Project 5: Strategic Decision Making in Presence of Adversaries (Hall)

In this research, we develop a new methodology for strategic decision making under uncertainty and in the presence of adversaries, and apply it to the MANPADS problem along with other decision analysis problems.

Modeling Area: Risk Assessment
Application Area: Transportation Security, MANPADS
Principal Investigator: Randolph Hall
Institution: University of Southern California
Student Research Assistants: Erim Kardes

Brief Description:
This investigation is motivated by the need to determine optimal strategies under uncertainty against an adversarial and adaptive opponent. This kind of a problem arises in the context of homeland security related decisions. To this end we propose the use of stochastic games. We first focus on complete information stochastic games and evaluate the effectiveness of MANPADS countermeasures within the stochastic game framework that takes into account the possible antagonistic strategies of the adversaries.

Objectives:
The objective of this research is to develop a methodology for risk analysis in the presence of adaptive adversaries using a formulation based on stochastic games. The long term objective is to demonstrate the use of stochastic games for the MANPADS problem. Sensitivity analysis is to be performed subsequently.

Major Products and Customers:
The major product of this research is a novel methodology for risk analysis, and to apply it to various decision making problem including MANPADS.

Interfaces to other CREATE Projects
This effort will interface with the MANPADS case study and in the longer term with RAW.

Technical Approach:
First, we consider that the adaptive nature of the adversary is uncertain. In other words, we propose a new approach that accounts for the uncertainty in the conversion from one threat category to the other that is based on the alternatives of the adversaries. Second, we consider that payoffs to the opponents are uncertain. We present an interesting new result, existence of equilibrium points in robust stochastic games. A new formulation that uses robust optimization techniques is proposed to solve robust stochastic games. Preliminary results are presented on a simple example with partial unknown data. This research includes the development of the model for the MANPADS case study, quantification of the model, and computation of optimal/robust optimal strategies.

Major Milestones and Dates:
- Existence of equilibrium has been shown and a sample equilibrium calculation is achieved on a small numerical example.
- Formulation of the stochastic game model for MANPADS Spring 2006.
- Solution methodology for the nominal and the robust model -- Fall 2006.
- Final report including the MANPADS case study-- Spring 2007.