Port Security Strategy 2012

SEA-11 Naval Postgraduate School
TDSI National University of Singapore
May 31, 2007

Port Security Strategy 2012 Team

SEA-11

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Mr. Leng Huei Toh
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Agenda

1300-1310	Introduction
1310-1330	Terrestrial Threats Group
1330-1335	Question Break #1
1335-1355	Regional Seaborne Threats Group
1355-1400	Question Break #2
1400-1420	Source Seaborne Threats Group
1420-1425	Question Break #3
1425-1445	Internal Personnel Threats Group
1445-1500	Question Break #4
1500-1600	Breakout Session in Bullard 100A

Tasking Letter
Meyer Institute of SE

- Design a conceptual system of systems to improve Port Security measures for U.S. ports, and Force Protection options for U.S. forces in U.S. and foreign ports.
- Potential focus areas:
  – Provide individual ship self protection
  – Integrate shipboard protection systems with shore-based systems
  – Integrate Allied and Navy vessels to commercial port security systems

Selected Documents

- Homeland Security Presidential Directive 13 (HSPD-13)
- National Strategy for Maritime Security
- International Outreach and Coordination Strategy
- International Ship & Port Facility Security Code and SOLAS Amendments 2002

SE Design Process

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November – February 2006-2007	February – March 2007	March - May 2007
DEFINITION	**DEVELOPMENT**	**MODELING/ANALYSIS**
Stakeholder Analysis System Decomposition Scope/Bound Problem	Alternatives Generation Feasibility Screening Qual. Func. Deployment	Performance Modeling Cost Benefit Analysis Scenario Results

Stakeholders Concerns

- Land based
  - Attacks on infrastructure
- Sea based
  - Attack from local waterways
  - Attack via container from foreign ports
- Internal based
  - Attack via employee sabotage

Overall Effective Need

"To protect commercial and Allied shipping by deterring and denying potential terrestrial, seaborne, and internal threats."

Problem Decomposition

- Terrestrial Threats Group
  - Threats from landside port perimeter
- Source Seaborne Threats Group
  - Threats from originating port
- Regional Seaborne Threats Group
  - Threats from seaside of in-port ship to port boundary
- Internal Personnel Threats Group
  - Threats from personnel at port facility

Terrestrial Threats Group

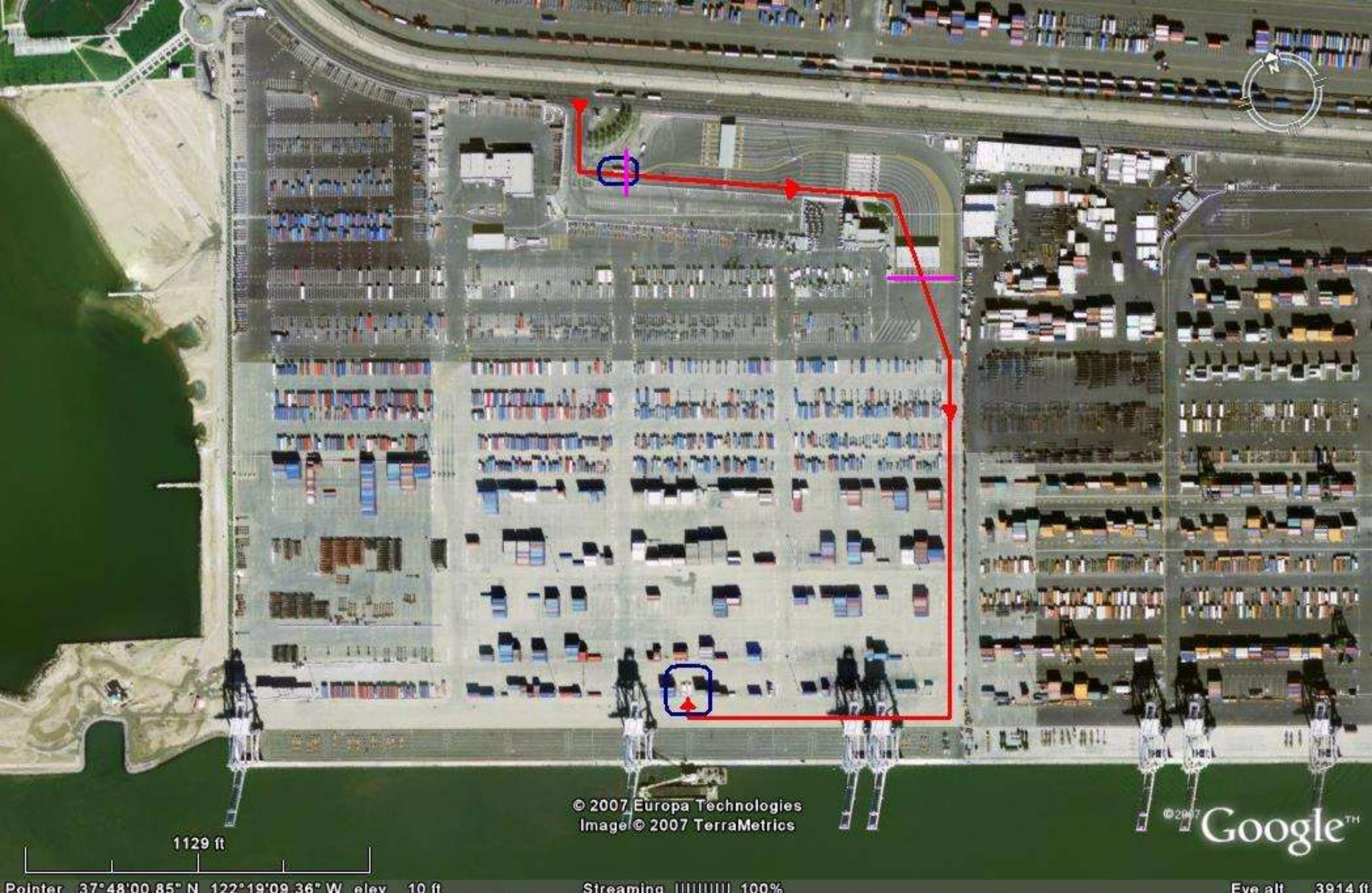
Andrew Cole – Group Lead
Yi Wong – Deputy Lead
MAJ Kim Chuan Chng
MAJ Wei Ting Soh
Mr. Leng Huei Toh
Mr. Lin Kiat Peh

Terminal Operator's Greatest Concern

- Prevent a vehicle laden with explosives from gaining access to the ports facilities while keeping total life cycle cost and impact on normal port operations to a minimum.

Terrestrial Threats Group Scenario

- A Container truck laden with explosives attempts to gain access to a terminal in a major U.S. port by speeding past the security guard at the terminal's entrance.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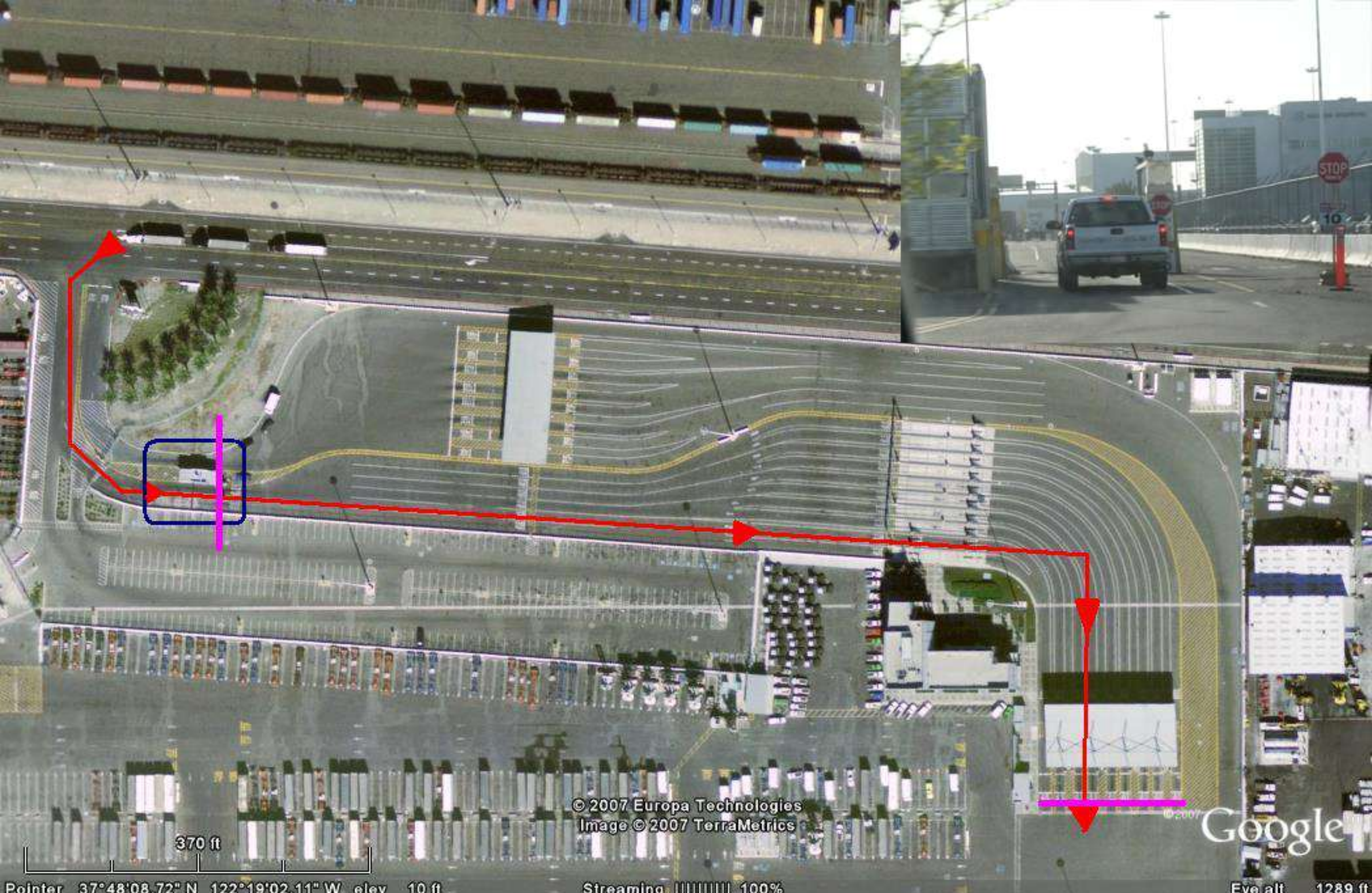
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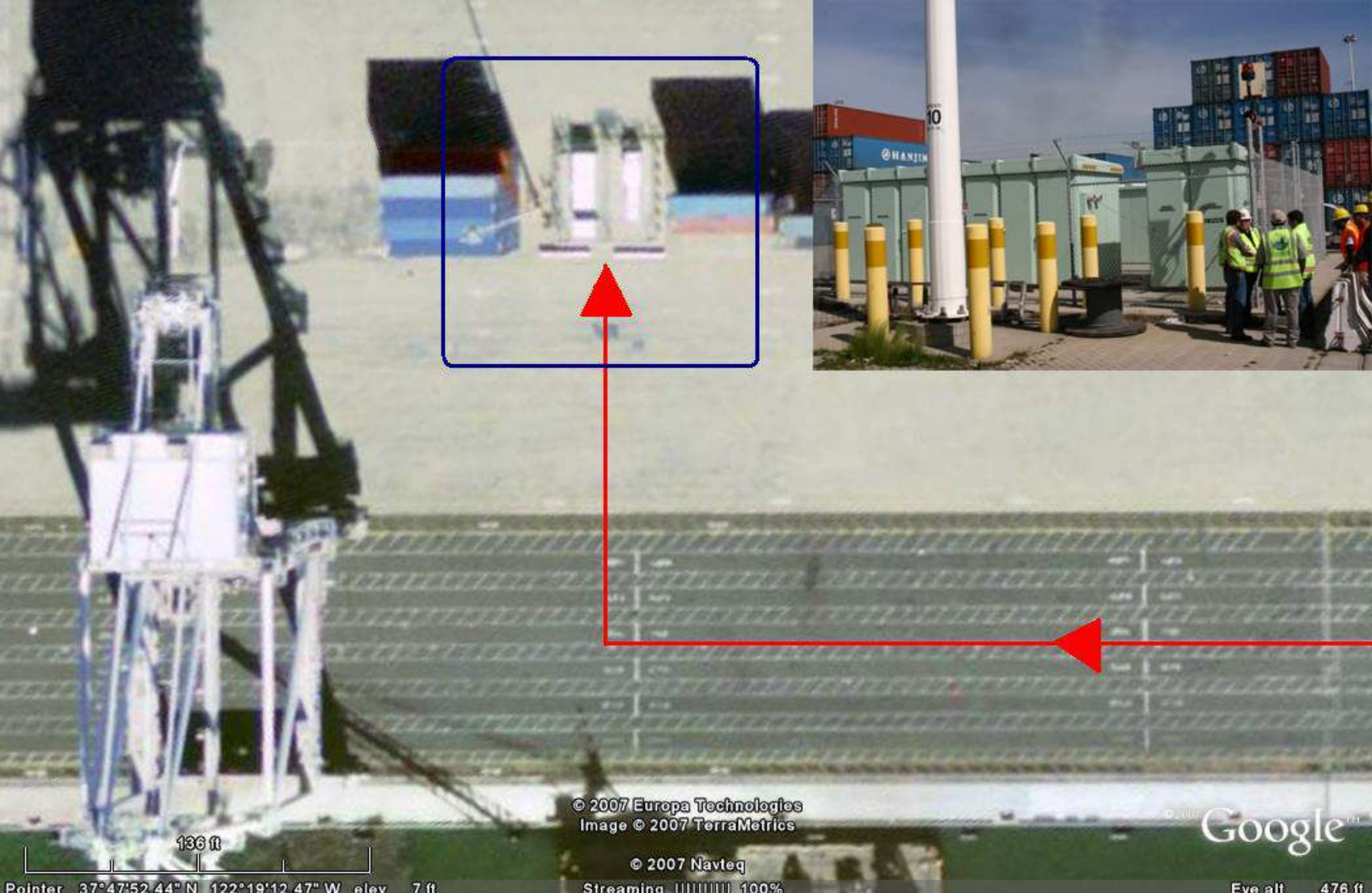
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Fort Lauderdale, FL
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Terrestrial Threats Group Alternatives

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Key Findings

- Each port terminal needs to assess its vulnerability to a vehicular IED attack
- Perimeter fencing should be hardened before gate security improvements are made
- In our study, an armed guard was not cost effective
- Physical barriers are more effective than armed guards.
- Pop-Up Barriers with staggered concrete blocks before the barrier and at least 300’ between the guardhouse and barrier provide the best effectiveness.

Terrestrial Threats Group Modeling

- The effect of staggered concrete blocks to slow incoming vehicles

3 levels: No blocks, blocks before guardhouse, and blocks before barrier

- The effect of the distance between the guard house and the barrier

5 levels: 100’, 300’, 500’, 700’, and 900’

Terrestrial Threats Group Metrics

- System Effectiveness

1-(Number Successful Attacks)/(Number Attempted Attacks)

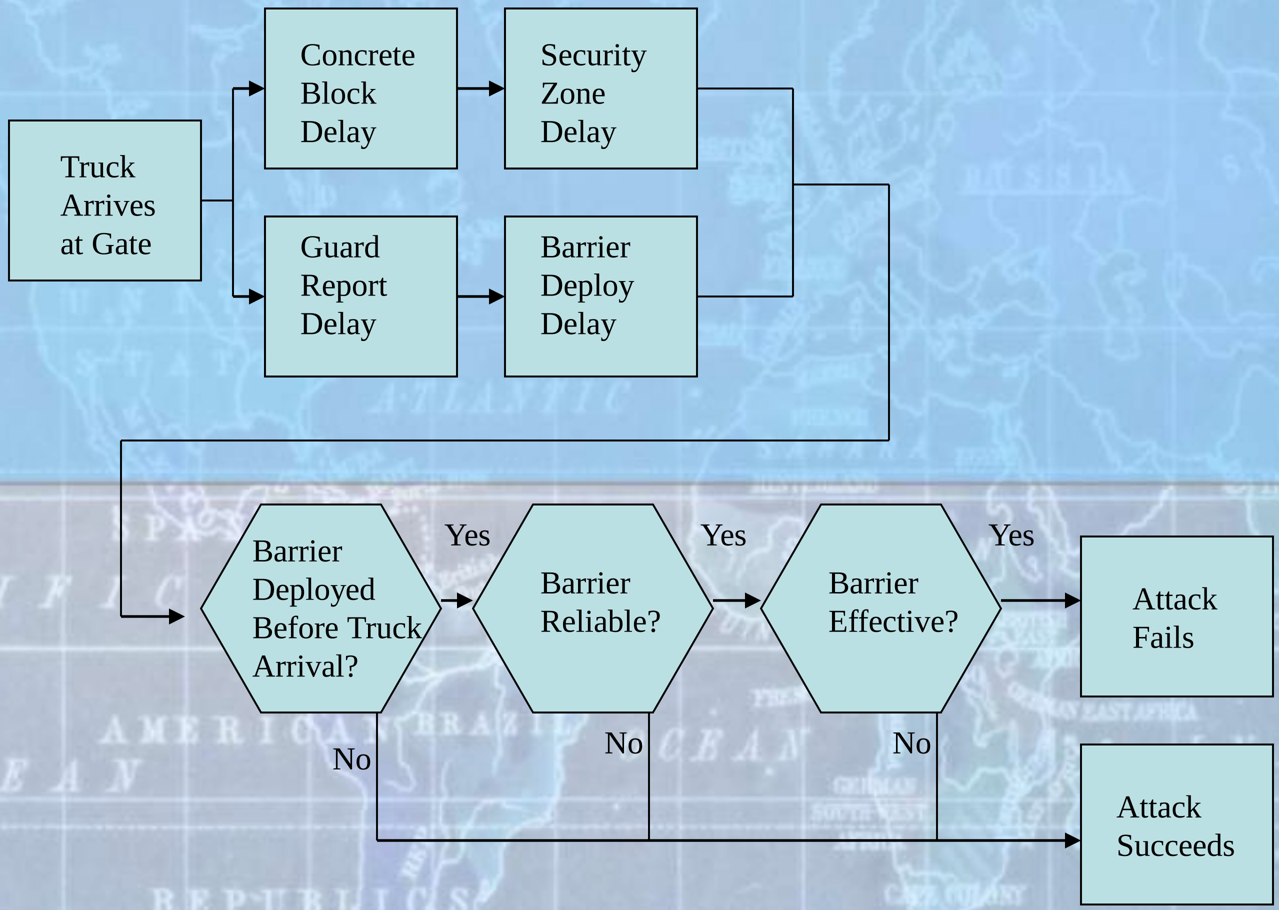
	Modeling Tool	Input Parameters	MOEs Obtained
Deny	Arena	1. Obstacle Delay 2. Barrier Delay 3. Security Zone Delay 4. Report Delay 5. Reliability 6. Effectiveness	1. System Effectiveness

Terrestrial Threats Group Modeling Replication Parameters

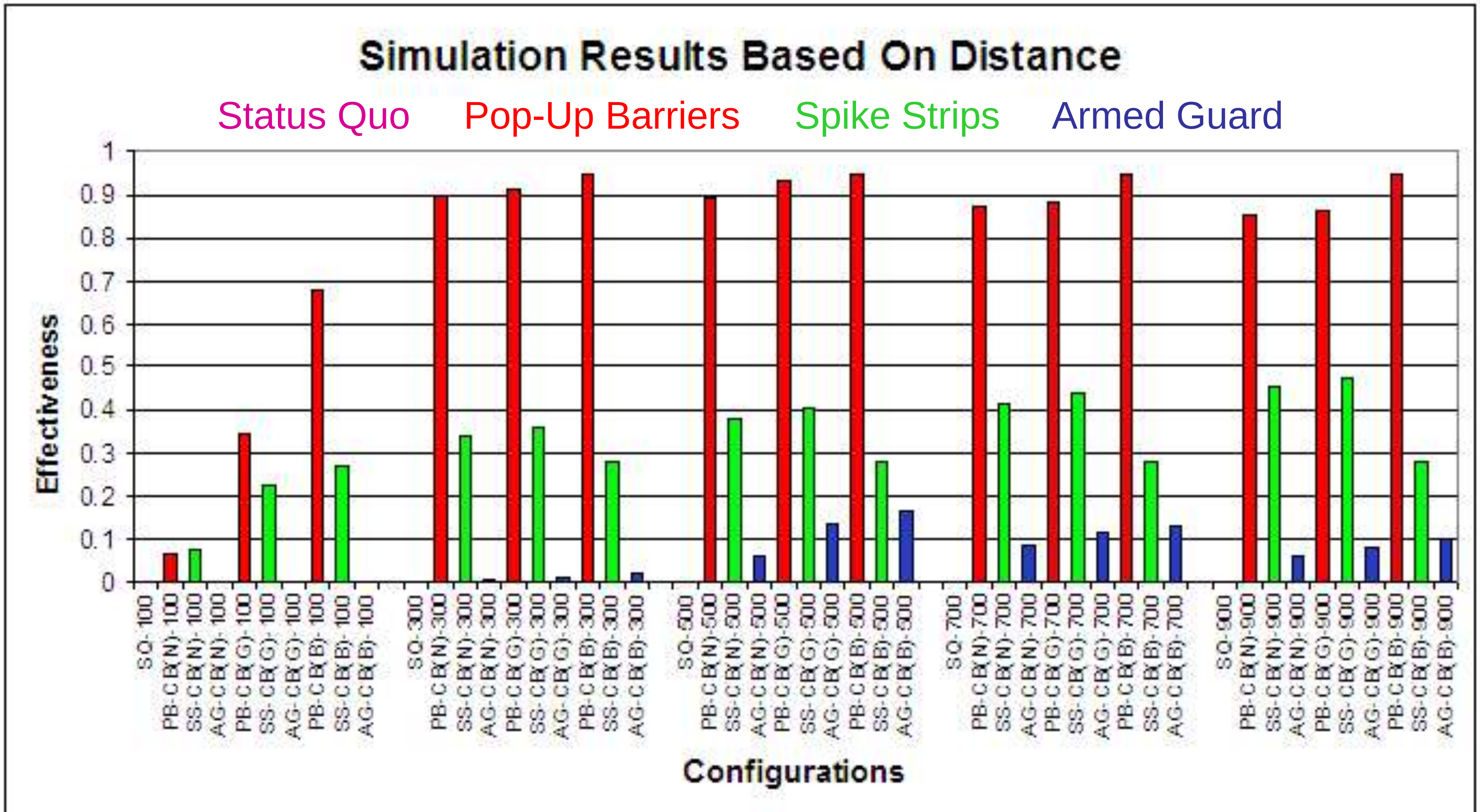
- Modeled in Arena
- 50 alternative permutations considered
- 34,680 simulated attacks ran against each permutation

(120 days with 289 attempted attacks per day)

Terrestrial Threats Group Model



Terrestrial Threats Group Modeling Results



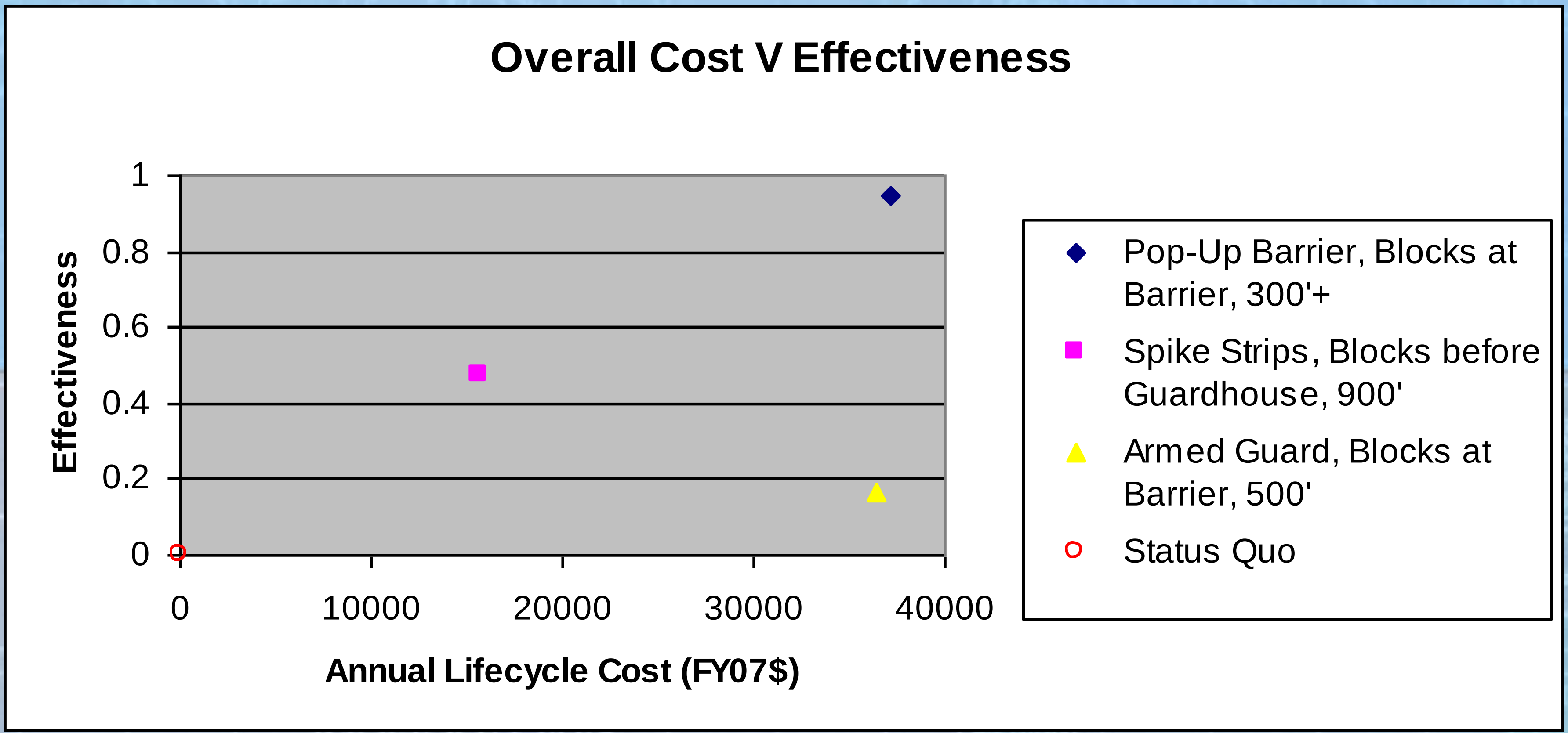
Terrestrial Threats Group Modeling Results

Alternative	Maximum Effectiveness	Configuration
Status Quo	0%	N/A
Pop-Up Barriers	95%	300'+, Blocks Before Barrier
Spike Strips	47%	900', Blocks Before Guardhouse
Armed Guard	16%	500', Blocks Before Guard

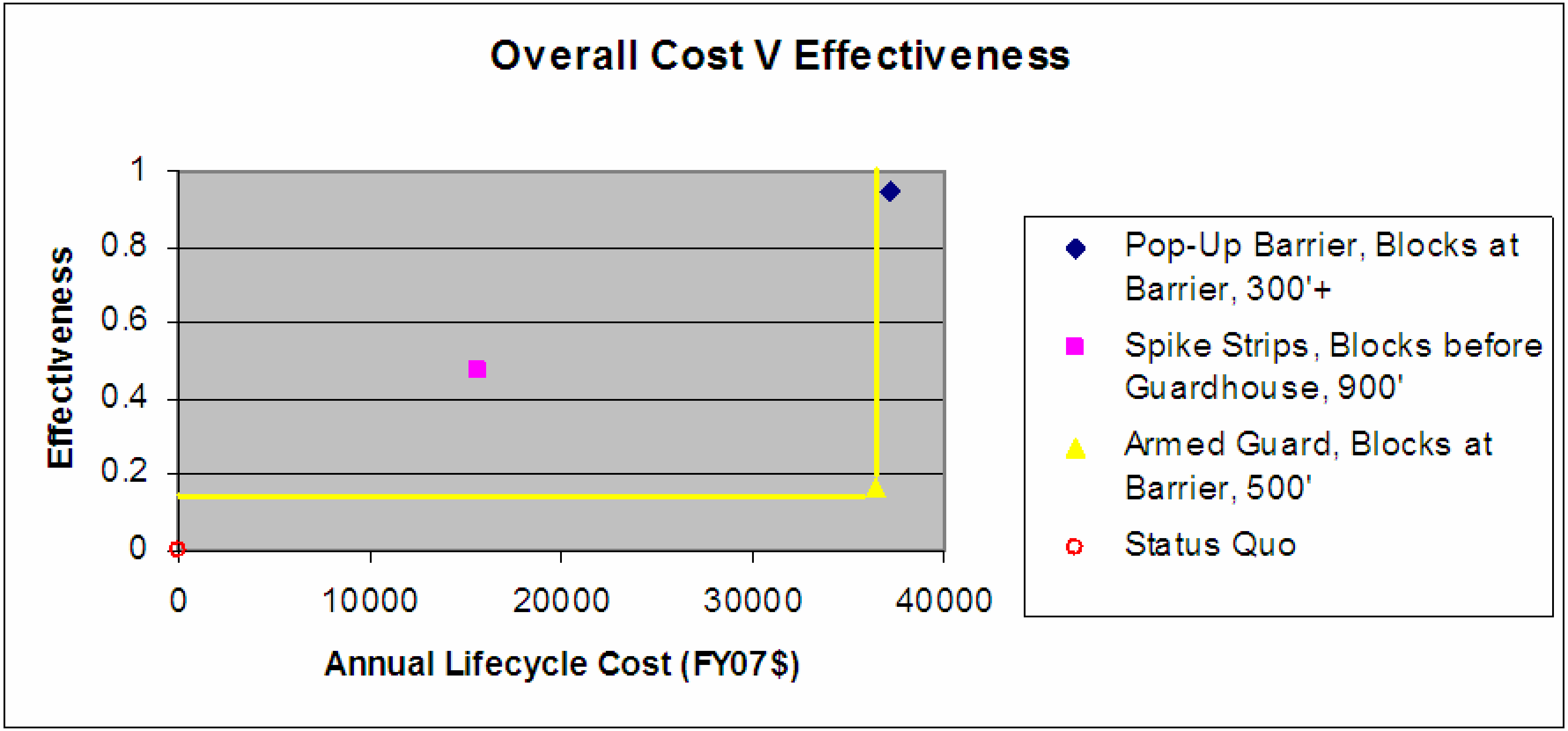
Terrestrial Threats Group Cost Estimation

Alternative	Anticipated Annual Lifecycle Cost (FY07$)
Status Quo	0
Pop-Up Barriers	37,100
Spike Strips	15,656
Armed Guard	36,365

Terrestrial Threats Group Cost Benefit Analysis



Terrestrial Threats Group Dominance



Terrestrial Threats Group Conclusions

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- Each port terminal needs to assess its vulnerability to a vehicular IED attack

- Perimeter fencing should be hardened before gate security improvements are made

Terrestrial Threats Group Conclusions

- Pop-Up Barriers with staggered concrete blocks before the barrier and at least 300’ between the guardhouse and barrier provide the best effectiveness

- In our study, an armed guard was not cost effective

Terrestrial Threats Group Recommended Future Study

- At gate screening for incoming vehicles. Study the effectiveness at preventing vehicular IEDs and the impact that additional screening would have on commerce.

- Additional screening for imported containers. Study the effectiveness for different screening methods and the impact that the screening would have on commerce. Possible collaboration Sandia National Laboratories.

Regional Seaborne Threats Group

LT Morgan Ames – Group Lead
Mr. Thiow Yong Lim - Deputy Lead
Mr. Chee Wai Ng
Mr. Chee Wan Ng
Mr. Kim Leng Koh
Mr. Chun Man Chan

Pier-side Ships' Greatest Concerns

- To increase port waterside readiness prior to terrorist attack while carrying on day to day port operations by detecting, tracking and employing appropriate courses of action.

Regional Seaborne Group Modeling Scenario

Options: - Small boat attacks (SWARM)
- Large ship collision
- Swimmer attack
- RPG attack

Stakeholders' Conclusion: Small boat attack scenario

Scenario:

Multiple small boats attack container terminal from different threat axis to inflict the most damage to moored ships and to the terminal. Desire of the terrorist is to inflict physiological damage and render the port facilities inoperable for a period of time.

Regional Seaborne Group Alternatives Generation

- Current "As Is" configuration:
  - 1 Helo
  - 4 Patrol craft
  - 1 Radar

- Increase detection capability by adding:
  - <u>Shore based Assets:</u>
    - Radars, EO/IR Sensors, Sonars and Buoys
      - E.g. Thermo Vision Sentry II
  - <u>Mobile Assets:</u>
    - USV

Regional Seaborne Group Alternatives Configuration

Type of Sensor Platform \ Sensor Configuration	(A) Current	(B) (A) + USV	(C) (B) + 1 Radar	(D) (B) + 2 Radars	(E) (D) + SentryII	(F) (E) + Sentinel	(G) (F) + Buoys + Sonars
1 x Helo	✓	✓	✓	✓	✓	✓	✓
4 x Patrol Craft	✓	✓	✓	✓	✓	✓	✓
1 x Radar Configuration (Existing)	✓	✓					✓
2 x Radar Configuration			✓				✓
3 x Radar Configuration				✓	✓	✓	✓
2 x Unmanned Surface Vessels (USV)		✓	✓	✓	✓	✓	✓
2 x ThermoVisionSentryII					✓	✓	✓
5 x ThermoVisionSentinel						✓	✓
2 x Networked Sensor (Buoys)							✓
5 x Active OmniDirectional Sonar							✓
4 x High Frequency Tactical Sonar							✓

Regional Seaborne Group Key Findings

- Most Effective: 1 x Helicopter
  4 x Patrol Craft
  1x Radar
  2 x Radar
  2 x USV
  2 x Thermo Vision Sentry II
- Cost: $21,312,000
- There needs to be:
  - network of sensors for port security
  - data fusion center
- Provide increased **AWARENESS**, increased port security

Regional Seaborne Group Modeling Metrics

- MOE: Terrorist Infiltration
  - MOP: Infiltration rate

- MOE: Target Detection
  - MOP: Detection rate

	Modeling Tool	Input Parameters	MOEs Obtained
Protect	Simkit	1. Number and type of sensors 2. Number of terrorists	1. Target Detection 2. Terrorist Infiltration

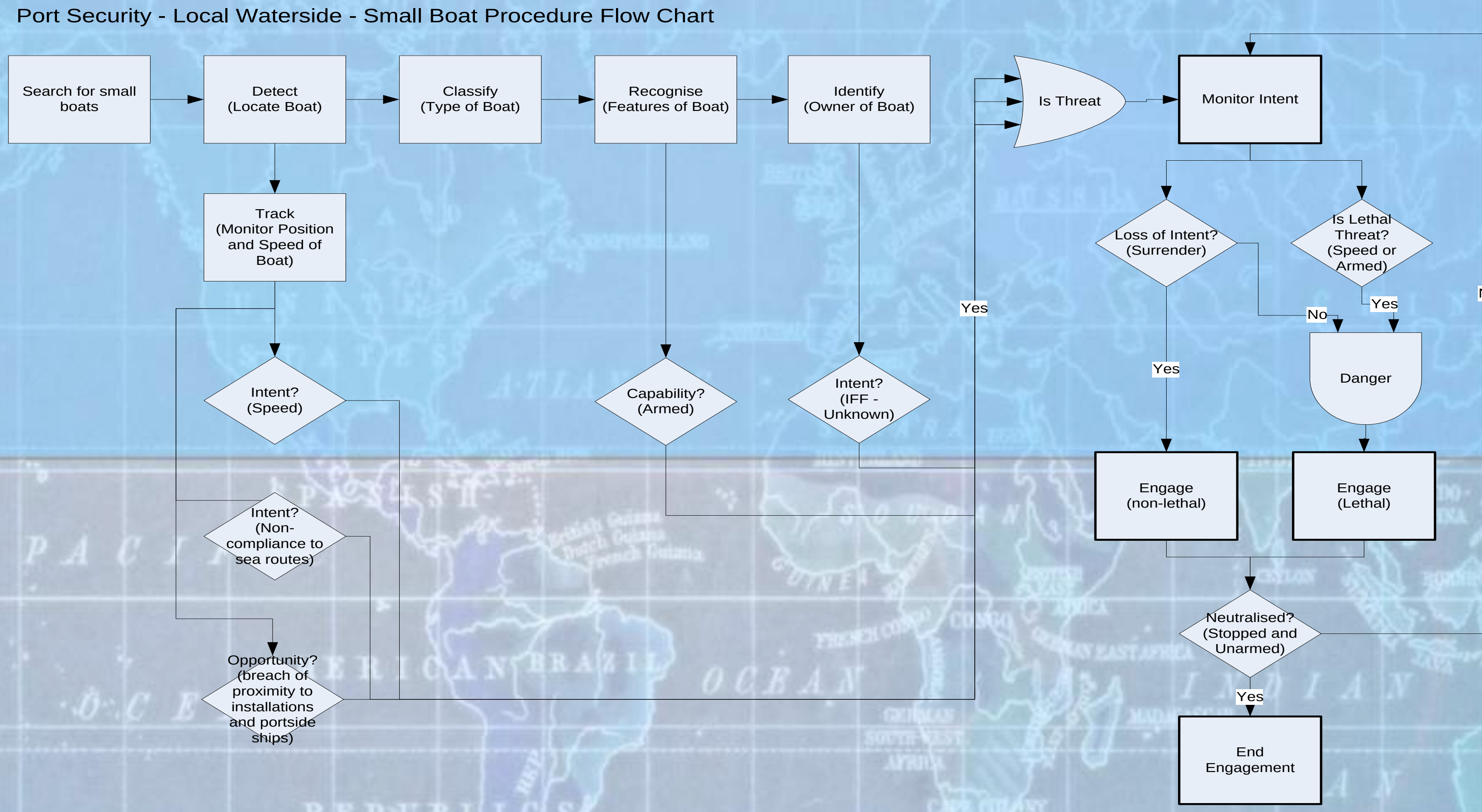
Regional Seaborne Group Modeling Tools

- Discrete Event Simulation
  - Event driven paradigm
  - Modeling of complex dynamic system
  - MOVES Simkit
  - Maneuvering Models
  - Sensor Models
    - Cookie-cutter
    - With detection and not detection

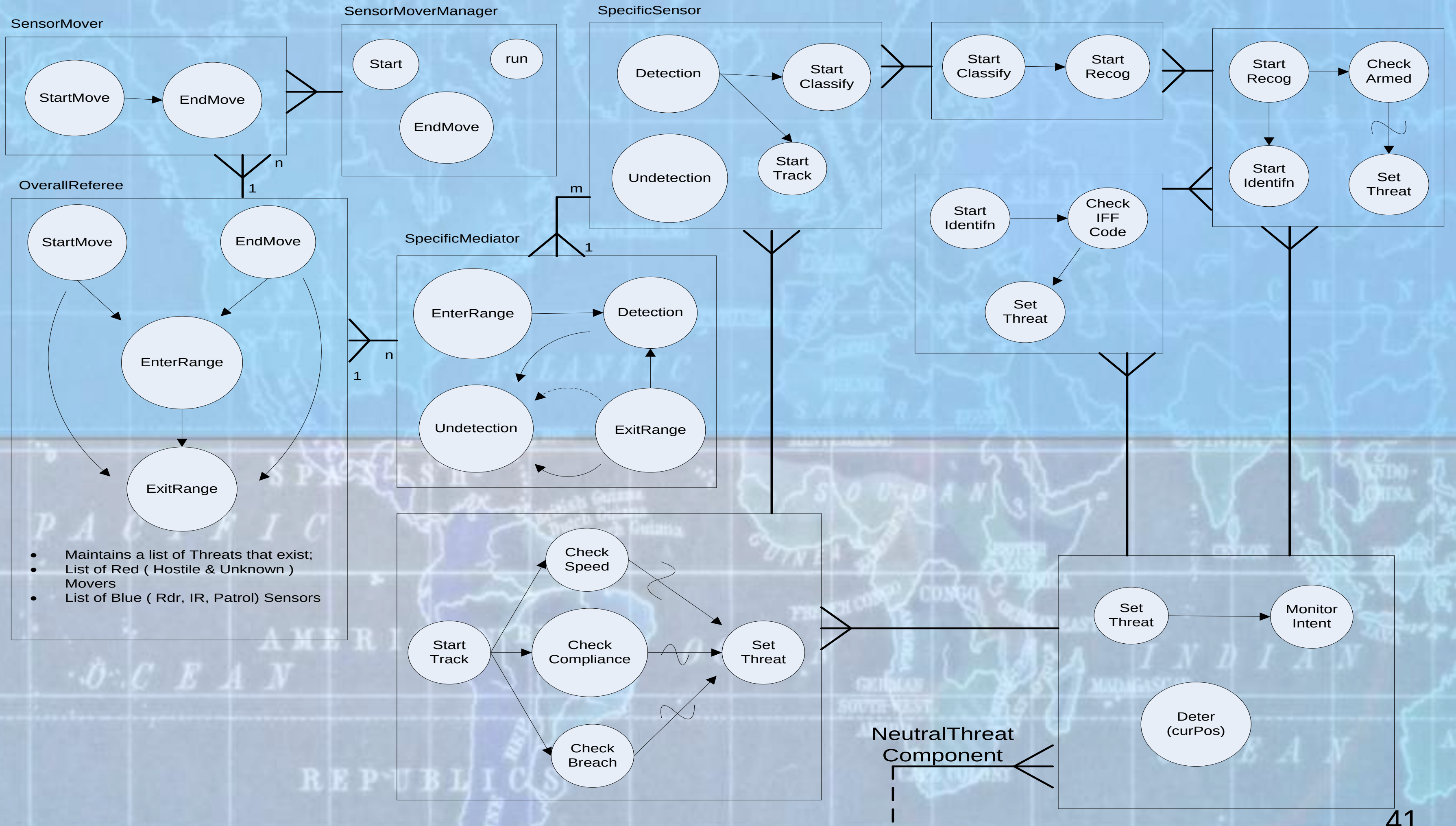
Regional Seaborne Group
Model Design and Implementation

- Port Security Local Waterside Simulation Application
  - Create Threats behavior
  - Create Sensor (basic) behavior
  - Create Scenario for different alternatives
  - Collection of results
  - Analysis of results
  - Recommendation of Alternatives

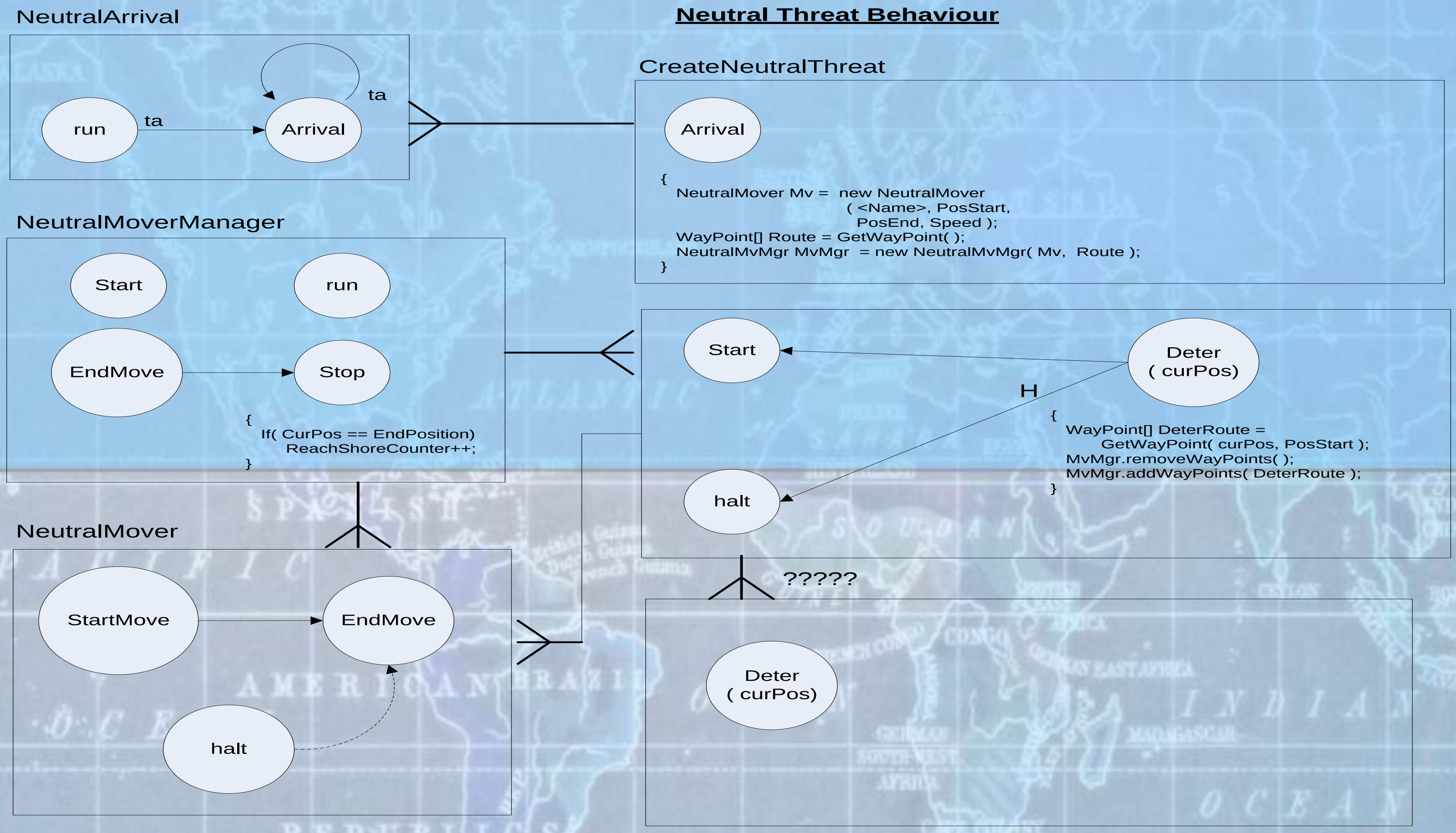
Regional Seaborne Group Flow Chart



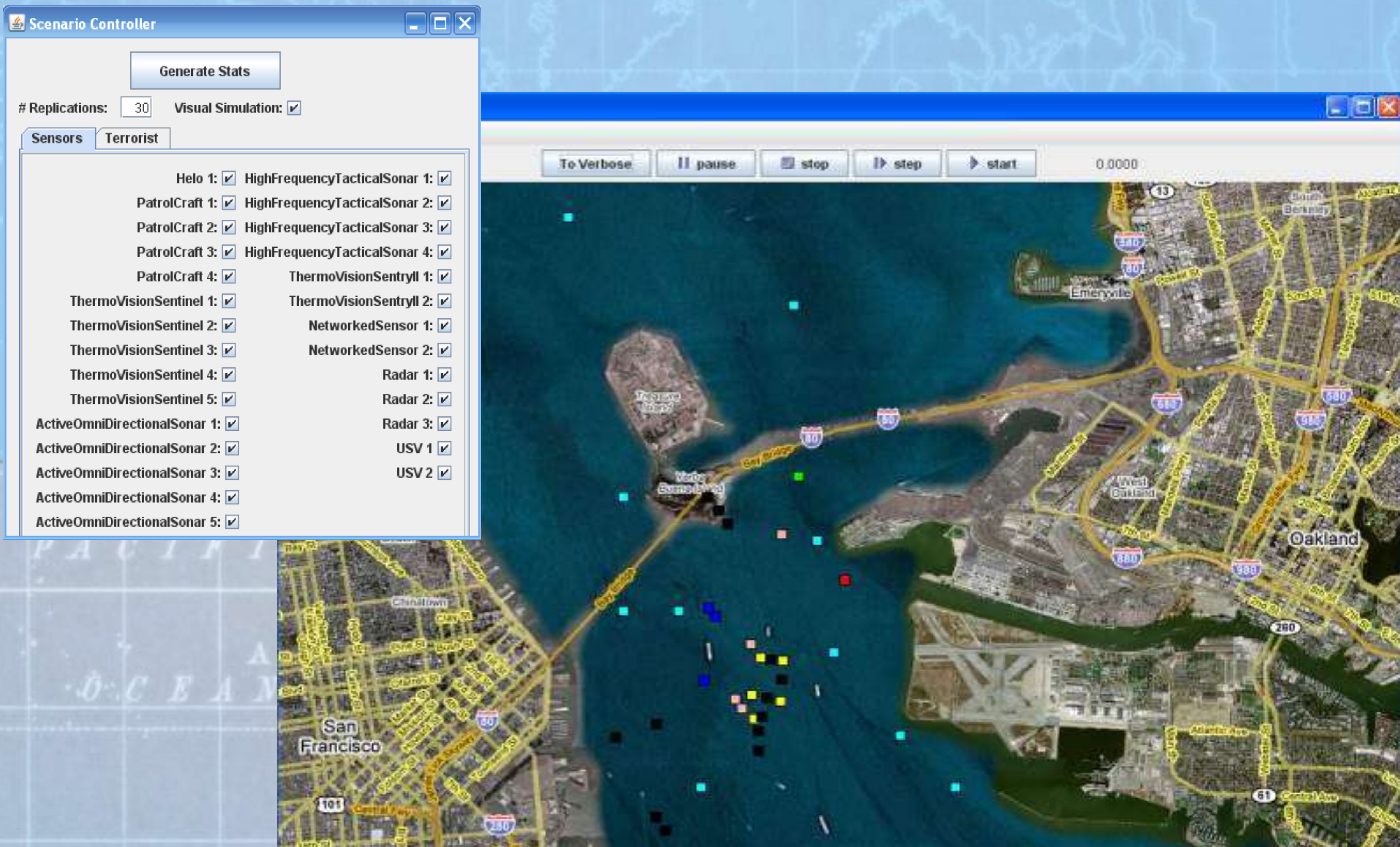
Regional Seaborne Group Discrete Events



Regional Seaborne Group Discrete Events



Regional Seaborne Group Model Inputs



Regional Seaborne Group Modeling Assumptions

- Homeland security level
  - Normal
- Focus is on small boat attacks
  - Threats come from within the San Francisco Bay, and originate from designated areas
  - Small boats travel at 30kts
  - Not considering air threats or threats from swimmers
- Sensor Assets
  - Placement of static sensors
  - Routes for mobile sensors
  - Search pattern follows detect-classify-recognize-identify algorithm
  - False Alarm Rate not modeled

Regional Seaborne Group Model Area

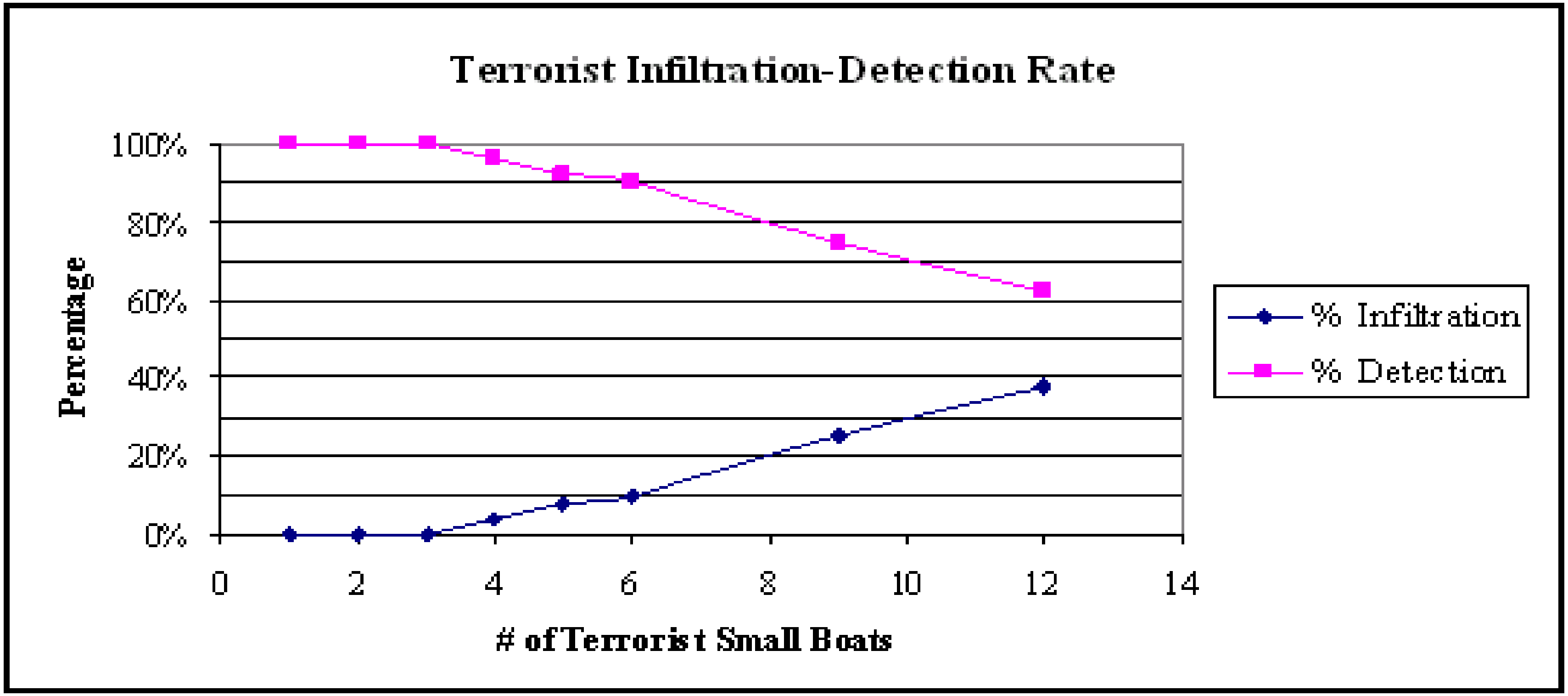
Regional Seaborne Group Routes

Regional Seaborne Group Sensor Placement

Regional Seaborne Group Limitations of the Model

- Model focuses on the detection of terrorist small boats. A successful detection means
  - Terrorist fails in mission
  - Terrorist is deterred
- Sensor Characteristics
  - Sensors follow a detect-classify-recognize-identify algorithm that takes 3 mins for each stage of the process (in Simulation time)
  - Sensors can only perform target detection-classification for a single platform at any one time.
- SimKit only implements type Point2D
  - Subsurface detection, e.g. sonars may not be modeled accurately.
  - Diskit, which is able to implement Point3D, has stability issues, hence not used.

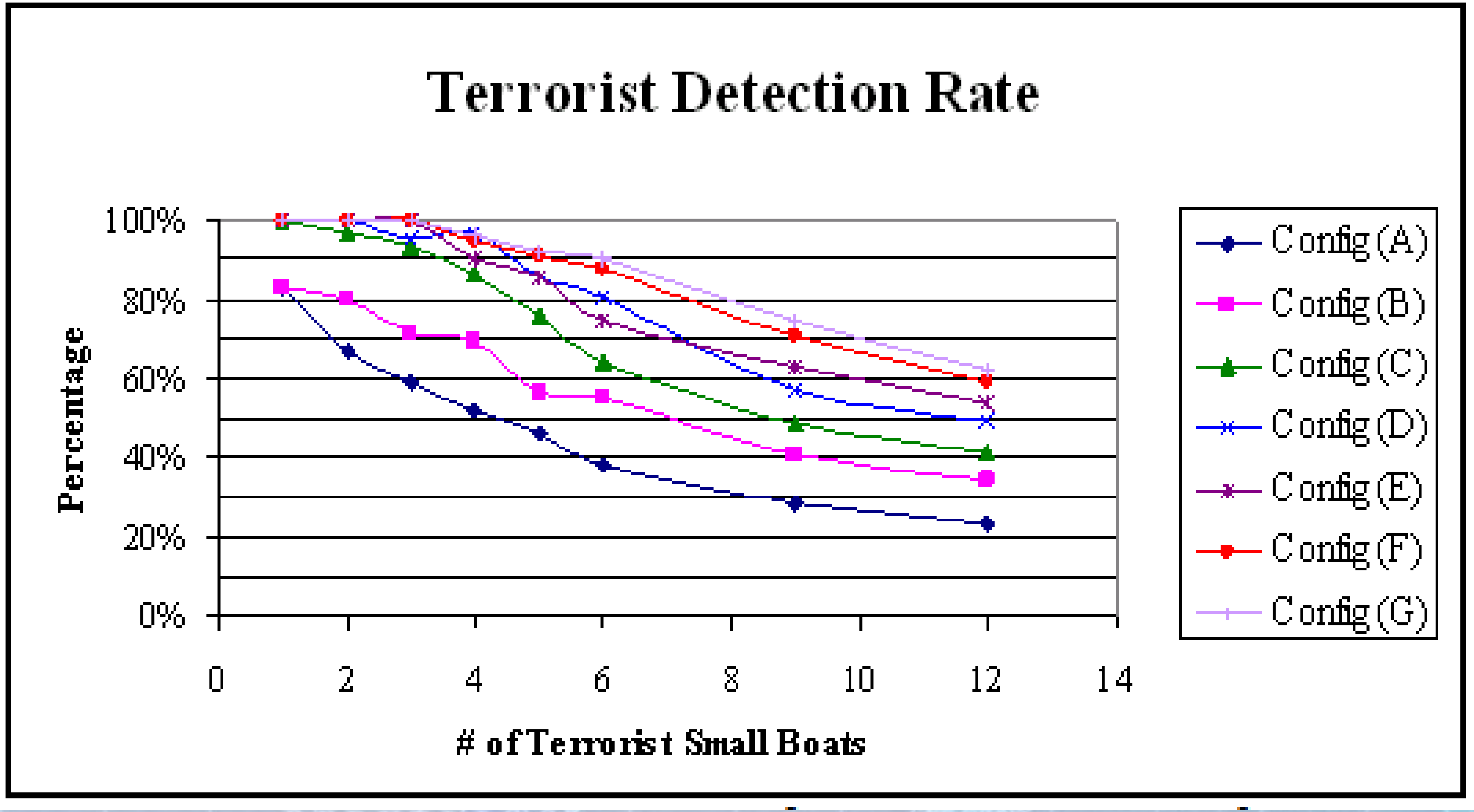
Regional Seaborne Group Results



F + Buoys + Sonar

Infiltration/Detection Rate for (G) Configuration

Regional Seaborne Group Results of the Modeling

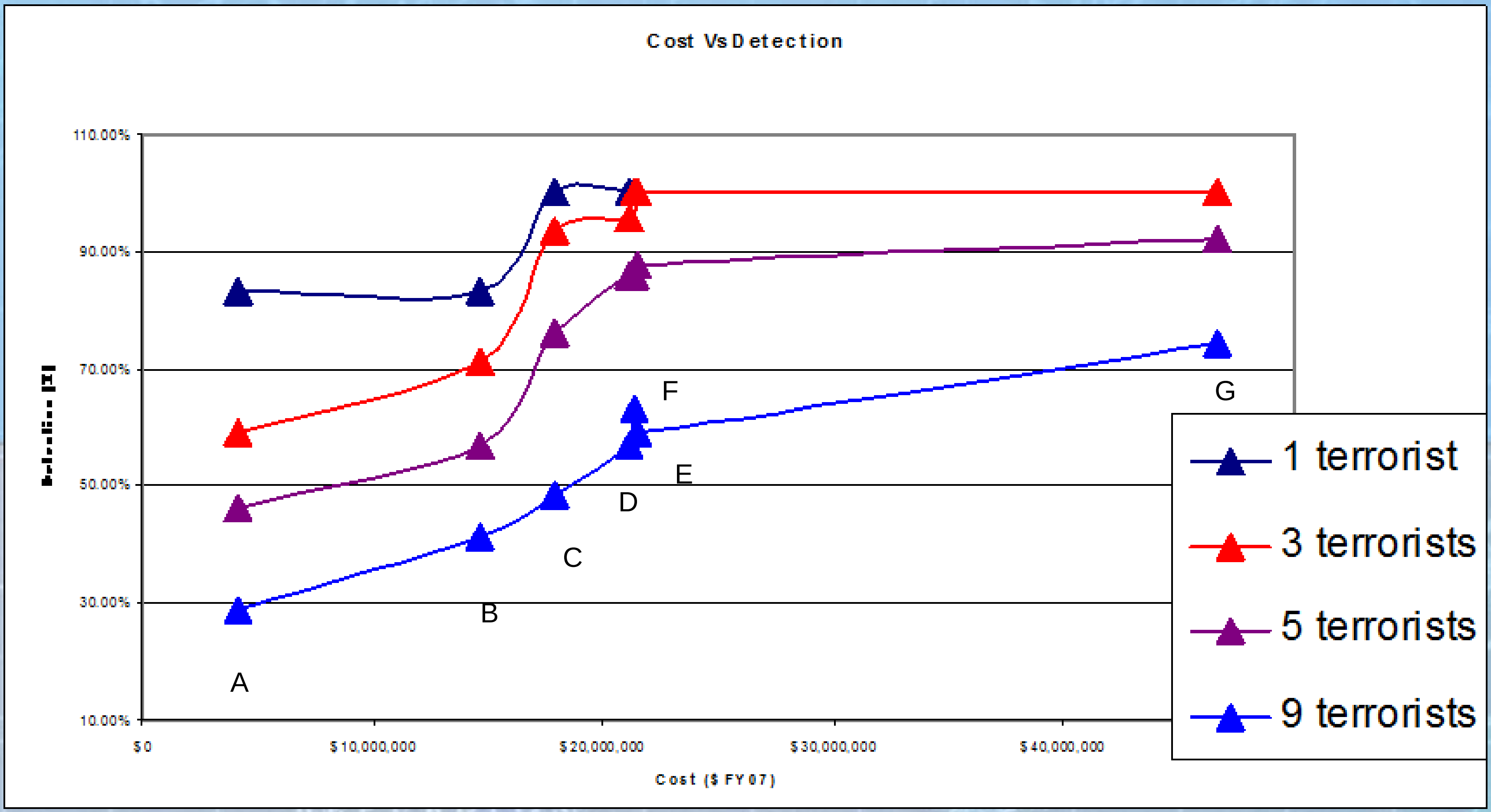


Regional Seaborne Group Cost Estimation

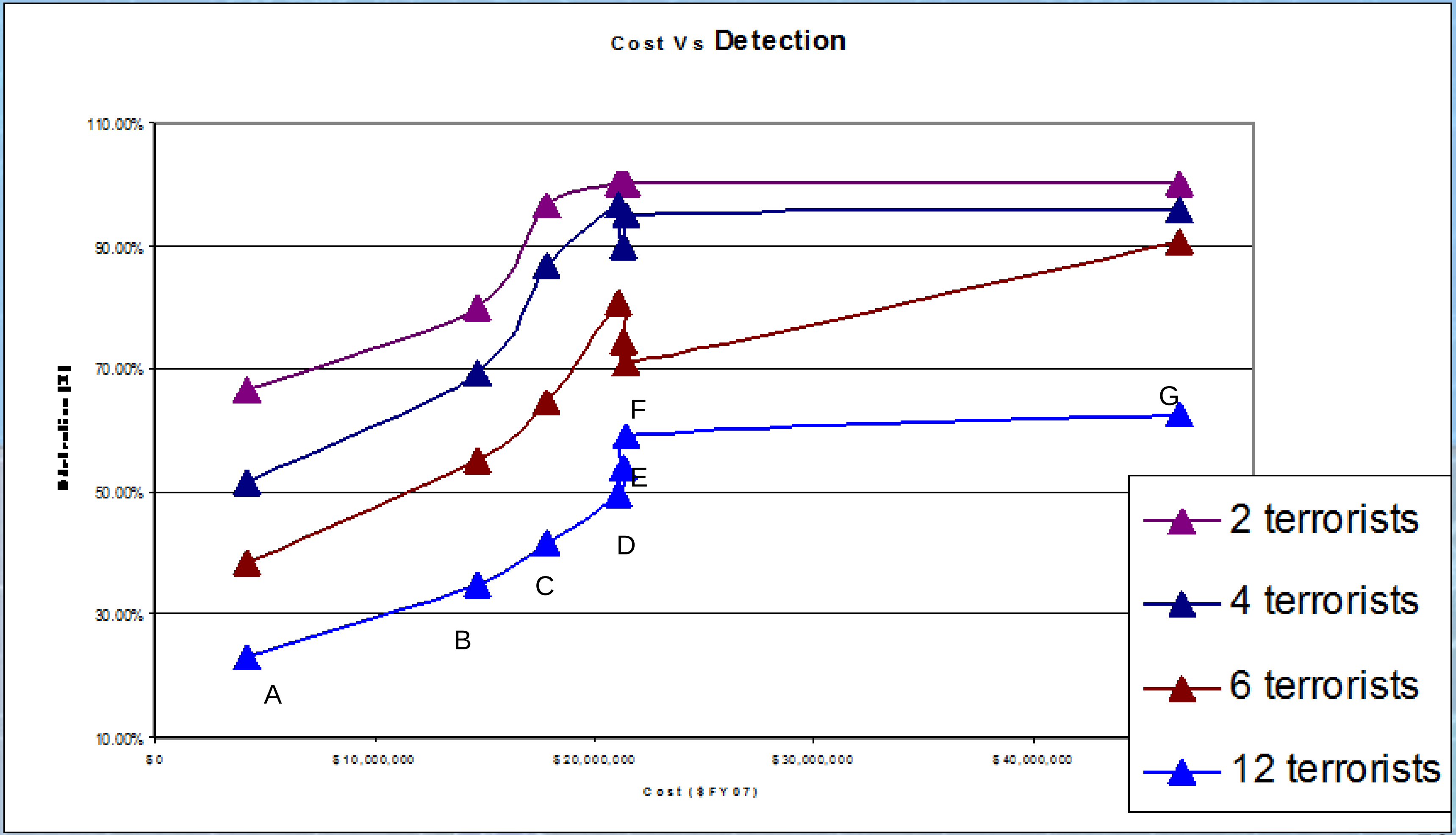
Configuration	$FY07M Cost	$FY18M Cost
A	4.14	41.4
B	14.64	76.4
C	17.89	83.9
D	21.14	91.4
E	21.31	91.48
F	21.45	91.96
G	46.65	133.96

****PROTECTOR USV used cost FY07 $3.5 million ****

Regional Seaborne Group Cost Benefit Analysis



Regional Seaborne Group Cost Benefit Analysis



RSTG Recommendation Revisited

- Most Effective: 1 x Helicopter
  4 x Patrol Craft
  1x Radar
  2 x Radar
  2 x USV
  2 x Thermo Vision Sentry II
- Cost: $21,312,000
- Without USVs: $11,312,000

Regional Seaborne Group Conclusions

- Layered sensors are the most sure way to prevent a terrorist attack
- Implementation of a Data fusion center.
- Sharing of information and awareness are key attributes for port security
- Products exist such as: Hawkeye, Project Athena, and HarborGuard. Provides sensors as well as C2 platform for fusion center.

Regional Seaborne Group Recommended Future Study

- Since RSTG examined the prevent aspect the engagement problem still remains
- Did not look into a single sensor having the ability to track multiple crafts
- Examine and implement the air threats and intelligence aspects into Port security
- Address the false alarm issue

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Source Seaborne Threats Group

LCDR Dale Johnson - Group Lead

Ms. Pei Tze Oh – Deputy Lead

Mr. Horng Lim

ENS Alan Marsh

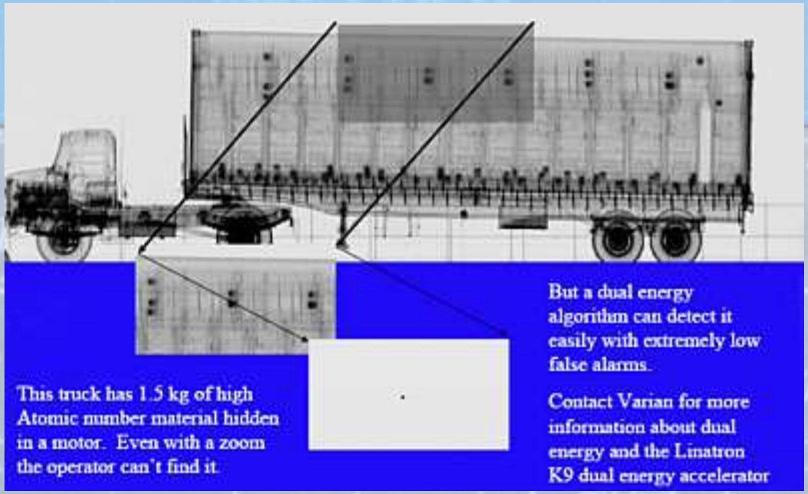
ENS Laura Okruhlik

Source Seaborne Group Effective Need

- Design a system to detect and deny all containers holding undesired cargoes from loading onto a container ship.
  - Undesired cargoes are defined as:
    - chemical agents
    - biological agents
    - radiological material
    - explosives
    - conventional weapons
    - weapon system parts
    - human cargo
  - Containers enter the source port via:
    - railway
    - vehicle (trucks)
    - transshipment (berthed ships)

Source Seaborne Group Scenario Objectives

- Good guys
  - Detect and deny all WMD at the source port



- Bad guys
  - Get at least one container with WMD to each destination port

Source Seaborne Group Detection Capability Metrics

- Analysis Questions of Interest
  - Comparison of Alternatives
  - Optimal Sensor Mix to maximize Pd
- MOE: Accuracy
  - MOP: Probability of Detection
  - MOP: Missed Detection
  - MOP: False Alarm Rate
- MOE: Timeliness
  - MOP: Productivity
  - MOP: Average inspection time per container

	Modeling Tool	Input Parameters	MOEs Obtained
Deny	Extend	1. Container Traffic 2. Sensor Performance	1. Accuracy 2. Timeliness

Source Seaborne Group Alternatives Generation

System	Manifest Screening	Scanning Location	Non-Intrusive Container Screening	% Screening	Intrusive Container Screening	Screening requirements	Data Sharing
Reference System	None	None	None	0%	None	None	None
0% inspection	ATS (status quo)	Mobile system	Gamma ray scanners	5%	Human	Containers that don't pass the non-intrusive inspection	Smart Tags
100% Inspection (100% of containers)	ATS+ (shippers submit manifests to ATS system 24 hours before ship loading)	On crane spreaders	X-ray scanners	25%	Animals	Random (fixed percentage)	Upload container screening data to destination port
Improved loading search		Fixed entry point with truck drive-through	Operator experience	50%	Portable Radiation Detectors	Containers tagged high risk by manifest screening	
Minimize port operations disruption			Trained animals	75%	Remotely-operated inspection robots	100%	
High Performance			Radiation detectors	100%			
100% Intrusive Inspection			Scales				

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Key Findings

- Best alternative – High Performance
  - Automatic Targeting System (Improved)
  - Gamma scanner and HAZMAT detector at container holding and loading areas
  - Fully equipped inspection station
  - US 2007 $82.67 million

- Optimal sensor mix to maximize Pd
  - Gamma scanner at port of entry
  - Radiation detector, gamma scanner at holding area
  - Scales, gamma scanner at loading area
  - Gamma scanner, HAZMAT detector, and trained animals at intrusive inspection station

Modeling & Simulation

All models are wrong, but some models are useful.

George Box

Source Seaborne Group
What the Model…

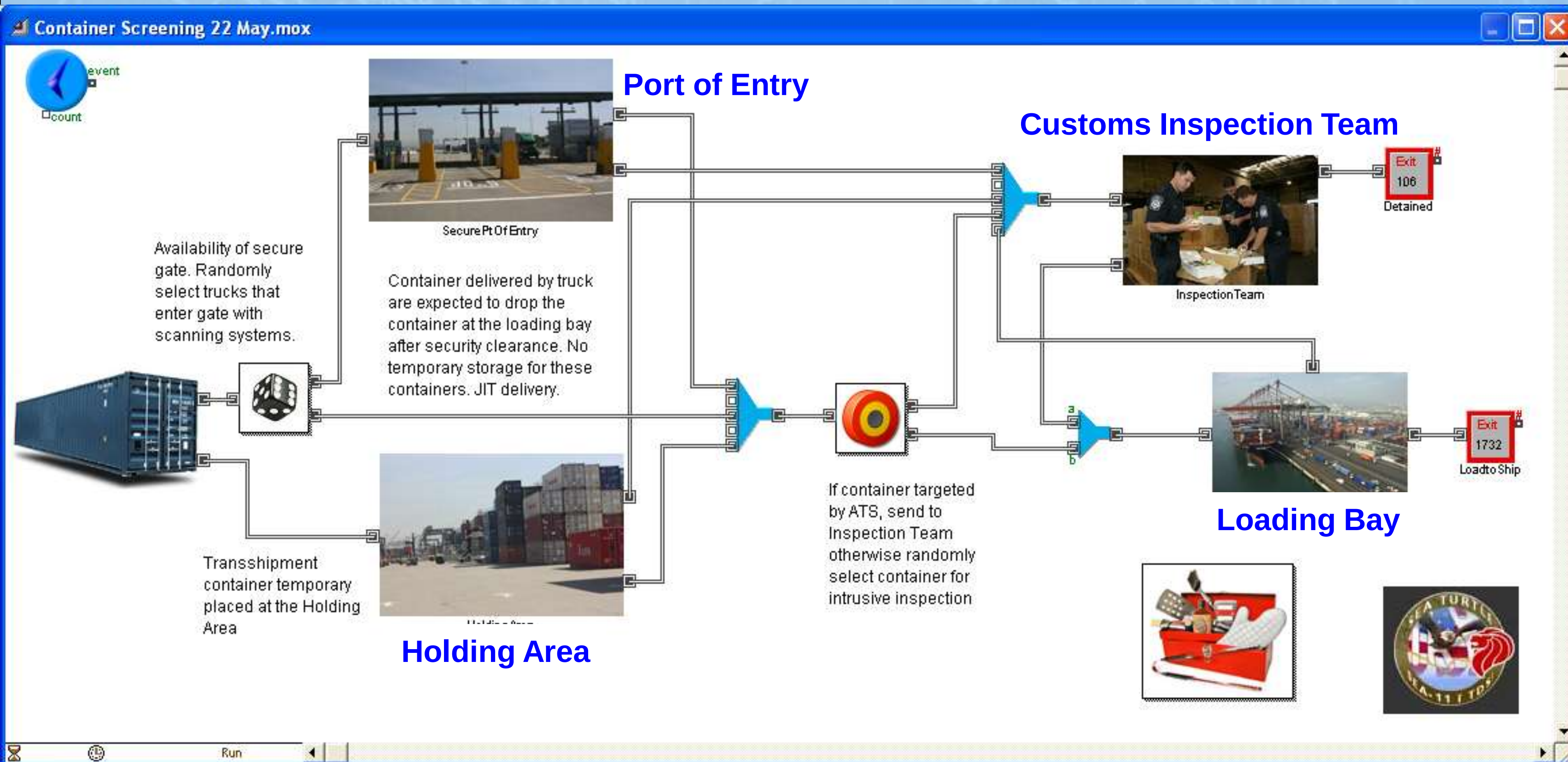
IS…

- A tool to compare relative performance of alternatives
- A high level abstraction of many factors that could drive MOPs
- An experiment to identify the most significant factors

IS NOT…

- A detailed simulation of actual port processes
- A prediction of real life performance of various inspection configurations

Source Seaborne Group Extend Model



Source Seaborne Group Derivation of Port Statistics

- Based on traffic data of world's biggest transhipment hub, PSA Singapore

- Annual Container Traffic
  - 22.3m TEUs transhipment
  - 23.2m TEUs total
- Daily vessel traffic
  - 60 ships
- Facilities
  - 4 terminals, 41 berths, 131 quay cranes

Source Seaborne Group Design Of Experiments

- Analysis of Alternatives
  - 6 different alternative configurations
- Optimal Sensor Mix
  - 17 different sensor configuration parameters
  - Full factorial testing requires 2^{17} runs = 131072 = runs
  - Extended Nearly Orthogonal Latin Hypercube
    - Efficient space filling properties: Cover total experiment space with minimum sample points
    - Reduce total runs from 131072 runs to 65 runs

Analysis of Alternatives

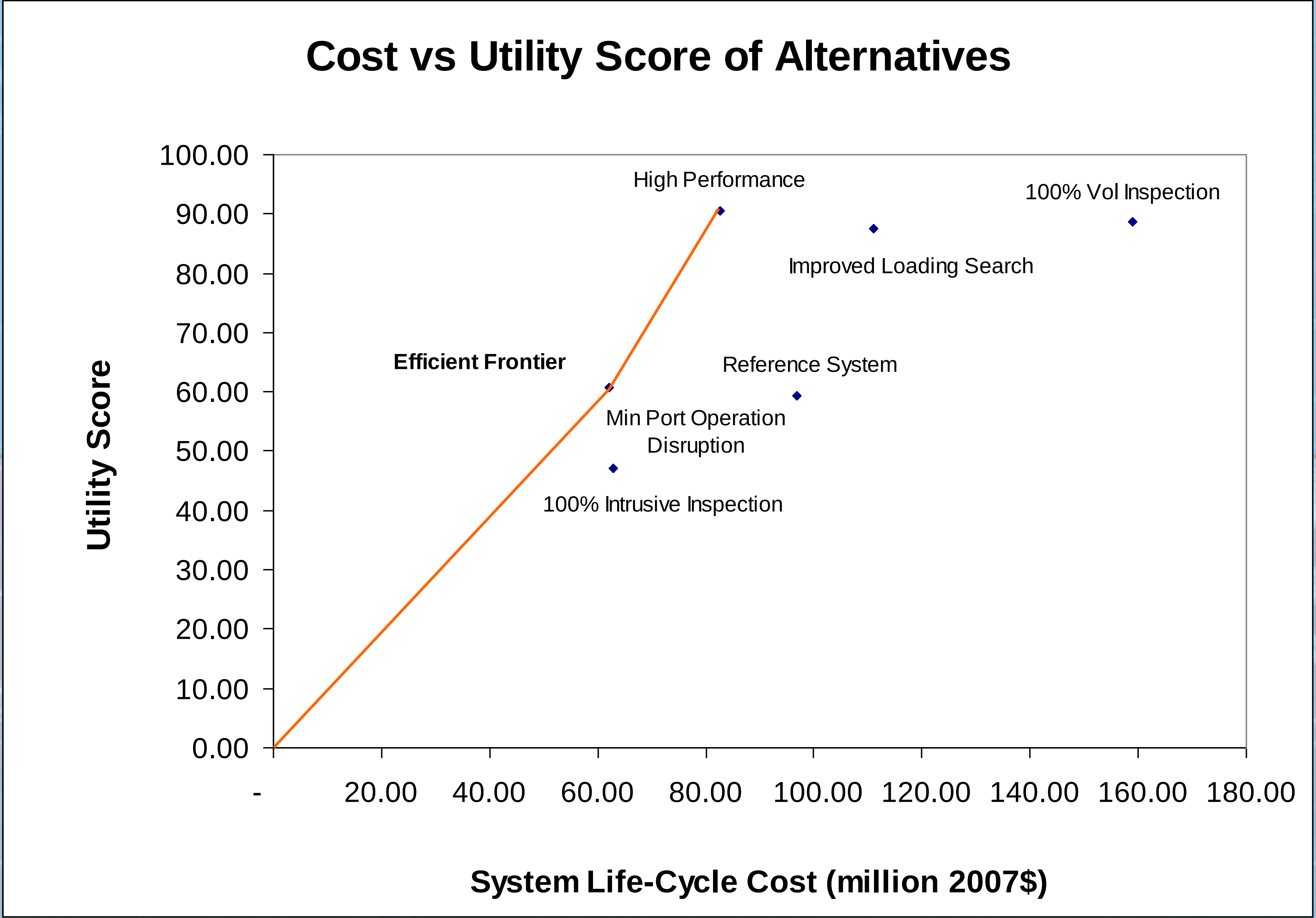
Source Seaborne Group Raw Score of Alternatives

Alternative	Prob of Detection	Missed Detection Rate	False Alarm Rate	Good Productivity [Containers per hour]	Change in Productivity Relative to Status Quo [%]	Avg Insp Time Per Container [min]
Status Quo	13.9%	86.1%	0.3%	159	NA	34
100% Vol Inspection	81.6%	18.4%	0.2%	161	1.4%	27
Improved Loading Search	83.8%	16.2%	0.2%	153	-3.7%	33
Min Port Operation Disruption	0.0%	100.0%	0.0%	165	3.6%	19
High Performance	96.8%	3.2%	2.5%	143	-9.8%	37
100% Intrusive Inspection	99.7%	0.3%	28.8%	10	-93.7%	28

Source Seaborne Group Utility Ranking & Cost Estimation

Alternative	Utility Score	Cost (US 2007 $ million)
100% Intrusive Inspection	47.09	62.1
Status Quo	59.37	97
Minimize Port Operations Disruption	60.64	63
Improved Loading Search	87.61	159.1
100% Volume Inspection	88.72	111
High Performance	90.57	82.7

Source Seaborne Group Cost Benefit Analysis



Optimal Sensor Mix for Pd

Regression Analysis

Source Seaborne Group
Logistic Regression Model

- Purpose of Logistic Regression Model
  - Determine significant factors that influence Pd
  - Predict Pd for sensor configurations that were not modeled

- Pd converted to binary response variable
  - Dirty Container detected = 1
  - Dirty Container not detected = 0
- Logistic regression model with logit link function used to fit data.
  - Saturated Model assumes all factors are significant in influencing Pd

Source Seaborne Group Logistic Regression Model

Legend

- **e: Land Entry Point**
- **h: Transhipment Holding Area**
- **i: Intrusive Inspection Team**
- **c: Crane (Loading)**

Analysis Method

- Significance of Regressors
- Type III Sums of Squares

	Df	Sum of Sq	Mean Sq	F Value	Pr(F)	Significant
eScales	1	0.03	0.03	1.06	**0.3026**	**No**
eAnimals	1	0.05	0.05	1.61	**0.2044**	**No**
eRadDetector	1	0.00	0.00	0.06	**0.8118**	**No**
eGammaScanner	1	0.38	0.38	12.30	0.0005	Yes
hRadDetector	1	0.86	0.86	27.95	0.0000	Yes
hGammaScanner	1	17.54	17.54	568.30	0.0000	Yes
iAnimals	1	14.56	14.56	471.60	0.0000	Yes
iRadDetector	1	1.68	1.68	54.58	0.0000	Yes
iGammaScanner	1	22.09	22.09	715.81	0.0000	Yes
iBioDetector	1	1.34	1.34	43.56	0.0000	Yes
iChemDetector	1	0.91	0.91	29.50	0.0000	Yes
cScales	1	0.00	0.00	0.05	**0.8293**	**No**
cRadDetector	1	0.00	0.00	0.05	**0.8155**	**No**
cGammaScanner	1	32.89	32.89	1065.55	0.0000	Yes
ATS	1	0.33	0.33	10.57	0.0012	Yes
Entry Scan %	1	0.20	0.20	6.40	0.0114	Yes
Intrusive Insp Random Selection %	1	0.05	0.05	1.70	**0.1927**	**No**

Source Seaborne Group Logistic Regression Model

- Subset Model Selection
  - stepAIC
    - Backwards elimination algorithm for finding best subset model
  - Mallow's Cp
    - Criteria for "best" subset model selection

- Factors NOT important to determining Pd
  - Land Entry Point: Scales, trained Animals, radiation detector
  - Crane: Radiation detector
  - Random selection percentage for intrusive inspection

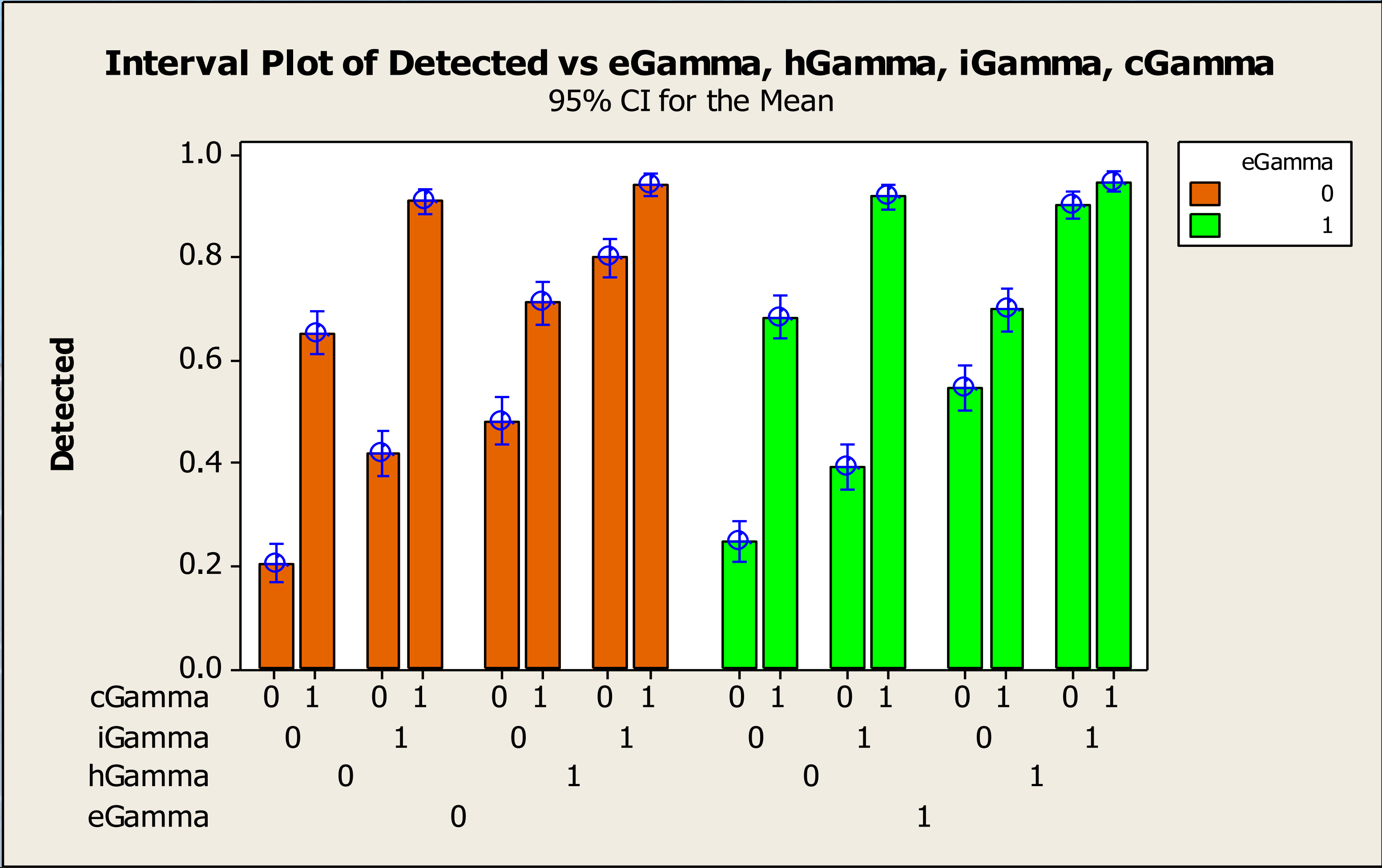
Source Seaborne Group Logistic Regression Model

- Gamma scanners most Significant contribution to Pd

Legend

- **e: Land Entry Point**
- **h: Transhipment Holding Area**
- **i: Intrusive Inspection Team**
- **c: Crane (Loading)**

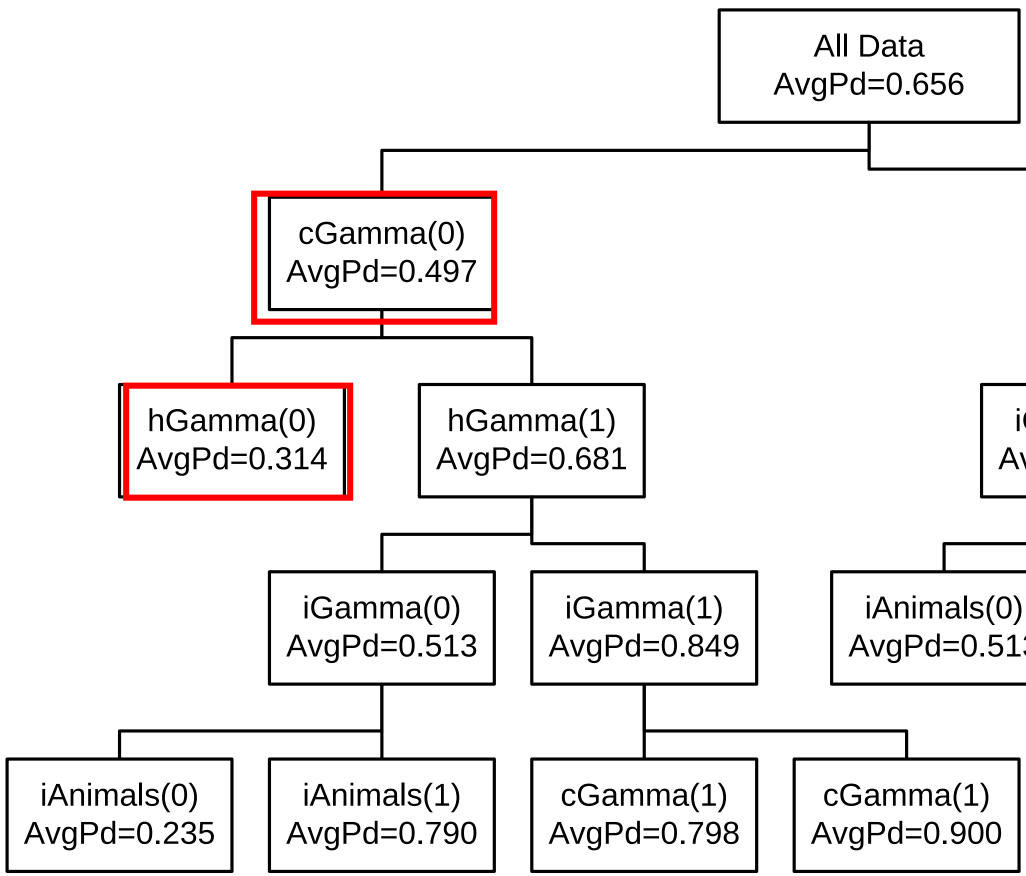
- **0: Sensor OFF**
- **1: Sensor ON**



Optimal Sensor Mix for Pd

Partition Analysis

Source Seaborne Group Partition Tree: Pd



Legend

- **e: Land Entry Point**
- **h: Transhipment Holding Area**
- **i: Intrusive Inspection Team**
- **c: Crane (Loading)**
- **0: Sensor OFF**
- **1: Sensor ON**

Source Seaborne Group Partition Tree: Pd

- Most Significant Factors for minimum Pd
  - Mean 31.4%
  - Crane Gamma scanner (off)
  - Holding area Gamma scanner (off)

- Most Significant Factors for maximum Pd
  - Mean 95.4%
  - Crane Gamma scanner (on)
  - Intrusive Insp Team Gamma Scanner (on)
  - Intrusive Insp Team Trained Animals (on)

Source Seaborne Group Partition Tree: Pd

- Most Significant Factors
  - Gamma scanners at various locations
  - Locations in descending preference
    - Crane, holding area and intrusive inspection team
  - Trained Animals a good supplement to increase Pd

Source Seaborne Group Partition Tree: False Alarm Rate (FAR)

- Most Significant Factors for minimum FAR
  - Mean 0.22%
  - Intrusive Insp Team Gamma Scanner (off)
  - Intrusive Insp Team Chemical Detector (off)
  - Intrusive Insp Team Biological Detector (off)
- Most Significant Factors for maximum FAR
  - Mean 0.43%
  - Intrusive Insp Team Gamma Scanner (on)
  - ATS Current, ATS Improved
  - Crane Scales (on)

Source Seaborne Group Partition Tree: Productivity

- Most Significant Factors for minimum Productivity
  - Mean 151 containers per hour
  - Intrusive Insp Team Random selection percentage >= 8%
  - ATS Current, ATS Improved
  - Crane Scales (on)

- Most Significant Factors for maximum Productivity
  - Mean 163 containers per hour
  - Intrusive Insp Team Random selection percentage < 8%
  - Intrusive Insp Team Gamma Scanner (off)

Source Seaborne Group Partition Tree: Avg Inspection Time

- Most Significant Factors for minimum Avg Inspection Time
  - Mean 29.6min
  - No ATS
  - Holding Area Gamma Scanner (off)
- Most Significant Factors for maximum Avg Inspection Time
  - Mean 44.9min
  - ATS Current, ATS Improved
  - Intrusive Insp Team Random selection percentage >= 0.07
  - Crane Gamma scanner (on)

Source Seaborne Group
Partitioning Analysis Recommendations

- Recommended Sensor Suite to optimize multiple MOPs
  - Gamma detectors
    - Crane, holding area, intrusive inspection teams
    - Trained animals complementary
  - No ATS risk profiling
  - Intrusive inspection random selection < 8%
  - Not deploying crane scales

- Estimated Performance
  - Average probability of detection of 90%
  - Average false alarm rate of 2.77%
  - Average productivity of 161 containers per hour
  - Average inspection time per container of 32.6 minutes

Conclusions and Recommendations

Source Seaborne Group Conclusions

- Source port and transit security is still in the infancy stage and providing an adequate security solution is a global problem.
- Large transshipment hubs pose additional security risks from cargo arriving by ship from less secure ports.
- False alarm rate is directly proportional to number of sensors in system and can negatively impact port operations and productivity.
- The number of inspection teams should be sufficient to handle the false alarms and volume of containers randomly selected for inspection.

Source Seaborne Group Recommendations

- Best alternative – High Performance
  - Automatic Targeting System+
  - Gamma scanner and HAZMAT detector at container holding and loading areas
  - Fully equipped inspection station
  - US 2007 $82.67 million

Source Seaborne Group Recommended Future Study

- Conduct detailed analysis on manifest screening and random selection percentages on port operations and ability to detect undesired cargos
- Review security vulnerabilities in transshipment process
- Improve accuracy in modeling port operations and sensors

- Scenarios of interest
  – UAV attack on container ship in transit close to source or destination port
  – Sinking of large container ship over Hampton Roads Bay Bridge tunnel, while 4 carriers are in port

Internal Personnel Threats Group

Mr. Henry Nguyen – Group Lead
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MAJ Chee Leong Tan
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Mr. Kar Leong Ong
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Internal Personnel Group Effective Need

To prevent insiders from committing or supporting terrorist acts within/through port facilities

By:

1. Minimizing impact to current operations
2. Deterrence
3. Control access to information and to physical locations
4. Respond if necessary

Internal Personnel Group Scenario

Concept 1: A disgruntled port terminal employee attempt to smuggle in explosives to cause damage to terminal infrastructures and prevent port operation.

Concept 2: Port terminal employee gain unauthorized access to electronics data to be used in support of planning and executing terrorist attacks.

Key Findings

- Combined scenarios with involving data access control, physical access control, and response implementing maximum alternative solutions were able to achieve an 18% improvement.
- By implementing metal detector, bag scanner, improved training, random searches, and improved communications can improve physical security by 194%.
- Additionally, if a mid-terminal fence is added and the gates are triggered shut upon intruder detection a total physical security improvement of 441% can be achieved.

Internal Personnel Group Alternatives for Modeling

- Deterrence
- Physical Access Control
  - Status Quo
  - Random searches
  - Metal detector & bag scanner
  - Training for guards
  - Mid-terminal fence (gate open/shut)
- Data Access Control
  - Two-factor authentication
- Response
  - Improved communication

Internal Personnel Group Metrics & Models

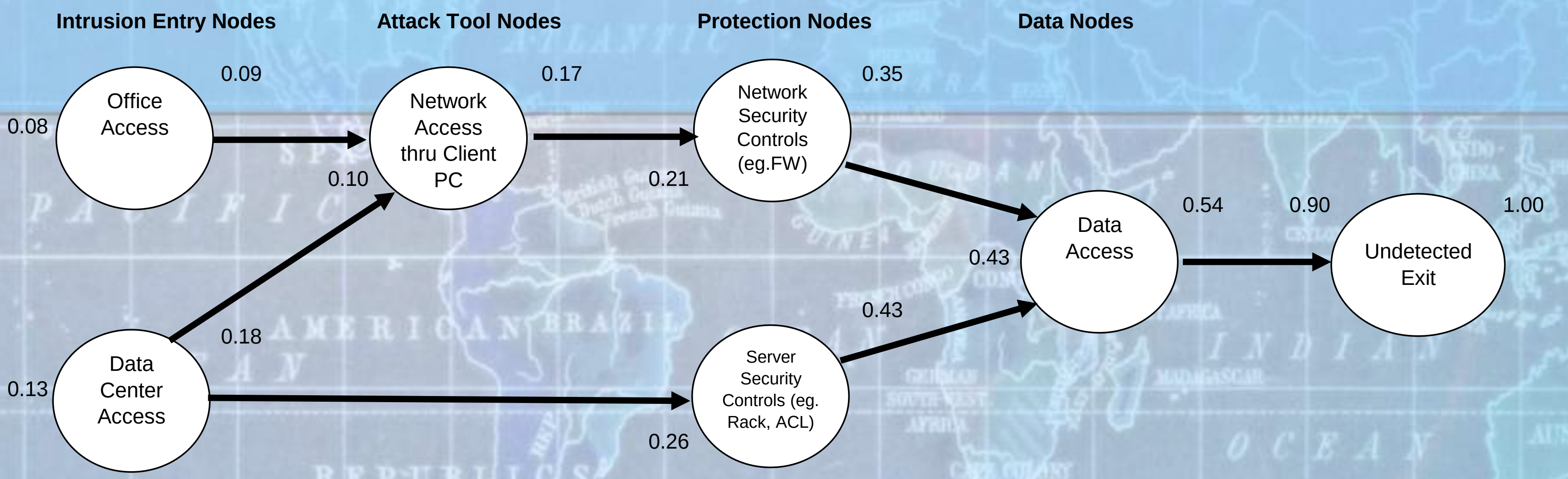
	MOEs	Input Parameters	Model
Deter	1. Probability of deterrence	1. Probability of interdiction 2. Severity of consequences for offenders	Mathematical model of psychological deterrence (Excel)
Physical Access	1. Probability of detection 2. Mean delay time	1. Probability of detection for various detection measures 2. Delay time associated with each detection measures	Queuing theory (Extend)
Data Access	1. Probability of detection	1. Probability of detection at various points of data access	Probabilistic model (Excel)
Response	1. Probability of interdiction	1. Quality of communications 2. Existence of internal fence	Agent based model (MANA)

Internal Personnel Group
The Model- Combining

- Goal: P(Successful Interdiction)
- How?
  - Each model produces probabilities
    - Data Access – Independent
    - Physical Access – Independent
    - Response – Dependent on Physical Access
    - Detererence – Dependent on all 3 above
  - Link them all together
  - Get P(Successful Interdiction) for all possible combinations and compare

Internal Personnel Group Data Access Modeling – System Level

- Model the intruder strategy at system level
- Nodes represent barriers that an intruder must penetrate
- Overall probability of success computed by considering the probability of success of all nodes



Internal Personnel Group Data Access Model – Random Test Case

- Probabilistic Model
- Based on Bayes Rule

Box 1. Bayes Rule.

$$\eta_1 = P(\text{intrusion}|\text{signal}) = \frac{P(\text{signal}|\text{intrusion})P(\text{intrusion})}{P(\text{signal}|\text{intrusion})P(\text{intrusion}) + P(\text{signal}|\text{no-intrusion})P(\text{no-intrusion})}$$

and

$$\eta_2 = P(\text{intrusion}|\text{no-signal}) = \frac{P(\text{no-signal}|\text{intrusion})P(\text{intrusion})}{P(\text{no-signal}|\text{intrusion})P(\text{intrusion}) + P(\text{no-signal}|\text{no-intrusion})P(\text{no-intrusion})}$$

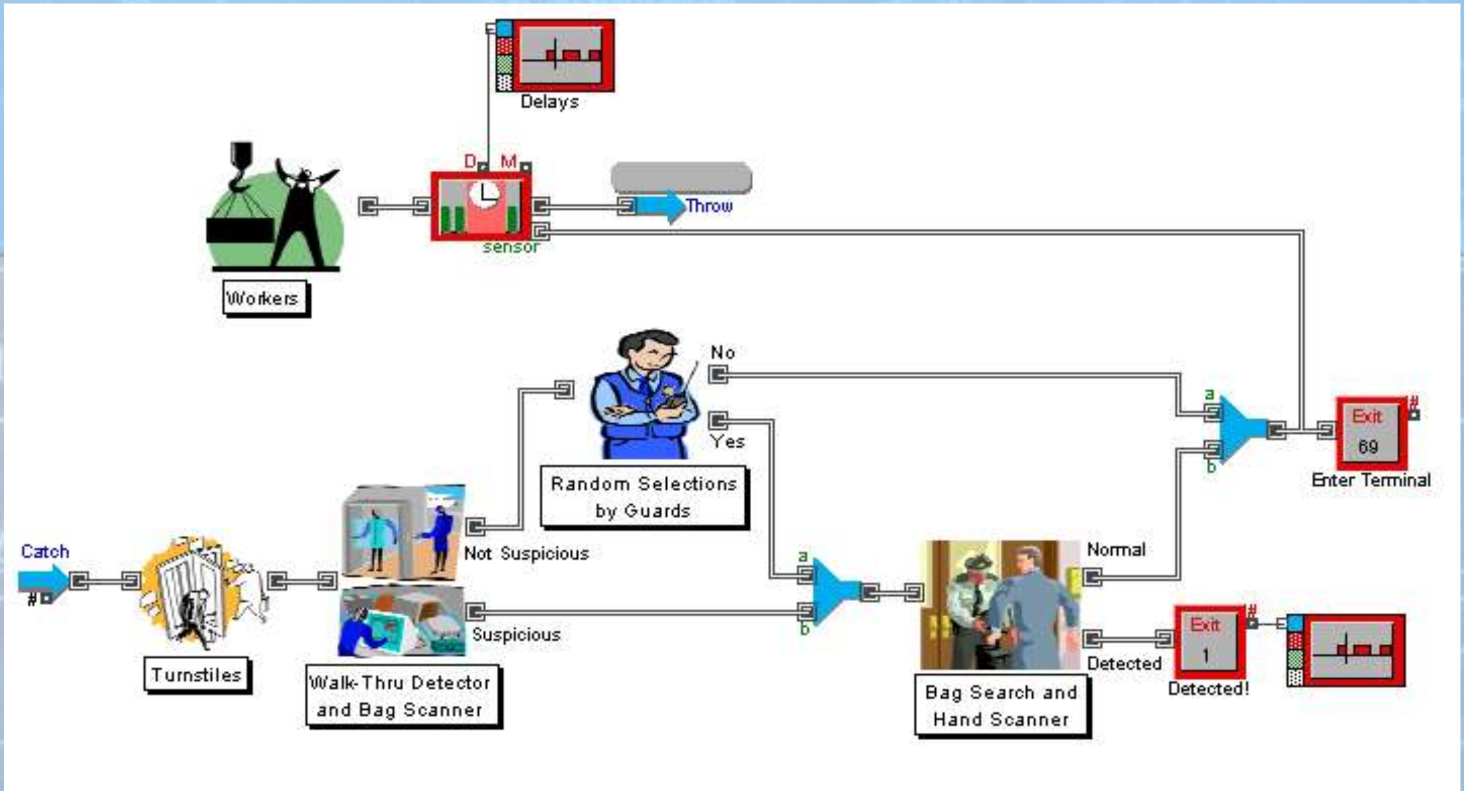
Results

- Min (Single Authentication and with IDS)
  - 79% effective
- Max (2 Factors Authentication and IDS)
  - 89% effective

Internal Personnel Group
Physical Access Model

<u>Alternatives modeled by EXTEND</u>

1. Status Quo - Turnstiles
2. Untrained Guard - Alternative 1 + Random Search with handheld Metal detector
3. Trained Guard - Alternative 2 + Training given to identify suspicious behavior
4. Maximum Control - Alternative 3 + Metal gate detector with bag scanner

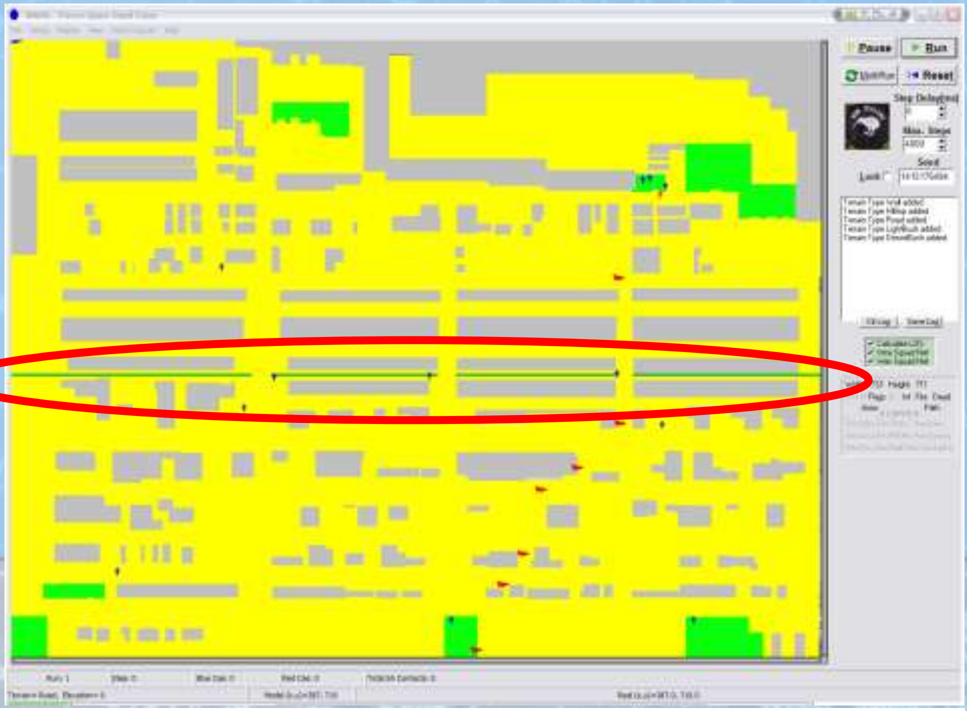


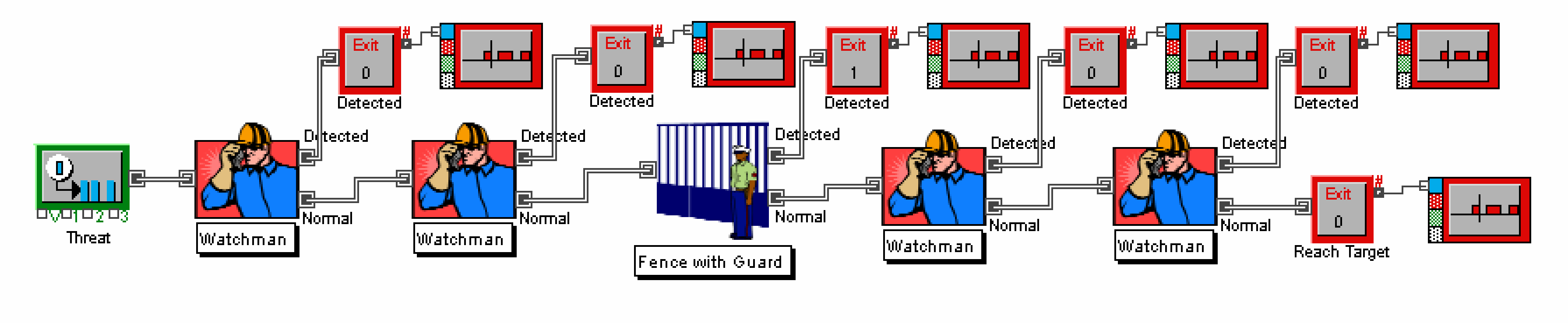
Internal Personnel Group Physical Access Model

TEMASEK DEFENCE SYSTEMS INSTITUTE

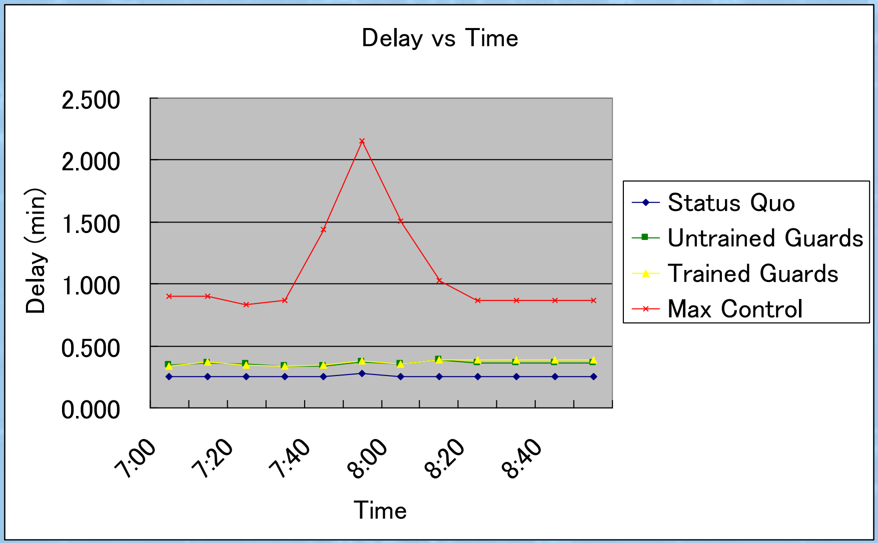
Internal movement models

1. Without internal fence – rely only on watchmen for detection
2. With internal fence – Watchmen + guard at internal fence





Internal Personnel Group
Physical Access Modeling Results



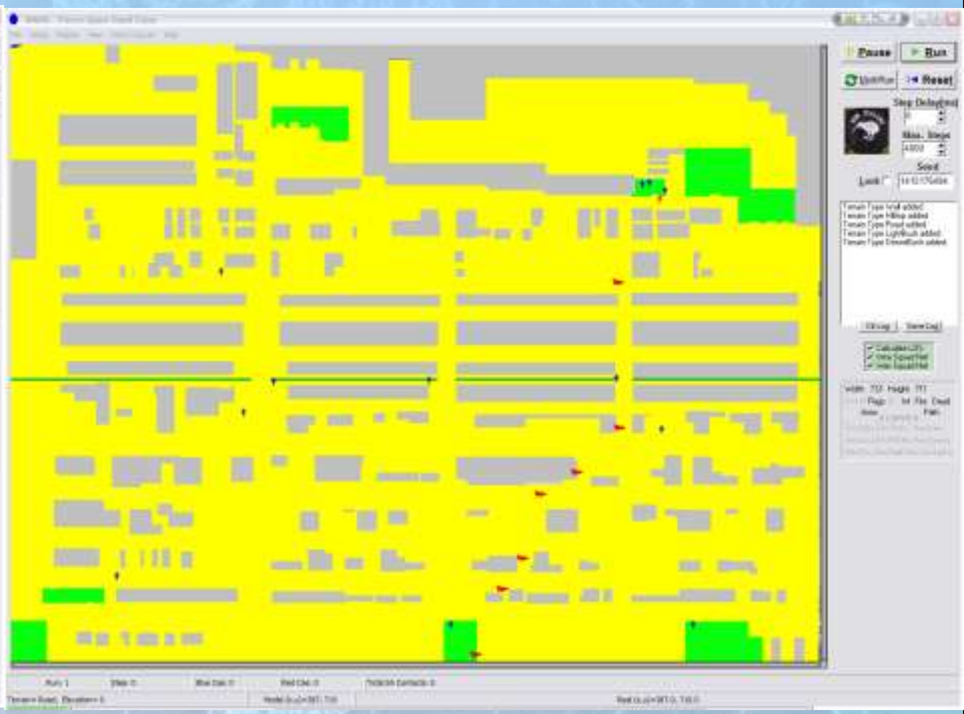
$P_{Detection}$	Without Internal Fence	With Internal Fence
Status Quo	.343	.669
Untrained Guards	.392	.694
Trained Guards	.497	.747
Max Control	.681	.839

Recommended:
Max Control with internal fence

Internal Personnel Group Response Model

<u>Alternatives modeled in MANA</u>

1. Poor Communications vs Good Communications
2. Mid-Terminal Fence w/ Gate Open vs w/ Gate Closed vs No Fence
3. Perpetrator starting at mid-field gate with good comms vs poor comms



Internal Personnel Group
Response Modeling Results

SCENARIO	P(Successful Interdiction)
No Fence, Bad Comms	0.32
No Fence, Good Comms	0.52
Fence w/ Open Gate, Bad Comms	0.63
Fence w/ Open Gate, Good Comms	0.77
Fence w/ Closed Gate, Bad Comms	0.48
Fence w/ Closed Gate, Good Comms	0.87
Mid-Terminal Start w/ Bad Comms	0.39
Mid-Terminal Start w/ Good Comms	0.54

Internal Personnel Group Deterrence Model – System Level

- Model based on research done by Robert Anthony (Institute for Defense Analysis) that appears in his paper “Deterrence and the 9-11 Terrorists”
- Involves both qualitative and quantitative analysis
- Provides quantitative value for psychological deterrence based on **probability of interdiction**
- The model also accounts for ‘severity of **consequences**’ from the perpetrator perspective.

Internal Personnel Group Deterrence Model – Results

- Equation:

$$P_D = 1 - (1 - P_I)\left(\frac{P_I}{P_O}\right)^x$$

- Results
  - Status Quo
    - 0.904*
  - Max Physical Access and Max Response
    - 0.935*
  - An increase of 3.4%

*Note: these results are for the combined Physical Access Control and Response model results.

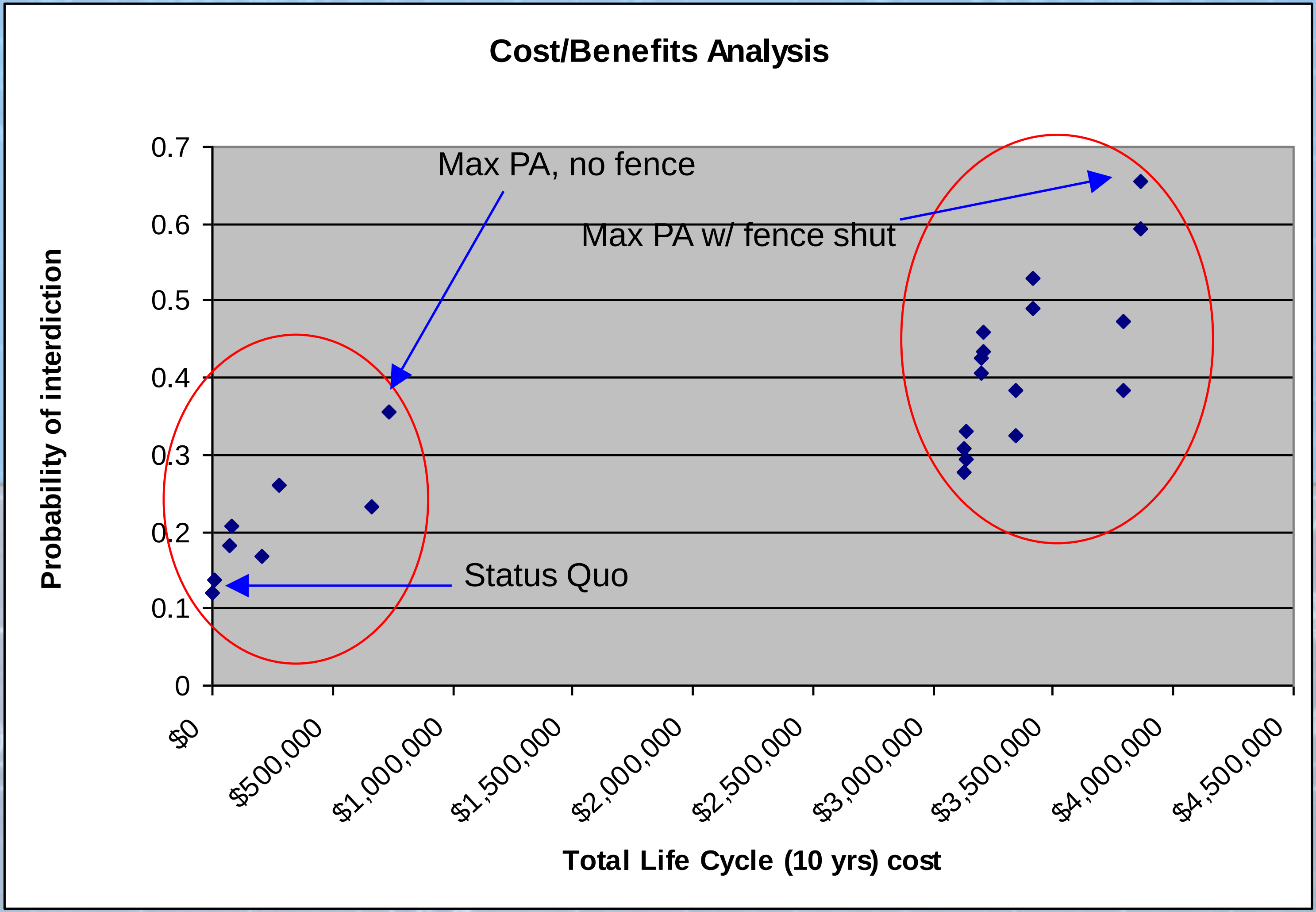
Internal Personnel Group
Combined Model Results
(with Data Access Results)

- Status Quo
  - 0.815
- Status Quo PA/Response with 2 factor authentication
  - 0.903
- Max PA/ Response with 1 factor authentication
  - 0.927
- Max PA/ Response with 2 factor authentication
  - 0.962

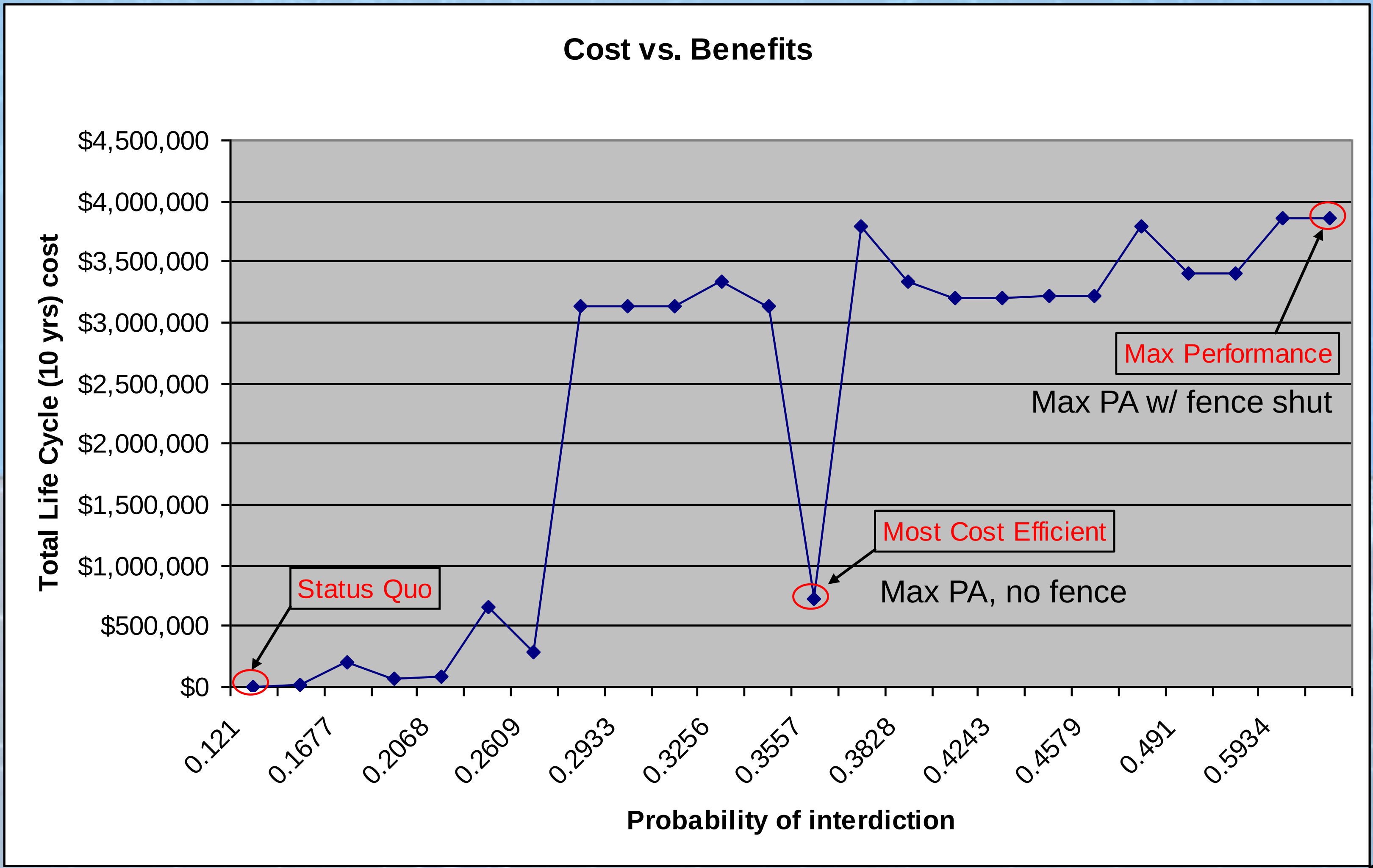
Internal Personnel Group
Physical Access - Response
Combined Model Results

P(Interdiction)			*Physical Access Control Measure*			
			Status Quo	**Untrained Guards**	**Trained Guards**	**Max Control**
No Internal Fence		**Bad Comm**	**.1210**	**.1359**	**.1677**	**.2334**
		Good Comm	**.1816**	**.2068**	**.2609**	**.3557**
With Internal Fence	**Open**	**Bad Comm**	**.3068**	**.3311**	**.3828**	**.4735**
		Good Comm	**.4052**	**.4327**	**.4910**	**.5934**
	Closed	**Bad Comm**	**.2781**	**.2933**	**.3256**	**.3823**
		Good Comm	**.4243**	**.4579**	**.5291**	**.6542**

Internal Personnel Group
Cost Benefit Analysis



Internal Personnel Group
Cost Benefit Analysis



Internal Personnel Group Conclusions

- With current port security infrastructure, incremental improvements in procedural changes and hardware modifications can increase the security effectiveness against internal threats from 12% to 36%.
- With substantial investment in manpower, procedural changes, and additional technologies implementation, the security effectiveness can be increased further to 65%.
- Given the difficulty of addressing internal threats and the potential impacts this has on the port operation, recommend making the investment for the higher performance gain.

Internal Personnel Group Recommended Future Study

- Preventive mechanisms to monitor suspicious activity and act upon them before they become threats
  – Pattern analysis for identification of abnormal behaviors
- Data mining techniques for misuse and anomaly detection
  – Statistical modeling
  – Temporal sequence learning
  – Neural network
  – Genetic algorithms

Summary

- Different agencies, whose efforts collectively provide port security, have different jurisdictions, organizational structures, and funding.
- A coordination problem exists amongst different agencies.
- The information received from the agencies must be rapidly received, displayed, interpreted and responded to in order for many of the modeled alternatives to be effective.
- From conducting this study, PSS12 recognized that the fusion of data is a critical issue that needs to be addressed.

Questions