Systems Engineering Research Center (SERC)

Remarks of The Honorable Zachary J. Lemnios
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Georgetown University, Washington, DC

Introduction

Thank you for the kind introduction, Debra. I would also like to thank Dr. Spiros Dimolitsas for hosting the event today. As you all know, Georgetown is one of our nation's leading universities in security studies, international policy, technology, law, and business. Over the past several years, the university has expanded their capabilities to include an ever-growing commitment to systems engineering. Their inclusion in the SERC is an exciting step forward.

We live in a complex and changing world. The innovative thinking that that SERC brings to the table addresses today's complex and changing socio-technical systems in a serious way. An understating of systems engineering and its relation to health care, transportation, and energy are all vitally important to the Department of Defense.

Since I became the Department's Chief Technology Officer in July 2009, we've had to fundamentally rethink our business model and research investments. The latest call for change came with DoD's new strategic guidance, issued in January 2012. I want to chat today about the Department's research and engineering enterprise and SERC's role in helping to fulfill our important mission.

The strategic guidance provides a vision for the kind of missions that the U.S. military will be expected to undertake by 2020. We will require capabilities to operate, deter, and defend the nation in new operational environments and find a way to do this in an affordable way. Technologies will be needed to execute these future missions. At the same time, circumstances require us to put together new capabilities now.

We will need:

- Technologies to address new domains of operation, such as cyber; the SERC's research in systemic security and trusted systems plays a key role in preparing for these threats and enabling us to use a systems perspective for cyber security.
- Systems with greater modularity for easier upgrades and modifications, with greater degrees of automation;
- Technologies for training and increasing the productivity of our engineers; and
- Technologies that help us gather more data and information, and process that information into useful forms.

Global Competition

All of these goals come against the backdrop of an increase in the pace of technology development and innovation, fueled by increases in global R&D spending, global partnerships, and easier access to technical information.

Indeed, the science and technology world is flattening, on what seems to me a daily basis. America remains the world's largest single investor in research and development, spending approximately $427 Billion[1] last year. A large sum, but as a percentage of the world's overall investment in research and development it is decreasing with each passing year. Nations with strong GDP growth – think China, Russia, South Korea - are using their increased wealth to bolster investments in basic science, applied research, and advanced technology development. And, these investments are increasingly focused.

For example, the Chinese National Medium-to Long-Term Plan for the Development of Science and Technology (2005-2020), aims to make a China an "indigenous innovator" by 2020, and to do this they are investing in 16 goal-oriented basic research "megaprojects."

In terms of the overall value of R&D investments, China ranks second only to the US, but they have clearly stated their ambition to reach for a leadership position. They now spend approximately 1.6%, of GDP, or a $200B, on R&D and intend to increase the investment to 2.5% of GDP by 2020. This means China would invest as much as $615 billion[2] if their GDP continues to grow along current trajectories. Not only are we seeing an overall rise in global investment in research and development, the barriers that have traditionally limited access to advanced technology and limited the pace of technology development are eroding quickly.

Multi-national joint ventures, where scientists and engineers collaborate globally on research projects and technology moves across borders are the new norm for the commercial world. This is being driven by a shift in customer bases – increasingly, US firms are gaining a majority of their revenues from overseas operations; for example Texas Instruments draws 89 percent of its revenues from overseas operations and for Intel, it's 79 percent[3]. The Intel China Research Center (ICRC) in Beijing, specializing in microprocessor, communications, and systems technology is just one of many examples of industry-led collaborative research centers. [4]

Nations are supporting new strategies to spur tech development by creating "innovation centers". For example, Russia has built the Skolkovo Innovation Center which claims to have a partnership of 450 companies and a $210 billion USD investment.

Budget

Despite our nation's challenging fiscal environment, the FY 2013 Department-wide S&T budget request of $11.9 billion maintains a strong S&T posture. The S&T budget request maintains Basic Research at $2.1 billion; funds DARPA at $2.8 billion to develop strategic concepts for the Department; funds Counter WMD S&T at $1.0 billion;

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[1] Battelle 2012 Global R&D Funding Forecast

[2] http://www.forbes.com/sites/kenrapoza/2011/05/26/by-2020-china-no-1-us-no-2/

[3] Financial Times; Global Shift in US Business Confounds Washington; 12 August 2012

[4] http://www3.intel.com/cd/corporate/icrc/apac/eng/170371.htm

and maintains S&T funding in each of the Military Departments at approximately $2.0 billion. As we move to finish the President's budget request for FY 2014, science and technology will remain an important and well-supported part of the President's request. Core funding for the SERC will also be represented.

We are going to need all of these resources to adapt to a research and engineering environment that is increasingly global, dynamic, and competitive. Global access to state-of-the-art defense technologies has lowered barriers for others to acquire or develop capabilities that challenge U.S. technical advantages. Proliferation of multi-national joint ventures and the ability to purchase technology know-how from other countries are breaking down barriers that have traditionally limited the pace of potential adversaries. We should not expect that all future "game-changing" technologies will come from U.S. sources.

The globalization of Defense S&T means that past areas of U.S. technical superiority, such as night vision, stealth, fifth generation fighters, are less absolute. It also means countermeasures to U.S. weapons systems are likely to appear more quickly. And unfortunately, the amount of time it takes to develop our premier weapon systems seems to be getting longer.

The democratization of technology has leveled the playing field for our potential adversaries. We are counting on the SERC and the rest of our Defense S&T enterprise to leverage our advantages and address these challenges judicially.

DoD Laboratories

There are 67 DoD laboratories in the Defense S&T enterprise engaged in activities ranging from basic research to acquisition support, employing over 38,000 scientists and engineers. Many of the systems acquisitions of the Department, from quick-reaction products to major platforms, are managed through the laboratory enterprise.

The laboratories are critical to implementing the Department's vision of an integrated S&T enterprise. They are now working on the Department's S&T priorities, implementing rapid fielding objectives, and seeking to advance novel concepts for defense use. They are transitioning advanced technology for the new strategic missions to the defense industrial base.

With the Department's strategic pivot, the Service Laboratories have an opportunity to be a major force in developing the necessary technologies for the focus areas identified in the Department's new strategy. They are uniquely suited to link basic research concepts to early-use military applications, and represent a key customer for the innovative thinking going on at the SERC as well as other UARCs and FFRDCs.

STEM

People are the key to innovation throughout the Defense S&T enterprise. America is at risk of falling behind in global Science, Technology, Engineering and Mathematics rankings. DoD employs 72,000 Civilian Engineers and 41,000 Civilian Computer Scientists and Information Technologists. How are we going to ensure the U.S. has the best and brightest people? The Department always needs world-class talent. For example, our DoD STEM program funds 670 undergraduate, graduate, and doctoral students and 430 of these students have transitioned into the DoD workforce. The SERC has funded 293 students and researchers since it was established 4 years ago. These are just small efforts, but they are focused explicitly on meeting our nation's long-term security needs.

The SERC, through its network of universities around the country, has the ability to engage the workforce throughout the entire lifecycle, from senior capstone courses with systems engineering concepts, to technical leadership for our most senior experts. And the SERC's new Doctoral Fellows Program will help create the pipeline of U.S. PhD's who are actively solving future systems problems.

Science and Technology Priorities and Investments

The Department's science and technology priorities and investments are well-aligned with the SERC's strategy and research portfolio. One of the SERC research priorities is Systems Engineering Transformation – research in areas such as concept engineering, model based systems engineering, and expedited systems engineering. We must transition this research into helping our DoD industrial base. We consider systems engineering to be integral to solving our most challenging problems and ensuring that we have the world's most capable military force.

The FY13 President's Budget Request includes a $3.4 billion investment in cyber with $486 million budgeted for Science and Technology (S&T). Soon after coming into office, President Obama identified cybersecurity as one of the most serious economic and national security challenges facing our nation. The Department of Defense faces cyber challenges in its enterprise and tactical, cyber physical systems.

The SERC's research in systemic security and trust will play a key role in preparing for these threats, establishing design patterns for building systems with embedded security, complementing the perimeter and network security solutions that we use today. Other important areas of research to the SERC include:

- **Engineered Resilient Systems (ERS) –** Adaptable designs; Faster, more efficient engineering iterations; Decisions informed by mission needs; Multi-level modeling
  [SERC: Agile Systems Engineering; Concept Engineering; Tradespace and Affordability; System of Systems Modeling]
- **Autonomy -** perception and situational awareness; adaptation and learning; and complex system dynamics
  [SERC: Systems of Systems Modeling]

- **Data-to-Decisions -** enhanced images; temporal, and text analytics; better software architectures
  [SERC: Affordability and Value; Concept Engineering]
- **Human Systems -** Personnel and training; Systems interfaces; Protection and sustainment, and Socio-cultural modeling.
  [SERC: Systems Engineering & Technical Leadership Education; SE Transformation; Systems of Systems Modeling; Agile Systems Engineering]

Another major systems trend is moving toward Systems of Systems and humans in the loop. We need to understand the impact of policy and the human element and the impact of emergence. We need to understand how humans behave in complex systems and the impact this can have on our systems. Research in these socio-technical problems – for DoD and our nation – is critical.

SERC Challenge

I'd like to close with a challenge for the SERC. As you know and have heard today, our nation and indeed our world face an uncertain world, with increasing complexity, fiscal austerity, creative adversaries, and easy access to technology. These all are part of complex challenges relating to national and economic security, transportation, energy, and health care.

- How can the SERC make sure that systems engineering stays relevant in an increasingly complex world? A world that requires systems to respond rapidly to changing threats.
- How can systems engineering and engineered resilient systems help us maintain an advantage over future adversaries, who have easy access to technology with low barriers of entry.
- How can we rapidly field systems, yet make sure they can respond and interoperate with our legacy systems, which will be forced to operate longer and in new environments for which they were not developed.
- How can the SERC help us educate and prepare the workforce of the future, who will help us solve these complex problems, and new ones that we cannot even imagine today. A workforce fluent in systems thinking and systems development, with multidisciplinary science and engineering capabilities.

Thank you for inviting me here today. The UARCs are important contributors to the Department's science and technology strategy, and the SERC is already demonstrating its impact in the areas of systems research. I appreciate the contributions of all of the SERC universities, the collaborators, and the many students who are engaging in this work. I look forward to our ongoing collaboration.