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Overview of Cooperative Monitoring Concepts and the CMC

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INTRODUCTION

International relations are often devoted to establishing agreements that define, control, or regulate issues of potential conflict. These agreements span a full range of national and international issues from resource allocations to national security. The scope of these agreements can vary from bilateral arrangements to global treaties or control regimes. In many cases, elements of the agreement are monitored to verify compliance or increase confidence among parties that the terms of the agreement are being met.

With the end of the Cold War, increasing political and diplomatic attention has been devoted to addressing issues of conflict and potential agreement in many regions of the world. Some of this attention results from concerns over the proliferation of weapons of mass destruction (WMD) that include nuclear, chemical, and biological weapons and their means of delivery. Balanced reductions of nuclear arsenals as well as enhanced protection, control and accounting of nuclear materials represent elements of these security challenges. Elimination of chemical and biological weapons arsenals are also within the WMD concerns. Approaches are needed not only to slow proliferation, but also ultimately to address the root causes of national desires to acquire WMD. The effort to address the motivation for proliferation needs to include regional security, confidence building and arms control.

Conventional military imbalances, territorial disputes and political instabilities as well as pressure over natural resources and the environment offer potential for conflict or promise for cooperation. A range of technologies exist that can be used to monitor borders, commerce and the environment. They can contribute to compliance determination with formal agreements or be used as confidence building measures (CBMs) among nations.

The Cooperative Monitoring Center at Sandia National Laboratories was created to address regional security issues that may motivate countries to acquire weapons of mass destruction. The CMC assists political and technical experts worldwide to acquire the technology-based tools they need to assess, design, analyze, and implement nonproliferation, arms control, and other cooperative security measures.

BUILDING CONFIDENCE

Efforts to build confidence among nations can take many forms. The overall objective is to move from conditions of minimal confidence between nations to conditions that achieve higher levels of trust and cooperation. Minimal confidence is characterized by distrust, lack of

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communication, public resistance to cooperative efforts, and lack of infrastructure within the governments for promoting cooperative agendas. The infrastructure needed consists of political, diplomatic, military and technical components.

The goals of confidence building are to achieve conditions of mutual trust, open communication and dialogue among parties, public acceptance and support for cooperative efforts, and an established infrastructure for addressing issues of concern. Successes along this spectrum of confidence building have been numerous over the past decade. These include improved interactions between U.S./Russia, NATO/Warsaw Pact countries, and Argentina/ Brazil. There are many elements that can contribute to confidence building. They vary from cultural exchanges and increased trade to technical exchanges and security agreements. This presentation focuses on the role that monitoring technology can play in building confidence among nations on a number of issues of regional and global concern.

COOPERATIVE MONITORING CONCEPT

Cooperative monitoring is the obtaining and sharing of agreed information among the parties to an agreement. It makes use of technologies that are shareable among all of the parties to the agreement. The data collected as part of a cooperative monitoring agreement are equally accessible to all of the parties to the agreement. Finally, cooperative monitoring includes procedures for addressing anomalies in the monitoring information. In that way, questions or issues can be resolved to avoid escalation of concerns that could lead to conflict.

There are many examples of cooperative monitoring systems, including formal treaty verification systems as well as less rigorous confidence-building measures. The systems may consist of inspections or sophisticated sensor and data processing equipment accessed remotely. As described later, these systems are not limited to arms control or military applications, but also may monitor a wide range of other regional concerns including natural resources, commerce and trade, the environment, or emergency response issues.

Cooperative monitoring systems supplement rather than replace other national means of data collection, including intelligence means. Ultimately, the entire set of shared and private data forms the basis of making national treaty compliance determinations.

A FRAMEWORK FOR COOPERATIVE MONITORING

In each case, establishment of a cooperative monitoring regime is a process. There is no single monitoring solution. A framework in which to consider the application of cooperative monitoring begins with a context for undertaking CBMs. The context has several elements that include the subject of interest, the scope of the agreement, and purposes for which an agreement is being considered.

A desire for improved relations will eventually lead to specific agreements that form the basis for establishing monitoring regimes. The agreements, whether formal treaties or less formal CBMs, have certain objectives and provisions intended to achieve the goals. Some of these provisions have specific measurable or observable parameters. These may include objects, activities, processes, or movements. Signatures are the specific characteristics of the item, object, or process being observed. They may include optical characteristics, thermal profile, chemical composition, acoustic patterns, isotopic composition, or other measurable quantities associated with the observation. These signatures allow sensor systems to detect and classify differences between the items observed.

Once the objectives and provisions of an agreement have been determined and the monitoring parameters defined, a wide range of monitoring system options using different types of technology are possible. Other factors such as cost, manpower, redundancy, timeliness, data and hardware security, power requirements, sensor function and display, environmental conditions and vulnerability need to be assessed. In addition, the level of access or intrusiveness permitted under the terms of the agreement will affect the types of possible monitoring systems.

There are feedback loops within the framework as well. Understanding monitoring options and limitations may result in a need to modify the original agreement to establish provisions that can be monitored.

MONITORING APPLICATIONS

Monitoring systems can be utilized for many applications related to arms control and nonproliferation. These include nuclear weapon and material controls, agreements on conventional military forces, limits on strategic delivery vehicles, and chemical and biological weapons agreements.

Nontraditional security topics also present an opportunity for cooperative monitoring. An example is the allocation of natural resources, such as water. Cooperative monitoring and management of pollution, commercial trade, energy resources, and manmade and natural disasters may provide opportunities for initiating dialogue on regional cooperation. Agreements on topics such as these can help reduce tensions that could lead to war or weapons proliferation. Monitoring may also present an opportunity to engage parties in a dialogue and build familiarity with the concept of cooperative monitoring on topics that are less contentious than security topics such as military forces or nuclear programs.

EXTENT AND TYPE OF MONITORING

There is no single way of monitoring. The extent of monitoring required will vary with the application and constraints. Generally, an increase in monitoring will lead to increased confidence that the agreement terms are being met. Political circumstances, specific monitoring requirements and system design will all shape the monitoring design required to achieve various levels of confidence. However, in no case will confidence from monitoring reach 100 percent. All systems are subject to some uncertainty. However, by including redundancy, utilizing different sensor phenomenologies, performing vulnerability analyses, and having extensive coverage, high levels of confidence can be achieved. It should be noted that confidence is as much a political issue as a technical one. The political tone set by national leaders, along with their willingness to provide needed openness, is critical to the technical contribution made by cooperative monitoring systems.

Many monitoring options, from limited monitoring provisions to extensive technical monitoring options, can be incorporated into the terms of an agreement. Human inspectors are a key element of many agreements. Baseline inspections may be included to establish and confirm initial agreement declarations. Agreements may also require regularly scheduled inspections or less frequent challenge inspections if there are concerns or there is evidence of treaty-prohibited activities. Other inspections, known as elimination inspections, may be required to ensure that items to be eliminated under the terms of the agreement have been destroyed or otherwise eliminated. Finally, permanent manned or unmanned monitoring may be possible under terms of an agreement. This monitoring may take place within a facility or outside from the ground, air, or space. Each monitoring option represents a different level of intrusiveness.

COOPERATIVE MONITORING TECHNOLOGIES

Many technologies can be used in cooperative monitoring agreements. Obviously, the specific objects to be monitored and controlled and the provisions of the agreement will establish the best choice of technologies.

Physical security sensor systems are designed to control, monitor, and record movements of vehicles, people, or objects. These may include sensors based on seismic, acoustic, magnetic or infrared technologies. They may also include video systems that can provide a means for identifying objects. Deployments may include exterior applications such as building perimeters, borders or border crossings to detect and characterize vehicle and personnel movement. They may also include interior applications in factories, storage facilities or offices.

Access control technologies limit timely access into secured or controlled facilities. In its simplest form, access control can be simply a locked door to an off-limits area. With increasing levels of sophistication, access control can include more complicated locking mechanisms that require codes, cards, or unique signatures associated with those who are permitted access.

Tags and seals are useful in arms control as well as many commercial applications. A tag is affixed to the object of interest to uniquely identify the item. A seal is used to authenticate whether an item previously closed or inspected has been opened or altered. Passive tags and seals have a unique identifier that is inspected periodically to confirm item identity or integrity. Active tags and seals transmit data about the condition of the seal to allow continuous status checks of the item being monitored. By adding satellite communications and global positioning system receivers, it is possible to track the status and position of monitored shipments of equipment or materials in near real time, anywhere in the world.

Satellite imagery is one way in which wide-area monitoring can take place. While satellites have long been available to only a few countries, extensive opportunities now exist for using the growing sources and capabilities of commercial satellite imagery. Cooperative opportunities exist to share information, conduct joint analyses and provide ground truth needed to permit better interpretation of imagery for cooperative agreements. Commercial satellite imagery has been particularly useful for environmental monitoring and land use planning and characterization.

Imagery from aircraft can also be used in the monitoring of agreements. Sensors based on aircraft can be quickly dispatched to monitor terms of an agreement and can achieve higher resolution than is available from space-based platforms. However, they must have permission to fly over or near the objects of interest. Optical, infrared and radar sensors have all been applied in international aerial monitoring regimes.

Seismic monitoring has been used for decades to measure underground nuclear testing and earthquakes. Seismic sensors placed in the ground record the patterns of earth motion created by explosions or earthquakes. On a smaller scale, seismic sensors can also be used to measure localized ground motion caused by vehicles on roads or people walking along paths. These smaller scale systems are useful as part of the physical security technology described earlier.

Countless other technologies may be useful for cooperative monitoring. Geographical information systems can be used to evaluate facilities subject to on-site inspections and then to plan and track inspections carried out at the facility. Other computer software tools are useful in providing training on how to host or conduct inspections given the specific constraints of treaties such as the Chemical Weapons Convention. Still others can be used to cooperatively design the layout of monitoring sensor systems and model their expected performance. These examples do not exhaust the monitoring possibilities. Other example sensors systems include those for chemical and nuclear materials, and a wide range of environmental monitoring technologies that could support specific applications. Collectively, these and other technologies provide information, which leads to insight on issues of concern between nations.

Individual components need to be integrated into an operational system. This introduces an additional set of design and cost considerations, including the need to communicate between sensors, to transmit data to a monitoring station, and to provide power for the system. Software to manage the sensors and data is another important element in system integration. Data security is also essential. Data authentication provides a means for ensuring that data have not been altered. Data encryption provides codes that scramble the information and require decoding to read the data. System performance and reliability measures, maintenance efforts and expense, and environmental operating conditions also help establish criteria for appropriate monitoring system design and choice of components.
A complete system design and evaluation also must include an assessment of system vulnerabilities. Many analysis tools can assist in analyzing the weaknesses of monitoring system designs.

THE COOPERATIVE MONITORING CENTER

Since the early 1960's the laboratories of the United States Department of Energy have played a significant role in the development and implementation of monitoring technologies in support of international treaties and agreements. These agreements include those for limitations of nuclear testing, elimination of intermediate range ballistic missiles, support of the International Atomic Energy Agency as well support for environmental agreements. In 1994 a program was initiated to make available to other nations some of the technology and experience gained by the United States in developing agreements during the Cold War. The Cooperative Monitoring Center (CMC) at Sandia National Laboratories in Albuquerque, New Mexico was created to address regional security issues that may motivate countries to acquire weapons of mass destruction. The CMC assists political and technical experts worldwide to acquire the technology-based tools they need to assess, design, analyze, and implement nonproliferation, arms control, and other cooperative security measures. Technologies demonstrated at the CMC are unclassified and exportable. The U.S. Department of Energy (DOE) provides primary CMC funding, with additional support provided by the U. S. Department of State.

Strategic initiatives at the CMC include global nuclear materials management, a stable transition to smaller nuclear arsenals with Russia, regional security and nonproliferation concerns, multilateral arms control, and resource management and environmental security. In collaboration with other laboratories, institutes and agencies, the CMC conducts projects in technology development, issue analysis, design concepts, technology training, field experiments and technical collaborations. Representatives from nearly 80 countries have visited the CMC for discussions on cooperative monitoring concepts, technologies, and applications. Programs of regional focus address Russia and the former Soviet Union, Northeast Asia, South Asia, the Middle East and Latin America.

A wide range of technologies is demonstrated at the CMC. Working with technical, military, policy and diplomatic experts from around the world the CMC explores ways that technologies can be used to monitor agreements and build confidence between nations. Emphasis is placed on monitoring options rather than prescriptive solutions to regional problems. The need to build infrastructure required for evaluating and implementing these cooperative measures is also stressed.

The visiting scholars program brings together international researchers to perform analyses on regional issues of interest to themselves and the CMC. These studies seek to identify ways in which cooperative technologies can be applied to permit implementation of regional treaties or agreements. Some CMC studies have brought together researchers from different sides of an issue such as India and Pakistan or Israel and Jordan. A series of CMC Occasional papers have been produced.

SUMMARY

Cooperative monitoring holds the promise of utilizing many technologies from conflicts of the past to implement agreements of peace in the future. Important approaches to accomplish this are to develop the framework for assessing monitoring opportunities and to provide education and training on the technologies and experience available for sharing with others. The CMC at Sandia National Laboratories is working closely with agencies throughout the federal government, academics at home and abroad, and regional organizations to provide the technical tools needed to assess, design, analyze, and implement these cooperative agreements. In doing so, the goals of building regional confidence and increasing trust and communication can be furthered.