

## **IEEE Keynote Address**

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### **NUCLEAR DEFENSE RESEARCH AND DEVELOPMENT**

A key United States Homeland Security mission is to counter the threat of nuclear and radiological attack. The US has taken actions to confront the nuclear threat posed to our nation. After the events of 2001, several agencies significantly increased investments in some elements of nuclear defense, particularly detection. Actions include preventing enemy acquisition of nuclear materials or devices, nonproliferation, interdicting materials or devices, and attributing the materials or devices to the threat source. If prevention fails, actions have been established to manage the consequences of an attack and attribute the act of terrorism to those responsible.

The Office of Science and Technology Policy (OSTP), within the Executive Office of the President, chartered a Subcommittee called Nuclear Defense Research and Development (NDRD) as part of the National Science and Technology Council, to provide a process for ensuring USG-sponsored research and development (R&D) for nuclear and radiological countermeasures addresses the highest priority gaps. The Subcommittee has developed a coordinated R&D portfolio to develop a system of defensive and consequence management capabilities. The Subcommittee has created a Roadmap to establish a robust and comprehensive R&D program addressing the threat posed by terrorist attacks using radiological or nuclear weapons. The ultimate objective of the Roadmap is to describe a suite of programs and timely deliverables that will produce a cohesive set of capabilities to effectively mitigate risks associated with radiological and nuclear threats.

Before discussing the Roadmap, let me provide some helpful background regarding OSTP and the NSTC. Congress established OSTP in the National Science and Technology Policy, Organization, and Priorities Act of 1976<sup>1</sup>.

The Act authorizes OSTP to:

- Advise the President and others within the Executive Office of the President on the impacts of science and technology on domestic and international affairs;
- Lead an interagency effort to develop and implement sound science and technology policies and budgets;
- Work with the private sector, state and local governments, the science and higher education communities, and other nations to ensure Federal investments in science and technology contribute to economic prosperity, environmental quality, and national security including building strong partnerships between these entities
- And finally to evaluate the scale, quality, and effectiveness of the Federal effort in science and technology.

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<sup>1</sup> Public Law 94-282

OSTP is led by Dr. John Marburger, who also serves as Science Advisor to President Bush. Under Dr. Marburger's leadership, OSTP has two primary missions. First and foremost, we advise the President and his staff on scientific issues. We work closely with our counterparts in other offices of the Executive Office of the President to ensure that science is adequately represented and well understood. We work closely with Homeland Security Council, Office of Management and Budget, Office of the Vice President, and National Security Council.

Secondly, OSTP coordinates research and development across the federal government. In areas where it is necessary to coordinate research across federal agencies, we provide these agencies with an opportunity to come together, discuss their research programs and develop a coordinated approach to ensure that there are no gaps in the research, no repetition in research investments, and that budgets are being used wisely.

How are these missions practically accomplished? There are two primary vehicles:

Dr. Marburger co-chairs the President's Committee of Advisors on Science and Technology (PCAST) and he leads the President's National Science and Technology Council (NSTC).

On September 30, 2001, President Bush signed Executive Order 13226 to form PCAST. PCAST was originally established by President George Bush in 1990 to enable the President to receive advice from the private sector and academic community on technology, scientific research priorities, and math and science education.

NSTC was established by Executive Order on November 23, 1993. This Cabinet-level Council is the principal means within the executive branch to coordinate science and technology policy across the diverse entities that make up the Federal research and development enterprise. Chaired by the President, the membership of the NSTC is made up of the Vice President, the Director of the Office of Science and Technology Policy, Cabinet Secretaries and Agency Heads with significant science and technology responsibilities, and other White House officials. The OSTP Director leads the day to day operation of the NSTC, and OSTP staff are integrated into its workgroups.

A primary objective of the NSTC is the establishment of clear national goals for Federal science and technology investments in a broad array of areas spanning virtually all the mission areas of the executive branch. The Council prepares research and development strategies that are coordinated across Federal agencies to form investment packages aimed at accomplishing multiple national goals. The work of the NSTC is organized under four primary committees: Science, Technology, Environment and Natural Resources and Homeland and National Security. Each of these committees oversees subcommittees, working groups, and task forces, focused on different aspects of science and technology and working to coordinate across the federal government.

The breadth of activities considered by the NSTC include:

- Climate change research
- Agricultural issues such as consideration of genetically modified organisms and food safety

- Environment issues such as mercury and dioxin contamination
- Visa issues impacting scientists and students
- Telecommunications and information technology
- Energy policy including fusion and fuel cells
- The National Nanotechnology Initiative
- And countering terrorism with science to name a few

OSTP has been actively investigating the relationship between science and technology research and our nuclear defense capabilities since immediately after 9/11. In December, 2001, Dr. Marburger discussed OSTP's plans to coordinate interagency efforts directed at Preparedness against Weapons of Mass Destruction and Critical Infrastructure Protection in a keynote speech at a AAAS symposium. In April 2002, again speaking to AAAS, Dr. Marburger announced a reorganization of OSTP to accommodate homeland and national security issues. Thus, OSTP personnel were ready to assume nuclear defense responsibilities when the President released the first National Strategy for Homeland Security. President Bush's Homeland Security Presidential Directives (HSPDs) and National Security Presidential Directives (NSPDs) formally codified US policy toward nuclear defense in 2005. When President Bush issued HSPD-14, the National Strategy to Combat Weapons of Mass Destruction, in April 2005, NSTC's Committee on Homeland and National Security released a report that framed priorities for detecting and preventing the trafficking of radiological and nuclear materials, providing an early warning system for biological threats, and speeding development and procurement of medical countermeasures. The report, called "Science and Technology: A Foundation for Homeland Security", is an important science-focused complement to the President's broad directive. Our focus on homeland and national security has enabled us to assure that our national priorities for S&T R&D keep pace with President Bush's national strategies and policy directives.

The NDRD was formed under the Committee on Homeland and National Security in March of 2007. Prior to this time the Domestic Nuclear Defense Policy Coordination Committee had tracked R&D priorities in support of nuclear defense through a working group that OSTP chaired. During the last year, the NDRD Subcommittee developed a coordinated FY10-FY14 R&D strategy in a Roadmap with clear national goals and a prioritized list for federal R&D investments across federal agencies consistent with national security strategy, homeland security strategy, and Presidential Directives. The NDRD Subcommittee is chaired by OSTP, and the following departments and agencies are represented:

- Department of Defense (Office of the Secretary of Defense and Defense Threat Reduction Agency)
- Department of Energy, National Nuclear Security Agency
- Department of Homeland Security (Domestic Nuclear Detection Office and Policy)
- Office of the Director of National Intelligence
- Environmental Protection Agency – National Homeland Security Research Center
- Federal Bureau of Investigations
- Department of Health and Human Services – Public Health and Emergency Preparedness
- Nuclear Regulatory Commission

Additionally the National Science Foundation and numerous offices within the Executive Office of the President—including Office of the Vice President, Homeland Security Council, National Security Council, and Office of Management and Budgets—are represented.

The NDRD Roadmap development approach included the following steps:

- Catalog current and programmed radiological and nuclear countermeasure R&D activities
- Develop a mechanism and criteria for high-level prioritization of unique capability needs to reduce the major risks associated with a radiological or nuclear attack, including user requirements and threat characterization
- Perform and document a gap analysis of required capabilities addressed by technology against the list of ongoing and future programs
- Identify technology shortfalls, as well as redundancies and program activities
- Provide guidance on options and trade-offs to establish a robust RDT&E program for the USG
- Document the path forward for iteratively assessing and improving the capabilities in the future

This approach laid the framework on which the NDRD Roadmap was developed. The NDRD Roadmap scope ranged from basic science to technology transition and operational evaluation. Due to restricted classification of some of the Roadmap topics, I will limit my discussion today to three mission areas of the Roadmap, nonproliferation, interdiction, and response and recovery.

The first mission area, nonproliferation, recognizes the challenge of developing remote sensing technologies for detecting and characterizing special nuclear material (SNM) production activities. The principal gap of nonproliferation R&D efforts is developing solutions to detection shortcomings with a focus on improving remote stand-off detection of the nuclear fuel cycle production process.

The second mission area, interdiction, recognizes the need for development of active and passive systems for detection of shielded and unshielded radiological and nuclear materials. Advances in passive spectral detection technology, such as, energy resolution, speed, sensitivity, cost, and size, will help to increase the detection of radiological and nuclear materials in weakly-shielded enclosures, but well-shielded materials continue to present a challenge. Advanced concepts and component technologies are needed to detect and verify materials at multiple application venues.

The response and recovery mission area recognizes the need for increased local capability and improvements in citizen awareness to effectively execute shelter-in-place, evacuation, or other protective action decisions following improvised nuclear device incidents. Guidance is needed for local officials to, and expedient actions for citizens to protect themselves are required. In addition, analysis of potential impacts of improvised nuclear devices on modern cities, including fallout characterization, survivability, safety, effectiveness of sheltering options and modern evacuation assumptions, is essential.

The NDRD working groups, with input and approval from relevant departments and agencies, developed ranked priorities for R&D in the mission areas and proposed programs for successfully accomplishing R&D goals. The NDRD Subcommittee then reviewed and endorsed working group priorities. The priorities for nonproliferation, interdiction, and response and recovery are as follows:

#### Nonproliferation:

- Develop remote sensing technologies for detecting and characterizing SNM production activities
- Develop new remote sensing capabilities for detecting and characterizing other nonproliferation activities
- Develop databases of signatures and observables for all SNM production processes
- Develop advanced computational capabilities for detecting proliferation, production, diversion, transport, assembly, and use of nuclear weapons, using simulation, algorithm development, and modeling
- Develop and collect enabling test and evaluation infrastructure (e.g., facilities, equipment, tools, and techniques). Assess analytical tools that support the broader mission of evaluating and validating nuclear nonproliferation

#### Interdiction:

- Develop active and passive systems for detection of shielded and unshielded radiological and nuclear materials
- Develop detector materials and systems to locate and identify nuclear materials for stand-off detection
- Adapt detection systems for use at sea
- Adapt detection systems for use in air travel
- Adapt detection systems for use in unattended regions and at borders

#### Response and Recovery:

- Increase local capability and citizen awareness to effectively execute shelter-in-place, evacuation, or other protective and response action decisions following an IND incident
- Develop and make available improved therapeutics and diagnostics for radiation injury and develop capability for prompt triage and dose assessment
- Develop capability to perform decontamination of critical infrastructure, such as transportation, power, water/wastewater, communications, medical, and essential government services, and wide-area urban decontamination for permanent restoration and normal land use, such as high-value structures, businesses, residences, parks, and waterways
- Develop capability to perform long-term medical care and management, including population monitoring
- Develop an empirically based risk communication program to help the public take appropriate self-protection measures, limit adverse social and psychological effects, maintain trust and confidence, and reduce morbidity and mortality

The top single priority from each working group was determined to be among the highest nuclear defense R&D priorities for the USG.

In addition, the NDRD Subcommittee identified two needs common to all NDRD mission areas that are required to effectively conduct nuclear defense R&D: 1) the necessary human expertise and skill base and 2) the accompanying physical infrastructure. Both must be developed, maintained, and continually renewed. A stable workforce is essential, and programs that support the education of nuclear defense disciplines are required to replenish the workforce. The success of the Roadmap recommendations is equally dependent on adequate physical infrastructure to conduct R&D activities. It is necessary to generate a clear, concise, and consistent definition of what physical infrastructure is required for nuclear defense R&D and then support the sustenance or new construction of this infrastructure. The human expertise and physical infrastructure requirements are needs that cannot be resolved in a short time period. They require long-term planning and sustained support.

The intended audiences for the Roadmap are diverse. The USG department and agency leadership might use the Roadmap to create effective programs provide guidance regarding R&D priorities to assist in developing program budget requests and implementing final budget guidance. The Office of Management and Budget (OMB) can create a federal budget that supports effective programs and provides metrics to measure progress and provide the basis for a long term process to monitor progress toward achieving interagency R&D goals. Policy makers can create a mechanism to assess policy implications and alternatives and provide information on how nuclear defense policy directions are being incorporated into R&D activities and support policy objectives. Finally, agency and department laboratories and contractors, non-governmental organizations, professional societies, academia, private sector, and other stakeholders in the general research community can better understand priority R&D topics to encourage focus on critical needs and fulfill programs with activities that that have a focus on critical areas of R&D.

This Roadmap for Nuclear Defense Research and Development summarizes nuclear defense R&D priorities and proposes programs for achieving those priorities. It is intended to serve as a living document — the NDRD Subcommittee intends to review the Roadmap for major threat changes that could change priorities every two years and produce a major updated Roadmap every five years. Future versions will build upon this one, expanding to include interagency investment strategies and program plans.

The engagement of the research community in Homeland security R&D related to nuclear defense has been an important objective for this Administration and for Dr. Marburger personally, since the days after September 11, 2001. This conference is a symbol of the commitment of our collective intellectual community to the protection of our nation as well as a showcase for the successful recruitment of scientific and engineering talent for advances in homeland security. Your presence here this morning creates a very welcome opportunity to learn and share ideas about the complex problems and possible solutions for the issues of security on the domestic front.

On behalf of Dr. Marburger, I'd like to thank you for your participation in and support of nuclear defense research and development, and provide my best wishes for your continued successes in support of our nation.

