American Society for Public Administration (ASPA)

Conference Paper

Federally Sponsored, Not-for-Profit Research and Development Centers:

Evolving Regional Roles to Engineer State and Local Emergency Preparedness Capabilities

April 2010

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Abstract

This paper examines the roles federally funded research and development centers (FFRDCs) and university affiliated research centers (UARCs) might play in delivering systems engineering and analytical capabilities to state and local jurisdictions to improve the nation's preparedness and address enterprise challenges for responding to and recovering from all-hazards incidents and emergencies.

Public law and Presidential guidance following the attacks of 9/11 outline general policies and specific activities to improve the nation's overall preparedness to respond to and recover from an array of all-hazards threats. The country's national preparedness architecture requires intergovernmental and private sector involvement in domestic security activities. At the national level, many foundational policies, processes, and systems have been established and are now being implemented to help the country prepare for and respond to the full range of incidents and emergencies that have national, regional, and local impact.[1]

Since 9/11, the nation has made great progress in identifying specific threats and in taking tangible steps to counter those threats. Despite this progress at the national level, state and local jurisdictions continue to struggle to upgrade preparedness or develop new capabilities in response to sometimes confusing and complex guidance from the national level. State and local authorities' ability to implement this guidance (along with associated funding, often in the form of federal grants) is hampered by a general shortage of systems engineering and program management competencies and resources. These sorts of resources are difficult for state and local authorities to maintain on public payrolls or to procure commercially given their constrained budgets. Systems Integrators and Consultants that often do this type of work at the federal level are reluctant to work for the limited available resources and then preclude themselves from competing for the implementation work.

Some observers and policy makers now suggest the federal government provide direct analytical and systems engineering assistance to state and local entities to help them develop homeland security capabilities to advance national priorities. One group of resources that have been largely untapped is the FFRDCs and UARCs. With federal sponsorship, FFRDCs and UARCs are able to provide state and local jurisdictions the capability to effectively define operational requirements, perform systems engineering, and develop integrated capabilities. The systems engineering lifecycle (SELC) provides a path for documenting critical needs and developing concepts and solutions that can be tested and evaluated.

[1] These include the National Incident Management System (NIMS); the National Response Framework (NRF) and supporting emergency support functions (ESFs); the National Infrastructure Protection Plan (NIPP) and supporting critical infrastructure and key resources (CIKR) sector plans; and the National Preparedness Guidelines which includes the National Planning System (NPS), National Planning Scenarios, Universal Task List (UTL), and Target Capabilities List (TCL).

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1. Introduction

1.1 Purpose

The paper examines the roles that federally funded research and development centers (FFRDCs) and university affiliated research centers (UARCs) can play in delivering systems engineering and analytical capabilities to state and local jurisdictions to improve the nation's preparedness and address enterprise challenges for responding to and recovering from all-hazards incidents and emergencies.

1.2 Overview

On the surface, creating National Preparedness seems a straightforward task. Jurisdictions and private concerns should create plans that integrate and coordinate public safety and emergency management functions and identify capability gaps. Those gaps are closed by implementing projects that create or modify capabilities. Follow on assessments through reports and exercises verify the improvements and the system cycles again.

Why then, after almost a decade and billions of dollars of grant investments, is the nation unable to effectively measure its Preparedness?

What tends to happen is that the federal government has created an elegant architecture that appears simple to some. Then jurisdictions are provided some limited incremental resources through grants, but fundamental tools to translate this architecture into requirements and executable projects are not included.

Public law and Presidential guidance following the terror attacks of September 11, 2001, outline general policies and specific activities to improve the nation's overall preparedness against an array of all-hazards threats.[2] The country's national preparedness architecture now encompasses a broad range of prevention, protection, response, and recovery activities necessary to confront the full spectrum of domestic threats facing the nation, both natural and man-made. [3]

Since September 11, the nation has made great progress in identifying specific threats and in taking tangible steps to counter those threats at national, state, territorial, tribal, and local levels using the collective resources and capabilities of government, non-government, private sector, and individual entities. Despite much progress, more work is needed to ensure that legislation and Presidential directives are implemented in ways

[2] Principal legislation includes The Stafford Act, The Homeland Security Act, The Intelligence Reform and Terrorism Prevention Act, The Post Katrina Emergency Management Reform Act, The 9/11 Implementation Act, and The Pandemic and All-Hazards Preparedness Act. Key Homeland Security Presidential Directives (HSPD) that implement this legislation include HSPD-4, National Strategy to Combat Weapons of Mass Destruction (2002); HSPD-5, Management of Domestic Incidents (2003); HSPD-7, Critical Infrastructure Identification, Prioritization, and Protection (2003), HSPD-8, National Preparedness (2003), and HSPD-10, Biodefense for the 21st Century (2004), and HSPD-21, National Strategy for Public Health and Medical Preparedness (2007).

[3] National Preparedness Guidelines, September, 2007.

that have a continually improving and enduring impact on the country's overall homeland security.

At the national level, many foundational policies, processes, and systems have been established and are being implemented to help the country prepare for and respond to a broad range of incidents and emergencies that have local, regional, and national impact. These include the National Incident Management System (NIMS) and its supporting Incident Command System (ICS); the National Response Framework (NRF)[4]; the National Infrastructure Protection Plan and its supporting critical infrastructure and key resources sector plans; and the National Preparedness Guidelines with their supporting National Preparedness System (NPS), National Planning Scenarios, Universal Task List (UTL), and Target Capabilities List (TCL).

These plans and systems do not constitute the entire universe of preparedness and response guidance stemming from post-9/11 national action, but they do represent a core collection of preparedness doctrine intended to shape national thinking about all-hazards preparedness and to guide future activity related to national preparedness policy making, planning, operations, and investment.

Despite this progress at the national level, state and local jurisdictions continue to struggle to upgrade preparedness or develop new capabilities in response to sometimes confusing and complex guidance from the national level. State and local authorities' ability to implement this guidance (along with associated funding, often in the form of federal grants) has been hampered by a general shortage of systems engineering and program management competencies and resources. Systems Engineering, as a management discipline, has not taken root at the state and local level, except in engineering organizations like transportation departments. These sorts of resources are difficult for state and local authorities justify to and maintain on public payrolls or to procure commercially given their constrained budgets

1.3 Preparedness as a System-of-Systems.

National preparedness doctrine describes a set of interrelated and interdependent systems that guides (sometimes very broadly and sometimes very specifically) planning, organizing, training, equipping, and assessment activities in ways that will ultimately harmonize and enhance preparedness at local, regional, and national levels. At times, this doctrine is explicit in defining individual roles and responsibilities, as in the functioning of the Joint Field Office within the ICS structure. At other times, it is broadly general to allow for flexibility among the many contributors to national preparedness, coming from a range of public and private sectors.

Given this range, it may be fair to characterize national preparedness doctrine as describing a complex system-of-systems including prevention systems, protection systems, mitigation systems, response systems, and recovery systems. These

[4] National Response Framework, 2008 - http://www.fema.gov/emergency/nrf/

component systems, in turn, are composed of constituent sub-systems. For example, response systems include sub-systems for commanding, controlling, organizing, equipping, and training in preparation for response missions, along with exercise and evaluation sub-systems designed to assess the systems', and sub-systems', overall readiness and ability to respond.

1.4 The National Preparedness System

The Post-Katrina Emergency Management Reform Act of 2006 (PKEMRA) directs the President, "consistent with the declaration of policy under section 601 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act (42 U.S.C. 5195) and title V of the Homeland Security Act of 2002 (6 U.S.C. 311 et seq.), as amended by this Act, [to] develop a national preparedness goal and a national preparedness system." [5]

PKEMRA specifically directs the President, "acting through the Administrator [of the Federal Emergency Management Agency (FEMA)], [to] complete, revise, and update, as necessary, a national preparedness goal defining the target level of preparedness to ensure the Nation's ability to prevent, respond to, recover from, and mitigate against natural disasters, acts of terrorism, and other man-made disasters."[6] PKEMRA further calls for FEMA to develop a comprehensive NPS to enable the Nation to meet the national preparedness goal and that the national preparedness system shall include the following components:[7]

- Target capabilities and preparedness priorities
- Equipment and training standards
- Training and exercises
- Comprehensive assessment system
- Remedial action management program
- Federal response capability inventory
- Reporting requirements
- Federal preparedness

The National Preparedness Guidelines[8] (Guidelines), published in September 2007, finalized the development of the national preparedness goal and its associated components. The Guidelines include a vision for national preparedness, a set of eight national priorities, an outline for 37 target capabilities, and a summary listing of 15

[5] *PKEMRA*, section 642, et seq.

[6] *Ibid*, section 643.

[7] *PKEMRA*, section 644, et seq.

[8] The *National Preparedness Guidelines superseded the Interim National Preparedness Goal* (March 2005), which initially implemented PKEMRA requirements.

national planning scenarios.[9] As noted in the document, "The Guidelines are the umbrella for a range of readiness initiatives... that collate many plans, strategies, and systems into an overarching framework [that is] the National Preparedness System. Plans and systems will be implemented and requirements will be matched with resources, consistent with applicable law and subject to the availability of appropriations."[10]

The Guidelines establish an all-hazards, risk-based, capabilities-based "call-to-action" and identify preparedness as "the foundation for successful National Incident Management System (NIMS) implementation."[11] The Guidelines also identify a cycle of preparedness for prevention, protection, response, and recovery that includes planning, organizing, staffing, equipping, training, exercising, evaluating, and improving activities. The Guidelines note that "Federal, State, local, tribal, and territorial governments, in cooperation with the private and non-profit sectors, each have a unique role in supporting the preparedness framework established by the Guidelines."[12]

The Guidelines establish a capabilities-based approach to preparedness that focuses on the ability to accomplish a particular mission or set of missions. For each of the 37 target capabilities identified, the guidelines highlight a high-level outcome that generally describes the characteristics of an achieved capability, but without specific metrics or performance measures. The Guidelines acknowledge that "the challenge for government officials, working with the private sector, non-governmental organizations, and individual citizens, is to determine the best way to build capabilities for bolstering preparedness" and that the "'best way' will vary across the Nation."[13]

Three planning tools support the Guidelines' capabilities-based preparedness process: the National Planning Scenarios, the target capabilities list (TCL), and the universal task list (UTL). The scenarios provide the context for preparedness planning and are "designed to identify the broad spectrum of tasks and capabilities needed for all-hazards preparedness." The TCL is a "comprehensive catalog of capabilities to perform homeland security missions, including performance measures and metrics for common tasks." The UTL, finally, is a collection of tasks, arranged in hierarchy, that describe in particular detail specific tasks required to prevent, protect against, respond to, and recover from events represented in the National Planning Scenarios.

When these tasks are identified as critical to achieving a given capability, and linked to operating conditions and performance standards, they provide primary sources of information in developing training and exercise objectives, and enable effective planning and performance evaluation.

[9] The vision for the National Preparedness Guidelines is: "A NATION PREPARED with coordinated capabilities to prevent, protect against, respond to, and recover from all hazards in a way that balances risk with resources and need." (*Guidelines*, p1).

[10] *Guidelines*, page 2.

[11] *Ibid*, page 3.

[12] *Ibid*, page 4.

[13] *Ibid*, page 10.

1.5 Work Remaining for the National Preparedness System

In reviewing the federal government's progress in improving national preparedness, the GAO observed in July 2007 that "[d]eveloping the ability to prepare for, respond to, and recover from major and catastrophic disasters requires an overall national preparedness effort that is designed to integrate and define what needs to be done, where, and by whom (roles and responsibilities); how it should be done; and how well it should be done—that is, according to what standards."[14] GAO specifically noted that, "[t]he nation's experience with hurricanes Katrina and Rita reinforces some of the questions surrounding the adequacy of capabilities in the context of a catastrophic disaster—particularly in the areas of (1) situational assessment and awareness, (2) emergency communications, (3) evacuations, (4) search and rescue, (5) logistics, and (6) mass care and sheltering."[15]

While substantial progress has been made in implementing NPS requirements as directed in PKEMRA, section 644, not all requirements have been fully satisfied. GAO testimony suggests that, of the eight components identified as being essential for a national systems under PKEMRA, work remains in developing those components associated with implementing a comprehensive system for assessing and reporting preparedness and for managing remedial efforts to improve preparedness when deficiencies are observed.

The fundamental challenge remaining is how to craft and implement a set of integrated standards, measures, and processes to track the status of national preparedness, report on the system's risk-adjusted strengths and weaknesses, identify specific areas for improvement in ways that suggest particular solution strategies, and monitor and assess the effectiveness of resulting remedial initiatives and investment decisions. Addressing a challenge of this magnitude is daunting given its high degree of complexity, competing resources demands, and distributed nature of execution. Ultimate success lies in methodical thinking, systematic analysis, and structured decision-making—the very essence of systems engineering. Appendix 1 further describes the systems engineering process.

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[14] Testimony of William O. Jenkins, Director, Homeland Security and Justice Issues, Government Accountability Office, "Homeland Security: Observations on DHS and FEMA Efforts to Prepare for and Respond to Major and Catastrophic Disasters and Address Related Recommendations," July 31, 2007.

[15] *Ibid*, page 16.

2. How Can FFRDCs and UARCs Advance National Preparedness?

2.1 Promoting the Implementation of a National Preparedness System

2.1.1 Understanding the National Preparedness Mission Domain

The National Preparedness Mission Domain is composed of those operational functions and activities at federal, state, territorial, tribal, and local levels that relate to preventing, protecting against, responding to, and recovering from terrorist attacks, major disasters, and other emergencies that occur within the United States. This mission domain consists of vast, overlapping organizations and systems, including intelligence systems, emergency response systems, medical systems, logistical systems, public information systems, human capital and professional development systems, and command and control systems. DHS and FEMA play central roles, but they are not exclusive players in this complex, interrelated set of missions. The development of this mission domain requires systems thinking and systems methodologies.

2.1.2 Planning Requirements

Defining operational and technical requirements is a systems engineering activity that can help guide acquisition planning and system design. The federal government, especially the Department of Defense, has a rich history of requirements development and employs these activities routinely. State and local governments do not generally employ formal systems engineering methodologies to develop and manage requirements. Instead, state and local authorities tend to have general expressions of operational needs and sporadic (and often inconsistent) technical requirements. Often times, technical requirements are driven by legacy technology or by newly acquired, but propriety commercial solutions. In the instances that state and local governments do have adequate program management resources, it is often difficult for them to find companies that will provide requirements development support because they don't want to be precluded from participating in a prime contract to build and deliver the intended capability.

2.1.3 Research, Development, Test and Evaluation (RDT&E)

Research, development, test, and evaluation (RDT&E) are key federal competencies that are often supported by FFRDCs and UARCs. RDT&E activities have a long history of helping the federal government develop and improve operational capabilities, especially in matters of national security technologies that serve the public interest. Traditionally, these sorts of national-level RDT&E resources have not been readily accessible to state and local governments. By their nature, these competencies are relatively expensive to assemble and to maintain on an enduring basis. As such, they are often beyond the reach of state and local authorities to generate for themselves.

While the commercial sector is certainly able to provide expert RDT&E assistance to state and local authorities, commercial firms often shy away (as with requirements development activities discussed above) from form engaging with them because awards for this kind of consulting support tend to be small and because participating in RDT&E activities (e.g., acquisition selection criteria) would preclude them from subsequent participation in contracting activities.

2.1.4 Guiding Acquisition

Capital planning and investment control (CPIC) is a key management process within government at all levels. Essentially, CPIC is a decision-making process for ensuring that capital investments in IT and other major initiatives support an agency's strategic planning, budgeting, procurement, and business activities. The process covers the life cycle of each system and includes explicit criteria for analyzing the projected and actual costs, benefits, and risks associated with the investments.

Because the formal processes of enterprise systems engineering encompass strategic, programmatic, and architecture planning, it is the logical framework for DHS and FEMA to use in guiding its investment efforts. The comprehensive nature of enterprise systems engineering analyses will help ensure DHS provides thoroughly prepared documentation to OMB that effectively integrates acquisition activities across the entire emergency preparedness and response mission domain.

2.1.5 Guiding Transformation

Effectively transforming an enterprise requires careful change management. Increasingly, enterprises such as DHS and FEMA must react to environmental and internal change drivers that necessitate varying degrees of transformation. These drivers reflect the impacts of environmental turbulence, such as changes to law, public policy, public attitude, technology, the operating environment, and the availability of resources. They also reflect the impacts of internal enterprise turbulence, such as changes to the organization, the culture(s) of the work force, and the interrelationships of processes. Changes brought on by any of these drivers, whether internal or external, exert pressures on an enterprise to transform and adapt rapidly, else risk losing its operational efficiency and mission effectiveness.

Change, however, must be carefully controlled to mitigate the risks of losing operational focus and wasting the precious resources of money and time. Effective change management is achieved through thoughtful planning and methodical execution. All planning and execution efforts must be predicated on systematic analyses of processes; a methodical understanding of interrelationships; and effective communication to key stakeholders of the transformation's purpose, method, and end-state. Positive control over change will be lost without these planning and execution antecedents in place. Enterprise systems engineering strategies provide DHS with the means to ensure full process and execution control.

2.1.6 Addressing Complexity and Ambiguity

Differing regional, state, and local requirements and priorities; distributed command, coordination, and response capabilities; and inconsistent state legal authorities all serve to add complexity and ambiguity to the task of effectively planning, implementing, and monitoring a national system of preparedness. For example, as missions and staffs are realigned to meet operational requirements, legacy information systems and organizational support structures are unable to keep pace with the change. As a result, integration efforts and investments in new processes and technology are stymied by unclear or conflicting lines of responsibility and authority.

Information flows related to requirements, resources, and capabilities cut both vertically and horizontally across preparedness and response mission communities that have unclear and conflicting oversight and resource priorities. DHS and FEMA need a methodical set of approaches to map these information flows to their appropriate domain stakeholders as threats change and mission requirements continue to evolve. Such a set of approaches will help ensure that the overall capabilities of preparedness systems and system governance responsibilities function in ways that provide optimal support to emergency management practitioners at all levels and in all threat environments. Comprehensive enterprise systems engineering provides methodologies to assess response and recovery capabilities and to identify mission priorities that would most benefit from new investments and system improvements.

2.1.7 Linking Stove Pipes

System stove pipes that may previously have been effective in passing along information vertically through emergency management disciplines (e.g., fire, rescue, police, emergency operations, military) do not scale well, nor do they allow for the sharing of information across disciplines within larger enterprise systems to enable common operational pictures and consistent data management.

Interdependencies and redundancies among organizational processes and systems can be made explicit by enterprise systems engineering because its methodology draws heavily from a variety of systems engineering techniques and applies them systematically and enterprise-wide. For example, one often finds within an enterprise several separate systems for human resource management, financial management, travel management, and payroll management. Often these systems are stove piped within the organization as they provide information hierarchically along functional lines, but share little or no information horizontally across systems. These stove-piped systems also tend to be in different phases of their respective program life cycles. Some may be decades-old legacy systems that use outdated technology, while others may be cutting-edge systems that use the latest technologies, and still others may reflect a mix of both old and new technologies in a complex patchwork of system fixes.

2.1.8 Linking Strategy to Performance:

Systems engineering methodologies can also help key preparedness stakeholders translate strategy into performance by facilitating the clear definition of elements comprising “mission maps” and guiding them in the development of stakeholder “scorecards” (Kaplan and Norton, 1996). Stakeholder scorecards can explicitly link an enterprise vision to stakeholder objectives, stakeholder objectives to mission execution, and mission execution to overall measurement of subsystem and enterprise performance. For example, an enterprise systems engineering framework can help ease the process of tracking and reporting performance as required by the Government Performance Results Act of 1993 (GPRA). The purpose of GPRA is to improve the public’s confidence in the capabilities of the federal government. It is specifically intended to improve the effectiveness, delivery, and management of federal programs, and to facilitate Congressional decision-making and oversight. (Section 2(b)).

One of the ways in which the OMB tracks an agency’s progress toward achieving GPRA goals is through the program assessment rating tool (PART). OMB uses PART assessments to help inform budget decisions and identify actions to improve results. Agencies are held accountable for implementing PART follow-up actions and for working toward continual improvements in performance. The PART looks at all of the factors that impact program performance, including the purpose and design of the program; performance measurements, evaluations, and strategic planning; program management; and the program’s results. These are the very factors an enterprise engineering methodology considers.

2.1.9 Facilitating “Governance by Network”

Stephen Goldsmith and William Eggers observe that traditional, hierarchical views of government no longer satisfy the needs of society in today’s complex and changing environment. In their recent work, Governing by Network, they make a compelling case that environmental changes (e.g., technological complexity, governmental outsourcing, and public expectations) are driving governments to focus less on managing people and programs, and more on marshalling and organizing resources (which often are controlled by other entities) to produce value and achieve policy objectives. Increasingly, they argue, governments must rely on networks composed of public agencies and private organizations to deliver public services and respond to public needs. Goldsmith and Eggers note in one homeland security example:

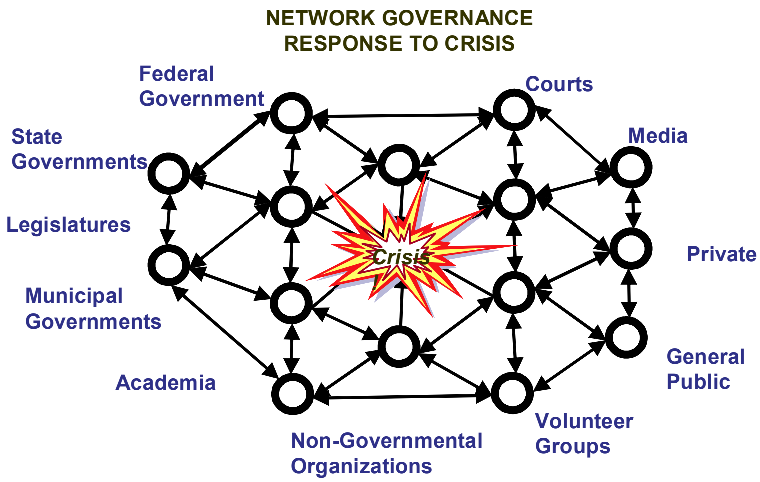

Figure 1: Network Context for Emergency Response

> "Neither the Federal Bureau of Investigation nor the Central Intelligence Agency can effectively stop terrorists. These agencies require the assistance of a law enforcement network that crosses agencies and levels of government. They need communications systems to capture, analyze, transform, and act upon information across public and private organizations at a speed, cost, and level that were previously impossible."

In essence, Goldsmith and Eggers' network construct describes society's evolving approach to managing virtual enterprises of the sort discussed earlier in this paper. Again, the national preparedness mission domain would benefit from using systems engineering practices to methodically capture, describe, and relate the processes of various stakeholders along the range of activities including disaster and incident planning, prevention, mitigation, response, and recovery.

2.1.10 Advancing the National Incident Management System (NIMS)

The NIMS was created in response to Presidential guidance provided in Homeland Security Presidential Directive (HSPD) -5 (Management of Domestic Incidents, February 2003). The NIMS seeks to provide a consistent, nation-wide template to enable federal, state, local, and tribal governments and private and nongovernmental organizations to work together. Taken collectively, the NIMS is a core set of doctrine, concepts, principles, terminology, and organizational processes to enable effective incident management at all levels. HSPD-5 requires that all federal departments and agencies adopt the NIMS and that they make adoption of the NIMS by state and local organizations a condition for federal preparedness assistance. [16]

The NIMS is composed of sections relating to command and management (including incident command), preparedness, resource management, communications and information management, supporting technology, and management and maintenance (including the NIMS Integration Center). The NIMS integration center (subsequently referred to as the National Integration Center in PKEMRA) serves essentially as DHS and FEMA's training and doctrine proponent for national preparedness and response. In many ways, it is the "engine" that powers the NIMS and national preparedness.

2.2 Assisting in Engineering Regional Preparedness Capabilities

Increasingly, Congress, DHS, and FEMA are looking to regional approaches for improving the nation's preparedness posture. For example, PKEMRA (section 1801) requires that DHS:

> "(5) conduct extensive, nationwide outreach and foster the development of interoperable emergency communications capabilities by State, regional, local, and tribal governments and public safety agencies, and by regional consortia thereof;
>
> "(6) provide technical assistance to State, regional, local, and tribal government officials with respect to use of interoperable emergency communications capabilities;
>
> "(7) coordinate with the Regional Administrators regarding the activities of Regional Emergency Communications Coordination Working Groups under section 1805…"

PKEMRA specifically authorized FEMA to "develop a demonstration program with regional and local governments in the formation of innovative public and private logistical partnerships and centers to improve readiness, increase response capacity, and maximize the management and impact of homeland security resources." [17]

Currently, DHS and FEMA are well underway in executing $968 million of fiscal year (FY) 2007 grant funding to improve interoperable communications under the Public Safety Interoperable Communications (PSIC) grant program, as well as continuing to execute another $3.1 billion of FY2009 grant funding to support regional, state, and local emergency preparedness efforts. In order to gain maximum effect on improving national preparedness, these federal resources must be sharply focused and effectively controlled, and their results closely monitored and measured.

There is an important systems engineering role to be played in support of federal grants administration. Just as DHS and FEMA now benefit from the support of an informed,

[16] National Incident Management System, March 1, 2004, (page 6).

[17] *Post-Katrina Emergency Management Reform Act of 2006*, Title III (page H7828).

independent cadre of technical experts to help comprehensively design standards and performance measures, assesses current capabilities, and develop and oversee the implementation of program reporting and control mechanisms relating to grants administration, states can potentially gain access to these same resources through direct federal assistance to meet their regional preparedness needs.

2.2.1 Conducting Regional Preparedness Capabilities Planning

Increasingly, all-hazards attention is being focused on developing regional preparedness and response capabilities based on integrated strategies that cut across state and local jurisdictions. For example, federal Homeland Security grant funding for regional preparedness and urban area security increased $71.5 million from $844.6 million in 2009 to $916.1 million in 2010.[18] These national investment programs, augmented by state and local funded investments, seek measurable improvements in emergency preparedness and response capabilities. As states, and their local communities, begin to converge on common approaches to interoperable communications, integrated planning and operations, and mutual assistance, issues of standards and doctrine take on greater and more central importance.

2.2.2 Direct Assistance to States through Regional Mechanisms

A recent report by the *Project on National Security Reform* (PNSR) notes that, "From the state and local perspectives, the cause of an incident or situation may not be as important as the capability to manage it. Practically speaking, consideration of capabilities informed to a lesser extent by risk is better for planning at the state level, where the effects of an incident or situation are more important than its cause. However, from a national preparedness perspective, it is indeed necessary to focus on causes to enable state and local jurisdictions to do the detailed operational planning which better anticipates effects. Moreover, from the federal perspective, given the size and complexity of the federal government, it is not possible to move entirely toward capabilities-based planning to the exclusion of risk-based elements."[19] FFRDCs and UARCs have deep analytical experience to help states discern this "middle ground" between federal and local views.

Some observers (among them PNSR) now suggest the federal government provide direct analytical and systems engineering assistance to state and local entities to help them develop homeland security capabilities to advance national priorities. For example, the PNSR proposes "establishing in each federal region a Regional

[18] FY2010 Preparedness Grant Programs Overview, Department of Homeland Security, December, 2009 (see: http://www.dhs.gov/xlibrary/assets/grant-program-overview-fy2010.pdf). Figures represent sums of three regional grant programs: Urban Area Security Initiative (UASI), UASI Non-profit Security Grants, and Regional Catastrophic Preparedness Grants Program (RCPGP) for FYs 2009 and 2010.

[19] Project on National Security Reform. *Reclaiming the System: Toward Efficient and Effective Resourcing of national Preparedness*, December, 2009, (p. 9).

Catastrophic Preparedness Staff (RCPS) to develop and sustain capabilities for risk assessment, catastrophic operational planning and capabilities assessment. Consideration should be given to building these standing intergovernmental and interagency staffs on the FPC Coordinating Committees which with the exception of Region One have not been developed. These RCPSs would be funded by federal direct assistance and would provide support to all existing regional mechanisms. Effectively, these staffs would conduct regional catastrophic preparedness evaluations and self-assessments based on regionally determined performance metrics in turn based on nationally determined objectives and planning assumptions." [20]

One group of resources that have been largely untapped is the nation's FFRDCs and UARCs. With federal sponsorship, (and in the case of FFRDCs, federal sponsor approval) FFRDCs and UARCs are able to assist state and local authorities in effectively defining operational requirements, performing systems engineering, and developing integrated capabilities. Using the systems engineering lifecycle (SELC) as a guiding framework, these federally-sponsored entities can help state and local jurisdictions develop a documented path for identifying critical needs and developing concepts and solutions that can be tested and evaluated. FFRDCs and UARCs have the knowledge and experience to help state and local authorities identify integrated sets of requirements essential to developing regional capabilities against which the private sector can design and build viable solutions. To this point, *DomPrep Journal* notes that, "FFRDCs and UARCs also could provide state and local jurisdictions the capability to effectively generate requirements and carry out systems-engineering programs. The systems-engineering cycle provides a ready path for documenting critical needs and then developing concepts and solutions that can be tested and evaluated. It also can document the scope of work involved in procurement and provide overall program-management support. Many if not all private-sector companies are reluctant to provide this service, it should be pointed out, because most state and local procurement rules would not allow them to participate in the downstream procurements."[21]

Because FFRDCs (and to a great extent UARCs) enjoy special relationships with their federal government sponsors, FFRDCs have access to information and decision processes not normally afforded commercial contractors, but which may be central the success of state and local initiatives which must dovetail with neighboring jurisdictions and federal activities (e.g., fusion center information sharing, emergency resource planning, and critical infrastructure information). This unique level of access, trust, and visibility allows FFRDCs and UARCs to develop and implement solutions having regional and federal nexuses well beyond what might be offered by either a local jurisdiction's or a commercial entity's capabilities. Figure 2 (below) offers a potential model for federal, direct assistance to state and local authorities by extending access to FFRDCs and UARCs through federal sponsorship and oversight. While matters of policy and funding must be better defined and agreed upon, the concept does suggest a mechanism for state and local authorities to express their analytic and systems engineering needs through a regional federal entity (in this case FEMA regions) and

[20] Ibid. (p. 7).

[21] *Providing Systems Engineering Support to State & Local Jurisdictions*, DomPrep Journal, July, 2009, (p. 14).

have those needs validated and resourced through a federal proponent. The underlying aim here is to establish a means by which unique federal analytic and engineering competencies can be extended to state and local authorities in ways that are efficient and effective, that meet the nation's shared objectives.

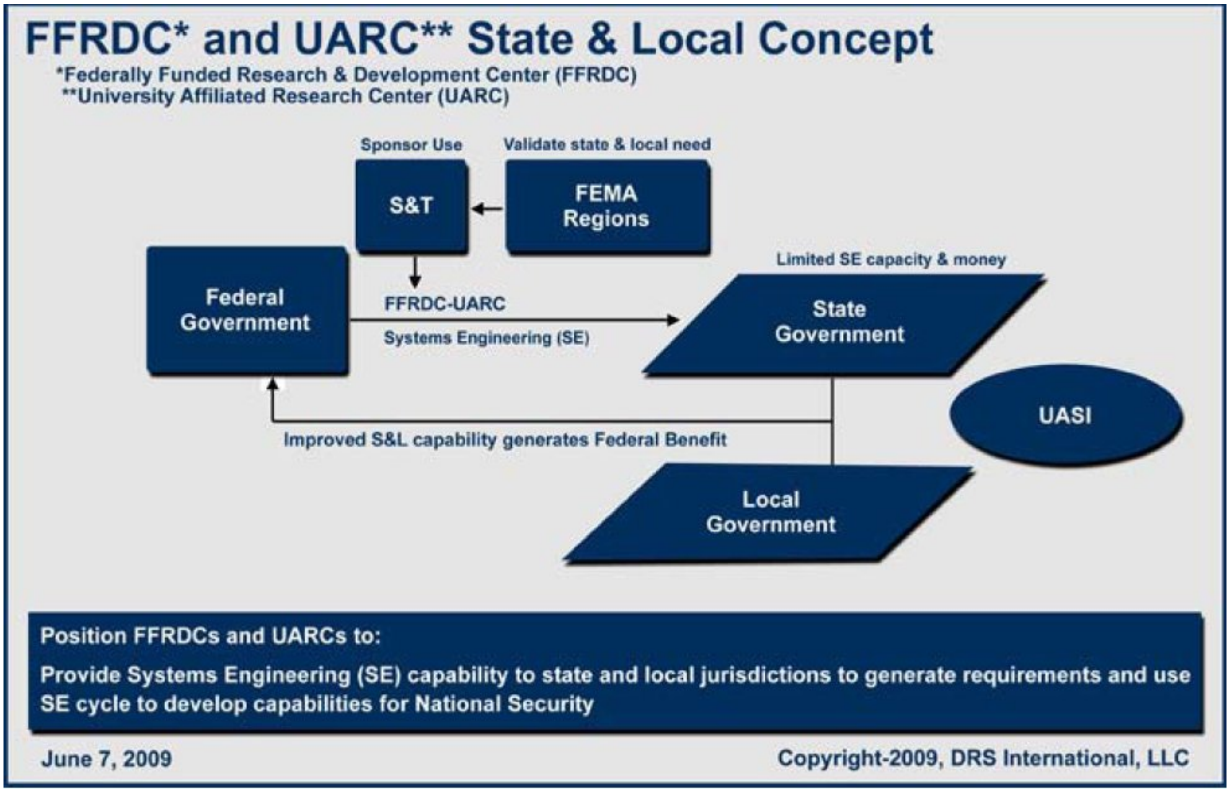

Figure 2: State and Local Concept[22]

2.3 Practical Examples of State and Local Systems Engineering Problems

The following short examples illustrate situations appropriate for systems engineering methodologies and represent real situations and possible requirements that could be developed. Effective systems engineering presupposes basic competency in program management. This competency is not one universally shared by practitioners in the homeland security and emergency management enterprise, with some jurisdictions

[22] State and Local Concept diagram appears in DomPrep Journal, Providing Systems Engineering Support to State & Local Jurisdictions, July, 2009 (p.14). Reprinted by permission of DRS, International, LLC.

faring much better than others. The challenge is to move from a collection of ad hoc approaches to more methodical, systems approaches.

Figure 3 (below) depicts the process the State of Maryland used from 2003-2006 as part of a Program Executive Office (PEO) to implement sound Systems Engineering and Program Management practices. More detail is included in References for Maryland Governor's Office Transition and Project Guide.

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2.3.1 Hazmat CDL project in Maryland

The USA Patriot Act of 2002, created the requirement by DHS and the Transportation Security Administration (TSA) to screen Commercial Drivers License (CDL) license holders for Hazmat endorsements. TSA completed the rules in May 2003. In Maryland, there were three departments (Motor Vehicles (MVA), State Police, and Public Safety) involved in the project. Each had funding and a share of the responsibility.

The Governor's Office of Homeland Security organized a program management process for all homeland security projects. A multi-department team was established whose first task was to analyze the system to determine how to integrate the MVA systems with the new field fingerprint scanners and enable forwarding of data to the FBI for screening.

On January 31, 2005 the Maryland MVA, in cooperation with the Maryland Department of Public Safety and Correctional Services (DPSCS) implemented Phase I of the CDL-HAZMAT program requirements of the at MVA's Glen Burnie branch office. Under Phase I all new applicants for a Hazardous Materials Endorsement (HME) were required to submit to a fingerprint based security check.

Based on the successful implementation of this pilot, additional locations (Bel Air & Waldorf) were rolled out on May 31, 2005 to coincide with the initiation of Phase II which requires all renewals and transfers of HME's to also undergo a fingerprint based security check.

Within six months (mid-June, 2005) the MVA processed 452 HAZMAT applicants and 355 security threat assessments were received from the TSA. The manual FBI process previously required 8 weeks. The new electronic process reduced the cycle to 7 days.

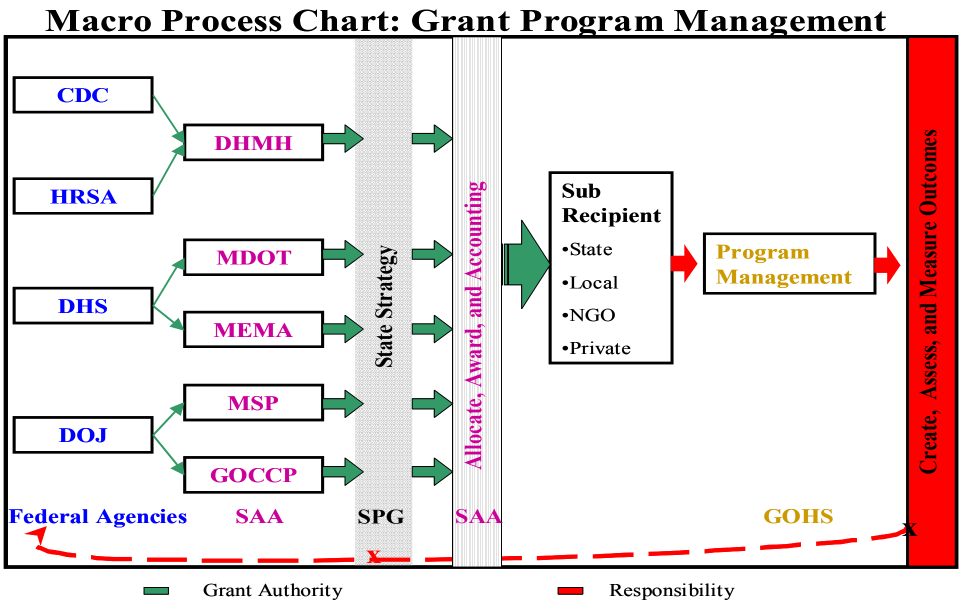

Figure 3: State of Maryland Process, 2003-2006

2.3.2 Interoperability Engineering

Also within Maryland, as of 2003, there was no comprehensive engineering analysis of the requirements to plan and implement a statewide interoperability program. The state had a seven-year, $70 million communications tower program underway, but no statewide governance. The Governor's Office established a statewide governance process in 2003 and within 14 months completed a statewide engineering plan for interoperability that served as a blueprint for 11 projects. These projects were then managed through an integrated, state interoperability executive committee (SIEC). Because sound program management and systems engineering practices were employed at inception, each project could be monitored, controlled and reported on at monthly in-progress and quarterly Senior Policy Group reviews. Management documents and systems engineering artifacts (e.g., production schedules, performance measures, testing plans, etc.) typically generated by these systems engineering methodologies provided flows of critical information that enabled overall project success.

2.3.3 Catastrophic Planning and Assessments

The *Project on National Security Reform*[23] further identifies two fundamental areas of conflict between federal and state and local interests relating to the all-hazards threats:

[23] Project on National Security Reform. *Reclaiming the System: Toward Efficient and Effective Resourcing of national Preparedness*, December, 2009.

(1) risk management for low probability, high consequence risks; and (2) the capability for detailed operations planning.

State and local jurisdictions often lack the capacity for sophisticated catastrophic planning that identifies capability gaps and supports preparedness assessments that fit into larger, national contexts. Understandably, state and local authorities must concern themselves with preparing for (and investing in) capabilities that respond to relatively high probably (but relatively low consequence) all-hazards, all crimes-type threats. State and local government's ability to frame vulnerability assessments against target capabilities listed in the federal government's TLC and national planning scenarios[24] is relatively limited. Systems engineering support would provide some of the capacity to develop these capabilities without overwhelming the state's resources or excessively distracting them from meeting the more immediate emergency management needs of their served public.

2.3.4 Additional areas for exploration

The list of opportunities for system engineering development in the homeland security enterprise is long and growing. Obvious areas for systems thinking include:

- **Professional development pipeline and training systems:** How do we implement a *National Security Professional* agenda and create the leaders of the future?

- **Homeland Security Information Network (HSIN):** How do we create a national system to communicate information through intergovernmental and private sector channels?

- **Enhancing Fusion Center Effectiveness:** How do we create protocols that coordinate the overlap between the Fusion Center mission and the Emergency Management mission at the state and local level that respects the need for discretion, but provides first responders immediate information to anticipate and execute response?

- **Credentialing:** How do we create a policy that allows very sophisticated identity management for high security facilities but also allows for low cost field solutions in rural areas, or low density population centers?

- **State-to-state resource management, logistics, and mutual aid (Emergency Management Assistance Compacts (EMAC)):** How do we continue to support the development of pre-packaged resources for mission assignments that support EMAC development and enhance state to state mutual aid?

[24] The Federal *National Planning Guidelines* (2007) outline 15 National Planning Scenarios ranging from terrorist nuclear attack on a US city, to coordinated chemical/biological attacks, to earthquakes and hurricanes.

- **Resilience:** How do we provide tangible regional project resources to analyze interdependencies and create integrated, long-term investment to mitigate single points of failure?

3. The Role of Not-For-Profit FFRDCs and UARCs

3.1 FFRDC & UARC Common Characteristics:

Fundamentally, FFRDCs and UARCs exist to conduct independent R&D, studies and analyses, and systems engineering work under the direction of the federal government and in the public's best interest. They were established following World War II to help federal agencies solve special systems engineering and R&D problems requiring intellectual capabilities beyond those the government could maintain on publicly funded staffs. Acting as non-profit, trusted advisors, FFRDCs and UARCs were created to work in the public interest to enable agencies to accomplish research, development, test and evaluation activities that are integral to the mission and operation of the sponsoring government agency.

Both FFRDCs and UARCs are authorized in law by Title 10 USC, section 2304(c)(3)(B) to provide essential engineering, research and development capability through non-competitive procedures. FFRDCs are further described in the Federal Acquisition Regulation (FAR, Part 35.017, (Title 48 CFR, Ch. 1 (10–1–02 Edition)) as meeting "special long-term research or development need which cannot be met as effectively by existing in-house or contractor resources. . . . An FFRDC, in order to discharge its responsibilities to the sponsoring agency, has access, beyond that which is common to the normal contractual relationship, to Government and supplier data, including sensitive and proprietary data, and to employees and installations equipment and real property."

UARCs are university-administrated laboratories that focus on specific technologies and/or mission areas. Like the R&D laboratories, UARCs maintain long-term competencies in particular core areas and develop and transfer important new technology to the private sector. Example URACs include the Johns Hopkins University Applied Physics Laboratory, Penn State Applied Research Center, and the Georgia Tech Research Institute.

The Post Katrina Emergency Management Reform Act of 2006[25] requires significant preparedness capabilities and assessments for states. The Federal Emergency Management Agency's (FEMA's) ten regions have a key role to play in this effort. FFRDCs and UARCs, as not-for-profit entities working in the public interest, can provide vital assistance to FEMA's regional staff to support integrated improvements (e.g., communications interoperability) for state and local jurisdictions; particularly urban area security initiative (UASI) defined jurisdictions.

[25] Post Katrina Emergency Management Reform Act of 2006[25] (PKEMRA, (Public Law 109-295; 120 Stat. 1394)).

FFRDCs and UARCs are able to provide state and local jurisdictions the capability to effectively define operational requirements, perform systems engineering, and develop integrated capabilities. The systems engineering lifecycle (SELC) provides a path for documenting critical needs and developing concepts and solutions that can be tested and evaluated. The SELC also provides a methodology for documenting the procurement scope of work and for providing program management support. Most private sector companies are reluctant to provide this service to the government since most state and local procurement rules would not allow them to participate in the subsequent procurements.

In general terms, FFRDCs perform functions that cannot be carried out as effectively by federal government agencies or for-profit companies. FFRDCs are characterized by having a special relationship with the sponsoring federal government agency based upon their independence and their commitment to the objectives of their government sponsor. FFRDCs operate with a pattern of cooperation that establishes long-term partnering relationships, as opposed to an "arms length" relationship often required for for-profit contractors. Federal regulations subject FFRDCs to a set of restrictions that makes this relationship safe for the government by ensuring FFRDCs do not produce commercial products and do not directly compete with the commercial sector for government work. FFRDCs also possess a body of scientific and technical expertise that generally cannot be recruited, sustained, and managed by the federal civil service.

As outlined in the Federal Acquisition Regulation, an FFRDC, in order to discharge its responsibilities to the sponsoring agency, has access, beyond that which is common to the normal contractual relationship, to government and supplier data, including sensitive and proprietary data, and to employees and facilities. An FFRDC is required to conduct its business in a manner befitting its special relationship with the government, to operate in the public interest with objectivity and independence, to be free from organizational conflicts of interest, and to fully disclose its affairs to the sponsoring agency.[26]

FFRDCs are operated, managed, and/or administered by a university or consortium of universities; other not-for-profit or nonprofit organizations; or an industrial firm, as an autonomous organization or as an identifiable, separate operating unit of a parent organization. Contracts with FFRDCs are generally performed on a sole source basis because FFRDCs are precluded from competing with private-sector contractors.

A great strength of FFRDCs lies in their flexibility to assemble teams of technical experts on a per-project basis. FFRDCs have the ability to promote technology transfers between the governmental and private sectors, and the knowledge base generated by the government agencies' use of FFRDCs may be used as a foundation for commercially relevant efforts in the private sector.

[26] *Federal Acquisition Regulation*, Part 38, Section 38.017, et seq. [Title 48 CFR Ch. 1 (10–1–02 Edition)]

3.2 Types of FFRDCs

The National Science Foundation's Master List of FFRDCs and the Department of Defense (DoD) FFRDC Management Plan (Department of Defense, Director of Defense Research and Engineering, Section B.8, pp. 2-3). define three types of FFRDCs, with differing scopes and core competencies:

- Studies and analysis centers
- R&D laboratories
- SE&I centers

Sponsor	R&D Lab	S&A Ctr	SE&I Ctr	Total
DoE	16			**16**
DoD	3	5	2	**10**
NSF	4	1		**5**
DHS	1	1	1	**3**
FAA	1			**1**
IRS - VA			1	**1**
HHS	1			**1**
NASA	1			**1**
NRC		1		**1**
Total	**27**	**8**	**4**	**39**

Table 1: FFRDCs by Type and Sponsoring Agency[27]

The government determines which type of FFRDC provider is required to meet its needs. There may be some overlap in competencies, but generally different FFRDC capabilities are applied to different stages of the systems management life cycle. Typically, studies and analysis centers (e.g., the DHS-sponsored Homeland Security Institute or the DoD-sponsored Institute for Defense Analysis) are engaged early in the life cycle of the government's response to some management challenge to identify a particular management issue or to refine the definition of a management problem.

R&D laboratories provide basic scientific and technology research to help identify and solve problems and transfer those solutions to the commercial market. SE&I centers validate issue and problem definitions, identify and vet process and technology solutions, define technical requirements and performance assessment measures, assist

[27] FFRDC=Federally Funded Research and Development Centers-- Types are described by the National Science Foundation (http://www.nsf.gov)

with development and acquisition of solutions from the private sector, and help oversee technical and systems management aspects of delivery and implementation.

Center Type	Traditional Federal Roles	Applicability to Building Regional Capabilities
Studies and Analysis FFRDCs	Independent Analyses; Policy Development; Alternative Approaches; High Level Strategy; Operational Requirements and Testing	Issue & Problem Definition; Mission Needs Development; Capabilities Requirements Definition
Systems Engineering and Integration FFRDCs	Capabilities Development; Systems Engineering; Strategic Planning and Systems Analysis; System Concepts and Architecture Development; Systems Requirements Definition and Specification; System Development and Acquisition Support; System Testing and Integration; Independent Assessments; R&D and Technology Transfer	Solution Development and Acquisition; Systems Integration and Interoperability; Lifecycle Systems Management; Acquisition Program Management; Integrated Concepts of Operation
Research and Development Laboratories (FFRDCs)	Basic Research; Incubation of New Technologies; Technology Transfer; Core Technology Competencies	Emerging Technology Transition; Advanced Technology Concepts and Technology Demonstrations
University Affiliated Research Centers	Basic Research, Systems Engineering; Strategic Planning and Analysis; Independent Assessments: R&D and Technology Transfer; Core Technology Competencies	Issue Identification; Emerging Technology Concepts and Technology Demonstrations; Technology Solutions Development

Table 2: FFRDC and UARC Traditional Roles[28]

3.3 Systems Engineering and Integration FFRDC Core Competencies

SE&I centers typically provide critical technical support in core areas not available from sponsors' in-house technical, engineering, and program management capabilities to ensure that complex systems or processes meet operational requirements. SE&I centers assist with the creation and choice of system concepts and architectures, the

[28] See also: Government Accounting Office (GAO) Report No. GAO-09-15: Opportunities Exist to Improve the Management and Oversight of Federally Funded Research and Development Centers; October, 2008.

specification of technical system and subsystem requirements and interfaces, the development and acquisition of system hardware and software, the testing and verification of performance, the integration of new capabilities, and continuous improvement of system operations and logistics. They often play an essential role in helping their sponsors formulate, initiate, and evaluate programs and activities undertaken by firms in the for-profit sector.

Both SE&I and R&D FFRDCs fill voids in which in-house and private-sector resources are unable or inappropriate to meet a government agency's core mission needs. Specific objectives for these types of FFRDCs are to:

- Maintain, over the long-term, a competency in technology areas for which the government cannot rely obtain in-house or from the private-sector
- Develop and transfer important new technology to allow both the government and the public to benefit from a wider, broader base of expertise

SE&I FFRDCs engage in research programs that emphasize the evolution and demonstration of advanced concepts and technology, and engage in system analysis, system engineering, and acquisition support to expedite the transfer or transition of technology.

4. Conclusion

This paper examines the potential for applying established systems engineering principles and practices to improving the nation's level of preparedness to respond to and recover from a range of all-hazards incidents and emergencies. It highlights several key challenges remaining for DHS, FEMA, and their state and local partners to address in order to fully implement an effective NPS as directed by PKEMRA and Presidential guidance. It also discusses why specific focus must remain on developing a set of national approaches for preparedness and a comprehensive regimen for directing, overseeing, and assessing the effectiveness of initiatives taken to improve national preparedness. Finally, it examines how the application of established program management and systems engineering practices could serve to enable an effective national preparedness system. Some writers suggest the federal government should now provide direct analytical and systems engineering assistance to state and local entities to help them develop homeland security capabilities to advance national priorities, specifically those relating to low probability, but high consequence threats. One group of national resources that remain largely untapped at state and local levels is the FFRDCs and UARCs. FFRDCs and UARCs are unique, federally-sponsored resources that offer state and local authorities the capability to effectively define operational requirements, perform systems engineering and analysis, and help develop integrated, regional capabilities.

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Appendix 1: Systems Analysis and Systems Engineering

Systems Analysis and Engineering Defined

In classical terms, systems engineering refers to a problem-solving approach that encompasses a development process from concept to production to operations. It involves integrating all disciplines and all aspects of large-scale systems: technical and economic, as well as political, social, and environmental. It is a logical sequence of activities and decisions that transforms an operational need into a description of system performance parameters and a preferred system configuration[29]

Practitioners of systems engineering have observed that:

> … [systems engineering] focuses on defining customer needs and required functionality early in the development cycle, documenting requirements, and then proceeding with design synthesis and system validation while considering the complete problem: Operations, Performance, Test, Manufacturing Cost & Schedule, Training & Support, and Disposal. One of the key attributes of systems engineering is the decomposition of the system into smaller functional pieces, solving each function at the atomic level, and then integrating them together to form the system. … Systems engineering considers both the business and the technical needs of all customers with the goal of providing a quality product that meets the user needs. … we know how the system will behave by its description but have little insight as to how it will behave as the environment it exists in evolves or how the system is employed in ways not imagined during the systems engineering process — an [infinite] set of possibilities and potentialities exist at this scale (Hill, 2004).

In broader terms, systems engineering methodologies that are applied to advancing the overall effectiveness of an organization or a major set of cross-cutting organizational activities brings one to consider an enterprise paradigm. In this context, the enterprise is viewed as a complex system of processes that can be engineered to accomplish specific organizational objectives. Enterprise approaches to systems engineering recognize the ever-changing, organic nature of the enterprise, and therefore have a valid world view or paradigm (Liles, et al., 1995).

[29] MIL-STD-499A, section 3.3

- Mission processes
- Information
- Technical infrastructure

An enterprise's organization is composed of its business units, its people, and the command relationships (both formal and informal) that link them together. Location refers to the geographical distribution of the enterprise and captures the degree to which an enterprise is centralized or distributed. The mission dimension captures the fundamental purpose of the enterprise and includes enterprise-wide goals and objectives. The mission process dimension includes those measurable activities that are essential to the effective operation of the enterprise and that often cross business units. The information dimension refers to the data, information content, and knowledge essential to the effective operation of the enterprise. Finally, the technical infrastructure dimension addresses the hardware, software, and networks that support people in performing the mission.

When examining an enterprise's composition, it should be recognized that these dimensions are highly interrelated and change dynamically over time. Changes to any one of these dimensions, either directly or indirectly, impact all of the other dimensions. Clearly then, any change within an enterprise should be planned and managed across all of the enterprise's dimensions.

Analyzing and Engineering Systems-of-Systems

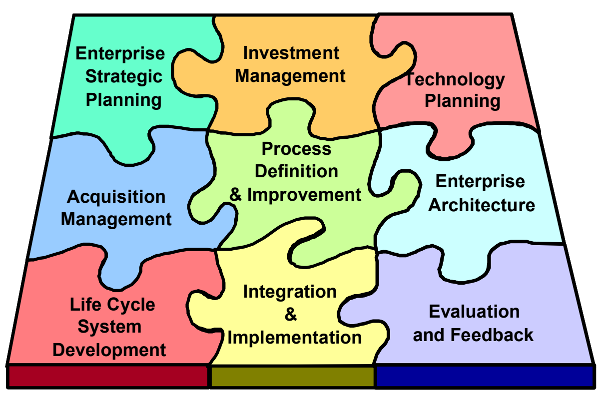


Figure 4: Major Systems Analysis & Engineering Domains

In general terms, enterprise systems engineering is the integrated and methodical use of management approaches to focus an organization's efforts toward achieving common, enterprise-wide goals with maximum effect. It is based on an understanding that the whole of an enterprise can be designed and improved in systematic ways that will achieve better overall performance than would be accomplished by ad hoc organization and process improvements. Enterprise systems engineering uses the enterprise's mission to identify and select the improvements that will have the highest impact. Multidisciplinary approaches to understanding and designing enterprise-wide business processes, structures, relationships, capabilities, information flows, and technologies promote the development and adoption of well-balanced, long-term solutions. Careful change management facilitates transitions to new operational approaches. The goal is a self-aware, adaptive enterprise that increasingly performs at higher levels of efficiency and effectiveness.

Researchers have described enterprise engineering as "that body of knowledge, principles, and practices having to do with the analysis, design, implementation and operation of an enterprise. In a continually changing and unpredictable competitive environment, the enterprise engineer addresses a fundamental question: 'how to design and improve all elements associated with the total enterprise through the use of engineering and analysis methods and tools to more effectively achieve its goals and objectives.' [Systems] engineering provides an analytical approach to the design, improvement, and installation of integrated systems of people, material, information, equipment and energy. It thereby provides the holistic view of the enterprise necessary for successful implementation of Enterprise Engineering" (Liles, et al., n.d.).

Enterprise systems engineering addresses a fundamental question: How can one design and improve all elements associated with the total enterprise through the use of engineering and analysis methods to effectively achieve the enterprise's goals and objectives? Specifically, how does one identify and integrate the best and most successful ways to change an enterprise and to understand new mechanisms, new ways of organizing work, new corporate architectures, and methods that can change an enterprise for the better? [Hill, 2004a]

Why is Systems Engineering Important for National Preparedness?

Supports a Capabilities Development Life Cycle Methodology

Just as other federal departments have done before them (e.g., the Department of Defense (DoD)), The Department of Homeland Security (DHS) implementing a system development life cycle (SELC) methodology that formally applies classical systems engineering principles to DHS' management processes.[30] The SELC methodology includes eight major process stages—planning, requirements definition, design, development, integration and test, implementation, operations and maintenance, and disposition. Each stage has a defined set of activities that represent a logical unit or collection of work. Each stage has associated artifacts to record the results of the activities performed. Stage reviews are held at appropriate points along the SELC to validate that the project has completed requirements for that stage and is ready to advance to the next stage. Exit criteria are directly related to the function of the stage and to the activities performed in the stage.

[30] DHS Acquisition Directive 102-01, (Appendix B, Systems Engineering Life Cycle), November, 2008.

This SELC methodology, while specifically intended for managing major information technology (IT) programs, is directly applicable to systems management of any major initiative that requires investment control and oversight, including such activities as grants administration and national preparedness improvement. The SELC methodology also provides a systematic set of mechanisms and processes to control investment decisions within the contexts of planning, programming, budgeting, and execution (PPBE), investment review processes, joint requirements management, and IT capital planning and investment control (CPIC) portfolio management.

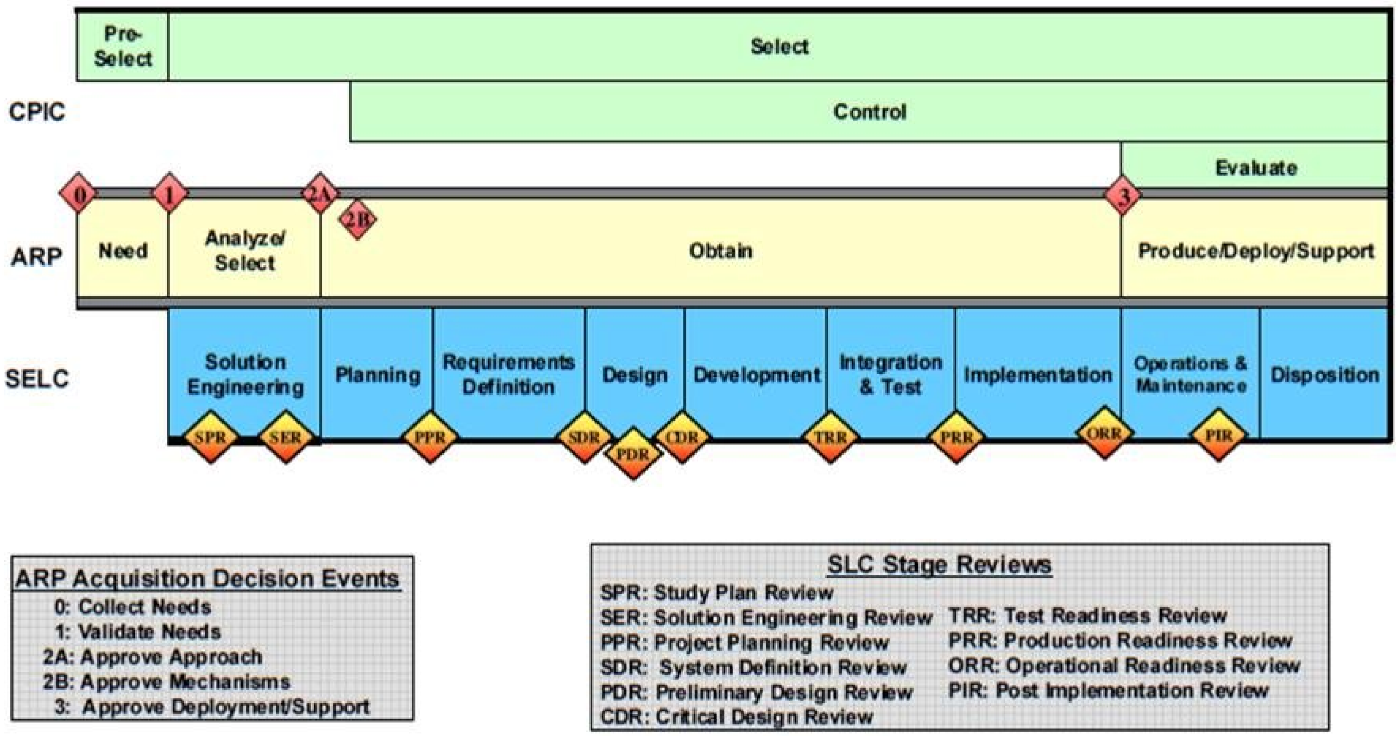


Figure 5: DHS Systems Engineering Life Cycle and Related Processes[31]

Systems Engineering Can Improve System Performance

An enterprise systems engineering approach can account for the idiosyncrasies of divergent systems by taking a holistic, "system of systems" view that formally represents (e.g., models) each system, identifies interrelationships, examines the systems in operation over time (e.g., simulations), considers system maturities, and suggests improved interim and optimal end-state processes and models. Because enterprise systems engineering approaches make explicit the dynamic nature of systems' processes and relationships, these approaches are able to better capture the full range

[31] DHS Acquisition Directive 102-01, Appendix B, Systems Engineering Life Cycle. November, 2007 (p. B-6).

of life cycle costs associated with investment planning, acquisition, startup, and operations and maintenance.

Enterprise Engineering Processes Enable Integration

As a strategic management approach, enterprise systems engineering leverages and integrates numerous planning and management disciplines within a holistic framework for transforming an enterprise. Viewed in broad terms, the disciplines that support enterprise systems engineering fall into two general categories—planning disciplines, and management and control disciplines.

Planning disciplines provide time-proven methodologies for guiding an enterprise to define its mission, identify its goals, and prepare objectives toward achieving those goals. Planning disciplines include strategic planning, enterprise architecture, systems engineering, organizational design, business process design, and performance planning. Planning and requirements definition are central to the first two stages of the PPBE process, which is the mechanism by which federal agencies, including DHS, translate their strategic plans into executable budgets.

Management and control disciplines describe a collection of methodologies that enable an enterprise to execute its planning in deliberate, controlled, and measurable ways to achieve its identified objectives and goals. Management and control disciplines include program management, acquisition management (CPIC), change management, information assurance and data management, and performance management. Management and control disciplines are central to the budgeting and execution phases of PPBE.

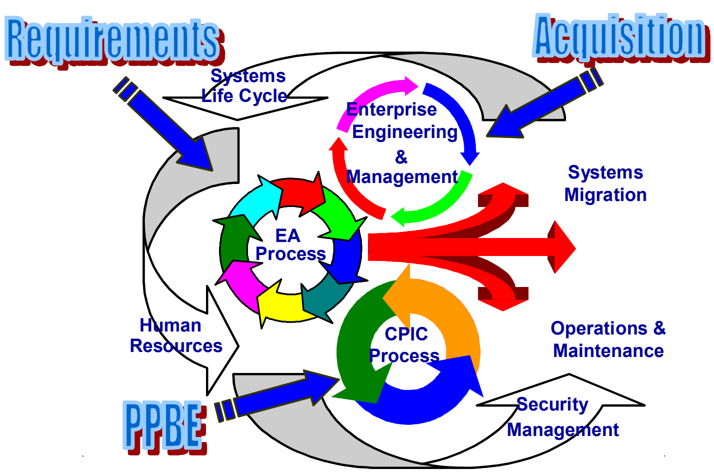
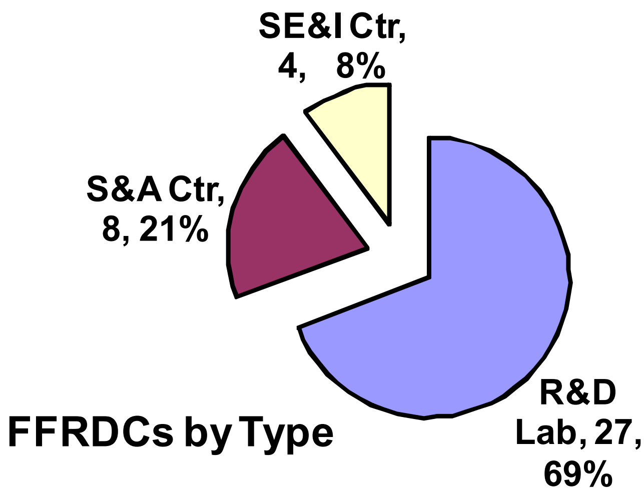
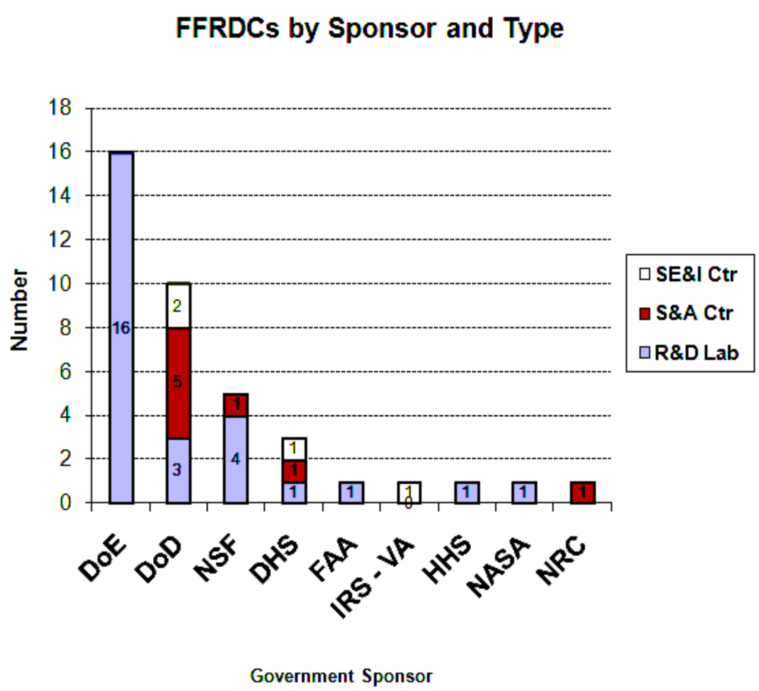


Figure 6: PPBE Cycle

In broad respects, enterprise systems engineering encompasses the steps required to establish an enterprise-wide view of systems architectures, to select projects based on business needs, and to align technology goals with business goals. This process also includes identifying specific technology solutions and process improvements that accomplish the objectives of the strategic plan in measurable ways and to fulfill emerging new requirements. The sets of the disciplines that support enterprise systems engineering (the planning and management functions discussed above) are fundamental to the business of government insofar as they help to define policy, identify mission shortcomings, define system requirements, measure performance, and provide the bases for decision-making on initiatives and investments.

Appendix 2: FFRDCs – Types, Sponsors, and Roles





SE&I: Systems Engineering and Integration
S&A: Studies and Analysis
R&D: Research and Development

Appendix 3: FFRDC Additional Information

FFRDC Name	Administrator Name	Sponsorhsip Type	Mission Type	Administrator Type	Sponsor	Program Overview (Operator's Characterizations)	Link to Center Information
Aerospace Federally Funded Research and Development Center	Aerospace Corporation	FFRDC	Sytems Engineering and Analysis Center	Not-for-Profit	Department of Defense, United States Air Force and the National Reconnaissance Office	The Aerospace Corporation is a private, nonprofit corporation that has operated a federally funded research and development center (FFRDC) for the U.S. Air Force since 1960, providing objective technical analyses and assessments for space programs that serve the national interest. As the FFRDC for national security space, Aerospace supports long-term planning as well as the immediate needs of the nation's military and reconnaissance space programs. Aerospace's involvement in concept, design, acquisition, development, deployment, and operation reduces costs and risks and increases the probability of mission success.	http://www.aero.org/
Ames Laboratory	Iowa State University of Science and Technology	FFRDC	Research and Development Laboratory	University	Department of Energy	At the forefront of current materials research, high-performance computing, and environmental science and management efforts, the Laboratory seeks solutions to energy-related problems through the exploration of physics, chemistry, engineering, applied mathematics and materials sciences.	http://www.ameslab.gov/final/About/Contract.html
Argonne National Laboratory	University of Chicago Argonne, LLC, owned solely by the University of Chicago. The new independent entity was supported in its proposal by the University of Illinois at Urbana/Champaign, the University of Illinois at Chicago, and Northwestern University, participating with the LLC in making significant financial commitments to support scientific activities at the laboratory. Under the new contract, Uchicago Argonne is also joined by industrial partners, Jacobs Engineering Group Inc. and BWXT Services Inc., who will play major management roles in business operations and nuclear operations, respectively.	FFRDC	Research and Development Laboratory	University	Department of Energy	Basic research in areas of science and technology, including experimental and theoretical research in the physical, life, and environmental sciences to advance scientific understanding generally and to support development of energy technologies. Major research interests include advanced techniques using synchrotron radiation for research in the physical and life sciences, algorithms and tools for massively parallel computers, studies of the human genome, synthesis of advanced materials, and detector systems for use at other research centers	http://www.anl.gov/
Arroyo Center	RAND Corporation	FFRDC	Studies and Analysis Center	Not-for-Profit	Department of Defense, United States Army	The Arroyo Center's efforts are generally focused on mid- to far-term, policy-oriented issues and are designed to assist the Army in improving its efficiency and effectiveness. It maintains both a technical and non-technical capability in a broad range of matters of concern to the Army. This includes the ability to address, through formal studies and analyses, a variety of problems potentially affecting Army missions and organizations, including threats, strategy, tactics, operations, technology, and resource management.	http://www.rand.org/ard/
Brookhaven National Laboratory	Brookhaven Science Associates, Inc.	FFRDC	Research and Development Laboratory	Not-for-Profit	Department of Energy	The fundamental elements of the Laboratory's role in support of the DOE strategic missions are the following: To conceive, design, construct, and operate complex, leading edge, user-oriented facilities in response to the needs of the DOE and the international community of users; To carry out basic and applied research in long-term, high-risk programs at the frontier of science; To develop advanced technologies that address national needs and to transfer them to other organizations and to the commercial sector; To disseminate technical knowledge, to educate new generations of scientists and engineers, to maintain technical capabilities in the nation's workforce, and to encourage scientific awareness in the general public.	http://www.bnl.gov/prime/mods/pdf/mod-m253-entire-contract-20100105.pdf
C3I -- Center for Command, Control, Communication and Intelligence	MITRE Corporation	FFRDC	Sytems Engineering and Analysis Center	Not-for-Profit	DOD CIO (ASD-NII)	The MITRE DoD C3I FFRDC was established in 1958 to support the development and fielding of electronically-based air defense systems. Today, the C3I FFRDC supports a broad and diverse set of sponsors within the Department of Defense and the Intelligence Community. These include the military departments, defense and intelligence agencies, the combatant commands, and elements of both the Office of the Secretary of Defense and the Office of the Joint Chiefs of Staff. The system engineering activities for these sponsors cover a wide range from concept development through the acquisition and fielding of advanced capabilities. Information systems technology, coupled with domain knowledge, underpin the work of the C3I FFRDC.	http://www.mitre.org/about/ffrdcs/c3i.html

FFRDC Name	Administrator Name	Sponsorship Type	Mission Type	Administrator Type	Sponsor	Program Overview (Operator's Characterizations)	Link to Center Information
CAASD -- Center for Advanced Aviation Systems Development	MITRE Corporation		Research and Development Laboratory	Not-for-Profit	FAA	MITRE has helped the Federal Aviation Administration (FAA) address the nation's most critical aviation issues since the company's creation in 1958. In recognition of this long and fruitful relationship, the FAA designated MITRE's aviation program as a Federally Funded Research and Development Center in 1990 and named the new entity the Center for Advanced Aviation System Development (CAASD). In addition to supporting the FAA, CAASD works with civil aviation authorities around the world, all of which face similar challenges. This enables us to increase our knowledge of best practices in aviation and share them with all our customers.	http://www.mitre.org/about/ffrdcs/caasd.html
CEM -- Center for Enterprise Modernization	MITRE Corporation		Sytems Engineering and Analysis Center	Not-for-Profit	Treasury/ Internal Reveniew Service / VA (co-sponsorship)	The IRS sponsored FFRDC, known as the Center for Enterprise Modernization (CEM) and, since early 2008, co-sponsored by the Department of Veterans Affairs, performs work for civilian agencies across the federal government. CEM offers a strategic systems perspective for the most prominent challenges facing our nation. As an honest broker bridging government, research, and industry communities, CEM brings a commitment to the mission of transforming how its customers do business. CEM combines systems engineering, enterprise-level integration, and change management competencies with expertise in financial management, financial intelligence, tax administration, healthcare, economic analysis, acquisition management, government infrastructure, and homeland security.	http://www.mitre.org/about/ffrdcs/cem.html
Center for Naval Analyses	CNA Corporation		Studies and Analysis Center	Not-for-Profit	Department of Defense, Department of the Navy	For over 50 years, the Center for Naval Analyses has provided "full-service" research and analysis services that have helped the military become more effective and efficient. CNA analysts pioneered the field of operations research through their groundbreaking work with the Navy during World War II. Today, our goal is the same as it was then: to use scientific techniques to support the effective use of naval forces — and other defense concerns.	http://www.cna.org/about/cna/
Center for Nuclear Waste Regulatory Analyses	Southwest Research Institute		Research and Development Laboratory	Not-for-Profit	Nuclear Regulatory Commission	The Geosciences and Engineering Division of Southwest Research Institute (SwRI) is a center of excellence in earth sciences and engineering. Internationally recognized for innovative solutions to complex problems in the earth, material, and planetary sciences and allied engineering disciplines, the Geosciences and Engineering Division creates multidisciplinary teams to solve client problems within a framework of risk assessment, system studies, and regulatory analyses. The Division's extensive experience base and understanding of engineering and science fundamentals also assists clients by identifying emerging technical issues.	http://www.swri.org/4org/d20/home/default.htm
Ernest Orlando Lawrence Berkeley National Laboratory	University of California		Research and Development Laboratory	University	Department of Energy	Berkeley Lab conducts unclassified research across a wide range of scientific disciplines with key efforts in fundamental studies of the universe; quantitative biology; nanoscience; new energy systems and environmental solutions; and the use of integrated computing as a tool for discovery. It is organized into 17 scientific divisions and hosts four DOE national user facilities.	http://www.lbl.gov/
Fermi National Accelerator Laboratory	Universities Research Associations, Inc.		Research and Development Laboratory	Not-for-Profit	Department of Energy	Fermilab's mission defines the goal of high-energy physics research: unlocking nature's deepest secrets, and learning how the universe is made and how it works. Fermilab builds and operates the accelerators, detectors and other facilities that physicists need to carry out forefront research in high-energy physics. Fermilab is the largest high-energy physics laboratory in the United States.	http://www.fnal.gov/

FFRDC Name	Administrator Name	Sponsorship Type	Mission Type	Administrator Type	Sponsor	Program Overview (Operator's Characterizations)	Link to Center Information
Homeland Security Studies and Analysis Institute (HS SAI)	Analytic Services Inc.	FFRDC	Studies and Analysis Center	Not-for-Profit	Department of Homeland Security, Science and Technology (S&T)	The HS SAI employs a systems and integrated approach to evaluating homeland security systems and technologies at all stages of development, deployment, and use. This approach requires a thorough knowledge of: The homeland security laws, policies, and treaties; Mission objectives, operational concepts and operational needs; and Strategies for determining which systems are needed and how they will be used. The approach also requires a deep understanding of system performance (including interoperability issues), the underlying technologies, the costs associated with developing, deploying, and using systems, and the supporting infrastructure requirements (including personnel and logistics).	http://www.homelandsecurity.org/Default.aspx?AspxAutoDetectCookieSupport=1
Homeland Security Systems Engineering and Development Institute (HS SEDI)	MITRE Corporation	FFRDC	Sytems Engineering and Analysis Center	Not-for-Profit	Department of Homeland Security, Science and Technology (S&T)	Sponsored by the Department of Homeland Security (DHS), the Homeland Security Systems Engineering and Development Institute (HS SEDI™) FFRDC was established in early 2009. Building on MITRE's existing work for the DHS, the HS SEDI provides systems engineering expertise and acquisition strategy advice to improve enterprise policies, processes, and tools for mission capabilities that ensure the nation's security. MITRE brings an interdisciplinary engineering approach to the unique challenges of homeland security, combining technical expertise, domain knowledge, and business capabilities to improve interoperability, develop flexible and expandable architectures, and integrate proven technology into practical solutions.	http://www.mitre.org/about/ffrdcs/hls/
Idaho National Laboratory	Battelle Energy Alliance (BEA). BEA, owned by Battelle Memorial Institute, teams with several institutions, including Battelle Memorial Institute, BWXT Services Inc.,Washington Group International, the Electric Power Research Institute and the Massachusetts Institute of Technology.	FFRDC	Research and Development Laboratory	Not-for-Profit	Department of Energy	The laboratory works with national and international governments, universities and industry partners to discover new science and develop technologies that underpin the nation's nuclear and renewable energy, national security and environmental missions. Its core competencies include nuclear reactor design, reactor demonstration and reactor safety; and signature capabilities in wireless and communication systems, process control and cyber security, Unmanned Aerial Vehicle platforms and sensors, and explosives testing and detection.	https://inlportal.inl.gov/portal/server.pt?open=512&objID=255&mode=2
Center for Communications and Computing	Institute for Defense Analyses (IDA)	FFRDC	Research and Development Laboratory	Not-for-Profit	Department of Defense, National Security Agency	The Centers for Communications Research conduct mathematical research supporting the twin tasks facing cryptologists: cryptography and cryptanalysis. Mathematics remains the fundamental science employed to create and analyze the complex algorithms used to encipher vulnerable communications.	https://www.ida.org/aboutus/organization/hpcc.php
Institute for Defense Analyses Studies and Analyses Center	Institute for Defense Analyses (IDA)	FFRDC	Studies and Analysis Center	Not-for-Profit	Department of Defense, Office of the Secretary of Defense	Its contract calls for Institute for Defense Analyses Studies and Analyses Federally Funded Research and Development Center (IDA) to provide studies, analyses, and test and evaluation support to the Office of the Secretary of Defense, the Joint Staff, the Unified Commands, and the Defense Agencies. Projects will address issues of both long-term and immediate concern in the following areas: national security issues, particularly those requiring scientific and technical expertise; exploration of issues in defense systems research and development; computer and software engineering; evaluation of military systems proposed or in development, and of military forces using those systems	https://www.ida.org/aboutus/organization/sacfull.php
Jet Propulsion Laboratory	California Institute of Technology	FFRDC	Research and Development Laboratory	University	National Aeronautics and Space Administration	JPL is home to more than 300 scientists working in planetary science and life detection, Earth sciences, astrophysics and space sciences. These broad fields take in diverse specialties ranging from how galaxies form and the nature of atmospheres on Earth and other planets to understanding oceans and earthquakes. Nearly all of JPL's scientists do work connected with the Laboratory's flight projects or pursue basic research of their own by applying for and winning NASA awards. Their basic research makes use of NASA-collected data, or aids in the formulation of new missions for the future.	http://www.jpl.nasa.gov/

FFRDC Name	Administrator Name	Sponsorhsip Type	Mission Type	Administrator Type	Sponsor	Program Overview (Operator's Characterizations)	Link to Center Information
Lawrence Livermore National Laboratory	Lawrence Livermore National Security, LLC (LLNS), a limited liability corporation. The LLNS management team includes Bechtel National, University of California, Babcock and Wilcox, Washington Division of URS Corporation, and Battelle.	FFRDC	Research and Development Laboratory	Not-for-Profit	Department of Energy	As a national security laboratory, LLNL is responsible for ensuring that the nation's nuclear weapons remain safe, secure, and reliable through application of advances in science and technology. The Laboratory's special capabilities have led to expanding responsibilities to meet other pressing national security needs, which include countering the proliferation of weapons of mass destruction and strengthening homeland security against the terrorist use of such weapons.	https://www.llnl.gov/
Lincoln Laboratory	Massachusetts Institute of Technology (MIT)	FFRDC	Research and Development Laboratory	University	Department of Defense, Department of the Air Force	MIT Lincoln Laboratory is a federally funded research and development center chartered to apply advanced technology to problems of national security. Research and development activities focus on long-term technology development as well as rapid system prototyping and demonstration. These efforts are aligned within key mission areas. The Laboratory works with industry to transition new concepts and technology for system development and deployment.include communications, space surveillance, missile defense, tactical surveillance systems, air traffic control as well as air defense. Throughout its history, the Laboratory has had an extensive program in advanced electronics technology which has led to major advances across the breadth of its programs	http://www.ll.mit.edu/
Los Alamos National Laboratory	Los Alamos National Security, LLC (LANS) comprises four top U.S. organizations that have extensive experience in nuclear defense programs—Bechtel National, University of California, BWX Technologies, and Washington Group International.	FFRDC	Research and Development Laboratory	University	Department of Energy	Los Alamos' core values combine security awareness, intellectual freedom and scientific excellence with national service to generate scientific and engineering solutions for the nation's most pressing problems. Maintaining the nation's nuclear stockpile is Los Alamos' most important job. Certifying that the nation's nuclear weapons remain safe and reliable without underground testing remains the biggest technical challenge. The laboratory is the second-largest manufacturing site in the nuclear weapons complex and one of only two national laboratories operating at this high level of mission importance and scientific excellence	http://www.lanl.gov/
National Astronomy and Ionosphere Center	Cornell University	FFRDC	Research and Development Laboratory	University	National Science Foundation	The National Astronomy and Ionosphere Center enables research in the areas of astronomy, planetary studies, and space and atmospheric sciences by providing unique capabilities and state-of-the-art instrumentation for data collection and analysis, together with logistical support to users. NAIC operates the Arecibo Observatory in Puerto Rico.	http://www.naic.edu/
National Biodefense Analysis & Countermeasures Center (NBACC)	Battelle National Biodefense Institute	FFRDC	Research and Development Laboratory	Not-for-Profit	Department of Homeland Security	NBACC is focused on developing appropriate science to identify perpetrators of biological events and to help guide the nation's investments in vaccines, drugs, detectors, and other countermeasures.	http://www.bnbi.org/news.html
National Cancer Institute at Frederick	Science Appliations International Corporation (SAIC), SAIC-Frederick, Inc.	FFRDC	Research and Development Laboratory	For-Profit Parent	Department of Health and Human Services, National Institutes of Health (NIH)	The NCI, established under the National Cancer Act of 1937, is the Federal Government's principal agency for cancer research and training. The National Cancer Act of 1971 broadened the scope and responsibilities of the NCI and created the National Cancer Program. NCI coordinates the National Cancer Program, which conducts and supports research, training, health information dissemination, and other programs with respect to the cause, diagnosis, prevention, and treatment of cancer, rehabilitation from cancer, and the continuing care of cancer patients and the families of cancer patients.	http://web.ncifcrf.gov/about/

FFRDC Name	Administrator Name	Sponsorhsip Type	Mission Type	Administrator Type	Sponsor	Program Overview (Operator's Characterizations)	Link to Center Information
National Center for Atmospheric Research	University Corporation for Atmospheric Research	FFRDC	Research and Development Laboratory	Not-for-Profit	National Science Foundation	The National Center for Atmospheric Research (NCAR) is a federally funded research and development center devoted to service, research and education in the atmospheric and related sciences. Our primary sponsor is the National Science Foundation, with significant additional support provided by other U.S. government agencies, other national governments and the private sector. NCAR's mission is to understand the behavior of the atmosphere and related physical, biological and social systems; to support, enhance and extend the capabilities of the university community and the broader scientific community — nationally and internationally; and to foster the transfer of knowledge and technology for the betterment of life on Earth.	http://www.ncar.ucar.edu/
National Defense Research Institute	RAND Corporation	FFRDC	Studies and Analysis Center	Not-for-Profit	Department of Defense, Office of the Secretary of Defense	NDRI conducts RAND's research for the Office of the Secretary of Defense, the Joint Staff, the Unified Combatant Commands, the defense agencies, the United States Marine Corps, and the United States Navy. NDRI's primary function is research on complex national defense policy and strategy problems.	http://www.rand.org/nsrd/ndri.html
National Optical Astronomy Observatories	Association of Universities for Research in Astronomy	FFRDC	Research and Development Laboratory	Not-for-Profit	National Science Foundation	The National Optical Astronomy Observatory was formed in 1982 to consolidate all AURA-managed ground-based astronomical observatories. NOAO's purpose is to provide the best ground-based astronomical telescopes to the nation's astronomers, to promote public understanding and support of science, and to help advance all aspects of US astronomy.	http://www.noao.edu/
National Radio Astronomy Observatory	Associated Universities, Inc.	FFRDC	Research and Development Laboratory	Not-for-Profit	National Science Foundation	The National Radio Astronomy Observatory designs, builds and operates the world's most sophisticated and advanced radio telescopes. Scientists from around the world use these powerful tools to study the Sun, planets and other objects in our own solar system, as well as distant stars, galaxies, and other mysterious objects many millions, or even billions of light-years away	http://www.nrao.edu/
National Renewable Energy Laboratory	Alliance for Sustainable Energy (ASE), a limited liability company consisting of Midwest Research Institute and Battelle Memorial Institute.	FFRDC	Research and Development Laboratory	Not-for-Profit	Department of Energy	NREL is the nation's primary laboratory for renewable energy and energy efficiency R&D. NREL develops renewable energy and energy efficiency technologies and practices, advances related science and engineering, and transfers knowledge and innovations to address the nation's energy and environmental goals.	http://www.nrel.gov/
Oak Ridge National Laboratory	UT-Battelle, LLC	FFRDC	Research and Development Laboratory	University	Department of Energy	Scientists and engineers at ORNL conduct basic and applied research and development to create scientific knowledge and technological solutions that strengthen the nation's leadership in key areas of science; increase the availability of clean, abundant energy; restore and protect the environment; and contribute to national security. ORNL also performs other work for DOE, including isotope production, information management, and technical program management, and provides research and technical assistance to other organizations.	http://www.ornl.gov/

FFRDC Name	Administrator Name	Sponsorhsip Type	Mission Type	Administrator Type	Sponsor	Program Overview (Operator's Characterizations)	Link to Center Information
Pacific Northwest National Laboratory (PNNL)	Battelle Memorial Institute	FFRDC	Research and Development Laboratory	Not-for-Profit	Department of Energy	PNNL develops and deploys technology to: 1) solve national issues related to the management and remediation of hazardous and/or radioactive waste and environmental contamination, and 2) reduce future environmental concerns. PNNL performs basic and applied research to deliver energy, environmental, and national security for our Nation.	http://www.pnl.gov/
Princeton Plasma Physics Laboratory	Princeton University	FFRDC	Research and Development Laboratory	University	Department of Energy	The Princeton Plasma Physics Laboratory is a Collaborative National Center for plasma and fusion science. Its primary mission is to develop the scientific understanding and the key innovations, which will lead to an attractive new energy source. Associated missions include conducting world-leading research along the broad frontier of plasma science and technology.	http://www.pppl.gov/
Project Air Force	RAND Corporation	FFRDC	Studies and Analysis Center	Not-for-Profit	Department of Defense, Department of the Air Force	For more than 60 years, RAND Project AIR FORCE (PAF) has offered an integrated program of objective, independent analysis on issues of enduring concern to Air Force leaders. Current research focuses on strategy and doctrine; force modernization and employment; manpower, personnel, and training; and resource management.	http://www.rand.org/paf/
Sandia National Laboratories	Sandia Corporation, a Lockheed Martin company	FFRDC	Research and Development Laboratory	For-Profit Parent	Department of Energy	Sandia's mission is to meet national needs in five key areas: Nuclear Weapons - ensuring the stockpile is safe, secure, reliable, and can support the United States' deterrence policy; Nonproliferation and Assessments - reducing the proliferation of weapons of mass destruction, the threat of nuclear accidents, and the potential for damage to the environment; Military Technologies and Applications - addressing new threats to national security; Energy and Infrastructure Assurance - enhancing the surety of energy and other critical infrastructures; Homeland Security - helping to protect our nation against terrorism.	http://www.sandia.gov/
Savannah River National Laboratory	Savannah River Nuclear Solutions (SRNS), LLC, Consisting of Fluor Daniel, Honeywell International, Inc., and Newport News Shipbuilding and Drydock Company (a Northrop Grumman Company).	FFRDC	Research and Development Laboratory	For-Profit Parent	Department of Energy	SRNL sovles complex problems of the times, such as the detection of weapons of mass destruction, the cleanup of contaminated groundwater and soils, the development of hydrogen as an energy source, the need for a viable national defense, and the safe management of hazardous materials. Building on 50-plus years of technological achievement and a framework of vital core competencies, the laboratory will continue to identify, develop and deploy innovative technologies to meet the needs of a variety of customers across the Savannah River Site, the Department of Energy and the nation.	http://srnl.doe.gov/
Science and Technology Policy Institute	Institute for Defense Analyses (IDA)	FFRDC	Studies and Analysis Center	Not-for-Profit	National Science Foundation	STPI supports the White House Office of Science & Technology Policy and the National Science Foundation. STPI assembles timely and authoritative information regarding significant science and technology developments and trends in the United States and abroad, and analyzes this information, with particular attention to how it affects the federal science and technology research and development portfolio and interagency and national issues. STPI also provides analytic support on S&T issues for other federal agencies who need the independence and objectivity of an FFRDC.	https://www.ida.org/aboutus/organization/stpi.php

FFRDC Name	Administrator Name	Sponsorhsip Type	Mission Type	Administrator Type	Sponsor	Program Overview (Operator's Characterizations)	Link to Center Information
SLAC National Accelerator Laboratory (changed in October 2008)	Leland Stanford, Jr., University	FFRDC	Research and Development Laboratory	University	Department of Energy	SLAC National Accelerator Laboratory is home to a two-mile linear accelerator—the longest in the world. Originally a particle physics research center, SLAC is now a multipurpose laboratory for astrophysics, photon science, accelerator and particle physics research. Six scientists have been awarded the Nobel Prize for work carried out at SLAC and the future of the laboratory promises to be just as extraordinary.	http://www.slac.stanford.edu/
Software Engineering Institute	Carnegie Mellon University	FFRDC	Research and Development Laboratory	University	Department of Defense, Department of the Army	The Carnegie Mellon Software Engineering Institute (SEI) works closely with defense and government organizations, industry, and academia to continually improve software-intensive systems. It's core purpose is to help organizations improve their software engineering capabilities and to develop or acquire the right software, defect free, within budget and on time, every time. To accomplish this, the SEI	http://www.sei.cmu.edu/
Thomas Jefferson National Accelerator Facility	Jefferson Science Associates, LLC; JSA combines SURA and Computer Sciences Corporation (CSC) to administer the Jefferson Lab	FFRDC	Research and Development Laboratory	University / Industry Partnership	Department of Energy	As a user facility for scientists worldwide, Jefferson Lab's primary mission is to conduct basic research of the atom's nucleus at the quark level. With industry and university partners, it has a derivative mission as well: applied research for using the Free-Electron Lasers based on technology the laboratory developed to conduct its physics experiments.	http://www.jlab.org/

Appendix 4: UARC Sponsors, Roles, and Additional Information

UARC Name	Administrator Name	Sponsorhsip Type	Mission Type	Administrator Type	Sponsor	Program Overview (Operator's Characterizations)	Link to Center Information
Applied Physics Laboratory	University of Washington	UARC	Research and Development Laboratory	University	Department of Defense, Department of the Navy	APL-UW scientists are developing expertise in coastal and small-scale oceanography and the new physics required for tactical superiority in shallow water environments. Our scientists and engineers make important contributions to understanding the earth's climate cycles with satellite and in situ sensing of ocean winds, currents, and air-sea fluxes; observations of Arctic sea ice, its variations and effects on mid-latitude oceans; and ocean tomography that reveals how the abyssal ocean mixes and sequesters carbon.	http://www.apl.washington.edu/
Applied Research Laboratories	University of Texas at Austin	UARC	Research and Development Laboratory	University	Department of Defense, Department of the Navy	ARL:UT conducts programs on basic and applied research, development, engineering, testing, evaluation, and assessment germane principally to the defense of the United States. ARL:UT's research efforts are now directed at high resolution sonar, shallow water acoustics, software system research, geographic system development for the USMC, satellite geodesy, anti-submarine warfare (ASW), active sonar, undersea surveillance, and information and data processing.	http://www.arlut.utexas.edu/
Applied Research Laboratory	Pennsylvania State University	UARC	Research and Development Laboratory	University	Department of Defense, Department of the Navy	As a university center of excellence in naval science and technologies, with preeminence in undersea missions and related areas, the Applied Research Laboratory provides solutions to problems in national security, economic competitiveness, and quality of life. ARL is primarily a science and technology-base laboratory with strength and leadership in the following research areas: acoustics, guidance and control, thermal energy systems, hydrodynamics, hydroacoustics, propulsion, materials & manufacturing, navigation & GPS, communications & information, and education.	http://www.arl.psu.edu/
Applied Research Laboratory	University of Hawai'i	UARC	Research and Development Laboratory	University	Department of Defense, Department of the Navy	The Applied Research Laboratory at the University of Hawai'i will serve as a research center of excellence for critical Navy and national defense science, technology and engineering with a focus in naval missions and related areas. ARL Core Capabilities: Oceanography and environmental research; astronomical research; advanced electro optical systems, laser, lidar and remote sensing detection systems; and research in various engineering programs to support sensors, communications, and information technology.	http://www.hawaii.edu/arl/
Center for Advanced Study of Language (CASL)	University of Maryland	UARC	Research and Development Laboratory	University	National Security Agency collaborating across DoD and the IC	CASL's mission is to improve foreign language abilities of the Intelligence Community and the DOD workforces. The federal government designated University of Maryland as the nation's University-Affiliated Research Center to provide language instruction and research on language acquisition and linguistics.	http://www.casl.umd.edu/about
Institute for Advanced Technology	University of Texas at Austin	UARC	Research and Development Laboratory	University	Department of Defense, Department of the Army	The Institute supports the Army with basic and applied research in electrodynamics, hypervelocity physics, pulsed power, and education in related critical technologies.	http://www.iat.utexas.edu/about.html
Institute for Collaborative Biotechnologies (ICB)	University of California, Santa Barbara (UCSB), in partnership with the Massachusetts Institute of Technology (MIT) and the California Institute of Technology (Caltech).	UARC	Research and Development Laboratory	University	Department of Defense, Department of the Army	The ICB conducts fundamental scientific research in two areas of emphasis: (1) sensors, materials and information processing and (2) technical fundamentals enabling transition of cutting edge biotechnology research into these application areas. Some 60 researchers from MIT, Caltech, and UCSB are divided into the following research teams: Biomolecular Sensors; Bio-inspired Materials and Energy; BioDiscovery Tools; Bio-inspired Network Science; and Cognitive Neuroscience.	http://www.icb.ucsb.edu/

UARC Name	Administrator Name	Sponsorhsip Type	Mission Type	Administrator Type	Sponsor	Program Overview (Operator's Characterizations)	Link to Center Information
Institute for Creative Technologies	University of Southern California	UARC	Research and Development Laboratory	University	Department of Defense, Department of the Army	ICT was established in 1999 with a multi-year contract from the US Army to explore a powerful question: What would happen if leading technologists in artificial intelligence, graphics, and immersion joined forces with the creative talents of Hollywood and the game Industry? ICT sees itself as leaders in an international effort to develop virtual humans who think and behave like real people. It creates tools and immersive environments to experientially transport participants to other places.	http://ict.usc.edu/
Institute for Soldier Nanotechnologies (ISN)	Massachusetts Institute of Technology	UARC	Research and Development Laboratory	University	Department of Defense, Department of the Army	The Institute for Soldier Nanotechnologies (ISN) at MIT is an interdepartmental research center founded in 2002 by a $50 million, five-year contract with the U.S. Army Research Office. Now in its second five-year contract, the mission of the ISN is straightforward: develop and exploit nanotechnology to dramatically improve the survivability of Soldiers. The ultimate goal is to help the Army create a 21st century battlesuit that combines high-tech capabilities with light weight and comfort. Imagine a bullet-resistant jumpsuit, no thicker than ordinary spandex, that monitors health, eases injuries, communicates automatically, and reacts instantly to chemical and biological agents. It's a long-range vision for how fundamental nanoscience can make Soldiers less vulnerable to enemy and environmental threats.	http://web.mit.edu/isn/
JHU Applied Physics Laboratory	Johns Hopkins University	UARC	Research and Development Laboratory	University	Department of Defense, Department of the Navy	The Applied Physics Laboratory (APL) is a not-for-profit center for engineering, research, and development. Located north of Washington, DC, APL is a division of one of the world's premier research universities, The Johns Hopkins University (JHU). The Laboratory has been a major asset to the nation since it was organized to develop a critical World War II technology in 1942. APL recruits and hires the best and the brightest from top colleges, and 68% of its recruits are engineers and scientists. APL staff work on more than 600 programs that protect the US homeland and advance the nation's vision in research and space science, at an annual funding level of about $980 million.	http://www.jhuapl.edu/
Space Dynamics Laboratory	Utah State University, Utah State University Research Foundation	UARC	Research and Development Laboratory	University	Department of Defense, Missile Defense Agency	SDL, a Unit of the USU Research Foundation, is a nonprofit research corporation owned by Utah State University. Charged with applying basic research to the technology challenges presented in the military and science arenas, SDL has developed revolutionary solutions that are changing the way the world collects and uses data. SDL continues to lead the way in the development of sensors and supporting technologies. Serves as the DoD University Affiliated Research Center (UARC) for sensors and supporting technologies.	http://www.sdl.usu.edu/about/
Systems Engineering Research Center (SERC)	Stevens Institute of Technology, with the University of Southern California (USC) serving as its principal collaborator. SERC is a collaborative research center comprised of 20 collaborator schools and research organizations.	UARC	Research and Development Laboratory	University	Department of Defense	The mission of the Systems Engineering Research Center is to enhance and enable the Department of Defense's (DoD) capability in Systems Engineering for the successful development, integration, testing and sustainability of complex defense systems, services and enterprises. SERC is a designated University Affiliated Research Center (UARC) supported by the Department of Defense. The DoD provides oversight and multi-year base funding for SERC.	http://www.sercuarc.org/about-us/serc-profile/
UARC at NASA Ames Research Center	University of California Santa Cruz	UARC	Research and Development Laboratory	University	NASA	The University Affiliated Research Center (UARC) is a performance-based task order research contract between NASA Ames and the University of California that is managed by the Santa Cruz campus. NASA Ames awarded this contract, reasoning that the UARC, with access to expertise at UC campuses, would do a better job contracting research to UC than by NASA doing so itself. An additional objective in creating the UARC was to foster scientific collaboration between UC faculty and students with NASA Ames scientists.	http://uarc.ucsc.edu/about/

About the Authors

Michael R. French, DBA, LTC USA (Ret)

Dr. Mike French serves as a Senior-Principal Systems Engineer and Department Head for Preparedness and Critical Infrastructure Protection with MITRE's newly formed Homeland Security Center and the DHS Systems Engineering and Development Institute (SEDI) FFRDC. Before joining MITRE, Dr. French served as a senior DHS government manager in the roles of Assistant Director for Management and Deputy Assistant Director for Mission Support and Information Technology with the ICE Office of Detention and Removal Operations (DRO). Dr. French is a retired Army Lieutenant Colonel of 21 years, having served in a variety of law enforcement, criminal investigations, and operations research assignments, including tours as district commander for criminal investigations, military chief of police, and senior operations research analyst for the Office of the Army Chief of Staff (Program Analysis and Evaluation or PAE), Pentagon. Dr. French holds a Bachelor of Arts degree in Criminology from the University of Maryland at College Park, a Master of Science degree from Boston University, an MBA from Jacksonville State University, and a Doctorate of Business Administration degree from the H. Wayne Huizenga School of Business at Nova Southeastern University. He is a resident graduate of the US Army Command and General Staff College and a graduate of the Army's Operations Research / Systems Analysis (OR/SA) professional development program taught by the Army Logistics Management College . He has taught at the graduate level and is academically and professionally published on the topics of computer crime, workload planning, police intelligence-sharing, and enterprise systems engineering. His professional associations include the Military Operations Research Society (MORS), Academy of International Business (AIB), International Association of Emergency Managers (IAEM), American Society of Public Administration (ASPA), and the Project Management Institute (PMI).

Dennis R. Schrader, PE, CAPT USN (Ret)

Mr. Dennis R. Schrader, president of DRS International, offers his clients more than 30 years experience in executive and engineering administration with expertise in emergency preparation and homeland security, hospital administration and project management. Prior to launching his company, Schrader served as Deputy Administrator of the National Preparedness Directorate of the Federal Emergency Management Agency (FEMA) after being confirmed by the United States Senate on August 17, 2007. In that capacity, he oversaw the coordination and development of resources and tools needed to prepare for all hazards scenarios, including acts of terrorism. These included strategy, policy and planning guidance to build prevention, protection and recovery capabilities. Prior to this assignment, Mr. Schrader served as Director of the Governor's

Office of Homeland Security for Maryland. As Maryland's first Director of Homeland Security, under Governor Robert L. Ehrlich, Jr., he is credited with the establishment of the office, as well as introducing efforts to improve public safety communications and advance information sharing abilities within the state. Using a Program Executive Office (PEO) strategy to foster collaboration during his tenure, Maryland developed many successful interagency projects like Maryland’s Information-sharing Fusion Center and improvements to the Hazardous Materials Commercial Driver’s License program. He was an active member of several homeland security committees including the Anti-Terrorism Advisory Council of Maryland and Maryland Pandemic Influenza Coordinating Committee. Previously, Schrader spent 16 years at the University of Maryland Medical System (UMMS), where his leadership posts included Director of Operations, Vice President of Facilities Management and Development and Vice President of Project Planning and Development. At UMMS, his work included development of medical preparedness plans for mass casualty incidents. He was a key member of the executive team that transformed the University of Maryland Medical Center into its current status as a prominent, nationally recognized institution. Schrader began his career in the auto industry as a manufacturing supervisor.

He then later shifted his professional career to that of a U.S. Navy Civil Engineer Corps officer, where he deployed to the islands of Guam and Diego Garcia, and served tours in Sicily and at the Bethesda Naval Hospital. He remained on active duty until 1987 and on reserve status until 2007. He retired from the Navy with the rank of Captain.

A native of Buffalo, N.Y., Mr. Schrader received his bachelor of Industrial Engineering degree from Kettering University and a Master of Science degree in Industrial Engineering from the State University of New York at Buffalo. He is a licensed professional engineer. Mr. Schrader resides in Columbia, Md. with his wife, Sandra, a former Maryland State Senator, and daughter, Whitney.