Abstract

We study defensive resource allocation in a multi-period multi-target attacker-defender game. At each period, the defender allocates a limited amount of defensive resources over multiple targets and the attacker could choose one target to attack. We develop and implement an algorithm to solve the optimization problem using backward induction and simple heuristics. We present some preliminary results comparing optimal allocations with and without carryover defense. Moreover, we study the cost of equity (fairness) in defensive resource allocation. In particular, we develop a novel model in which a government allocates defensive resources among multiple targets, while reserving a portion of defensive resources (represented by the equity coefficient) for equal distribution (according to geographical areas, population, density, etc.). We find that cost of equity increases convexly in terms of additional expected loss. Furthermore, such cost is lower when: (a) government uses per-valuation equity; (b) the cost-effectiveness coefficient of defense increases; and (c) the total defense budget increases. Finally, we consider the attacker being either strategic or non-strategic. The attack probabilities of a strategic attacker are endogenously determined in the model, while the attack probabilities of a non-strategic attacker are exogenously provided. We study the robustness of defensive resource allocations by comparing the defender's total expected losses when: (a) the defender knows the probability that the attacker is strategic; (b) the defender falsely believes that the attacker is fully strategic, when the attacker could be non-strategic; and (c) the defender falsely believes that the attacker is fully non-strategic, when the attacker could be strategic. We find that game models are generally preferred even when the probability of a non-strategic attacker is significantly greater than 50%.

Citation

Shan, X. and J. Zhuang, "Multi-period Defensive Resource Allocation Considering Equity and Possibly Non-strategic Attackers", Society for Risk Analysis (SRA) Annual Meeting, San Francisco, CA, December 9-12, 2012.