OA4202 Red Team Modeling Project Executive Summary

"Small Boat Attack in the Malacca Straits"

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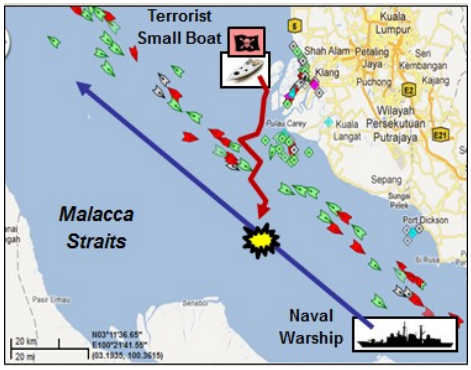
1. Problem Statement and Objective

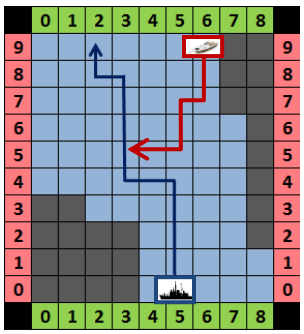


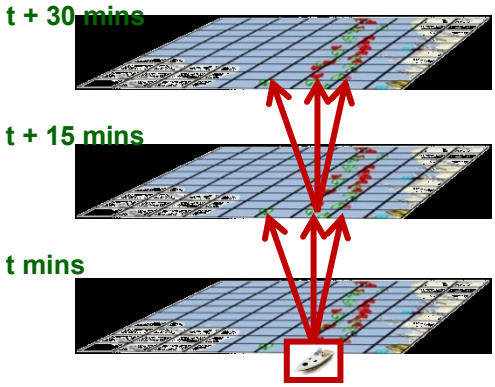
Since the bombing of USS Cole by a small Al-Qaeda explosive-laden boat, trends in maritime terrorism has indicated that small boat attacks are emerging as a cost-effective and successful strategy against commercial and military vessels[1]. Being small, these boats are fast and highly maneuverable, leading to difficulties in tracking of these vessels. Identifying them as hostile is an even greater challenge, as they often hide behind shipping lanes and coastal terrain, which disrupts and renders radar signals ineffective. Coupled with their ambush locations along narrow sea straits, any shipping passing through is confined and vulnerable to attacks. For warships, sovereignty issues of land along the narrow passage prevent the employment of long range missiles or guns against small boats.

In this project, we apply Network Flows and Modeling to provide insights on how warships in the Malacca Straits can be protected from this threat, by looking at how the small boat attempts to find the starting position and minimal risk path of engaging the warship.

2. Network Representation

The area of interest is divided into gridded cells of 5nm x 5nm, representing node positions for ships. To reflect a space-time domain, the network of cells is duplicated for each 15-minute time step, (based on the time to traverse a node for a ship travelling at 20kts). Edges denote possible movements from a given node in the current time step to another node in the next time step.





[1] Hill B. P. (2009). *Maritime Threat and the Small Boat Threat to the United States: A Proposed Response*. Master's Thesis. Monterey, CA: Naval Postgraduate School.

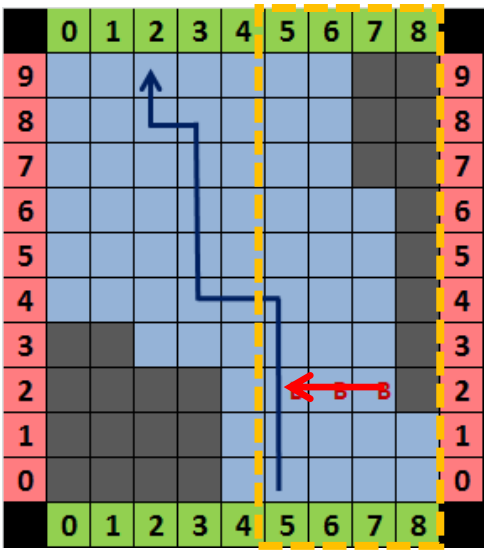
Edge costs are defined by the reliability of the path for destination node it is connected to. Reliability levels are associated with risks due to exposure (e.g. not in shipping lanes or coasts), distance, as well as line-of-sight, from the warship. The Linear Program for Shortest Path is used for determining both the optimal starting location and minimal risk path (or maximum reliability path).

Surveillance assets deployed on the edges or nodes (influencing all surrounding edges) represent attacks on the network. Two modes of attack can be employed: (1) a fully blocking sensor preventing entry with an exorbitantly high risk cost, and (2) a degradation sensor that increases the risk cost of bypassing it.

3. Results and Analysis

3.1 Base Case: No Interdiction

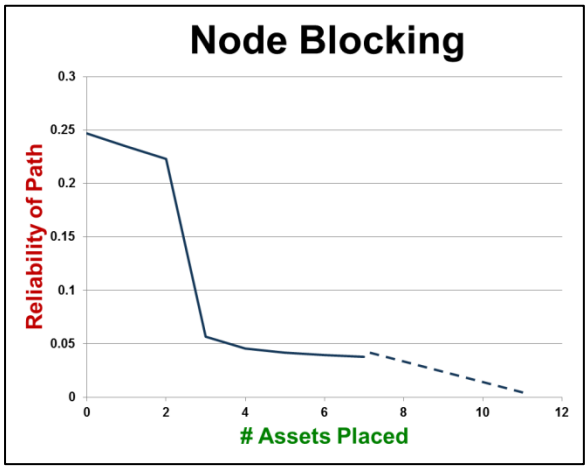
We first consider the baseline case where no additional surveillance assets are deployed for interdiction. The warship travels along the path represented by the blue arrow from (5,0) to (2,9). The most reliable path for the boat, denoted by the red arrow, is to travel from (7,2) to (6,2) to (5,2) where it reaches the warship with probability 0.247. We observe that the solution exploits the cover of the shipping lanes, represented by the rectangle, and takes the most direct path to the warship.



3.2 Node Blocking Interdiction

We now look at the effects of placing surveillance assets on the maximum reliability of the paths available to the boat. From the resilience curve, we note the following:

- When we place 1 and 2 assets, the boat responds by taking a slightly longer route to avoid the assets, but still has the same origin (7,2).
- When 3 assets are placed, the boat starts instead from (0,4). It has become more risky for the boat to start from the east (7,2) and take a detour around the assets compared to starting from the west (0,4). This results in the greatest drop in the resilience curve.
- When 11 assets are placed, the boat will not be able to reach the warship.

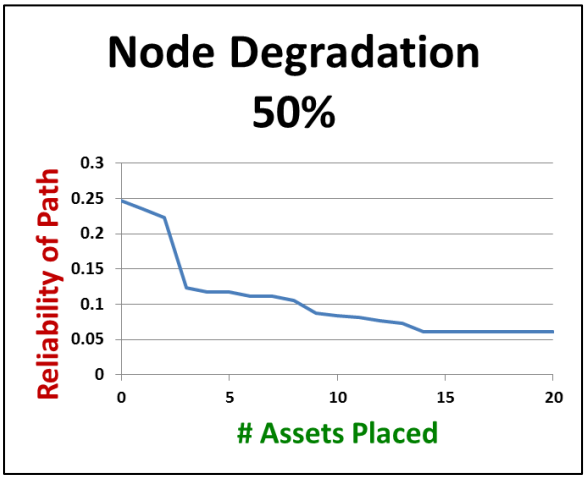


3.3 Node Degradation Interdiction

It is more realistic that the assets do not completely block off nodes, but instead degrades the probability of the boat evading capture if the boat travels to that node. We consider the case where

the asset has a 50% probability of stopping the boat. Again, we make observations based on the resilience curve:

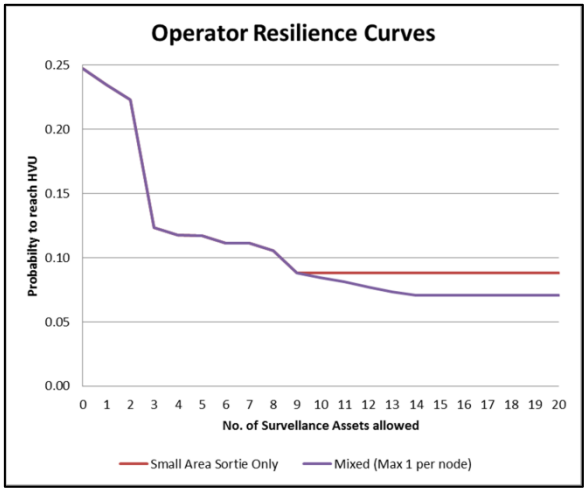
- As with the case of node blocking, When we place 1 and 2 assets, the boat responds by taking a detour to avoid the assets, but still has the same origin (7,2).
- However, when 3 assets are placed, the most reliable path is as if no assets are placed. The increased probability of capture in this case does not deter it from going into that node.
- There is no additional benefit in placing more than 14 assets to deter the boat attacks.



3.4 Mixture of Surveillance Assets

Finally, we consider the mixture of the following two types of assets which model the use of maritime patrol aircraft sorties at specific windows in time:

- Large Area Effect (LAE) asset, which has a longer range, influencing arcs coming in from 2 nodes away, but less effective, with 50% probability of stopping the boat on arcs influenced.
- Small Area Effect (SAE) asset, which has a shorter range of 1 node, but more effective with 50% probability of stopping the boat on arcs influenced.



From the comparison of the resilience curves we observe the following:

- The first 3 assets placed have the most impact on decreasing the risk from the small boat attack.
- If restricted to having only 1 asset at a map grid at any time, the LAE asset can further improve the probability of stopping the boat after performance saturation for SAE assets at 9 SAE assets placed.
- There is benefit in allowing both types of assets on the same node, with the mixture of asset types occurring from 5 assets deployed onwards.