

## Trading off Border Security against Target Hardening

This project is to study factors that affect the relative desirability between target hardening and overarching protections, such as border security.

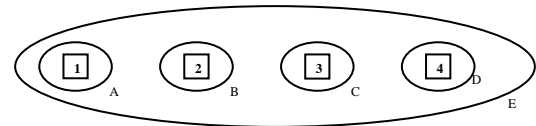
**Modeling Area:** Risk analysis

**Case Studies Supported:** Border security

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**Other Investigators:** Naraphorn Haphuriwat  
(Graduate student)



Sample system with four targets

### Brief Description:

In principle, defenders concerned about protecting multiple targets can choose to protect them either individually (through target hardening), or collectively (through overarching protections such as border security, public health, emergency response, or intelligence). Decision makers may find it relatively straightforward to choose which targets to harden, but are likely to find it difficult to compare seemingly incommensurate forms of protection – e.g., target hardening, versus a reduction in the likelihood of weapons being smuggled through the border. Unfortunately, little previous research has addressed this question, and fundamental research is needed to provide guidance and practical solution approaches. Therefore, we propose to investigate the factors affecting the relative desirability of target hardening versus overarching protections such as border security.

### Objectives:

Little previous research has focused on strategies for allocating defensive investments between hardening of individual targets and overarching forms of protection, such as border security. Therefore, the objective of this work is to investigate the factors affecting the relative desirability of target hardening versus overarching protections. We hope that the results will help decision makers achieve more nearly optimal allocations of resources when faced with choices among seemingly incommensurate forms of protection such as target hardening versus border security.

### Interfaces to other Center Projects:

Not yet initiated

### Interfaces to non-Center Projects:

Not yet initiated. However, we have been in touch with the Wisconsin Office of Justice Assistance with regard to estimating the cost effectiveness of defensive investment.

### Major Products and Customers:

The results of this work will help to identify the most cost-effective investment strategies for homeland security. Moreover, the findings of this research are in principle applicable not only to terrorism, but to other types of risks due to intentional or malicious actions, such as computer security.

The final project deliverable will be a refereed journal article documenting our model for optimally allocating defensive budgets between target hardening and overarching protections (such as border security), and its results. More specifically, the results of the simulation and sensitivity analyses will shed light on the optimal balance between investment in target hardening and overarching protections. We anticipate that the primary customers for our work will be federal, state, and local policy makers, although facility owners and operators may also find it useful.

**Technical Approach:**

The first step in the proposed work is to set up a game-theoretic optimization model, assuming that the defender has a specified number and variety of targets to protect, with a finite specified budget. As in previous work, both the probability of an attacker successfully penetrating the border and the conditional probability of a successful attack on a target given that the border has been penetrated will be assumed to decline exponentially in the extent of defensive investment. Since target valuations are allowed to be heterogeneous, the model will allow us to study the effects of variance and skewness in the target valuations on the resulting optimal defensive resource allocation, using Monte Carlo simulation and sensitivity analysis. In particular, we will allow the target valuations in any iteration of the simulation be randomly chosen from either the Johnson family of distributions, or the generalized beta distribution, since both families of distributions make it possible to systematically vary the variance and skewness of the distribution, while holding the mean value and the functional form of the distribution constant.

**Major Milestones and Dates:**

1. Develop a game-theoretic model for allocation of defensive investment that allows arbitrary numbers of heterogeneous targets to be protected by continuous levels of defensive investment in either target hardening or overarching protection – September-November 2008
2. Use Monte Carlo simulation to generate multiple sets of randomly chosen target valuations with given variance and skewness for both the Johnson and the generalized beta family of distributions – December 2008-January 2009
3. Perform sensitivity analysis of model results at the simulated sets of target valuations – February-June 2009
4. Synthesize, interpret, and document results – July 2009-August 2009