Riverine Sustainment 2012

SEA-11/TDSI

RIVERINE SUSTAINMENT

2012

Welcome

Dr. Paul Shebalin (RADM)

Professor, Systems Engineering Department, NPS

Key Takeaways

- Supply
  - Key Factors were Supply Ship Cycle Time, Basing Alternatives, and Survivability
  - Air Assets Did Not Significantly Improve Throughput and Raised Cost Substantially.
- Repair
  - Mean Supply Response Time Was the Biggest Factor.
- Force Protection
  - Current Mortar Defenses were Insufficient.
  - The Nobriza/Barge Baseline was Most Effective MOB Alternative.
  - IR Illuminators were Valuable for Point Defense

Agenda

0900 – 0915	*Introduction*
0915 – 0945	*Supply*
0945 – 1000	*Break*
1000 – 1015	*Repair*
1015 – 1045	*Force Protection*
1100 – 1200	Break Out Sessions
	(In the Bullard Labs)

SEA 11 Cohort

LCDR Mike Galli, USN B.S. Business	Naval Flight Officer Next Duty: CDCO, USS Ronald Reagan
LT Jim Turner, USN B.S. Mechanical Engineering	Nuclear Submariner Next Duty: Submarine Advanced Course
LT Kris Olson, USN B.S. Work Force Education	Surface Warfare Next Duty: CHENG, USS Rushmore
LT Neil Wharton, USN B.S. Sociology	Surface Warfare Next Duty: CHENG, Harpers Ferry
CPT Everett Williams, USA B.S. Physics	Army Artillery Next Duty: West Point Instructor
LT Mike Mortensen, USN B.S. Systems Engineering	Surface Warfare (Nuclear) Next Duty: OPSO, USS Higgins
ENS Tom Schmitz, USN B.S. Systems Engineering	Student Naval Aviator Next Duty: Naval Flight School
ENS Matt Mangaran,USN B.S. Systems Engineering	Student Naval Aviator Next Duty: Naval Flight School

TDSI Cohort

- MAJ Tan Boon Leng
- LT Eric Pond
- CPT Gil Nachmani
- Ong Hsueh Min
- Ong Wing Shan
- Goh Choo Seng
- CPT Ho Chee Leong
- Cheng Hwee Kiat
- CPT Teng Choon Hon
- Lim Han Leong
- CPT Yow Thiam Poh
- MAJ Mak Wai Yen
- Hui Kok Meng
- Lim Meng Hwee
- CPT Phua Poh Sim
- CPT Joshua Sundram
- Tan Kian Moh

Tasking

- From the Wayne E. Meyer Institute
- Tasking: “Collaborate with the Naval Expeditionary Combat Command (NECC) to design a system of systems for performing emerging Navy missions associated with coalition operations in littoral and riverine environments.”

NAVAL POSTGRADUATE SCHOOL

Wayne E. Meyer Institute of Systems Engineering
Naval Postgraduate School
777 Dyer Rd., Monterey, CA 93943

6 December, 2006

MEMORANDUM FOR SEA-11 STUDENTS

Subj: SEA-11 CAPSTONE PROJECT OBJECTIVES

Enclosures: Tab A: Background for Capstone Project Development
Tab B: Preliminary Objectives for the Maritime Security Cooperation Project
Tab C: Preliminary Objectives for the Port Security/Force Protection Project

1. The objective of this memorandum is to provide guidance for the conduct of the integrated projects required for the completion of your degree. You will be required to complete your project by the first week of June, 2007, in accordance with the following plan and milestones.

   (a) Develop a project proposal and a project management plan during the course of Prof Paulo's SI 3002 Project Management class. This proposal and plan will serve to focus your initial research and analysis. You should plan to review and update this plan frequently as you progress with your research.
   (b) Conduct project reviews approximately every six weeks, finishing with a final brief to be scheduled for the first week of June, 2007.
   (c) Begin outlining and preparing your Project Report as early as you can. Work with your faculty advisors, about every week, to prepare your Project Report for their approval and signature. The final report is due by 1 June, 2007.

2. Background information on the character and objectives of the projects is outlined in Tab A. The preliminary objectives statements for the two projects are contained in Tabs B and C. Your initial efforts should be to refine these objectives statements, based on research of current guidance documents and subject to the approval of your faculty advisors.

3. You will be expected to identify and integrate students and faculty from across the campus -- and other resources from outside the school -- to participate in your projects. This participation could include students who would join your groups, students doing related individual thesis topics, and faculty inside or outside NPS who have expertise related to your projects. It will be your responsibility to integrate the

Revised Problem Statement

"Define, Analyze, and Recommend Alternatives for Supply, Repair, and Force Protection that Increase Sustainability of the Riverine Force in Riparian Environment Utilizing Technologies Currently in Use or Available for Use by 2012."

Riverine Maritime Security Operations

Maintain Security of the River Ways by Conducting Patrol and Interdiction Operations to Slow or Disable the Flow of:

- Narcotics
- Arms
- Slavery
- Terrorists

Riverine Squadron

- Tactical Operations Center
- O-Level Repair
- Limited Medical
- Motor Transport
- Combat Service Support
- Security Forces
- Intelligence Cell

- 12 SURCs
- 65 Rolling Gear
- 224 Personnel

Riverine Mission

The primary mission of the Riverine Force is to conduct shaping and stability operations (including Theater Security Cooperation activities), to provide Maritime Security, and to carry out additional tasks specifically related to the GWOT:

- Riverine Area Control/Protect Critical Infrastructure
- Interdiction of Riverine Lines of Communication
- Fire Support
- Insertion / Extraction of Conventional Ground Forces
- Humanitarian Assistance/Disaster Relief (HADR)

Sustainment Support

- "How it Should Work"
  - DOTMLPF

- Drawn from:
  - Joint & Service Documents
  - Research Material
  - Field Reports

Field Research

- **NECC**
  - N3, N4, N7, N9
  - Riverine Group One
  - Naval Coast Warfare Group One
- **Research Groups**
  - NAVSEA Operations Logistics Study Group
  - MIT Naval Architects
  - Coalition Operating Area and Surveillance Targeting System
  - Total Ship Systems Engineering
  - Tactical Network Topology
- **Naval Special Warfare**
  - Special Boat Team Twenty-Two
  - Naval Small Craft Instruction and Technical Training School
  - Logistics Support Group One

Wants, Needs, Desires

- Sustainable Logistics System
- Higher Availability Rates
- Minimized Footprint
- Secured Support Bases
- Defense versus Mortar Attacks
- Improve Communications Between Coalition Partners.

Research Focus

- Supply
  - How to sustain a force up river in a logistically barren area?
  - What metrics are the most influential in determining the trade space?
- Repair
  - What is the Best Way to Conduct Maintenance in a logistically barren area
- Force Protection
  - What Force Protection Measures are Most Effective in Threat Denial

Systems Engineering Process

Problem Definition

- Determine Customers and Stakeholders
- Determine Problem Statement and Scope
- Determine Status-quo
- Perform Functional Analysis
- Create Functional Architectures

Design & Analysis

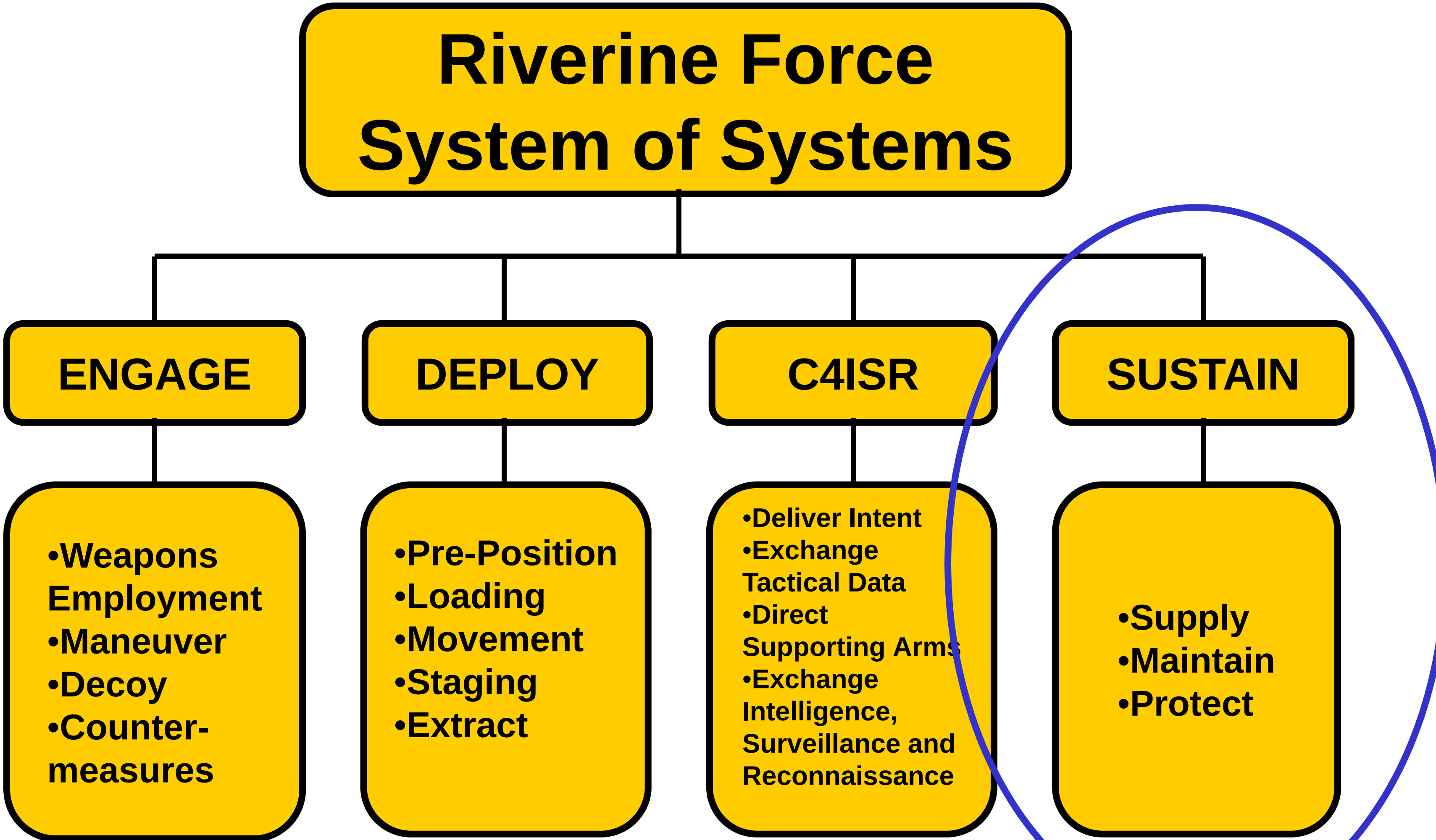
- Conduct Mission Analysis
- Determine System Metrics
- Develop Scenarios and Concept of Operations
- Create Physical Architectures

Decision Making

- Determine Modeling Approach
- Create Operational Architectures
- Perform Qualitative Modeling
- Analyze and Decide

Adapted from Buede, Blanchard, and Fabrycky

Riverine Force Functional Hierarchy



Riverine Sustainment Functional Hierarchy

Sustain

- **SUPPLY**
  - •Maintain
  - •Movement
  - •Bring Back
- **MAINTAIN**
  - •Repair
  - •Service
  - •Replace
- **PROTECT**
  - •Predict
  - •Deter
  - •Deny

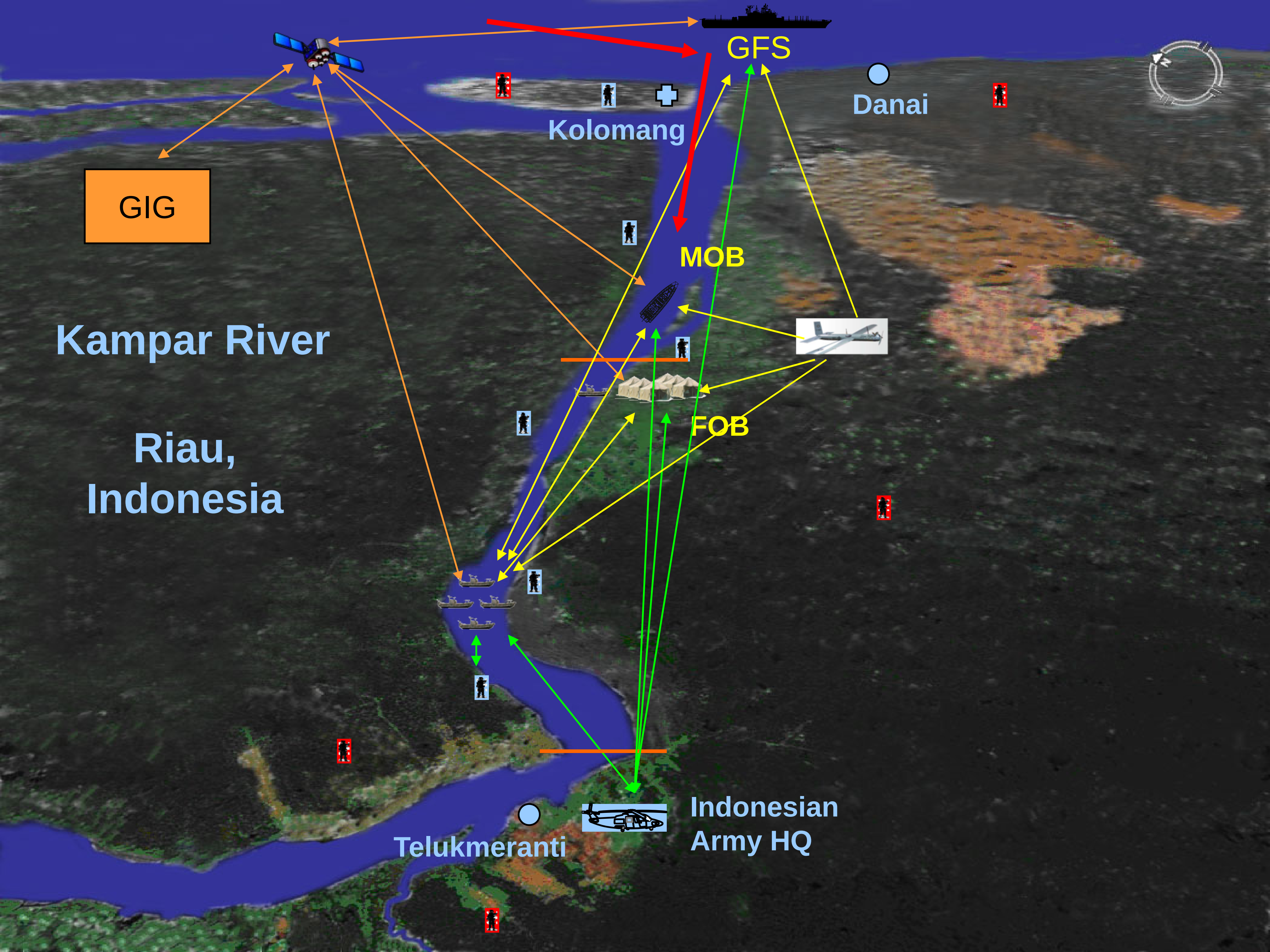
Scenario

LT Jim Turner

Operational Setting

- **Kampar River**
  - Lightly populated
  - Length: 300 nm
  - Width: 1 nm to 5 nm
  - Jungle canopy, mangroves and brackish water
  - Indonesian Army

- **Red Forces**
  - Level II threat
  - Can operate at or near company strength
    - Automatic weapons
    - RPG’s and mortars
    - Crew served weapons
    - Small boats
  - “Networked Comms”
    - Cell phones
    - PRC-117 equivalent


GFS
Danai
Kolomang
GIG
MOB
Kampar River
FOB
Riau,
Indonesia
Indonesian
Army HQ
Telukmeranti

Basing

ENS Matthew Mangaran

Riverine Support Base

- "Riverine forces often operate in remote locations and may not be collocated with existing support facilities." (RF CONOPS)
- Support Base functions tailored to specific mission:
  - Operational Support
  - Medical Support
  - Logistics
  - Hotel Services
  - Helicopter Support
  - Maintenance
  - Administration
  - Salvage

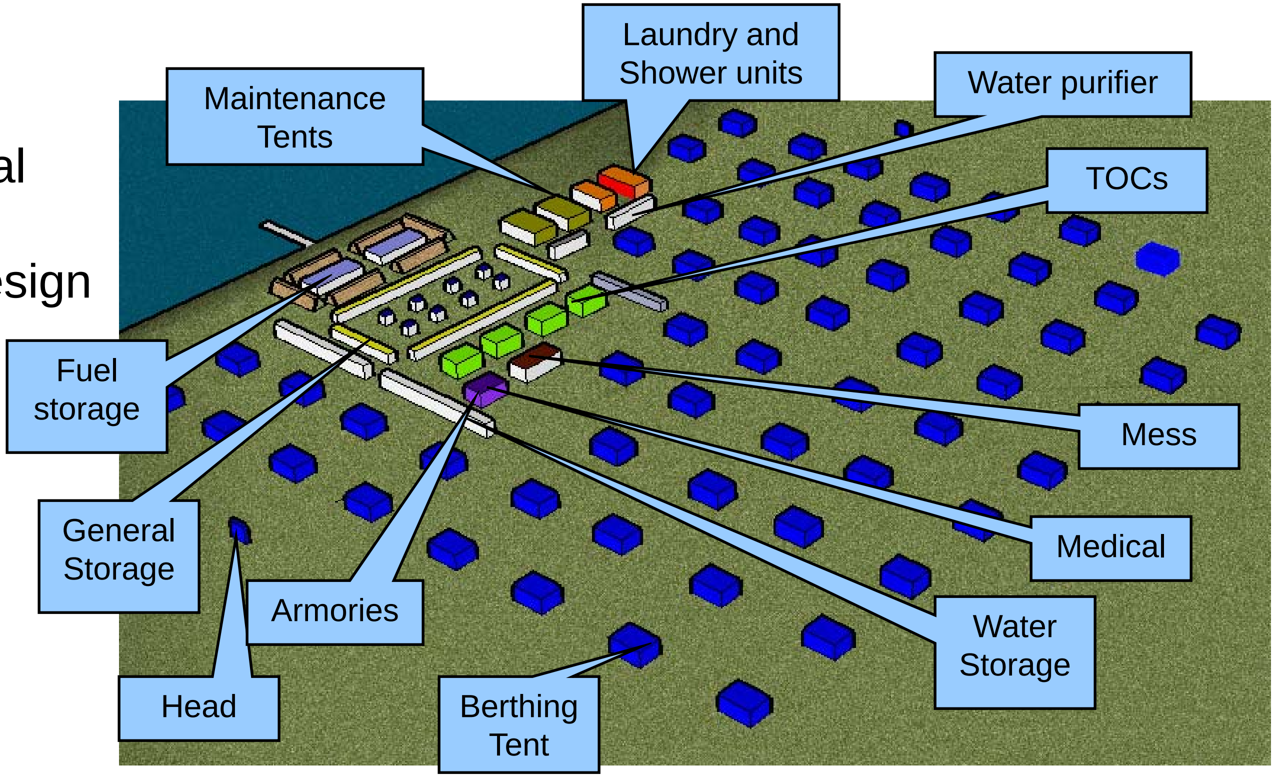
Riverine Support Base

- Forward Operating Base
  - 400 (+/- 50) person camp
  - Ashore along the River
- Mobile Operating Base
  - Afloat on the river
  - Ex. Nobriza, RCSS, Barge
- Global Fleet Station
  - Permissive environments in International water
  - Ex. LPD-17, LCS, HSV, LPD/LSD

FOB

The FOB was a configuration of the Naval Construction Battalion's (Seabees) Tent camp design

The RST configured the structures with considerations for force protection and ease of conducting operations.



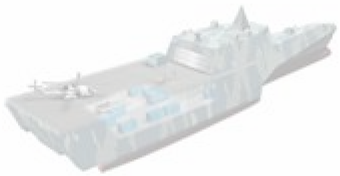
MOB Alternative Criteria

- Force Protection
  - Weapons, sensors, flight deck
- Troop Capacity
  - RF consists of 224 plus detachments
- Storage Capacity
  - Fuel, water, food, ammo, repair parts
- Ease of Movement
  - Draft
- Maintenance and Support
  - Well deck, crane, ramps, causeway, facilities

MOB Alternatives

Littoral Combat Ship (LCS) (Lockheed Martin)

- Modular Weapon Zone
- Stern Ramp and Side Door



Littoral Combat Ship (LCS) (General Dynamics)

- Multiple Weapons
- Large Hangar and Flight Deck

Barge (APL-40)

- Used in Vietnam War
- Tailored for mission

+

Nobriza (Colombia)

- Heavily Armored
- Power Projection

High Speed Vessel

- Max speed 45+ knots
- Large hangar

RSS-207 Endurance (Singapore)

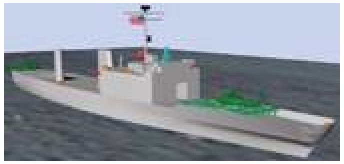
- Large Well Deck
- Automated system require a crew of only 65

Logistic Support Vessel

- Semi-submersible variant
- Large Deck

KRI-511 Teluk Bone ex-USN LST-839 (Indonesia)

- Bow Gate
- Smaller LST



Riverine Combat Support Ship (RCSS)

- Additional Flight Deck
- Stern gate and Floating Causeway

KD-1505 Sri Inderapura ex-USN LST-1192 (Malaysia)

- Stern Gate and Floating Causeway
- Larger LST

MOB Feasibility Screening

- Troop Capacity – At least 150
- Storage Capacity – 15 days for crew and RF
- Maneuverability – Shallow draft, meet with RF
- Maintenance and Support – Accommodate small boats and perform maintenance

Alternative	Troop Capacity	Storage Capacity	Maneuverability	Maintenance & Support
LCS	NG	G	G	G
HSV	NG	G	G	G
LSV	NG	NG	G	G
RCSS	G	G	G	G
Barge	G	G	NG	G
Nobriza	NG	NG	G	NG
RSS-207 Endurance	G	G	G	G
KRI-511 Teluk Bone	NG	G	G	G
KD-1505 Sri Inderapura	G	G	G	G
Nobriza + Barge	G	G	G	G
Multiple Nobrizas	G	NG	G	NG

G: Go NG: No Go

Supply

LT Michael Mortensen

Supply System Key Takeaways

- Key Factors of Supply Success were Supply Ship Cycle Time, Basing Alternative, and Logistics Connector Survivability.
- Air Assets Did Not Significantly Improve Throughput and Raised Cost Substantially.
- For a Single Connector, "Jim G" Supported the Best Supply Ship Cycle Time.

Supply System Objectives

To Move Materiel to a Forward Base in a Logistically Barren Area Via Waterways. System Must Transport, Store, Distribute Materiel as Effectively as Possible.

- **Maintain**
  - **Ensure Flow of Materiel**
- **Movement**
  - **Minimize Time per Transport Event**
- **Bring Back**
  - **Minimize Time per Transport Event**

Metrics:

Throughput

Percent Supply Level

Operational Habitability

Supply Ship Presence Duration

Operational Availability

Alternatives

LCAC

Speed: 40+ unloaded / 25+ loaded

Capacity: 1,809 sq. ft. / 60 tons

Throughput: 23 tons/hr

Load/Unload: well deck, bow ramp, travel on land


LCU-1610

Speed: 12 unloaded / 6+ loaded

Capacity: 1,850 sq. ft. / 143 tons

Throughput: 14.3 tons/hr

Load/Unload: well deck, bow ramp, beach


LCU-2000

Speed: 11.5 unloaded / 8+ loaded

Capacity: 2,588 sq. ft. / 350 tons, can dispense fuel from its own tank

Throughput: 41 tons/hr

Load/Unload: bow ramp, beach

LCM

Speed: 12 unloaded / 6+ loaded

Capacity: 588 sq. ft. / 60 tons

Throughput: 5.3 tons/hr

Load/Unload: well deck, bow ramp, beach


SEACOR Marine Jim G
Mini Supply

Speed: 11 unloaded / 9 loaded

Capacity: 1,825 sq. ft. / 320 tons separate tanks for fuel/water

Throughput: 44 tons/hr

Load/Unload: moor alongside

SEACOR Marine Sharon F
Crew/Fast Support Vessel

Speed: 24 unloaded / 22 loaded

Capacity: 1,804 sq. ft. / 296 tons separate tanks for fuel/water

Throughput: 85 tons/hr

Load/Unload: moor alongside


H-53E

Speed: 150 unloaded / 110 loaded

Capacity: 16 tons

Throughput: 25 tons/hr

H-60

Speed: 160 unloaded / 110 loaded

Capacity: 5 tons

Throughput: 8.15 tons/hr

V-22

Speed: 300+ unloaded / 110 loaded

Capacity: 5 tons

Throughput: 10 tons/hr

Feasibility Screening

- Throughput: Assuming Distance of 40 nm, Re-Supply Operation of 300 Tons, and Done Within 24 Hours, Throughput Should be Greater Than 12.5 tons/hr.
- Cargo Weight: Carry One SIXCON (900 gallon container, 5 tons)
- Survivable: Low Profile, Steel Hull

Alternative	Throughput	Cargo Weight	Survivability
LCAC	G	G	NG
LCU-1610	G	G	G
LCM-8	NG	G	G
LCU-2000	G	G	G
Jim G	G	G	G
Sharon F	G	G	NG
H-60	NG	NG	G
H-53	G	G	G
MV-22	NG	NG	G

G: Go NG: No Go

Supply Risk Analysis

Likelihood	Insignificant	Minor	Moderate	Major	Catastrophic
Almost Certain					
Likely				S(2)	
Moderate			O(2)	S(4)	
Unlikely			O(1,3,4)	S(1,3)	
Remote to None					

Consequence

O: Operational Availability

S: Survivability

1: LCU-1610

2: Jim G

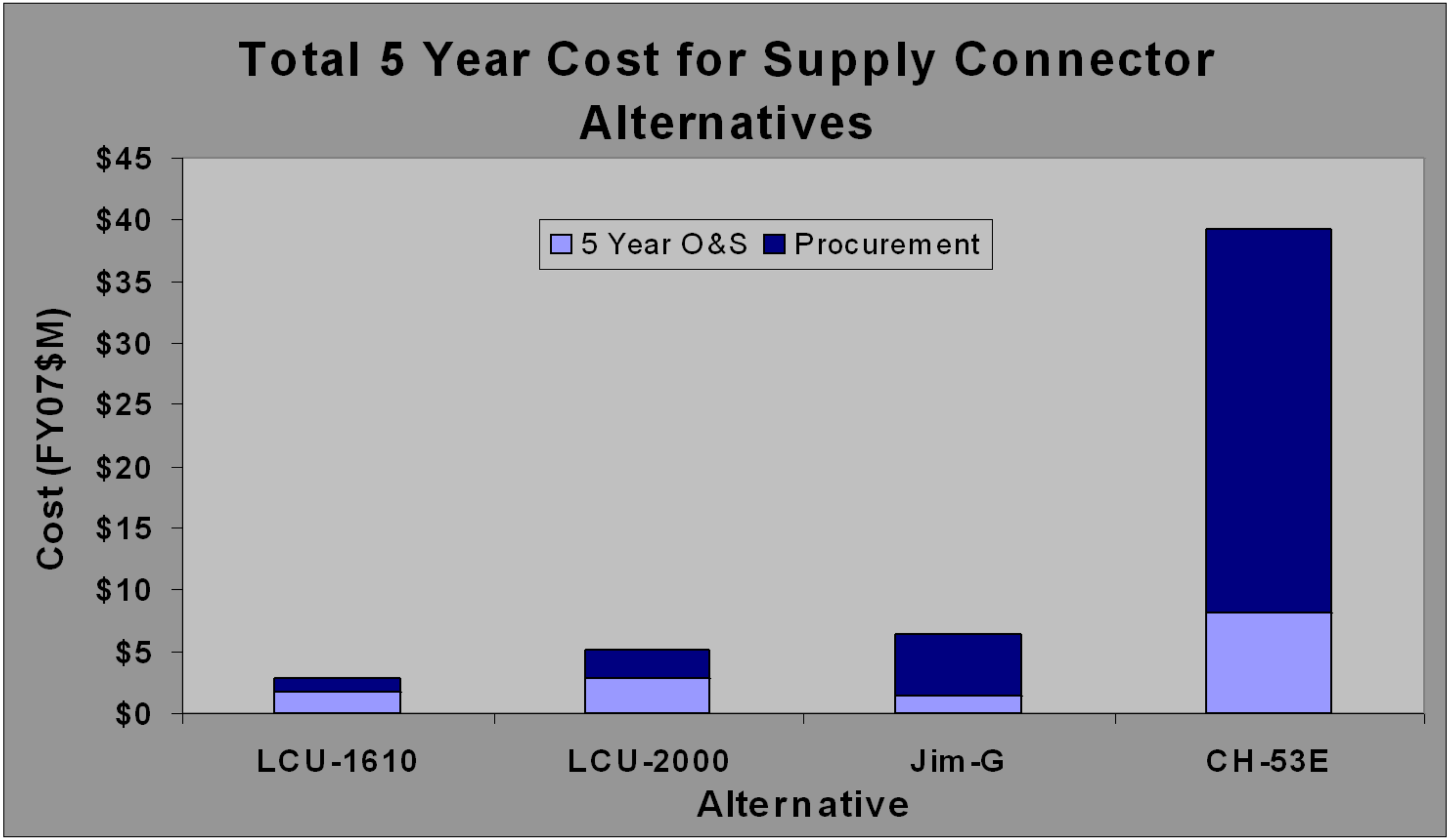
3: LCU-2000

4. H-53E

Cost Estimate Assumptions

- Procurement + 5 Year Operating and Support Cost
- Fiscal Year 2007 Dollars (FY07$)
- We assumed average OPTEMPO each year.
    - Cost from the past will be the same in the future
- Some data could not be retrieved for specific systems. Instead we found systems that are analogous to the system we were interested in and adjusted the cost.
- Commercial systems cannot be construed as a quote or offer for sale from the manufacturer.

CH-53E Most Expensive



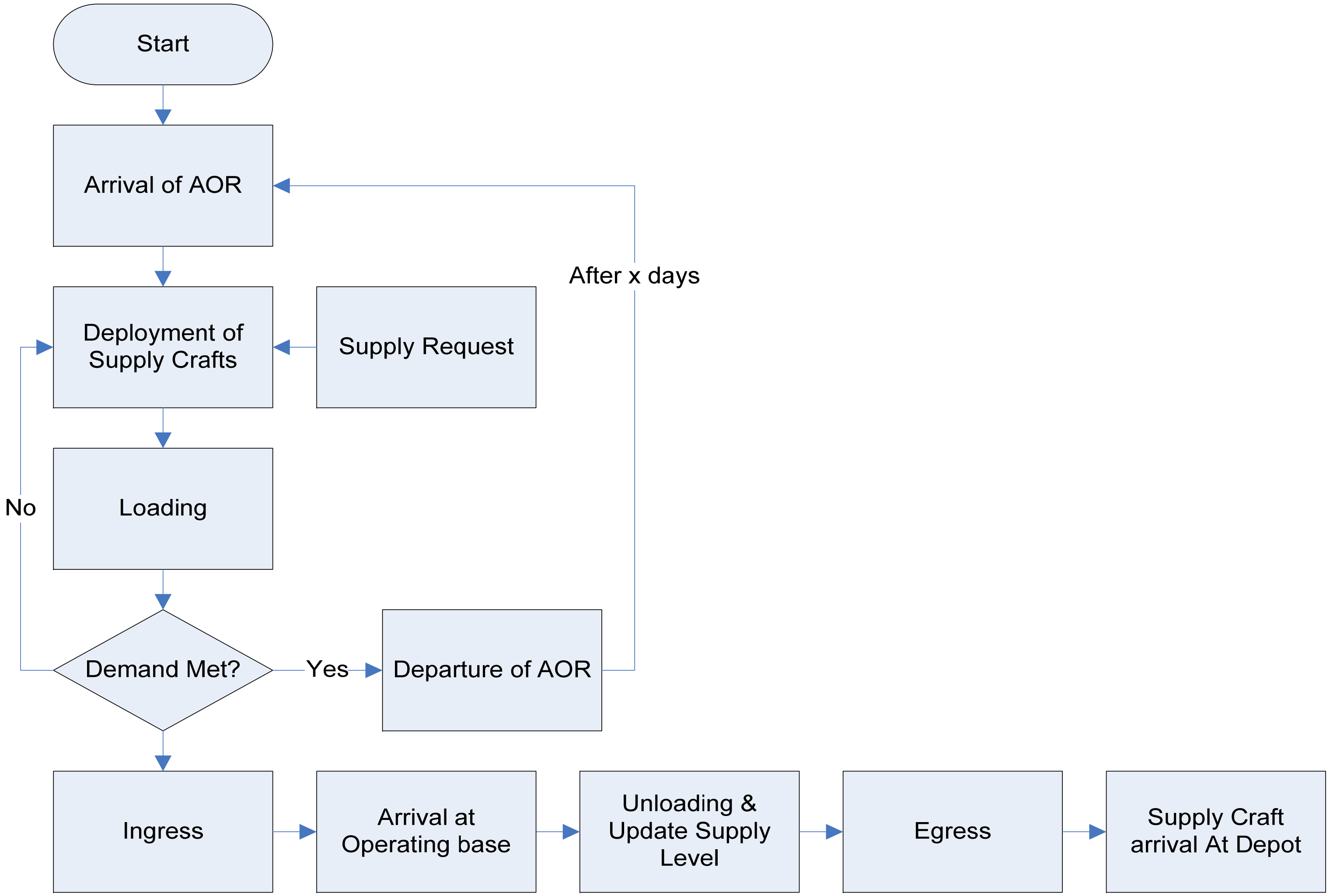
Supply M&S

Tan Kian Moh

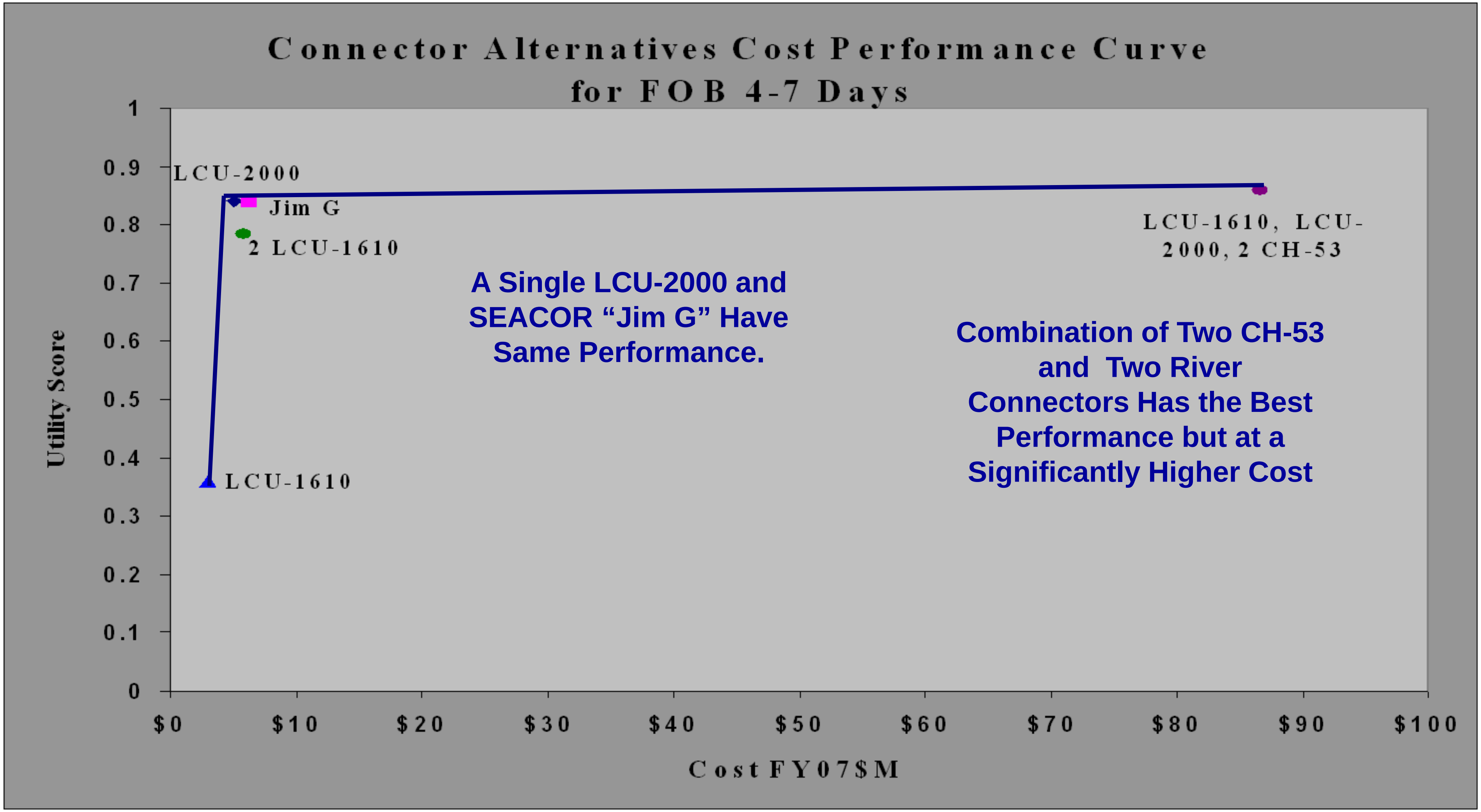
Modeling and Simulation

- SIMKIT
  - Determined Best Mix Using Two Waterborne Craft and Two Helicopters.
  - Broad Overview of Riverine Logistics Transport Using Gross Tonnage and Weather.
  - Consumption Rate is Linear
- EXTEND
  - Comparison of Two Best Waterborne Supply Craft from SIMKIT Between LCU-2000 and SEACOR “Jim G”
  - In Depth Look at how Crafts are Affected by Weather, Hostilities, Configuration Capacity, and Class of Supply.
  - Consumption Rate is Based on Operational Tempo and Number of Personnel at Basing Alternative.

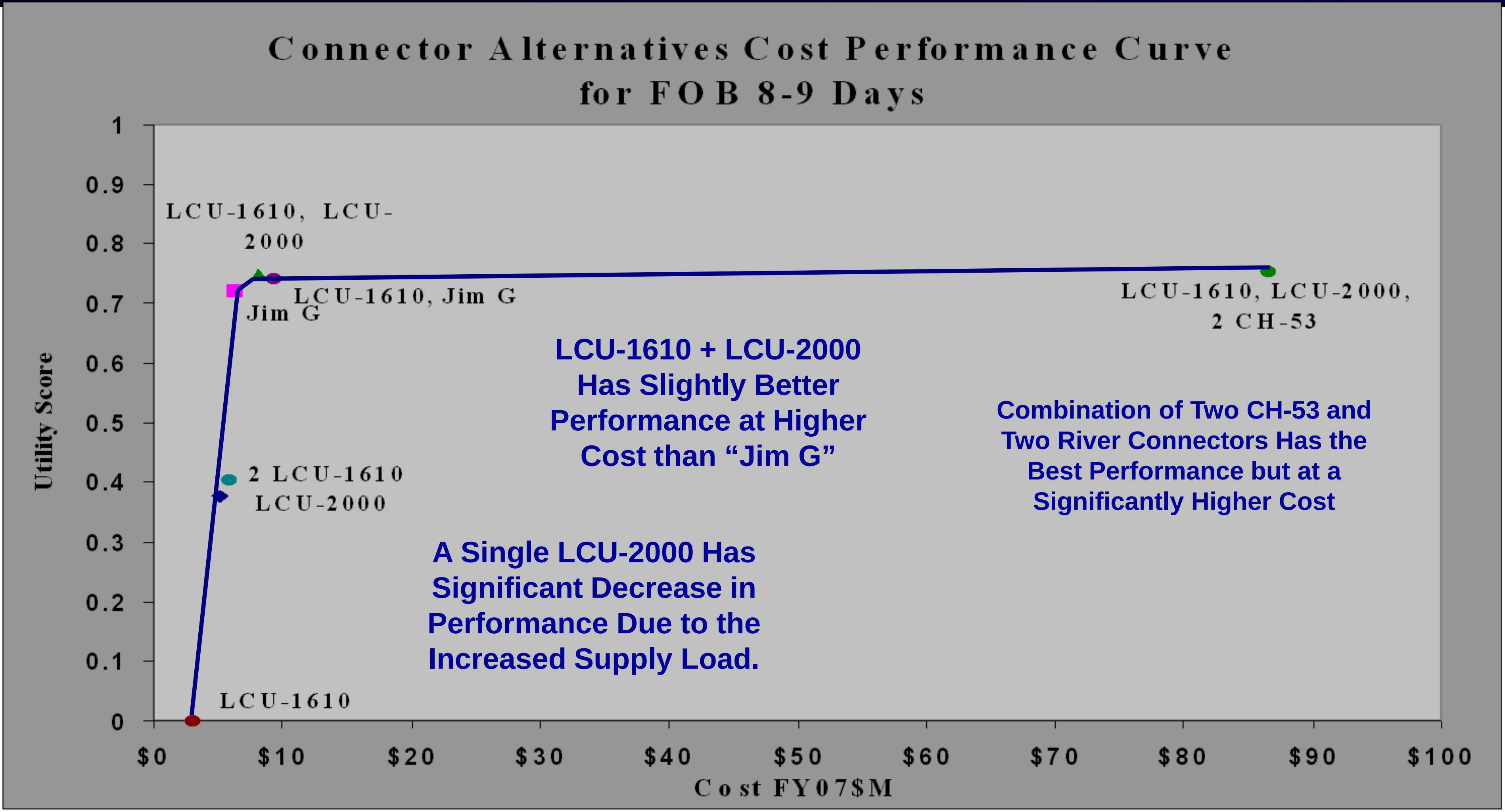
Modeling Flow



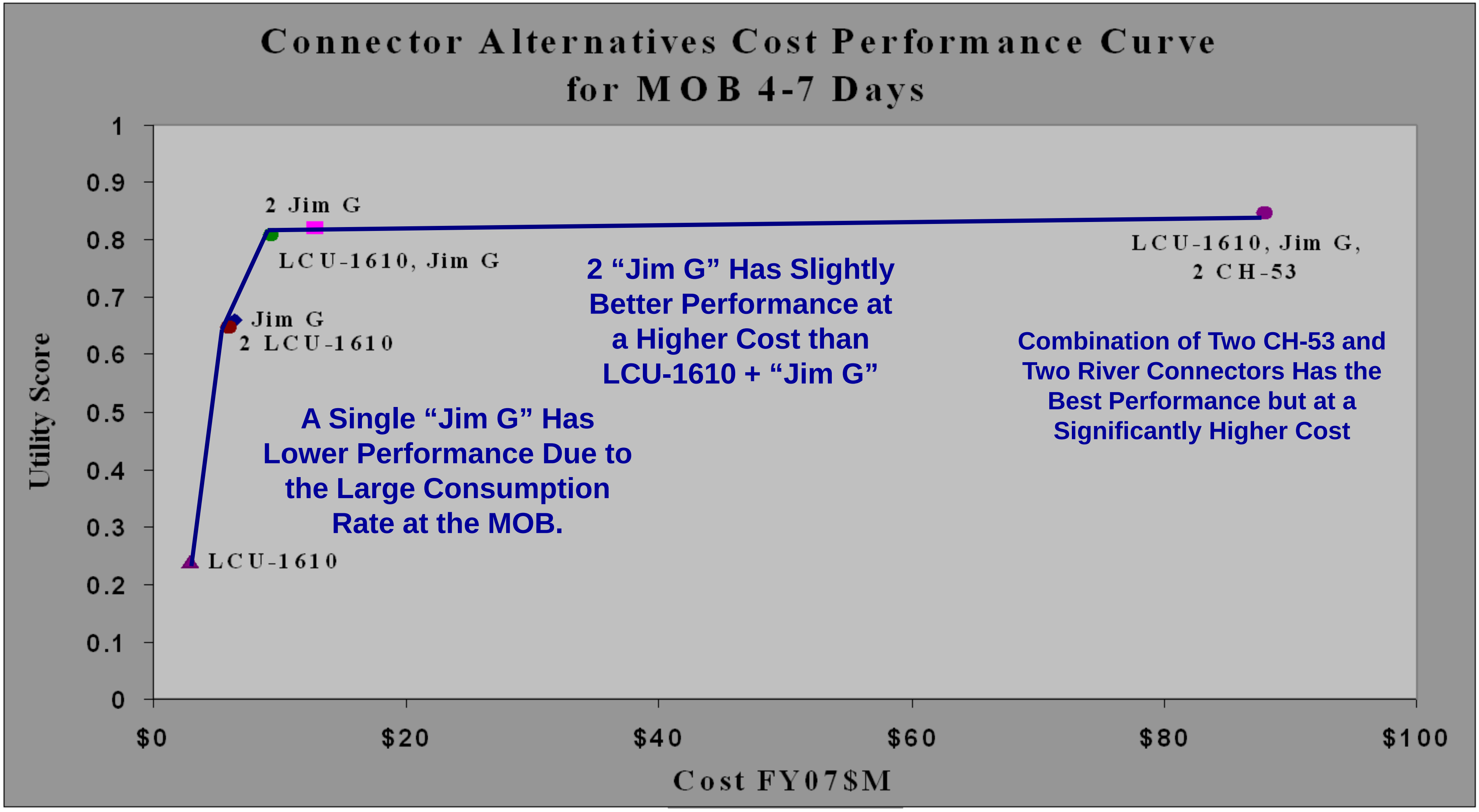
LCU-2000 Most Cost Effective



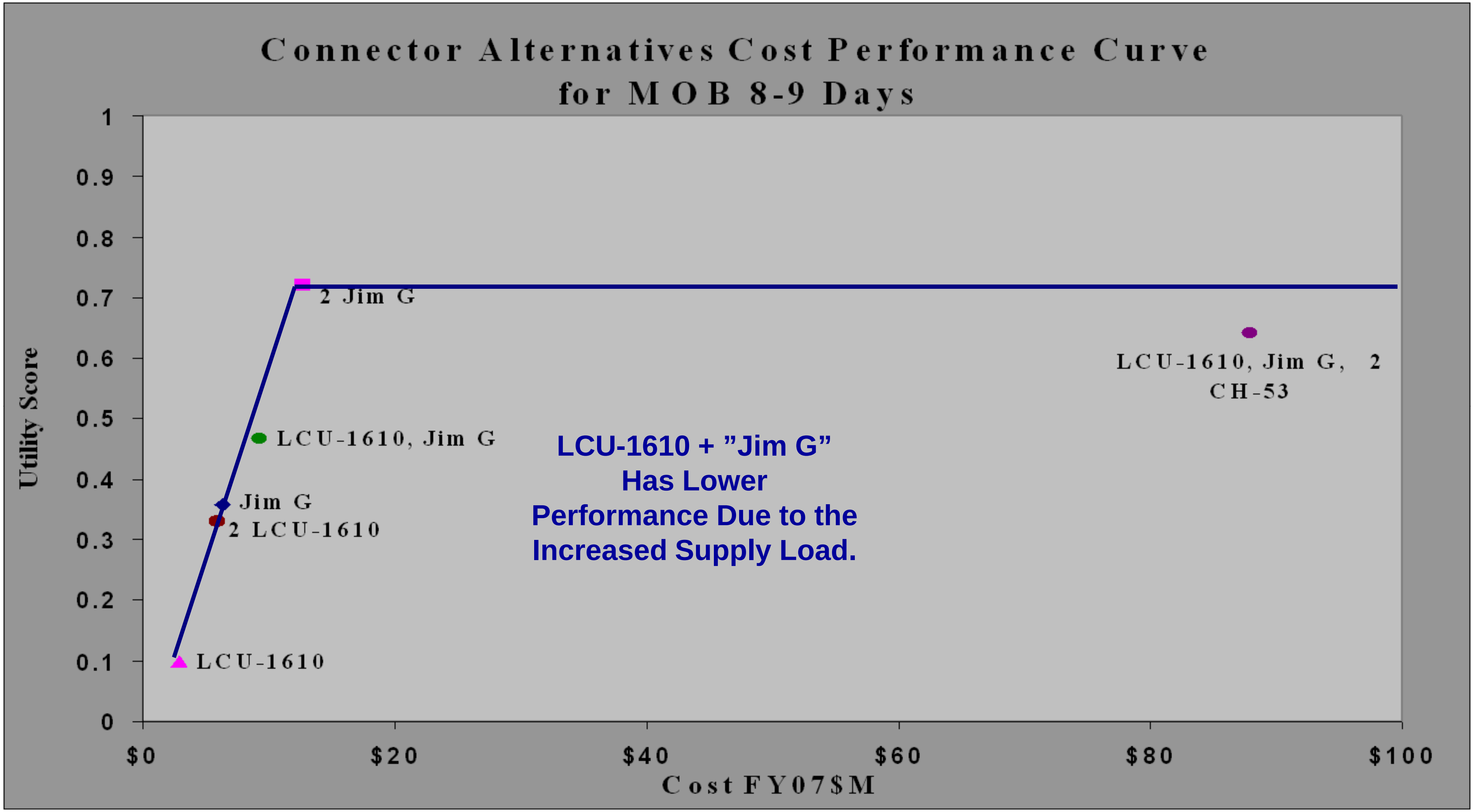
“Jim G” Most Cost Effective



LCU-1610 + Jim G Most Cost Effective



2 Jim G Most Cost Effective



To Maintain .95 Ao_{fuel} SURCs

- Max Supply Ship Cycle Time
  - FOB Low Conflict: LCU-2000 – 10 Days
    SEACOR "Jim G" – 12 Days
  - FOB High Conflict: LCU-2000 – 6 Days
    SEACOR "Jim G" – 7 Days
  - MOB Low Conflict: LCU-2000 – 8 Days
    SEACOR "Jim G" – 9 Days
  - MOB High Conflict: LCU-2000 – 5 Days
    SEACOR "Jim G" – 6 Days

Findings and Conclusion

- Key Factors of Riverine Sustainment Supply Success are Supply Ship Cycle Time, Basing Alternative, Logistics Connector Survivability, Operational Availability of the SURCs and Cost
  - LCU-1610 as a single supply craft is dominated by LCU-2000 and “Jim G”
  - Combinations of supply craft perform better at long supply ship cycle time
- Air Assets Do Not Significantly Improve Throughput and Raise Cost Substantially.
  - 1% increase in utility by CH-53’s does not justify $80M in cost
- For a Single Connector, “Jim G” Supported the Best Supply Ship Cycle Time.

Questions?

Repair

LT Neil Wharton

Repair Research Takeaways

Our model predicted:

- 13 SURCs are required to maintain an average of 9 available SURCs.
- 9 personnel produce an operational availability of 91%.
- MSRT has the greatest effect on A_o.

Repair System Objectives

Repair: Conduct Both Preventive and Corrective Maintenance in a Riverine Environment

Preventive Maintenance

- **Decrease Repair Time**
- **Increase Operational Availability**

Corrective Maintenance

- **Decrease Repair Time**
- **Increase Operational Availability**

Metrics

- **Operational Availability (A_o)**
- **Average Number of SURCs Available**
- **Mean Corrective Maintenance Time (MCMT)**
- **Mean Preventive Maintenance Time (MPMT)**

Repair Risk Analysis

Likelihood \ Consequence	Insignificant	Minor	Moderate	Major	Catastrophic
Almost Certain					
Likely		E2			
Moderate			O2 E3	C3 O1 O3	
Unlikely		C1			
Remote to None	E1	C2			

Likelihood

Consequence

C: Cost

O: Operational Availability

E: Environment

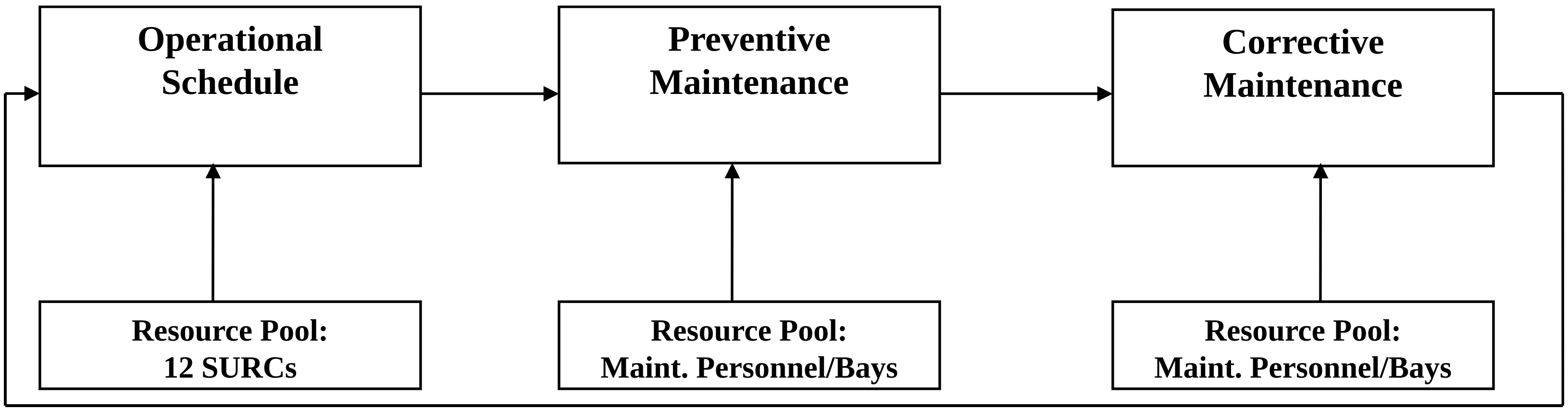
1: Add Personnel

2: Add Maint. Bays

3: Add SURCs

Repair Modeling

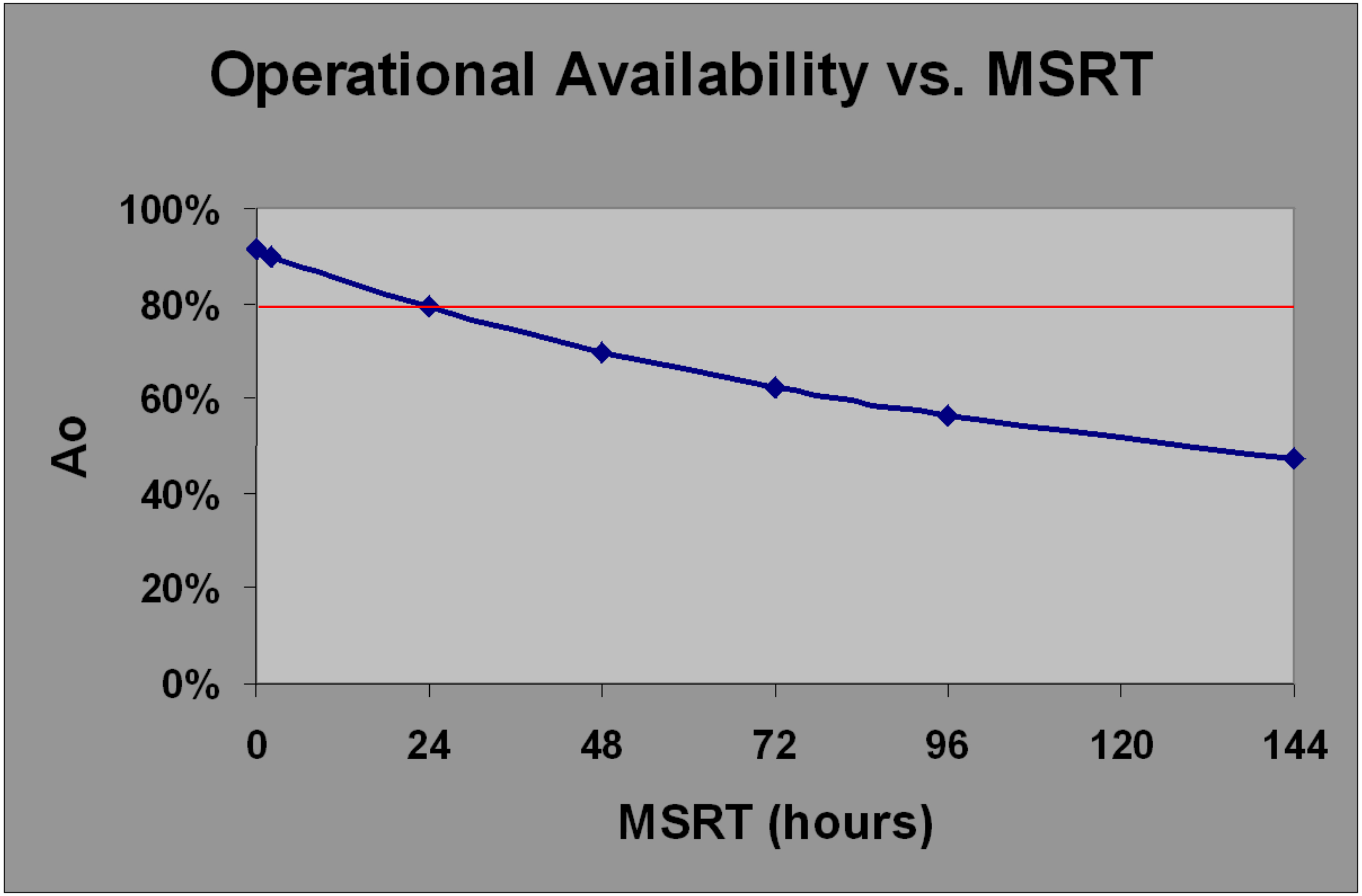
- EXTEND v 6.0.8 Provided the Queuing Model for the RF Maintenance Function
- Basic Functional Flow Model:



No Significant Differences in Maintenance Alternatives

Alternative	Ao
Increase Bays & SURCs	0.9125
BAYS	0.9126
Status Quo	0.9128
SURCs	0.9147
Personnel	0.9225
Increase All 3 Alternatives	0.9237
Increase Personnel & Bays	0.9242
Increase Personnel & SURCs	0.9256

SURC Availability Decreases as MSRT Increases



Repair Conclusions

- MSRT is the Biggest Driver of Ao.
- Riverine Force Needs 13 SURCs.
- Increasing Personnel and/or Maintenance Bays does Not Significantly Increase Operational Availability.

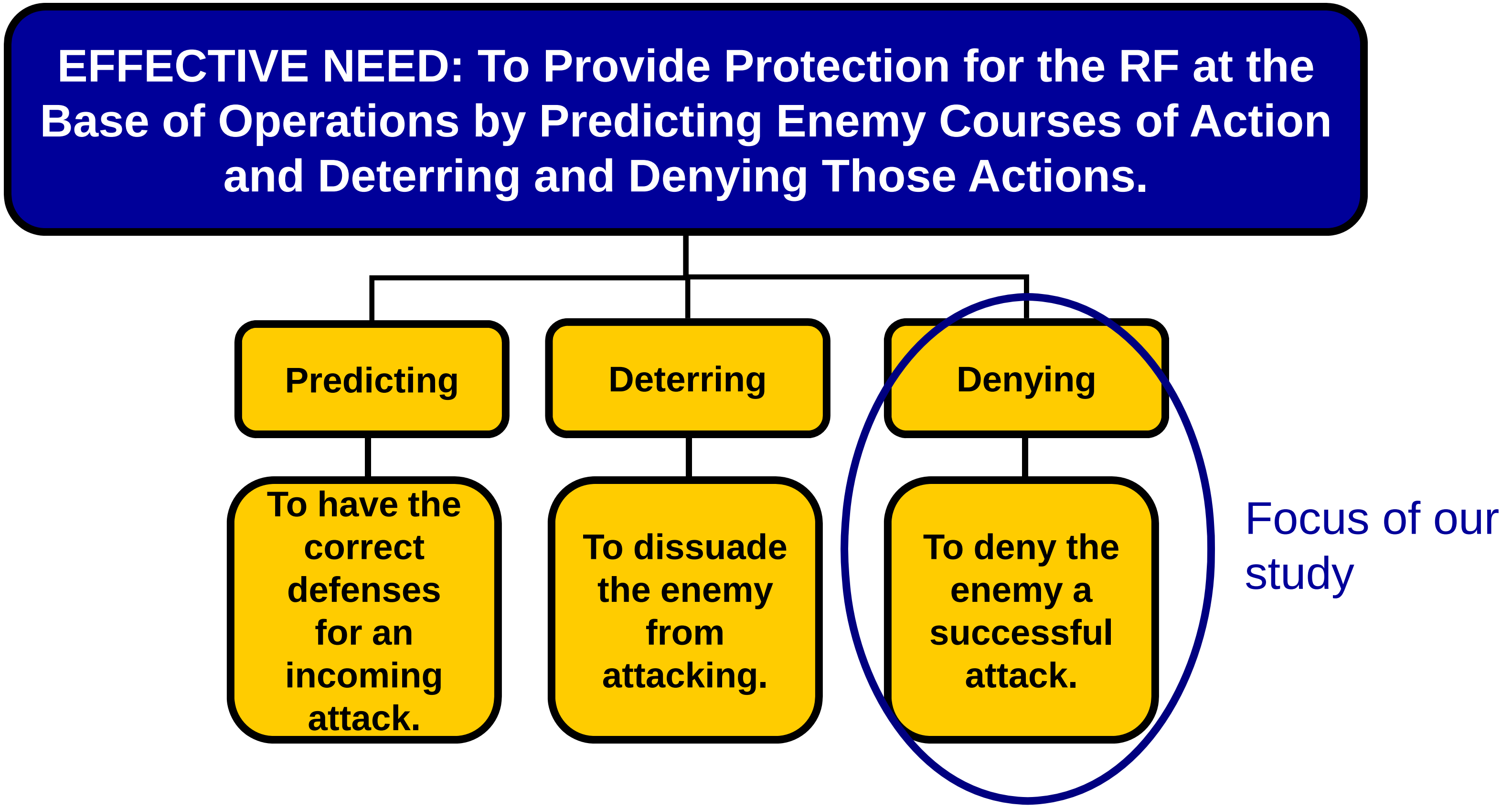
Questions?

ENS Tom Schmitz

Force Protection Takeaways

- Current mortar defenses are insufficient. If U.S. forces cannot rely on host nation support for base defense out to expected mortar threat range, then a FOB becomes a vulnerable basing alternative.
- A water barrier and Remote Operated Small Arms Mounts (ROSAMs) are the most cost effective means of defending the FOB against a boat attack.
- The Nobriza and Barge Baseline is the most cost effective means of defending a MOB against a boat attack.
- IR Illuminators are valuable assets.

Force Protection Objectives Hierarchy



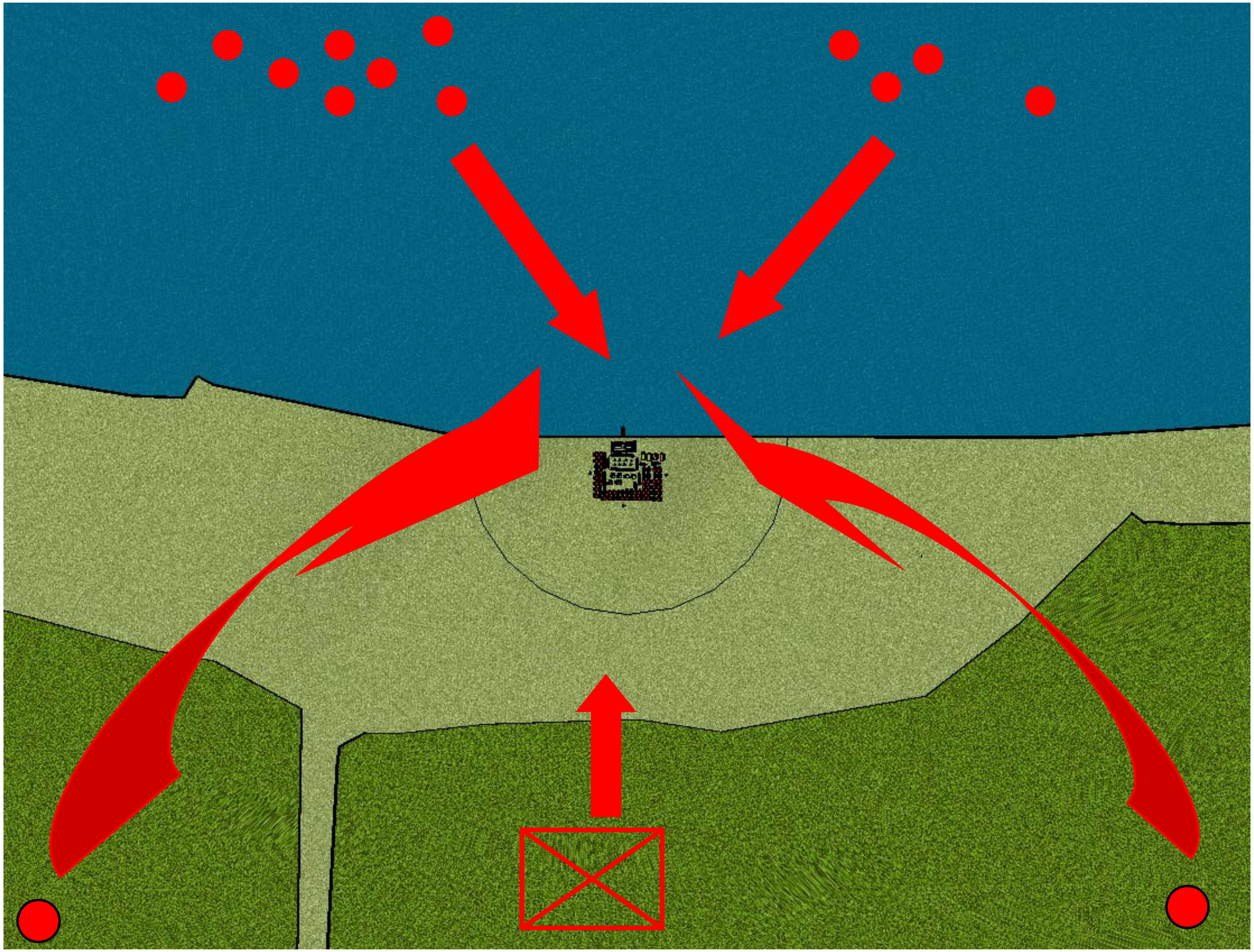
Metrics:

Mortar Attack: Time to Detect and Hits on Base

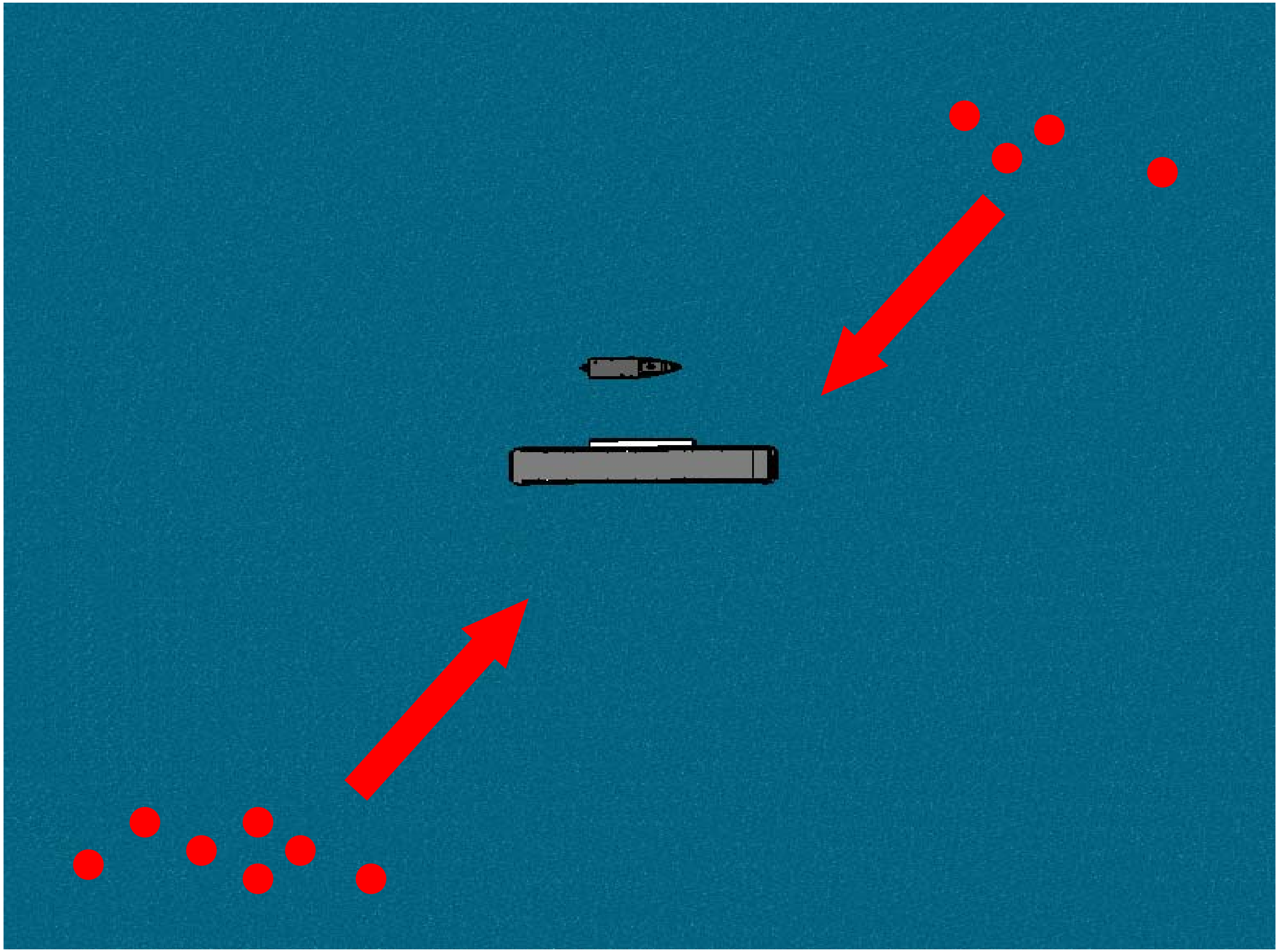
Commando Raid: Force Exchange Ratio and Infiltrations

Boat Attacks: Mean Detection Distance, SURCs Destroyed, and Casualties

Threats Considered



Threats Considered Continued

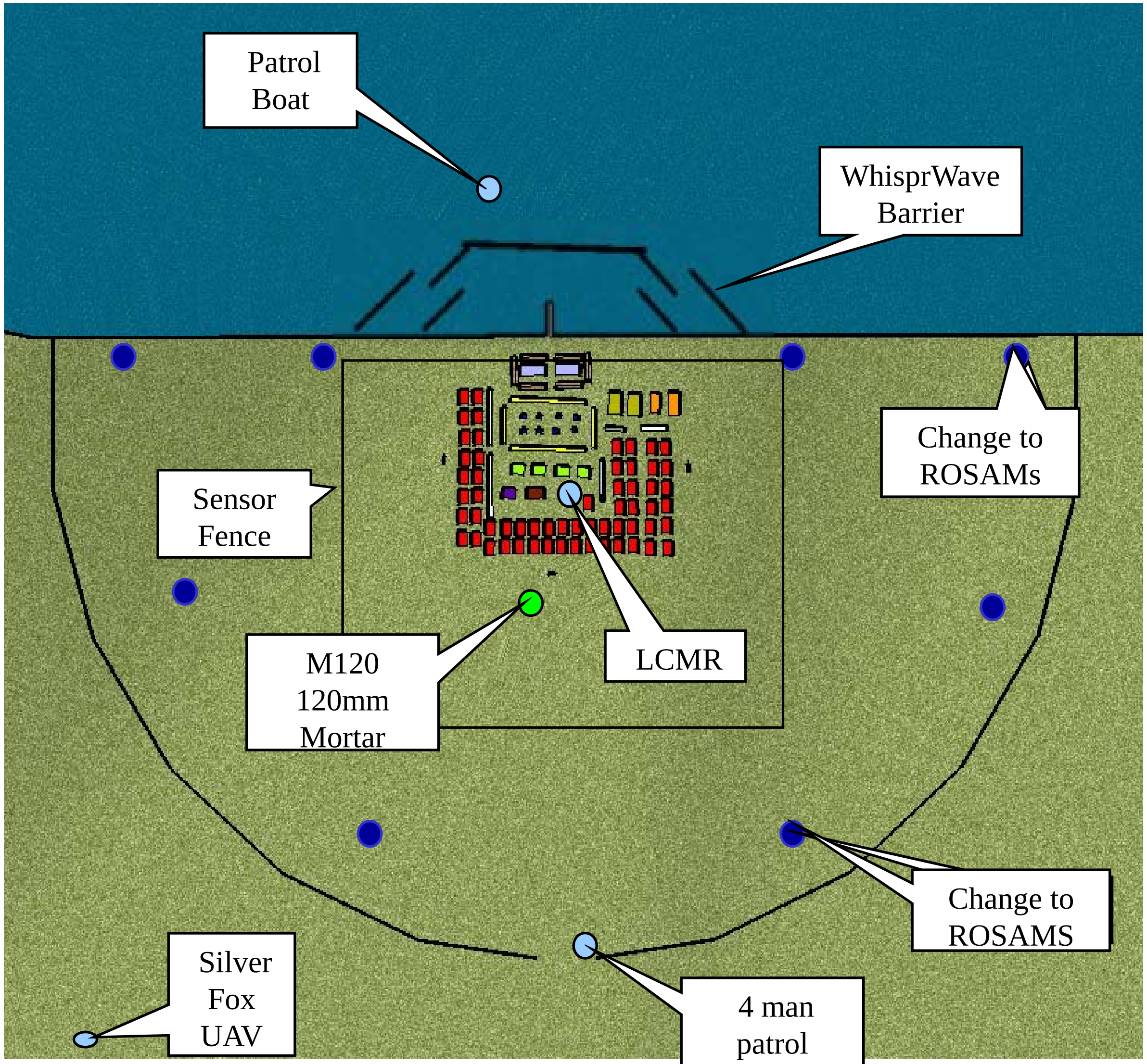


FOB Alternative Generation

Mortar Defense
Baseline
Baseline plus Mortar and UAV
Baseline plus Mortar and LCMR
Baseline plus Mortar, LCMR, and UAV

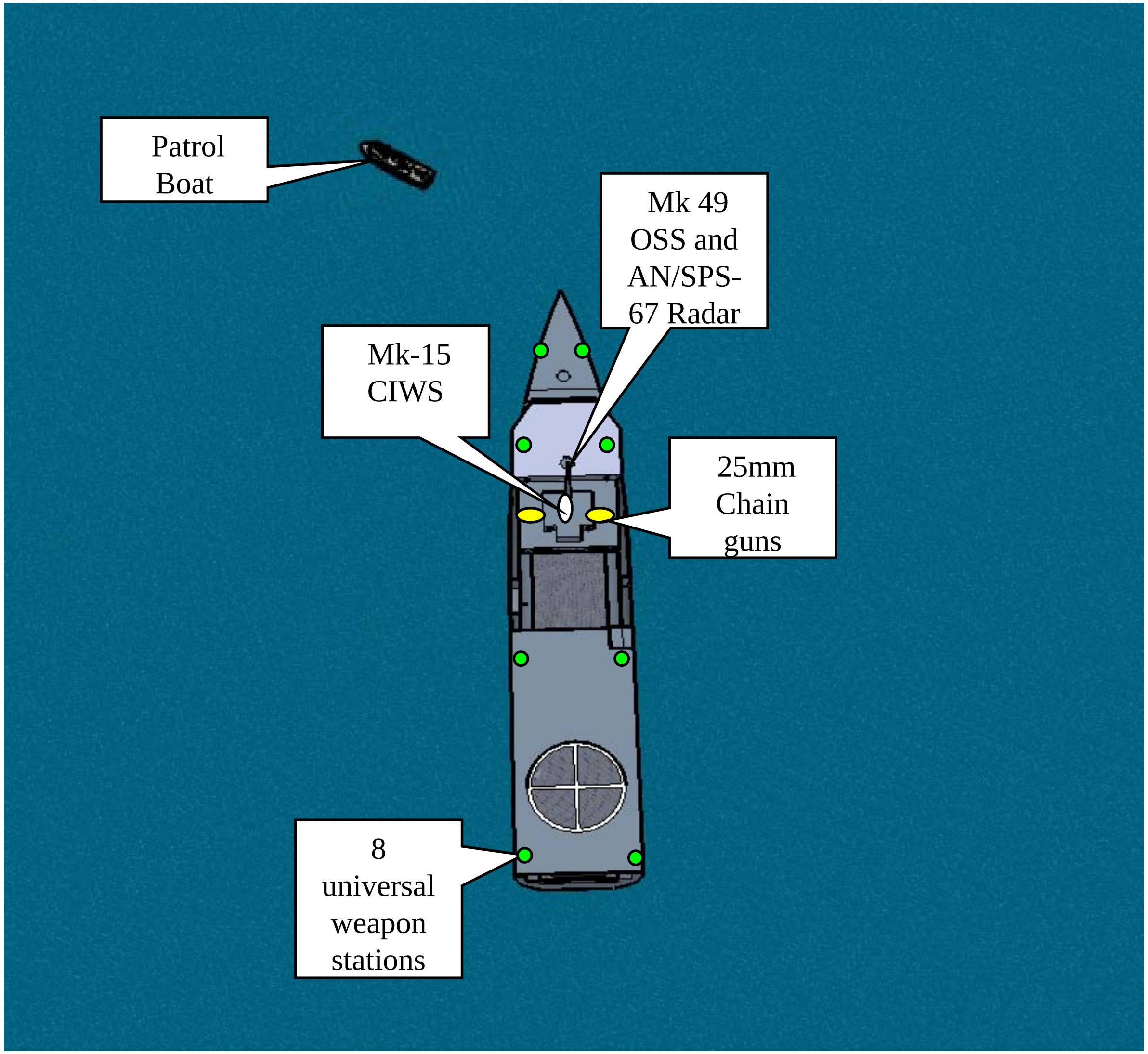
Commando Raid on FOB Defense
Baseline
Baseline plus Sensor Fence and Mortar
ROSAMs

FOB Boat Attack Defense
Baseline
Baseline plus Water Barrier
Water Barrier and ROSAMs
Baseline plus Water Barrier and Patrol Boat
ROSAM plus Water Barrier and Patrol Boat



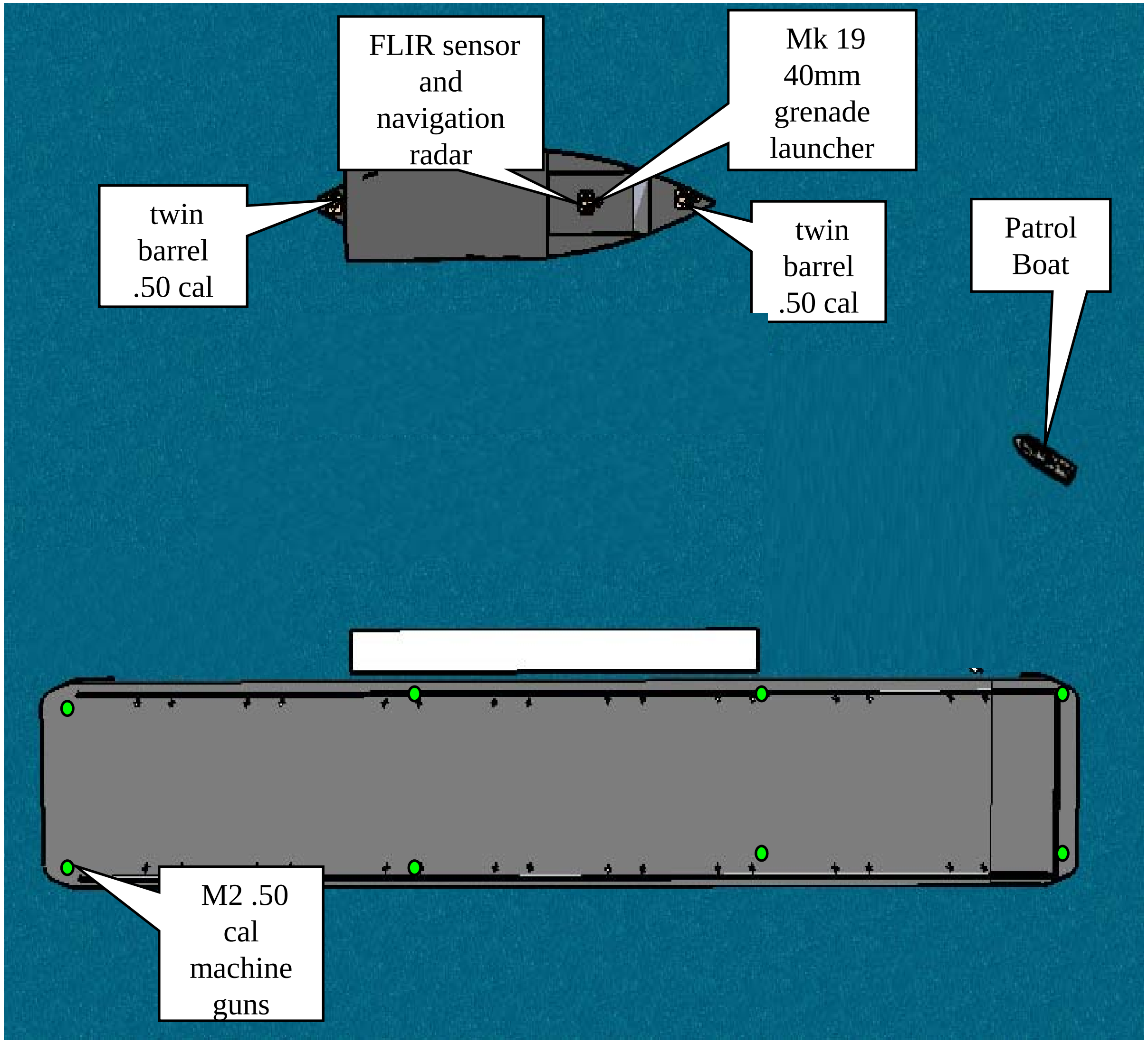
MOB Alternative Generation

MOB Boat Attack Defense
RCSS
RCSS plus Patrol Boat



MOB Alternative Generation

MOB Boat Attack Defense
Nobriza and Barge
plus Patrol Boats and Water Barrier



Force Protection Risk Analysis

Likelihood \ Consequence	Insignificant	Minor	Moderate	Major	Catastrophic
Almost Certain					
Likely					
Moderate		M(4)	T(1) M(1)	C(3)	
Unlikely		T(2) M(2)	T(5) C(2) M(5)		
Remote to None	T(4) M(3) T(3) C(1) C(4)	C(5)			

Likelihood

Consequence

M: Military Effectiveness

C: Collateral Damage

T: Technical

1: LCMR

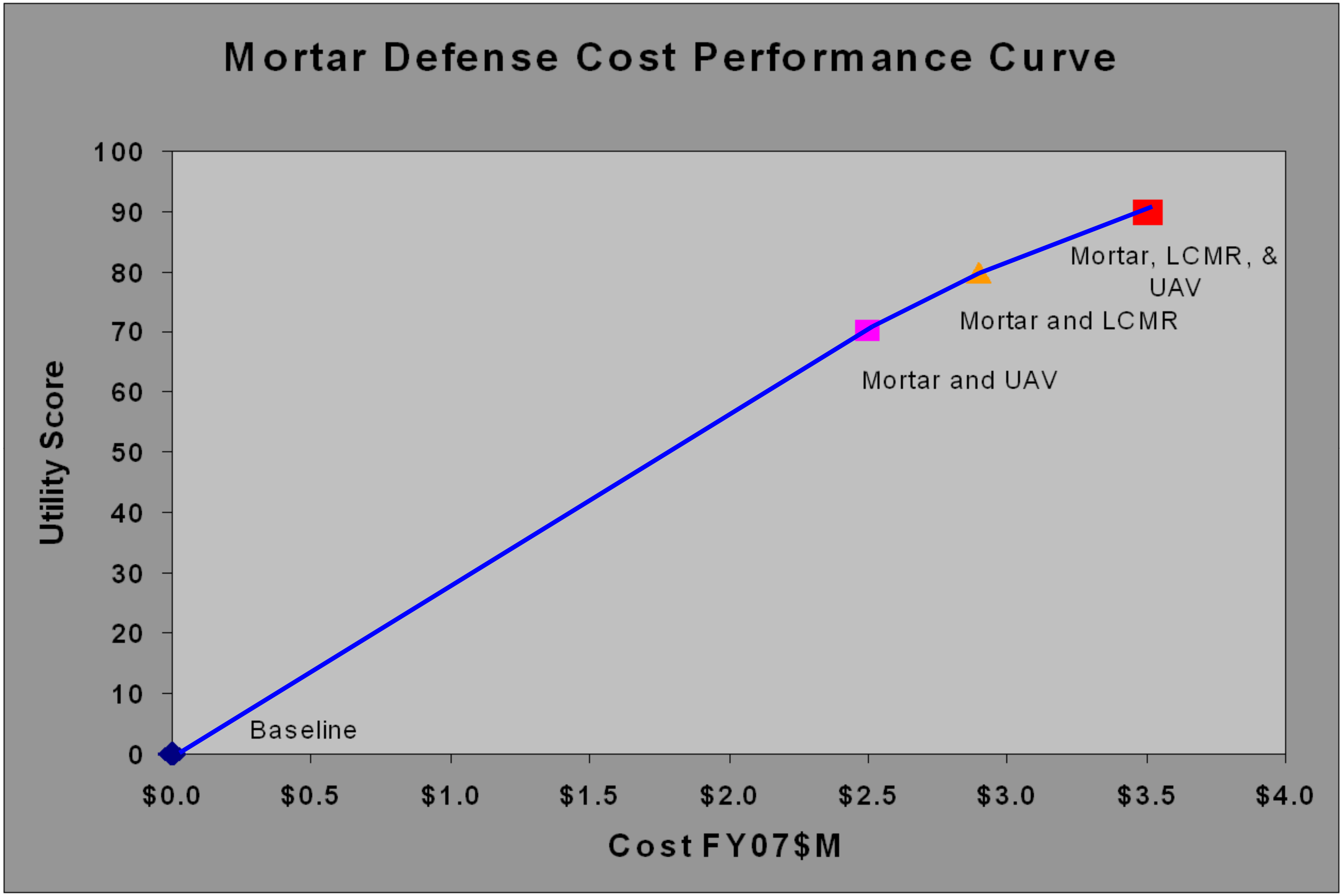
2: ROSAM

3: Mortar

4: Sensor Fence

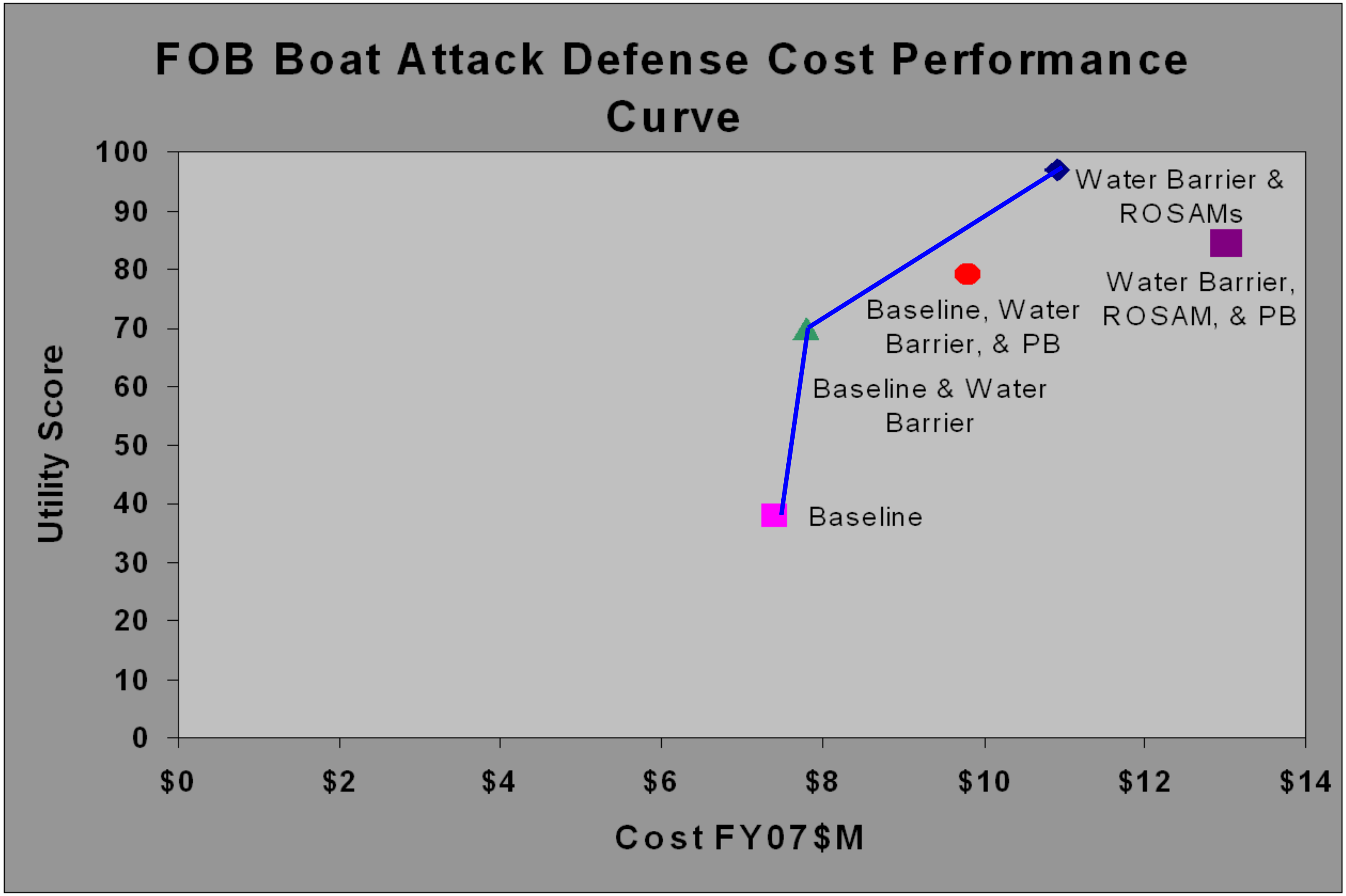
5: WhisprWave

No Mortar Defense Alternative is Dominated

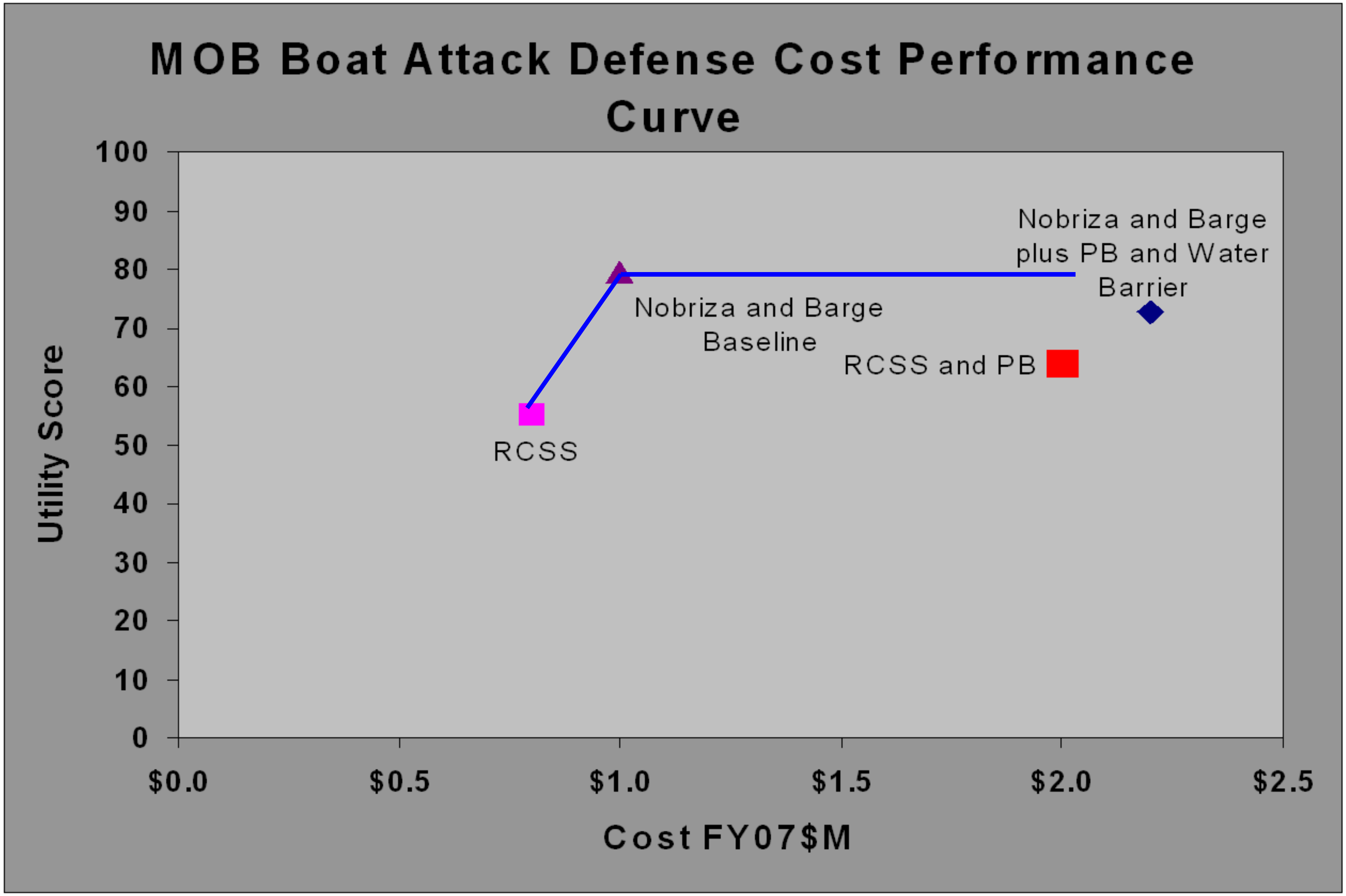


Baseline, Sensor Fence, and Mortars is the Most Cost Effective

The Baseline and Water Barrier is the Most Cost Effective



Nobriza and Barge Baseline is the Most Cost Effective



Force Protection

CPT Gil Nachmani

MATLAB Simulation

Compared to MANA:

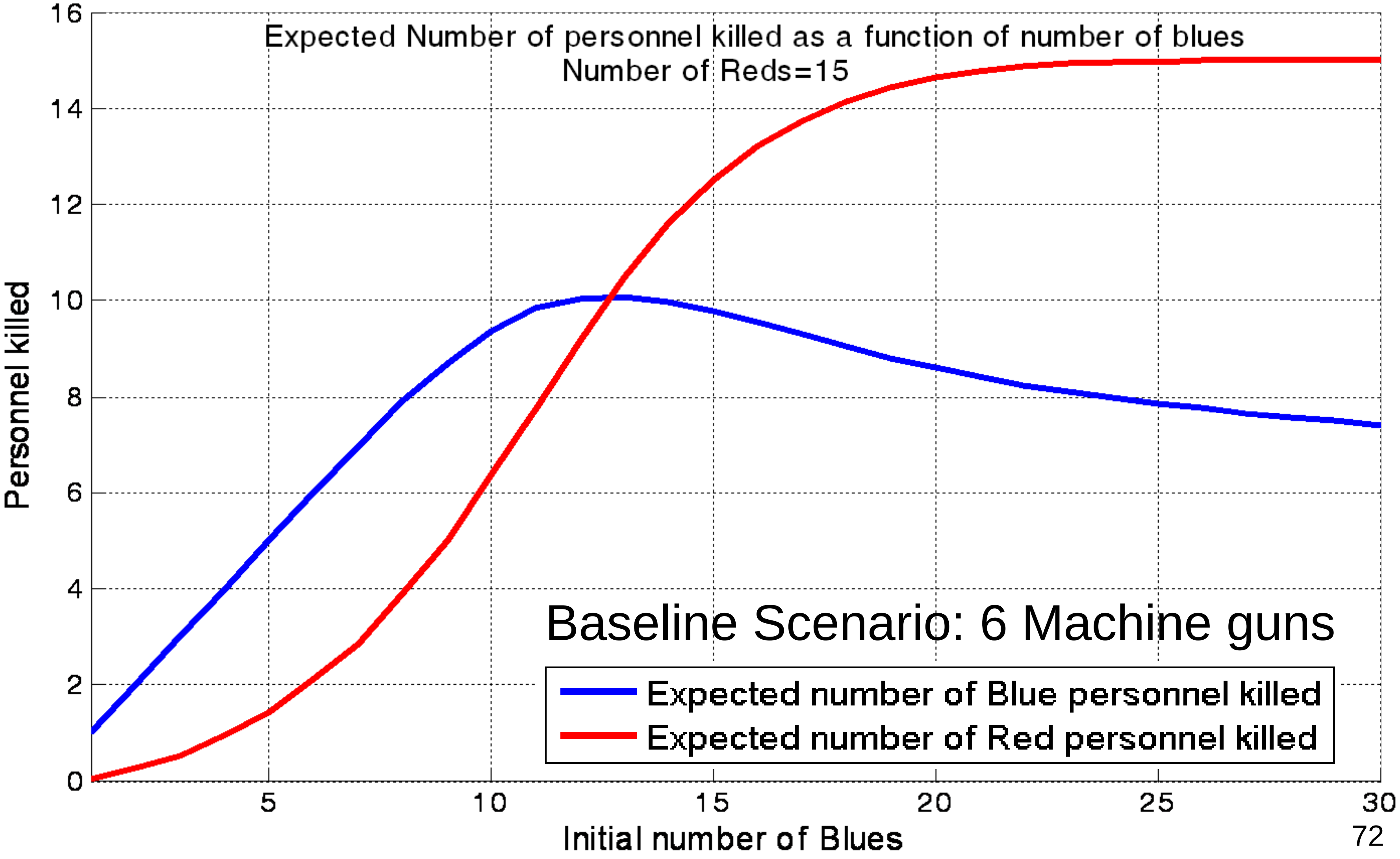
+ Full Control of Variables /Parameters
+ Complete Understanding of the Models

- Simplified Tactical Considerations
- Simpler Scenarios

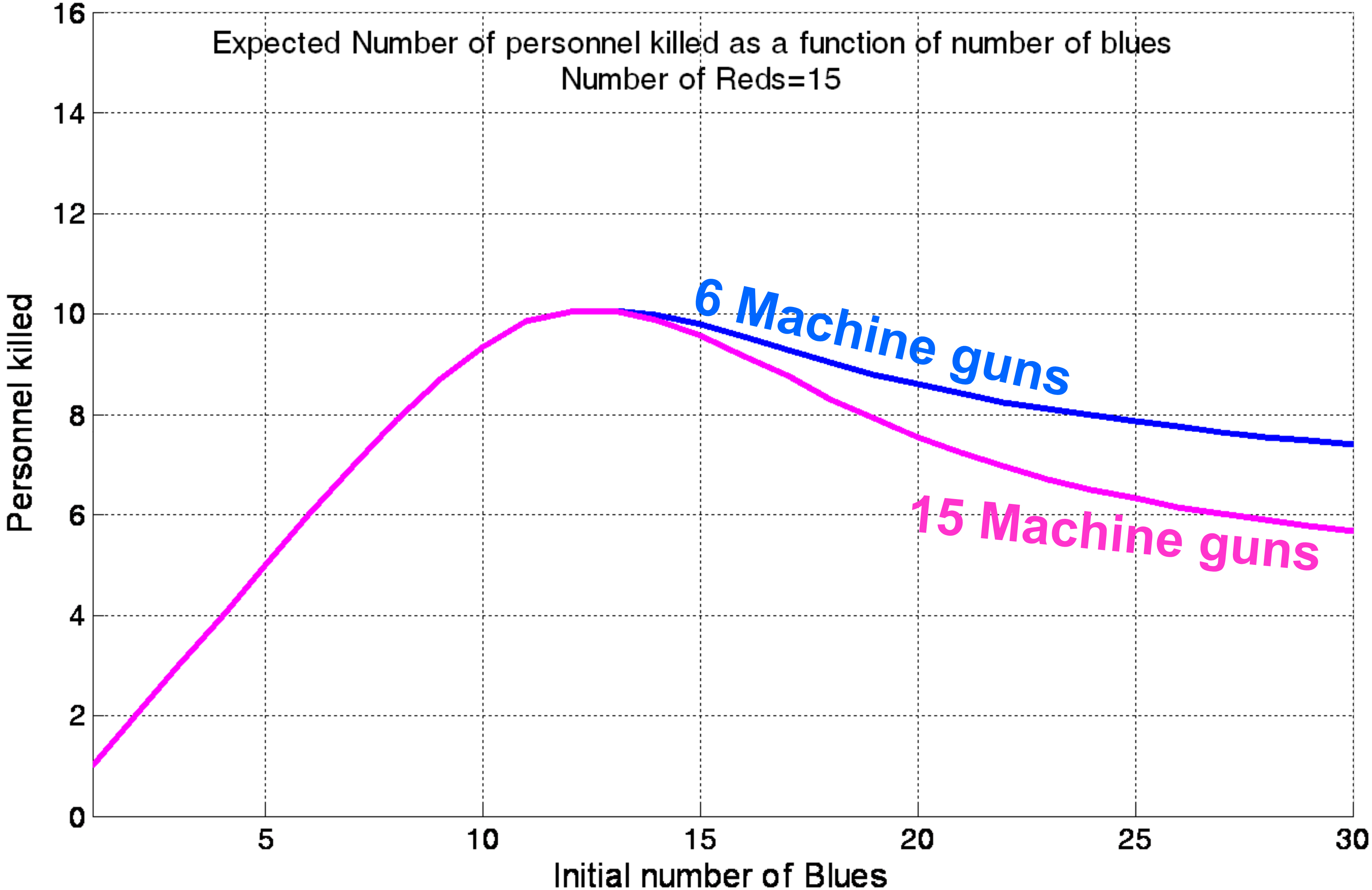
MATLAB Simulation

Stage	Possible Outcomes	Variables
Sensing and Detecting	**Red Forces are Detected Before Combat Starts** **Red Forces Manage to Approach Surprise Range**	**Number of sensors**
Combat	**Blue Forces Annihilated** **Red Forces Annihilated**	**Defensive Measures:** Machine guns IR illuminators Bunkers

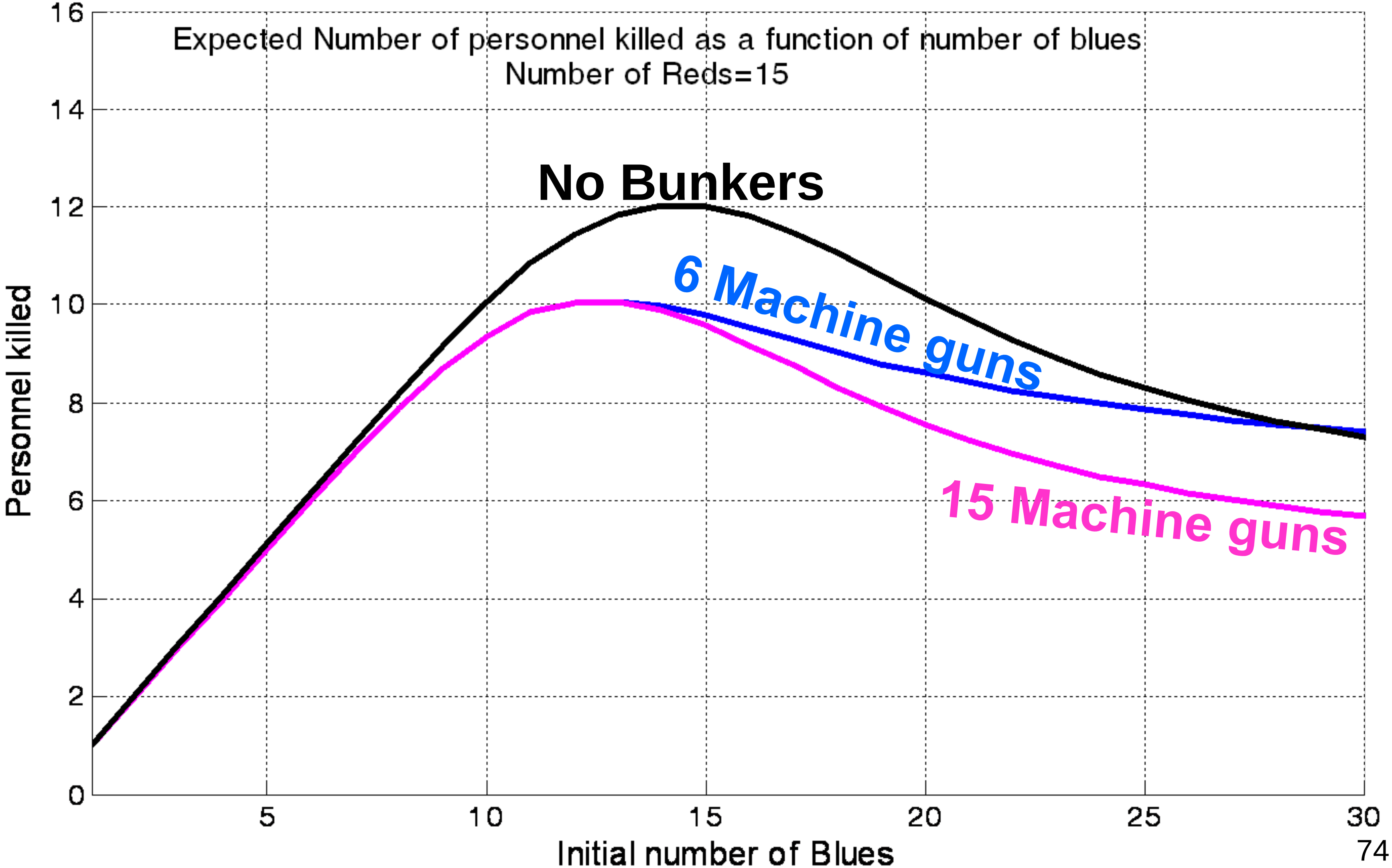
Effects of Defensive Measures



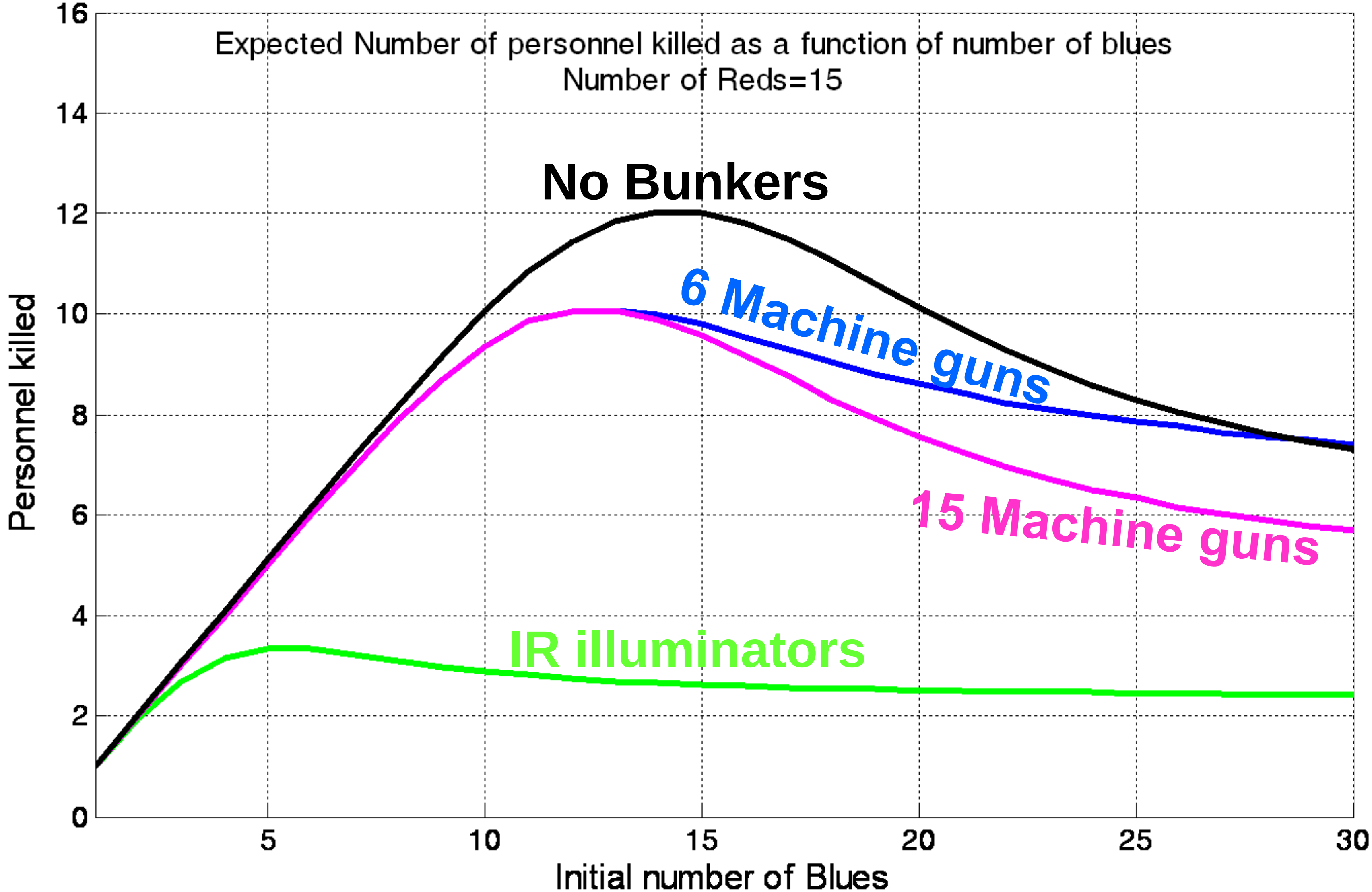
Effects of Defensive Measures



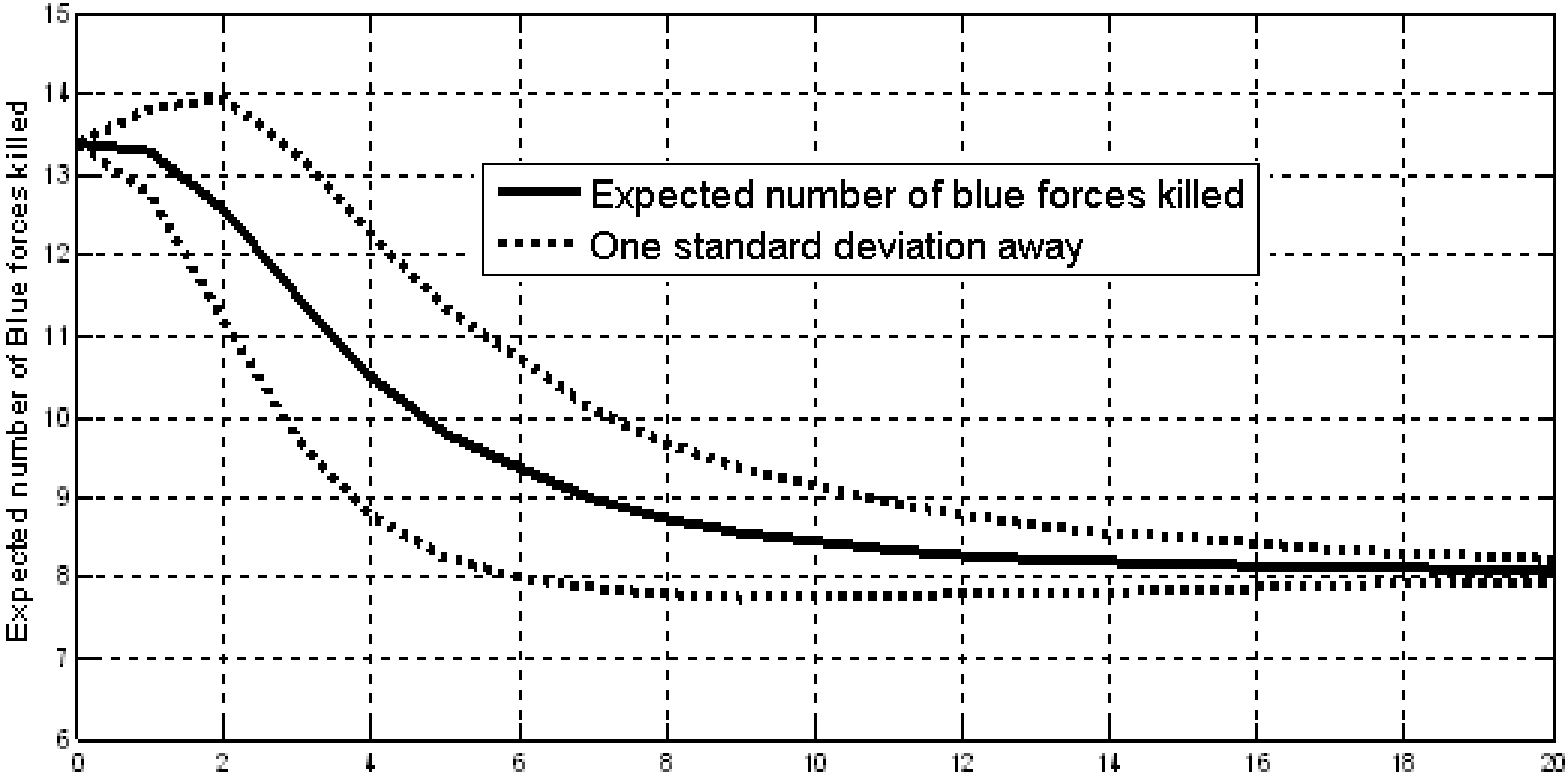
Effects of Defensive Measures



Effects of Defensive Measures



The Effect of IR Sensors



Number of IR Sensors

MATLAB Conclusions

- **Illuminators are the Most Valuable Measure** (recommend obtaining one for every person)
- **IR Sensors are Important, but Costly** (recommend 5-10 sensors)
- **Bunkers are Important for Small Numbers of Blue Forces** (recommended one for each machine gun post, 6 in total)
- **Additional Machine Guns are Important for Larger Numbers of Blue Forces** (recommended 6)

Questions?

For Further Questions Break Out Session Start at 1200 in Bullard 100B