THIRD GENERATION ATTRIBTUE MEASUREMENT SYSTEM*

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ABSTRACT
A Third Generation Attribute Measurement System (3G-AMS) project has been tasked by the U.S. National Nuclear Security Administration's Office of Nuclear Verification to develop a next-generation attribute measurement system for dismantlement verification, confirming the declared attributes of nuclear weapons and/or components through attribute measurements of plutonium (Pu), highly enriched uranium (HEU), and high explosives (HE). Primary objectives for a 3G-AMS are that (1) it be certified for use on a nuclear warhead in a nuclear weapons facility; (2) it be certified for information protection, that is, information beyond what is prescribed is not acquired through measurements; (3) its authentication be demonstrated, that is, it provides accurate data as prescribed and contains no additional functionality; and (4) it confirms the declared attributes of the nuclear weapon or components that are being measured. This presentation will provide an overview of this 3G-AMS.

INTRODUCTION
Attribute Measurement Systems have been developed and demonstrated at least three times in the United States, under the Trilateral Initiative (1996–2002), FMTTD (Fissile Material Transparency Technology Demonstration, 2000), and NG-AMS (Next Generation Attribute Measurement System, 2005–2008) [1].

Each Attribute Measurement System has contributed to the growing body of knowledge regarding the development and use of such systems in warhead dismantlement and other potential monitoring scenarios. The Trilateral Initiative, besides developing prototype hardware/software, introduced the topic to the international community. The "trilateral" parties included the United States, the Russian Federation, and the International Atomic Energy Agency (IAEA). With the participation of a Russian delegation, the FMTTD demonstrated that measurements behind an information barrier are feasible while meeting security certification requirements. The NG-AMS system explored the consequences of maximizing the use of commercial-off-the-shelf (COTS) equipment, which made construction easier but authentication harder. This 3G-AMS will focus on authentication within a regime and will

- be able to be ***authenticated*** by a monitoring party,
- be ***certified*** for the protection of sensitive information,
- be ***certified*** for use in a nuclear weapons facility while a monitoring party present, and
- ***confirm*** the declared attributes of nuclear weapons and/or components.

This 3G-AMS will operate on both weapons systems and weapon system components, measuring attributes of Pu, HEU, and explosives.

This measurement system will rely on subject matter expertise from the DOE complex, including personnel from Lawrence Livermore, Los Alamos, Oak Ridge, Pacific Northwest, and Sandia national laboratories and the Pantex Plant.

AUTHENTICATION

Exercising Authentication is a key component of this 3G-AMS as it has not been truly exercised in the past. Authentication is the process of ensuring that the information produced and presented by an attribute measurement system accurately represents the measurement that is being performed. Authentication can include hardware testing, software testing, chain of custody, random selection, vulnerability reviews, etc.

In the 3G-AMS, Authentication will be part of the system development at each step of the process. Moreover, Authentication will also be included in the design process to ensure that it is not precluded once the system has been fabricated.

CERTIFICATION

Certification is split into two primary pieces: information and facility. Information Certification is defined as [2]:

> A comprehensive assessment of the management, operational, and technical security controls in an information system, made in support of security accreditation, to determine the extent to which the controls are implemented correctly, operating as intended, and producing the desired outcome with respect to meeting the security requirements for the system.

This definition argues that Information Certification is a process that continues throughout the life cycle of the product and includes requirements gathering, design, build and integration, test, operation, and retirement/disposition of the equipment. Information Certification has been exercised in past measurement systems, and the expertise gained from those systems will be relied upon during the development of the current attribute measurement system.

Facility Certification is the process by which a system is certified for use in a weapons facility. In order to meet all of the applicable facility standards, including safety, security, standoff, mechanical, electrical, etc., a team from the weapons facility will be involved in the design process at the beginning and continue through the deployment and use of the equipment in their facility. To ensure facility compliance and reduce the overall approval timeline, individual modules of the attribute measurement system will be tested during their development, fabrication, and overall system integration.

ATTRIBUTES

Prior attribute measurement systems have only measured properties related to plutonium. This new measurement system will take into account the possible presence of uranium and explosives. The following attributes may be measured by this 3G-AMS:

- Pu Presence
- ^{239}Pu and ^{240}Pu Mass
- Plutonium (Time since last separation)
- Pu Density
- ^{240}Pu to ^{239}Pu Ratio
- ^{235}U Presence
- U Enrichment
- ^{235}U Mass
- U Density
- HE Presence
- HE Mass
- HE Thickness

The 3G-AMS will be designed and fabricated in a modular fashion, with interface control between each of the modules in the system. The modularity in the system will allow for additional attribute measurement modules to be added later as needed.

To measure these attributes, this 3G-AMS will also evaluate passive imaging and active interrogation techniques. These techniques have not been used in past systems and, although complex, may offer some advantages for system simplicity and also in reduction of measurement time. In addition, these new methods may be necessary for the measurement of certain attributes that may be included, such as the presence and mass of explosives.

JOINT DEVELOPMENT

The 3G-AMS project is pursuing a joint development concept for the design, development, and deployment of the 3G-AMS. Joint Development is possibly the most straightforward approach to the challenging problem of balancing equipment functionality, certification and authentication. Joint Development will include Authentication and Certification team input at the start of the attribute measurement system design and continue through the end of the project. The Authentication and Information Certification elements of the project will be semi-autonomous in this process, representing and protecting their respective interests. They are semi-autonomous in the sense that the lead, not the entire team, for each of these efforts has some prior knowledge of the other team, but each team's goals will be developed and held independently.

CONCLUSIONS

Previous attribute measurement systems have exercised Information Certification, Facility Certification, and measurement of plutonium attributes. This third generation attribute measurement system will more fully exercise Authentication, Information Certification, and Facility Certification while developing a system to measure declared attributes of a weapon or weapon component. Therefore, attributes for this present system will necessitate measurements of not only plutonium but also of uranium and high explosives. This system may also make use of active interrogation and passive imaging techniques, which may be necessary for the new materials possibly present in the declared item being measured. A Joint Development process will be used in development of this system as a measure to ensure that both Authentication and Certification are included in the as-built version of this third generation attribute measurement system.

ACKNOWLEDGMENTS

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REFERENCES

1. Smith, Morag K., *Attribute Measurement Systems, Carnegie Workshop on Technical Approaches to Support Arms Control, 9 April 2009,* LA-UR-09-02188. A Russian System was also developed under the AVMP, Attribute Verification Measurement Project, under the U.S.-Russia Warhead Safety and Security Exchange (WSSX) Agreement.

2. FIPS Publication 200, *Minimum Security Requirements for Federal Information and Information Systems,* http://csrc.nist.gov/publications/fips/fips200/FIPS-200-final-march.pdf .