Risk-Based Resource Allocation in Maritime Security and Maritime Domain Awareness

Duane Boniface

ABS Consulting

dboniface@absconsulting.com

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Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
OCT 2009		**00-00-2009 to 00-00-2009**

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
Risk-Based Resource Allocation in Maritime Security and Maritime Domain Awareness	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **ABS Consulting,16855 Northchase Dr,Houston,TX,77060**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES
Maritime Domain Awareness and Counter Piracy, 26-29 October 2009, Ottawa, Canada. U.S. Government or Federal Rights License

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT **unclassified**	b. ABSTRACT **unclassified**	c. THIS PAGE **unclassified**	**Same as Report (SAR)**	**31**	

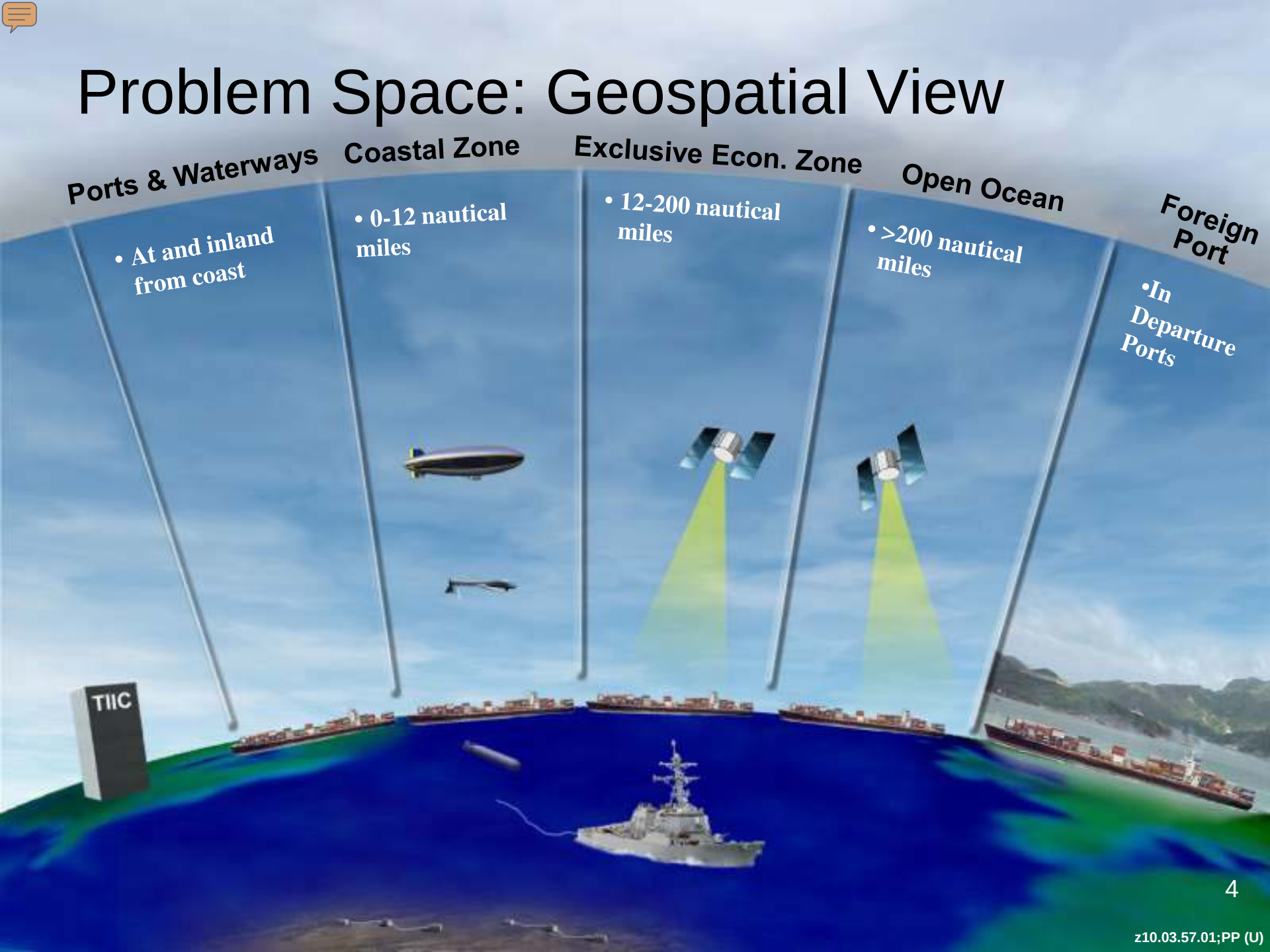
Overview

- Problem Space
- RBDM Approach
- Levels/Applications
  - Acquisition
  - Planning & Execution

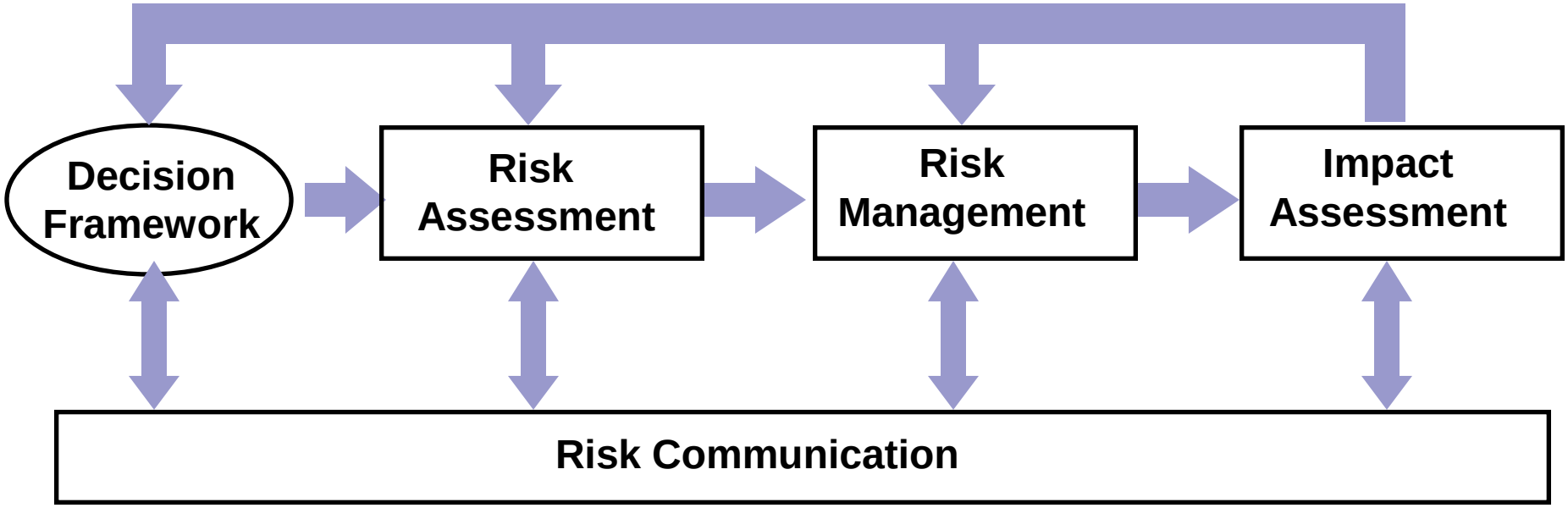
Problem Space

- EEZ Area: 3.36 million square nautical miles
- Over 7,000 vessels calling on U.S.
- Approximately 60,000 calls in U.S. ports
- Up to 6,600 containers on board a single container ship, each with at least one shipment
- Approximately 6 million container arrivals by sea per year
- Multiple agencies involved with non-interoperable/interconnected databases
- Limited resources to monitor, inspect, interdict

Problem Space: Geospatial View



Risk Based Decision Making



Levels/Applications

- Planning and Execution
  - Strategic
  - Operational
  - Tactical
- Acquisition

Planning and Execution

- Support Resource Allocation
- Support Analysis and Replanning

- Alternatives
  - Assess risk for each vessel and plan accordingly (man to man)
  - Assess risk geospatially and plan accordingly (zone)

Stages

- Decision Framework
  - How best allocate finite resources to manage risk
  - Assume for example that only concerned about security risk and resource removal
- Risk Assessment
  - Draw upon regional risk assessment to develop risk profile
    - IPOE
    - MSRAM
    - Other

Planning and Execution:
High Level Risk Assessment

Goal:	Concern:	Location(s) of Concern
Security	**Vessel as Transport**	Ports and Waterways
	(Vessel being used to transport personnel, weapons, equipment or funds for terrorist-related activities.)	Coastal Zone*
		EEZ & Beyond*: unlikely given difficulties of transfer.
	Vessel as Weapon	Ports and Waterways
	(Kinetic or chemical energy of vessel used by agents on board as either improvised weapon of mass destruction or weapon targeting critical infrastructure.)	Coastal Zone*
		EEZ & Beyond*: unlikely given difficulties of targeting
	Vessel as Target	Ports and Waterways
	(Vessel targeted externally as mass-casualty inducting target, either due to the number of people on board {e.g., ferry, cruise ship}, or due to the hazardous nature of the cargo {e.g., using the vessel as an improvised weapon of mass destruction}.)	Coastal Zone
		EEZ & Beyond: unlikely given difficulties of targeting, lesser consequences
Enforcement of Laws and Treaties	**Vessel as Resource Removal *** (Vessel being used to extract and/or remove U.S. resources such as groundfish, minerals, etc.)	Ports and Waterways: Unlikely given limited resources, likelihood of interdiction
		Coastal Zone*
		EEZ & Beyond*

Existing Resources:

- IPOE
- MSRAM
- CMT
- NCRA
- TSSRA

* Requires complicit crew

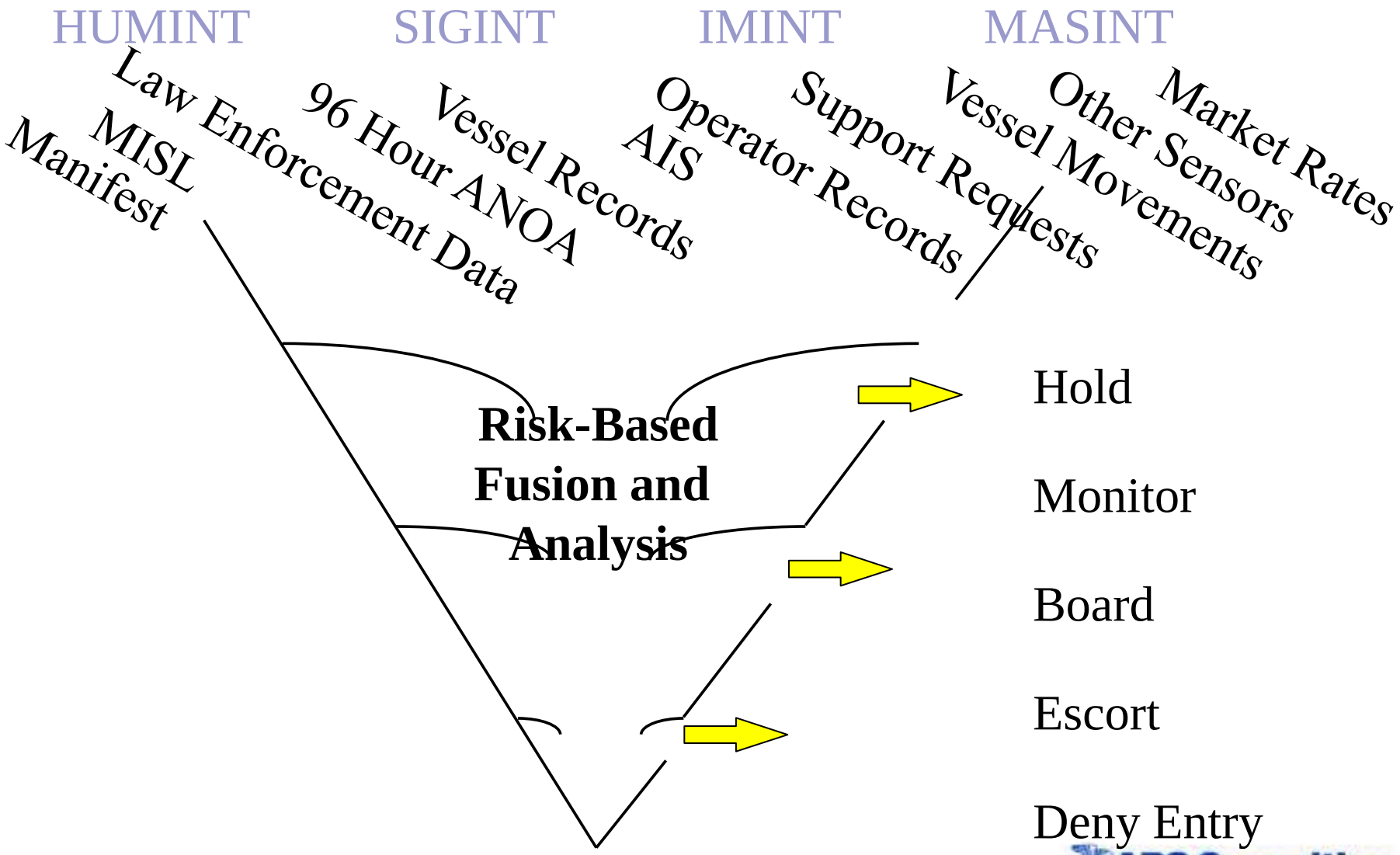
Planning and Execution:
High Level Risk Management

Goal:	Concern:	Location(s) of Concern	Risk Management
Security	**Vessel as Transport**	Ports and Waterways	Hold, Monitor, **Board**, Deny Entry
	(Vessel being used to transport personnel, weapons, equipment or funds for terrorist-related activities.)	Coastal Zone*	**Hold**, Monitor, Board, **Deny Entry**
		EEZ & Beyond*: unlikely given difficulties of transfer.	**Monitor**, Mitigate additional EEZ risk by monitoring for rendezvous
	Vessel as Weapon	Ports and Waterways	Hold, Monitor, Board, Deny Entry, **Escort, Sea Marshal**
	(Kinetic or chemical energy of vessel used by agents on board as either improvised weapon of mass destruction or weapon targeting critical infrastructure.)	Coastal Zone*	**Hold**, Monitor, **Board, Deny Entry**, Escort
		EEZ & Beyond*: unlikely given difficulties of targeting	**Monitor**
	Vessel as Target	Ports and Waterways	Hold, Monitor, **Escort**
	(Vessel targeted externally as mass-casualty inducting target, either due to the number of people on board {e.g., ferry, cruise ship}, or due to the hazardous nature of the cargo {e.g., using the vessel as an improvised weapon of mass destruction}.)	Coastal Zone	Hold, Monitor, **Escort**
		EEZ & Beyond: unlikely given difficulties of targeting	**Monitor**
Enforcement of Laws and Treaties	**Vessel as Resource Removal** (Vessel being used to extract and/or remove U.S. resources such as groundfish, minerals, etc.)	Ports and Waterways: Unlikely given limited resources, likelihood of interdiction	**Monitor**, Board,
		Coastal Zone*	Monitor, **Board**,
		EEZ & Beyond*	Monitor, **Board**,

Impact Assessment

- Assessment
  - Cited as challenge throughout Navy, Coast Guard, particularly at operational level
- Use model to:
  - Determine where results less than expected
  - Evaluate potential changes to planning and execution

“Man to Man”: Decision Support System



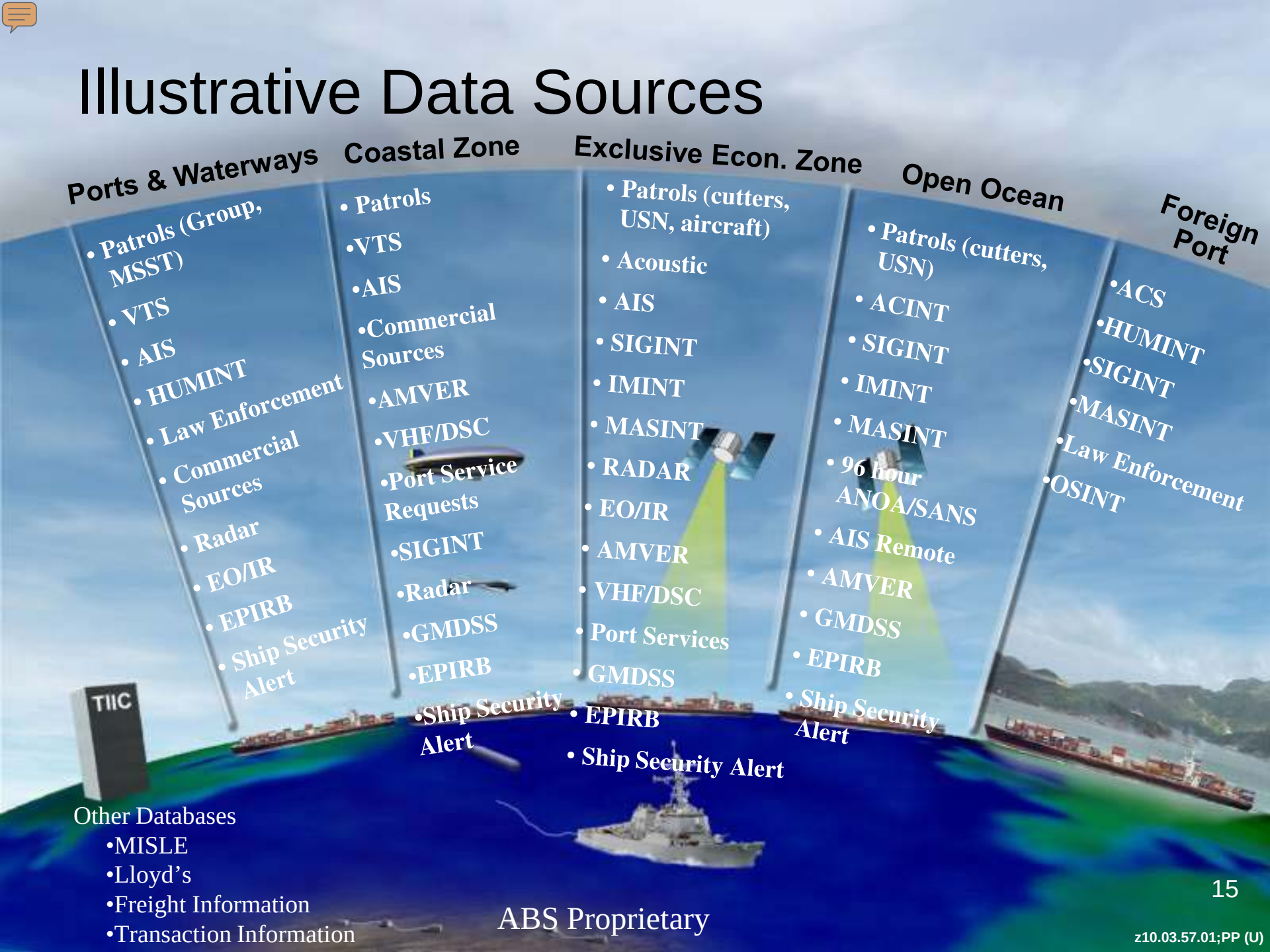
Acquisition

- Similar to Planning and Execution
  - More detailed, less subjective given time available, resources involved
- Overarching Approach
  - Cost-Benefit/Cost-Effectiveness Analysis
    - Maximize *Net Benefits = Social Benefits – Social Costs*
    - Such that $\text{Benefit}_i / \text{Cost}_i > \eta_i$, for all individuals/groups i

      where η_i is some acceptable threshold for equity
    - And other constraints specific to the situation

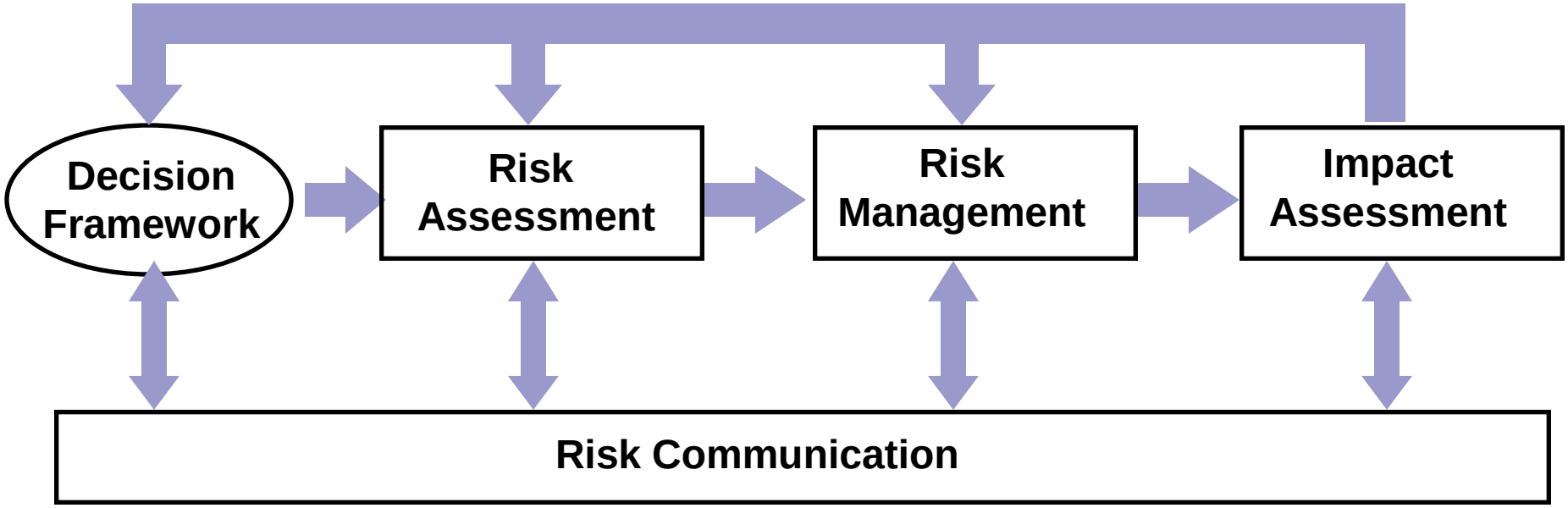
Illustrative Threat Scenarios

Illustrative Data Sources

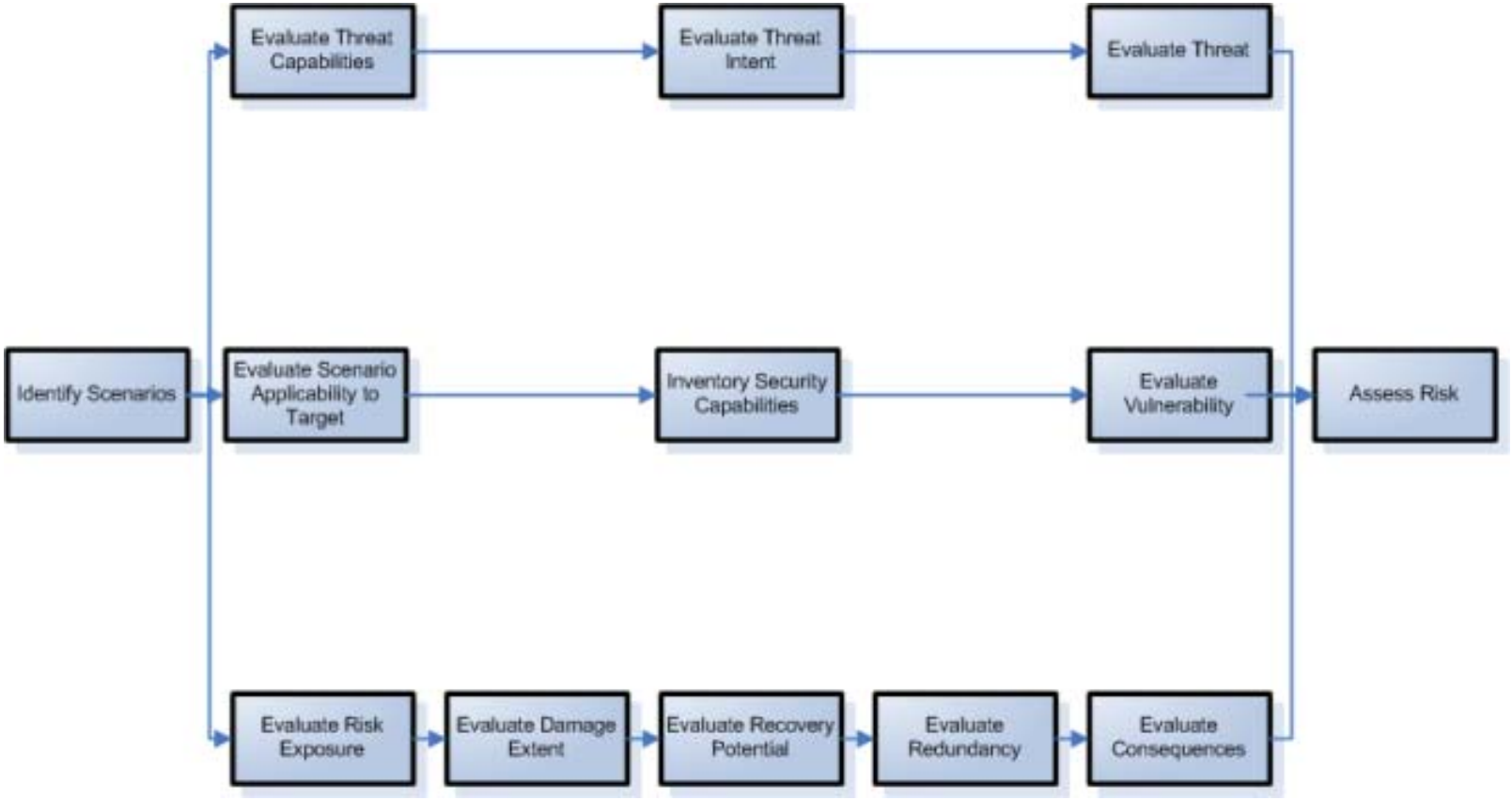


Other Databases
- •MISLE
- •Lloyd's
- •Freight Information
- •Transaction Information

Risk Based Decision Making



Overarching Approach: Risk Assessment



Terminology

- **Threat**: Probability that an attack scenario is selected given that an attack is to be undertaken. This includes the deterrent effect of existing and forthcoming countermeasures.
- **Vulnerability**: Probability that attack reaches the intended target, given that a particular scenario is planned. This includes all preparatory efforts once the scenario is selected up to and including the breach of applicable defensive systems to allow interaction of the attack with the target.
- **Consequence**: Outcome of interaction of the attack with the target, to include target hardness relative to that attack, and broader systemic effects as mitigated by response, redundancy and recovery.

Model

- Risk[Scenario] = P[Attack] * P[Scenario | Attack] * P[Attack Intersects Target | Scenario] * Consequence
  - P[Attack] a function of intent and capability
  - P[Scenario | Attack] a function of specific scenario-related capability and intent
  - P[Attack Intersects Target | Scenario]
  - Consequence
  - <Reasonable Minimum, Best Estimate, Reasonable Maximum>
    - Use Best Estimate for primary analysis, use Reasonable Minimum, Reasonable Maximum for uncertainty analysis, sensitivity analysis

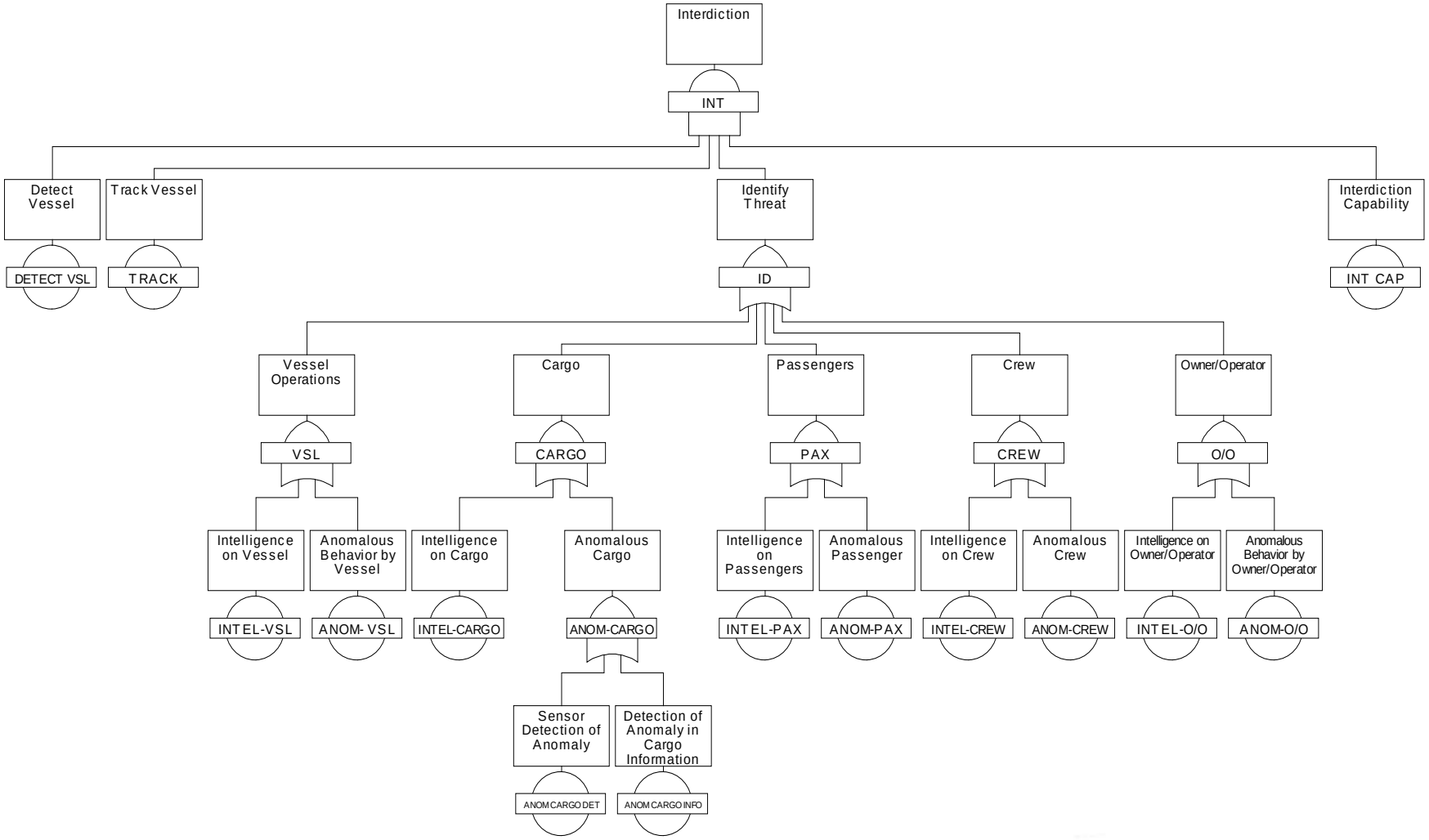
The above is an approximation of:

$$R \equiv \sum_{i=1}^{m} \sum_{j} \sum_{k} \sum_{l} P[i\_Attacks\_in\_Time\_t] * P[Scenario_{jk} \mid i\_Attacks] *$$
$$P[l\_Successes \mid i\_Attacks] * P[Defensive\_Systems\_Breached \mid Scenario_{jk}, Attack] *$$
$$E[Consequences \mid Defensive\_Systems\_Breached, Scenario_{jk}, i\_Attacks, l\_Successes]$$

Vulnerability

- Probability that attack intersects target given scenario
- Consider
  - Inherent Difficulty
  - National Defenses and Mitigation
  - State and Local Defenses and Mitigation
  - Target Defenses and Mitigation

Vulnerability Fault Tree



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Consequences

- Life Safety
- Primary Economic
- Post-Primary Economic
- Psychological
- Mission

Risk Management

- Identify Investments
  - Enhance detection
  - Enhance analysis
  - Improve interdiction
  - Combinations
- Evaluate Investments
  - Life cycle cost
  - Effectiveness
  - Cost-effectiveness
- Decide and Design
  - Determine optimal investment

Management Strategies

Assets: Existing & Planned

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MDA Functional Support

Goal:	Concern:	Alertment Basis:
Security	**Vessel as Transport** (Vessel being used to transport personnel, weapons, equipment or funds for terrorist-related activities.)	• Detection of anomaly in cargo. • Detection of anomaly in crew. • Detection of anomaly in passengers. • Detection of anomalous behavior by vessel. • Detection of anomalous behavior in vicinity of vessel.
	Vessel as Facility (Vessel being used for manufacturing, training, logistics, etc.)	• Detection of anomalous behavior in vicinity of vessel. • Detection of anomalous behavior in vicinity of vessel.
	Vessel as Weapon (Kinetic or chemical energy of vessel used by agents on board as either improvised weapon of mass destruction or weapon targeting critical infrastructure.)	• Detection of anomaly in crew. • Detection of anomaly in passengers. • Detection of anomalous behavior in vicinity of vessel. • Detection of threatening behavior in vicinity of vessel.
	Vessel as Target (Vessel targeted externally as mass-casualty inducting target, either due to the number of people on board {e.g., ferry, cruise ship}, or due to the hazardous nature of the cargo {e.g., using the vessel as an improvised weapon of mass destruction}.)	• Detection of anomalous behavior in vicinity of vessel. • Detection of threatening behavior in vicinity of vessel.
	Vessel as Response Asset (Vessel as resource to prevent and/or mitigate/respond to mishap.)	• Identification of vessels in vicinity.
Enforcement of Laws and Treaties	**Vessel as Transport** (Vessel being used for smuggling activities such as illegal immigration, drug trafficking, etc.)	• Detection of anomaly in cargo. • Detection of anomaly in crew. • Detection of anomaly in passengers. • Detection of anomalous behavior by vessel. • Detection of anomalous behavior in vicinity of vessel.
	Vessel as Resource Removal (Vessel being used to extract and/or remove U.S. resources such as groundfish, minerals, etc.)	• Detection of anomalous behavior by vessel. • Detection of illegal behavior by vessel.
Safety	**Vessel in Danger**	• Identify unsafe operations. • Identify delayed/missing vessels.
	Vessel as Response (Vessel as resource to prevent and/or mitigate/respond to mishap.)	• Identification of vessels in vicinity
Environmental Protection	**Vessel as Pollution Source** (Vessel as source of oil, hazardous material, non-indigenous species, etc.)	• Identify operations of concern. • Support forensic evaluation
	Vessel as Response (Vessel as resource to prevent and/or mitigate/respond to mishap.)	• Identification of vessels in vicinity
Mobility	**Vessel Traffic Management**	• Support real-time operational management. • Support planning and analyses (e.g., Port Access Routes Studies)

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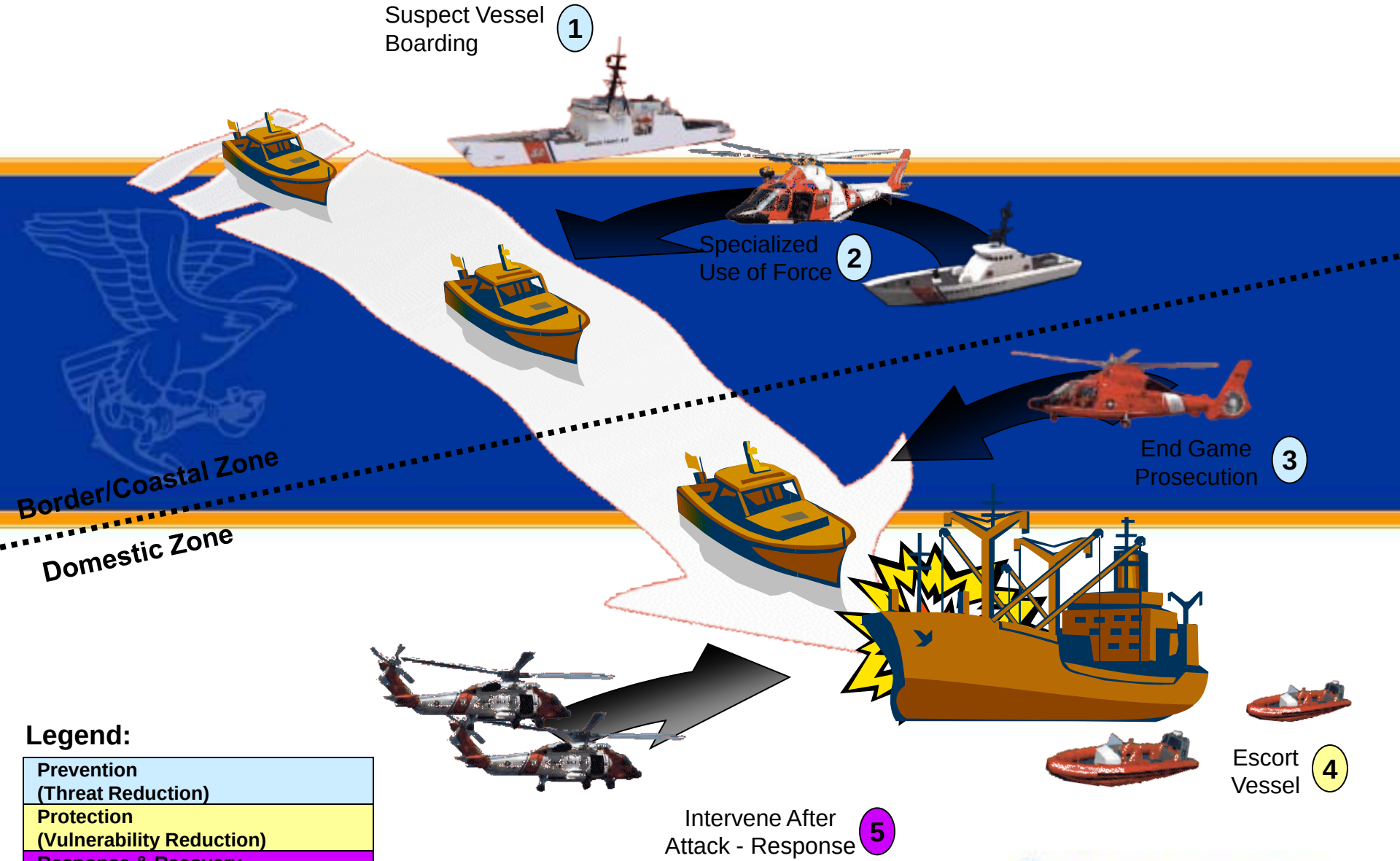
Identify Interventions

Waterside attack on Vessel Scenario



Legend:

Prevention (Threat Reduction)
Protection (Vulnerability Reduction)
Response & Recovery (Consequence Reduction)

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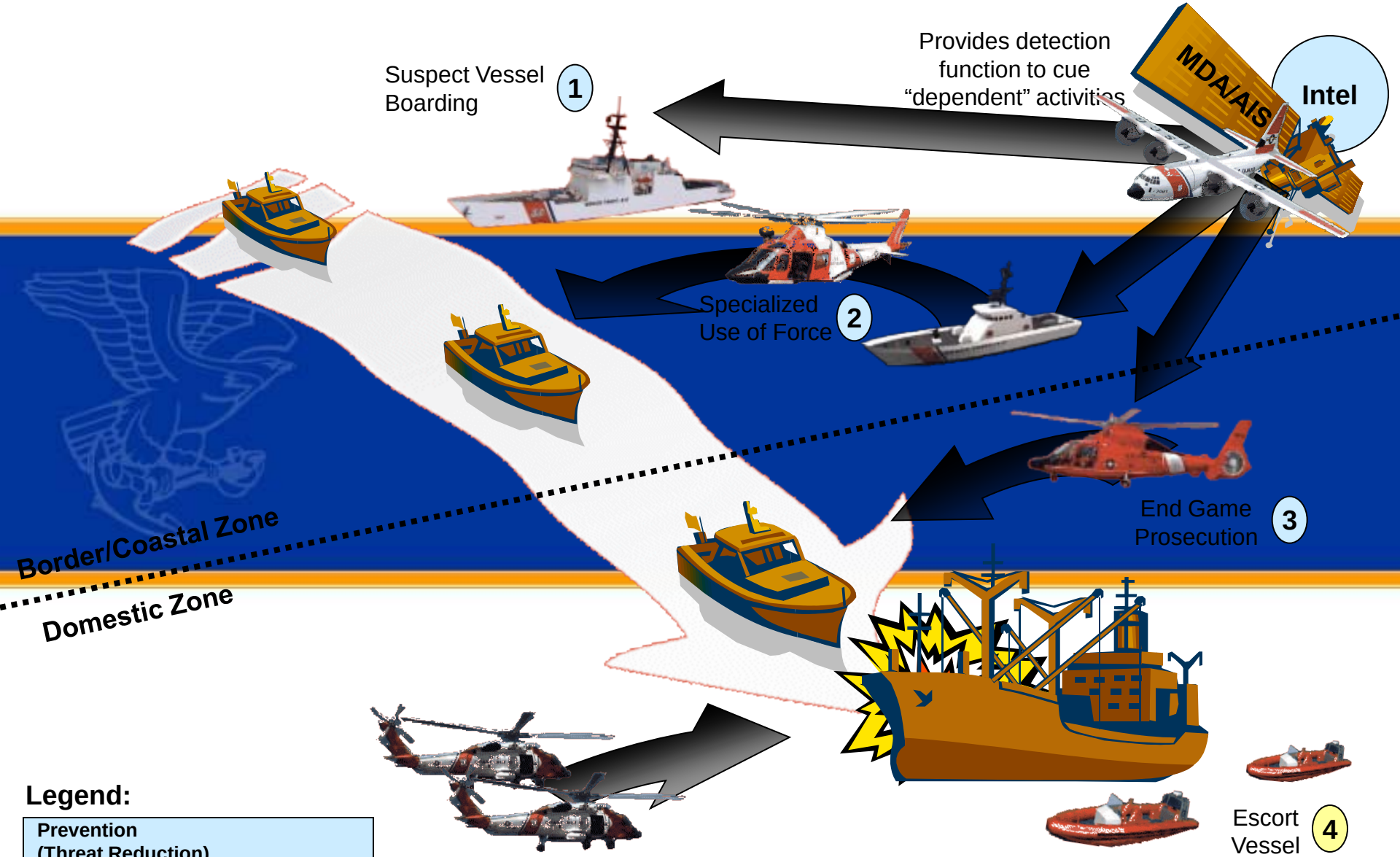
Identify Interventions

Waterside attack on Vessel Scenario



Legend:

Prevention (Threat Reduction)
Protection (Vulnerability Reduction)
Response & Recovery (Consequence Reduction)

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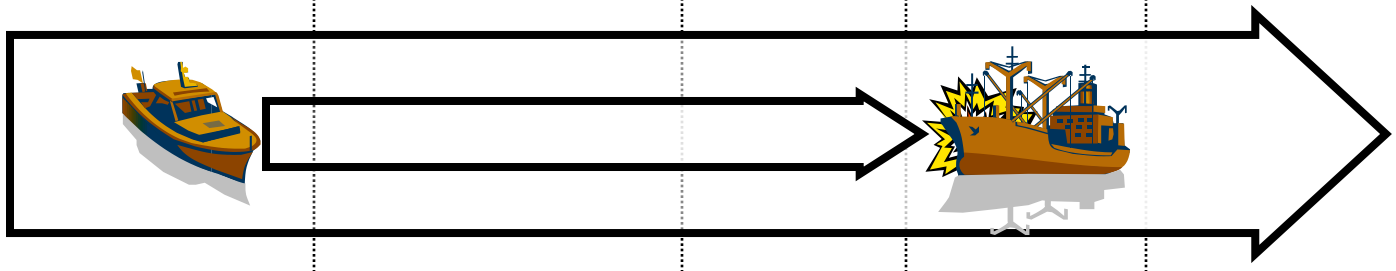
Waterside attack on Vessel Scenario Risk Calculation



Raw Risk 700 RIN * **Line of Assurance Failure Probabilities** 99% * 95% * 90% * 80% * 90% = **Residual Risk** 427 RIN

Targets directly protected by activities

1. Suspect Vessel Boarding*
2. Specialized Use of Force*
3. End Game Prosecution*
4. Escort Vessel
5. Intervene After Attack - Response

700-427 = 273 RIN

300-229 = 71 RIN

344 RIN

Risk Reduction

34%

Raw Risk 300 RIN * **Line of Assurance Failure Probabilities** 99% * 95% * 90% * 90% = **Residual Risk** 229 RIN

Targets not directly protected by activities

1. 2. 3. 5.

*Lines of Assurance dependent on external detection activities (e.g., MDA)

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Impact Assessment

- Look for and use opportunities to refine assessment, re-evaluate risk management
  - Drills
  - Exercises
  - Experiments
  - Actual Events (security and otherwise)

Conclusion

- Complexity of maritime problem space and limited assets demands strong analytics
- Risk-based approaches provide structured methods for analyses that acknowledge uncertainties