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Title:

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Author(s):

Brian G. Scott

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An Analysis on the Distribution of Nuclear Material Theft/Smuggling Scenarios

Brian G. Scott
Los Alamos National Laboratory
Decision Applications Division
Probabilistic Risk and Hazard Analysis Group

Abstract

Recent events have focused on the possible increased threat of nuclear theft/smuggling in environments where traditional safeguards controls and expenditures have declined. Discussions concerning the exact nature of the threat have been debated. This paper proposes a model to analyze the potential distribution of that threat. A number of basic assumptions concerning the characteristics of the model are postulated. Using these assumptions, a model is developed that assigns probabilities to a set of decisions performed by the individuals involved in theft/smuggling. The individuals' decisions are based on their perceived cost/benefit. The results of the model are evaluated in terms of degree of smuggling network complexity and probability of success. Basic sensitivity analysis of the model is discussed. This paper, by attempting to model the potential distribution of nuclear material theft/smuggling events increases to analytical tools available to those individuals interested in understanding, evaluating and countering the threat of nuclear material theft/smuggling.

Introduction
As other experts have stated, "the nuclear material traffic is fraught with ambiguity"[1]. Part of this stated ambiguity is that the evidence tends to "reinforce the hypothesis that two basic smuggling pathways can be employed for transferring nuclear material: an overt, strategically innocuous channel and a covert channel that poses a significant security threat." Admitingly, "little is known about the workings of illegal nuclear markets, especially such critical aspects as the organized crime connection to the business, the criminal environment in the former secret cities, and the emerging nuclear material smuggling routes…" [2].

Modeling of Threat
A model for such a scenario described in the introduction should be able to estimate the behavior of a system adequately in order to provide sufficient input to the decision making process. Since such a model is involved in estimating human decision-making, the models will not mimic reality, but allow for logical connections and conclusions to be made between estimated behavior extrapolated consequences.

A wealth data exists concerning nuclear smuggling. Occasionally, the beginnings of good threat definitions appear; however, logical connections between good definitions and good recommendations are sparse. In addition to the plethora of sometimes ambiguous data on nuclear smuggling, the decision maker is confronted with a full spectrum of expert opinion conclusions ranging from "not a threat, it just a bunch or amateurs" to "large threat, organized crime is involved." A plausible qualitative model of the threat across the full spectrum of scenarios is illustrated in Figure 1.

The model developed below will attempt create probability distributions based on estimates and assumptions of human-decision making. The probability distributions will estimate the probability of "sets" of actions. It is envisioned that the probability distribution will serve two basic functions: 1) incorporate feedback from the set of known nuclear smuggling attempts in order to better reflect "reality" and 2) provide a framework to gauge the utility of various anti-smuggling proposals.

Model Assumptions

All models need assumptions. The first set of assumptions of the smuggling model is based on the characteristics of the individual who can gain possession of the nuclear material. This individual has probably suffered a decline in economic conditions. Under such circumstances, limited exploitation of one's workplace may be socially permitted and acceptable. In addition, past criminal penalties for smuggling, including nuclear-related smuggling may be known to be relatively low.

The individual in possession of the nuclear material may know of cases where money can be made through less than traditionally legitimate means. Making money be such methods requires, among other things, the correct combination of deception, resourcefulness, connection to other individuals, and the foresight leverage existing conditions and/or change to one's advantage. As the stakes become higher, an ability not be imposed by societal and legal constraints may be useful.

A review past nuclear smuggling cases indicates that the individuals who initially obtain the nuclear material, for the most part, do not possess the profile of highly successful corrupt individuals. In addition, the individuals caught from nuclear smuggling incidents are, many times, not the same individuals who initially obtained the nuclear material. Sometimes the chain of custody becomes very murky, but connections are observed between individuals that are related through acquaintance, employment or family. Occasionally, the individual initially possessing the NM attempts to sell it. An interesting case is this type is the Luch engineer, Yuriy Smirnov who allegedly decided to wander around Moscow to look for a buyer[3]. Frequently, the individuals involved do not have criminal records.

> Model Assumption #1: The individual possessing the NM does not have knowledge or experience to engage in an immediate sale.

Note that the above would be a poor assumption for drug smuggling or organized crime activities where the enterprise is driven many times by the buyer, profits are predicted with high confidence, sophisticated methods to avoid detection have developed, and distribution networks have been created.

Usually, the individual possessing the NM has a decision to make: 1) attempt to sell the NM "high up the food chain" and obtain maximum gain upon completion of the "deal", or 2) sell, or transfer the NM “on consignment” to someone “low on the chain” and obtain a relatively low, if any, immediate gain. If the NM is sold on consignment, the advantage is that the initial possessor can increase he odds of consummating a successful “sale”. An example of this scenario could be the 1994 theft of Elektrostal HEU, in which a machine repair worker collaborates with two former employees who established a company to sell rare-earth metals[4].

> Model Assumption #2: The current possessor and potential smuggler of NM is required to make decisions concerning contacting others to assist in the sale.

Again, it is noted that the above assumption would not by valid for sophisticated drug or other smuggling networks. In such networks, the infrastructure is in place coordinate transactions. Sources, buyers and transactions routes are known. Independent operations that threaten the profitability of the smuggling organization are discouraged.

A lone “low-level” would-be smuggler has daunting path in front of him. Progress in this case is not a linear connection of steps. Progress in measured by the increased chance for sale of NM outside Russia. This progress is dependent on the “business” aspects of a start-up firm: How many buyers have knowledge of the wares? How much credibility does the seller bring to the buyer? What guarantees can the seller give to the buyer as far as the quality or future sales? These “business” factors are dependent on the “network” that supports the buyer. A fine line distinguishes successful from non-successful enterprises. Credibility, advertising, known entities and long-term relationships have more of a multiplicative than additive effect on success. In illegal schemes, since the suspicion and paranoia is relatively high, the effect of these business factor is probably more pronounced. Since multiplicative effects influence the “tail” of the distribution to a greater degree than additive effects, the model will concentrate on the multiplicative effects of NM smuggling.

A publicized diversion of nuclear material (non-weapons grade) at Elektrokhimimpribor reportedly involved the participation of plant managers, shop chiefs and MINATOM officials. Allegedly, the Elektrokhimpribor smuggling participants engaged with an organized crime group, who threatened to reveal the operation.[5]

A decision to engage with additional individuals not always advantageous. While the chance for successful transaction may increase with additional layers of personnel, the percentage of any of the profits will probably decrease. In addition, since the group is not an organized venture, but a loose compilation of entities, the likelihood of detection may increase.

> Assumption #3: A decision to engage with more sophisticated level of smuggling can be modeled as an estimated probability. The estimated probabilities from different decisions to “engage with others” can be multiplied to provide a probability of a set of decisions taken.

Result of the Model Assumptions
A decision tree diagram that provides for 5 independent choices is illustrated in figure 2. Once probabilities are assigned to the choices, a binomial distribution can be generated. The actual distribution of the 5 categories of "distribution levels" is dependent on the probability assignments. Figure 3 illustrates the distribution for a probability of 0.5 given to all five choices and a probability of 0.1 given to all five choices.

Discussion of the Model
Models are only as good as the relevant analysis that can be gained from them. The model, once baselined, can assess the effectiveness of implemented strategies of preventing nuclear smuggling.

The model infers that a decreased supply of nuclear material, could cause profits to increase; therefore, increasing the probability to "engage with others" (both from recruitment and sufficient profits), thus increasing the probability of higher-level networks.

The model allows a categorization or binning of smuggling incidents. More sophisticated incidents are binned in higher categories, while less sophisticated incidents are binned lower. These binned incident can then be baselined against the binomial distribution to estimate the probabilities to "engage with others". An increase in the level of observed sophistication of smuggling incidents can indicate that the global estimated probability of incorporating greater levels of smuggling capability is worthwhile.

Even without accurate baselining, the model points to some interesting conclusions. Efforts that disproportionately thwart low-level smuggling attempts, can drive the potential smugglers to deceased on more sophisticated networks. For example, if smuggling interdiction is geared to the lower level networks (such as sting operations or border interdictions that predominately thwart the amateur smugglers), the model predicts that the increased sophistication of networks may occur due to a change in the decision-making of the potential smugglers. Since higher level networks usually require more smuggled material to cover increased expense, this effect may not only increase the sophistication of the network, but the amount of material smuggled as well.

Sophisticated smuggling networks are difficult to thwart. It appears that, from the perspective of nonproliferation, the model predicts that relatively high payoff can be achieved by discouraging possessors of potential smuggled nuclear material from engaging in organizational smuggling. Without a systematic analysis of both the decision-making of possessors of potentially smuggled nuclear material and the current non-proliferation strategy, any recommendation of the exact coordinated strategy to optimize a reduction in the level of sophistication would be speculative. Considerations for a strategy to counter nuclear material smuggling sophistication may include amnesty/incentive programs for return of stolen nuclear material, increased productive engagement with personnel closest to the nuclear material, economic incentives for facilities to identify nuclear material that may have been stolen, penalties proportionate to the level of organized criminal involvement, and increased monitoring of criminal organizations for nuclear material smuggling involvement.

Conclusion

The application of mathematical modeling to nuclear material smuggling can lead an increased analysis of assumptions used to assess the threat of nuclear material smuggling, the metrics used to baseline, assess and predict smuggling, and the non-proliferation strategy considerations that can be applied to counter nuclear material smuggling. The model proposed in this paper draws relationships between the increased threat of nuclear material smuggling and an increase in the level of sophistication of a nuclear material smuggling network. Due to this relationship, the model can assess changes in the level of threat of smuggling and the effect of changes a counter-smuggling strategy would have on the smuggling threat. The model predicts that some counter-smuggling strategies can lead to an increased threat of nuclear material smuggling by encouraging a higher level of smuggling sophistication. Total nuclear containment may be a worthwhile goal to prevent nuclear smuggling, but at least in the short term, it may be an unreachable one. As more realistic strategy may be to reduce to odds of proliferation. Models can contribute toward recommending a probabilistic approach to proliferation risk reduction.

References

[1] Lee III, Rensselaer W, “Smuggling Armageddon”, 1998 St. Martin’s Press, pg.139
[2] Ibid. pg. 135
[3] Ibid. pg. 42
[4] Ibid. pg. 111
[5] Ibid. pg. 130

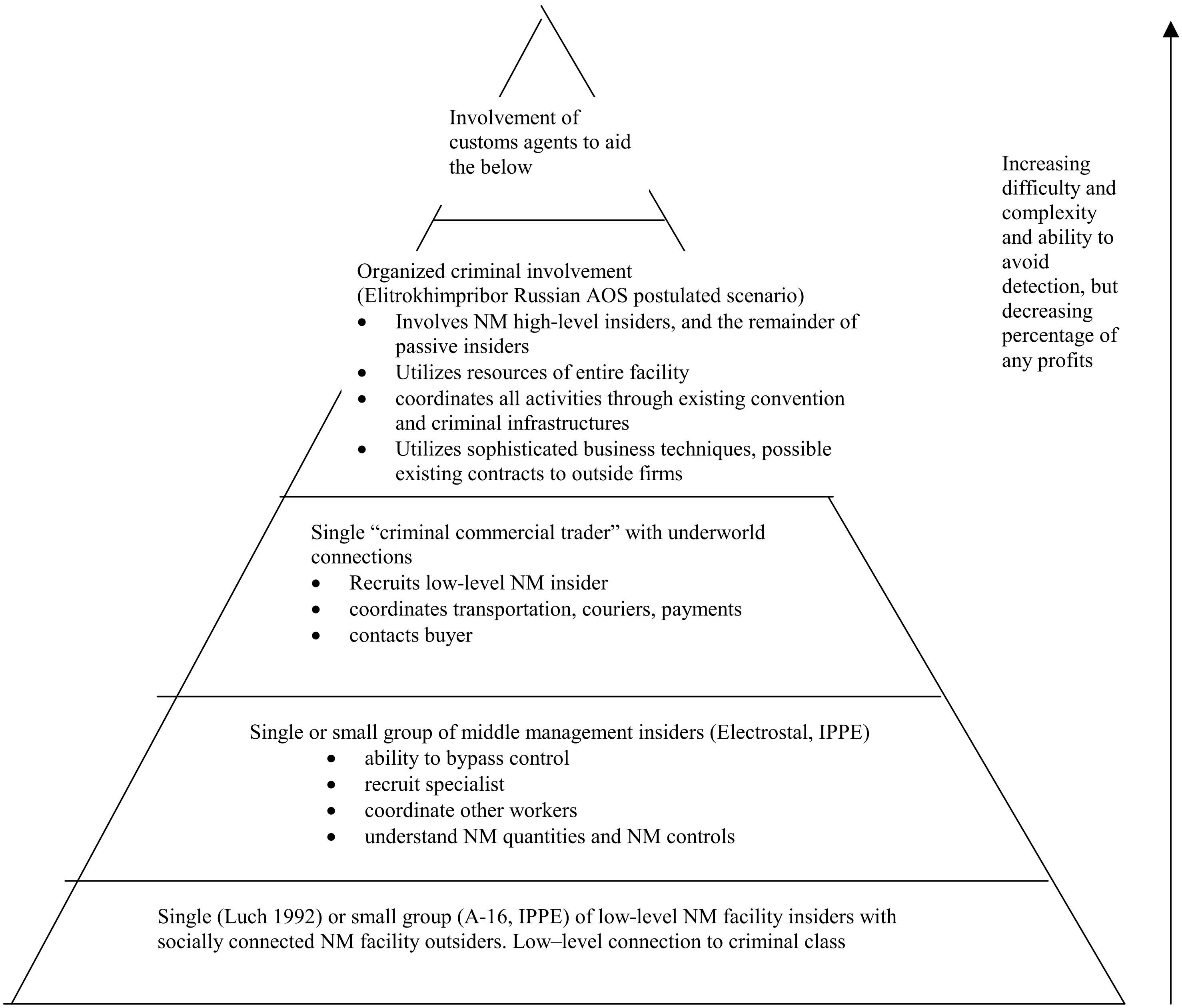


Figure 1. Illustration of possible threat definition

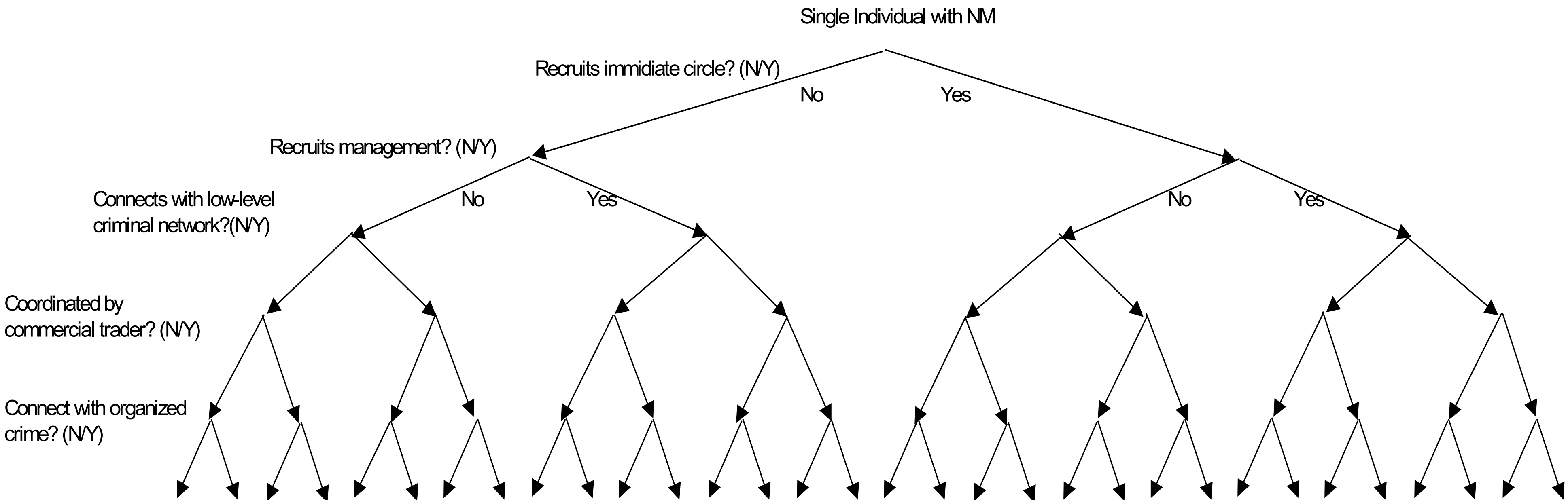
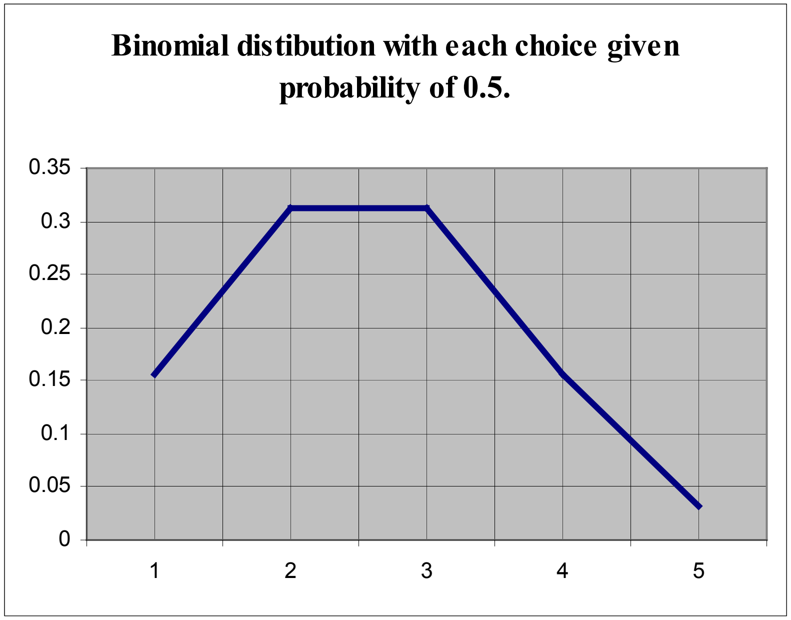


Figure 2. Tree diagram representing smuggling choices



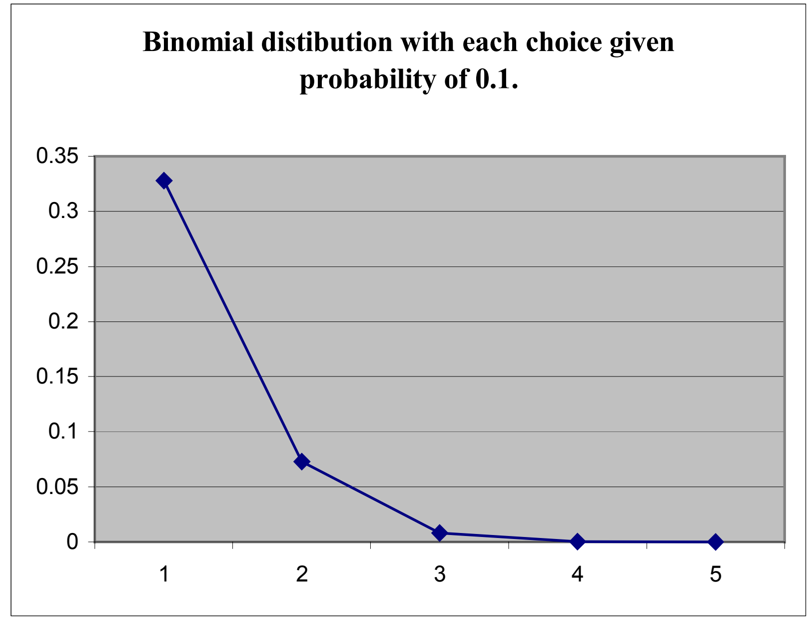


Figure 3. Binomial Distributions of 5 categories given the probability of “yes” choices of 0.5 and 0.1.