# Verification Technology
# Research and Development Needs

The following represents the priority needs of the Bureau of Arms Control, Verification and Compliance (AVC) for research and development programs to address critical arms control and nonproliferation technology requirements in the realm of verification and transparency. Responding to these priorities may involve the use of current technologies in unconventional ways, while others will require years of basic research, a properly resourced transition and acquisition process to build deployable systems, and diplomatic legwork on our part to create a feasible environment for deployment.

## SUPPORT FOR THE PRESENT GENERATION OF TREATIES, AGREEMENTS AND INITIATIVES

### Missiles and Nuclear Arms Reduction

*The New START Treaty has a verification regime in which National Technical Means (NTM) play a significant role. The Intermediate-Range Nuclear Forces (INF) Treaty also remains in force. While the inspection regime for the INF Treaty has expired, Section 403 of the Arms Control and Disarmament Act (22 U.S.C. 2577) requires yearly compliance reporting.*Capabilities are needed to assess the accuracy of information provided by states.

### The Nuclear Non-Proliferation Treaty

*In April 2009, the President outlined his nuclear security strategy in Prague. He indicated that the Administration would work to strengthen the Nuclear Non-Proliferation Treaty (NPT). These initiatives will require improved capabilities to detect and characterize activities associated with the nuclear fuel cycle and with nuclear weapon development.*

- Remote detection capabilities for undeclared or clandestine nuclear facilities and nuclear weapon development activities.
- Detection of diversion and unauthorized activities in declared facilities.
- Big Data Analytics tools to support compliance verification.

**Nuclear Test Ban Treaties, Agreements, and Moratoria**

*In outlining his nuclear security strategy in Prague, President Obama indicated that the Administration would work for the ratification of the Comprehensive Nuclear-Test-Ban Treaty (CTBT). Other test limitation treaties are already in force, including the Limited Test Ban Treaty (LTBT), the Threshold Test Ban Treaty (TTBT) and the Peaceful Nuclear Explosion Treaty (PNET). Section 403 of the Arms Control and Disarmament Act (22 U.S.C. 2577) requires yearly compliance reporting on such treaties if the United States has evidence or serious suspicion that a Treaty Party is not complying with the obligations of such treaties.*

*While global explosion monitoring technology is mature, several factors serve to drive the need for ongoing research to upgrade and refine our capabilities in this area. We cannot effectively manage risk associated with the test moratorium and eventually the CTBT by resting on our laurels. Challenges include distinguishing between natural and manmade explosions, distinguishing between chemical and nuclear explosions, increasingly sophisticated foreign nuclear programs that may be able to circumvent the need for high yield testing and ever improving foreign denial and deception capabilities to impair collection. As a result we will need to be able to detect much lower yields (well within the power of conventional explosions), to counter the use of evasive techniques (e.g., decoupling), and finally to distinguish between very low yield nuclear events versus conventional explosions. Enabling research needs to be performed to enhance understanding of the underlying physical phenomena, to develop new collection instruments and data exploitation techniques, and to develop ways to exploit new signatures associated with nuclear testing. Topics suggested by AFRL, DOE/NNSA/NA-222 in conjunction with AFTAC provide guidance on the research needed. A detailed description is available on request, but the State Department's Berkner Panel Report of 1959*[1] *still provides good guidance concerning the key research areas (source phenomena, wave propagation, better detection, and better data processing techniques; specific subtopics have of course changed over the last half century).*

- Improved seismic detection and identification of underground explosions.
    - The correlation between seismic signal magnitudes and yield is normally stated in terms of an assumption of an explosion that is "fully coupled, in a region of stable geology, in hard rock and at a standard depth of burial." Each of these factors needs to be better understood both individually and in various combinations

[1] Fifty years ago this Berkner Panel report led to the creation of the ARPA-funded World-Wide Standardized Seismograph Network (WWSSN), which among other things led to the great scientific finding - confirmation of plate tectonics, using year-long recordings of analog seismic data. Today's IMS or USAEDS can do that with just a month-worth digital data. But there is no doubt there is still a need to do research on better, smaller, more rugged seismic and acoustic sensors.

    - A more complete theoretical understanding of the impact of geology, soil type, and depth of burial at the emplacement point on both regional and global seismic signals. This should include the effects for explosions at higher yields.

    - Decoupling associated with underground tests conducted in very large cavities is of particular concern and we need to improve our understanding of this effect. Decoupling reduces the effective magnitude of observable effects of an underground nuclear explosive test. This can push some tests below the detection and identification threshold.

  - Distinguishing seismic signals generated by explosions from occurrences such as earthquakes, resource extraction (e.g., gas fracking), mine collapses and other modes of rock failure.[2]

- Tools and technologies to provide data and a detailed in-depth post-event analysis for events of verification concern, such as declared or suspicious foreign nuclear tests, to include raw seismic data from USAEDS, IMS, USGS, and other networks. We need region-specific calibration research.

- We also need to detect, locate, identify and characterize possible explosions occurring underwater, in the atmosphere, and in outer space.

The CTBT provides that detection and characterization of radionuclides during OSI can be limited to only radionuclides relevant to the OSI. An agreed list of radionuclides considered "relevant" has been arrived at in the CTBT Preparatory Commission. Accurate and useful determination of the presence and abundance of these relevant radionuclides generally requires acquisition of full gamma-ray spectra containing information about radionuclides present that are not on the "relevant" list. Research is needed to explore the feasibility of "information barriers" either by development of reliable and sufficient analysis techniques that can work with only partial spectra or the development of software/hardware solutions to allow the collection and analysis of complete spectra without making the full spectral data (or information about non-"relevant" radionuclides) available to inspectors.

- Demonstration of the use of amateur systems to track space-based activities and to detect potential precursors to the deployment of space-based weapons.

[2] Examples of relevant research thrusts include Advanced Explosion models, Local and Regional Monitoring and Discrimination

## Biological Weapons Convention

*Current policy initiatives are primarily derived from the National Strategy for Countering Biological Threats (Strategy), the National Security Strategy and the Quadrennial Diplomacy and Development Review. The Strategy, in particular, tasks the U.S. government to pursue capabilities in seven key areas to protect the homeland and its citizenry from natural or manmade biological threats. Within those seven areas are specific calls for technological developments or improvements, notably: building knowledge as to the global disease burden and technological capabilities; improving intelligence on deliberate biological threats; facilitating data sharing and knowledge discovery; ensuring robust capabilities for law enforcement and security; ensuring robust capabilities to disrupt or interdict illicit activity; and, enhancing microbial forensics and attribution.*

The provisions of the Biological Weapons Convention (BWC) prohibit offensive biological weapons programs. Though there are no formal cooperative verification provisions in the Convention, measures to demonstrate compliance are being explored.

## Chemical Weapons Convention

*Current policy initiatives and priorities are primarily derived from National Security Directives and implementation directives for the Convention on the Prohibition of the Development, Production, Stockpiling and Use of Chemical Weapons and on Their Destruction. The Treaty eliminates an entire category of Weapons of Mass Destruction through its prohibitions and application of strict verification measures. Through its non-proliferation mandate and verification regime, the Treaty seeks to ensure that toxic chemicals and precursors are only used for purposes not prohibited by the Treaty. It is critical to maintain the ability to verify compliance with this Treaty even as advances in the chemical industry and science and technology complicate verification efforts.*

Updated risk assessments to evaluate advances in global dual-use technologies for the civilian chemical industry that have application to chemical weapons (CW) programs.

- Advances in chemical synthesis and analytical methodologies.
- Advances in materials' science, e.g., nanotechnologies.
- Advances in chemical-biological crossover technologies.
- Advances in the miniaturization of plant technologies such as micro-reactors.
- Development of new toxic chemicals.

- Tech watch for next generation commercially available detection and sensor monitoring capabilities, particularly those that might improve a violator's ability to find and suppress signatures associated with a covert program.

Capabilities are needed to detect indicators of possible material violations of the CWC:

- Transfer of weapons and Schedule 1 chemicals or precursors and other toxic chemicals.
- Geo-location history of material, containers, or documents related to chemical weapons.
- Weaponization (includes production and processing related to weaponization).
- Weapon testing (detected via air monitoring, soil sample testing, imagery, etc.).

Also needed are tools and techniques to support sampling and analysis of chemical agents and their degradation products in a variety of matrices and environments, as well as equipment allowing more rapid sampling and analysis in the field.

An updated assessment and evaluation of advances in calmatives and incapacitating chemicals is also needed:

- Determine development and /or production facilities.
- Detect employment for law-enforcement, antiterrorist and other sub-military actions.

## Conventional Arms Control

*Current policy initiatives are primarily derived from National Security Directives and implementation directives for the Treaty on Conventional Armed Forces in Europe. The Treaty eliminated the enormous conventional forces disparity that existed between East and West during the Cold War. Combined with other developments in Europe, the Treaty impedes the ability of any State Party to conduct large-scale offensive action on short notice, and lays the foundation for the modern European security architecture. It will be critical to maintain the ability to verify compliance with this Treaty as long as it remains in force, as well as to prepare for future conventional arms control agreements undertaken in an environment of continual technological advances.*

## Open Skies

*There is a need for sensors (digital video, IR and SAR) that meet the criteria outlined in the Treaty on Open Skies and its subsequent Decisions, ensuring aerial observation of all the territories of the parties to the Treaty.*

For this category, infrared (IR) and side-looking synthetic aperture radar (SAR) capabilities for Open Skies aircraft are needed.

## U.S. National Space Policy

*The National Space Policy (NSP) released in June, 2010 says that the United States will consider space-related arms control concepts and proposals that are equitable, effectively verifiable, and which enhance the national security of the U.S. and its allies. The Administration is also expanding its efforts in international cooperation in space activities and conducting expedited reviews of key issues, such as long term sustainability of space activities and orbital debris mitigation that will require improved space situational awareness.*

*There is an ongoing need to further develop measures to verify the ban on WMD in space, and the prohibitions on interference with National Technical Means.*

New tools and technologies are required to improve our ability to assess and monitor possible violations of the Outer Space Treaty's ban on WMD in space.

*The Administration is pursuing transparency and confidence building measures (TCBMs) to promote safe, responsible, and peaceful behavior in space. For example, the United States is working with the EU and interested countries on an international "Code of Conduct for Outer Space Activities." We cannot develop and promote new space arms control concepts and proposals if we cannot monitor compliance. As we consider initiatives to further define "rules of the road" for behavior in space, we need to dramatically improve our posture on space object situation awareness. In particular, if we are to have a space conduct control regime, we need to detect and attribute a wide range of prohibited behavior by possibly very small satellites of unknown provenance at orbits as distant as GEO. We need to understand the "art of the possible" in this regard.*

Although it will be politically binding only, the proposed international "Code of Conduct for Outer Space Activities" will require an improved ability to detect and monitor the activities of satellites, actions taken against satellites, and debris fields in space. This ability may also contribute to ongoing U.S. activities in various international fora concerned with orbital debris monitoring and mitigation. The following capabilities are needed:

- Ability to monitor interference with non-NTM satellites (e.g., other national security, civil, commercial space).

- Ability to detect and attribute “bad behavior” and irresponsible activities that do not immediately and noticeably degrade or interfere with our satellites (such as deploying a small satellite close to another satellite or even latching on to it). When we see ambiguous activity in space such as close encounters between our satellites and space debris, can we divine their intentions?
- Development of citizen-based monitoring capabilities as well as public reporting networks for influencing compliance with guidelines governing conduct in space.

## EXPLORATORY RESEARCH FOR FUTURE OPTIONS IN ARMS CONTROL AND TRANSPARENCY

*Existing verification and transparency strategies are by themselves insufficient to address all the challenges that are likely to be posed by the arms control and transparency initiatives of the future. Possible future arms control and transparency regimes, such as for nuclear warhead reductions, may involve issues that do not easily lend themselves to monitoring by currently available inspection tools and NTM capabilities. New challenges will arise as nuclear arms control advances along the "road to zero." We need to be able to detect and monitor smaller items of inspection, and quantities of controlled materials, warheads and delivery systems. Further complicating the picture, more players may come under the umbrellas of verification regimes. Verification technologies are the linchpin of the arms control process. The inability to verify constrains policymakers' options, but new technologies can provide enhancements to our ability to verify.*

*In April 2009, the President outlined a long term goal of a world free of nuclear arms. The "road to zero" will be long. The negotiations on future treaties to further reduce nuclear weapons may move away from the traditional focus on strategic delivery systems and towards limits on nuclear warheads.*[3]

*Verification of treaties that directly address nuclear warheads will require new approaches that balance the need to protect sensitive information with the inherent difficulty of remotely detecting nuclear devices. We need to develop the best possible technologies to mitigate the difficulties associated with striking this balance.*

Tools are needed to verify the presence or absence of nuclear weapons:

- Mathematical approaches to building confidence in the data collection and processing behind an information barrier, especially in multilateral verification scenarios.
    - Such processes could include zero-knowledge protocols, verifiable software algorithms, garbled logic circuitry, or other combinations of approaches.
    - Technologies that can perform verification on encrypted data (such as homomorphic encryption methods) and ensure data integrity in collection and transmission using fundamentally secure encryption methods (e.g., quantum encryption).
    - Acknowledging the extensive R&D work that has taken place to date, the demonstration of a fully authenticable information barrier Radiation Detection Equipment (RDE).

[3] When President Obama signed the New START Treaty in April 2010, he stated his intention to pursue new reduction negotiations that would involve non-deployed and non-strategic warheads in addition to deployed systems, i.e. warheads mated to their delivery vehicles.

- Additional research into methods and technologies that intrinsically protect classified information.[4]

- Improved tools are needed to assure continuity of chain of custody of a nuclear device. Specifically, once an item has been inspected and /or catalogued, we want to be sure that it stays that way.

- Improved tools and processes are needed for authenticating chain of custody for equipment used to verify non-nuclear objects and weapons.

*Advanced tools and technologies to support implementation of possible future fissile material control regimes, such as the proposed Fissile Material Cutoff Treaty (FMCT). A broad series of technical approaches should be considered, including but not limited to tags and seals, radiation measurements, and other ways to detect and characterize nuclear activity, equipment, and materials.* We need to develop an optimum mix of technology and access regimes to detect fissile materials in transit. Specific needs include:

- Sharable detectors of controlled nuclear materials.

New technologies will also be needed to:

- Sharable methods of tagging and fingerprinting materials.

- New concepts for “intrinsic tags” within containers of materials. Intrinsic tags typically use some physical feature of a material (e.g., variations in surface markings) that is both unique and difficult to duplicate. Tags that could easily detect tampering with any part of a container, rather than just a seal, would be especially useful.

- Development of Technical Guiding Principles.

- Radiation Technology.

- Remote Monitoring Technology.

- Chain of Custody.

- Possible Experiments and Demonstrations.

We need to refine our understanding of the nuclear warhead life cycle and to promote the emergence of new options for verifiable nuclear arms reduction and /or transparency regimes. Efforts should be undertaken:

- To identify new parameters and signatures associated with the nuclear enterprise that could become regulated quantities as part of a future nuclear reduction and /or transparency regime.

- To develop the conceptual framework, terminology, and procedures to address the disposition and /or storage of nuclear weapons components that remain after dismantlement.

**Ubiquitous & Persistent Sensing: Using Sensors on Widely Dispersed Platforms**

*We are looking for new observables that could be incorporated into future arms control and transparency regimes. We are also seeking IT technologies to provide near real-time information to inspectors in the field.*

Ubiquitous sensing may contribute to a new generation of safeguards and nonproliferation technologies. In particular, it may be used to enable constant measurement of all nuclear materials at all times.[5]

- Develop seals and tags that can be widely dispersed, read remotely by inspectors at a distance, and are trusted by both the hosting and inspecting parties:
    - Sensors to detect presence of fissionable materials.
    - Sensors to verify quantity of fissionable material present.
    - Sensors to detect tampering and provide integrity assurance of monitored equipment.
- Understand how ubiquitous sensing impacts the overall proliferation regime.

The proliferation of mobile devices and the emerging internet of things are already creating an ambient environment permeated with sensors, and we need to understand how these technologies may impact arms control.

- Understand and adapt the internet of things (IOT) to support arms control goals such as transparency and data assurance for feeds from verification sensors.[6]

---

[5] This formulation follows William Charlton at Texas A&M.

[6] The "internet of things" is a term for an emerging internet where everyday objects (household appliances, thermometers, lights, cars and their components) are connected to the internet and are able to directly communicate and cooperate with one another. For example, in one scenario posted in a blog on the internet (http://blogs.cisco.com/news/the-internet-of-things-infographic/ ), your meeting might be pushed back 45 minutes, telling your alarm clock to give you an extra five minutes of sleep, which then tells your coffee maker to start making coffee five minutes later as well. It might also check the weather and tell your car to start in 5 minutes to melt the ice accumulated overnight in a snow storm. The internet of things is already five times larger than the

    - For example, there may be arms control applications for information assurance and identity verification technologies originally developed to support the IOT.
    - Encrypted IOT traffic to be unlocked later for spot compliance checks. This could lead to new classes of signatures that could be monitored and regulated under future arms control regimes.

- Mobile devices such as smart phones and tablets may serve as sensor platforms, as communications hubs connecting humans and ambient sensor networks, and as tools for managing information on location and in real-time. We need to develop safeguards/verification applets that could be installed on mobile devices carried by inspectors. For example, we need to:
    - Understand the data already by collected by mobile devices and see whether applets can be written to adapt these capabilities to support inspections.
    - Connect all safeguards/verification sensors in an inspected facility wirelessly to the inspector's mobile device.
    - Employ the use of specially designed quick response (QR) codes to rapidly decode and track munitions, warheads or smaller items using smart media.
    - Access in real-time virtual models of a facility while it is being inspected (assuming adequate broadband connectivity).
    - Develop a suite of apps that might be in an inspector's toolbox, including for example functions such as scanning, reading and translation of text; access to previous site reports, site diagrams and photos; real-time reports on environmental conditions; inspection logistics support (general travel needs and coordination); and mission planning software.
    - Develop new constructs for self-assembling fields of disparate sensor types, including new capabilities to collect, integrate, and analyze outputted data.

## Expanding the Open Skies Paradigm

*Two transparency concepts first proposed in the 1950s may play an increasing role in the arms control regimes of the future: the cooperative aerial reconnaissance regime and "public technical means."*

---

internet we use every day: ATM and all banking transactions, medical data, shipping data, telemetry and tracking data are all examples.

*The Open Skies Treaty has established the precedent for cooperative aerial reconnaissance regimes.*

The following efforts are needed to expand upon this concept:

- Identification of releasable technologies to exploit access based on the Open Skies concept and design of aerial access regimes that reflect these technical opportunities.[7]
- Removable ("roll-on, roll-off"), modular sensor systems that allow the same aircraft to be deployed in multiple scenarios.[8]

## Embracing Public Technical Means

*Public Technical Means includes data, interactions and analysis in the public domain. This includes "societal verification," which is evolving from its initial definition of individuals taking responsibility to report treaty violations to include aggregate activities involving highly empowered citizens carrying powerful "smart phones" and sharing information across social networks and the resulting crowd interactions.[9] This will likely be a game changer in many areas, and arms control will probably not be the leading adopter,[10] but this emerging interaction between people and technology could help empower a new generation of transparency measures and arms control verification provisions. We need to understand the underlying phenomena to assess possible paths forward.*

Tools for Information Discovery: We need tools to screen and provide alerts regarding incorrect information that appears on networks.

- We need capabilities to screen and vet online information.

---

[7] Generally, commercial off-the-shelf technologies are most suited for such missions. Depending on the context, there may also be a role for newly developed or custom-built technologies, but it will need to be assumed that non-U.S. nationals will have access to the equipment and that all Treaty parties will have access to the data.

[9] This language is taken from Stubbs and Drell.

[10] Given the complex ethical and legal questions involved, communities addressing topics such as climate change and disaster relief will likely take the lead in employing information obtained from citizen sensors and social media, but the arms control community needs to be fully aware of the emerging norms in this area to lay the groundwork for the creative use of such public technical means in the context of future arms control and transparency initiatives. Active research will be needed to develop an understanding of the full range of issues that need to be addressed and resolved before such tools are deployed.

- Understanding the use of public incentives in conjunction with social media to develop information (such as the DARPA Red Balloon Challenge).[11]
    - Are systems such as Amazon's Mechanical Turk system useful to gather and analyze social media data?[12]
    - What might be the means and methods to engage concerned citizens to employ new information technologies and social media in support of arms control and transparency efforts[13] (e.g., verification challenges)?
- Tools to protect public verification activities from social pressures and censure.

Tools to Supplement Analysis of Existing Information: There is a continuing need for the development of new analytic tools that can collect information from a wide variety of sources, collate that information into user-defined categories, and display the information in ways that can be analyzed for better understanding. This may include information from traditional intelligence sources, but also information from open source resources and non-traditional sources, including some of the "social network" applications. Examples may include, but are not limited to:

- Visual analytics and other new information technologies to aid analysts in identifying, extracting, and connecting crucial facts from a deluge of disparate data streams and integrating them into a coherent picture.

---

[11] The 2009 DARPA Red Balloon Challenge explored how incentive-based social networking might be used to crowd source problem-solving. A $40,000 award was promised to the first team to locate all ten red weather balloons tethered at locations somewhere in the continental United States. The MIT Team won by pursuing a social networking strategy where the prize money was distributed to participants that facilitated successful balloon sightings (following a sliding scale with the highest amounts going to those who themselves spotted a balloon and lesser amounts going to members of the referral chain that led to the balloon spotter).

[12] The *Amazon Mechanical Turk* is an Internet marketplace that gives *Requesters* (usually businesses) the ability to crowd source tasks (known as *HIT*s or *Human Intelligence Tasks*). Typical *HIT*s might involve choosing the best among several photographs of a store-front, writing product descriptions, or identifying performers on music CDs. Solution *Providers* can then browse among existing tasks and complete them for a monetary payment set by the *Requester*. *Requesters* pay 10 percent over the price of successfully completed *HIT*s to *Amazon.com*, the site host. The name *Mechanical Turk* comes from "The Turk," a chess-playing "automaton" of the 18th century. It was later revealed that this "machine" was not an automaton at all, but was in fact a chess master hidden in a special compartment controlling its operations. Likewise, the *Mechanical Turk* web service allows humans to help the machines of today perform tasks for which they are not suited.

[13] Concerned citizens have already employed social media to find people trapped in buildings or rubble following natural disasters (e.g., the Haiti earthquake) or to solve environmental cleanup problems due to industrial accidents (e.g., the Gulf oil spill). Some of these techniques could be also used, for example, to identify a disease outbreak in a remote area.

- Data fusion to improve sensor performance or queuing. For example, data fusion may be used to lower detection thresholds for problem areas in which large numbers of false positives pose a challenge.

- Analytic techniques to detect false data within collected data sets.

- 3-D modeling software to support individual characterization and visualization (including interiors) of buildings and facilities to support facility analysis in a virtual way or provide memory aids for inspectors.

- Tools to exploit virtual globes and other forms of geospatial databases (e.g., applications that exploit Google Earth). This includes meta-search engines and viewers to put all the pieces together from Open Source GEOINT (e.g., member state information reported to international organizations, media reporting, commercial satellite imagery, wikis, social networks, blogs, NGO databases, Open Source Services).

    - Next-generation improvements to existing products such as GeoHack and GAIAGI.

    - New conceptual advances in this area.

- The role of thinking machines such as IBM's Watson to support analysis.[14]

- Predictive analytics by humans and machines to determine event direction or alert to data that indicate event detection.

- Development of analytical tools for torrents of user-generated content (such as twitter feeds).

    - Gill-like tools to strain and analyze highly diluted information present on tweets, photos, videos.

    - Tools to examine, decipher, and analyze the temporal response of web activity, blogs and tweets.

    - Tools to make complex data generated by social media and web traffic quickly accessible to wider audiences (in particular policymakers).

---

[14] An early adoption of Watson-type intelligence to an area of AVC interest may be in the area of algorithms used to analyze symptoms in case of possible exposure to chemical, bio and bio-toxin agents. This application would address the "detect and treat" response to a possible chemical, biological or biotoxin accident or use incident. A machine like Watson could also be used to identify in a short space of time the most likely synthetic pathways that can employed to produce the most significant yields of a chemical or biological agent using non-traditional precursors.

- Approaches making current analytical tools adaptable to evolving social media interfaces.

Facilitating the Activities of Public Verification Communities: We need to explore innovative methods to foster collaboration between NGOs, concerned citizens and government to support arms control goals.

- Develop the concept of public challenges to pursue further arms control policy research and development strategies.
- Develop arms control web portals, social media sites, and applets for the use of by NGOs and concerned citizens.
- Develop the concept of "public verification challenges."[15]
- Arms control is a work in progress, and will remain so for many years to come. By encouraging STEM (science, technology, engineering, and math) education today, we develop the national competencies that will be necessary to conduct effective and verifiable arms control in the future. We would therefore like to support STEM education and raise public awareness of technical verification as a possible career choice.
- Develop the most effective means to pose problems soliciting public input using sufficiently developed problem statements without unduly confining the resulting solutions.
- Formulations of success measures for public challenges.

[15] Governments will have an interest in proving that they are meeting their arms reduction obligations and may want to engage their publics in helping them to make the case.