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R. Pasupathy, S.-H. Kim, A. Tolk, R. Hill, and M. E. Kuhl, eds

BEHAVIORAL INFLUENCE ASSESSMENT FOR ORGANIZATIONAL COOPERATION IN CYBER SECURITY

Asmeret Bier

Cognitive Modeling Department
Sandia National Laboratories
Albuquerque, NM 87185, USA

ABSTRACT

Even with substantial investment in cyber defense resources, the risk of harm from cyber attacks can be significant for modern organizations. The effectiveness of cyber defense might be enhanced if organizations that face similar cyber threats have programs in place that allow them to share information and resources relating to cyber security. Despite clear benefits, cyber defense teams also face motivations not to cooperate with those in other organizations. These motivations include potential damage to reputation, competition, and group inertia. We created a simulation model to better understand decision-making and cooperative dynamics in cooperative cyber defense programs. The model uses the Behavioral Influence Assessment framework, a hybrid cognitive-system dynamics modeling framework based on psychological, social, and behavioral economic theory. The model was populated and calibrated using data and interviews with subject matter experts, and used to explore policy options that could make a cooperative cyber security program more effective.

1 INTRODUCTION

Cyber attacks pose a major threat to modern organizations. These organizations must put substantial resources into protecting themselves and their customers, clients, and others against cyber attacks to avoid potentially serious consequences, such as disruption of operations, espionage, identity theft, and attacks on critical infrastructure. Even with a substantial investment in cyber defense resources, however, the risk of harm from a cyber attack is significant for many organizations.

The effectiveness of cyber defense can likely be enhanced if programs are implemented that allow organizations that face similar cyber threats to share information and resources. The threats faced by different organizations may be similar or identical, and much of the work done by cyber defenders at these organizations may be redundant. By sharing information about cyber attacks, effective defense strategies, and personnel with specific expertise, organizations may better protect themselves against cyber threats while maintaining or even reducing the resources dedicated to cyber security. Despite these potential benefits, cooperative cyber defense strategies are not common. Cyber defense teams must balance the potential benefits of cooperation against motivations not to cooperate, including potential damage to reputation, competition, and group inertia.

In order to better understand potential dynamics of cooperative cyber security with particular emphasis on decision-making, we created a model using the Behavioral Influence Assessment (BIA) framework, a hybrid cognitive-system dynamics modeling framework based on psychological, social, and economic theory. The model was populated and calibrated using data and interviews with subject matter experts, and used to explore policy options that could make such a program more effective.

2 BEHAVIORAL INFLUENCE ASSESSMENT

Behavioral Influence Assessment (BIA) is a system dynamics-based modeling framework for simulating systems that involve human behavior and decision making. The theoretical framework of the BIA is based on well-established psychological, social, and economic theories that have been incorporated into a single structure that is both self-consistent and dynamic. BIA uses a hybrid cognitive-system dynamics architecture. Cognitive models are implemented using system dynamics and embedded into an encompassing system dynamics model, which simulates interactions between people, groups, and physical, economic, or other system components.

The cognitive portion of the BIA begins with individuals or groups being exposed to cues (stimuli relevant to the decision-maker). These cues are processed to create cognitive perceptions, the decision-maker's assessment of the world or situation. Over time, cognitive perceptions become expectations, which are compared to cognitive perceptions to determine discordance with the current situation. Discordance and cognitive perception affect beliefs, a category of cognitive processes that includes the components of the theory of planned behavior (attitudes, social norms, perceived behavioral control) (Ajzen 1991) and affect. Intentions are calculated using utility functions. A multinomial logit function (McFadden 1982) compares intentions to determine realized behaviors, and over time those behaviors become physical realized actions.

One of these cognitive models is populated for each individual or group being included in the system. These cognitive models are connected to each other and to a world model sector using system dynamics. The world model sector includes all of the non-cognitive components of the system of interest, including physical systems, economics, etc. Outputs from the world model and the cognitive models act as inputs, or stimuli, for the cognitive model in subsequent time steps. Theoretical and mathematical details of the BIA are discussed by Backus et al. (2010).

3 BIA FOR ASSESSING ORGANIZATIONAL COOPERATION PROGRAMS

We created a BIA model of organizational cooperation for cyber security between two generic organizations. The model describes the social and organizational dimensions of a potential cooperative relationship for cyber security between simple, generic organizations, focusing on decisions about whether and how much an organization should participate in cooperative behaviors. Using the model, we analyzed various program designs, giving insight into which designs are likely to result in high levels of participation. Since participation in such programs is often a bottleneck in determining their success, we believe that models such as this one can help in the design of cooperative programs between organizations that effectively encourage participation and strengthen cyber security among the participants.

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