalition, interagency, and joint environment.
  - Must have eyes and ears. The scale of the intelligence is not specified.

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Tasking - Definitions

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- The system should be capable of collecting maritime intelligence and conducting rapid intercepts based on that intelligence to execute theater security, crisis response, and law enforcement missions in a coalition, interagency, and joint environment.
  - The System of Systems must exert a minimal amount of force..

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Tasking - Definitions

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- The system should be capable of collecting maritime intelligence and conducting rapid intercepts based on that intelligence to execute theater security, crisis response, and law enforcement missions in a coalition, interagency, and joint environment.

- Consider current fleet structure and funded programs as the baseline system of systems to execute security and shaping missions in developing these concepts of operations, then develop alternative architectures for platforms, manning, command and control, communication, and operational procedures to evaluate against the current program.

  – Current fleet structure as a baseline stuggests a near-term timeline for consideration.

Tasking (complete statement)

- Design a system of systems to employ a regional Maritime Interdiction operation in a logistically barren area.

- The system should be capable of collecting maritime intelligence and conducting rapid intercepts based on that intelligence to execute theater security, crisis response, and law enforcement missions in a coalition, interagency, and joint environment.

- Consider current fleet structure and funded programs as the baseline system of systems to execute security and shaping missions in developing these concepts of operations, then develop alternative architectures for platforms, manning, command and control, communication, and operational procedures to evaluate against the current program.

Project Definition
Scope of the Problem

- Location is a hypothetical geometry with multiple inputs/multiple outputs
  - End product generally applicable to any hotspot
- “Threats” are targeted towards the “lower end of warfare”, such as:
  - Implements of Insurgency
  - Narcotics
  - People

Project Definition
Scope of the Problem

- Boardings of greatest interest are level 1-3. Level 4 boardings will not occur, however we may force a level 4 boarding into level 1.
- Larger vessels (>300 tons), will be compliant boardings with the interest of getting the boarding team through expeditiously.
- If a large vessel is smuggling something, they won’t know about it. “Smaller vessels are less controlled and are therefore of greater concern” – OPNAV N867
- “Speed boats” are not considered here.

Project Definition
Timeline Implications

- 2013-2014 is approximately 5 years out. Timeframe picked exclusively on the basis of how long it takes to go from a “good-idea” to dispersal of congressionally authorized funding.
- If timeline were picked earlier, only systems that could be purchased with discretionary funds could be used.
- If timeline were picked later, then the utility of our results becomes more uncertain.

Project Definition
Need for a solution

- MIO is a dangerous activity – needs further study.
- MIO is a good way to interdict the transport of material, either selectively or totally.
- Material transported by sea is generally of use to either an insurgency, terrorist organization or rogue state.
- Transported material may also be economically/physically destructive to friendly states.

Stakeholders (participating)

- Sponsor for SEA-13 is…
  - OPNAV N867 – Surface Warfare plans/prep - MIO
- Coast Guard – Deploying Operations Group is the only other stakeholder willing to talk to us.

- Vast majority of organizations contacted were unwilling to talk to us due to classification concerns.

Stakeholder Analysis (non-participating)

- Originators:
  - The drug cartels and the Taliban
  - Weapons: Manufacturers
  - Al Qaeada and other terrorist organizations
  - Mafia (Triads et al)
- Mid-course
  - Security at non-maritime routes
  - Target ship crew
  - Target ship's owners
- Consumers
  - Insurgencies (one big reason for MIO)
  - Narco-traffickers (distributors, middle-men)
  - An insurgency's stakeholders
- Ubiquitous: US and allies

Functional Analysis

- 1.0 To supply (logistics)
- 2.0 To Maintain/achieve Info Superiority
- 3.0 To Manage
- 4.0 To Maneuver (intercept)
- 5.0 To Board
- 6.0 To Search
- 7.0 To Recover
- 8.0 To Detain (intercept)
- 9.0 To Disable (intercept)
- 10.0 To be legal
- 11.0 To abort

Functional Architecture

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- Logistics
  - Fly things in on demand
  - Store things in the area
- Info sup (intel)
  - Surface collection
  - Aerial collection
- Info sup (comms)
  - HF comms
  - Line of sight (with relays)
  - Satcom
- Boarding/Recovery
  - From ships
  - From subs
  - From aircraft
  - From land
- Searching
  - With humans
  - With dogs
  - With IMS (et al
- Management
- Intercept
  - With UAV's
  - With USV's
  - With manned helos
  - With manned boats
- Legal
- Abort

Architectures

- Architecture 1 – **Surface w/air**
  - Small surface craft conduct delivery and recovery
  - Undetermined # and class of surface ships are primary launch platforms.
  - ISR by UAV/Aircraft
- Architecture 2 – **Subs**
  - Sub launched craft
  - UAV's launched from sub
- Architecture 3 – **Air**
  - All MIO's are HVBSS
  - Boarding teams rappel onto target ships
  - A/C launched from LHD like ship
  - Protects boarding team with A/C
- Architecture 4 – **Non logistically barren**
  - Land based A/C or small craft launched from land
  - Heavy use of port facilities for inspection

Criteria for Consideration

	Weight	**Surface**	Sub	HVBSS	NLB
Effectiveness	10	**10**	2	7	9
Crisis Response Capability	9	**10**	1	8	0
Logistic Independence	8	**8**	5	7	0
Survivability	7.5	**7**	10	6	5
Relative Footprint	7	**10**	0	7	10
Climate Independence	6	**10**	10	9	4
Risk	5.5	**10**	1	4	6
Cost	5	**8**	1	5	0
Mobility	3	**10**	10	10	0
Stealth	2	**2**	10	4	0
Weighted Score		9.0	4.2	6.8	4.0

Architectural Refinement

- The **SURFACE W/AIR** architecture is clearly superior to other architectures given the constraints of the problem.
- Alternative architectures will not be revisited.
- The remainder of analysis is focused on making major refinements to the selected architecture.

Agenda (contd)

- Scenarios and Operations Mgmt
- Boarding and Recovery
- Search
- Information Superiority
- Intercept
- Logistics and Costing
- Modeling and Simulation
- Conclusions

SEA13 / TDSI Scenario Development

<u>OPERATIONS MANAGEMENT GROUP</u>

Team Lead: Brett LeFever

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Cher Howe Ong
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Asset Management

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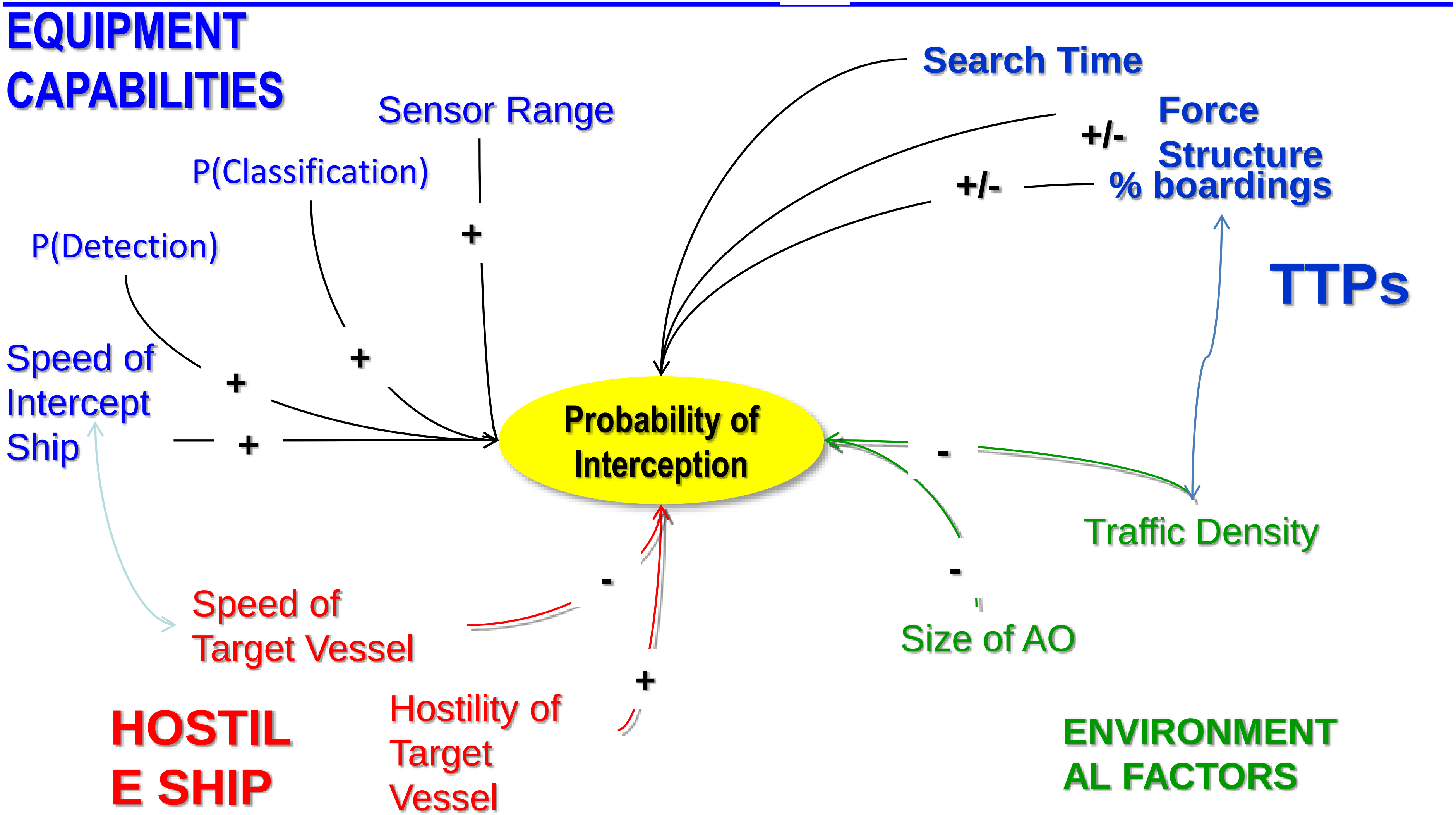
Scenario Development

-



CONOPS Phase Plan

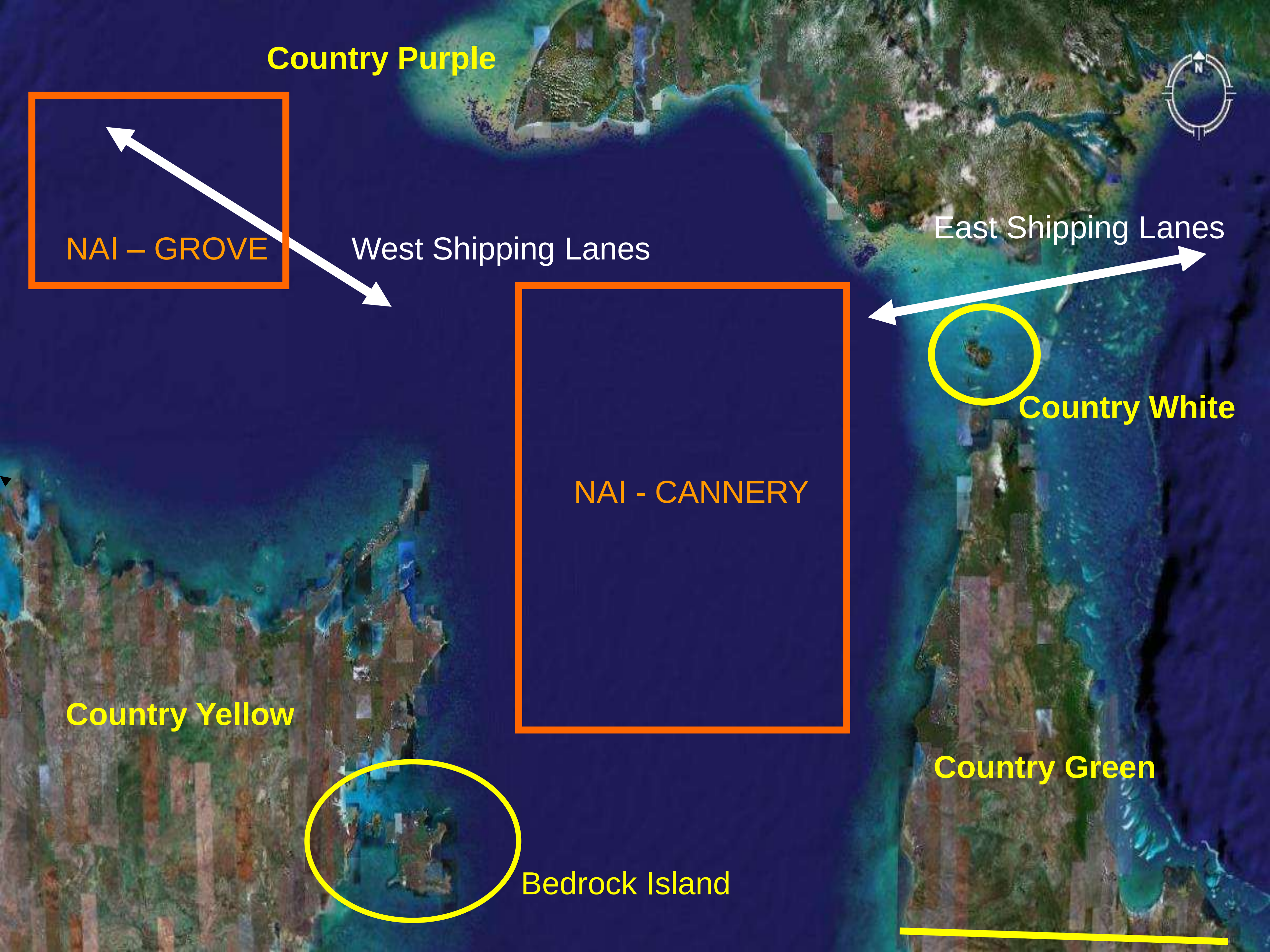
- Established a Planning Group
- MIO as a Primary Mission
  - Joint Pub 5 - 6 Phases of Campaign
    - ***Phase 0: Shape the Battle Space***
    - ***Phase 1: Deterrence***
    - Phase 2: Seize the Initiative
    - Phase 3: Dominate
    - Phase 4: Stabilize
    - Phase 5: Enable Civil Authority

SEA-13/TDSI Scope

- Scope of Scenario
  - Focus on Phase 0, 1, and 2
  - Beyond Phase 2
    - Not Logistically Barren
    - Not ROE Limited Operations
      - MIO Operations transition to Blockade
      - ROE allows destruction of Opposed / Non-Compliant Vessels
  - Develop Phase Scenario
    - Phase Not Bounded by Time
    - Separate Operations
    - Transition By Trigger States

General Area of Operation

- MIO is Global Operation
  - Target Dense Case
  - Target Sparse Case
  - Applicable to “Whole World”
- High Interest Shipping Lanes
  - Maritime Traffic is International (Flag State, Cargo State…)
  - Piracy is present
- Critical Area of Interest
  - Significant Significance to Global Economy
    - Straits of Malacca
    - Straits of Gibraltar
    - Gulf of Guinea
    - Straits of Hormuz



Country Purple
NAI – GROVE
West Shipping Lanes
East Shipping Lanes
Country White
NAI - CANNERY
Country Yellow
Country Green
Bedrock Island

Quick Look Region Background

Country	Alliance	Disposition To Straits	Relationship
Purple	Non-Ally	Indifferent	Neutral
White	Friendly	Critical	Allied
Green	Ally	Critical	Partner
Yellow	Non-Ally	Distracted	Threat
Separatist	Suspect	Critical	Threat

Scenario Story Line

- After a Bloody Revolution Extremist Group has taken Control of Bedrock Island from Country Yellow
- Separatist are using Bedrock Island as Base of Operation for future Separatist Movements in the Region
- US Intelligence suspects the Separatists are sending/receiving military supplies and people through the Busy Shipping Lanes

Logistic Assumptions

- Country Green will allow U.S. a port to operate.
  - 20 hour flight to San Francisco / Los Angeles / San Diego
  - 15 hour flight to Honolulu
- Other Allied Nations
  - U.S. Logistic Hub in Forward Deployed Base 10 hour Flight
  - Allied Nation limited Logistic Support (Country Green)
- U.S. Forces will be have typical Support ships Avail
  - T-AO -> Fuel / Limited Cargo
  - T-AFS -> Stores / Ammunition
  - T-AE -> Ammunition / Stores
- Logistically Barren
  - Friendly Port in AOR
  - Normal ESG/CSG Support Ships

Ship Categories

- Class I: < 300 Tons — Trawler, Dhows, Tugs
- Class II: < 300 Tons — Passenger Ferry
- Class III: > 300 Tons — Gen Cargo (Coastal)
- Class IV: > 300 Tons — Ore/Bulk/Oil Carrier
- Class V: > 300 Tons — Pass Ferry / Ro-Ro
- Class VI: > 300 Tons — Container Ships

300 Tons is critical tonnage for International Rules / Regulations

OPERATION: Academic Fury

Scenario Description

Red Numbers Denote Number of MIO Teams Carried

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Standing Force Package

- MIO Teams (VBSS / HVBSS capable)
  - Non Air Capable
    - PC → x2 MIO Teams
  - Air Capable
    - FFG → x2 MIO Teams
    - DDG/ CG → x3 MIO Teams
    - LPD/ LSD → x3 MIO Teams
    - LHD/CVN → x4 MIO Teams

MIO Mission Package

- MIO Mission Package (Air Capable Platform)
  - x2 Search/ ISR VTUAV
  - x1 Search/ ISR USV
  - x1 Combat Support UCAV Package for ISR UAV
- Trade-Off
  - Replace 1 Helicopter on Air Capable Ship
  - Replace x1 RHIB w/ USV
  - Loss of Helicopter and RHIB redundancy

Phase Summary

Phase	Target	Force	Boarding
0	Single Ship	SAG	Compliant
1 High Density	Multiple Ships	ESG + Allies	Compliant/NC
1 Low Density	Multiple Ships	ESG + Allies	Compliant/NC

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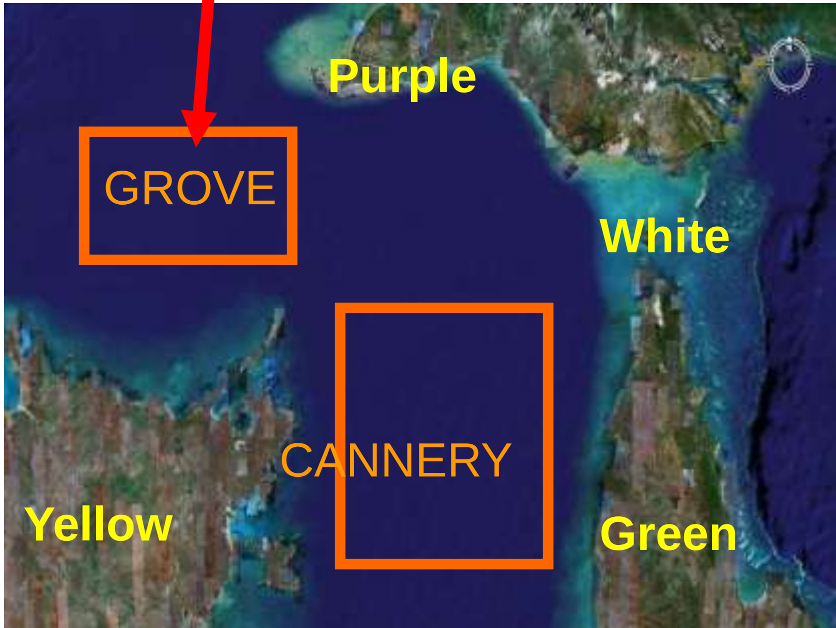
Scenario 0 -- Setup

- US Forces
  - US SAG On Scene
    - x2 DDG (Helo Capable) for MIO Operations
    - US MPA Available from Country Green
    - **Intelligence Specific Targets**
  - Targeted Boardings
    - High Traffic Density
    - Single Known Target
      - No Random Boardings
      - Large Container Ships
      - Large Coastal Traffic



Scenario 1 HD -- Setup

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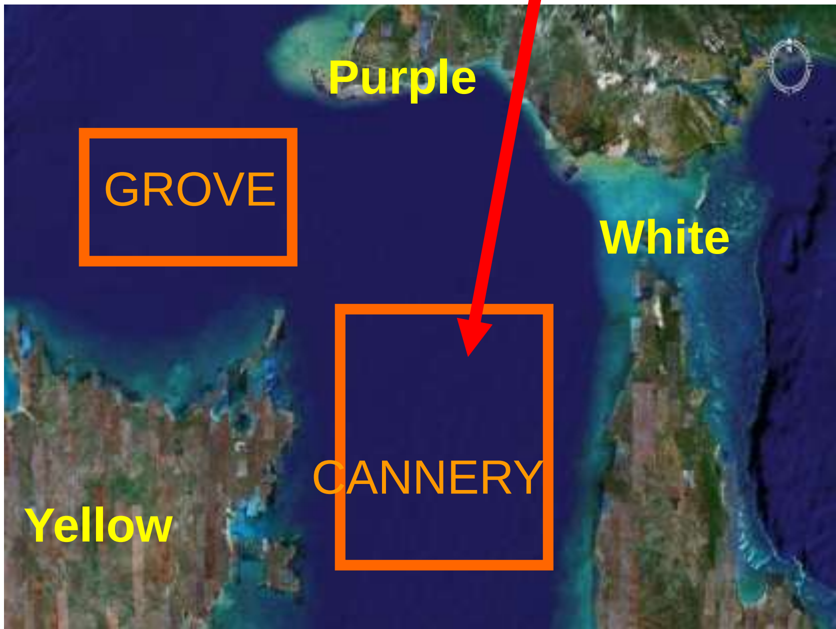
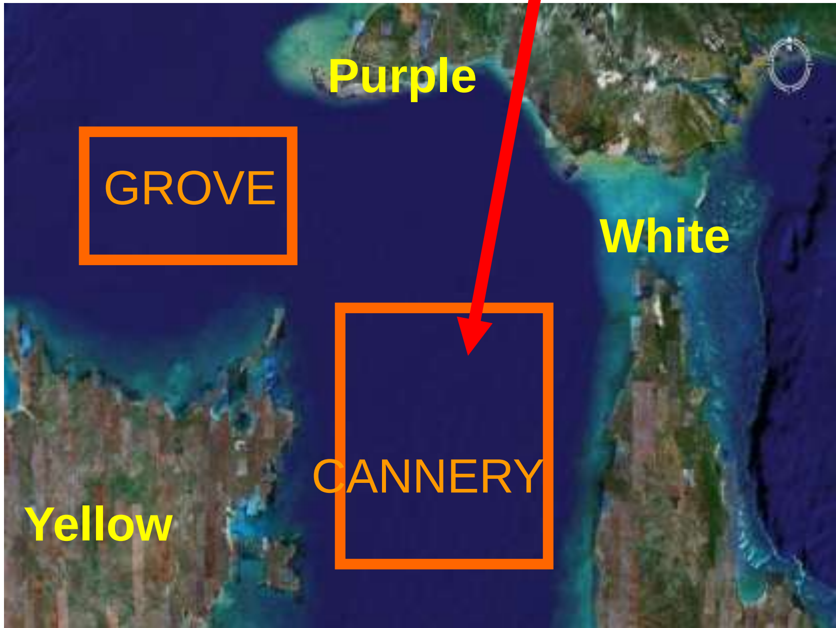
- US Forces
  - US ESG On Scene
    - ESG Total Force Package
      - X1 LHD, x1 CG, x3 DDG, Country White Corvette, Country Green FFG
    - US MPA Available from Country Green
    - Country White AEW Available
    - Country White / Green Surface Units
  - General Boardings
    - **High Traffic Density**
    - Multiple Targets
      - Unknown Identity
      - Coastal Fishing
      - Cargo Dhow Traffic
      - Passenger Ferries



Scenario 1 LD -- Setup

SEA-13 MARITIME INTERDICTION OPERATIONS

- US Forces
  - US ESG On Scene
    - ESG Total Force Package
      - X1 LHD, x1 CG, x3 DDG, Country White Corvette, Country Green FFG
    - US MPA Available from Country Green
    - Country White AEW Available
    - Country White / Green Surface Units
  - General Boardings
    - **Low Traffic Density**
    - Multiple Targets
      - Unknown Identity
      - Coastal Fishing
      - Cargo Dhow Traffic
      - Passenger Ferries



Scenario Goals

- Create Evaluation
  - Number of MIO Boarding Units
  - Number of Aircraft Sorties
  - Expected Success Rate of Operation
  - Logistically Barren Data
    - Loss of Aircraft
    - Loss of Boarding Asset
- Create Mission Ready Scenarios
  - Real World Test
  - Affect Current Planning
  - Affect Current MIO mission Areas
  - Planning Tools for Commander

Operations Management

Team Lead: Brett LeFever

Lior Harari
Cher Howe Ong
Kok Kiang Lee
Robert Silva
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Operations Management

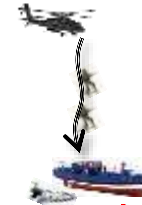
3.0 Manage Operations

- 3.1 *Determine force requirements/mix*
- 3.2 *Determine Mission*
- 3.3 *Contingency planning*
  - 3.3.1 Handle confiscated ship disposal
  - 3.3.2 Handle disposal of toxic/elicit cargo
- 3.4 *Assign parent ships to target ships*
- 3.5 *Maintain a common operational picture*
  - 3.5.1 Determine friendly force status
    - 3.5.1.1 Communicate with friendly forces
    - 3.5.1.2 Receive position/status reports from friendly units
  - 3.5.2 Achieve Maritime Domain Awareness
- 3.6 *Disperse orders to friendly forces*

Major Developments

- CONOPS Development
  - CONOPS
  - Scenario
- Low-Resolution Model
  - MANA Scenarios Build
  - Validate Current Force Mix / Structure
  - Used to Prime NSS Model
- JAVA Queuing Model
  - Builds Queuing Model
  - Gives Bounds of MIO operation
    - Logistically Barren Question
    - Validate NSS Model
- Contingency Planning
  - Non-Model Events
  - Operationally Significant Events

Low Res Model – Model Setup



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Model Assumptions

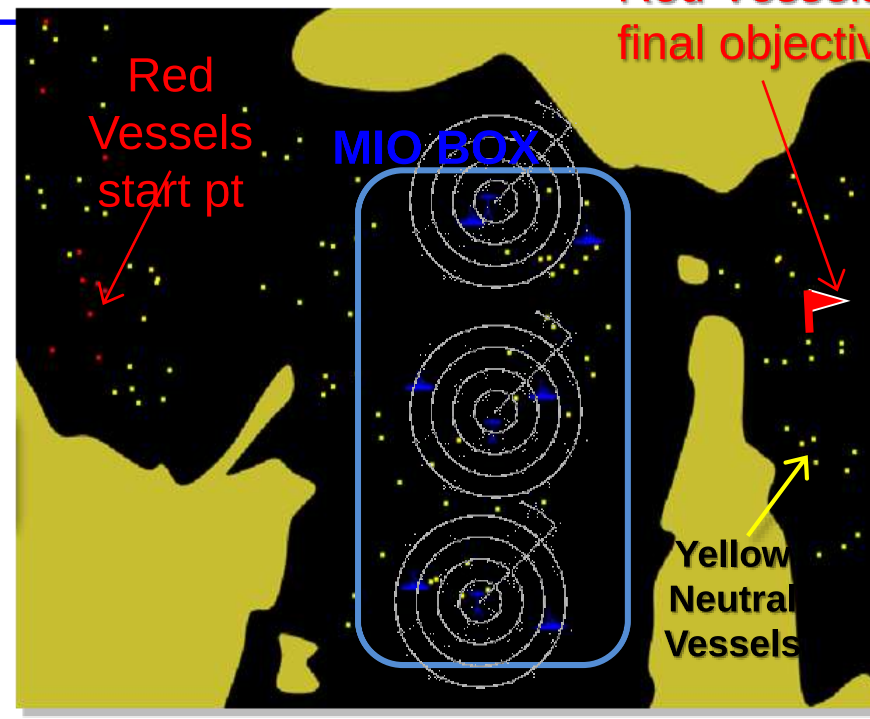
TTPs
- Spiralling out search Pattern
- 24hr operational time frame
- 100% boarding
- 3hr Boarding and search time

Equipment Capabilities
- Simple Detection:
-P(Detection & Classification) = 1 within 6nm

- 3hr Flight time and 15 min refuel for aerial search vehicle

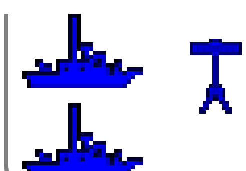
- Speed = 20nm/hr for all

Scenario Setup



RED
- Arrival of 1 ship/ 30min up to 10 ships
- Attempts to avoid all Blue ships

Blue
- 3 x set of



Low Res Model – Simulation Results

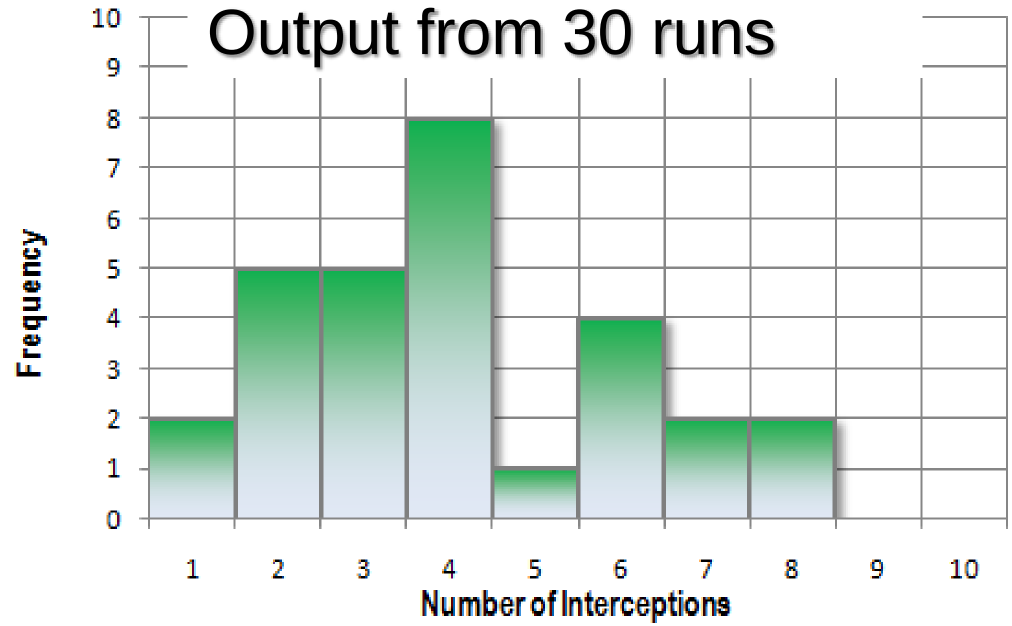
Measure of Effectiveness

Probability of Intercept =

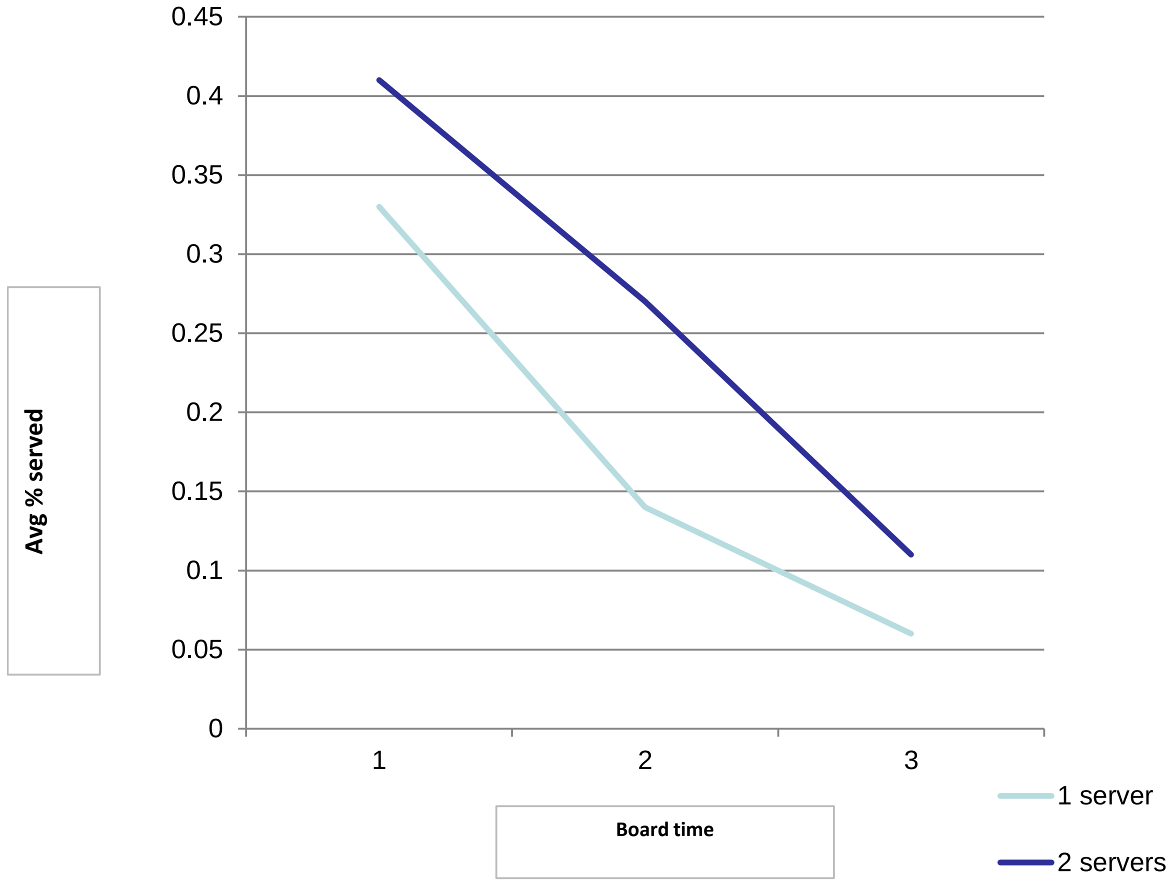
$$\frac{Number\ of\ Intercepted\ Red\ Vessels}{Total\ Number\ of\ Red\ Vessels}$$

0.41 with $\sigma = 0.19$

Output from 30 runs



Ships Queuing Model



Queuing Theory Model

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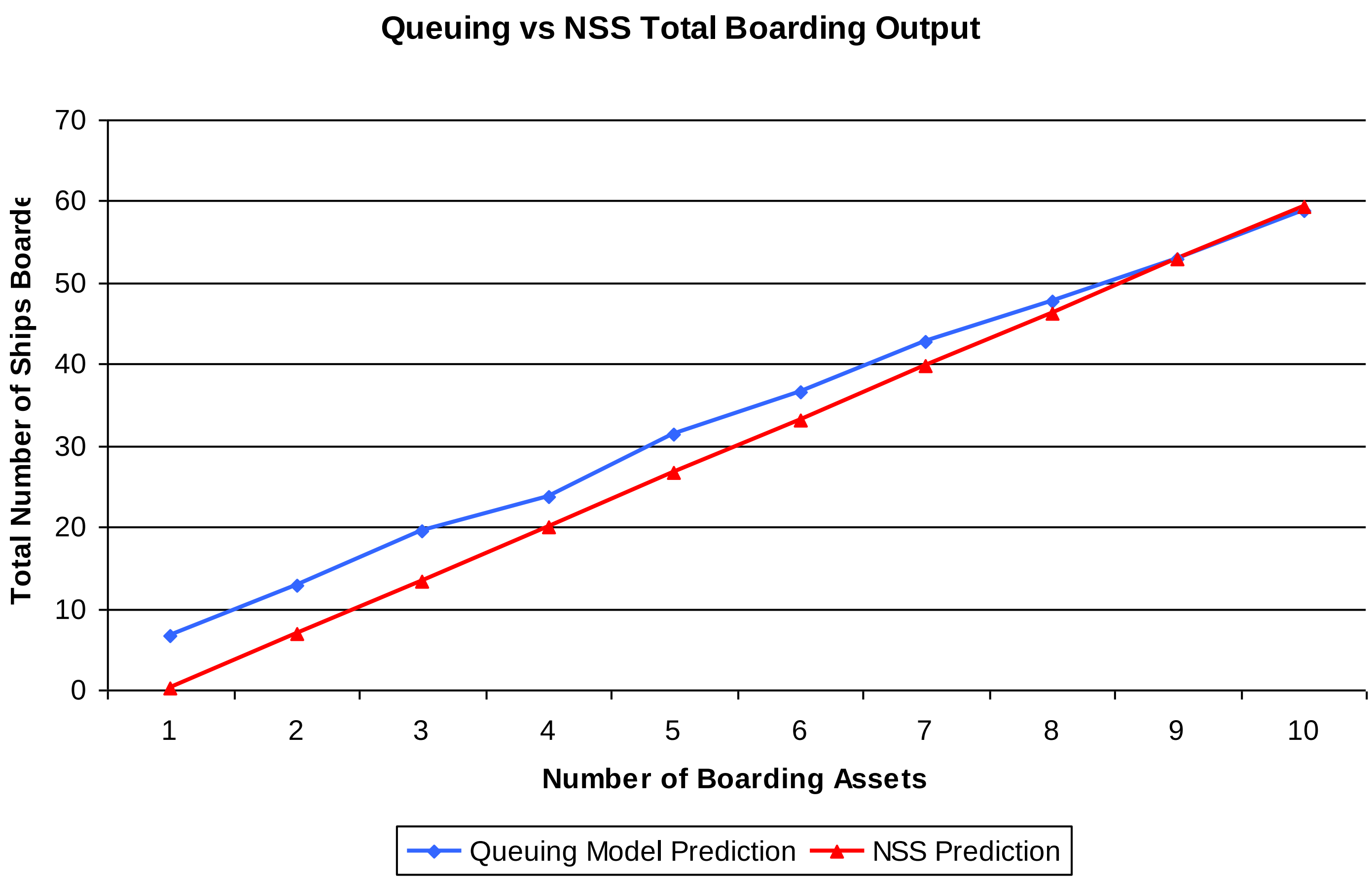

Contingency Planning

- Cover the “Other Cases”
  - UN Law of the Sea
  - Coalition Shifts
  - Unexpected Technological Threat
  - Aircraft Loss
  - Boarding Team Captured
  - Prize Ships / Unexpected Cargo Seizure
  - Mission Abort
  - Medical Contingency
  - Hostile Actions

Conclusions

- Low-Resolution Model
  - Supports Current Force Structure ESG
  - Aircraft value required Higher Fidelity Study
- Queuing Theory Model
  - Boarding Time Dramatically Affects Efficiency
  - Good Approximation to Total Boardings
- CONOPS/ Contingency
  - MIO planning has significant Operational Footprint
  - Coalition Warfare is Critical to Success

Agenda (contd)

- Scenarios and Operations Mgmt
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Boarding and Recovery

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Christopher McCook

Recommendations

- In a MIO, an ESG type of configuration is optimal given manpower, helicopters and # of RHIB's.
- Increasing the number of ships:
  - Improves quantity of MIO's
  - Decreases mission flexibility
  - Reduces logistic independence
- An optimal force package can be created based on total # of boardings in a defined shipping density

Deliverables

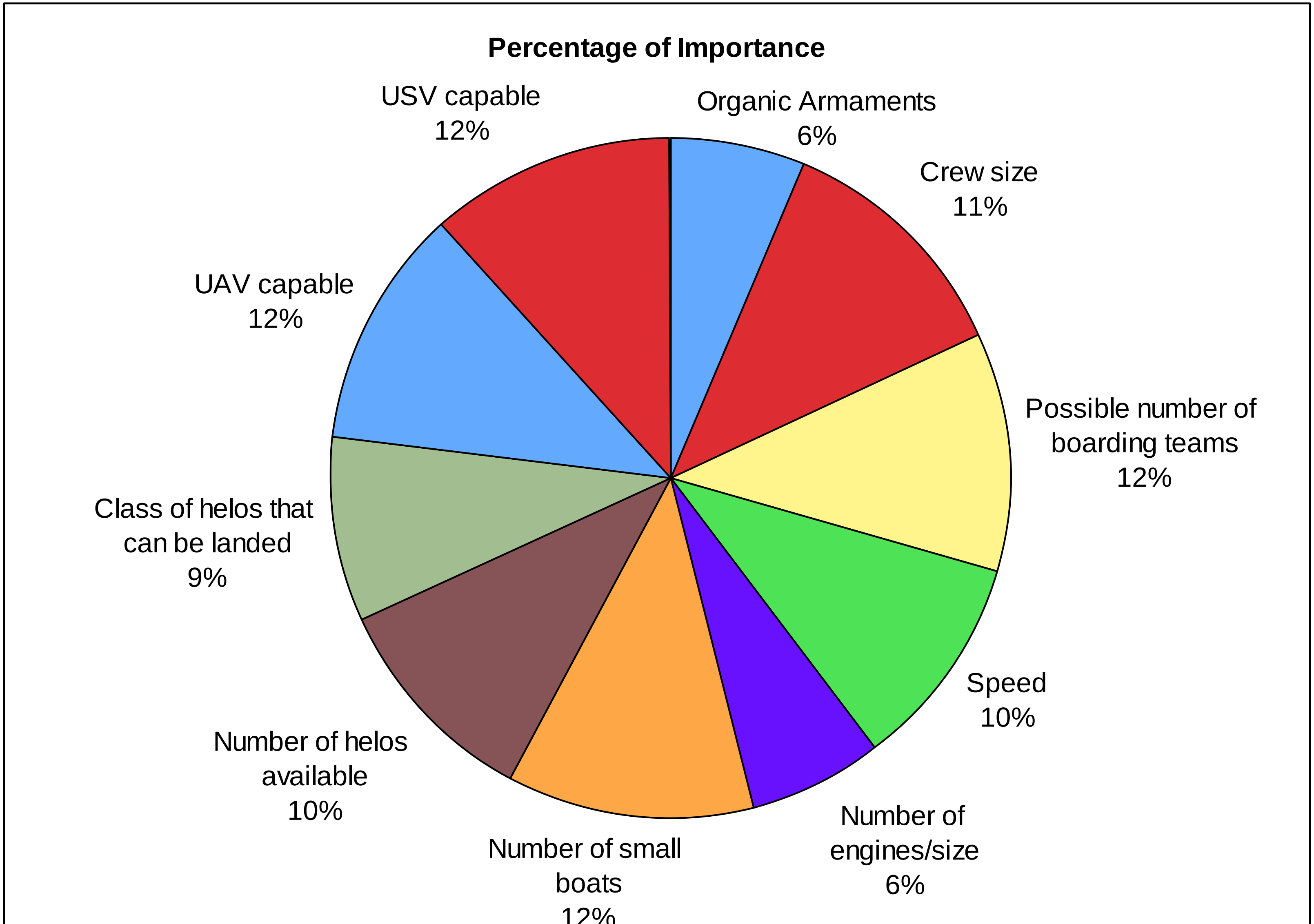
- Sensitivity Analysis of worldwide assets to show US and Coalition relative capabilities.

- Force package alternatives to United States Expeditionary Strike Group compositions

17 Countries, 108 Ships

- Australia
- Britain
- Canada
- Denmark
- France
- Germany
- Greece
- Indonesia
- Italy
- Portugal
- Singapore
- Spain
- Taiwan
- Turkey
- Pakistan
- Philippines
- United States

Weights of Characteristics



What is “effectiveness”?

- “Effectiveness” is a ships ability and proficiency at the following tasks:
  - Have organic armaments that will ensure compliant boarding
  - Have a crew size to support boarding missions
  - The speed of the mother ship to pursue escaping non-compliant vessels
  - Have helicopter and RHIB capabilities
  - Types of helos that can be landed on the flight deck
  - Control and deploy UAV’s and USV’s

Individual Asset Matrix
Top 10

1) Tarawa class (LHA)	90.5%
2) LHA 6 class	90.1%
3) Wasp class (LHD)	89.5%
4) Ticonderoga class	88.8%
5) Arleigh Burke class	88.8%
6) Keelung (Kidd) class	88.5%
7) Spruance class	88.2%
8) San Antonio class	87.4%
9) Austin class (LPD)	85.6%
10) De la Penne	85.3%

Individual Asset Matrix Bottom 10

99) Votsis class	25.1%
100) Roussen (Super Vita) class	24.7%
101) Larkana class	22.9%
102) Jalalat class	22.3%
103) Auk class	22.1%
104) Sea Wolf class (fast attack craft)	21.7%
105) Rajshahi Town class	20.5%
106) Tomas Batilo (Sea Dolphin) class	17.9%
107) Cyclone class (coastal patrol)	16.7%
108) San Juan class	12.9%

Force Package Analysis

- Optimization Analysis determined Joint force packages equivalent to an ESG using 3 Capacities:
  - Personnel capacity
  - Helicopter capacity
  - RHIB capacity

Current ESG Baselines

- Package 1
  - 1x LHA, 1x LSD, 1x LPD, 1x Ticonderoga, 2x DDG
    - 4143 total personnel underway
    - 31 helicopters
    - 17 RHIB's
- Package 2
  - 1x LHD, 1x LPD, 1x LSD, 1x FFG, 2x DDG
    - 4218 total personnel underway
    - 31 helicopters
    - 17 RHIB's
- Package 3
  - 1x LHD, 1x LPD, 1x LSD, 1x FFG, 1x DDG
    - 3856 total personnel underway
    - 29 helicopters
    - 15 RHIB's

Scenario Constraints

- Max deployable forces:
  6, 8, 10, 12 ships

- No more than 2 ships of any given class/type for each trial

- Further details available during Breakout session

Results

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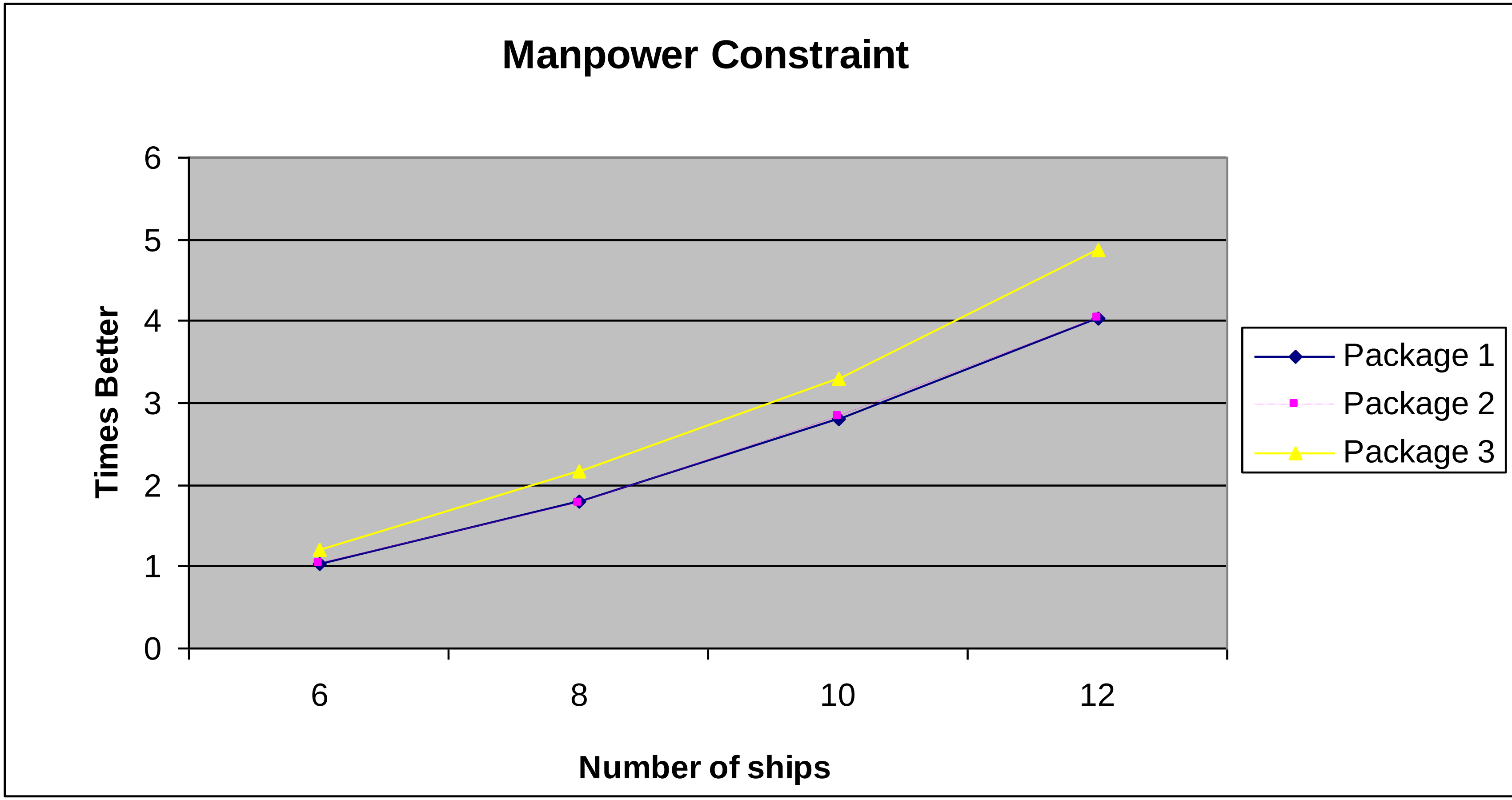
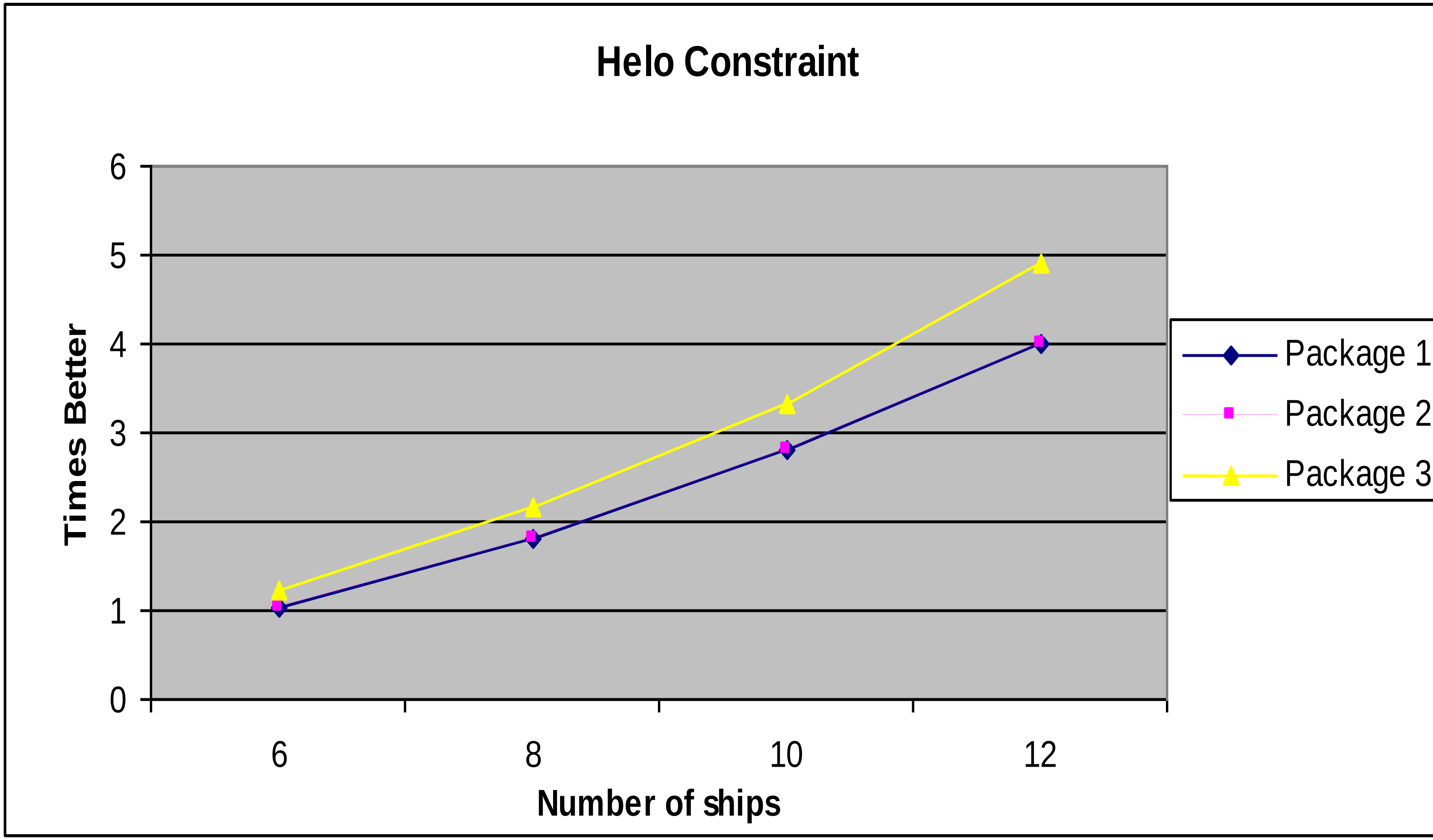
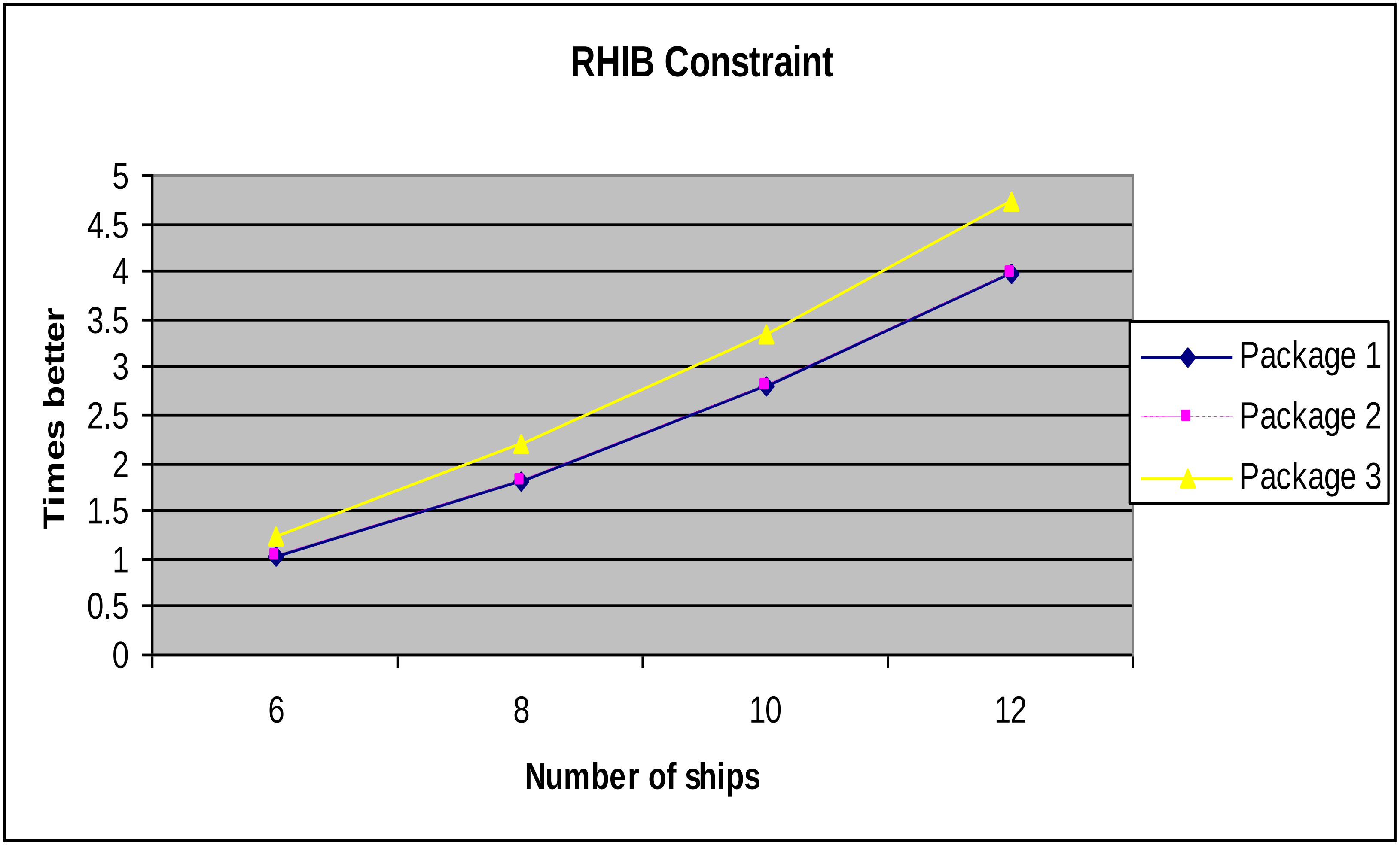


Results


Helo Constraint
Times Better
0
1
2
3
4
5
6
6
8
10
12
Number of ships
Package 1
Package 2
Package 3

Results


RHIB Constraint
Times better
5
4.5
4
3.5
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2.5
2
1.5
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0.5
0
6
8
10
12
Number of ships
Package 1
Package 2
Package 3

Agenda (contd)

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- Scenarios and Operations Mgmt
- Boarding and Recovery
- Search
- Information Superiority
- Intercept
- Logistics and Costing
- Modeling and Simulation
- Conclusions

Search

Team Lead: Kine Seng Tham

Choon Wei Poh
Chun Hong Low
Pick Guan Hui
Robert Beauchamp

Search Onboard The Ship

- Objective:
  - Study how one can find and identify targeted cargos more effectively.

Current Practice of Search

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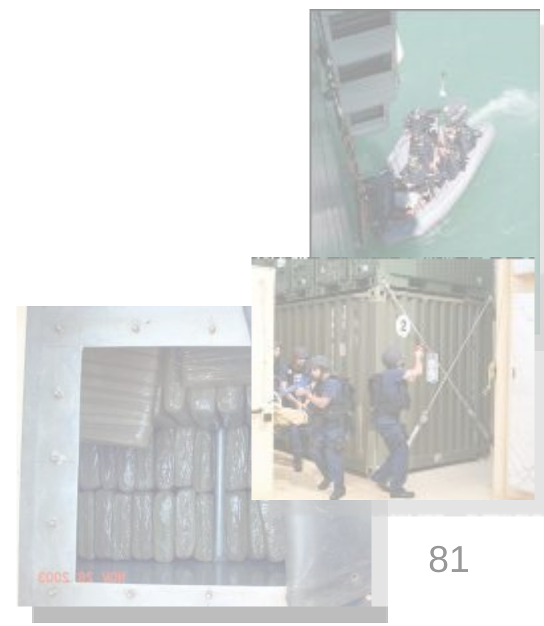
- Suspect vessel is boarded & secured.
- Boarding team split into a security team & a sweep team.
- Sweep team sweep the ship & cargos visually.

- Equipment used:
  - cutters, pry bar, flashlight, mirror, etc.

- Entire process is:
  - Inefficient, and
  - usually takes a long time.



Approach

- Study & understand problem.
- Identify targeted cargo.
- Understand what is needed to search a suspect vessel.
- Identify technology available.
- Recommend current technology & equipment.
- Recommend technology to grow.
- Determine requirements for future equipment.

Problem Definition

- Objective
  - find and identify targeted cargos more effectively.
- Constraints
  - Cargos are hidden.
  - Sensors used need to either “see” through walls or detect traces of the targeted cargo outside the walls.
  - Chosen sensor, ideally, has to be able to be brought onboard the suspect vessel.
  - Use current technology.

Targeted Cargo

- Smuggled humans & animals.
- Illicit narcotics.
- Firearms – Guns, Mortars.
- Explosives.

Search the Suspect Vessel

- Functional Decomposition

6.0 To search the suspect vessel

6.1 Determine search methodology (exhaustive, random or targeted)

6.2 Determine search target set (weapons, narcotics, people, etc)

6.3 Determine needed asset mix to search a ship

6.3.1 Determine number of people needed

6.3.2 Determine amount of time given to search

6.4 Transport search equipment to or from the parent ship and suspect vessel

6.5 Search the ship

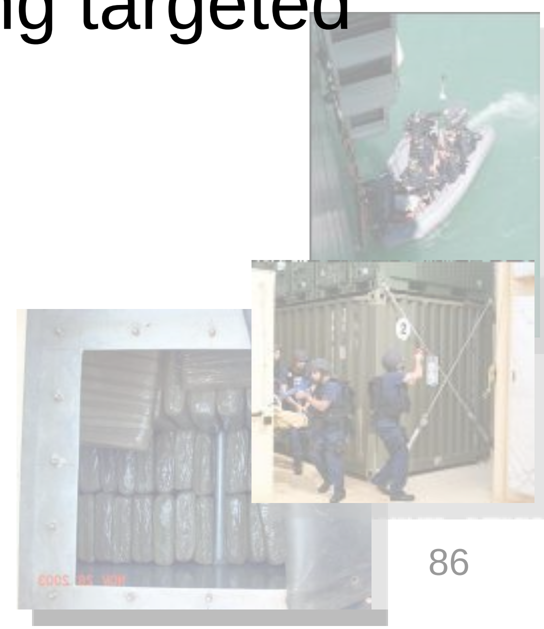
6.5.1 Detect suspected target cargo

6.5.2 Identify targeted cargo

6.5.3 Classify targeted cargo

Search the Suspect Vessel

- Measurement Of Effectiveness (MOE)
  - MOE S61: Time taken to search for targeted cargo for a given probability of detection.
  - MOE S62: Probability of detecting targeted cargo for a given search time.



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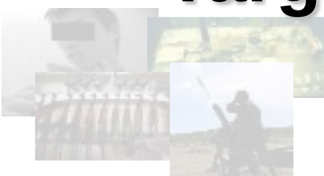
Identify Technology

Targets



Technology Available

<u>Technology Available</u>
- Ion Mobility Spectrometry
- Millimeter Wave
- Dogs or other animals
- x-ray or γ-ray
- Infrared (IR)
- Electromagnetic Waves

<u>Criteria</u>
- Advantage
- Limitation
  -> See through metal?
- Feasibility to bring sensor onboard suspect vessel

Technology Identified

<u>Technology Identified</u>
- Ion Mobility Spectrometry (IMS)
- Dogs

Ion Mobility Spectrometry (IMS)

- Good for Searching

~~Humans & animals~~	✓ **Narcotics**	~~Firearms~~	✓ **Explosives**

- How it works
  - Trace particles are left behind when explosives/narcotics are handled.
  - Detects and identifies trace amounts of substances.
  - Swabs are used to collect trace particles and analyzed in spectrometer.
  - Result will show whether traces of narcotics/explosives are present and also which type (if present).

- Limitations
  - A clean swab for every sample.
  - Battery Life.

- Feasibility for Shipboard Use
  - Fast -> Analysis Time of <30 sec.
  - Small and light.
  - In use with USCG.

Dogs

- Good for Searching

✓ Humans & animals	✓ Narcotics	~~Firearms~~	✓ Explosives

- How it works
  - Use keen sense of smell -> about 100,000 times stronger than a human being's.

- Limitations
  - Stamina is around 30 minutes.
  - Require long period of training.
  - Susceptible to seasickness.
  - Special logistic requirements.

- Feasibility for Shipboard Use
  - Dogs can be heavy but can still be hoisted onto the vessel using harness attached to them.

How Effective is the Equipment?

- Compare between unaided human eyes, IMS and Dogs.

- Analytic Search Models are used.
  - Exhaustive Search
  - Random Search

- Inputs
  - Number of Equipment: 1.
  - Search Area: 250m^2.
  - Sweep width and speed of movement.

- Measure
  - Time to search the entire suspect vessel.
  - Probability of Detection (Pd) achieved in a given search time of two hours.
  - Time taken to search the vessel in order to achieve a required Pd.

How Effective is the Equipment?

- Time to Search Entire Suspect Vessel

Equipment	Pd	Sweep Width (m)	Speed of Movement (m/s)	Area Searched (m^2)	Exhaustive Search Time (min)	Random Search Time (min)
Human Eyes	0.6	2	0.033	250	63	330
IMS	0.95	6	0.042	250	17	88
Dogs	0.95	2	0.1	250	21	110

- Simulation produces same conclusion.

How Effective is the Equipment?

- Probability of Detection Achieved for a Given Time to Search

Equipment	Sensor Pd	Sweep Width (m)	Speed of Movement (m/s)	Area Searched (m^2)	Max. Pd Achieved in 2 hours	
					Exhaustive Search	Random Search
Human Eyes	0.6	2	0.033	250	0.82	0.41
IMS	0.95	6	0.042	250	1	0.95
Dogs	0.95	2	0.1	250	1	0.95

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How Effective is the Equipment?

- Time Needed to Search Suspect Vessel to Achieve a Given Probability of Detection

Equipment	Sensor Pd	Sweep Width (m)	Speed of Movement (m/s)	Area Searched (m^2)	Time (min) to Achieve Pd of 0.95	
					Exhaustive Search	Random Search
Human Eyes	0.6	2	0.033	250	204	N/A
IMS	0.95	6	0.042	250	17	91
Dogs	0.95	2	0.1	250	21	115

How Effective is the Equipment?

- Main Takeaways from Models:
  - IMS and dogs improve search over using unaided human eyes.
  - The improvement (in terms of time taken to search and probability of detection) by IMS over dogs are insignificant.

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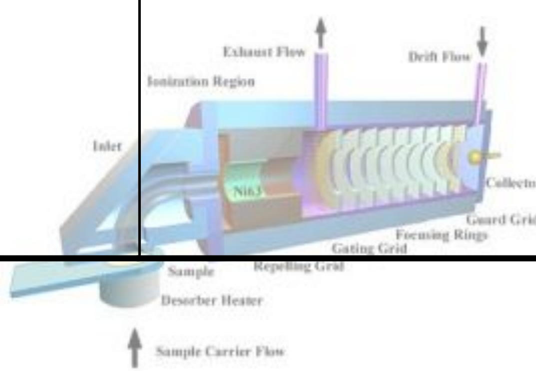
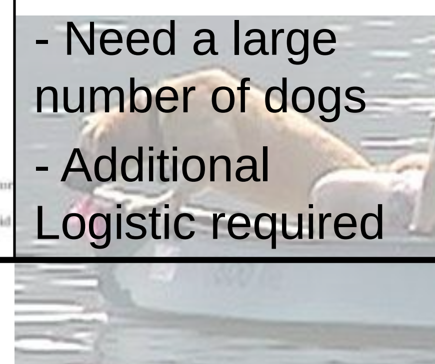
Conclusion

	IMS	Dogs	Human Eye
Human & Animals		x	x
Illicit Narcotics	x	x	x
Firearms			x
Explosives	x	x	x
Advantage	- Portable	- Proven - Portable	- Widely available
Limitations	- Need Traces	- Need Traces - Seasick - Need a large number of dogs - Additional Logistic required	- Cannot see thru' wall - Slow





Technology Implementable in Not Too Distant Future

- Show great potential in improving the effectiveness of search, but foreseen not to produce any equipment by 2013-2014 that are suitable for MIO.

	γ / x-ray	**MMW**
Human & Animals	x	x
Illicit Narcotics		
Firearms	x	
Explosives		x
Advantage	- See thru' Metal	- No radiation - Portable
Limitations	- Not easily portable - Human exposed to radiation	- Unable to see thru' Metal

Agenda (contd)

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Information Superiority

Team Lead: Eric Boernke

Cheng Hoe Kee
Kah Wei Ho
Eng Siong Ng
Chuan Lian Koh
Choong Wee Cheong
Virginia Taylor

Functional Decomposition

- Information Superiority
  - 7.1 Collect Information
    - 7.1.1 Microscopic Intelligence
      - 7.1.1.1 Biometric Collection
      - 7.1.1.2 Non-networked Computer Exploitation
    - 7.1.2 Macroscopic Intelligence
  - 7.2 Transmit Information
    - 7.2.1 External Communications
    - 7.2.2 Internal Communications

Biometric Data Collection

Biometrics

- Technology used for measurement and analysis of physiological characteristics for identification and verification purposes
  - Fingerprints
  - Irises
  - Voice patterns
  - Facial patterns
  - Hand measurements

Source: Court Technology Lab, National Center for State Courts

Why use Biometrics?

- Use of biometrics for identification and verification has became increasingly affordable and accurate.

- Biometrics can help to speed up the process of identification and verification significantly

Types of Biometrics

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BIOMETRICS COMPARISON CHART

Biometric	Verify	ID	Accuracy	Reliability	Error Rate	Errors	False Pos.	False Neg.
Fingerprint	✓	✓	◎◎◎◎	▶▶▶	1 in 500+	dryness, dirt, age	Ext. Diff.	Ext. Diff.
Facial Recognition	✓	✗	◎◎◎	▶▶	no data	lighting, age, glasses, hair	Difficult	Easy
Hand Geometry	✓	✗	◎◎◎	▶▶	1 in 500	hand injury, age	Very Diff.	Medium
Speaker Recognition	✓	✗	◎◎	▶	1 in 50	noise, weather, colds	Medium	Easy
Iris Scan	✓	✓	◎◎◎◎	▶▶▶	1 in 131,000	poor lighting	Very Diff.	Very Diff.
Retinal Scan	✓	✓	◎◎◎◎	▶▶▶	1 in 10,000,000	glasses	Ext. Diff.	Ext. Diff.
Signature Recognition	✓	✗	◎◎	▶	1 in 50	changing signatures	Medium	Easy
Keystroke Recognition	✓	✗	◎	▶	no data	hand injury, tiredness	Difficult	Easy
DNA	✓	✓	◎◎◎◎	▶▶▶	no data	none	Ext. Diff.	Ext. Diff.

Biometric	Security Level	Long-term Stability	User Acceptance	Intrusive	Ease of Use	Low Cost	Hardware	Standards
Fingerprint	▶▶▶	▶▶▶	▶▶	Somewhat	▶▶▶	✓	Special, cheap	Yes
Facial Recognition	▶▶	▶▶	▶▶	Non	▶▶	✓	Common, cheap	?
Hand Geometry	▶▶	▶▶	▶▶	Non	▶▶▶	✗	Special, mid-price	?
Speaker Recognition	▶▶	▶▶	▶▶▶	Non	▶▶▶	✓	Common, cheap	?
Iris Scan	▶▶▶	▶▶▶	▶▶	Non	▶▶	✗	Special, expensive	?
Retinal Scan	▶▶▶	▶▶▶	▶▶	Very	▶	✗	Special, expensive	?
Signature Recognition	▶▶	▶▶	▶▶	Non	▶▶▶	✓	Special, mid-price	?
Keystroke Recognition	▶▶	▶	▶▶▶	Non	▶▶▶	✓	Common, cheap	?
DNA	▶▶▶	▶▶▶	▶	Extremely	▶	✗	Special, expensive	Yes

Source: Biometric Comparison Chart (from Court Technology Lab, National Center for State Court)

Data sizes

- Facial Image – 15KB to 20KB
- Fingerprint – 10KB per finger
- Iris – 30KB per eye
- Estimated total data per person is 100KB

Source: “Technical Advisory Group on Machine Readable Travel Documents” page 25 to 31, *ICAO TAG-MRTD/17-WP/16*, 1 June 07

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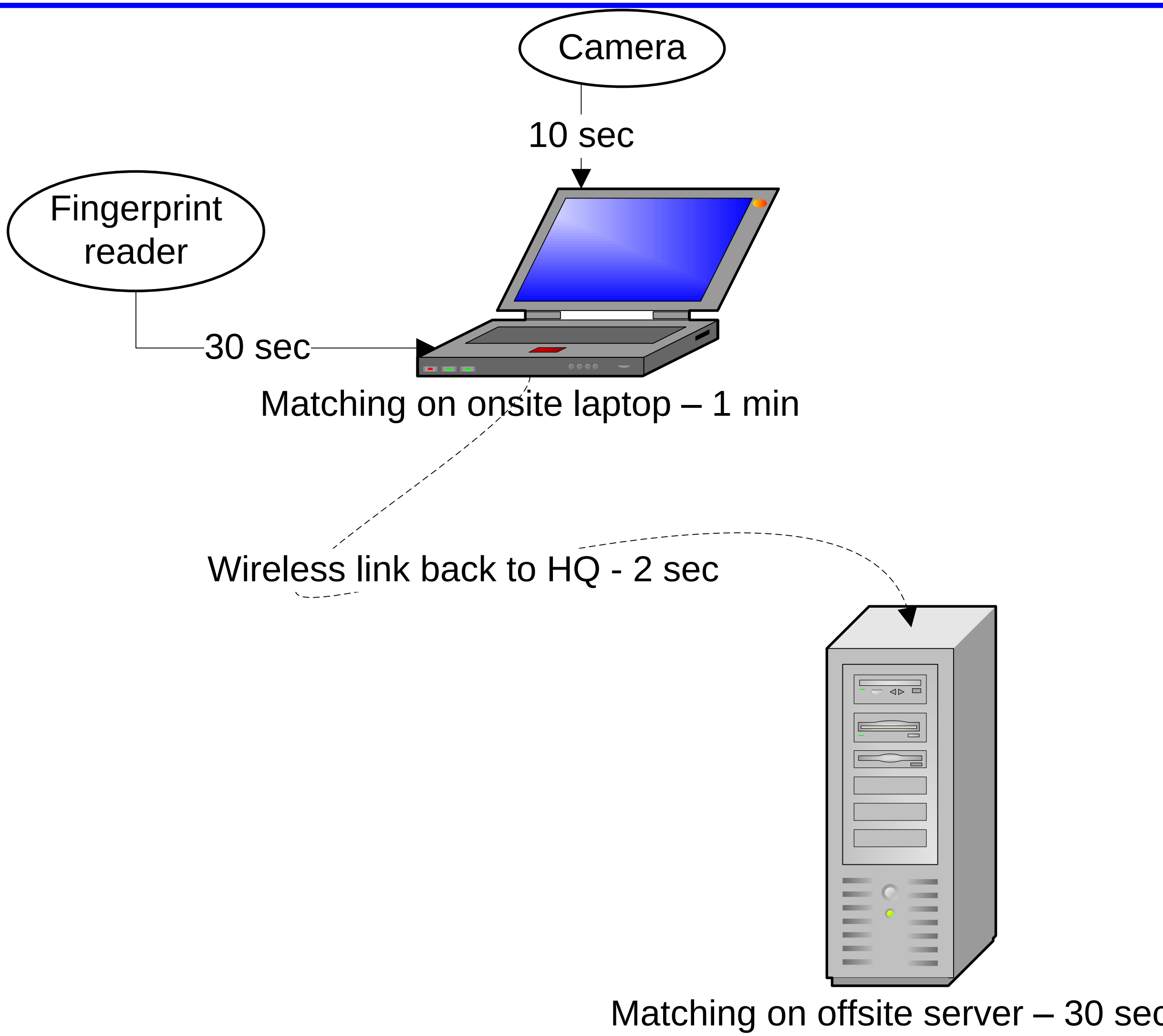
Proposed Solution #1 – Self develop



Proposed Solution #2 - IBIS

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Source: “IBIS Mobile Identification System”, L-1 Identity Solutions,

Proposed Solution #3 - HIIDE

Source: "Hand-Held Interagency Identity Detection Equipment", L-1 Identity Solutions and NIST XML & Mobile ID Workshop, DOD biometrics Task Force

HIIDE in Use

Recommended Solution

- HIIDE - $10,000 each
- Support both fingerprint and iris biometric
- Integrated facial image capture
- Single device solution
- Portability – less than 2.5lbs, 8” x 5” x 3”
- Supportability & Maintainability – Single vendor

Non Networked Computer Exploitation

Steps

- Access System
  - Accessing Operating System and file system
- Gathering and Collecting Relevant Information
  - DOcument & Media EXploitation (DOMEX)

Challenges

- Wide Range of Skills Required
  - Operating System specific skills to hack into the system on board
  - Cracking encrypted files
  - Domain Knowledge for information to be sought
  - Analytic skills

Challenges

- Wide Range of Skill Required
  - Softskill to complete task within time and tools constraint
    - Efficiency
    - Meticulousness
- Automated DOMEX still very much under research

Challenges

- Difficult to gauge time needed for non networked exploitation
  – Depends on
    - State of system to exploit (OS type, security state)
    - State of information (encrypted, non encrypted)
    - Skillset/Experience of Forensic Investigator
    - Cooperation of ship crew
    - Depth of exploitation

Challenges

- *"For example, in 2005 the United Kingdom passed legislation extending the time that terrorism suspects could be held without being charged from 14 days to 90 days, in part because the two weeks provided by the previous terrorism law did not provide sufficient time for the forensic analysis of a typical hard drive."*

Prof. Simson L. Garfinkel

"Document and Media Exploitation"

Recommendation

- Most optimal to
  - clone the disk in question or
  - seize the system to perform an offsite analysis in the forensic lab and with support of more forensic staff.
- Take a forensic expert along to attempt to do some real-time hacking only if intelligence exists that doing so will be fruitful.

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Intel Utilization

- Macroscopic Intelligence (regarding the identification/location of all vessels in the maritime environment) is collected by organic or inorganic assets.
- ESG staff onboard LHD fuses this with the microscopic intelligence collected by the boarding teams.
- Decisions are made based on their analysis as to the next boarding.
- Could switch from Phase 1 to Phase 0 based on collected intelligence.

External Communications

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External Communications - Objectives

- Set up ship-to-ship communication links for boarding team to communicate back to mother ship once the team is onboard the interdicted target ship.
- Set up ship-to-global communication links for mother ship to communicate with global MIO partners or stakeholders over the internet.

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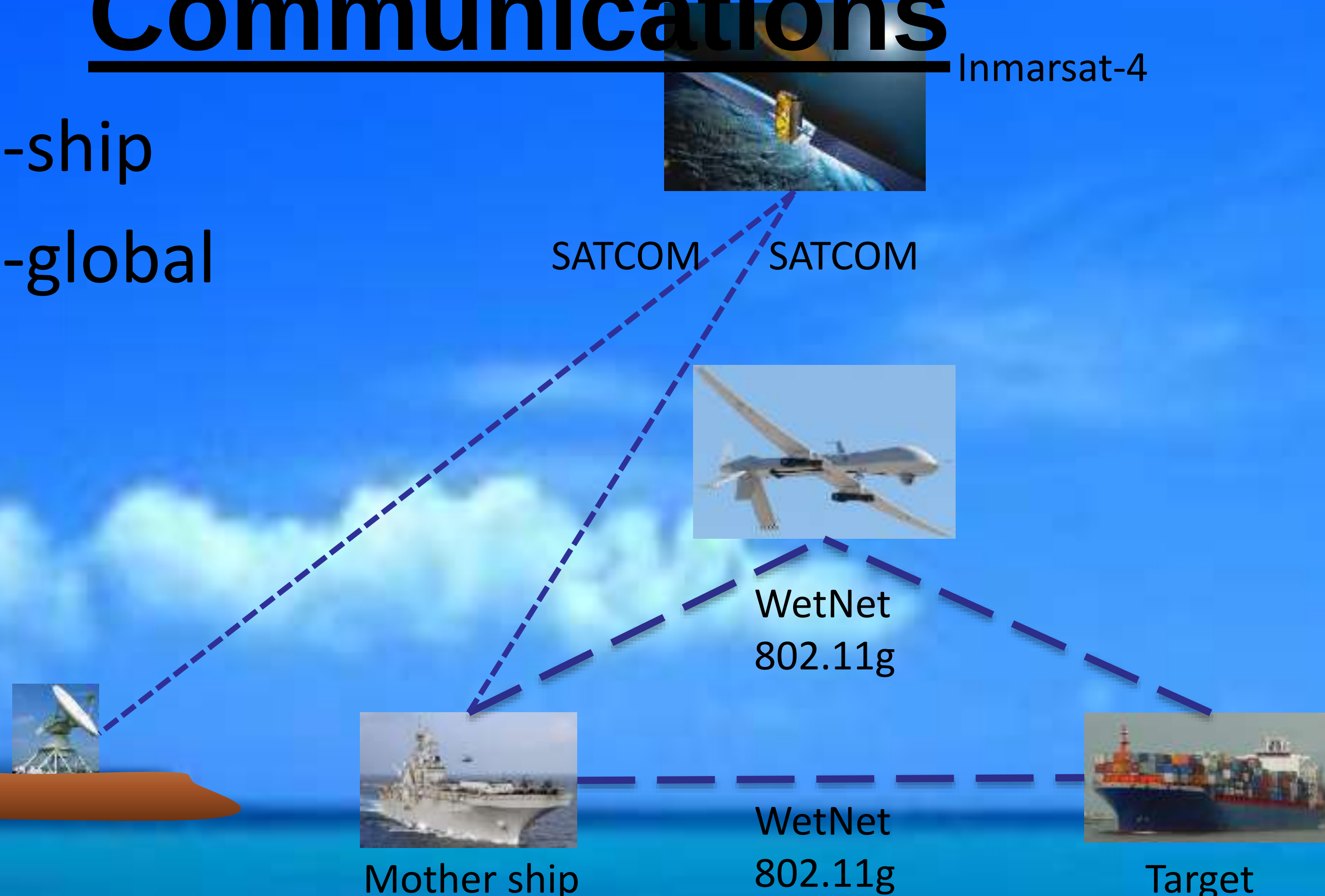
MIO External Communications

-Ship-to-ship

-Ship-to-global



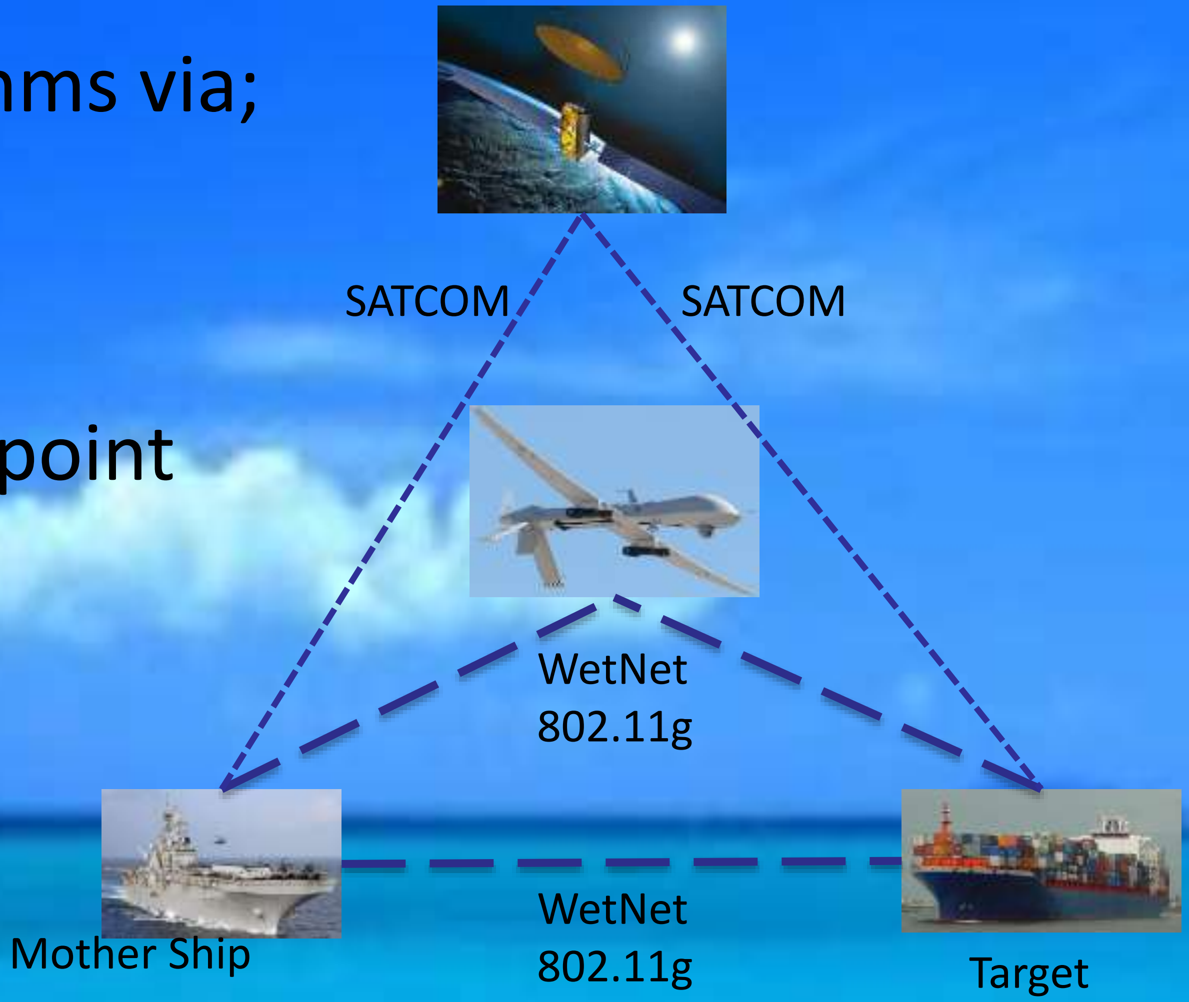
Alternative Architecture for Ship-to-Ship Communications

Ship-to-ship comms via;

-Satellite

-UAV (As relay)

-Direct point-to-point



Comparison of Options for Ship to Ship Communications

Comparison Factors	Point to Point	UAV Relay	Satellite Relay
Reliability	Relatively more reliable compared to using relays since there are no additional points of failure	Introduces an additional point of failure compared to point to point option.	Introduces an additional point of failure compared to point to point option.
Cost	Relatively lower cost compared to using relays since less assets are required	Relatively cheaper than using satellite relays and offers synergy with the planned use of UAV for other MIO functions	More expensive than using UAV relays
Recommendation	Recommended when mother ship is within line of sight (LOS) of target ship	Recommended for use when mother ship is beyond LOS of target ship	Not recommended for MIO ship to ship communications

Ship to Ship - WetNet

- An IP-based network radio system by Harris Corporation, based on the IEEE 802.11g protocol and operates at a maximum data rate of 54Mbps.

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Ship to Ship – WetNet

- Benefits of WetNet technology
  - Available in both civilian and commercial frequency bands
  - Compatible with standard IP addressing and network topologies
  - Standard Ethernet-based physical device interfaces
  - Robust
    - Cyclic Redundancy Check encryption
    - Automatic Repeat Query packet delivery
    - Orthogonal Frequency-Division Multiplex

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Ship to Global – Maritime Broadband

- Maritime broadband services support
  - Can Achieve High Speed Maritime Communications
  - Kit can be installed on vessels of partner nations
- Inmarsat 4 satellites
  - Inmarsat 4 F1 (Launched Mar 05)
  - Inmarsat 4 F2 (Launched Nov 05)
  - Inmarsat 4 F3 (Early 08)

Ship to Global- Fleet Broadband Coverage

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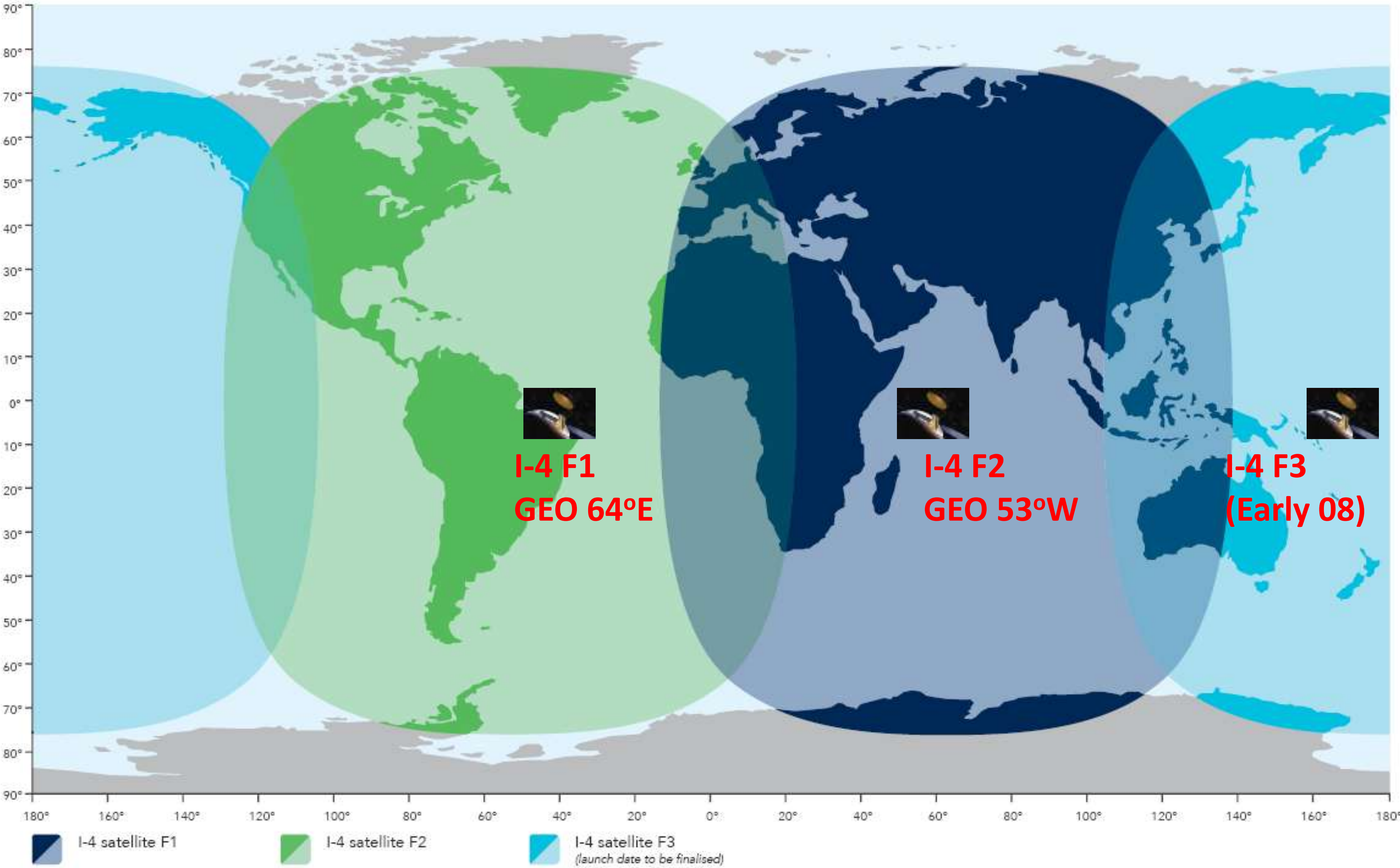

MOE & MOP

- **The MOE is based on tracking of the amount of downtime of communication links during actual operations.**

- **The MOP proposed for the external communications;**
  - **Time required to transmit different sizes of the data across the communication links.**
  - **The error rates of the communication links.**

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Performance Analysis Example

# People	Size of Data	Transmission Method	One-way Transmit Time
10	4.16 MB	WetNet	.77 sec
		Inmarsat	15.4 sec
100	41.6 MB	WetNet	7.7 sec
		Inmarsat	154 sec
1000	416 MB	WetNet	77 sec
		Inmarsat	25 min

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Recommendations/ Suggestions

- The recommendations for the external communications is to set-up the ship-to-ship communications using WetNet technology and engage the Fleet broadband services provided by Inmarsat for the ship-to-global communications. This provides seamless communications in a Rician faded spectrum for all parties involved during MIO operations.

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Internal Communications

- Requirements
  - Pass audio communications in Rayleigh faded environment
  - Sufficient link margin to support networking devices
  - Relay capability
- NPS Thesis compared four different radios' performance under adverse channel conditions.
- Trellisware Radio system determined to be vastly superior

Agenda (contd)

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- Information Superiority
- Intercept
- Logistics and Costing
- Modeling and Simulation
- Conclusions

Intercept

Team Lead: MAJ TEO, Hoon Hong (Crafty)

CHUA, Weng Heng
KAM, Khim Yee
KOH, Leong Kar
LIM, Lee Tat Rudy
NEO, Say Beng
SOH, Mun Lok
TAN, Sharon

Objectives

- Intercept detected threats
- Disable non-compliant threats

Functional Decomposition

8.1 Intercept

- 8.1.1 Intercept Level 1 adversaries
- 8.1.2 Intercept Level 2 & 3 adversaries
- 8.1.3 Intercept Level 4 adversaries
- 8.1.4 Protect the boarding team (post boarding)

Functional Decomposition

8.2 Disable

- 8.2.1 Determine Weapons Availability
- 8.2.2 Match Weapons to Targets
- 8.2.3 Determine Weapons Payload
- 8.2.4 Utilize Appropriate Weapon
- 8.2.5 Assess Battle Damage

MOE / MOP for Intercept and Disable System

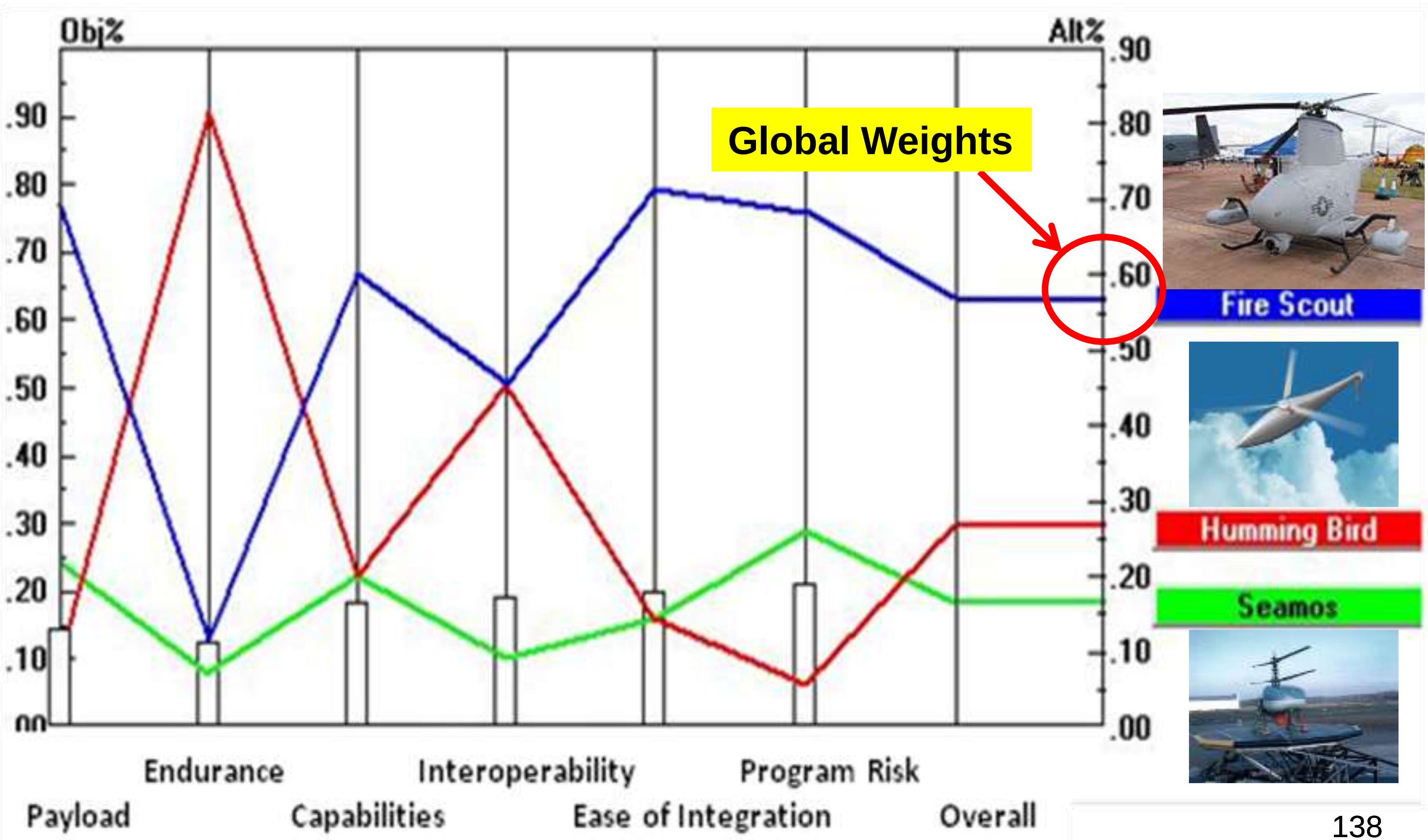
- MOE
  - Number of suspect vessels successfully interdicted
  - Number of adversary casualties
- MOP
  - Probability of disabling a threat
  - Time to disable
  - Number of weapons required to disable

Approach

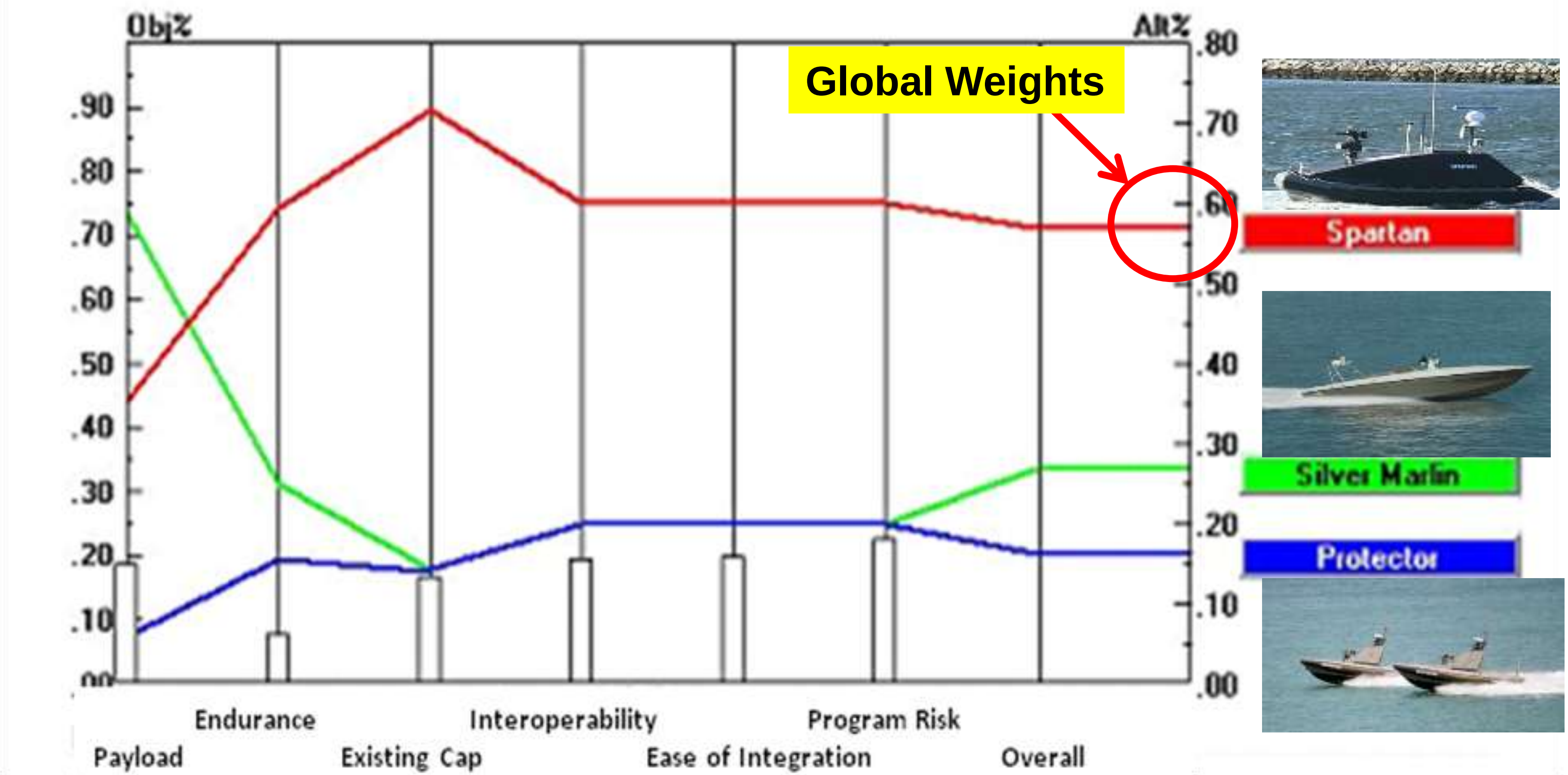
- Develop intercept CONOPS
- Trade studies on UAV, USV and weapons selection using Analytical Hierarchy Analysis*
- Note: All selections meet requirements

*Expert Choice Software

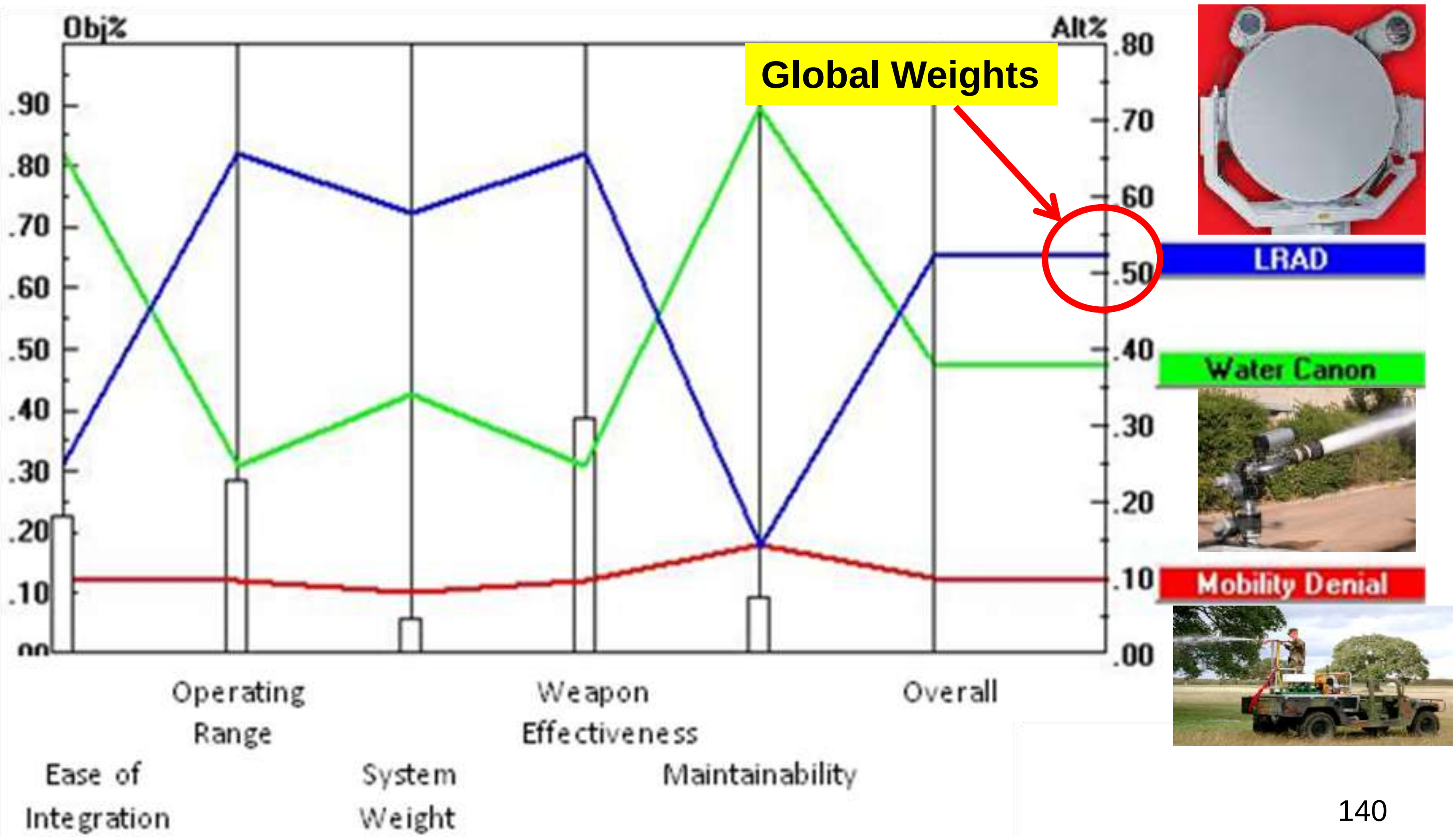
UAV Selection



USV Selection



Non-Lethal Weapons Selection



Platform-Weapon-Target Matrix

Platform	Target	Weapon Type	Weapon System
Fire Scout	Platform	Non-Lethal	
		Lethal	Hellfire[1]
Spartan	Personnel	Non-Lethal	LRAD 1000
		Lethal	7.62mm Gun[1]
	Platform	Non-Lethal	MK 11 static RGES[2]
		Lethal	7.62mm Gun Hellfire or Javelin (under development)

[1]No selection required as it is the weapon undergoing integration with the platform.

[2]No selection required as it is the only non-lethal weapon available.

Recommended Configurations

Mission	Equipment	
ISR	ISR	EO/FLIR Systems (Brightstar III) Laser Range Finder
	Weapon	Nil
Disabling	ISR	EO/FLIR Systems (Brightstar III) Laser Range Finder
	Weapon	Hellfire Missile (planned)

MQ-8B Fire Scout Configuration

Mission	Equipment	
ISR, Disabling, Warning Fire, Support Fire	ISR	EO/FLIR Systems Chemical/Biological Detector Laser Range Finder
	Lethal	GAU-17 7.62 Gun Hellfire Missile (under development) or Javelin Missile (under development)
	Non-Lethal	Long Range Acoustic Device (LRAD) MK11 Static RGES

Spartan USV Configuration

Agenda (contd)

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- Conclusions

Logistics

Team Lead: Roy de Souza

Hui-Ling Chen
Labrisha Mason
Mike Matson
Lu Pin Tan

Scope

- Approach
- Team Logistics Functional Decomposition
- Findings
- Functional Areas
- Performance Measurements
- Cost Estimation

Approach

- Application of the Systems Engineering Process
  - Derivation of an Aim Statement
  - Derivation of the Need Statement
  - Functional Decomposition of Logistics
  - Performance Measurements
  - Assumptions

- Global Overview

- Specialist Approach from Functional Decomposition

Functional Decomposition

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Logistics for MIO

To Transport

To Maintain

To Supply

Global & Specialist Approach

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Step 1

Region 1	Region 2	Region 3	Region 4
Transportation	Transportation	Transportation	Transportation
Maintenance	Maintenance	Maintenance	Maintenance
Supply	Supply	Supply	Supply

Step 2

Transportation

Region 1
Region 2
Region 3
Region 4

Maintenance

Region 1
Region 2
Region 3
Region 4

Supply Chain

Region 1
Region 2
Region 3
Region 4

Findings

Minimize the Impact of Long Support Turnaround

1) Enhance Support for Mission Critical Systems
   a. Buffer for Common Faults via Common Faults Analysis

2) Establish Forward Logistics Support
   a. Continuation of Supply Nodes Concept
   b. Specialized Forward Maintenance Teams

Develop Robust Data Feedback System

1) Covering Logistics Status of Supply, Maintenance and Transportation
   a. Condition Monitoring of Equipment
   b. Supply Stockage Levels

Challenges

- Determining how Logistically Barren shapes MIO as compared to any other Maritime Operations
  - What's new?
  - What's different?

- Open source data:
  - Too generalized
  - Lack of current detailed logistic examples

- Pinpointing the customer's need
  - Who are the customers?
  - How will those needs be met?
  - What is most important, Why?

Supply Concept

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Pre-deployment Supply Phase (In-port)

Cargo from
manufacturer

Supply Hub

Cargo delivered
to customer

Logistic Sustainment At Sea

Cargo from
Supply Node

Sea /Air Transportation

Cargo delivered
to customer

Supply Phase by Phase

- **Phase 0 : Shape the Battle Space**
  - Procurement of needed supplies
  - Pre-deployment replenishment (pier-side)
  - Planning begins for sustained logistics operations
  - Assess storage capacity in OPAREA

- **Phase 1 : Deterrence**
  - Identify overseas logistics nodes
  - Replenishment at Sea (RAS) operations begin
  - Temporary storage facilities in OPAREA instituted

Transportation Concept

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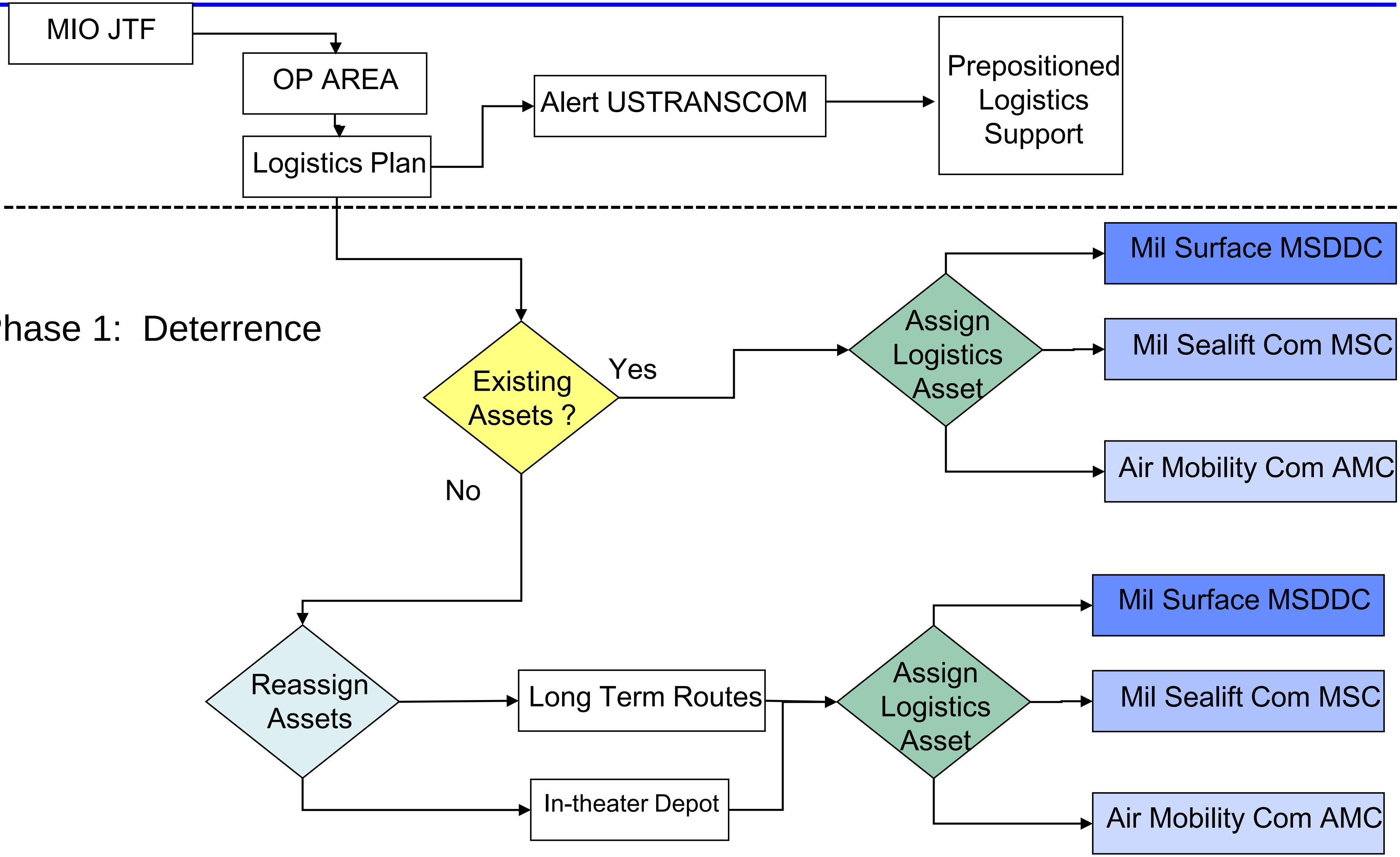
Phase 0: Shape the Battle Space

Phase 1: Deterrence



Transportation: Phase by Phase

- Phase 0: Shape the Battle Space
  - Alert USTRANSCOM (MSDDC, MSC, AMC)
  - Conduct operator refresher on common faults
  - Establish Land / Air / Sea requirements for required range and depth of supplies to be stocked at identified supply nodes from OEMs / other supply nodes
  - Establish Land / Air / Sea requirements between identified supply nodes to the port of departure
  - Establish Land / Air / Sea requirements between identified supply nodes to the designated re-supply area (at sea)
  - Determine mission essential assets to be put on reserve list for low availability / long downtime assets

- Phase 1: Deterrence
  - Monitor Logistics Report Status (Transportation)
  - Understand the availability of equipment for the next phase and activate reserve assets (if required)
  - Coordinate Land / Sea / Air assets for sustenance operations

Maintenance Concept

Repair: Conduct Both Preventive and Corrective Maintenance in MIO Environment

Preventive Maintenance

- Decrease Repair Time
- Increase Operational Availability

Corrective Maintenance

- Decrease Repair Time
- Increase Operational Availability

Maintenance: Phase by Phase

- Phase 0 : Shape the Battle Space
  - All equipments are in readiness for the operations
  - Determine the optimum packages, spares and personnel needed for maintenance before setting off from port
- Phase 1 : Deterrence
  - Maintain all equipments in good state for the operations
  - Plan for fastest way to get maintenance gears and personnel to keep systems in effective operational state

Supply-Transportation Network

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OEM → Supplier → Supply Node (Land) → Supply Node (Port) → Supply Ship → End User

Transport Time		5 days		2 days		2 days		2 days		15 days
Wait Time	30 days		1 day		1 day		1 day			

Performance Measures

- Computation of the Supply-Transportation Network (from the designated Area of Operation)

  – Push Method = **29** days (Nominal Value)
    - Scheduled Resupply

  – Pull Method = **64** days (Nominal Value)
    - Includes the ad hoc manufacturing time
    - Coordination time required

Phase 0
Logistic Regression Helo

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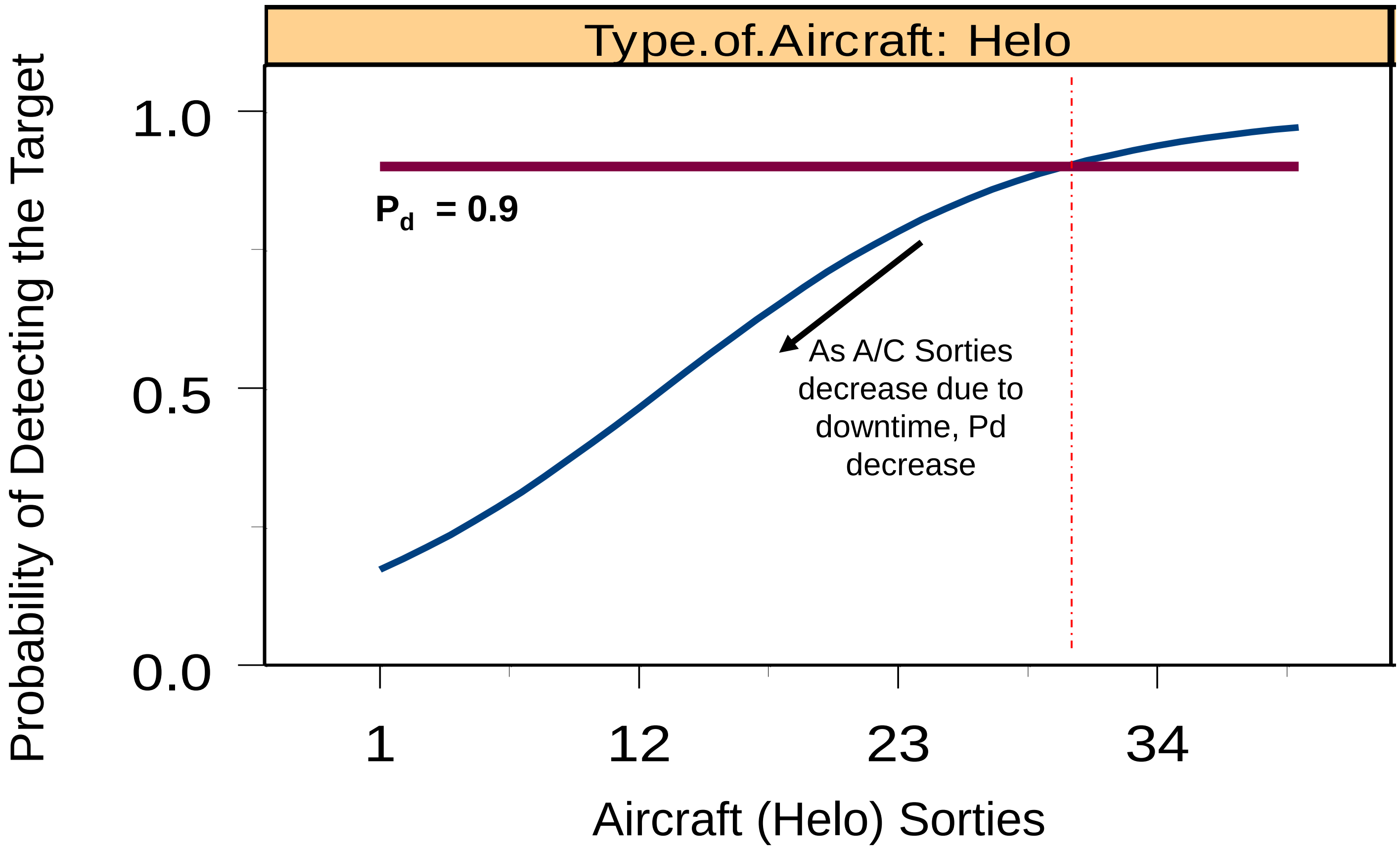
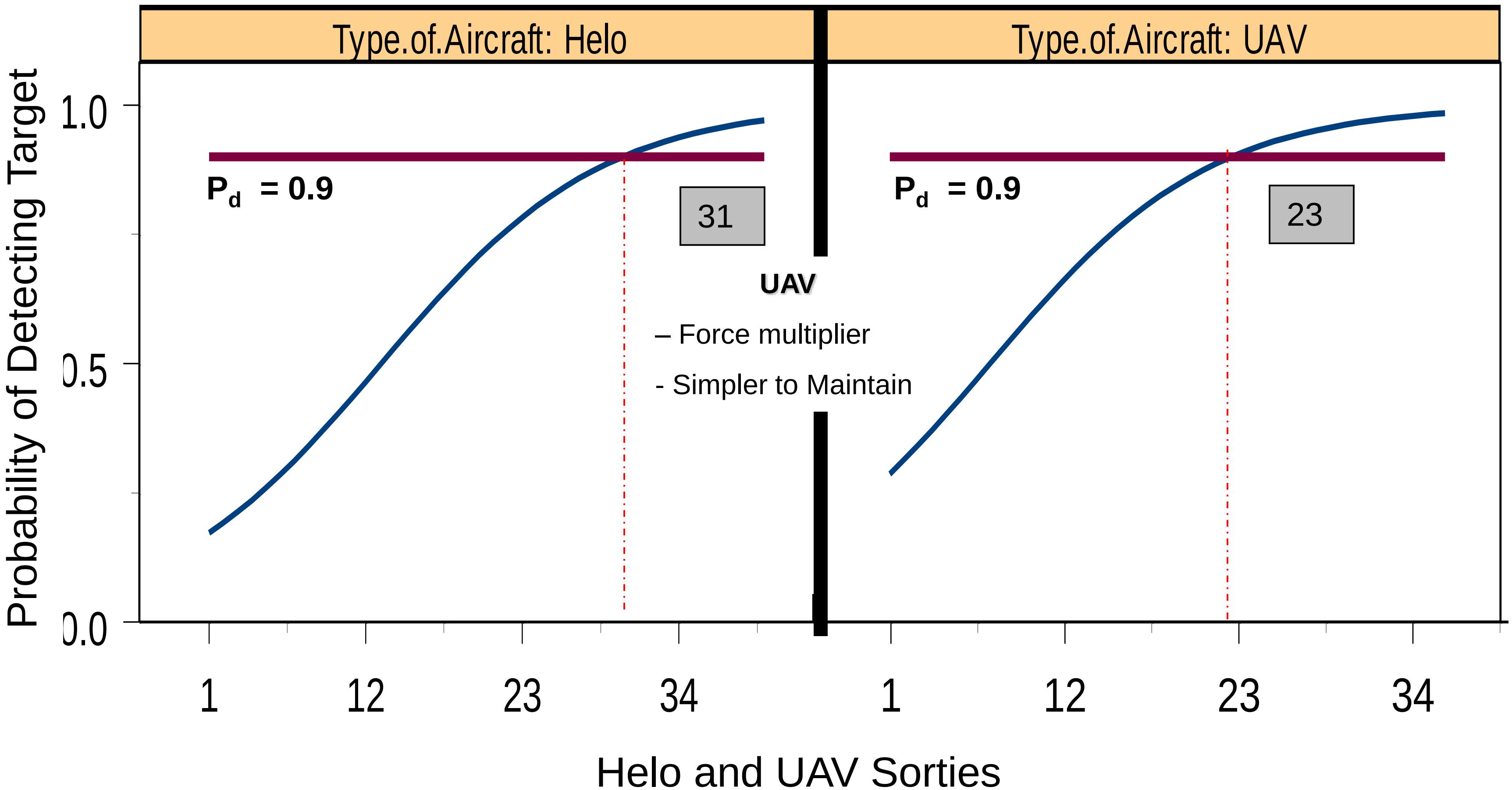


Logistics Barrenness is depicted by the inability to acquire the required Helo Sorties due to maintenance downtime

Phase 0
Logistic Regression Helo and UAV



Phase 0 - Logistic Regression (Ships)

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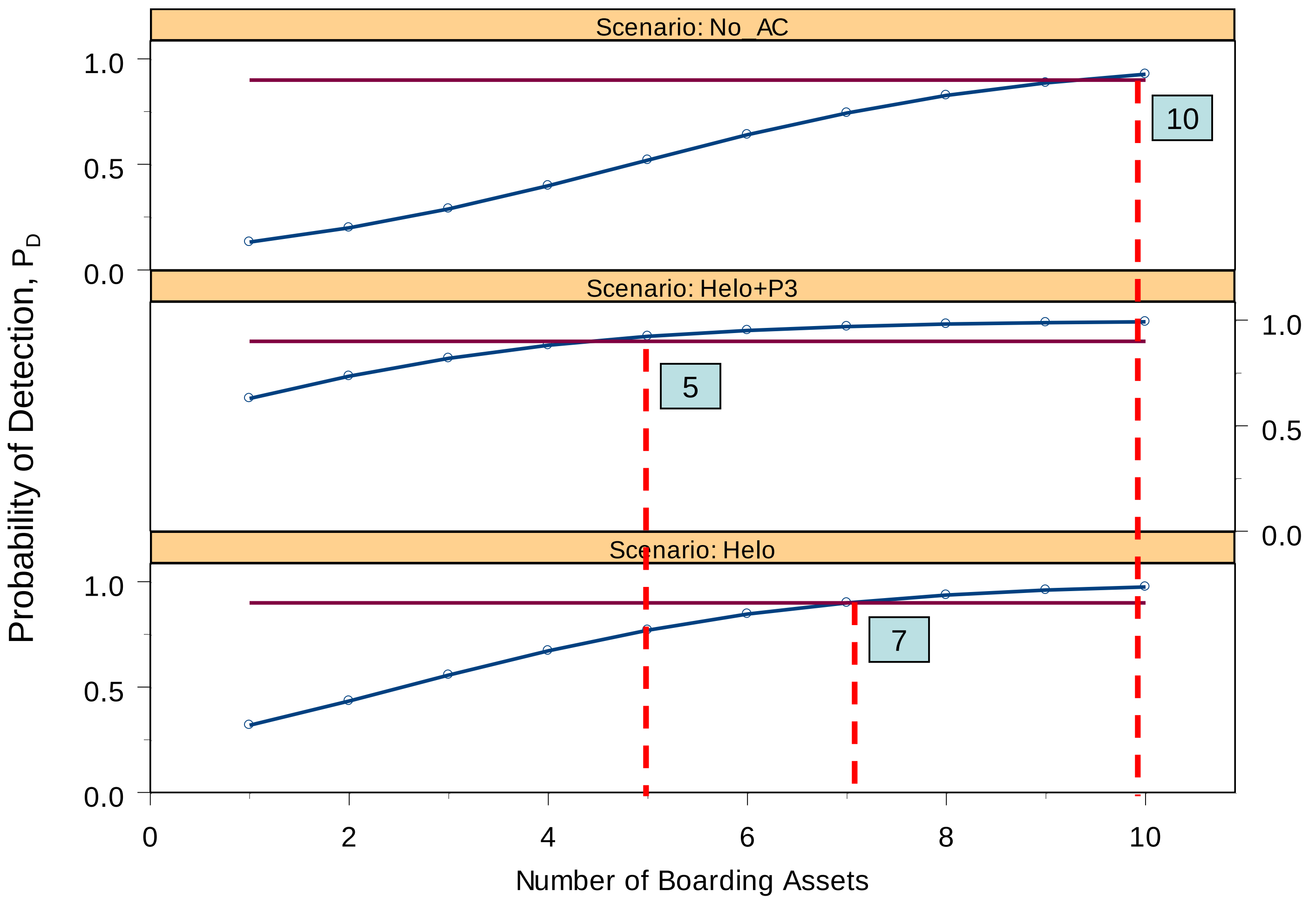

P_D = 90%

Phase 1 - Logistically Barren

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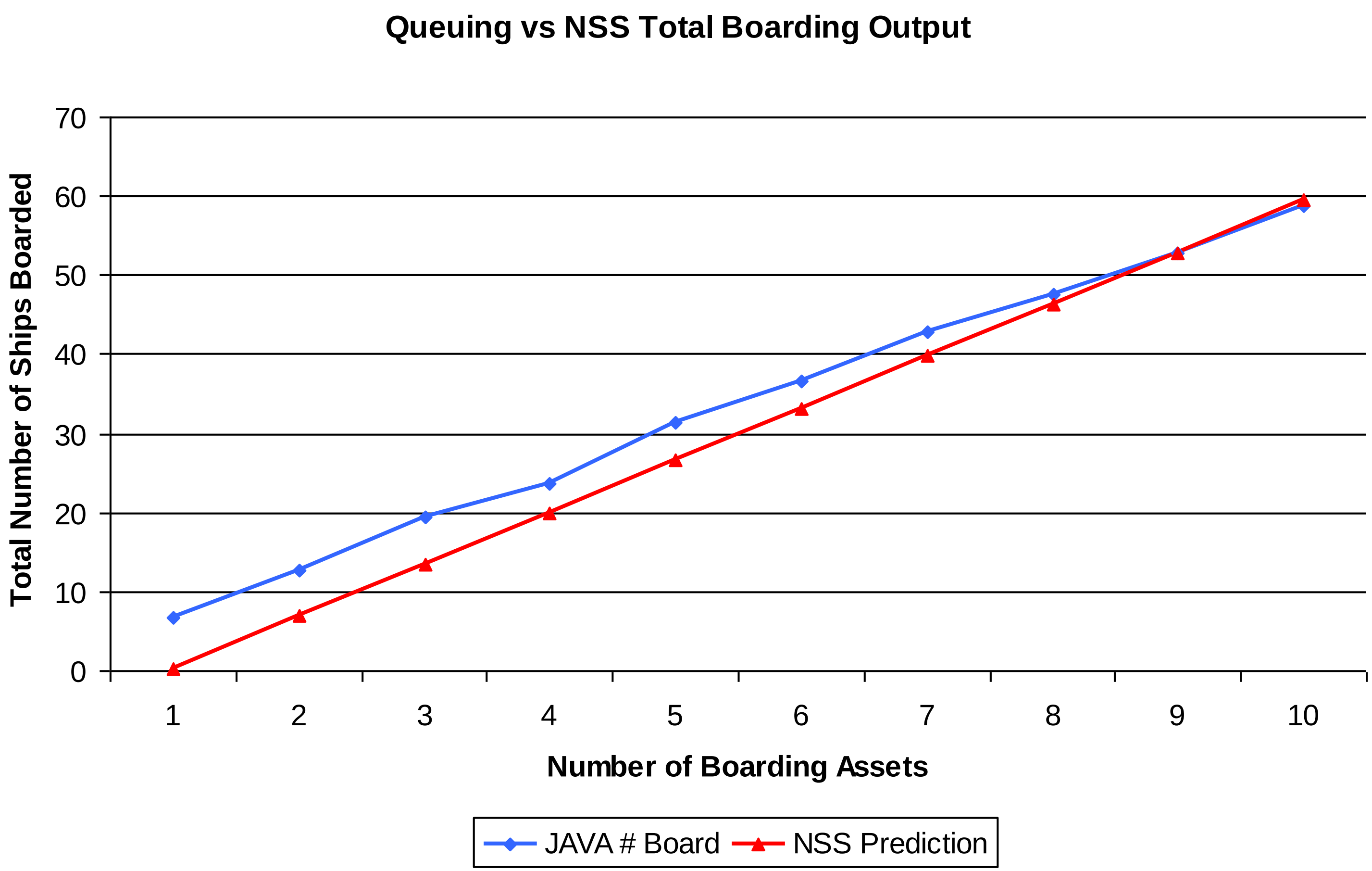

Assumptions for Cost Estimation

- Duration of Estimates
  - Estimates done for the number of interdiction operations and the duration for the period of estimates
- Récurrent Versus Non-Récurrent Cost
  - Operations and Support costs are considered for current existing equipment
  - Procurement Costs are considered for equipment to be procured, and subsequently, the Operations and Support costs for the follow up 30 days of operations
- Fiscal Year Tabulation
  - Cost estimates are calculated in the fiscal year of 2008 (FY08$)

Cost Estimation

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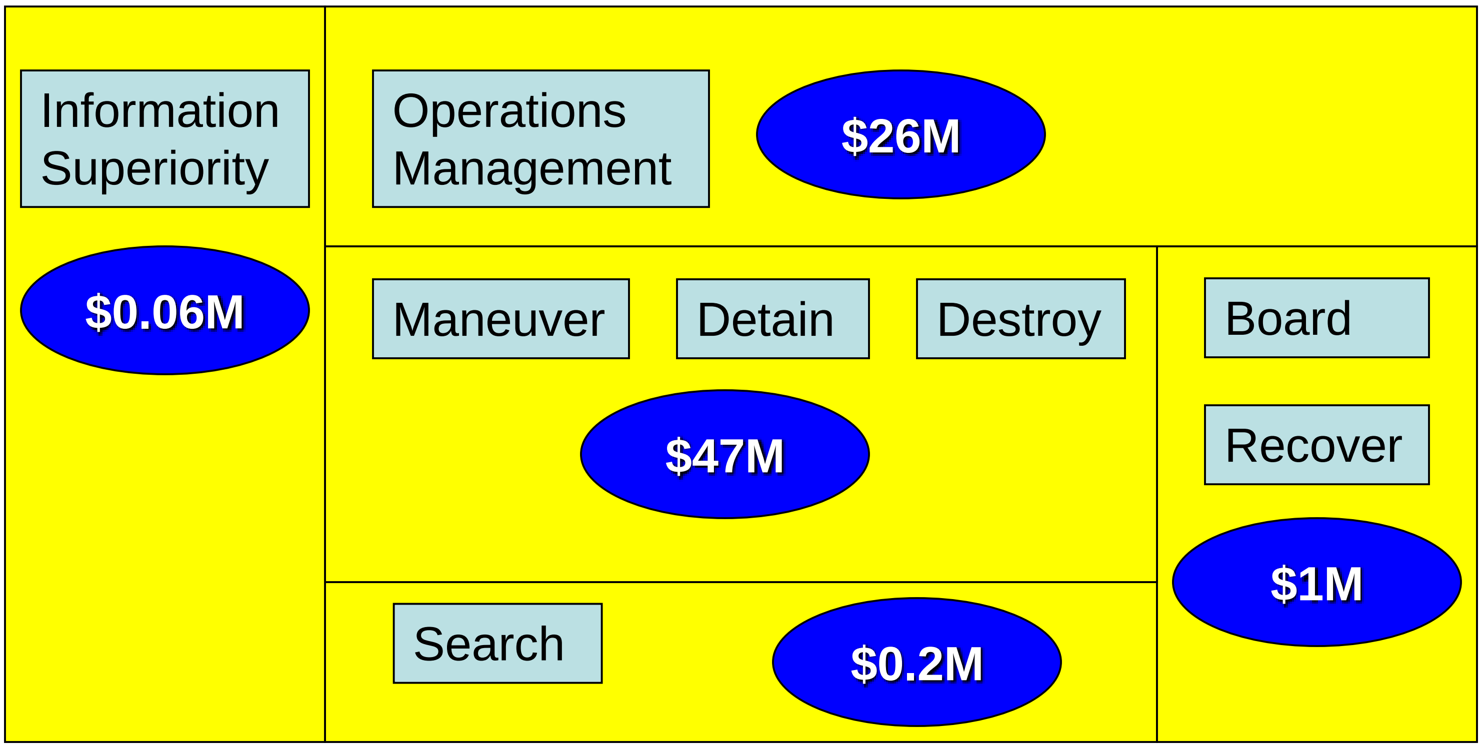
- By Functional Areas for first 30 days



$74.26M

Details in the BreakOut Session…….

Cost Estimation

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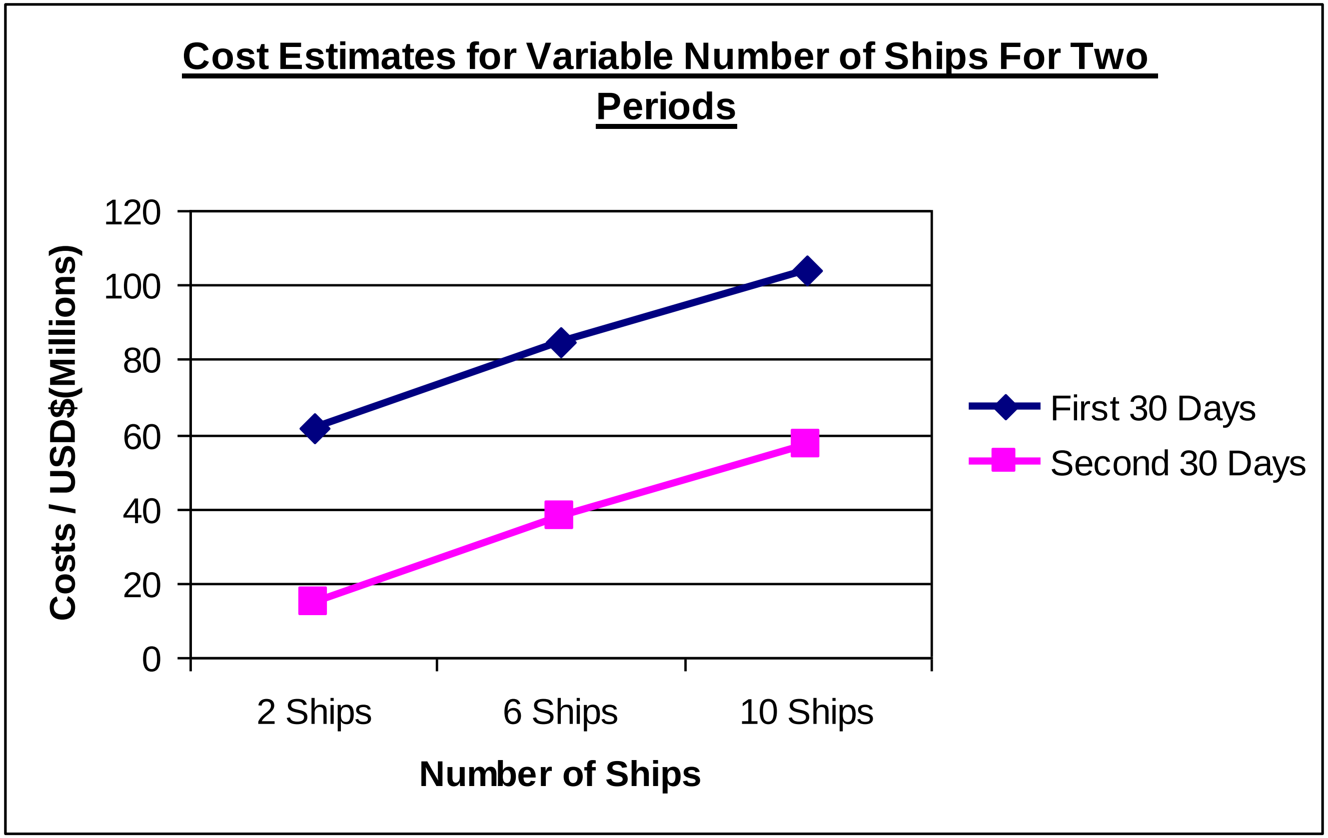
- Variables
  - Number of Ships (2 Ships, 6 Ships and 10 Ships)
  - First 30 days, Second 30 days



USD$22,000 per MIO for 2 x Ships

SEA-13 MARITIME INTERDICTION OPERATIONS

Agenda (contd)

- Scenarios and Operations Mgmt
- Boarding and Recovery
- Search
- Information Superiority
- Intercept
- Logistics and Costing
- Modeling and Simulation
- Conclusions

Modeling and Simulation Group

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Team Members:

Kong Pin Foo
Yew Heng Kwok
LT Brett LeFever
Hoe Wai Leong
ENS Abel Marten
Kim Soo Ong
LCDR Walt Sandell
ENS Andrew Turo
Teck Hwee Wong

MANA Modeling:
Boarding Team Search

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Search Model Variables

Ship Type

1) Cargo Dhow (26 x 9 meters)
2) Container Ship (121 x 25 meters, first level only)

Sensor

1) Visual search, inspectors using only eyeballs
2) Inspectors using an Ion Mobility Spectrum (IMS) based detector

Number of Search Teams (one team = pair of inspectors)

1) Two search teams
2) Three search teams

Eight Different Search Model Permutations

Search Permutation #	Ship Type	Sensor	# of Search Teams
1	Cargo Dhow	Visual	2
2	Cargo Dhow	Visual	3
3	Cargo Dhow	IMS	2
4	Cargo Dhow	IMS	3
5	Container Ship	Visual	2
6	Container Ship	Visual	3
7	Container Ship	IMS	2
8	Container Ship	IMS	3

Cargo Dhow Layout
(26 x 9 meters)

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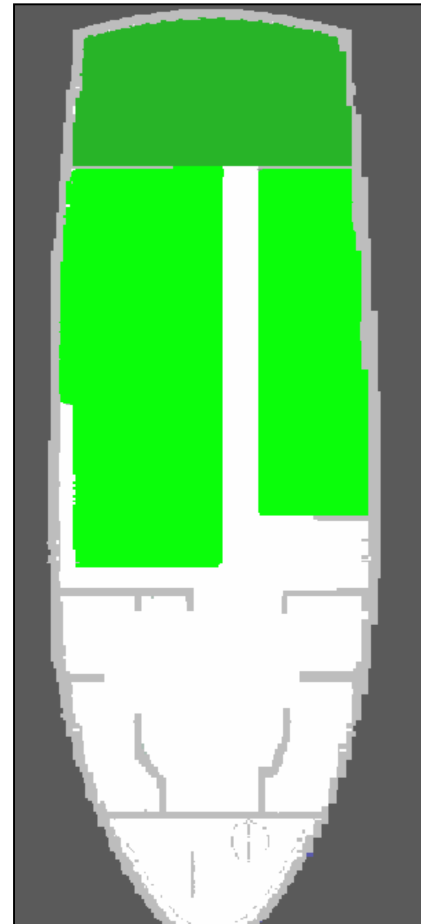

Container Ship Layout (121 x 22 meters)

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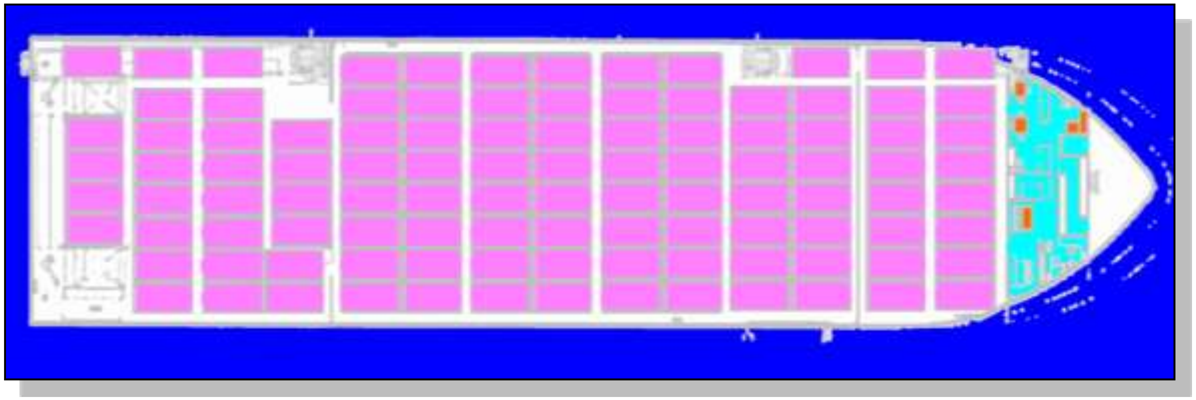


Cargo Dhow Search Results

<table>
<tr><th>Cargo Dhow Search Model Results
(Sample of 30 runs)</th><th>*Mean Time to Search Cargo Dhow</th><th>Percentage of Runs Contraband was Found</th></tr>
<tr><td>Visual Search, 2 Inspection Teams</td><td>106 minutes</td><td rowspan="2">37 %</td></tr>
<tr><td>Visual Search, 3 Inspection Teams</td><td>77 minutes</td></tr>
<tr><td>IMS Search, 2 Inspection Teams</td><td>78 minutes</td><td rowspan="2">85%</td></tr>
<tr><td>IMS Search, 3 Inspection Teams</td><td>54 minutes</td></tr>
</table>

*Key understanding here: not advertising specific times – comparing the improved effectiveness with IMS sensor package

Comparison: MANA Model and General Analytical Model

- MANA Model and General Analytical Model were both used in estimating relative time to search an entire vessel
- Similar baseline assumptions were made for both the Cargo Dhow MANA simulation and General Analytical Model
- Different constraints inherent to the different models
- Did not expect same numbers – did expect same conclusions

Sensor	General Analytical Model Two Sensors (min)		Cargo Dhow MANA Model Two Search Teams (min)
	Exhaustive Search Time	Random Search Time	
Human Eyes	32	165	106
IMS	9	44	77

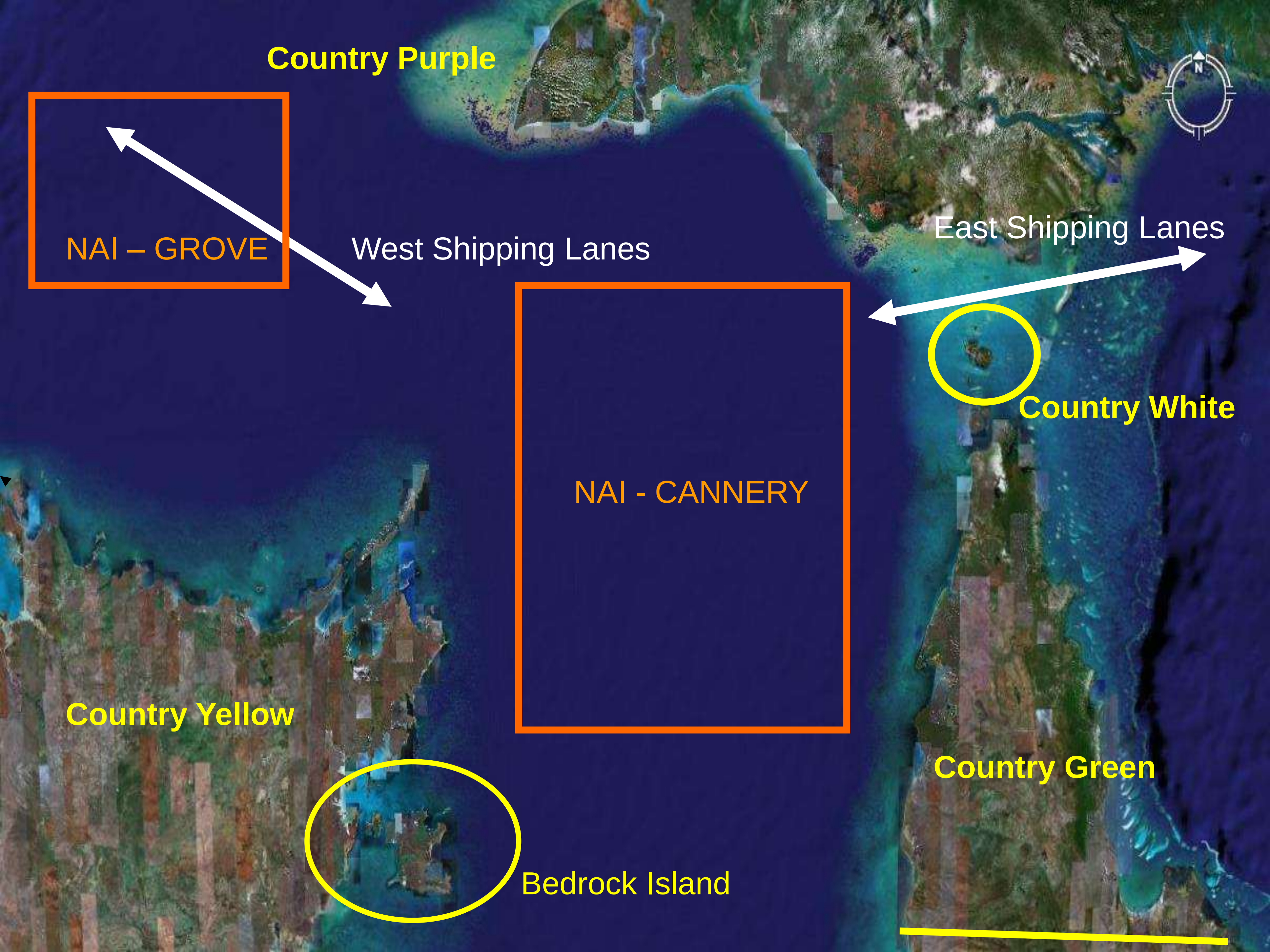
- Results are within an order of magnitude
- Same conclusion: **IMS improves search over using human eyes**

Container Ship First Level Search Time

Container Ship Search Model Results *(Sample of 30 runs)*	Mean Time to Search Container Ship
Visual Search, 2 Inspection Teams	7.9 hours
Visual Search, 3 Inspection Teams	5.3 hours
IMS Search, 2 Inspection Teams	0.9 hours
IMS Search, 3 Inspection Teams	0.6 hours

Naval Simulation System (NSS)

- Monte-Carlo based simulation tool
- Developed by SPAWAR and Metron, Inc.
- Extremely flexible, high level of detail, high fidelity
- Object oriented
  - Analyst creates objects (Ships, Aircraft, etc…) and defines behaviors and interactions within simulation


Country Purple
NAI – GROVE
West Shipping Lanes
East Shipping Lanes
Country White
NAI - CANNERY
Country Yellow
Country Green
Bedrock Island

NSS
Scenario Initialization

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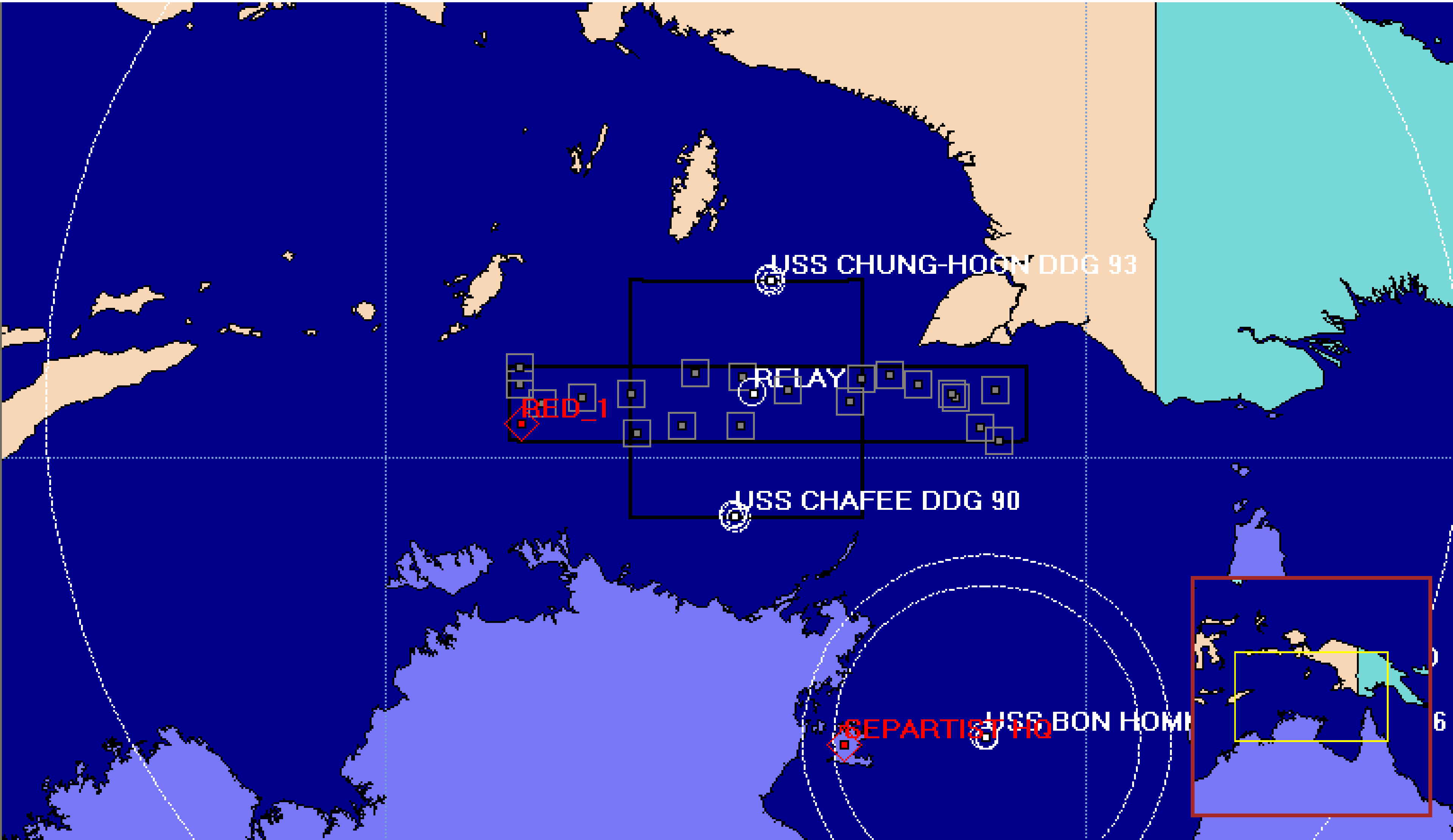

NSS
Scenario Running

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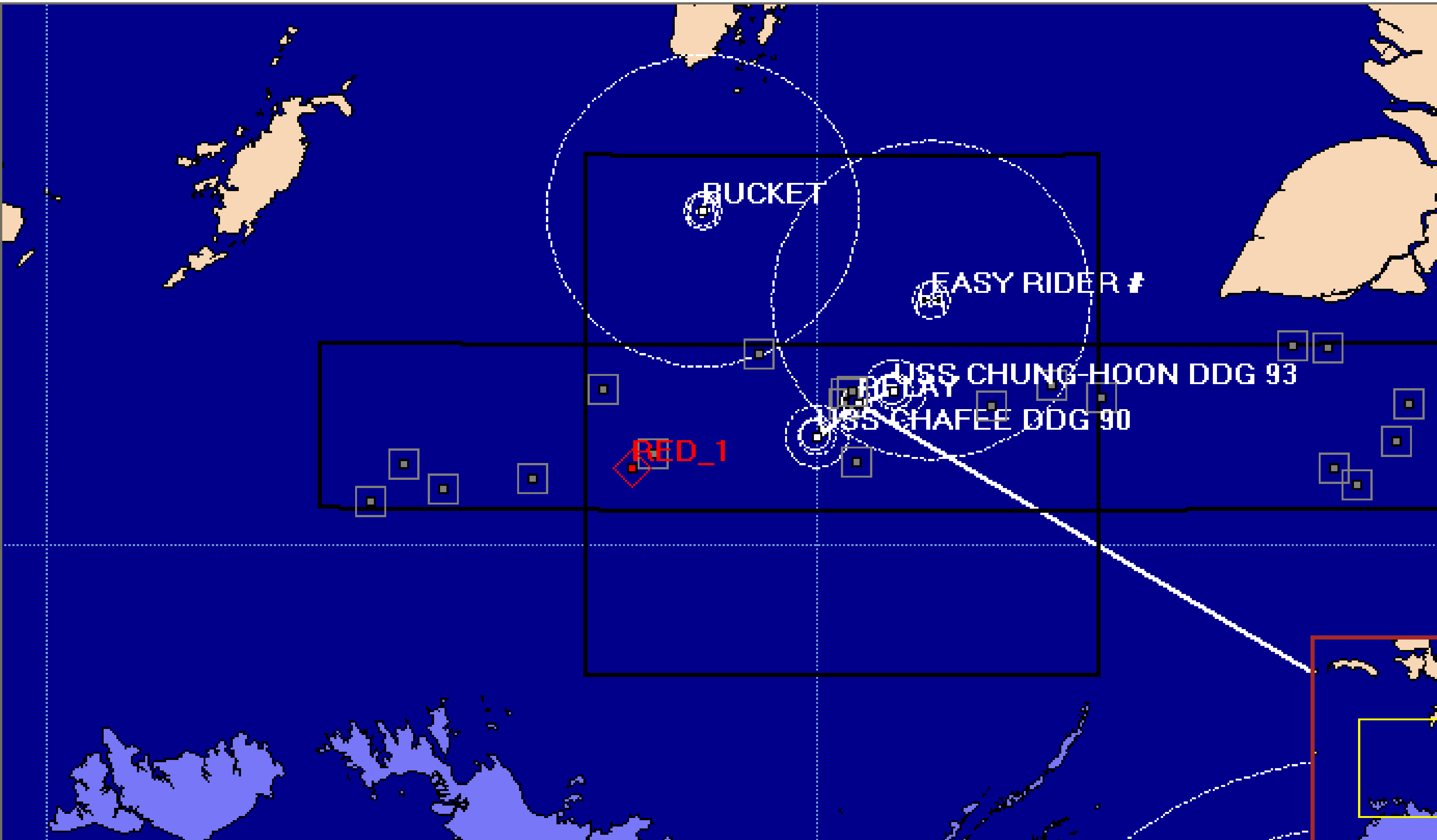

NSS
Suspect Vessel Located

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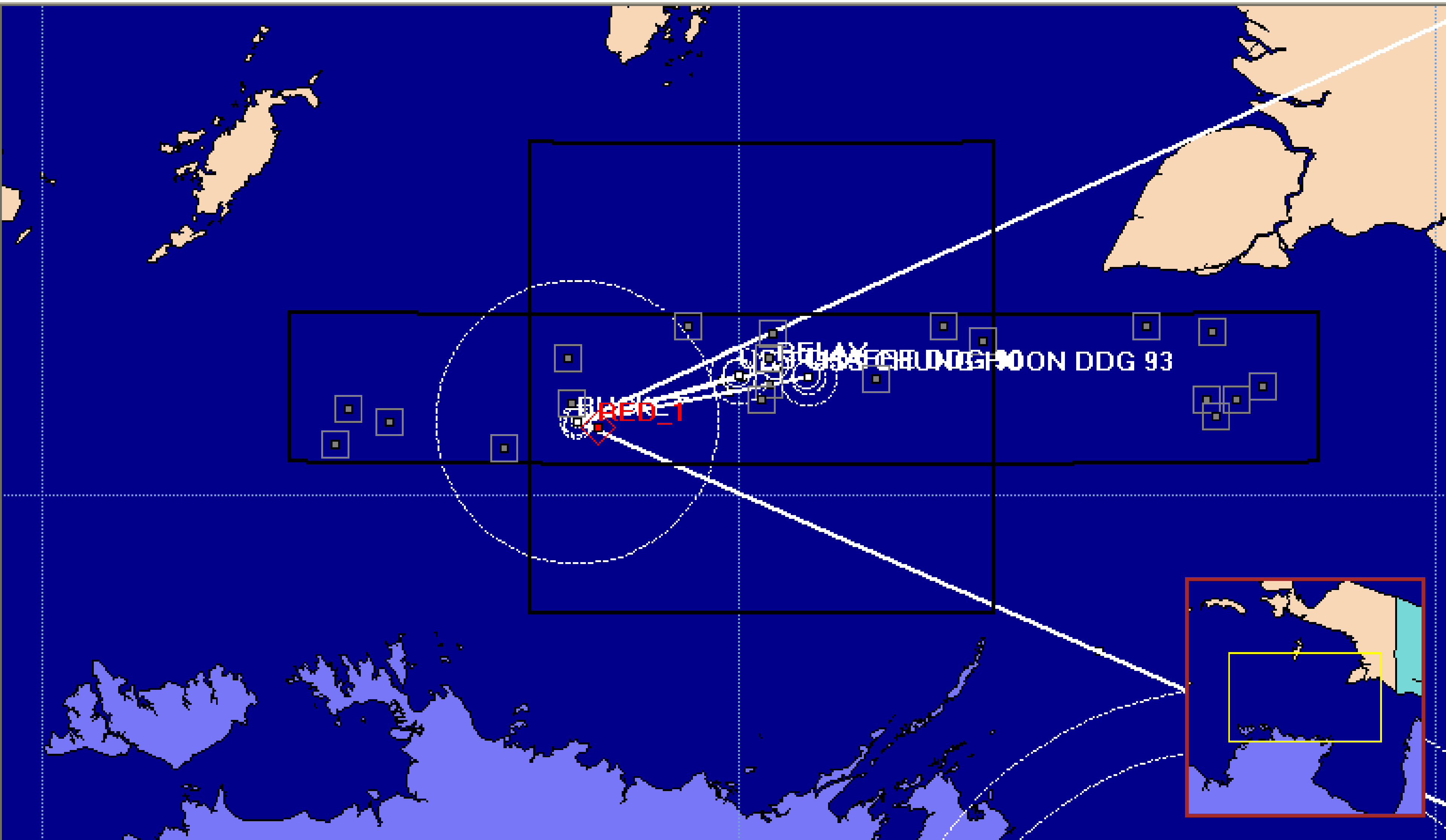
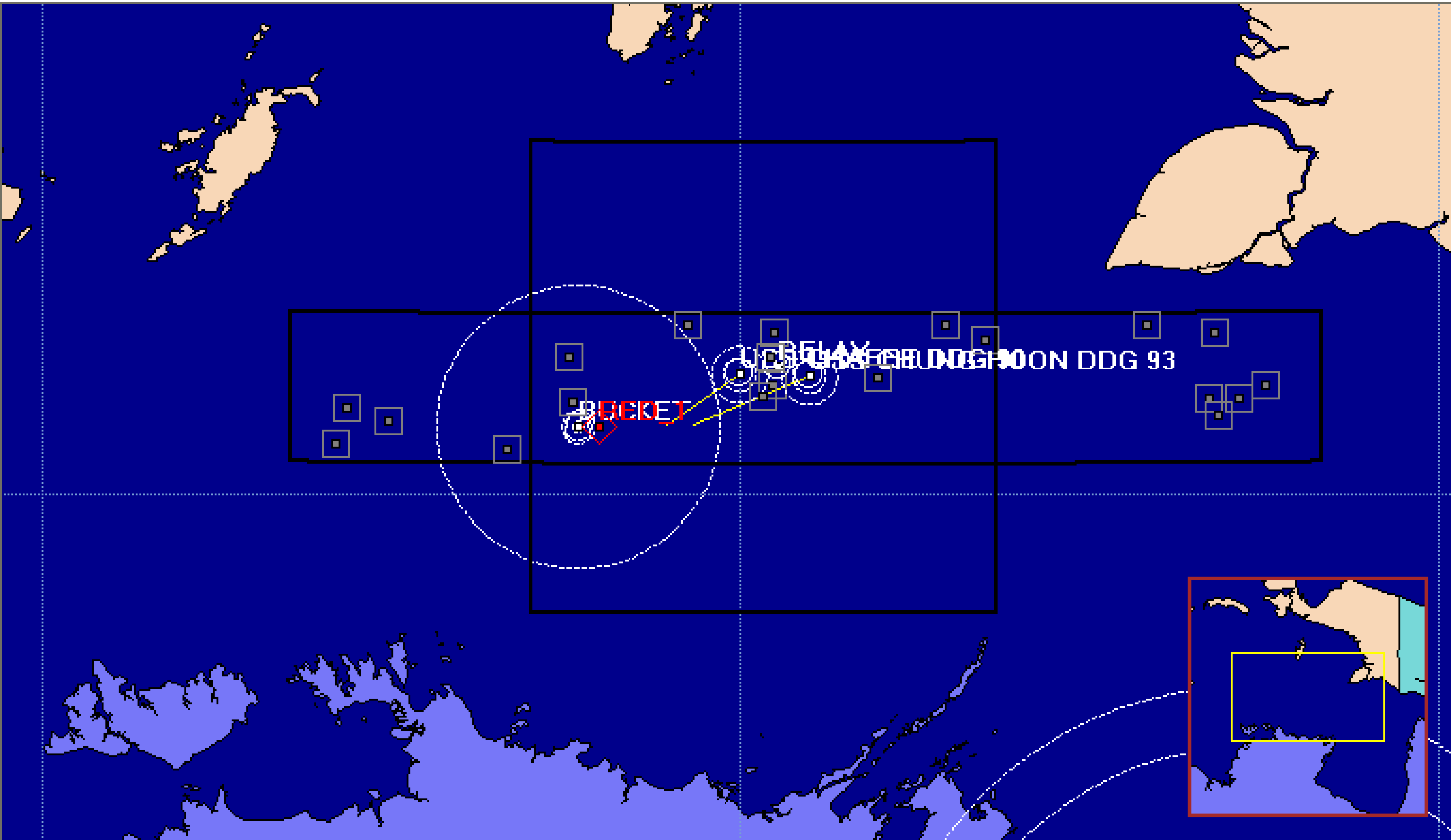


NSS
Destroyer Intercept Vectors



NSS – Destroyer Intercept and Boarding

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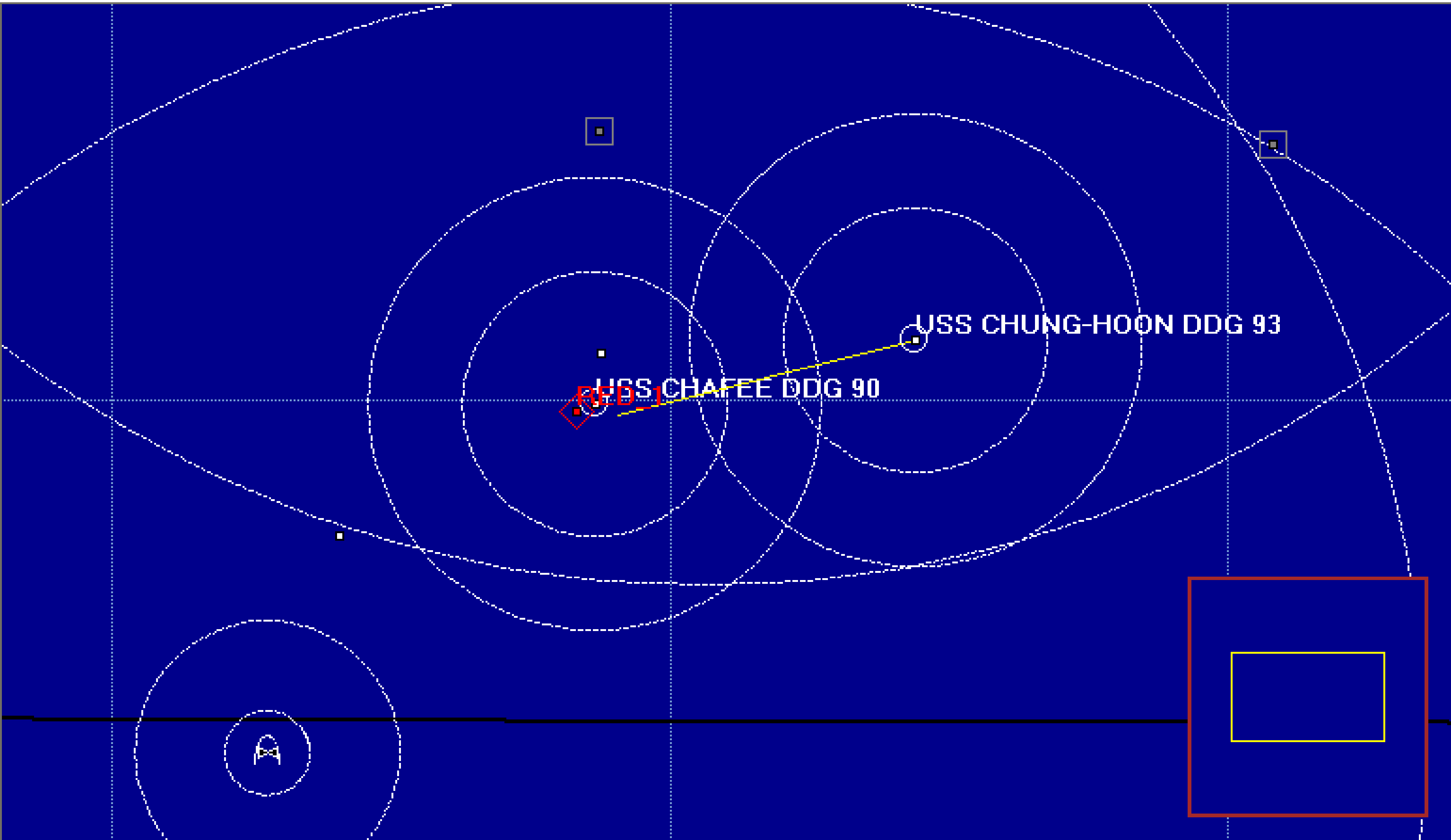


Phase 0

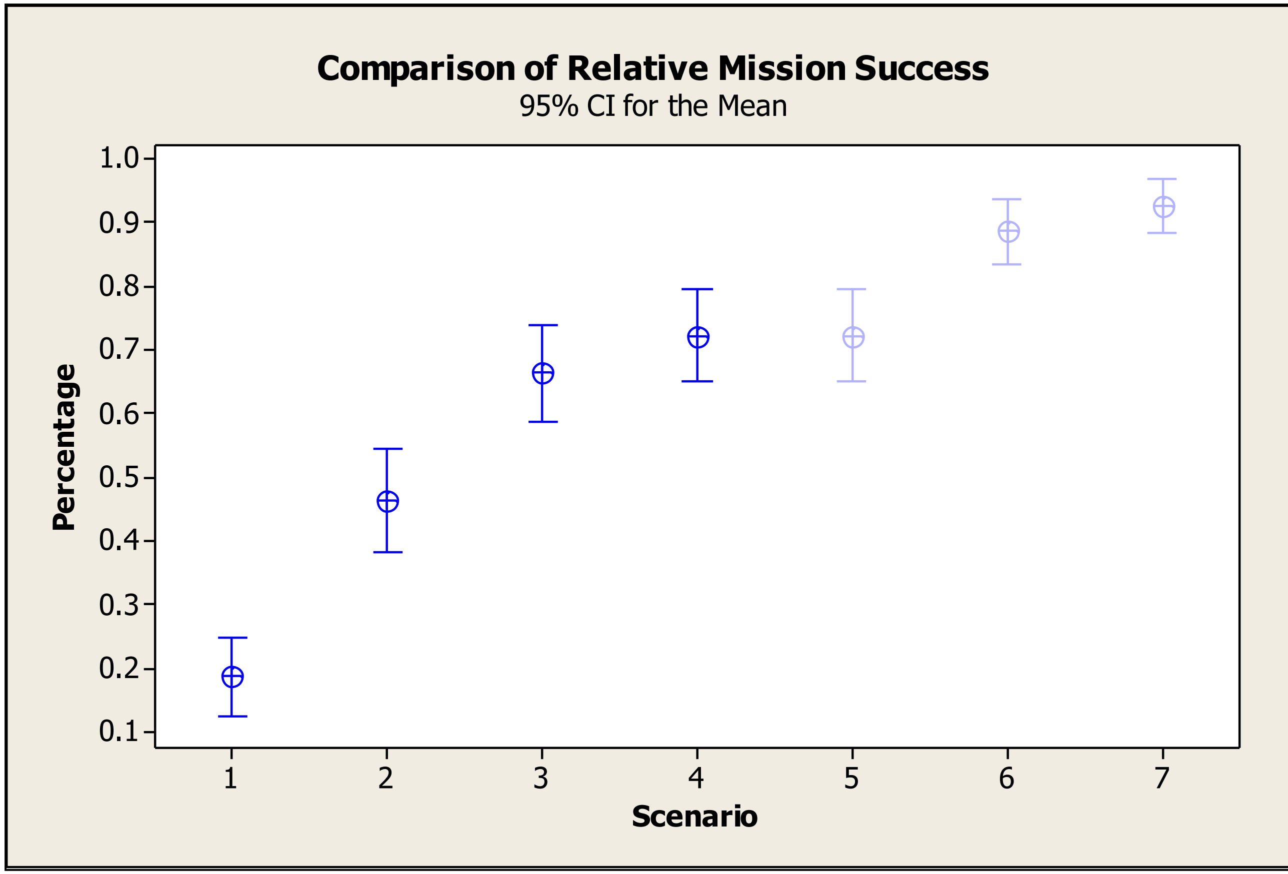
- Looking for one suspect vessel in an area of high density commercial shipping traffic
  – Vessels must get within 7nm to ID contacts
  – Maritime Patrol Aircraft and Helicopters can ID at 9 nm
- Simulations are run for a period of 24 hours
- 7 alternative force structures compared

Phase 0
Scenario Breakdown

		US (Blue)			Green
Scenario	**Name**	**Destroyers**	**Helos**	**UAVs**	**Maritime Patrol Aircraft**
1	**No Aircraft**	**2**	**0**	**0**	**0**
2	**Helos**	**2**	**4 (2 Airborne)**	**0**	**0**
3	**1 UAV per DDG**	**2**	**0**	**6 (2 Airborne)**	**0**
4	**2 UAVs per DDG**	**2**	**0**	**6 (4 Airborne)**	**0**
5*	**Helos and Green**	**2**	**4 (2 Airborne)**	**0**	**4 (1 Airborne)**
6*	**1 UAV and Green**	**2**	**0**	**6 (2 Airborne)**	**4 (1 Airborne)**
7*	**2 UAVs and Green**	**2**	**0**	**6 (4 Airborne)**	**4 (1 Airborne)**

Phase 0 Results

- Number of Aircraft has a significant effect on the task force's ability to find the "red ship"



Phase 1(High Density)

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- Looking for contraband in a high traffic density area
  - Conducting searches of random vessels in the area
- Conducted over a period of 24 hours
- 7 alternative force structures compared
- 200 x 300 nm Area of Interest
- 200 Ships

Phase 1(High Density) Scenario Breakdown

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		US (Blue)			Green	White	
Scenario	Name	Destroyers	Helos	UAVs	Maritime Patrol Aircraft	Airborne Early Warning	Patrol Craft
8	UAVs no allies	3	0	9 (4 Airborne)	0	0	1
9	Helos no allies	3	6 (2 Airborne)	0	0	0	1
10	No Aircraft	3	0	0	0	0	1
11*	UAVs and White	4	0	12 (6 Airborne)	0	4 (1 Airborne)	1
12*	UAVs and Green	4	0	12 (6 Airborne)	4 (1 Airborne)	0	1
13*	UAVs White and Green	5	0	15 (6 Airborne)	4 (1 Airborne)	4 (1 Airborne)	1
14*	Helos White and Green	5	9 (3 Airborne)	0	4 (1 Airborne)	4 (1 Airborne)	1

Phase 1 (High Density) Results

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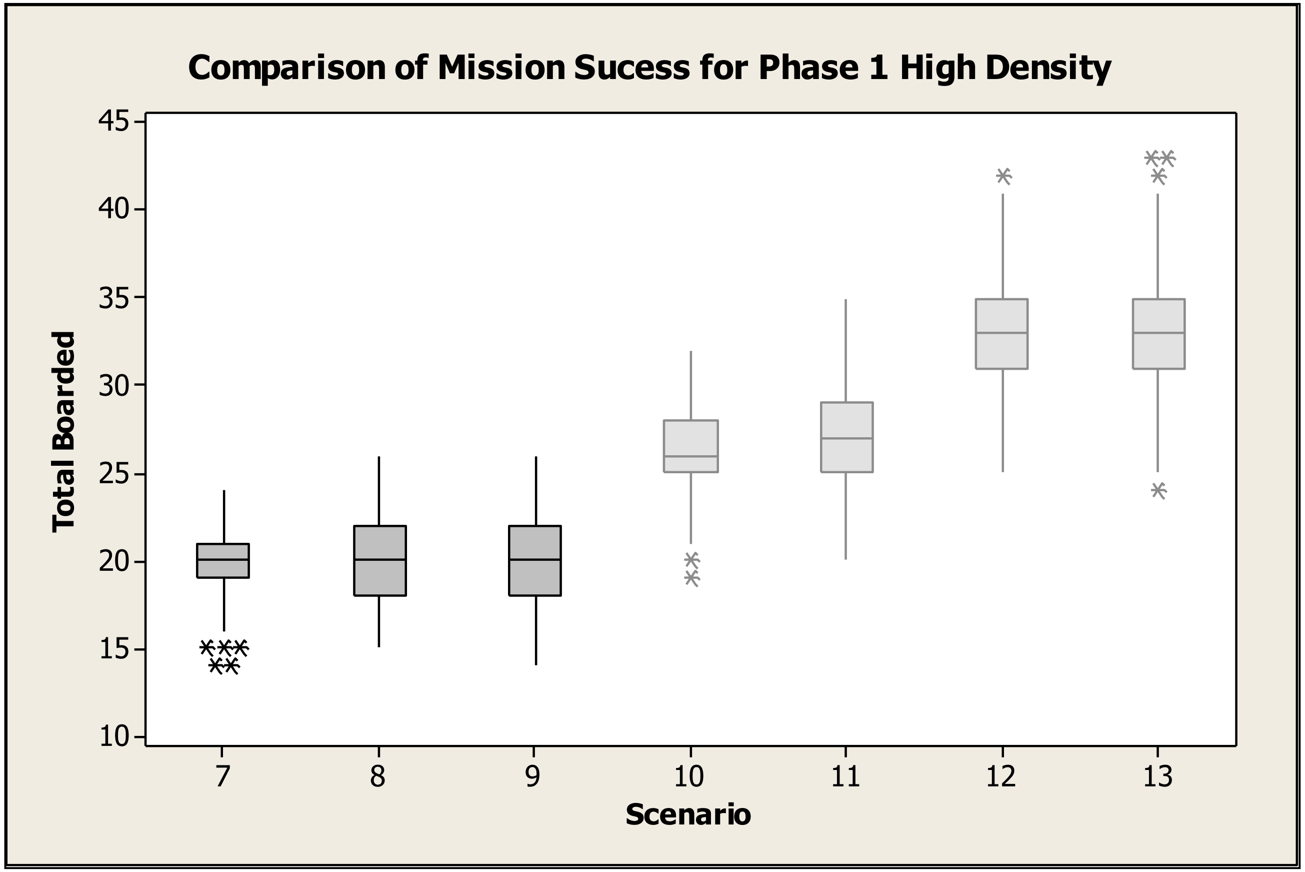

- Since surface vessels are the only ones which can conduct searches…their number is sole driver of number of ships searched given high traffic density

Phase 1(Low Density)

- Same setup as Phase 1 (High Density) but only 12 ships in Area of Interest
- What are the dominant factors in a scenario where there is significantly lower traffic density?
- 5 alternative force structures compared

Phase 1(Low Density) Scenario Breakdown

		US (Blue)			Green
Scenario	Name	Destroyers	Helos	UAVs	Maritime Patrol Aircraft
14	No Aircraft	2	0	0	0
15	Helos No Allies	2	4 (2 Airborne)	0	0
16	UAVs No Allies	2	0	6 (4 Airborne)	0
17*	Helos All Allies	2	4 (2 Airborne)	0	4 (1 Airborne)
18*	UAVs All Allies	2	0	6 (4 Airborne)	4 (1 Airborne)

Phase 1(Low Density) Results

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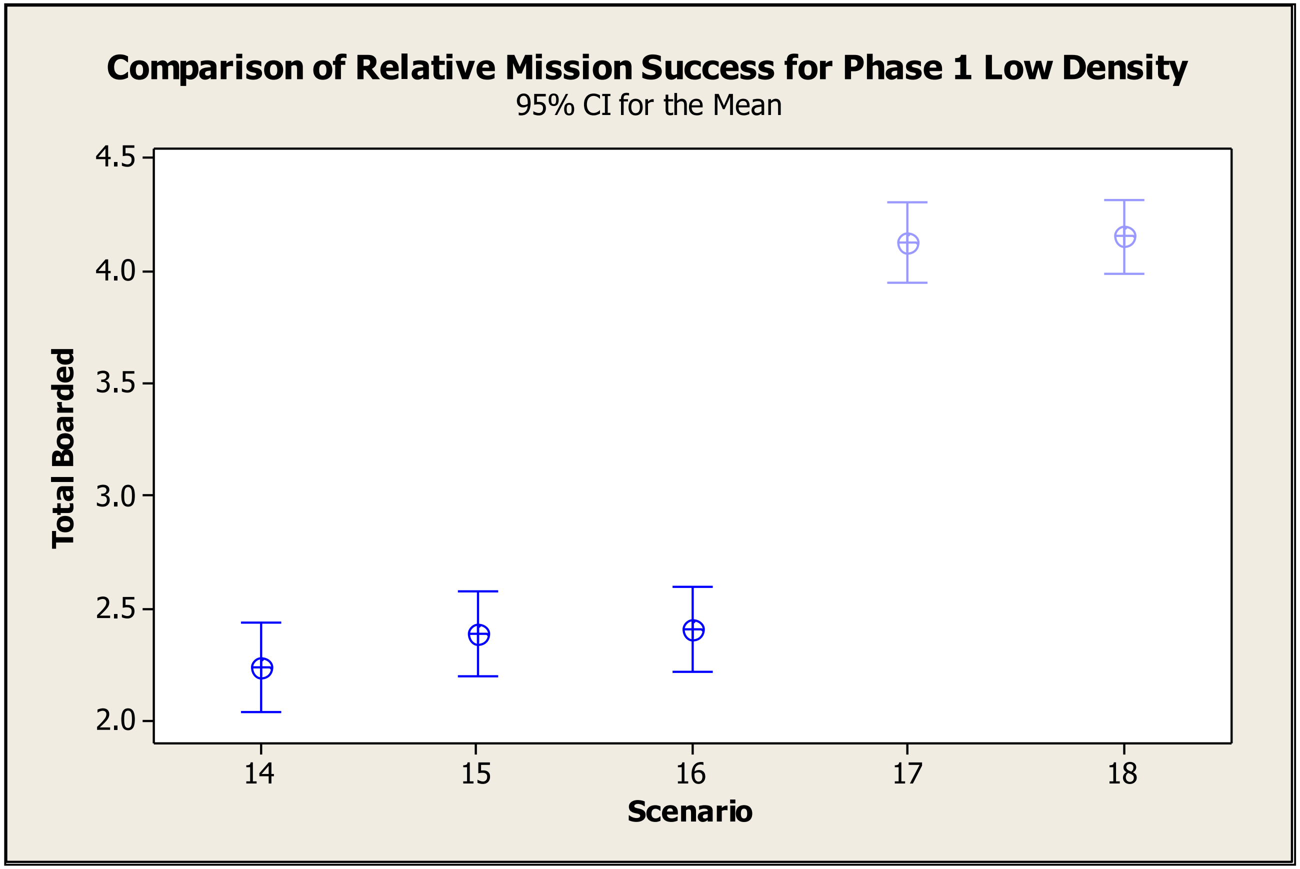

- Significantly lower traffic density – Maritime Patrol Aircraft dominate the outcomes

Conclusions

Bottom line

- Recommended approach as follows:
  - ESG force composition
  - Surface launched boarding teams with HVBSS capability
  - Employ augmented sensors during the MIO
  - Employ UAV’s for macroscopic surveillance
  - Employ biometric collection
  - Employ WETNET/Trellisware comms architecture
  - Utilize armed UAV, armed USV and non-lethal weapons as is appropriate for non-compliant/opposed MIO’s and deterrent for compliant MIO’s
  - Utilize a push based logistics approach

Conclusions

- Four architectures examined
- Radical alterations to the morphology of current baseline produce vastly inferior results in most cases.
- HVBSS centric approach is a runner-up, but is risk-prohibitive
- Surface ship approach remains ideal

Conclusions

- Analysis of the MIO problem is supportive of current ESG architecture.
- Currently employed ESG ships are the most ideal MIO platforms of all 108 platforms from 17 nations evaluated in this analysis.
- Augmented search capability (dogs or IMS) greatly improves probability of a find (given the presence of an illicit cargo)

Conclusions

- When the US Navy sends a vessel, we plan for a mission duration. Should plans change, a choice will have to be made between tapping into TRANSCOM assets or abandoning the mission.
- TRANSCOM assets/nodes exist all over the world.
- There's no reason to be truly logistically barren.
- There is no difference between steaming in circles and doing MIO as far as the logistics tail is concerned.

Conclusions

- Real-time biometric analysis of target crew is achievable given recommendations.
- Spartan/Firescout/LRAD are the ideal supporting platforms.
- The number of possible boardings is linear with number of boarding assets and amount of time spent on each target ship.
- UAV’s (or long endurance aircraft) are more valuable than manned (or shorter endurance aircraft) for finding individual vessels.
- Aircraft are not of much value when saturated.

Conclusions

- The accompanying report gives all the details necessary to allow one to plan a large scale regional MIO in a logistically barren environment for the 2013-2014 timeframe.
- Each real world scenario will be different. The assets brought will vary depending on circumstances. This report is a beginning to that planning.

SEA-13 MARITIME INTERDICTION OPERATIONS

Breakout Schedule

- Breakout sessions will be available for further questions at the following times and places:

Time	Bullard 100	Bullard 212	Bullard 108
1300	Intercept	Info Sup	Boarding
1400	Intercept	Info Sup	Boarding
1500	Logistics	Mod/Sim/OR	Search
1600	Logistics	Mod/Sim/OR	Search

SEA-13/TDSI thanks you for your kind attention

Special Acknowledgements:

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LT Tad Drozdowski, USCG Deploying Operations Group

Professor Mark Rhoades, Naval Postgraduate School