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AVNG as a Test Case for Cooperative Design

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ABSTRACT

Designing a measurement system that might be used in a nuclear facility is a challenging, if not daunting, proposition. The situation is made more complicated when the system needs to be designed to satisfy the disparate requirements of a monitoring and a host party – a relationship that could prove to be adversarial. The cooperative design of the elements of the AVNG (Attribute Verification with Neutrons and Gamma Rays) system served as a crucible that exercised the possible pitfalls in the design and implementation of a measurement system that could be used in a host party nuclear facility that satisfied the constraints of operation for both the host and monitoring parties. Some of the issues that needed to be addressed in the joint design were certification requirements of the host party and the authentication requirements of the monitoring party.

In this paper the nature of the problem of cooperative design will be introduced. The details of cooperative design revolve around the idiosyncratic nature of the adversarial relationship between the parties involved in a possible measurement regime, particularly if measurements on items that may contain sensitive information are being pursued. The possibility of an adversarial interaction is more likely if an information barrier is required for the measurement system. The origin of the antagonistic elements of the host party and hosted party relationship will be considered. In addition, some of the conclusions will be presented that make cooperative design (and development) proceed more efficiently. Finally, some lessons learned will be presented as a result of this expedition into cooperative design.

INTRODUCTION

Previous and present arms control verification regimes[1] have considered the confirmation of declared items based upon the idea of the measurement of certain attributes that are consistent with attributes of the declared item. This is represented in the Venn diagram shown in Figure 1. The reasoning being that if one chose from the set of all attributes that describe the declared item, then a verification measurement that was consistent with all of the chosen items would imply that the item under scrutiny would be confirmed to be consistent with the class of declared items. Clearly, this approach has some limitations – which will not be considered here – but in a verification – or better confirmation – regime that intends to build confidence this approach is relatively adequate.

[1] The term "regime" has been chosen versus agreement or treaty because a great deal of the work that has been performed over the last decade was specifically applied to an agreement or treaty to be signed that had a certain characteristic nature.

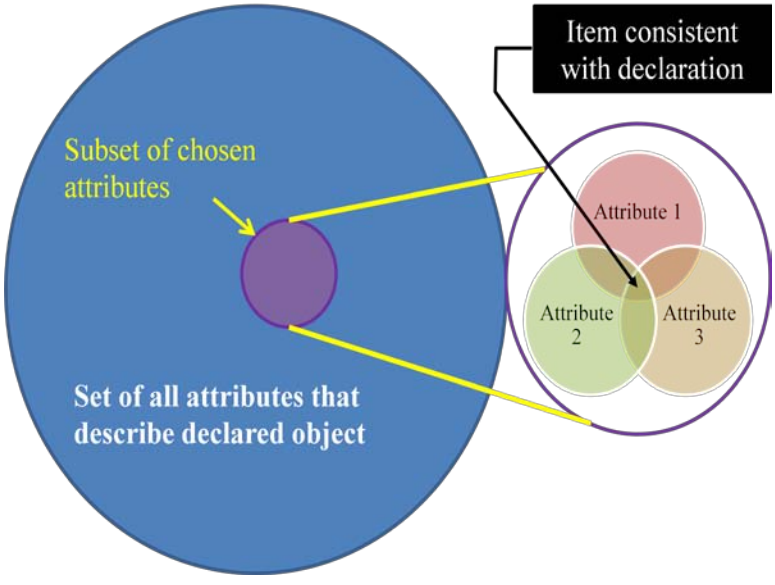

Figure 1 - Diagram of an attribute measurement scheme.

The development of the AVNG system assumed a verification regime that had chosen items that were only composed with plutonium and pursued three items for the model regime:

1. The presence of plutonium.
2. The isotopic ratio of $^{240}Pu/^{239}Pu$ to be less than an agreed upon threshold.
3. The mass of plutonium in the item to be greater than an agreed upon threshold.

Given the constraints of the chosen attributes the United States and Russian Federation, technical experts were able to develop a collaborative effort to produce a measurement system. In the course of the development of the collaboration it was determined – rather defined – that the attributes which were considered had sensitive aspects therefore an information barrier had to be implemented with the measurement system.

CHALLENGES TO COOPERATIVE DESIGN

The challenges to the cooperative design center mainly on the fact that partners in a measurement regime have disparate goals for that regime – this is particularly the case when the host party[2] has the constraint that some of the agreed upon attributes have sensitivities.

Antagonistic interaction of regime partners

[2] In the course of this paper *host party* will be used to describe the entity that owns the items that are under consideration. In different contexts *host party* can be called an *inspected party* or a *monitored party*. The term *host party* is in some ways more regime neutral than the other terms. In other words, the terms *inspected party* and *monitored party* imply something about the regime being considered. To this point the term *hosted party* will be used to describe that entity that has the responsibility to corroborate the declaration by the host party. This term is used over other terms such as, *inspecting party* and *monitoring party*. Use of *host* and *hosted parties* allow for more generalized considerations of a regime.

The existence of sensitivities within the nature of attributes under consideration intensifies the antagonism between the regime partners. The ultimate goal of the host party is first and foremost to protect any sensitive information that may be released in a measurement. The next goal – with diminished importance – to the host party is adherence to the stipulations of a declaration. In opposition to the goals of the host party; the goal of the hosted party is to make sure that the conditions of the regime are satisfied and that the host party adheres to the stipulations of the declaration. Since the host party is not able to share all of the information concerning the nature of the attributes being considered – the hosted party, naturally, does not trust the veracity of the measurements.[3] Therefore the host party is obligated to demonstrate to the hosted party that the measurements have relevance and that there is no mechanism for the host party to influence the measurement result. This discussion is the origin of the understanding of the necessity for authentication of any measurement system. The breadth of the authentication of a measurement system is an on-going research question that is beyond the scope of this paper. In the cooperative development of the AVNG the first order accomplishment of the authentication goal was to insist on joint measurements with the AVNG performed on plutonium standards. Though this is not the ideal solution for the authentication of the measurement system; it does provide the hosted party some confidence that the system performs as it should.

Necessity of Information Barriers

There are sensitive features in the attributes that the host party needs to protect; this precipitates the requirement for the host party to develop an information barrier for the measurement system. An information barrier – by nature – is a linear combination of hardware, software, control and procedures that offer insurance to the host party that its sensitive data is being securely held. Ideally information barriers are not monolithic but incorporate a layered approach. In a layered approach it is possible for the host party to insure that data are protected should a specific layer fail. In the case of the AVNG the Russian Federation developed a multi-layer information barrier that was consistent with information barriers that had been constructed by the United States in the nineties. It is interesting that the information barriers developed by the Russian Federation and United States experts were similar. It is the opinion of the author that this is not so much a function of the cooperative development but a function of the nature of the information that needed to be protected. The information that was regarded as sensitive in the case of the AVNG was the same information regarded as sensitive in the development of information barriers by the United States previously. Therefore, the approach to the information barrier design was similar – though the Russian Federation was more comfortable with software solutions than the United States.

The need for an information barrier is a complicated – and maybe convoluted – requirement. An information barrier is not simply doing an exercise of “data blinding” so that the hosted party cannot access the sensitive information. Assessing the need for in

[3] The assumption being made here is that the host party will provide the measurement equipment. This is the case even in a situation that the regime partners are involved in joint development. The rationale for this fact is that the host party has additional constraints that are not a function of the regime. These limitations include, but are not limited to, environment, safety, health, and security requirements for the facilities associated with the host party facilities. These requirements, in general, have no bearing on the nature of the regime; but are very vital for the host party to fulfill.

information barrier comes out of detailed risk analysis of the loss of information associated with a particular measurement on a specific attribute.[4] The requisite for an information barrier is only necessitated when there is a clear loss mechanism of sensitive information and the loss of that sensitive information produces a political and/or technical disadvantage for the host party.

NECESSITIES FOR COOPERATIVE DESIGN

Given that there are technical and political challenges to cooperative design there are several necessities for the seamless cooperative design of a measurement system.

Well constrained problem

The most obvious necessity for cooperative design of a measurement system is that the problem must be well contained. It is clearly impossible for members – or possible members – of a regime to design a general measurement system because that problem is too large. It serves the regime members to understand the issues independently for general cases until a regime has been suitably defined. Constraining the problem space allows the regime partners to focus only on the variables that are relevant without being confused with a limitless manifold of possibilities.

The AVNG had the good fortune to be working on a narrowly defined problem; developing a measurement system that investigated three specific aspects of a plutonium source with the presence of an information barrier applied to all of the attributes. The need for the information barrier was assumed therefore the host party (the Russian Federation) did not have to do a risk analysis for the information that might be lost in the AVNG. It is not clear how the design of the AVNG would have proceeded if there had not been agreement on the nature of the attributes that were being considered. It is clear that the hosted party (the United States) would not have been privy to the discussions on the nature of the attributes if the necessity of their protection were not presumed.

Unfettered communication on a technical level

Cooperative design of a measurement system has as an absolute requisite that there be free and unfettered communication between regime partners on a technical level. The technical experts must be able to interact during the design process to ensure that common goals are being considered. This implies that a communication infrastructure must be the first order of business in the development of the collaboration. The communication must be frequent, varied and safe for the project to continue smoothly. A caveat is that there has to be some sort of trust between the regime partners for the design process to be advanced. This trust factor may be as simple as that all parties have the goal of the system being designed and

[4] It is the opinion of this author that there is a clear lack of understanding in the both the technical and policy communities when parties in both of these communities call for "research into advanced information barriers" this is simply ill-fated and a waste of resources. Information barriers cannot be developed in a vacuum; they must be produced in the context of the measurements for a specific regime with a detailed risk analysis and knowledge of the loss mechanism of any information.

implemented. Without this simple level of trust the cooperative design of a measurement system is next to impossible to accomplish.

The AVNG was blessed with a great deal of communication between the technical experts from the Russian Federation and United States. The parties met twice a year face to face in the early stages of the collaboration with intensive discussion on all aspects of the design of the AVNG ranging from detailed physics and statistics issues; to engineering details. In addition, the two parties had monthly conference calls and free access to each other through electronic messaging. This communication allowed for the technical experts from both parties to ensure that changes and additions in the design of the AVNG could be implemented in a timely fashion.

LESSONS LEARNED

The biggest lesson learned from the development of the AVNG is that even though there was a great amount of communication between the RF and US experts more could have been done. In addition, it is clear that the timeframe for the AVNG was much too long. There was a large turnover in the personnel over the years that this project progressed which caused some delays in the process. In any realistic regime it is clear that time for the development of the measurement system must be kept to a minimum.[5] Finally, the AVNG process showed that joint, collaborative design of measurement system by antagonistic, adversarial parties is possible, though it requires a great deal of work.

FUTURE PROSPECTS

The future holds the promise for the development new measurement systems for new regimes. What does the future hold for cooperative design? Though it is clear that cooperative design will need to be pursued when a regime or regimes have been defined; it is not clear whether or not this is going to occur in the short term. The author is of the opinion that there is a great deal of work that needs to occur on the unilateral basis[6] before more cooperative design can occur on any new regime. However, when a regime has been suitably defined, a collaborative design effort should be pursued.

ACKNOWLEDGEMENTS

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[5] In the spirit of full disclosure the “delays” in the AVNG were not entirely a function of the technical experts. In any endeavor of this sort the technical experts are at the mercy and pleasure of budgets and policy makers.

[6] This is stated with a huge admonition. There are present agreements whose conditions are similar to the AVNG project and measurements systems for these agreements will probably be developed on a collaborative basis.