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HEARING

ON

NATIONAL DEFENSE AUTHORIZATION ACT FOR FISCAL YEAR 2008

AND

OVERSIGHT OF PREVIOUSLY AUTHORIZED PROGRAMS

BEFORE THE

COMMITTEE ON ARMED SERVICES
HOUSE OF REPRESENTATIVES

ONE HUNDRED TENTH CONGRESS

FIRST SESSION

TERRORISM, UNCONVENTIONAL THREATS AND CAPABILITIES SUBCOMMITTEE HEARING

ON

DEPARTMENT OF DEFENSE COUNTER-PROLIFERATION, COUNTERTERRORISM, AND SCIENCE AND TECHNOLOGY PRIORITIES

HEARING HELD
MARCH 21, 2007

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HOUSE OF REPRESENTATIVES,
COMMITTEE ON ARMED SERVICES,
TERRORISM, UNCONVENTIONAL THREATS AND CAPABILITIES
SUBCOMMITTEE,
Washington, DC, Wednesday, March 21, 2007.

The subcommittee met, pursuant to call, at 2:50 p.m. in room 2212, Rayburn House Office Building, Hon. Adam Smith (chairman of the subcommittee) presiding.

OPENING STATEMENT OF HON. ADAM SMITH, A REPRESENTATIVE FROM WASHINGTON, CHAIRMAN, TERRORISM, UNCONVENTIONAL THREATS AND CAPABILITIES SUBCOMMITTEE

Mr. SMITH. We will go ahead and get started. I apologize for running late. Everybody here knows how that works. We are allegedly going to have some more votes here in an hour to 2 hours, so I wanted to get started quickly. I will just make a couple brief comments, recognize Mr. Thornberry and move forward. We have two panels of witnesses today to discuss the science and technology (S&T) budget within Department of Defense (DOD) and science and technology projects focussing particularly on efforts to combat weapons of mass destruction.

I will introduce the first panel, and we have with us the Honorable John Young, who is Director of the Defense Research and Engineering (DDRE) Department, the DOD; Dr. James Tegnelia, Director, Defense Threat Reduction Agency (DTRA), and also the Director for Combating Weapons of Mass Destruction, U.S. Strategic Command (STRATCOM); and Dr. Anthony Tether, who is the Director of DARPA, Defense Advanced Research Projects Agency. We are very interested in your testimony, science and technology becoming an increasingly important component of our ability to defend ourselves and also properly arm our military. I am very interested in the projects that you have going and how we can help make the proper investments in research, engineering and development and also how we can take that research, engineering and development and as quickly as possible, translate it into equipment for our soldiers in the field, amongst other topics.

And with that, I will turn it over to the ranking member of the committee, Mr. Thornberry, for any opening comments he may have.

STATEMENT OF HON. MAC THORNBERRY, A REPRESENTATIVE FROM TEXAS, RANKING MEMBER, TERRORISM, UNCONVENTIONAL THREATS AND CAPABILITIES SUBCOMMITTEE

Mr. THORNBERRY. Thank you, Mr. Chairman. I welcome the witnesses. I agree with you on the importance of the topic, and I am concerned about the Administration's request as far as dollar values. Congress significantly increased this area last year and yet the budget request this year seems to be back down again. I know in your testimony, a number of you tried to put the best face you could on that. Looks still hard to justify to me, but I look forward to hearing your testimony as well as hearing about some of the specific programs.

Mr. SMITH. Thank you very much. And with that, we will turn it over to Mr. Young.

STATEMENT OF HON. JOHN J. YOUNG, JR., DIRECTOR, DEFENSE RESEARCH AND ENGINEERING, U.S. DEPARTMENT OF DEFENSE

Mr. YOUNG. Chairman Smith, distinguished members of the subcommittee, I appreciate the chance to appear before you on the panel to discuss the Defense Department's fiscal year 2008 research and engineering efforts on the efforts of counterproliferation and counterterrorism. I will reserve my comments on the broader DOD science and technology program for the second panel discussion. I would ask that my written statement appear at the appropriate place in your formal record. During my past year as the Director of Defense Research and Engineering, the entire science and technology team has actively worked to address many of the conclusions of the Defense Department's 2006 Quadrennial Defense Review (QDR). As you are doing with this hearing, the QDR counterproliferation (CP) and counterterrorism (CT). The QDR described the shift of the United States's strategic environment over the last two decades.

The threat has evolved from a few nation state threats to decentralized network threats from nonstate entities, from single-focus threats to multiple complex challenges, from one-size-fits-all deterrents to tailored deterrents for rogue powers, terrorists networks and near-term competitors. The DOD science and technology program should change in response to this new environment and the associated demand for new capabilities. Countering the proliferation of weapons of mass destruction and the capabilities of terrorist networks requires totally new and enhanced capabilities in the broader area of censors, persistent surveillance, network management, information mining, cultural understanding, tagging tracking and locating, biometrics and other areas.

We are making adjustments to the DOD S&T portfolio to meet this changing threat. I am pleased to be with the directors of the Defense Threat Reduction Agency and Defense Advanced Research Projects Agency, the two organization playing a primary role in developing the technologies to address proliferation and terrorism. I am sure they will outline specific CP and CT efforts within their respective agencies.

In addition to DTRA and DARPA, the individual services through their respective S&T programs are making significant con-

tributions to counterterrorism and counterproliferation capabilities, and those should come up in the second panel. I want to highlight some key Office of Secretary of Defense (OSD) programs which Congress has supported because they are vital tools for the war on terrorism and counterproliferation. Our adversaries in these areas are extremely agile, highly adaptive and use any and all available technology. Thus, we have seen a much greater need to develop, adapt and harvest technology as fast as possible. Congress's support of our rapid reaction programs is critical to allowing the Defense Department to work with agility and short timelines.

The S&T efforts are the rapid action technology office and the quick reaction fund are essential to our warfighters who are daily engaged in the war on terrorism. These programs complement each other with each focussing on a specific part of this challenge. In the global war on terror, our adversaries are learning and adapting quickly as this Nation employs our best technology, weapons systems tools and tactics. This reality adds new importance and urgency to the work of every member of the Nation's defense technology and acquisition team.

I am grateful for Congress's support of the budgets and programs which allow this team to deliver results for our warfighters.

Mr. SMITH. Thank you very much.

[The prepared statement of Mr. Young can be found in the Appendix on page 39.]

Mr. SMITH. Dr. Tether.

STATEMENT OF DR. ANTHONY J. TETHER, DIRECTOR, DEFENSE ADVANCED RESEARCH PROJECTS AGENCY

Dr. TETHER. Thank you for inviting me today to testify about DARPA's efforts. My written testimony summarizes our plans and activities across all our strategic thrusts, and I submit it for the record. As requested, my remarks today will focus on what we are doing in the areas of counterproliferation and counterterrorism. With respect to counterproliferation and our strategic thrusts in the "Detection, Characterization and Assessment of Underground Structures" in part of "Urban Area Operations" is very much on point. Our adversaries are well aware of our Intelligence Surveillance Reconnaissance (ISR) capabilities and global reach, so we should expect them to continue to build facilities, underground and above ground to hide and protect certain activities, including weapons of mass destruction (WMD).

In response, DARPA is developing a variety of sensor technologies and systems, seismic, acoustic, electromagnetic, optical, and chemical to find, characterize and conduct pre and post-strike assessments of these structures.

While much of our work in this area is classified, I can tell you that we are developing sensor systems with orders-of-magnitude better performance, emphasizing clutter rejection in very complex environments. With respect to counterterrorism, our strategic thrust in urban operations is developing technical solutions to finding and countering adversaries in urban clutter which are often applicable to the problem of finding terrorists in the clutter of everyday living.

For example, our Advanced Soldier Sensor Information System and Technology program, ASSIST, is currently improving the intelligence gathered and used by our ground troops. It will allow patrols to refer to and add to the collective experience of other patrols and specific neighborhoods. Such cop-on-the-beat intelligence is very useful when you are looking for a terrorist. Our Wasp micro air vehicle, from our Advanced Manned and Unmanned Systems thrust, is a small, quiet, reliable and portable unmanned aerial vehicle (UAV) designed for front line reconnaissance and surveillance. In fact, I have one with me, if you could bring that up. Wasp is ideal for small unit operations, both in cities and open terrain, and is an in operational tests overseas today.

Now, that is a vehicle that has been in combat. That has flown in Iraq. It was actually—if you notice, you will see a little bullet hole. It was sent back to us I guess for depot repair. I wasn't quite sure what the Marines wanted to do with it. But it was shot at and then continued flying and doing its mission. Those vehicles—there are 200 of them in Iraq today with Marines in the Fallujah and Ramadi area. And at last count, we have over a thousand sorties, those vehicles being used.

Our Tactical Language and Cultural Training systems are designed to teach every soldier a bit of the language and culture needed to interact with the local population. Such knowledge is key to a smooth relationship with the locals, which is crucial to counterterrorism. And we have to get the locals to have confidence enough to tell us what is going on.

We have a very aggressive program to vastly improve machine language translation. Our TRANSTAC program has demonstrated the first two-way speech translation in Baghdad, Arabic. While conversations are limited to certain subjects like checkpoints, this technology is pointing the way to greatly easing and improving our work with local populations. Our Global Autonomous Language Exploitation, GALE program, is designed to translate and distill foreign language material such as TV shows in near real-time, and it is already accurate enough that translators edit GALE's output rather than retranslate the original material. These translation devices will greatly improve the speed and depth of our understanding of local people and their political media environment. This understanding will be a powerful tool in fighting terrorists because we will be better prepared to understand the local situation in real-time and to communicate our intentions to the local population.

However, our flagship work in counterterrorism is biological warfare defense, which started at DARPA in the mid 1990's and led to a broader strategic thrust that we call the Bio-Revolution. Our current drive is toward a portfolio of technologies needed to reduced the development time needed for new drugs from years to weeks. More specifically, to shorten the time needed from an emergence of a zero day or new pathogen to millions of doses of a therapy to only 16 weeks. Once we know what we need, we still need to manufacture millions of doses of it quickly. Our goal is 12 weeks instead of years at pennies per dose. To do this, we are looking at leveraging the large-scale industrial fermentation processes used in making enzymes as well as techniques for farming mushrooms, plants and shrimps for specific proteins.

But at the end of the day, DARPA's main thrust is still core technology. While I have mentioned many systems today, the real DARPA contributions are the advanced components that come from investments in core technology such as materials, electronics, photonics, micro-systems and information technology.

DARPA has a robust portfolio of programs in core technology, and I have no doubt they will lead to even more innovative and effective counterproliferation and counterterrorism capabilities.

Congressman Smith, Mr. Chairman, I came to DARPA about two months ago and received about four hours of briefings on our efforts. Even then I only saw a small part of what DARPA is doing to keep our forces the most potent in the world. I invite all of you to come to DARPA to receive more detailed briefings if you can. But until then, I urge you all to at least scan our strategic plan, of which you all have a copy in front of you on your desk, which will give you a better sense of the breadth of our plans and our ambitions. And with that, I will be glad to answer your questions.

Mr. SMITH. Thank you very much.

[The prepared statement of Dr. Tether can be found in the Appendix on page 67.]

Mr. SMITH. Dr. Tegnelia.

STATEMENT OF DR. JAMES TEGNELIA, DIRECTOR, DEFENSE THREAT REDUCTION AGENCY

Dr. TEGNELIA. Chairman Smith, members of the subcommittee, it is a pleasure to introduce to you today the research and development program for the Defense Threat Reduction Agency. I would like to cover very briefly three topics. The first topic is the mission of the agency and the unique capability—or the unique interaction that we have with the strategic Congressman. That is topic one. Topic two, I would like to talk to you about the research & development (R&D) challenges that we face in combating weapons of mass destruction. And then finally, I was asked to talk about a piece of legislation which you chartered in 1994 called the Counterproliferation Review Committee (CPRC), which allows us to report our R&D and technology and development activities to the Congress as we make progress and answer challenges in this counterproliferation area.

Those are the three topics I would like to cover. First topic is let me talk about the mission of the Defense Threat Reduction Agency. It is a combat support agency with the sole purpose of combating weapons of mass destruction. Let me start with combat support. That means we support all of the regional combatant commanders in their worldwide responsibilities for combating weapons of mass destruction.

In 2005, Secretary Rumsfeld appointed the strategic command as the lead combatant command in the war on combating weapons of mass destruction. That means he has the responsibility to develop for the regional commanders, to field for the regional commanders and to exercise their toolkit for fighting weapons of mass destruction. He has asked DTRA to support him in that role and we have a unit of STRATCOM in our facility at Fort Belvoir to perform that function. I mentioned that we combat weapons of mass destruction. We interpret that to mean the nexus of weapons of mass destruc-

tion with both terrorists and rogue nations and to make sure that we have the tools necessary to prevent the use of those weapons.

DTRA is an organization of 2,000 people, 1,500 of them are Fort Belvoir, the other 500 people are in liaison offices and field offices in just about every time zone in the northern hemisphere. Those field offices mostly support our cooperative threat reduction activity. We have a budget of $2.7 billion, Mr. Thornberry, down slightly from last year. About $1 billion of that $2.7 billion is research and development.

And what I would like to do is turn to my second topic, which are what are the challenges the agency faces particularly in R&D. In my testimony, which you have for the record, we address six challenges. Three of those challenges are what I would refer to as operational, and three of them are focused mainly on research and development. Let me just list the operational ones. There is more detail in the prepared statement. Situational awareness is an operational issue. We work with the intelligence community to make sure that we understand the threats to our forces. WMD materiel control. How do we work with our allies that would like to cooperate with us in eliminating or reducing the threat of weapons of mass destruction? In particular, the Nunn-Lugar program addresses that particular issue. And the final operational one is associated with supporting our Northern Command as it does its homeland defense responsibility. We do a lot of exercises and a lot of training and the like for both the National Guard and the Northern Command in their homeland defense-related activities. Those are the operational challenges.

But I would like to do is talk about the three research and development challenges. The first research and development challenge is preventing nuclear terrorism. We addressed three issues associated with that nuclear terrorism threat. The first issue, which we work with the Department of Homeland Security and the Department of Energy, is in detection of nuclear material. How can you find a nuclear weapon? Today, our sensors are approximately 100 meters capability to be able to find something with nuclear material in it. We are looking for orders of magnitude increase in that capability, and we have some ideas related to that. The second thing that we are trying to do is build a national capability associated with forensics. If someone were to use a nuclear device, how would we determine where that device came from? What would we do to make sure one event wasn't followed immediately by other events? That is the subject of nuclear forensics. That responsibility also is with the domestic nuclear detection office in homeland security. We provide some important services related to that mission for them.

And then, the last issue is how do you render safe a nuclear weapon? If you were actually to get hold of a terrorist device, how would you make sure that that terrorist was not able to initiate that device, that we could, in fact, demilitarize it so it was no longer a nuclear weapon? Those are the R&D challenges associated with combating nuclear terrorism. The second R&D challenge is protecting the warfighter against weapons of mass destruction. The particular issue that we work there is chemical and biological defense activity. How do you detect the use of a biological weapon, the chemical weapon? How is it that you provide therapeutics and

prophylaxis to the individual soldier so that that person is not infected by a biological weapon or that you can, in fact, defeat that weapon or cure that disease before it kills a soldier. Those are the challenges that we work with on protecting the warfighter.

In particular, we are now moving on, is it possible to provide radio radiological therapeutics to the individual soldier to help him in a nuclear environment? The last R&D challenge that we are associated with is helping General Cartwright in transforming the nuclear deterrent. We work on two elements of that nuclear deterrent. The first thing we do is provide him with hard and deeply buried target capability making use of conventional forces. In that regard, we work with DARPA to develop both categorization techniques for underground facilities. We also work with the Defense Intelligence Agency (DIA) to characterize those facilities, and we work on both kinetic and nonkinetic weapons for the defeat of hard and deeply buried targets, again, for General Cartwright.

The second research challenge we do with regard to the triad is in the area of nuclear effects. The Congress has been very much interested in the subject of EMP, electromagnetic pulse. We support the committee that the Congress has chartered to look at the electromagnetic pulse problem. We do inspections of our equipment to make sure that they are in the best condition they can to withstand electromagnetic pulse, and we also have a program that we work with both the DDR&E and with DARPA related to hardening electronics to make sure that they can survive in that difficult environment.

We just fielded one generation of hardened electronics and are now working together to get to the next generation of hardened electronics. That completes the R&D challenge. The last topic that I would like to address with you is, is your legislation associated with the counterproliferation review committee? That legislation was provided as part of the 1994 authorization bill, and it set up a review committee of the Secretary of Defense, the Director of the Central Intelligence Agency (CIA), the Chairman of the Joint Chiefs of Staff, and the Secretary of the Department of Energy aimed at reviewing and establishing both the progress that we are making on counterproliferation technology and the challenges that remain ahead of us.

If I would presume to make a recommendation to you, Mr. Chairman, that language has not been updated since 1994. Since that time and since 9/11, there are significant organizational changes which have occurred in the executive branch to address this particular problem.

As you know, the Department of Homeland Security, my agency, works a lot with the new Office of the Director of National Intelligence, CP, Counterproliferation, the National Counterproliferation Center, NCPC and NCTC National Counterterrorism Center and their activity should be part of this coordination mechanism. We also now have Northern Command, which is a very important element in establishing what the priorities are for our developments of our research and development activity.

We would recommend that the language be updated to be able to reflect the existence of these new organizations. I also would like to recommend—we now report on our findings once a year. Should

we expand the membership of the CPRC to include those new organizations? We would request that you ask us to report on a biannual basis because of the scope of the effort that would be associated with that review. Mr. Chairman, with that remark, I will complete my remarks, thank you.

[The prepared statement of Dr. Tegnelia can be found in the Appendix on page 104.]

Mr. SMITH. Thank you very much, gentlemen. A couple questions, and I will turn to my colleagues. First of all, I am curious about the level of coordination. There is a number of different agencies that have an interest in WMD, countering WMD, Department of Homeland Security, Department of Energy, Department of State. And I know they have efforts ongoing in those areas. How well do you coordinate? And does the strategic command sort of take the lead in all of that and make sure that we are maximizing our resources as well as our plan? If I can start with you, Dr. Tegnelia and Mr. Young, if you have comments.

Dr. TEGNELIA. Let me start off with the fact that we do an extensive amount of coordination, and I would suggest to you that it is broken up into two general areas. The first coordination activity is associated with a programmatic coordination. We spent a lot of time with the Department of Energy, the Department of Homeland Security. I will give you a specific example in just a second, and the Department of State. The Department of State provides us requirements with regard to our cooperative activities overseas.

You may be aware of the fact that the Department of State has a new initiative called the Global Initiative on the Prevention of Nuclear Terrorism. We support them in their overseas-related activities and have presented to their plenary activities and perform activities with them. With the Domestic Nuclear Detection Office (DNDO), just to give you an example, the DNDO has members from across the executive branch of the Department, and DTRA is the organization that is responsible for making sure that the Department of Defense people are in the DNDO to make sure that the Department of Defense's requirements are, in fact, established.

I have a personal interest in that since the top three people in DNDO are ex-DTRA people. And I guess I am happy about that, but you hate to lose the talent like that. So we do an extensive amount of coordination. I personally am from the Department of Energy on detail for the Department of Defense to show how that exchange goes. One last comment, we do a lot of exercising together. We, very oftentimes, at least once a year, do a series of exercises called top-off which involve all of the departments of the government that you mentioned in trying to make sure that we understand the capabilities of one another and we know how to work together.

General Cartwright plays a large role in that. We just this week, yesterday, came off of the latest exercise which had a significant amount of interagency play associated with it, primarily related to the interdiction mission PSI, prevention security initiative that the Department of State operates. So there is an extreme amount of—I believe there is a large amount of interaction and coordination for that activity. Just as a coincidence, we have a meeting after this is over with the Under Secretary of State, General Cartwright and

Ambassador Brill from NCPC and myself to try to make sure that the coordination keeps going. So it is a very active activity with it.

Mr. SMITH. Dr. Tether.

Dr. TETHER. From a research viewpoint, we have a joint program which is closely coordinated with DTRA. We have a formal memorandum of agreement (MOA) between us that kind of outlines cooperation, not that Jimmy and I really need the MOA, but it is good for everybody else that reads it to know it is okay to cooperate with each other. Generally, once DARPA takes the technological excuse off the table that something can be done, that is usually where we end. DTRA goes the rest of the way and does the intermediate development required to pass it on for final development to the acquisition program Joint Program Executive Officer for Chemical & Biological Defense (JPEO CB) which is under Major General Steve Reeves. There have been many transitions to DTRA, most notably in DARPA's work in very broad spectrum pathogen countermeasures which went directly from DARPA into DTRA's TMTI, the Transformational Medical Technologies Initiative.

Our program managers regularly interact so there is more interaction going on, I think, than we really know, and I think a lot of it is, quite frankly, is one, DTRA does our contracting for us in this area, and quite frankly, Jimmy and I are good friends from 25 years. So the people know——

Mr. SMITH. That always helps.

Dr. TETHER. It always help. It is unfortunate that that has to be part of the chemistry, but I don't know of any other way sometimes for that to happen. But we participate in his reviews. He participates in ours. You know what, I think the coordination between DARPA and DTRA in this area in particular is very good.

Mr. SMITH. If I could, I had two other quick—I think that answers my question. Two other quick questions I want to get to before I move on to my colleagues. And specifically for you, Dr. Tether, on your research efforts. You talk about your mission being short, mid and long range in terms of doing the research. I am just wondering if that has changed at all, you know, given the pace of operations right now in the military in Iraq and Afghanistan, the more immediate needs, we see things in the field, we need them quickly, if you shifted funds toward more near or mid term research and away from the long term?

Dr. TETHER. I don't believe so. I have been asked that question. I guess we are about well balanced because I can find 50 percent. I can put people in a room and half of them would say we did, and half of them would say we didn't. Whatever we are doing I think it is balanced.

Mr. SMITH. It would make a certain amount of sense for me, I mean, the question may have came out wrong, to do that, actually, given the short-term needs.

Dr. TETHER. Well, we definitely have gone back—first of all, DARPA in the early 1990's, mid 1990's was looking at—at that time what was called the transnational threat, the threat without a country, which has currently become known as a terrorist. And we realized at that time that there were a couple things, one, that the transnational threat or the terrorist was going to be small groups of people, that it wouldn't be a force-on-force fight, it

wouldn't be tanks against tanks. And we started developing technologies in the 90's. We also started our bio program at that time because in looking at the transnational threat, you say they don't have any infrastructure. So what kind of major WMD, if you will, could they bring forth? And obviously biology is one that doesn't take much infrastructure. So we started our bio program. Whether it was serendipity or just luck in some sense when the war started, we had already developed many technologies, which quite frankly were put on the shelf, because we got them to the point where we took the technical excuse off the table, but there was no urgency by anybody to go the rest of the way.

So what we did do when the war started is we went back and we harvested those technologies. Now we did spend money, but the big money was spent in the 1990's. Now, let me just give you a couple examples. We had developed in the 1990's a technique to detect people being shot at, on vehicles or just being shot at. And we had developed it very well. It turns out that there is no formal requirement in the Army to know that you are being shot at. Still can't believe that.

Mr. SMITH. Some of the folks behind you—there is an informal requirement, but yes.

Dr. TETHER. But that is kind of what stopped it. When it came time to put the money down, there was no formal requirement, and that stopped it. In 2002, General Keith Alexander, who knew about the program and called up the office and said look, my guys are coming home with their vehicles all shot up. They didn't even know they were being shot at. I do remember this program that you had in the 1990's, and can you do something about it? And we did go and find the contractor and gave him some money, but compared to the development costs, really very small, to bring that technology, it is called boomerang. It is now in Iraq. It is now in Iraq and it is both for moving vehicles and both for stationary vehicles.

And in fact, there is now an order that came from the Army to BBN, who is the contractor for 600 boomerangs, 400 of them being decoys just to stock because they have learned—the word is out that don't shoot at that vehicle or facility that has that boomerang because they will shoot back at you. But that is really what we have been doing for the most part. Yes, it has been a little bit extra money, but in terms of percentages, it really has been very small.

Mr. SMITH. And Mr. Young, as far as DDR&E is concerned, short, mid term, have you changed your equation at all in light of the Iraq War and other short-term demands?

Mr. YOUNG. I don't—I would probably agree with Dr. Tether's assessment. I think we find ourselves putting more money in these areas in general, but a balance between some of the programs I mentioned in the beginning, the Iraq reaction programs, seek to field technologies in 12 to 18-month cycles, and I could cite to you several examples that are well partnered with Federal Bureau of Investigation (FBI) or Bureau of Alcohol, Tobacco and Firearms (ATF) or Homeland Security, and then some initiatives that are in the budget before you that are really on 5 to 10-year cycles to deliver new tools in the space of human social cultural behavioral modeling and others.

So we continue to have balance. We are working harder at harvesting and that sometimes takes supplemental moneys and other moneys, but in the core budget I think we maintain balance in near term and far term development efforts.

Mr. SMITH. Okay. Thank you, gentlemen. Mr. Thornberry.

Mr. THORNBERRY. Thank you. Mr. Young, I would just like to ask you to briefly tell us where we are in efforts to make sure that all of the S&T money we spend across the Department of Defense is not only coordinated, but spent strategically so that it is not individual organizations' priorities that are driving the train, but the needs of the department as a whole.

Mr. YOUNG. It is a great question and a great opportunity to tell you we worked that process pretty hard, and there was a process called Reliance that had some benefits but produced a lot of paper and a lot of meetings, and we have changed that to what I believe is a more streamlined and efficient process we call Reliance 21, but it leads the DDR&E team to work with the services, but it leads the services and the agencies to work together.

A few weeks ago we had a three-day strategic review with virtually all the witnesses you will have today presenting their programs, hearing other services and agency programs, and then within those areas, we are setting up technology focus teams, some of those teams look at traditional areas like materials to make sure we are well coordinating in getting taxpayer value without duplication in those areas. Some are in these areas like counterproliferation, where we need new technologies, we want to push but we want to push in a coordinated way. Those focus teams are going to go through the efforts in more detail than you can in that three-day effort, and then make potential recommendations for adjustment as part of our 2009 budget process as well as execution year changes in the program.

So I could talk to you much longer but I want to tell you I think we are working that process very hard with a consciousness that we need to get maximum value for taxpayer dollars. We don't want to do anything twice, and we want to coordinate the efforts across the whole of the enterprise.

Mr. THORNBERRY. So how close are we to where we need to be?

Mr. YOUNG. I would tell you—well, the best way to answer that question is to tell you, for a $10 billion science and technology effort, I would love to have a database that would let—aside from senior people have briefings—a researcher at any lab in DOD go in and look in a topic area and see somebody else has done something similar, have a discussion and see whether that effort needs to continue with a harvesting of the knowledge previously. I don't have that database. We have made two runs at it.

This year's run at it has produced better data. I am dependent on the services and the agencies to provide that data set. In some cases, they have their own tools, and we are trying to use those tools as is, but do what you often probably hear about, sir, is middle wear to bridge that to a common system. But that is one of my highest priorities is to get a better database tool to ensure collaboration at the working level beyond high-level meetings and technology focus teams in certain technology areas.

Mr. THORNBERRY. Makes sense. Thank you, Mr. Chairman.

Mr. SMITH. Ms. Castor.

Ms. CASTOR. Thank you very much, Mr. Chairman. Gentlemen, with the rapid development of the Internet and our reliance on information technology, another asymmetric threat is that of a concerted attack on our information systems and networks, whether we are talking about banking, finance, transportation, communication. Could you address the—in your opinion, the likelihood of a widespread attack on some of the information systems, be they military, our own military or in the finance world in this country, and are any of your programs focused on cyber security? And are any of your programs focused on countering the emergence of the online terrorist movement?

Dr. TETHER. Yes. We have a major part of our program looking at that. Some people consider our information warfare as another form of WMD, and I guess it is not quite technically pure, but if you let it be called a weapon of mass disruption, then it clearly qualifies you know as an WMD weapon. We are not trying to necessarily save the world on the Internet, but we are trying to make sure that the DOD systems are protected and that no one can get in and basically disrupt them at the wrong time. And in that, we have several efforts. A lot of them are in that document you have there, our bridging the gap document. But we have found out how to handle worms, we have found out how to handle basically cyber attacks on ad hoc mobile systems. We are doing quite a bit. Unfortunately the real threats are not those threats. Those are the noisy threats. Those are the guys who come in and they want to be known. You know, they are the hackers and they love nothing more than bringing down systems. But they are almost doing it for publicity. The threats that are really the insidious threats are the ones that come into your system and don't let you know they are there, and those are the very difficult threats.

And while every detail on that probably is going to be classified, and I would love to give you a classified briefing on it, let me tell you, we have major programs in trying to work that threat, which is the one that we worry about the most, you know, the enemy amongst us type——

Ms. CASTOR. Can I ask a follow-up question?

Mr. SMITH. Sure.

Ms. CASTOR. Is there an adequate talent pool coming out of our colleges and universities that are being attracted to these kind of positions from our engineering schools and——

Dr. TETHER. There is a——

Ms. CASTOR [continuing]. To work for us? To work for you?

Dr. TETHER. I understand. And that is really the problem. The question, I think you are asking is, are there U.S. citizens? Because we have a lot of people coming out of colleges who are in computer science and networking but many of them are not U.S. citizens. They are here in the United States going to school. And we really worry about that. We have programs trying to address that shortfall. And I believe—people will tell you that the problem is a lack of money, and I don't think that is the case.

I mean, I think it is just—we just haven't come up with reasons, challenges to make this field exciting for kids. You know, to give them something that they really want to go and do. So we are try-

ing hard by hiring young professors, associate professors. Young is not necessarily an age, young from the time they went and became a professor. With the whole purpose of trying to come up with ways to attract young people. Many studies have shown that the number of freshmen going into colleges 1999 to the year 2003 when asked what they wanted to do, it dropped by a factor of four for those who said they wanted to go into computer science. Now that is really a major worry.

So we are trying hard to overcome that by coming up with challenge problems, and I don't think it is money. I think it is just imagination that we just need to come up with the problems that these people will be willing to come and work on. So far—to answer your specific question though, so far I haven't had a problem, but I am worried about the future.

Mr. YOUNG. Maybe I could add a couple comments to that. We have with the Congress's support a National Defense Education Program where we provide fellowships, graduate study assistanceships to undergraduate and graduate students. We have been able to award 50-plus and a few more each year and continue those. The first 10 are now working for us. Each year of support comes with a year of service requirement, and we are growing that program. It is a modest but a role DOD plays in growing that talent pool.

We put before you a new initiative to do some of the things that Dr. Tether mentioned, provide larger research grants to some of the premiere young faculty members with a bias toward those faculty members and have those grants last for a three- to five-year period, so they can train students and do work. We ask that all that work be—the people who work on the work be capable of getting security clearance and the work be classified if necessary.

So it is a boost to our research program. It is a boost to the research opportunities for people in the academic community and frankly, it will be a boost to our basic research knowledge base. And that initiative, I think, is very important to us and very important to addressing the challenge you raise. It is a mix of things, as Tony pointed out, having good work for these students to do, giving them incentives to pursue the technical education careers and in working with them to become part of our team once they finish that education.

Mr. SMITH. I realize this is sort of outside of your area, but the other thing we need to do is on the K–12 level doing a better job in math, science, computer engineering. Back in my district, we did a career fair and exactly did that with intel, because a lot of it is by the time you get to the college level, you have lost so many of them. I think we have a good program. The ones that are coming out of college are the ones who get interested in this.

I think we have still got some just fabulous students coming out, but it is too small a percentage that is going in in the front end, not that you are in front charge of K–12 education, but——

Mr. YOUNG. If I could finish one point on the National Defense Education Program this year, for what we think it will be, depending on the size, 50 to 75 awards. We had 1,900 applicants and 880 in the end, that turned in final complete full applications. So there is a pool out there. To your point, sir, we have a program right now, a modest initiative called Materials World Modules where we

seek where a DOD lab or entity is partnered with a local community school to give them training materials that try to bring sports into technical perspective, you know, composites—use of composites for support materials and get them interested in that regard, and we have also included in this budget a shift and an expansion of that program, again, to try to get people at the earliest levels.

I mean, DOD can play a modest role here, but I wouldn't tell you we are driving the train, but we do feel a need to play a role in attracting those students at the earliest possible age.

Mr. SMITH. It seems to me, if a bunch of fifth and sixth graders went over to DARPA and saw what you guys were doing, I think they would say, I want to do that. Because you are doing some really, really interesting stuff.

Dr. TETHER. For one thing, the last part of my written testimony describes some projects that really are after, just that we have an effort where we have, again, young professors that we brought in to come up with ideas. However, the evaluation of their ideas was not done by us. We made them go to high schools and brief high schools on those ideas because we wanted to find out what ideas were exciting to high schools.

Mr. SMITH. That is a very good idea.

Dr. TETHER. They actually came up with some really neat ideas, and some really strange ones, like some material that changes to a car when you say I want a car. Actually there is no reason why it can't be done. The programming is hard. But they are under contract, and what they have to do every quarter is go to a different high school in the country and explain what they are doing. I mean, just for that purpose.

Mr. SMITH. Mr. Saxton.

Mr. SAXTON. Thank you very much. First of all, let me welcome Mr. Young and Dr. Tether and Dr. Tegnelia back. We have been working together for many years, and it has been productive, not so much on our part, but for the warfighters that you serve and for the safety concerns that you always have in the front of your mind for the American people. We appreciate that very much, and we know that our country has benefited very much from the work you do.

So thank you for what you do. And I would also like to thank and welcome back our old friend, Jean Reed, who I haven't seen here in some months since he left the Hill. You look right at home, Jean, and I hope you feel that way.

Mr. Chairman and Ms. Castor, I would like to chime in where you left off on this high school secondary ed issue that has to do with developing scientists and computer scientists and engineers. I think this is really an important subject. And I came across something a year or two ago which I thought was quite exciting. I happen to be in New York City, and I ran across a couple fairly wealthy guys who were able to put $12.5 million into a program each year, their personal money, and the program worked like this, it said, why is it that kids aren't getting involved in computer science and science and engineering interests in high school?

And they concluded it is probably because teachers were maybe not quite as exciting in those areas as they might be. So they took their $25 million and each year they go to find—they find some col-

lege graduates who are excited about science and technology, and they say to them, look, if you will be a teacher, we will pay for your masters degree in education. You are already excited about science. We will pay for your degree in education. And we will give you a stipend while you are going to school so you can live.

And then when you graduate with your master's degree, if you go and teach in a high school, we will give you a stipend—I am just going to use a figure of $20,000 on top of your teaching salary as long as you are teaching science and math. And they have had great success in New York City with that program. An so while trying to build on their success while the Republicans controlled the House, I introduced a bill that created a national demonstration program, if you will. I couldn't get my Republican colleagues too interested in it, but maybe now we could explore it again, because it is a program that has shown some great results, and I think—I believe in it, and I believe it has been successful, and I think maybe we can look at it again.

Anyway, Dr. Tegnelia, I understand the process that DTRA is using to pursue technologies under Transformational Medical Technologies Initiatives, good program.

Dr. TEGNELIA. Yes.

Mr. SAXTON. Can you tell me a little bit more about how the chem biodefense program would pursue emerging scientific breakthroughs that are happening outside the TMTI program? How do you keep pace with medical breakthroughs when you are required to use transitional acquisition procedures?

Dr. TEGNELIA. Sir, first of all, we have put a lot of effort into getting the TMTI program off and running. And we now are at the point where we have got 70-something contracts underway and going in that particular program. Every year we go back out with a broad area announcement (BAA) to relook at the base to make sure that if there are new ideas there, we are prepared to go out and fund those new ideas under the TMTI program.

So we continue to keep the pipeline open for new and interesting ideas. The other thing that we have done because we are concerned about the issue that you are concerned about is we started a basic research program. That basic research program is concerned with not only therapeutics and prophylaxis and genetics and genomics associated with that kind of program. It is also into the detection business. So we brought in 26 universities who have new ideas and new people who are in the process of looking at biological sciences.

So we think that by working with the universities, by working with the new startup companies who are generating a lot of these new ideas and having continual programs which review that, and then working with PhRMA, as they move to put some of these new drugs into the market, we have a good cross-section of the people participating with DTRA to do that program. Jean, maybe you would like to comment on that as well.

Mr. REED. Yes, sir. If I could for just a moment——

Mr. SMITH. For the purpose of our record, if you would make sure you are on the mike there, and identify yourself before you offer the testimony.

Mr. REED. Yes, sir. I am Jean Reed. I am the Special Assistant for Chemical Biological Defense and Chemical Demilitarization

Programs in the Office of the Secretary of Defense, and I have oversight for the assistant to the Secretary of Defense for nuclear, chemical and biological programs for that functional area. Reinforcing Dr. Tegnelia's comment, we make a great deal of use of the broad area announcements announcing, you know, a particular focus area both with the Transformational Medical Technologies Initiative, but also in the broader area of the totality of the core—of the core thrusts and the chemical biological and defense program to invite really the brightest and the best to participate in that program.

One of the major contributions that the Congress has made to that program is the use of the chemical biological defense initiative in which money is added to the program by the Congress but without any fetters, if you will, in terms of saying to the Department, pick out those technologies that appear to have great technical promise and to contribute to the overall operational capability of the force and pursue those technologies as opposed to pursuing what might be a specific earmarked program.

That program has contributed—that the Congress originated has done a great deal of good for the overall program. But basically, sir, we are, with the overall program strategy, then laying out through the broad area announcement process the ability to, if you will, mind what is out there.

Mr. SAXTON. So if something came along outside of the normal process and it looked like it was promising, it is something that you might be able to take a look at even though it doesn't fit within the construct of timelines, et cetera.

Mr. REED. Yes, sir. There are loads of good ideas out there, and we are open to hearing those ideas.

Dr. TEGNELIA. And we have several mechanisms to make sure that that would happen. By the way, I should mention, Dr. Tether is also very much investing in the biological sciences activity, and he is really stretching the envelope a little bit with regard to some of the science that he is working on.

Mr. SAXTON. Yes, sir. I am aware of some of the instances where they are being stretched and they are starting to show some results too. Thank you.

Mr. SMITH. Mr. Hayes.

Mr. HAYES. Thank you, Mr. Chairman. Gentlemen, thank you. Lets make a quick visit to Fort Bragg. Are you all familiar with their group, is it the defense technology accelerator? I am not sure I am giving you the right name. It is a very interesting concept, working with particularly former special forces soldiers who are using private entrepreneurs and others, developing technology for a whole host of things. Let's talk about IEDs for a minute. Joint IED task force. Are you familiar with this group? And if yes, that is one answer. Are you, are you all familiar with them at all?

Dr. TETHER. Yes, I am. They have called me and talked to me, yes.

Mr. HAYES. Any interaction going on there?

Dr. TETHER. Actually, in our case, we have very good interaction already with Special Operations Command (SOCOM) Fort Bragg.

Mr. HAYES. I misspoke when I said Fort Bragg. My mind always says Fort Bragg, but this is outside the gate. This is a private.

Dr. TETHER. No. I understand. I understand. And they are retired, and they offered to help bridge the gap, if you will, between what is going on in S&T and their knowledge of the requirements and they are very helpful. But we are, you know, there is activity going on, and we are using them.

Mr. HAYES. Okay. Well, I appreciate that. And having just visited there about two weeks ago, I was very much impressed by the number of different ideas and people that were coming to the table. I would think—I am sure you all get hundreds of cards and letters every day with great ideas, but they really seem to be doing a good job of vetting some technology that would help identify IEDs and my charge was, find me a way that we can explode them in the bomb maker shop, not on the road.

So I just wanted to make sure that that was something that you all were looking at and again, listening to several groups present that morning, it would be very helpful, look at them even more closely if not. Of course, open hearing, IED issue still is the biggest threat we face. I am confident you are doing everything you can to——

Dr. TETHER. We have a major effort between us and Joint Improvised Explosive Device Defeat Organization (JIEDDO) basically using NTC as the—National Training Center in Fort Irwin, California, to address directly the moving upstream to try to find out the bomb makers place as opposed to each IED separately. As you said, it is a little difficult to say anything more because we might tell them what we are doing, and these are very smart people who undoubtedly will get a copy of this hearing.

Mr. HAYES. Yeah.

Mr. YOUNG. Can I add copy to that?

Mr. HAYES. Sure.

Mr. YOUNG. Because of the nature of that threat, which is very harmful to our forces, the DDR&E team we went through. The JIEDDO program, had had a series of meetings in the last couple of months to make sure that program is coordinated. To Congressman Thornberry's question, we brought—there is a defense science and technology advisory group. We brought JIEDDO, the chief scientist in as a member of that group so they are very conscious at what the service is doing and at that strategic review we had a month or so ago, they came and presented their view of the threat and then what they are spending because JIEDDO is spending money a lot of times on near-term solutions, increasingly looking at some longer term solutions with S&T dollars, and then counting on the services to make some investments in those areas and so we are working very hard to make sure we have as much momentum as possible in that space, sir.

Mr. HAYES. Thank you, Mr. Chairman. I yield back.

Mr. SMITH. Thank you. I think what we will do now is we will go to our second panel. I thank Dr. Tether and Dr. Tegnelia for their testimony. We have votes coming up quick not too distant future, so I want to get the other folks up. That would be Dr. Killion, Admiral Landay and Mr. Jaggers, and Mr. Young will be on the second panel as well. Thank you very much.

Thank you, gentlemen. I will introduce the new members of the panel. We have been joined by Dr. Thomas Killion, who is the Dep-

uty Assistant Secretary General of the Army for Research and Technology, their chief scientist. Rear Admiral William Landay, who is the Chief of Naval Research. There is a lot more after that, but I will just leave it at that. Mr. Terry Jaggers, who is the Deputy Assistant Secretary of the Air Force for Science, Technology and Engineering. We will get started.

Mr. SMITH. I believe, Mr. Young, you have comments for this panel as well in addition to what you said before. So we will again begin with Mr. Young.

STATEMENT OF HON. JOHN J. YOUNG, JR., DIRECTOR, DEFENSE RESEARCH AND ENGINEERING, U.S. DEPARTMENT OF DEFENSE

Mr. YOUNG. Chairman Smith, thank you again very much. I really am grateful for the opportunity to appear and talk about the science and technology program of the Department of Defense with this committee. The second year I had the opportunity to appear before the Congress as the Director of Defense research and engineering, and I am very pleased with the direction and focus of the Department's science and technology program. And I will briefly discuss key elements with you. At the highest level, the Defense Department's fiscal year 2008 science and technology budget request of $10.77 billion represents a continued corporate commitment to strong science and technology funding during a year with difficult budgetary demands from the ongoing war on terror. As noted in my written statement, from fiscal year 2002 to 2008, the science and technology budget has grown eight percent in real terms, and these years are the seven highest DOD requests for science and technology since the current budget process started in 1962.

The military services and DARPA budget and managed the bulk of defense science and technology funds and thus have critical roles to play in our program. I am glad to be here with the service science and technology executives who are all striving to enhance the capabilities we have for support of our warfighters. At the next level of detail, we have sought to ensure that the funds requested for S&T are guided by strategy objectives. The vision for the defense research and engineering program is to develop technology to defeat any adversary on any battlefield.

This vision encompasses both state and nonstate actors as well as all potential fields of conflict from the physical battlefield to the cyberspace to other nontraditional battlefields. The vision is well aligned with the challenges outlined in the Quadrennial Defense Review. To realize this vision, we must apply several key requirements. First, the S&T program must be balanced to address near mid and far-term needs of the Defense Department. The Defense Department program must be robust and assure our proficiency across a broad spectrum of military and commercial technologies. Further, the S&T program must address urgent needs today while also assuring the Defense Department is prepared for the future.

We must have an integrated research and engineering program as discussed earlier, frankly with contributions from the services and the agencies. The S&T program must deliver the maximum value for the tax dollar. We have reengineered our process for co-

ordinating across the DOD S&T program. The new Reliance 21 process provides a renewed emphasis on integrating and coordinating the S&T investment of all—across all components and ensuring that the science and technology issues are addressed during the DOD budget cycle. Next, a program that contributes to the development of future science and engineering workforce. The Department of Defense employs almost half of all Federal physical scientists and engineers.

Our work requires highly educated, technically experienced and security-clearable personnel. Programs such as the National Defense Education Program allow the Defense Department to play a necessary role in the Nation's efforts to recruit, educate and train our future scientists and engineers. Finally, a program that adapts to department needs and the threat environment. Guided by the QDR and Secretary's strategic planning guidance task and expert insights, the DDR&E team established a number of new initiatives within the S&T program focused on nontraditional DOD capabilities as well as DOD needs. I would like to briefly highlight a few of these efforts.

The human social cultural and behavioral modelling initiative will give the Defense Department needed tools that can inform U.S. commanders, decision processes and provide aids to help their understanding of different nations' culture and infrastructure.

Mr. YOUNG. The QDR highlighted these lessons in stating current and future military operations will require enhanced capability to understand social and cultural terrains as well as various dimensions of human behavior.

Biometrics capabilities are already being employed by the men and women who are daily engaged in the war on terrorism. Our initiative in this area will give these warfighters new biometric tools which are relevant to the unique demands of the tactical military environment. Tagging, tracking and locating will be an essential tool across the full spectrum of future conflict.

Over the past year, the DDR&E and component staffs have been working with the U.S. Special Operations Command to define the future capabilities needed to tag, track and locate military platforms and individual adversaries. The resulting TT&L science and technology roadmap is funded in the budget before you.

Beyond new capabilities, our robust Science and Technology Program has created opportunities to deliver mission-capable technology to the warfighter. Let me highlight a couple.

Networking is now pervasive in our daily lives. The S&T networking initiative will identify opportunities to harvest new advances in military and, more importantly, commercial networking and communications technology to deliver greater network-centric capability to our warfighters sooner. The planned S&T investments will concentrate on network interoperability, improving capacity, adding bandwidth, and building networks in mobile tactical settings.

The second initiative seeks to deliver low-cost airborne communications relays to support theater missions such as convoy movements. Today, in some cases, aircraft which can perform other surveillance missions are being pressed into service solely for communications-related missions.

Energy use on the battlefield is an important logistics consideration. The DDR&E team led a task force which reviewed the Department's investment in energy programs. As a result, we worked with the services to include funds for pursuit of technologies that can increase the energy efficiency of our systems and reduce the battlefield logistics' demand for fuel and batteries.

Finally, the rising costs and complexity of weapons systems continues to be a priority need for the Defense Department. The budget initiates a defense manufacturing technology, a science and technology effort to pursue the development of cost-reducing manufacturing technologies.

To leverage the Department's investment in super computers, the budget also includes funds to work in partnership with the services on a new generation of engineering design tools for military aircraft, naval ships and radar antennas to create an initiative which should enable the rapid development of optimized designs with fewer flaws in the design and better performance.

Mr. Chairman, fortunately for this Nation, the DOD S&T program is a broad and comprehensive effort which I cannot do justice to in a short period of time. I appreciate the chance to highlight several key priorities, and I am most grateful for the Congress' strong support for the Defense Science and Technology Program. I look forward to the comments from my colleagues and the committee's questions.

Mr. SMITH. Thank you, and I appreciate the detailed testimony that you gave us in our booklet. You are right. It is too long to go into in formal testimony, but it is very helpful for us to have it in front of us. Thank you.

[The prepared statement of Mr. Young can be found in the Appendix on page 39.]

Mr. SMITH. Dr. Killion.

STATEMENT OF DR. THOMAS H. KILLION, DEPUTY ASSISTANT SECRETARY OF THE ARMY FOR RESEARCH AND TECHNOLOGY

Dr. KILLION. Thank you, Chairman Smith and other distinguished members of the subcommittee.

I appreciate the opportunity to discuss with you the fiscal year 2008 Army Science and Technology Program and the significant role that S&Ts are playing in supporting the warfighters today and in achieving the Army's transformation.

I have previously submitted a written statement for the record and request that it be accepted.

I want to thank the members of this committee for your important role in supporting our soldiers who are at war today and for your support of the Army's S&T investments that will sustain technological preeminence for our future soldiers. Your continued support is vital to our success.

Our Army S&T investment strategy seeks to mature and to deliver technologies that will enable a transformed, full-spectrum future force, while seeking opportunities to spiral technology into current force systems to enhance today's capabilities. We maintain a diverse portfolio of technology investments to exploit the potential of emerging technology in the near term, while sustaining funda-

mental research to enable potentially paradigm-shifting technologies in the future.

In terms of the focus of today's hearing, the Army S&T, per se, does not have major investments specifically targeted on counterproliferation. We are certainly investing in technologies that are relevant to the counterproliferation mission as it focuses on WMD such as sensors, communications, battle command, munitions and force protection, but, primarily, we are a significant partner with the Defense Threat Reduction Agency and with the joint PEO for chem/bio defense as the executive agent for major research programs and the source of an expert workforce and unique national facilities at our Edgewood chem/bio center as well as elements of the U.S. Army Medical Research and Materiel Command.

As far as counterterrorism is concerned, it is not an overgeneralization to say that our entire program is relevant to the Army's mission to identify and defeat terrorist threats. We have all seen in the ongoing global war on terror, that defeating this threat is a full-spectrum mission, ranging from special operations to stabilization operations in the presence of an adaptive and aggressive insurgency to conventional warfighting against organized forces. Our Science and Technology Program seeks to enhance current capabilities and implement innovative solutions that will equip our soldiers with the tools to be victorious anywhere in this spectrum and beyond.

I would like to emphasize two other points.

First, just as the Army fights as part of the Joint Force, we in the S&T community collaborate with the other services and defense agencies to develop technologies jointly to achieve greater efficiency and speed in solving problems. A significant example here is our joint effort with the Air Force and OSD to develop joint precision airdrop systems for efficient force resupply.

Second, while our focus is necessarily on the near- and mid-term, we must sustain our commitment to basic research for the next generation of warfighters. Our budget requests funds research across the science disciplines. However, we have also focused research in specific areas with high innovation potential such as nano science, biotechnology, immersive environments and network science, seeking unique and, in some cases, unanticipated applications for the future Army.

In closing, I would like to thank you, Mr. Chairman, for the opportunity to testify before this subcommittee to sustain your support for Army science and technology investments. I am proud to represent the efforts of thousands of Army scientists and engineers dedicated to providing our soldiers with the best possible technology in the shortest possible time.

I will be happy to answer any questions you or the members of the subcommittee may have.

Mr. SMITH. Thank you.

[The prepared statement of Dr. Killion can be found in the Appendix on page 122.]

Mr. SMITH. Admiral Landay.

STATEMENT OF REAR ADM. WILLIAM LANDAY III, USN, CHIEF OF NAVAL RESEARCH, U.S. NAVY

Admiral LANDAY. Chairman Smith, distinguished members of the subcommittee, it is an honor to appear before you today to update you on the progress of science and technology efforts within the Department of the Navy. I would like to thank the subcommittee for its interest and support in naval science and technology.

I also have previously submitted my written testimony and request that it be entered into the record.

The naval science and technology challenge is to enable revolutionary operational concepts that support the vision of the Navy and Marine Corps as laid out by the Secretary of the Navy, the Chief of Naval Operations and the Commandant of the Marine Corps. They envision a force that is joint, expeditionary, distributed, persistent, forward-deployed and capable of defeating a competitor in major combat operations or in various scenarios in the global war on terror.

To meet this challenge, our S&T enterprise must focus on developing not only tomorrow's Navy and Marine Corps but also the one after that, yet be nimble enough to rapidly address critical problems addressing today's fleet and force, we must do three things exceptionally well.

First, we focus on areas that provide the biggest payoff to support the Navy and the Marine Corps. Second, we must be innovative in our thinking, in our science and in our business processes, because every dollar spent in overhead is a dollar not spent on science and technology. Third, we must continually improve our ability to rapidly transition our science and technology efforts into acquisition programs and into the fleet and force.

The fiscal year 2008 President's budget requests $1.67 billion for an S&T portfolio that accomplishes what I have described. That reflects approximately a two percent growth in constant year dollars over the President's 2007 budget request.

The Navy and Marine Corps leadership recently approved and updated a Naval Science and Technology Strategic Plan. It ensures the alignment of naval science and technology with naval missions, future capability needs and an evolving global technological landscape. It ensures that science and technology have a long-term focus but is responsive to the near-term warfighter needs.

The S&T plan specifically identifies 13 key areas for science and technology investment that will have a high payoff in supporting the Navy's and Marine Corps' warfighting visions and needs. I have addressed those areas in my written testimony, so I will not list them here, but, in order to execute that strategy, we are focused on addressing the changing global S&T environment in the following ways:

We must monitor, assess and leverage emerging science and technology in a global manner. The increasingly rapid movement of technology and innovation around the world demands that we be able to take advantage of emerging ideas in science, regardless of where they originate.

We must maintain an investment portfolio that is balanced between the long-term scientific discovery that comes with the basic

research program and the near-term focused product nature of the advanced technology development programs.

We must focus on delivering value to today's sailors and Marines, while ensuring that the well of new and novel technology development remains deep in support of the next generation of sailors and Marines.

Finally, we must focus our efforts on the transition of technology and innovative concepts to the warfighters. We are not about science and technology. We are about science and technology in support of our sailors and Marines.

The Navy WMD detection program is developing technologies to detect smuggled nuclear weapons and WMD materials in a maritime environment. Our research benefits from a continuing partnership with the Defense Threat Reduction Agency, which is a silent member of the Senior Executive Service that works with us on specific naval applications and technologies that they are needing.

Similarly, our Large Vessel Stopping Program will develop nonlethal technologies to provide the Navy the capability to stop and/or to restrain uncooperative, large marine vessels in support of search interdiction in counterterrorism operations.

We have a near-term focus on Iraq and Afghanistan and a long-term focus on strengthening the Navy's ability to meet any challenge and to adapt to any security environment. We have made adjustments to our portfolio to address the emerging S&T needs of the Navy Expeditionary Combatant Command as it will shortly commit forces to the fight along the rivers in Iraq.

We are moving away from functional roles and responsibilities toward a greater integration of capabilities, a more effective partnership between research and acquisition and a broader vision of how to achieve shared goals with DDR&E, the Army, DARPA, and the Air Force research organizations. This is evidenced by new directions in our Navy science and technology plan, by real increases in the President's 2008 science and technology budget, and by the fact that approximately 15 percent of our research portfolio involves partnerships with other DOD organizations.

I believe the state of our science and technology investment is sound and represents careful stewardship of taxpayer dollars and will make significant contributions to our warfighters as they serve in defense of the United States both today and well into the future.

Thank you again for your continued support.

Mr. SMITH. Thank you very much, Admiral.

[The prepared statement of Admiral Landay can be found in the Appendix on page 135.]

Mr. SMITH. Mr. Jaggers.

STATEMENT OF TERRY J. JAGGERS, DEPUTY ASSISTANT SECRETARY OF THE AIR FORCE FOR SCIENCE, TECHNOLOGY AND ENGINEERING, OFFICE OF THE ASSISTANT SECRETARY FOR ACQUISITION

Mr. JAGGERS. Mr. Chairman, members of the subcommittee and staff, thank you. I, too, have submitted written testimony that includes a more expansive list of area force S&T activities, but for the purpose of this testimony I will submit my comments to the counterproliferation activities.

I am pleased to have the opportunity to provide testimony on the fiscal year 2008 Air Force Science and Technology Program. As the Nation adapts to a new security environment filled with unconventional and nontraditional threats, so the Air Force adapts to fight the global war on terror and the proliferation of weapons of mass destruction. The Air Force continues to rebalance and to focus its core S&T competencies to aggressively pursue new technologies focused on countering these new threats of today, while modernizing our systems for tomorrow.

Air Force leadership recognizes the value of its S&T program to provide a wide range of technology options to enable us to achieve our vision of becoming an integrated air, space and cyber force capable of rapid and decisive global engagement anywhere, anytime.

This is exemplified in our fiscal year 2008 President's budget request, which at approximately $1.9 billion reflects a $66 million increase in core S&T funding. This translates to 1.6 percent real growth from the previous year. These investments sustain a strong and balanced foundation of basic research, applied research and advanced technology development needed to support future warfighting capabilities.

My written statement delves more deeply into ongoing research to counter traditional threats by reducing our dependence on foreign oil through the evaluation of alternative fuels, the development of improved engine technology such as the highly efficient embedded turbine engine and the adaptive, versatile engine technology, the interoperability between manned and unmanned vehicles, the launch of operationally responsive tactical spacecraft experiments, the development of airborne-directed energy capabilities, and research in both bio- and nano-inspired materials. Today, however, I would like to present our focused research efforts on counterproliferation and counterterrorism.

Created in response to the Quadrennial Defense Review, our Air Force technical vision guided many of the counterterrorism and counterproliferation initiatives in this budget request. Born from the Air Force kill chain to find, fix, track, target, engage, and assess the enemy in a traditional theater, we have added "anticipate" to the front of this kill chain to inspire our scientists to develop new technologies that predict our enemies' intentions before they act and "anything, anywhere, anytime" to the end of the kill chain to focus the need for more research in the "24x7" tagging, tracking and locating of terrorists and WMD in what is now a global theater of war.

Anticipating enemy actions is a difficult challenge. Working with the U.S. Special Operations Command, our Human Effectiveness Directorate has a program under way to apply mathematical techniques from economics, psychology, sociology, and market science to quantitatively assess and optimize the impact of information operations in an effort to anticipate enemy leadership intentions. They are conducting basic research to investigate the role of culture on cognition and behavior, applied research to create cultural research tools, and advanced technology development to demonstrate the decision-aids, models and simulations required by the warfighter.

We are proud to be leading DOD in this area; and our researchers, along with those of the Army and Navy, have worked closely

with DDR&E in developing their human social, cultural, and behavioral modeling program, a program which complements ongoing efforts to fund areas the services have not yet had the resources to cover.

In addition, our Sensors and Information Directorates are collaborating on near-term efforts to improve command and control, intelligence, surveillance, and reconnaissance by using closed-loop simulation capabilities to better predict our adversary's actions. By exploiting data from multiple network sensors, providing object-tracking and identification, including data fusion and global change detection techniques, this effort will allow automated, predictive identification and the tracking of space, air and ground vehicles with ultra-high confidence.

Efforts funded within our basic research program at the Air Force Office of Scientific Research are already yielding exciting results in counterterrorism and proliferation. AFOSR started funding a University of California San Diego effort in fiscal year 2002 to study photoluminescence quenching effects in certain polymers to understand how these effects might be used in integrated nano sensors to strengthen our warfighter's ability to anticipate threats and acts of terror.

A by-product of this basic research—and I, too, have a little show-and-tell that I would like to bring up. A by-product of this basic research contributed to the development of a low-cost and robust improvised explosive device detection sensor, currently being commercially marketed for use in field settings such as security checkpoints at airports, stadiums and amusement parks.

Sir, I will pause at my written point here to explain what that is. You have seen in the security checkpoints in the airports that they take a swab and they wipe down your hands and then they put it in a large machine that is not on wheels, but it is a very expensive and large, relatively immobile machine. All of that is contained in that device, and what that does basically is—you take, more or less, a lint brush, which Tim just pulled out, and you wipe it on people and their hands and their clothes, and then you stick the paper in that. And, in the field, they can look through that binocular port there and actually get not a spectral signature of the material or the chemical residue but actually see a go/no go or a pass/fail. So it is very portable, lightweight, and it is actually available in the commercial market, too. Actually, the work we did in the basic research led to the production of that by DARPA, and that is how we are getting it to the field.

Equally challenging is the ability to prosecute the kill chain against targets anywhere, anytime. This requires research in tagging, tracking and locating terrorists or WMD anywhere on the globe "24x7." One such project that could facilitate tracking by using unmanned aerial vehicles is called Synthetic Interface Research for UAV Systems, or SIRUS. This research in human effectiveness will enhance an operator's ability to acquire, assess and act on information.

A supporting research program is leading to the development of a multi-sensory modeling database that will provide automatic target recognition and combat identification enhancements to improve

Blue Force tracking as well as the capability to enable future covert targeting and tracking by the year 2011.

In addition, we are exceptionally proud of our research in biotaggants as a transformational technology to counterproliferation and acts of terrorism. Biotaggants attach either a passive-identifying material, or taggant, to a biological warfare agent that can then be read by line-of-sight spectroscopy or an active taggant that is activated by radio frequency energy so it can be read through walls. In the future, use of these biotaggants will revolutionize our ability to track WMD around the globe.

In the near term, however, our Sensors Directorate rapidly developed the Angel Fire electro-optical staring array. Deploying with the Marine Corps this year, Angel Fire is an airborne wide-area, image-gathering, persistent electro-optical sensor array that distributes real-time imagery straight to the warfighter. Angel Fire provides the capability to zoom in and observe more closely any area within the collected image cone as well as allows the playback of significant events, essentially providing a "Google Earth, TIVO-like" capability to monitor areas of interest.

On September 6th, 2006, the Secretary and the Chief of Staff of the Air Force directed the establishment of a new operational command for cyberspace. The cyber technologies we are developing within our Information Technology Directorate will provide this new command with capabilities similar to those developed for conventional Air Force employment, such as strike or reconnaissance systems. This research not only postures us to combat traditional threats in cyberspace but those emerging unconventional threats as well.

Technologies being developed include cyber platforms with the mission of destroying worms or viruses, thus bolstering our information assurance capabilities. An example of this is the Air Force Research Laboratory's Defensive Cybercraft, which essentially acts as a defensive intelligence, surveillance and reconnaissance asset to not only defend against attacks but begin to locate and track terrorists and other bad actors that choose to wage war in the cyber domain.

Coupled with the aforementioned game-changing research in directorate energy, nano technology, hypersonics, and biotechnology, the Air Force's S&T investments in cyberspace will position us well to counter future disruptive threats facing the Nation.

The initiatives I have described will not be without their challenges. The Air Force S&T program is in a time of great change as we reshape our scientist and engineer workforce, retool our processes under the Secretary's Air Force Smart Operations 21 Initiative, understand the S&T required to meet the demands of the cyberspace mission, and move toward a capability based planning construct using focused, long-term challenges, or FLTCs.

Despite the challenges facing the Air Force S&T, we are emboldened to tackle these challenges head on as we prosecute the global war on terror and counterproliferation. Our fiscal year 2008 budget builds on the past S&T successes and our traditional core competencies, a future tech vision with a clear focus on counter and new security threats and reflects my five guiding S&T principles: first, to value our scientists and engineers; second, to ensure a bal-

anced portfolio between the near, mid and far term; third, to focus our investments on needed capabilities; fourth, to honor commitments with our mission partners; and, fifth, to continue to hone and improve our tech transition processes.

Air Force leadership has shown their commitment to the Air Force S&T program by, again, maintaining positive real growth of the S&T budget, and we feel we are investing in those areas critical to the Nation's defense.

Mr. Chairman, thank you again for the opportunity to present testimony, and thank you for your continued support for the Air Force S&T program.

Mr. SMITH. Thank you very much.

[The prepared statement of Mr. Jaggers can be found in the Appendix on page 153.]

Mr. SMITH. I appreciate all of your testimony.

I have a couple of quick questions, and then I will turn to Mr. Thornberry.

First of all, Mr. Jaggers, you mentioned in your testimony you are conducting research to investigate the role of culture and the predictive modeling of societies. What does that mean exactly? Could you explain that program a little bit more?

Mr. JAGGERS. What we are trying to do—and we are doing this, actually, in collaboration with the DDR&E as well as other services, as well as a larger interagency community, including the intel community, as well as the warfighters.

The competency that the Air Force brings to bear on this is our Human Directorate that really builds on past experiences and successes with modeling human behavior of pilots, looking at fatigue, looking at the human effectiveness of our pilots during long-duration missions and that sort of thing. We take those models that we have done in those areas plus the expertise of psychology and try to understand the cultural differences in other societies and create models based on mathematical algorithms and statistics to try to predict the behavior of other cultures. The competency we bring to the larger community is obviously leveraged by others to support the intel community and others.

What we hope to get from this larger activity here is trying to understand what action an enemy may take as a predictive signal or cue to tip us off on to what they might take as far as a counter-error or anything that would harm or put our air assets or any Air Force assets at risk of threat. So this is part of our technology vision of anticipating enemy actions, working with OSD and others to try to see the cues and the tip-offs, but based on——

Mr. SMITH. That answers my question. Thanks. I appreciate it.

There is something Mr. Killion mentioned—it might have been Mr. Young—about developing manufacturing technologies to help reduce the time frame that it would take. That is something that I think would be enormously helpful.

As you know, we have—pick your favorite program and start calculating how long it has taken to develop it. It is enormously frustrating, not to mention enormously expensive, and some of this—I mean, Joint Strike is trying to push the outer laws of physics, which are more flexible than most people realize; and, you know, that is fine, but there are some other things that—it seems like we

ought to be able to come up with our fighter planes, our ships, our big ticket items, airplanes quicker than we are.

Is there some hope here that we are going to be able to take that maybe from 20 years down to 10, or how is that playing out specifically?

Mr. YOUNG. Boy, I would agree with your desire for hope.

I am hesitant to advertise it as such, but some of the initiatives I mentioned are targeted to that. The tool I mentioned will seek to build models where now you can design an aircraft ergonomically and then go into a structural model and optimize the structure. We have efforts that usually take hard manufacturing problems and apply technology to making timelines shorter, the costs lower. We would like to take a step back and invest in a more general space, just like we do in materials or electronic devices. We would like systems to come faster and be lower cost.

Mr. SMITH. And I think a lot of that also is a decision—the further we can sort of narrow the range of what is possible—because you do want to push the envelope. You want to try to come up with the best piece of equipment you can. You want to test some theories out. We can test those quicker. That is not going to work. We are not going to go down that route. We are going to focus here. That would be enormously helpful.

Mr. YOUNG. Could I add one more comment?

Mr. SMITH. Certainly.

Mr. YOUNG. Maybe we will say the same thing.

Within that space, one thing that takes time is the amount of software and capability we put in systems these days; and so across all of the services we are looking at initiatives here to better reuse tools. We have already done the auto generate code, all of the steps that will let us develop more code with fewer flaws in it, because that is a significant timeline in our efforts, and Army Secretary Bolton and Tom have been leaders in saying we need to work on that space. The DDR&E team wants to work in that space. I think all of the services are inclined.

Dr. KILLION. What I was going to mention is not that area.

It is a real challenge for us. The initiatives we have taken are in our specific programs where we would combine an investment in the technology development with an investment in manufacturing technology. A good example there is our Flexible Display Center at Arizona State University where we are partnered through them with industry, and not only are they exploring the boundaries of what we can do in terms of developing displays that are flexible like this sheet of paper—high brightness and lower power and so on—but also the manufacturing methodologies and tools that would go into building such displays at an affordable cost and at a production scale. So at the same time you are developing the technology, you are optimizing the methods by which you could produce it.

Mr. YOUNG. Maybe I could briefly respond.

Congress asked us, as we take programs into the system's design and development phases, to make sure the technology is ready, which is exactly your comment, Mr. Chairman.

We intend to apply also what Tom mentioned, manufacturing readiness, so the DDR&E team is already providing that informa-

tion to the Under Secretary of Defense for the acquisition of technology readiness so that, hopefully, those phases will take less time and cost less. Because we again, from another angle, brought mature technology and the ability to produce that technology to that problem.

Mr. SMITH. Mr. Thornberry.

Mr. THORNBERRY. Thank you, Mr. Chairman.

I want to get back to a topic. You all were here when we were talking about the importance of getting and keeping top quality people to work in facilities. My understanding is that there are, in some facilities at least, demonstration projects which grant extra flexibility in the hiring and in the evaluating of employees and that when the new national security personnel system comes into effect that the way it works now is that these facilities can take whatever is the most flexible in order to manage that workforce and hopefully get and keep the kind of people we want.

If all of that is right, how many facilities have these demonstration programs—and do you all have an opinion about this intersection between the new national security personnel system and the demonstration programs that they already have?

Admiral LANDAY. Well, I would start off, at least from the perspective of the Navy.

Our Naval Research Lab, for example, is under one of the lab demonstration programs, and I think it is doing exactly what you would like to have as it gives the commander and the technical director of that lab greater flexibility not only in rewarding the performance of folks in the lab based on their contribution but some additional flexibility. It is probably not as much as they would like in order to be able to hire and bring folks on board.

My headquarters, the O&R part of that, is under the current standard government service; and I can tell you from where I sit they are two completely different worlds. I envy the guy's ability who works for me to do things that I would like to be better able to do, so whether that is national security or other lab demos, I think moving in that direction is a significant benefit.

My sense is we have looked between the national security personnel program and the lab demos. I think we are still wrestling because the lab demos tend to be more comfortable to the labs because the labs have been doing them for a while, and they are comfortable with them. I think the context of all of them are the same, and so I think that was really the intent.

I will tell you that one of the challenges is you would like people to be able to move back and forth between organizations. I would like to bring people from my labs into headquarters. I would like people from my labs to go work in Army labs and be able to hire Army lab people in my labs, and if we all get multiple different personnel systems, that sometimes becomes a real challenge for us. So, you know, having a very common system, I think, is critical, but flexibility, I think, we are all very much supporters of.

Mr. THORNBERRY. I will be interested to know what other facilities, if you all could provide for the record, have a demonstration project; and if you have an opinion about those flexibilities and how they will be impacted by the new national security personnel system, I would appreciate it.

Mr. Young, the Office of Force Transformation was largely folded into your organization. I do not expect an answer now, but can you get somebody to provide the committee what happened to programs that they had under way once it got folded into DDR&E so that I can see what happened to those specific initiatives?

Mr. YOUNG. We will get you a longer answer, but what I want to assure you is that every program they had continues, and I put them with one of the stronger people on my team, Ben Riley, who has managed a lot of our counterterrorism and rapid reaction response efforts and is working with them to continue what they are doing and working with them to vet, if you will. As a first stage of new ideas they have, we expect that program to continue.

Mr. THORNBERRY. Good. I would appreciate the more detailed answer, but I appreciate your answer here.

Mr. THORNBERRY. Thank you, Mr. Chairman. I yield back.

Mr. SMITH. Thank you. I just had a couple more questions before we wrap up.

One of the things Mr. Thornberry said at the outset is that the overall fiscal year 2007 budget for the Science and Technology and the DOD, I believe, is maybe down a little. It sounds like the Air Force is up from 2007, but just, you know, we ramped up for a couple of years because of the global war on teror (GWOT).

An acceptable answer is that there are needs elsewhere, and we all have about 35 top priorities around here, and that is part of the problem. But just within your own little world, very important world, where do you see that money being in a flat budget line as proposed in 2008?

Mr. YOUNG. I am probably the right person to start, and I would refer back to my initial comments. There has been eight percent real growth since 2002, and we are historically in constant dollars at a period of time of the highest level of R&D investment in general.

I believe the leadership comment, which I agree with, would be we have to size the S&T investment to meet the needs of the Department, so I do not know if a metric that says three percent or two percent is right. I know we are beginning to look at that, and I have asked my team to take a look at that.

I can cite for you an example. I asked Dr. Tether to take a look, and we find that we have selected 20 percent of the selectable proposals, but I do not think we have enough fidelity to tell you those 20 percent are the absolute A-plus proposals and the next ones are all Bs or the next ones are all Cs, so we need to get better metrics and build the program from the bottom up.

This year, I am very pleased we were able to move over across the Future Year Defense Program (FYDP), up over $1 billion, into these newer technology areas where we needed investment in human social, cultural, behavioral, biometrics, tagging, tracking, locating. I would be less comfortable if I were to tell you that money limits prohibited us from investing in those areas, because we have those investments, and the services continue to make those core investments that they must make in engine technology or emissions technology, and the Army grew their emissions investment.

I think the program is whole, and then we end up back with you, to your point, that we do not have enough metric data to tell you

if we desperately need another dollar or if we had another dollar we would spend it well or if we had another dollar we would spend it on a B or C effort.

Mr. SMITH. Does anybody else want to——

Dr. KILLION. I would echo what John says in that I believe we are, of course, challenged in terms of the fiscal environment we are in. We are at war. I am supporting an Army that is engaged all over the globe in terms of the S&T program, and how much the Army has available to invest in S&T as opposed to other considerations in the budget is always a challenge. I think we are making smart investments today. We have tried to balance the portfolio as best we can, protect our basic research program and, very reasonably, it is about 18 percent of our S&T program.

Another consideration is in terms of what you really want to be able to do at the end of the day, which is transition the technology coming out of S&T. So just plugging up the S&T budget is not going to help us very much. Yes, you will have more things in the mill, but you also need to be able to take that and turn that into real systems that go into the hands of the troops, and that is the part of the equation that has to be addressed.

Admiral LANDAY. If I may add to that, I would agree. We have had this discussion very aggressively, probably, in the last year in the Navy as we have been looking through all of the science and technology. There is a need to have some basic level of very broad science and technology, because nobody can tell you with 100 percent clarity what the problems are going to be 5 and 10 years down the road.

The challenge, of course, is we could make that so broad and so deep that, you know, the things that you have to do in the near term you cannot do. So Secretary Young said, I think, we all struggle with how much is enough and how do you know you are at least focusing in the right broad areas.

The other challenge that we have, as Dr. Killion mentioned, is, in the end, it has all got to transition, so there is a real effort to look at science and technology but focus it on those areas that you think really do support the Department or your particular department.

I think the thing we all wrestle with the most, as Secretary Young said, is not do you have enough, but when new areas emerge do you have the ability to get into those new areas while you are continuing to do work in the good science areas. I think that is what we all really, really focus on.

Mr. JAGGERS. And I will be brief, because my comments certainly reflect the comments of my peers here.

The Air Force, as you know, is modernizing virtually everything in the Air Force from space to air; and the trick, as Dr. Killion said, is trying to balance the S&T that supports the modernization of those assets and ensuring that, in the big Air Force, some of that Air Force investment can handle the through-put of the S&T being pushed to the modernization programs.

Then the other trick, as Admiral Landay said, is trying to pursue transformational or revolutionary technologies and then balancing that tech push with, again, a through-put to handle that tech push or directed energy, for example, trying to understand the effects of

directed energy and create platforms that can handle directed energy.

So, in the Air Force, we are fortunate to actually be on an upward slope for S&T investments, but I think that reflects, quite frankly, on the overall modernization strategy in the Air Force.

Mr. SMITH. I think you should submit a more formal answer on your budget situation. Not now. Just have your staff sort of, you know, get into some of those details on the funding of the A programs and the B programs. If you could have someone send that over to the committee, that would be great.

The last area I want to ask about—it is a quick question that might have a long answer—is alternative energy. In each of your areas, what are you investing in in terms of finding alternative sources but also in improving efficiencies? I think the greatest area this is in is batteries, you know, improving battery life. What is sort of, you know, right there that could help us in those areas?

Mr. YOUNG. Let me offer—certainly I will be brief and will tell you the energy task force that the DDR&E team led—and the real leader of the team, Al Shaffer, is behind me—looked across all of the services at everything in the Department, including facilities work. I think we could submit for the record the investments we identified that were in the budget for those programs, and then we identified gaps and opportunities and needs, and we put some new initiatives in the budget, which we can identify for you, also.

Mr. SMITH. Why don't we do that? Because this is the kind of thing that could be a very long answer. If you could just submit to the committee, to my office—you know, somebody from your office—here is what we are doing on alternative sources of energy and increasing energy efficiency. I think that would be probably the best way to do it.

Mr. SMITH. Mrs. Drake, do you have questions?

Mrs. DRAKE. I just have one question, Mr. Chairman.

Mr. Young, thank you for being here, and I am sorry I could not be here for the whole meeting.

But there are plans to terminate the Medical Free Electron Laser Program in fiscal year 2008. Can you provide us with a good rationale for the abrupt termination of this program, especially in light of all of the discussion that we are having right now about making sure we have absolutely the best care for our wounded warriors?

Mr. YOUNG. I can add for the record, but I will give you a quick summary of it. It fits with the discussion we had.

At the start of this budget season, my office was handed a bogey to cut about $35 million and about $300 million across the FYDP within the programs that are strictly within DDR&E cognizance, and then there were new things I was asked to do or felt we needed to do for the warfighter. So when you do that, you have to go through and cut things, and several things were trimmed. We trimmed basic technology demonstrations (TDs). We trimmed several projects.

This one we cut because, at this stage in time, we have been investing in medical free electron lasers for 25 years now, and we spent over $400 million on this program. I think we need to ask ourselves whether we should continue in that vein or open the door

to a different idea of what we need to do in that area. The program is being done. There are quality programs. Some of them address combat casualty care. Some of them address basic medical technology. Because it is far beyond now the medical free electron laser. Some are not even laser-related.

So there are programs in the Department, particularly in the Army, some in the Navy, and medical advanced technology where these entities could compete, and they could compete to provide solutions for combat casualty care that might or might not—you know, in their case might involve laser technology or might not, but it would be open to other spaces. But limiting this program to the providers under the guise of the medical free electron laser I felt we needed to move beyond after 25 years and $400 million.

Mrs. DRAKE. I guess, Mr. Chairman, it just leaves in my mind the medical reason you would do that and how it is going to impact our troops that we are not going to have this program that we had for 25 years, and we are not going to have this type of treatment that we have had for 25 years.

So, obviously, you have looked at that and feel comfortable that this is an okay thing to do and that we are not removing something that our men and women would need?

Mr. YOUNG. Well, again, as I cited, we have several medical technology programs that invest in a broad set of solutions to our medical issues where their ideas are the best ideas. They should compete and offer those solutions. They can also compete within the National Institute of Health budget that has grown by something like 100 percent, but at some point in time, the Defense Science and Technology Program needs to move on to other technology instead of being limited to a certain area and a certain set of technologies.

You could rightly discuss whether we need more money in combat casualty care, given the situation we find ourselves engaged in in the war, but even then I would advocate it ought to be open to every technology that can address those issues and not limit it to a set of people who work from medical free electron perspectives.

Mrs. DRAKE. Thank you very much.

Thank you, Mr. Chairman. I yield back.

Mr. SMITH. Thanks.

Mr. Thornberry, do you have anything further?

Mr. THORNBERRY. No.

Mr. SMITH. Well, thank you very much for your testimony. I look forward to continuing to work with you as we move through on our authorizing the budget. Thank you. It has been very, very informative. I appreciate it.

With that, we are adjourned.

[Whereupon, at 4:39 p.m., the subcommittee was adjourned.]

A P P E N D I X

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HOLD UNTIL RELEASED
BY THE COMMITTEE

STATEMENT TESTIMONY OF

HONORABLE JOHN J. YOUNG, JR.
DIRECTOR OF DEFENSE RESEARCH AND ENGINEERING

BEFORE THE UNITED STATES HOUSE OF REPRESENTATIVES

COMMITTEE ON ARMED SERVICES

SUBCOMMITTEE ON TERRORISM, UNCONVENTIONAL THREATS

AND CAPABILITIES

March 21, 2007

Introduction

Mr. Chairman, distinguished members of the Subcommittee, thank you for this opportunity to appear before you to discuss the Department's FY 2008 science and technology (S&T) program.[1] This is the second year I have had the opportunity to appear before Congress as the Director of Defense Research and Engineering (DDR&E), and I am excited by the direction and focus of the Department's S&T program. I will use the opportunity of this hearing to describe the overall Department of Defense (DoD) S&T program, while also touching on the oversight of the Department's research efforts in counter proliferation and counterterrorism technologies. I am also pleased to have the chance to highlight in this hearing some of the new and expanded initiatives we have undertaken across the Department and within the Office of the Secretary of Defense (OSD) to address desired capabilities described in the 2006 Quadrennial Defense Review (QDR).

Last year, I told you about the vision put in place for the DoD's Research and Engineering (R&E) program: "Develop Technology to Defeat Any Adversary on Any Battlefield." This vision encompasses both state and non-state actors, as well as all potential fields of conflict, from the physical battlefield to cyber space and other nontraditional battlefields. In addition, this vision is consistent with the challenges outlined in the Quadrennial Defense Review and the FY 2008 Defense S&T program submitted by the President, a vision supported by the individual S&T programs of the Services, Agencies, and the Office of the Secretary of Defense.[2] To realize this vision requires:

- *An S&T program that is balanced to address near, mid, and far term needs of the Defense Department.* We will describe an S&T program that seeks to balance investment that addresses the known capability needs and threats of today with the potential capabilities needs and threats of tomorrow. In the short-term, the S&T program should emphasize support to the combatant commander through rapid prototyping, demonstrations, and fielding. In the mid-term, the S&T program should show increased emphasis on the needs of tomorrow's forces and broad based support of DoD acquisition programs. Finally, in the far-term, the DoD S&T program should still deliver both

[1] The formal responsibilities of the DDR&E, as Chief Technology Officer of the DoD, incorporates S&T and Advanced Component Development and Prototyping; the combination of these two makes the research and engineering (R&E) program. There will be segments of this testimony that moves into R&E.
[2] The DoD S&T submission is comprised of the Service (Army, Navy, Air Force, and Marine) programs; Agency programs (DARPA, DTRA, DLA, and SOCCOM), and the Office of the Secretary of Defense (DDR&E and Chemical Biological Defense Program) programs.

technology and intellectual talent that ensures the U.S. military can retain superiority for future generations.

- *An integrated R&E program, with contributions from the Services and Agencies.* We will describe the process called "Reliance 21", which provides a renewed emphasis on integrating and coordinating the S&T investment across all DoD components with a focus on the warfighter. The integrated contributions of the Services and Agencies are critical to optimize the DoD S&T product.

- *New and revised processes to increase the efficiency and affordability leading to fielding enhanced DoD capabilities.* We will describe existing and new processes to integrate S&T more completely into DoD acquisition and sustainment programs for the express purpose of decreasing development time for acquisition programs and reducing the cost of existing and emerging weapons systems.

- *A program that addresses the future science and engineering (S&E) workforce.* We will describe the DoD response to a number of blue-ribbon panels that highlight the need for scientists and engineers capable of executing national security programs for the United States.

- *New areas of emphasis within the S&T portfolio.* We will describe new initiatives within the DoD S&T program focused on "non-traditional" DoD capabilities. In its simplest form, the DoD S&T program is being reshaped to increase "non-kinetic" capabilities while decreasing relative emphasis on conventional platforms and weapons (kinetic systems). Non-kinetic capabilities include information technologies, sensors, persistent surveillance, decision making and cognition, and so forth. Interestingly, these non-kinetic technology areas are consistent with many of those required to improve both counter proliferation and counterterrorism capabilities of the DoD.

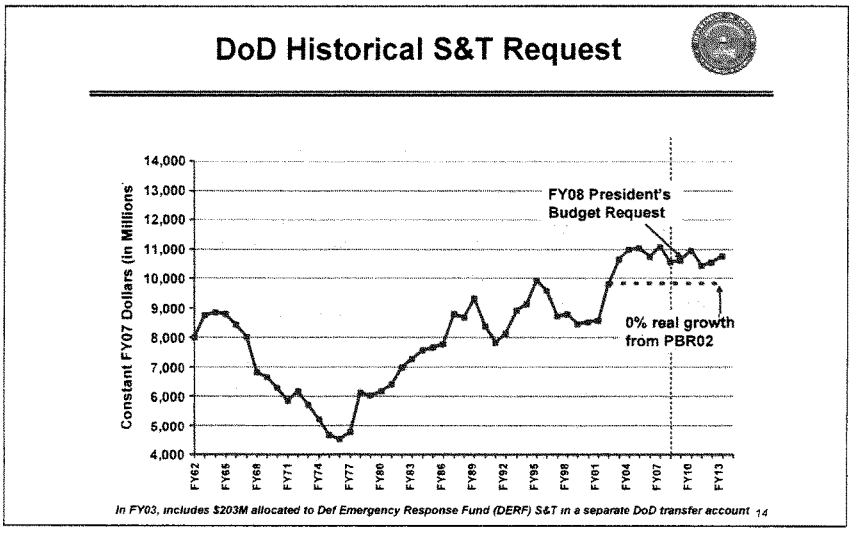
The R&E program we have submitted addresses the "Any Adversary, Any Battlefield" vision while simultaneously maintaining flexibility to address current issues. The body of this testimony addresses the overall DoD S&T program, key Service and Agency components of the program, and specific projects and initiatives in the FY 2008 budget request.

As a whole, the S&T program addresses the Defense Department's requirement to develop capability for today's force and maintain a technology edge across the broad spectrum of conventional military systems. The new initiatives are focused on increasing the U.S. capabilities for "the Long War", as

described in the 2006 QDR, fielding new technologies which enhance our warfighter's toolset, and reducing the cost and time requirements for fielding new weapon systems.

FY 2008 Science and Technology Budget Request

The FY 2008 President's Budget Request of $10.77 billion represents a continued corporate commitment to maintain strong S&T funding during a year with difficult budgetary demands from the on-going war on terror. Although in real terms this request is lower than the FY 2007 request of $11.08 billion, this year's request still represents a strong investment that demonstrates continuing commitment to S&T. Figure 1 displays the long-term trend of the DoD budget request for S&T. From FY 2002 to 2008 the S&T budget has grown 8% (in real terms) and these years are the seven highest DoD requests for S&T since the current budget process started in 1962.



There is one additional factor that is important when comparing the FY 2007 and FY 2008 President's Budget Submission. Between FY 2007 and FY 2008 the Air Force appropriately migrated over $300M from special program S&T accounts to more mature research and development accounts. Consequently, the true change in S&T work from FY 2007 to FY 2008 is less than is shown by the raw numbers. To accurately compare the FY 2007 and FY 2008 requests, we must

remove the special programs funding[3] from the FY 2007 budget; doing so results in the DoD's FY 2008 S&T request being slightly larger in FY 2008 than FY 2007 in then year dollars, and being only two percent lower than the FY 2007 request in constant year dollars (see Table below).

Comparison of DoD Research and Engineering Requests
(President's Budget – Total Obligation Authority)

Then Year Dollars (in millions)	FY 2007 Request	FY 2008 Request
Basic Research	1,422	1,428
Applied Research	4,478	4,357
Advanced Technology Development	5,183	4,987
Advanced Technology Development (Special Program Migration Adjusted)	4,867	4,987
Total DoD Science and Technology	**11,083**	**10,772**
Adjusted DoD Science and Technology	**10,767**	**10,772**
Advanced Component Development and Prototypes	15,387	15,662
Total DoD Research and Engineering	**26,470**	**26,434**

The FY 2008 request represents a year of transition. We continue to shift the S&T program to focus on transformational technologies, as evidenced in our new technology vectors. Similar to last year, over 40 percent of our investment is in three areas: information systems; sensors, electronics and electronic warfare; and basic research. This profile supports technologies needed to advance counter proliferation and counterterrorism capabilities. Furthermore, the FY 2008 request resulted in a Secretary of Defense-directed shift in S&T funds of over $300M in FY 2008, and a $1.6 billion shift (over the Future Years Defense Program (FYDP)) to develop new capabilities.

The overall DoD S&T program is comprised of contributions by the Services and Defense Agencies. Within the Services and Agencies, the FY 2008 budget is comparable to the FY 2007 budget, as shown in the following tables. It is important to recognize that the Services budget and manage the bulk of DoD S&T funds and thus have critical roles to play in the overall DoD S&T program. Consequently, before going through the DoD S&T program as an integrated whole it is important to highlight some important individual programs from each component.

[3] These funds were formally found in Program Element 0603801F

Army S&T Requests
(President's Budget – Total Obligation Authority)

Then Year Dollars (in millions)	FY 2007 Request	FY 2008 Request
Basic Research	312	306
Applied Research	685	686
Advanced Technology Development	722	736
Total Army Science and Technology	**1,719**	**1,728**

The Army's S&T program has to be as adaptable and responsive as our Soldiers in the field. The Army's S&T strategy is to pursue technologies that will enable the future force while simultaneously seizing opportunities to enhance the current force. Major elements of the Army's FY 2008 S&T budget includes:

- Force Protection technologies, the Army's single largest S&T investment area, which focuses on providing active/passive protection for rotorcraft survivability; active protection for countermeasures against kinetic and chemical energy threats, directed energy weapons; and passive protection such as lightweight armor.
- C4ISR technologies to enable networked surveillance and knowledge systems for collaborative real time mission planning, on-the-move operations and to enable networked lethality. These technologies include secure, mobile, ad-hoc networks for sustained high tempo full spectrum operations; third generation infrared (IR) technologies for extended range threat detection and identification; and a suite of sense-through-the-wall systems.
- Lethality technologies including the 120 mm Line of Sight/Beyond Line of Sight ammunition suite to enhance precision and provide multi-function munitions for the M1A2 Abrams and Future Combat Systems; and the next generation of Non Line of Sight – Launch System.
- Other significant Army S&T investments are found in soldier system technologies, logistics technologies, unmanned systems, advanced simulation, and basic research.

Navy (DoN) S&T Requests
(President's Budget – Total Obligation Authority)

Then Year Dollars (in millions)	FY 2007 Request	FY 2008 Request
Basic Research	456	467
Applied Research	639	678
Advanced Technology Development	505	522
Total DoN Science and Technology	**1,599**	**1,667**

The Navy continues to refine and align their program to meet Department of the Navy needs, and has defined 13 Naval S&T focus areas. Within these areas are the traditional fleet technologies, but the Navy has also established focus areas in power and energy, maritime domain awareness (surveillance coupled with information processing), and assured access to hold an adversary at risk. Among the technologies being pursued in maritime domain awareness are networked sensors across the air and sea environment with a goal to locate, tag, and track any target of interest on, under, or above the water. Within assured access, the Navy is attempting to integrate unmanned vehicles, information from space, communications and weapons (including non-lethal weapons) to allow effect littoral and riverine operations. Throughout the Navy S&T program, a consistent theme emerges. The Navy is aggressively integrating sensors, information processing and communication to provide dominant situation awareness.

Air Force S&T Requests
(President's Budget – Total Obligation Authority)

Then Year Dollars (in millions)	FY 2007 Request	FY 2008 Request
Basic Research	370	375
Applied Research	973	1,011
Advanced Technology Development	805	577
Total Air Force Science and Technology	**2,148**	**1,964**

The Air Force has shown tremendous foresight in adopting its "Anticipate, Find, Fix, Track, Target, Engage, and Assess – Anything, Anywhere, Anytime" technical vision that focuses the Air Force S&T program on fighting the global war on terror and countering the proliferation of weapons of mass destruction. An example of the Air Force's contribution to the ongoing war on terror is an electro-optical staring array called Angel Fire. Angel Fire distributes real-time imagery straight to the warfighter, providing the ability to zoom in and observe an area more closely. Angel Fire also allows for playback of significant events with a "TIVO-like" capability to monitor areas of interest, highlighting Air Force expertise in sensors technology. The Department looks to the Air Force to bring their core competencies to bear on these threats now and in the future, and to continue to provide our warfighters with the best capabilities to defeat the enemy in this new era of irregular warfare.

DARPA S&T Requests
(President's Budget – Total Obligation Authority)

Then Year Dollars (in millions)	FY 2007 Request	FY 2008 Request
Basic Research	151	153
Applied Research	1,503	1,403
Advanced Technology Development	1,590	1,477
Total DARPA Science and Technology	**3,243**	**3,033**

The Defense Advanced Research Projects (DARPA) continues its historical role as the engine for radical innovation in the DoD in FY 2008. This February, DARPA delivered its updated Strategic Plan to Congress, laying out in broad terms its strategic thrusts. This document provides a good sense of DARPA's plans and ambitions. In the area of counter proliferation, DARPA's strategic thrusts in the "Detection, Characterization and Assessment of Underground Structures" and the "Detection, Precision ID, Tracking and Destruction of Elusive Targets" are particularly relevant. In the area of counterterrorism, DARPA's strategic thrust in "Urban Area Operations" and its work in machine translation and biological warfare defense promise to make important contributions to defeating terrorists.

DTRA S&T Requests
(President's Budget – Total Obligation Authority)

Then Year Dollars (in millions)	FY 2007 Request	FY 2008 Request
Basic Research	5	5
Applied Research	318	182
Advanced Technology Development	105	213
Total DTRA Science and Technology	**428**	**401**

The Defense Threat Reduction Agency (DTRA) continues to emphasize research that will enhance our counter proliferation capability and ability to counter weapons of mass destruction (WMD). These include technologies that improve our ability to assess vulnerability and enhance survival, such as DTRA's advanced modeling of weapons and munitions effects and the integration of our modeling tools into a WMD Toolset for broader applicability. We are also investing in means to deter threats and defeat potential threat sites through better target assessment and tailored ordnance, such as hard target penetrators and massive ordnance blast technologies. Heavy penetrator sled tests are being conducted to demonstrate the key technologies of penetrator materials, shapes, and controlled detonation devices. Technologies for improved radiation-hardened microelectronics and electromagnetic pulse assessments will reduce our

vulnerability, and new solid-state neutron detectors and particle counters will advance our ability to detect and categorize threat materials.

S&T for Today's Force

In this section, we will highlight S&T programs that generally deliver products or technology over the next three years, that is, the early years of the President's Future Years Defense Program (FYDP).

As the Global War on Terrorism (GWOT) continues, the combatant commanders need new capabilities to be rapidly transitioned from the S&T program to use in the field. Thus, we have seen a much greater need to develop and harvest technology as fast as possible. To address these requests, we sought and harvested technology over the past several years to deliver new tools and systems that address the critical military needs of our battlefront customers. We continue to expand our work on experimentation, demonstrations and prototypes to shorten development cycle time. The Department has been successful because of Congressional support of several rapid reaction programs allowing the DoD to quickly develop and deploy technology. The S&T efforts of the Rapid Reaction Technology Office (RRTO), the Quick Reaction Fund (QRF), and the Joint IED Defeat Office (JIEEDO) are essential to our warfighters who are engaged daily in the war on terrorism. These programs complement each other, which each focusing on a specific part of the challenge.

The Rapid Reaction Technology Office (RRTO) focuses primarily on technologies that can mature in 6-18 months to be used in the broader GWOT. The RRTO will also work on less mature technology for defeat of emergent and future improvised explosive device (IED) threats. The RRTO's initial objective was to focus DoD technologies on counterterrorism issues. This counterterrorism mission continues, but over time, the RRTO has focused on several key areas, including leveraging the DoD S&T base and those of other Federal Departments; stimulating interagency coordination; anticipating adversaries' exploitation of available commercial technologies; and accelerating fielding of new capabilities. While most aspects of RRTO programs are classified, previous areas of focus include test and fielding of capabilities for wide area surveillance and tracking; standoff detection of explosives; special communications capabilities; counter IED applications; and counter weapons of mass destruction capabilities. Generally, all of these technologies are directly consistent with the tools needed to address counter proliferation mission. Through the several years of its existence, the RRTO has had a number of successes, and a few examples are outlined in the following paragraphs.

The Joint Experimental Range Complex (JERC), Yuma Proving Grounds, is a 24/7 expansive test area with roadways, buildings and infrastructure representative of the Iraq operating area. The facility has become the "gold standard" for technology/hardware to be tested prior to deployment to Iraq or Afghanistan. The JERC facility offers a broad range of infrastructure for systems demonstration and testing prior to deployment. Representatives from each Service, numerous government labs and industry have tested at the JERC.

The Persistent Threat Detection System (PTDS), which is a persistent surveillance capability consisting of an aerostat with embedded camera, distributed cuing sensors and a control module. When an event of interest is detected, the camera, in an integrated suite, is slewed to the target and tracked until reaction forces arrive. Acoustic, IR and radar sensors cue an optical sensor aboard an aerostat. The camera can be automatically or manually slewed to the target while the control module communicates with reaction forces. The RRF developed the PTDS capability, then transitioned it to the JIEDDO for subsequent fielding. In this case, the Rapid Reaction Fund (RRF) developed the technology, and the JIEDDO rapidly matured it for fielding.

The Biometric Identification System for Access (BISA), which is a semi mobile biometrics enrollment station that collects fingerprints, iris scans and other biometric information on personnel seeking access to a controlled facility. BISA allows for rapid enrollment and queries of biometric data bases to screen personnel. The system fuses commercial-off-the-shelf biometric enrollment equipment into a module and packets the collected information in a format used to query national data bases. Since the first unit was operationally deployed, BISA has been responsible for detecting numerous persons of interest. Additional units are in procurement through the Army's biometrics task force.

The JSTARS Ground Motion Target Integrator (GMTI), which deployed a trained group of GMTI analysts to an operational theater to form a target fusion cell to support counter-insurgency operations within in area of interest. Although specific details can't be described here, a 90-day demonstration was successfully conducted. The results have led to the establishment of a permanent capability.

The Quick Reaction Fund (QRF) allows us to take a different approach, investing in capabilities that can be demonstrated within a 12 month window and working on new capabilities or technologies that can transition to acquisition programs or address a very short term need for GWOT. The QRF is a complementary program to rapidly develop and demonstrate technologies to support today's force. The QRF is differentiated from the RRF in that QRF has a shorter time horizon and focuses on technology beyond the more narrow scope of

GWOT. The Joint Staff validates the need for the QRF projects. A couple of recent examples will highlight this difference.

The M1A1 tanks had no infrared (IR) sights for the .50 caliber gun system. Using QRF, we designed, packaged, and tested an integrated IR sight for the tank. This was done in a matter of months, and led to the retrofit by U.S. Marine Corps Systems Command of nearly 500 M1A1's in the Marine Corps inventory--all within a year.

In another case, the QRF funded the development and packaging of a 24-hour battery to be used with the boomerang counterfire sensor. Boomerang will locate the source of a sniper based on sound. The limitation with the initial system is that batteries needed to be replaced many times a day, creating a logistics burden and potentially exposing the force during resupply. Using QRF, we developed a high-quality fuel cells power source that lasts over 400 hours--providing an enhanced force protection capability. The fuel cell has returned to the lab for ruggedization, but demonstrated the capability using QRF.

The JIEDDO uses mature S&T to engineer and develop capabilities to combat IEDs in a near term (3-9 month) window. In February, 2007, the Director, Defense Research and Engineering and senior representatives from the DDR&E organization participated in a series of meetings with senior representatives of the JIEDDO to address current counter IED capabilities and JIEDDO's strategic S&T plan to counter the IED threat. These meetings built on an existing interaction where the DDR&E representatives participate in the resourcing, evaluation and approval process for new counter IED related capabilities. This close interaction has resulted in JIEDDO plans to allocate funds for 19 counter IED projects to be launched with coordinating oversight of DDR&E representatives.

In the Global War on Terrorism, our adversaries are learning and adapting quickly as this Nation employs our best technology, weapon system tools and tactics. The GWOT adversary adapts with great speed to each step we take. Authorization and appropriation of these quick response funds have allowed the Defense Department's research and engineering leaders to work with industry and universities to address urgent, emerging warfighting needs. Today's GWOT timelines are often much faster than our Nation's budget process and procedures. The Congress' support for these flexible high value programs has been extremely helpful in keeping pace with our adversaries and providing the best available tools to the men and women who are performing GWOT missions.

The Congress has also provided great support for a number of programs which use more traditional budget and program processes while still seeking to get available technology and products quickly into the warfighters toolbox and

existing or new weapon systems. Each of these programs takes a different approach to the same fundamental goal -- capability for U.S. military forces.

The Defense Acquisition Challenge (DAC) program process allows anyone to demonstrate a product or concept which can enhance a current warfighting tool or deliver a new capability. The DAC differs from the RRTO and QRF programs in that DAC funds test and evaluation of late stage technologies and commercial products for insertion into current acquisition programs or fielded systems. By seeking and testing non-developmental items with Technology Readiness Levels of 7 or higher, the DAC program minimizes or precludes R&D costs and time investments. It may be useful to briefly describe a couple successful DAC effort to illustrate the important benefits of this program.

The Army improved combat medical readiness through the Mini-Combat Trauma Patient Simulator (Mini-CTPS). Combat operations require considerable trauma-and-stabilization-skills autonomy due to long evacuation legs, as well as a minimal footprint in the field. The Mini-CTPS system answered this need by providing a patient simulator with extremely realistic physiological models specially tailored for emergency medicine. Since testing successfully under the DAC program, the Mini-CTPS system has been used to train over 3,500 U.S. Corpsmen and Medics in mass casualty and triage, meeting the immediate combat-training need. The Army procured four systems with over 400 mannequins, reducing the attrition rate in corpsman training from an average of 23% to just 6% through the use of Mini-CTPS.

Through the DAC Program, and in collaboration with the Air Force, Angel Fire will provide "Google Earth"-like persistent tactical situation awareness in high resolution (.5m), zoomable, city-sized images of infrastructure, tracking vehicles and people in real-time to hundreds of users simultaneously. This expansive and persistent coverage over a selected area will enhance counter proliferation and counterterrorism capabilities, forensic analysis, and predictive analysis. Angel Fire was successfully demonstrated at the Marine Corps Air/Ground Combat Center in summer 2006. By request of and through the support of the Marine Corps, along with deployment funding support from JIEDDO, Angel Fire is currently enroute to the theater and will be providing real-time, high-resolution, city-sized, zoomable images by April 2007. The DAC program accelerated transition and deployment of Angel Fire by six months to a year and saved over $10M in research and development.

The Foreign Comparative Test (FCT) program provides a mechanism exclusively dedicated to identifying and testing existing foreign military components and systems for potential use with today's warfighters. It is very similar to DAC, except FCT works with allied and coalition nations. FCT also

integrates mature technology. For example, Special Operations Forces required a highly reliable and modular combat rifle to replace the aging, 1960's-technology, M4A1 carbine. Under the Foreign Comparative Testing Program, U.S. Special Operations Command competitively evaluated the Special Forces Combat Assault Rifle (SCAR) Light (5.56mm) and SCAR Heavy (7.62mm), both with the 40mm Enhanced Grenade Launcher. SOCOM selected the model made by FN Herstal of Belgium in their Columbia, SC, plant. The SCAR triples the service-life, barrel-life and mean-time-between-failures when compared to any of the six aging weapons it replaces, including the current M4A1 carbine. All SCAR versions cost less than existing weapons it replaces in the inventory. The initial contract resulted in an production of over 1,000 rifles, with follow-on production for 14,889 rifles, at a total procurement value of $28 million. FCT accelerated the SCAR deployment by at least three years, while avoiding $2.2M in R&D and $6M in procurement costs through competition and innovation.

Filling an urgent need for more reliable machine guns that performs even under extreme environments—including when wet or full of sand or mud—the lightweight MK-46 5.56mm and standard MK-48 7.62mm machine guns were evaluated by the U.S. Special Operations Command on an accelerated schedule. SOCOM tested the weapons in just seven months, initially fielding them to Navy SEAL teams in combat in less than 12 months from starting the Foreign Comparative Testing project, saving over $9M in R&D. The DoD has procured and deployed over 1,700 of these machine guns, made by FN Herstal of Belgium.

In addition to capability and performance, evaluation of FCT candidate projects includes maintenance, sustainment, and procurement cost avoidance. Procurement cost avoidance often results from the competitive aspect of the program. For example, the Buffalo mine protected clearance vehicle now in use in Iraq and Afghanistan avoided over $35M in R&D alone, while delivering life-saving capability to the warfighter in just two years.

Another program that has the capability to support today's force is the Technology Transition Initiative (TTI). The TTI differs from other programs for today's force in that it specifically identifies technologies for insertion into formal acquisition programs, and address technology insert in a 2-3 year window. The approach is to work with the acquisition executives to identify and move developmental technology to a formal acquisition program for fielding.

For example, TTI accelerated the transition of the Digital Planning Tools for Joint Ground Warfare for the Army and Marine Corps by approximately two years. TTI funding was used create an asymmetrical warfare planning capability for Joint Forces. The capability will transition from the Agile Commander Advanced Technology Demonstration and the Combined Arms Planning and

Execution System (CAPES) to provide a Stability and Support Operations (SASO) and Military Operations on Urbanized Terrain (MOUT) asymmetrical warfare planning capability for Joint Forces. The First Marine Expeditionary Force and the 101st Air Assault Division used early versions of this capability during their Operation Iraqi Freedom rotations in FY 2006. Full capability will transition to these programs with the first software release in FY 2007.

New Initiatives to Support Today's Force

In the FY 2008 budget request, the DDR&E initiated several new initiatives support today's force.

Synthetic Aperture Radar Coherent Change Detection (SAR CCD) enables tactical users to detect minute changes in terrain due to human activity or develop a persistent picture of activities within an area of interest. Currently, SAR CCD requires post mission processing and extensive human analysis to develop a product that is time late and not easily accessible by tactical decision makers. The objective of the SAR CCD project is to engineer a real time CCD capability aboard an existing tactical UAV equipped with mini-SAR equipment. The goal is to reduce the cost of the real time SAR CCD system by a factor of 50% compared to current SAR CCD assets.

Currently, there is a need for a low cost communications relay capability to support convoy movements within the Iraqi theater; in some cases, aircraft which can perform other surveillance missions are being pressed into service for communications relay missions. It may be possible to expand the communicating relay capability into an airborne network gateway that will integrate different networks (such as EPLRS and SINCGARS) currently found in an area of operations. The "network gateway" can be thought of as a hub for the various networks to come together with information which is then relayed through the other networks in the area. Building on supportive prior investments by DARPA and the Services, the DDR&E program will focus on urgent delivery of a communications relay or airborne gateway solution to meet the needs of current operations.

S&T for Tomorrow's Force

The S&T team is also focused on the challenges of delivering technology and products to the Nation's military force of tomorrow. For this discussion, we will review programs and initiatives which deliver results in the next 3-6 years – basically the mid-to-later portion of the President's FYDP.

In 1995, the Department of Defense initiated the Advanced Concept Technology Demonstration (ACTD) to get new technologies and innovative concepts into the hands of the warfighter as quickly as possible. After ten successful years of ACTDs and recent rapid capability application to the joint warfighter in the new era of the Global War on Terrorism, we initiated the Joint Capability Technology Demonstration (JCTD) Program to further refine the process of rapidly bringing emerging technologies to the joint warfighter. This rapid capability application approach is tied directly to the Combatant Commander's most critical needs, and is meant to provide a faster, more integrated joint and coalition response to meet the emerging asymmetrical threats facing our nation.

The JCTD program supports tomorrow's forces and often delivers early products to today's forces. JCTD projects develop and demonstrate capabilities on a 2-4 year or shorter timeline, giving the Defense Department a process which is more agile than formal acquisition programs. Over 60 ACTDs deployed capability and products in support Operations ALLIED FORCE, NOBLE EAGLE, ENDURING and IRAQI FREEDOM. Some illustrative recent projects that have spun capability out to the warfighter are Coalition Combat Identification (CCID) and Joint Precision Airdrop System (JPADS) ACTDs.

The nine-nation Coalition Combat Identification (CCID) ACTD was initiated in 2001; however, this year, it was extended to focus on improving coalition combat identification interoperability and exchange from an intelligence, surveillance, reconnaissance airborne platforms. The major component of CCID is the Battlefield Target Identification (BTID) system. BTID enhances coalition task force combat effectiveness, reduces fratricide, and improves situational awareness and interoperability in coordination with Blue Force Tracking command and control battle command systems. The Army and Marine Corps have budgeted $695M in the FY 2008-2013 program to transition CCID components. These technologies will be assessed and demonstrated in Joint Forces Command's Exercise Bold Quest this September.

Another successful JCTD is the Joint Precision Airdrop System (JPADS) ACTD. JPADS was initiated in 2004 to address the Joint Warfighter requirement to sustain forward deployed combat power using high altitude, precision airdrop into a dispersed and unsecured battle space. The JPADS ACTD has demonstrated airdrops from 25,000 feet of sequential 10,000 pound precision airdrop systems fully integrated with the JPADS mission planner from both C-17 and C-130 aircraft with in-flight wireless updates sent to each system to multiple targets within 250 meter accuracy. This was most recently demonstrated during the second of three planned joint military utility assessments last month. JPADS will be transitioned to Army and Air Force programs. During the development

process, the program manager identified a lightweight system that is being bought off-the-shelf to meet immediate needs of the combatant commanders.

The Weapons Data Link Network (WDLN) ACTD was initiated in 2005 and successfully demonstrated interface standards and datalink message sets for future weapon data links to enable a fully-integrated, joint weapons grid to collaboratively address the find, fix, track, target, engage, and assess "kill chain" requirements. WDLN prototyped the hardware and software datalink solution set and standards for five major weapons programs like Small Diameter Bomb Phase II, Joint Standoff Weapon (JSOW), and Joint Air-to-Surface Standoff Missile. WDLN is providing the ability to fully exploit weapons delivery platform capabilities, including in-flight dynamic re-tasking for improved time-sensitive targeting and is an example of rapid software prototyping and application.

Finally, our prototyping efforts are addressing a rapid application solution for an urgent operational need to negate unintended collateral damage while destroying the intended target. The Focused Lethality Munition (FLM) JCTD, initiated in 2006, will rapidly develop and deploy a solution to this need. The existing Small Diameter Bomb I (SDB) airframe will marry two technologies resulting in a precision-guided weapon with sub-four meter accuracy that delivers a warhead with focused lethality. This solution will minimize potentially lethal fragments, which may cause unintended damage to persons or structures. Under the JCTD model, FLM will deliver capability to the warfighter in 22 months and, if successfully demonstrated, will transition into the formal acquisition process at Milestone C for Low Rate Initial Production. The targeted Program of Record is the Small Diameter Bomb Program. This vital capability will greatly improve the combatant commander's decision-making process, enabling the prosecution of targets located near potentially high collateral damage areas like urban targets.

New Initiatives to Support Tomorrow's Force

Working toward delivery of products in the later half of the President's FYDP, the Department has a number of new initiatives driven by the priorities of QDR, GWOT and the pressing military issues identified by the Joint Staff. Because of the QDR emphasis on counterterrorism (CT) and counter proliferation (CP), these new initiatives are important tools for delivering capability for the CT and CP missions.

To date, military applications of biometrics exploitation to date have largely focused on the use of fingerprints to identify personnel for entry into controlled areas. During the past three years the military value of biometrics technology in counterterrorism, combating terrorism, and counter insurgency operations has been repeatedly demonstrated in forensics application in support of

irregular warfare operations and in the identity verification of foreign nationals working in support of U.S. Forces.

The DoD does not currently have a strategic, synchronized, integrated, and coordinated R&D approach to expand the forensic exploitation for the broad range of biometric markers to exploit all biometrics information available for identification of personnel. We are developing a comprehensive biometrics Science and Technology (S&T) program to address aspects of identity management ranging from information security to forensic analysis. This plan will also address all facets of intra-DoD and interagency coordination, including standards and development of common data bases to share biometric data across agencies at the federal, state and local levels. This follows an October 2006 designation, by the Deputy Secretary of Defense, of my office as Principal Staff Assistant (PSA) for biometrics. The scope of the PSA responsibilities is to fully address and exercise control over all facets of the Department's biometrics programs, initiatives, and technologies.

A second new initiative is Clandestine, Tagging, Tracking and Locating (CTTL). Over the past year, the DDR&E and component staffs have been working with U.S. Special Operations Command (USSOCOM) to advance the capability of our forces to clandestinely tag, track, and locate high value individuals in the Global War on Terrorism. We also know that this is an important effort from recent reviews by the Defense Science Board. The analyses concluded that serious gaps exist in current capabilities and that the S&T program needs to be enhanced and focused on clandestine measures to prosecute operations against high value individuals (targets). We have developed a roadmap that represents the Special Operations Forces' priorities and the S&T community's opportunities for making important advances. The 2006 QDR reconfirmed the importance of this area, and we have taken an action to increase investment for clandestine TTL across the Department. Our activities are coordinated with those of the Intelligence Community (IC) and will emphasize advanced nanotechnology, biology, and chemistry to give us a means to find, identify, and track individual human beings with minimal exposure of our forces and with an ability to project this capability into areas of limited access.

The third initiative is Human, Social, Culture and Behavior (HSCB) modeling. This new initiative springs from a lesson learned in the on-going GWOT. That lesson learned is that the DoD has capability gaps in software tools and decision aids that will allow U.S. commanders to better understand different cultures. The QDR highlighted these lessons in stating current and future military operations will require enhanced capability to understand social and cultural "terrains" as well as various dimensions of human behavior. The HSCB will develop the required scientific base and will field matured technologies that

support human terrain understanding and forecasting across a span of missions and geographic regions. The DDR&E staff worked with the components and IC in 2006 to identify capability needs in 75 areas; there were gaps in roughly 70 of these areas. The HSCB initiative will address these gaps and integrate complex human factors into the pre-planning, planning and execution cycle of military operations. HSCB modeling is focused on filling capability gaps within data collection/infrastructure and knowledge management, and then developing the models to forecast societal and cultural behaviors. Deliverables from this program will include software modules that are fully integrated into DoD command and control and other systems.

The DDR&E is also sponsoring an initiative to provide options for future precision geopositioning. The DoD is making an investment in FY 2007 to support an enabling technology development program exploiting the on-orbit capabilities of the existing Iridium constellation innovatively coupled with current GPS assets to accelerate, by up to 6 years, the availability of anti-jam and positioning, navigation and timing capabilities to the warfighter. iGPS offers the potential to provide anti-jam capability an order of magnitude greater than planned for GPS-III, location accuracies to decimeter levels, navigation signal coverage in urban environments, and bi-directional communications for Joint Blue Force Tracking/Situational Awareness. These iGPS capabilities are fully compatible with current and planned future GPS capabilities. Following successful demonstrations of capabilities in this enabling technology development program, in FY 2008 the Department will initiate funding for a technology concept demonstration effort that will provide rapid development and earlier operational implementation of iGPS capabilities in a theater sized area of operation employing existing high power space-to-ground antennas and a limited number of modified user equipment for field tests. It is anticipated that the post development efforts will transition to operations by users such as SOCOM.

The Secretary of Defense's Strategic Planning Guidance (SPG) tasked DDR&E to lead an effort to handle the sharing of track information between respective Service surveillance platforms. The Combatant Commander will have significantly greater capability and flexibility if we ensure that systems like AWACS, Patriot, Aegis and JLENS can share information and create a single integrated air picture. The Department is allocating necessary funding to developing the tools to integrate this information across the Service platforms and to testing of these capabilities in live, joint demonstration exercises. We have also initiated with the Air Force, a largely classified program to integrate hyperspectral technology with tactical UAV to provide greater in-theater discrimination of targets.

S&T Enablers for the Future Force

The true center of gravity of the S&T program appropriately continues to be developing and delivering advanced technology for the future force – providing tools for the men and women who will serve this Nation in the year's beyond the President's FYDP. We also have a key role in minimizing the threat from potential adversaries using technology to disrupt our military advantages. The Department's S&T program has a long history of developing critical capabilities that have forged our conventional military advantage—many of these capabilities did not emerge from short term needs or acquisition programs. For instance, the global positioning system emerged from basic research into precision timekeeping at the Navy Research Laboratory; night vision goggles emerged from early work in infrared detection at the Army's Night Vision Laboratory; and the internet came from work on the "arpanet" at DARPA. Similarly, technology work within the DoD is shaping the capabilities of tomorrow. These capabilities may be different than today's, but the goal remains the same -- retain U.S. military superiority.

The S&T tools in this area are the Department's vital basic and applied research (6.1 and 6.2) funding as well as the advanced technology development (6.3) funding budgeted within the Services and Defense Agency program elements. Using a variety of programs and processes, these efforts address a broad spectrum of needs from developing game changing new technology to lowering the cost of weapon systems to training a new generation of scientists and engineers. First, we will present just a few examples of emergent research areas that should improve ourcounter proliferation and counterterrorism capabilities.

The FY 2006 Strategic Planning Guidance asked us to work with the Defense Threat Reduction Agency to review and implement a plan to improve the capability to remotely detect fissile materials at standoff distance. My staff worked with DTRA and DARPA to identify possible solutions. The result is an increase in emphasis of applied research to address the problem by DTRA, because there is no immediate solution. DTRA is increasing their work in sold-state neutron detectors and novel scintillation detectors in the FY 2008 budget request. We will continue to monitor the progress in this area, and continue to seek new ideas through solicitations at places like DARPA.

Research in the DoD Chemical and Biological Defense Program has made important progress in both medical and physical protection. Advancements in the medical program include protection of two animal species against lethal Ebola virus infection using genetic strand material, protection of monkeys against multiple strains of Marburg virus using a single-dose vaccine, and development of the first drug to demonstrate 100 percent protection against the human smallpox

virus in primates. Gains in the physical program include demonstration of materials using self-detoxification for chemical agents, laboratory-scale systems to detect and discriminate among chemical agents one kilometer away, and a joint-service monitor to detect biological warfare agents in potable water. Integrated solutions from this program include chemical biological radiological nuclear unmanned ground reconnaissance and a system for contamination avoidance at seaports of debarkation.

The Army's Future Force Warrior not only demonstrates the Department's ability to develop and field new technologies but also highlights our success in migrating breakthroughs across Service boundaries. An initiative to develop and demonstrate revolutionary capabilities for soldier systems, Future Force Warrior is creating a lightweight individual combat system that includes weapon, head-to-toe individual protection, netted communications, power sources, and enhanced human performance. As a result of cross-Service information exchange, Army's Future Force Warrior will adopt an Air Force advancement that combines state-of-the-art hearing protection with an improved microphone. This will enable our troops to communicate clearly with one another through the overwhelming noise of close combat or aircraft operations, and will preserve their ability to communicate with their families when the mission is completed.

Military personnel must be able to operate safely in environments that may be dominated by laser energy, including high-energy laser weapons. The battlespace may be at the edge of space or deep in an urban alley. Air Force sponsored research has extended our understanding of interactions between lasers and tissue, thereby advancing health hazard assessment, development of battlefield triage and treatment for laser eye injuries, and specifications for laser eye protection. One key success is greatly improved and affordable laser eye protection—for aircrews and other warfighters—against a wider range of laser threats and compatible with combat-vision needs, life-support equipment, corrective-prescription requirements and color-discrimination demands.

Research investments in materials technologies are providing enhanced properties for ultimate performance and affordability through durability and greater damage tolerance. A product of DoD nanotechnology that incorporates hard ceramic nano-particles, such as tungsten carbide, titanium carbide, and zirconium oxide, in a strong but tough metal matrix is being tested as low friction, hard yet tough coating for gears and bearings. These materials have been transitioned to industry for demonstration testing on the lift-fan gears of the Joint Strike Fighter. Longer range basic and applied research in nano-materials promises to provide new non-linear optical polymers that can be used in optical limiting for laser-eye protection or optical switching, molecular sieves for highly

selective filtration, nano-textured surfaces that better capture light for photovoltaic cells, and additive nano-particles that increase the power of explosives.

In May 2006, DDR&E initiated a task force to define an investment roadmap to lower DoD energy requirements and to identify alternative energy sources in response to an SPG tasking from the Secretary of Defense. As a result of the Task Force, the FY 2008 defense budget increased funding for energy efficiency programs for weapons systems, tactical vehicles and in facilities and technologies to identify new, cost effective energy sources. We increased funding for the Highly Efficient Embedded Turbine Engine, the fuel efficiency element of the Versatile Affordable Advanced Turbine Engine program, enabling some technologies to be spiraled into programs earlier than planned. The small heavy-fueled engine quick demonstration will enable long duration UAVs and mobile ground power. We are also prototyping a carbon composite UAV that could fly for up to six days. We added funding to the Army's hybrid electric vehicle program to build a lightweight fuel efficient demonstrator, and successful technologies may be integrated into the Joint Light Tactical Vehicle. The Navy reinstated the legacy energy conservation program to continue to test and integrate fuel efficient technologies on ships.

Another important on-going energy effort is the Department's Energy and Power Initiative which is focused on providing both advanced technologies and technology options to warfighters and military systems. Energy storage capacity associated with lithium-ion batteries has been increased across a militarily significant range of operating temperatures and lithium-ion systems have been transitioned to the B-2. Capacitors are being made a viable energy storage medium, which permits serious consideration being given to electromagnetic armor and electromagnetic launch systems. We have now demonstrated the capacity to operate a 600 kilowatt fuel cell using Navy logistics fuel. The initiative also includes electronics technology associated with power conditioning and high-power semiconductors and diodes based on silicon-carbide for high temperature, high current applications. These technologies together are making more electric and more efficient ships, aircraft, and ground vehicles realistic alternatives for future procurement.

New Initiatives for the Future Force and Workforce

The DDR&E generated several new initiatives that should provide dividends to the future force. The Computational Research and Engineering Acquisition Tools and Networking Technology initiatives are a product of excellent collaboration between the Services and the DDR&E team. The Department's Manufacturing S&T initiative is largely a result of a Defense Science Board study recommendation and the need to take more than incremental

steps to reduce the cost of manufacturing defense systems. Finally, we have expanded current programs and initiated new efforts in training and attracting the Nation's next generation of scientists and engineers.

Computational Research and Engineering Acquisition Tools and Environments known as CREATE is a new project within the High Performance Computing Modernization program. CREATE develops and deploys computational engineering tools for acquisition programs to use supercomputers to design military aircraft, naval ships, and RF antennae for military platforms. Benefits derived from CREATE include reduced acquisition costs and schedule overruns, early integration of major vehicle subsytems, improved flexibility and agility. CREATE should enable rapid development or optimized designs with fewer flaws and better performance.

The second new initiative strives to improve and accelerate network capabilities. This initiative fills gaps in existing DoD S&T programs that were identified in 2006 by a multi-agency joint analysis team chartered by DDR&E. The planned S&T investments will concentrate on network interoperability and on improving network capacity in mobile, tactical settings. The thrust will analyze, model, and develop protocols and technologies to allow ad hoc communications between different groups while on the move and without benefit of a stationary transmission tower, as is commonly used for cellular telephone technology. This thrust will also develop options to improve the use of the available frequencies, known as spectrum management.

The Defense-wide ManTech S&T Program includes several pilot projects in its introduction phase. These projects aim to realize a large return on investment that will be shared by each of the Services: propulsion systems for air and surface vehicles; manufacturing and application of low-observable materials, system-on-chip initiative aimed at communications; and rapid prototype manufacturing for prosthetics--the latter effort being pursued in cooperation with the National Naval Medical Center at Bethesda and with Walter Reed Hospital.

The future force also includes the scientists and engineers who are vital to development and delivery of the military systems that will continue to ensure our Nation's security through technical superiority. The Department of Defense employs almost half of all Federal physical scientists and engineers (S&E). Our work requires highly educated, technically experienced, and security-cleared United States citizens. The DoD investment to recruit, educate, and train our future S&E should begin today, as our current "boomer" workforce is retiring. Over the next 10 years, the DoD laboratories expect to lose about 13,000 S&Es.

The available pool of qualified S&E's in critical areas of interest to DoD is declining. In the U.S., only 15% of undergraduates receive degrees in natural science or engineering as compared to South Korea (38%); France (47%); China (50%) and Singapore (67%). In 2005, there were more engineering students enrolled in Mexico than in the United States. At the same time, the total demand for scientists in the U.S. is projected to increase by 17 percent and 22 percent for engineers.

Under the National Defense Education Program, DDR&E sponsors four initiatives that encourage, stimulate, support, and educate the students that are vital to our future workforce.

- **Science, Mathematics, and Research for Transformation (SMART) Defense Scholarship Program** competitively awards scholarships and fellowships to clearable United States citizens in defense-critical S&E disciplines. Scholars are obligated to one year of DoD employment in return for each year of scholarship support received. Thirty SMART scholars received awards in FY 2005; 32 received awards in FY 2006. Ten graduates are already at work in DoD facilities. More interesting is the response in the FY 2007 for roughly 50 scholarships. In FY 2007, we received over 1,400 applications and almost a thousand complete applications have been submitted for this year's competition.

- **National Security Science and Engineering Faculty Fellows (NSSEFF)** creates a competitive award program for outstanding, clearable, university faculty scientists and engineers that is large enough to be attractive ($600K annually), and long enough (5 years) to produce quantifiable research results. We start the program with a modest $5.4M investment in FY 2008. Biased toward early-career faculty members, NSSEFF funds 50 top-flight university researchers over the FYDP, all working in fundamental DoD research areas.

- **Pre-Engineering Curricula Modules** are practical, middle and high school curriculum enhancements that tie physical science and mathematics concepts to real-world applications. This effort augments successful work that increases middle and high school students interest in science and engineering, points up the value of college preparatory high school courses, and results in more college-bound high school graduates prepared to do secondary work in science and engineering.

- **Investment in S&E enrichment programs** for pre-college students and teachers associated with the current Materials World Modules (MWM) program and the requested Pre-Engineering curricula module program. A

recent experiment evaluating the effects of the MWM program showed significant increase in science and engineering knowledge gained and very significant increase in science interest (over the control group).

Refine the Business Processes of the DoD S&T

The DSTAG serves as a strategic coordination board for the S&T program. The DSTAG is comprised of the S&T Executives representing the components having a large S&T program and includes a representative from the Joint Chiefs of Staff. This regular forum provides the primary means for coordination on the execution and planning of the Defense Department S&T program. In recognition of the need to focus on all aspects of S&T development, we have made the Chief Scientist of the JIEDDO a member of the Defense Science and Technology Advisory Group (DSTAG).

A vital element to technology development for the future force is a vibrant capacity to coordinate ideas. The past year has seen substantial advances in the process by which the Department ensures that its S&T enterprise is strategically well-focused, coordinated, and responsive to warfighting needs. The new Reliance 21 S&T management process, developed collaboratively by the DSTAG, emphasizes strategic alignment with the Department's highest priorities, and rapid budgeting for S&T efforts for underinvested needs. Reliance 21 is founded on the principle that transparency fosters higher quality research, greater efficiency, and improved effectiveness. Central to the goal of transparency is a comprehensive database of DoD S&T investments to enable DoD scientists, engineers, and executives to formulate and conduct well-coordinated research programs. For the first time, all the DoD S&T organizations prepare biennial S&T strategic plans that are informed by and harmonized with an overarching DoD S&T strategic plan prepared by DDR&E.

In addition, the DoD S&T leadership conducts an annual S&T Strategic Overview to share their investment plans, assess progress of high-priority thrusts, and identify gaps and overlaps. The most recent review held in February identified key research areas in large data set reduction, software producibility, and urban operations that are now being examined by multi-agency teams to develop S&T investment recommendations. Six additional multi-agency technology focus teams, on topics including directed energy, human systems, and combating weapons of mass destruction, have begun work to formulate S&T investment roadmaps that will inform future S&T budget development.

In addition, to identify opportunities for accelerated or more coordinated fielding of technologies, Reliance 21 employs joint analysis teams focused on key technologies, including networks, jamming-resistant global positioning system

augmentation, radars, and energy security. And, to take greater advantage of the unrivaled reservoir of technical knowledge resident in DoD's S&T workforce, Reliance 21 charters defense support teams of expert scientists and engineers inside and outside the Defense Department to assist DoD acquisition programs to resolve difficult technical challenges. Current defense support teams are providing assistance to efforts related to space-based detection of missile launches and biometrics-based identity management.

A key component of Reliance 21 is almost a standalone element – enhanced interaction between the intelligence and S&T communities. As stated in the QDR, the strategic environment of the U.S. has shifted significantly over the last two decades. The threat has evolved from a few nation-state threats to decentralized network threats including non-state enemies, from single- focused threats to multiple complex challenges, from "one size fits all" deterrence to tailored deterrence for rogue powers, terrorist networks and near-term competitors. Embedded in this framework is a need to place more emphasis on potential adversary development of disruptive technology. We continue to increase our efforts to monitor global technology developments and to better understand their implications for U.S. national security. Over the past two years, my office has worked closely with the Under Secretary for Intelligence and the National Intelligence Council to strengthen our ability to anticipate new and evolving technology-based threats. We have conducted a series of technology net assessments that determine where differences between U.S. and foreign technology trends and capabilities exist and assess whether the differences pose a discernable threat to U.S national security. We are engaged with our Allies in collaborative programs to assess emerging and disruptive technologies and their effects. These assessments are only the beginning of our efforts; we will continue to expand programs that provide us with a more robust capability to anticipate disruptive technology challenges and reduce the possibility of technological surprise.

The Militarily Critical Technology Program (MCTP) is a Congressionally mandated program to provide DoD's input to the Export Control process. In response to a program assessment by the Government Accountability Office (GAO) last year, DDR&E has launched a three-pronged effort to re-focus the MCTP. A new Deputy Under Secretary of Defense for International Technology Security (DUSD(ITS)) has been appointed and staffed his office to re-engineer the program. Further, the Under Secretary of Defense for Acquisition, Technology and Logistics (USD(AT&L)) has made the urgent update of the MCTP a 2007 Strategic Goal. DUSD(ITS) is working closely with Commerce Department Export Licensing Officers to improve usability and searchability of MCTP information, and with technology working groups on a wiki-like interface to make virtual collaboration on MCTP creation as easy as possible. As part of this re-

engineering process, DUSD(ITS) has commissioned the Defense Technical Information Center (DTIC) and Google, Inc. to conduct a "fly-off" of web-enabled systems to better support both the creation and access of MCTP information. The urgent update of the MCTP content will be completed in April 2007; the reengineering effort prototype will complete in FY 2007 and final system in FY 2008.

The Department's policy is to ensure that Major Defense Acquisition Programs (MDAPs) receive approval to go forward into system design and development or low-rate production only when all critical technologies have demonstrated that they meet acceptable levels of maturity. Experience shows that acquisition programs that proceed with immature technologies are more likely to suffer cost and schedule overruns. Technological maturity for critical technologies is determined through a formal Technology Readiness Assessment (TRA) at Milestones B and C performed under DDR&E oversight. The DDR&E staff works closely with staff of the acquisition program, often over a period of many months or even years to foster verification of technology maturity. The DoD's efforts are consistent with Section 2366a of Title 10 USC that requires the USD(AT&L) to submit certification to the Congress that MDAPs do not receive Milestone B approval until the Milestone Decision Authority certifies that "the technology in the program has been demonstrated in a relevant environment."

In May 2006, the USD(AT&L) issued an implementation memorandum to ensure full compliance by the Department with this law. Recent Milestone B TRAs conducted by DDR&E in concert with Service acquisition executives include: the Navy Amphibious Assault Ship Replacement Flight 0; the Combat Search and Rescue helicopter (CSAR-X); the Navy Enterprise Resource Planning (ERP) program; the WIN-T Warfighter Internet – Tactical, and the National Security Agency Public Key Infrastructure Increment 1. In addition, we have initiated a process of "quick-look" technology readiness evaluations at a much earlier stage of the acquisition process to identify potential technology maturity gaps prior to Milestone B. In this way, if we find immature critical technologies early in the acquisition process, alternative technical approaches can be found or S&T investments can be made to address the technology immaturity at an earlier stage of acquisition. In addition, the Joint Staff and my office have begun to develop a process to advise the Joint Requirements Oversight Council on technology maturity, risk, and suitability as criteria for requirements validation and capability document approval. One recent example of a technical assessment to inform requirements validation was provided for the F-22 block upgrade. The evaluation of technology maturity is now a major tool to assist both the requirements development process and the formation of major acquisition programs. It also serves to improve integration of the S&T and acquisition communities.

Building on the positive benefits of conducting TRA's, the DDR&E team is moving forward with defining a process for assessing manufacturing readiness levels (MRL). One of DDR&E's ManTech priorities during the past year has been to standardize terminology and assessment processes that describes and determines MRLs. Working with ManTech representatives from the Services, and with manufacturing executives from the private sector, we are producing MRL tools to assist project managers in government and the defense industry in assessing readiness of technologies for production.

The final business process improvement involves S&T information reuse. The 21st Century has brought a new form of war that is being fought against groups of extremists, who use modern technology and unconventional weapons including biological agents, improvised bombs, and small nuclear devices to attack the U.S. and our allies. As the focus of the Nation's defense priorities shifts to counter these threats, DoD scientists, engineers, program managers and others simply will not have time to sift through mountains of data to find significant pieces of information to meet critical requirements. It is essential to our Nation's technological superiority that we develop innovative information discovery and analysis tools that will provide essential information rapidly, accurately and reliably to support DoD's newly-emerging priorities.

Information is key to effective decision making. Data that is unknown, inaccessible, or incorrect leads to duplication of effort; delays and potential failure in reaching strategic and near term goals; jeopardizes our forces; and places our nation's security at risk.

In this era of ever-changing technology and shifting requirements, the value of central information sources, which acquire, organize, analyze and disseminate information, has become more apparent. The implementation of an information gateway to Defense scientific, research and engineering information will serve as the centerpiece of DDR&E's information innovation initiatives providing single sign-on access to both public and limited access data sources within the DoD and world-wide. In addition, this information gateway will facilitate the collection and dissemination of program information and tools that will assist program managers in analyzing the cost effectiveness of DoD's research and development programs.

DDR&E launched the first phase of the gateway in 2005 at the Defense Technical Information Center with the R&E Portal which was aimed at the DoD research and engineering community. Based on the success of the Portal in supporting the needs of DDR&E program managers, we now plan to expand the concept to meet the needs of DoD scientists, engineers and managers in the test and evaluation Community. The expanded features for the gateway will include a

unified search capability and additional analysis tools, as well as collaborative environments where scientists and engineers can identify others working in their area of interest and form virtual research communities to leverage the knowledge investment in the broader Defense scientific community.

Conclusion

The need for a stable, healthy DoD S&T program is a central element to fighting the global war on terror. This Long War has stretched the S&T community into expanding our support role in providing balanced product to today's force, tomorrow's force, and the future's force. We believe we are meeting this challenge, and we truly appreciate the continued support of this committee in providing us the tools and resources to carry out this vital mission.

Statement by

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NOT FOR PUBLICATION UNTIL RELEASED BY THE SUBCOMMITTEE

Mr. Chairman, Subcommittee Members and staff: I am pleased to appear before you today to discuss the Defense Advanced Research Projects Agency's (DARPA) on-going Fiscal Year (FY) 2007 activities, and our FY 2008 plans to continue as the engine for radical innovation in the Department of Defense (DoD).

DARPA's original mission, inspired by the Soviet Union beating the United States into space with Sputnik 50 years ago, was to prevent technological surprise. This mission has evolved over time. Today, DARPA's mission is to prevent technological surprise for us *and* to create technological surprise for our adversaries. Stealth is one example of how DARPA created technological surprise.

DARPA conducts its mission by searching worldwide for revolutionary high-payoff ideas and then sponsoring research projects that bridge the gap between fundamental discoveries and their military use.

DARPA is the Department of Defense's only research agency not tied to a specific operational mission: DARPA supplies technological options for the entire Department and is designed to be a specialized "technological engine" for transforming DoD.

This is a unique role within DoD. The Department's operational components naturally tend to focus on the near-term because they must meet urgent needs and requirements. Consequently, a large organization like DoD needs a place like DARPA whose only charter is radical innovation.

DARPA delivered its updated Strategic Plan to the Congress this February[1]. Our updated plan reflects the continuity in DARPA's recent overall strategy. The new plan looks to the future more than previous ones and provides a list of significant technical research – Future Icons – that we believe will eventually prove to be memorable DARPA accomplishments.

Future Icons

It is often said that past results do not necessarily indicate future performance. Nevertheless, the following is a list of ongoing DARPA research that promises major benefits to DoD, and which

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[1] The Strategic Plan may be downloaded from DARPA's website, www.darpa.mil

may become icons of significant technical achievement by themselves. To be clear, this is basic and applied research and development of technologies that some day may be incorporated into fielded systems – and even prototypes of some of those systems. DARPA rarely engages in the development of full systems to the point that the systems can be used in the field as any other weapon or system might be. However, if we get the concepts right, if we learn the right things from the research, and if the technology proves out, here are some of the results we may get:

- **Networks**: self-forming, robust, self-defending networks at the strategic and tactical level are the key to network-centric warfare.
- **Chip-Scale Atomic Clock**: miniaturizing an atomic clock to fit on a chip to provide very accurate time as required, for example, in assured network communications.
- **Global War on Terrorism**: technologies to identify and defeat terrorist activities such as the manufacture and deployment of improvised explosive devices and other asymmetric activities.
- **Air Vehicles**: manned and unmanned air vehicles that quickly arrive at their mission station and can loiter there for very long periods.
- **Space**: the U.S. military's ability to use space is one of its major strategic advantages, and DARPA is working to ensure the United States maintains that defense advantage.
- **High Productivity Computing Systems**: supercomputers are fundamental to a variety of military operations, from weather forecasting to cryptography to the design of new weapons; DARPA is working to maintain our global lead in this technology.
- **Real-Time Accurate Language Translation**: real-time machine language translation of structured and unstructured text and speech with near-expert human translation accuracy.
- **Biological Warfare Defense**: technologies to dramatically accelerate the development and production of vaccines and other medical therapeutics from 12 years to only 12 weeks.
- **Prosthetics**: developing prosthetics that can be controlled and perceived by the brain, just as with a natural limb.
- **Quantum Information Science**: exploiting quantum phenomena in the fields of computing, cryptography, and communications, with the promise of opening new frontiers in each area.
- **Newton's Laws for Biology**: DARPA's Fundamental Laws of Biology program is working to bring deeper mathematical understanding and accompanying predictive ability to the field of biology, with the goal of discovering fundamental laws of biology that extend across all size scales.
- **Low-Cost Titanium**: a completely revolutionary technology for extracting titanium from the ore and fabricating it promises to dramatically reduce the cost for military-grade titanium alloy, making it practical for many more applications.
- **Alternative Energy**: technologies to help reduce the military's reliance on petroleum.

- **High Energy Liquid Laser Area Defense System**: novel, compact, high power lasers making practical small-size and low-weight speed-of-light weapons for tactical mobile air- and ground-vehicles.

The Future Icons span a huge range of science and technology, from networking to air vehicles to biology to lasers. More importantly, they are tremendously difficult technical challenges that will be hard to solve without fundamentally new approaches – ones which may require bringing multiple disciplines to bear and perhaps even result in entirely new disciplines.

This research is technically bold. Some of it will succeed, some will fail, and some will go in directions we cannot foresee. But because the challenges are so hard, so important, and so fundamental, when we *do* succeed it will yield very high payoffs for our military.

DARPA's Nine Strategic Thrusts

DARPA's strategy for accomplishing its mission is embodied in strategic thrusts. Over time, as national security threats and technical opportunities change, DARPA's strategic thrusts change. The nine strategic research thrusts that DARPA is emphasizing today are:

- Robust, Secure, Self-Forming Networks
- Detection, Precision ID, Tracking, and Destruction of Elusive Targets
- Urban Area Operations
- Advanced Manned and Unmanned Systems
- Detection, Characterization, and Assessment of Underground Structures
- Space
- Increasing the Tooth to Tail Ratio
- Bio-Revolution
- Core Technologies

Robust, Secure, Self-Forming Networks

The DoD is in the middle of a transformation towards "Network-Centric Operations." The promise of network-centric operations is to turn information superiority into combat power so that the U.S. and its allies have better information and can plan and conduct operations far more quickly and effectively than any adversary.

At the core of this concept are networks – networks that must be at least as reliable, available, secure, and survivable as the weapons and forces they connect. They must distribute huge

amounts of data quickly and precisely across a battlefield, a theater, or the globe, delivering the right information to the right place at the right time.

But for these networks to realize their full military potential, people can no longer be central to establishing, managing, and administering them. The networks must be able to form, manage, defend and heal themselves so they always function at the enormously high speeds that provide their advantages.

Tactical networks must locally link effects to targets and be agile, adaptive and versatile. Strategic and operational networks must globally link air, ground, and naval forces for operational maneuver and strategic strike, and enable knowledge, understanding and supply throughout the force. DoD now has the opportunity to bridge the gap between these two families of networks, allowing the strategic and tactical levels to rapidly and effectively share information and insight.

DARPA is developing technologies for wireless tactical net-centric warfare that will enable reliable, mobile, secure, self-forming, ad hoc networking among the various echelons with the most efficient use of available spectrum.

A seminal DARPA tactical networking program was the Small Unit Operations Situational Awareness System to link together dismounted Soldiers operating in difficult environments such as in cities and forests. This self-forming and self-healing communications network technology transitioned to the Army, where its basic network waveform is being integrated into the Joint Tactical Radio Systems Ground Mobile Radios and the Handheld, Manpack, Small Form Factor Radios.

The next logical step was to move up from connecting individual Soldiers together to connecting tactical ground and airborne vehicles together. Our Future Combat Systems–Communications (FCS-C) program developed a gateway approach that makes a mobile, self-healing ad hoc network for ground maneuver vehicles and unmanned air vehicles operating in cluttered, complex terrain, which includes the urban environment.

One problem that has plagued the DoD for years is radio interoperability. A special feature of FCS-C Gateway is that interoperability is built into the network itself, rather than having to build it into each radio, so any radio can now be interoperable with any other. We showed that it is

possible to have previously incompatible tactical radios talk seamlessly among themselves and to more modern systems, including both military and commercial satellite systems. This offers a potentially more affordable route for military communications interoperability in the future. FCS-C Gateway has transitioned to U.S. Special Operations Command for their evaluation and use.

Complementing this is our work to compensate for the difficult physical and frequency environments in which our tactical units may need to communicate. Tactical units sometimes have to work in the uniquely cluttered environments of cities, which creates problems because signals bounce around and take multiple paths that degrade the links. The Mobile Multiple-Input/Multiple-Output Network (MNM) program is turning this problem into an opportunity by actually exploiting the multipath effect to improve communications between vehicles moving in cities without a fixed communications infrastructure. MNM was recently tested using several vehicles operating at speeds up to 45-60 miles per hour in complex terrain, and the technology transferred more data using less bandwidth than the program goals.

The military frequency spectrum is cluttered and limited in extent, with most of the spectrum already allocated to users who may or may not be using it at a given time and place. The neXt Generation (XG) Communications program is developing technology to increase the radio spectrum availability by ten times by taking advantage of spectrum that has been assigned but is not being used at a particular point in time. XG technology assesses the spectrum environment and dynamically uses spectrum across frequency, space and time. XG is designed to be successful in the face of jammers and without harmful interference to commercial, public service, and military communications systems. XG is transitioning to the Army to solve spectrum challenges in-theater.

DARPA is working to bridge strategic and tactical networks with our Optical and Radio Frequency Combined Link Experiment (ORCLE) program. The Department's strategic, high-speed fiber optic network, called the Global Information Grid (GIG), has an integrated network whose data rate is hundreds to thousands of megabits per second. To reach the theater's deployed elements, data on the GIG must be converted into a wireless format for reliable transmission to the various elements and echelons within the theater. ORCLE provides the wireless means for distributing GIG information to operational assets that further distribute the

information down to tactical forces – even if some high data-rate links are degraded by atmospheric or physical obstructions – by teaming high-speed optical communications with high-reliability radio communications. ORCLE's proof-of-principle was successfully tested at White Sands Missile Range last year.

We also are working on very high-speed optical networks for the global strategic network. Our Dynamic Multi-Terabit Core Optical Networks: Architecture, Protocols, Control and Management program will leverage DARPA's photonics and secure networking research programs to revolutionize the operation, performance, security, and survivability of DoD's long-haul strategic networks.

It is also essential that the tactical and strategic networks are secure. DARPA is developing technologies to make networks not only secure, but also disruption-tolerant and, when attacked, self-reconstituting.

Networks rely on a widely available timing signal, or common clock, to sequence the movement of voice and data traffic. The timing signal is provided by the Global Positioning System (GPS), and we should expect adversaries to attack our networks by denying us use of the GPS signal.

To protect the networks, DARPA has been developing microelectromechanical systems (MEMS) technology to create a miniature atomic clock – measuring approximately one cubic centimeter – to supply the timing signal should the GPS signal be lost. The Chip-Scale Atomic Clock (CSAC) will allow a network node, such as a Soldier using a Single Channel Ground and Airborne Radio System (SINCGARS), to maintain synchronous operation with the network for several days after loss of the GPS signal. Last year we demonstrated the first CSAC the size of a pager that maintains time accurately to within one second over 200 years. We currently have plans to insert a CSAC into an Army SINCGARS radio to demonstrate that it can provide a time signal if GPS is not available.

Finally, as the DoD moves towards development and deployment of true mobile ad hoc networks (MANETS), the ability to defend this type of network becomes more and more important. The Defense Against Cyber Attacks on Mobile Ad Hoc Network Systems program will develop defenses for MANETS, including automatic and dynamic quarantine response and forensics

analysis of malicious code, that can sense failures and attacks and recover automatically in real-time.

Detection, Precision ID, Tracking, and Destruction of Elusive Targets

For many years, the Department of Defense has steadily improved its ability to conduct precision strike against both stationary and moving ground targets. America's adversaries have realized that, if they are to survive the United States' superior precision strike capabilities, they either have to move, hide, or "blend-in" in cluttered environments such as urban areas.

DARPA is responding by assembling sensors, exploitation tools, and battle management systems to rapidly find and destroy ground targets in any terrain, in any weather, moving or stopped, with minimum accidental damage or casualties. To do this, we must seamlessly meld sensor tasking with strike operations to use platforms or a network of platforms that carry both capable sensors and effective weapons.

Let me give you some examples of our work and progress in this area.

DARPA's Fast Connectivity for Coalitions and Agents (Fast C2AP) program uses software agents to allow naval watchstanders to automatically monitor vessels and locate, investigate, and intercept vessels engaged in suspicious activity. Last year, Fast C2AP was deployed to both the U.S. Navy's Sixth Fleet and the North Atlantic Treaty Organization's Component Commander-Maritime and was utilized in NATO's Operation Active Endeavor. Fast C2AP increases the number of vessels that watchstanders can monitor from tens to thousands per watch, and reduces the time required to obtain detailed information regarding ships by 30-60 minutes. Fast C2AP is transitioning to the Navy.

To track vessels at sea, DARPA's Predictive Analysis for Naval Deployment Activities (PANDA) program is developing technology to automatically learn the normal behavior of over 100,000 vessels and detect when those vessels deviate from the behavior. PANDA will automatically filter deviation detections to alert on those vessels exhibiting suspicious activity – including activities that have not been previously seen or defined. In so doing, PANDA will allow analysts/operators to focus on those vessels whose current behavior is unusual, rather than relying on a predefined list of behaviors or vessels. In addition, PANDA will provide increased situational awareness by characterizing normal behavior for vessels.

DARPA's Wide Area All Terrain Change Indication Technologies (WATCH-IT) program has developed software to exploit the data collected from foliage penetrating radar. WATCH-IT uses change detection to monitor the arrival and departure of vehicles, interferometry to estimate terrain height, and tomography to construct three-dimensional models of structures hidden under the trees.

DARPA's laser detection and ranging (LADAR) sensors can obtain exquisitely detailed, 3-D imagery through foliage to identify targets in response to these cues. By flying the LADAR over a target, photons can be collected from many different angles. Those that pass through gaps between leaves, however few, can be collated together into a full image. New computational methods can match these data against 3-D geometric models of a variety of target types, even identifying gun barrels, rocket launchers, and other equipment that indicate the military nature of the vehicle.

DARPA is developing software tools to "stitch-together" information obtained from a variety of tactical sensors (e.g., moving target indicator radar, synthetic aperture radar, optical, video, and acoustic sensors), and then cue the sensors to obtain more information. For example, the change detections obtained from radar could cue the LADAR sensor to watch a new arrival. Conversely, if Predator video lost a target because it entered a forest, the radar could be cued to search for the vehicle when it stops.

We are also pursuing intelligence, surveillance, and reconnaissance capabilities in littoral waters. Our Collaborative Networked Autonomous Vehicles (CNAV) program will create a field of dozens or hundreds of networked unmanned undersea vehicles, connected by wireless acoustic communications that will work collaboratively and autonomously. Last November, and again this year, a CNAV network was tested and achieved field-level performance goals.

This strategic thrust also includes some of our most ambitious work to defeat the improvised explosive devices threat. I cannot say more about this in an open forum.

Urban Area Operations

By 2025, nearly 60 percent of the world's population will live in urban areas, so we should assume that U.S. forces will continue to be deployed to urban areas for combat and post-conflict stabilization. Unstable and lawless urban areas give terrorists sanctuary to recruit, train, and

develop asymmetric capabilities, possibly including chemical, biological, and radiological weapons of mass destruction (WMD).

Urban area operations can be the most dangerous, costly, and chaotic forms of combat. Cities are filled with buildings, alleys, and interlocking tunnels, which provide practically limitless places to hide, store weapons, and maneuver. They are hubs of transportation, information, and commerce, and they are homes for a nation's financial, political, and cultural institutions. Cities are densely packed with people and their property, creating an environment in which our adversaries can mix in and use civilians as shields to limit our military options. And insurgents don't just mix in, they *blend* in.

Warfighting technology that works superbly in the open, and even in the rugged natural terrain of the traditional battlefield, is less effective in the urban environment. By moving into cities, our adversaries hope to limit our advantages, draw more of our troops into combat, inflict greater U.S. casualties, and cause us to make mistakes that harm civilians and neutrals.

Our research seeks new urban warfare concepts and technologies that would make a smaller U.S. force operating in an urban area more effective, suffer fewer casualties, and inflict less collateral damage. If successful, these new urban warfare concepts and technologies would enable U.S forces fighting in or stabilizing an urban area to achieve the same or greater overall effect as a larger force using today's technology.

This thrust's research includes: improving urban intelligence; tagging, tracking, and locating targets: improved weapons for congested urban areas; technology to detect, prevent, or mitigate asymmetric attacks, such as suicide bomber attacks; and improved command, control, communications, and intelligence specifically suited for urban operations.

Hundreds of coalition patrols operate each day in Iraq. On patrols, our Soldiers and Marines interact with the local population and build an understanding of the environment and the pattern of life. Each individual on a patrol has a significant role as an information-gatherer, and the information is of critical importance.

DARPA's Advanced Soldier Sensor Information System and Technology (ASSIST) program will enhance the intelligence gathering capabilities of our ground troops. ASSIST is developing sensors, networks, and databases that allow a patrol leader to directly add to and use the

collective experience of previous patrols, including the details about specific neighborhoods. It allows patrol leaders and other officers to build a detailed picture of the area of operations through standardized reports. A Soldier returning from patrol enters ASSIST-collected data, such as the GPS track and photos, and Soldiers preparing for patrols would use the collected data to search for information about people, infrastructure, and past events. Soldiers in Iraq began testing this year, and their initial assessment was overwhelmingly favorable.

A typical urban mission may require a U.S. team to pursue adversaries inside a multi-story building. Defenders have a major advantage because they know the building's interior layout. DARPA's Radar Scope, which weighs less than 1.5 pounds and runs on AA batteries, allows U.S. forces to sense through nonmetallic walls, such as concrete, to determine if someone is hiding inside a building or behind a wall. Recent Army tests showed that Radar Scope was successful at detecting a person hiding behind concrete and adobe walls. DARPA is deploying 50 Radarscopes to the Army, Marines, and others for evaluation in-theater.

Improvised explosive devices (IEDs) remain a significant threat to our forces in Iraq and Afghanistan. Our Hardwire program is developing a novel hybrid armor concept primarily to protect vehicles. Hardwire's unique composition and topology uses conventional, commercially available technology and materials, and has demonstrated outstanding protection against armor piercing rounds, fragments, and IEDs in a test at the U.S. Army Aberdeen Test Center. Hardwire's armor weight is much lower than steel armor, meaning that we can achieve protection equivalent to conventional armor but at much lower weight, or greater protection at the same weight.

Another significant threat is small arms fire. DARPA's low-cost Boomerang shooter detection and location system provides a new force protection tool that warns Soldiers when they are being fired upon and the direction from where the fire is coming.

We used evaluation reports from operations with the first deployed Boomerang units to improve the system. We sent these improved Boomerang units to deployed forces, and the Soldiers tell us the system's performance has been spectacular. Over all, DARPA provided over 60 Boomerang systems to the Army. Marine Corps, Special Forces, and others. Beyond DARPA's systems,

hundreds of additional Boomerang systems have been deployed in Iraq and Afghanistan, with both Army and Marine Corps units, and more are on the way.

DARPA's Crosshairs program is extending the success of Boomerang by developing an integrated detection and warning system for our ground forces against a broad range of threats including small arms, rockets, missiles, and mortars. Our Slapshot program is looking at ways of protecting light vehicles like HMMWV's from rocket propelled grenades (RPGs). In October a Slapshot system on a HMMWV defeated two live-fire RPGs without damage beyond minor scratching of the vehicle's armor.

We have also developed a smaller, highly portable, lighter-weight sniper rifle called the DARPA XM-3, which is currently being evaluated in-theater.

In the area of command and control, we need ways to control unmanned aerial vehicles (UAVs) so that they are efficiently deployed and do not aggregate on a single target. Our Heterogeneous Urban Reconnaissance, Surveillance, and Target Acquisition Team (HURT) program simultaneously controls multiple UAVs to conduct autonomous, coordinated area searches. HURT allows warfighters to stay focused on the fight, rather than having to pilot UAVs. HURT will provide on-demand, live video from such synchronized aerial vehicles as DARPA's Wasp micro air vehicle in support of force protection and cordon and search missions.

The Real-time Adversarial Intelligence and Decision-making (RAID) program is developing technologies to help a tactical commander estimate the location, strength, and intent of hostile forces and predict their likely tactical moves. Think of RAID as a computerized tactical advisor. In a recent experiment at Ft. Leavenworth, RAID software helped junior officers best a team of seasoned officers in estimating the location, strength, and intent of hostile forces in a simulated urban combat environment.

Command Post of the Future (CPOF) is a distributed command and control system that provides commanders with planning and mapping tools, and allows command and control centers to be wherever the commanders are – without regard to a fixed geographic location. Deployed forces are currently using over 600 CPOF systems in Iraq. Soldiers say CPOF allows them to share information and respond more quickly, while providing greater flexibility and insight. CPOF has transitioned to an Army Program of Record.

DARPA is adapting commercial computer game technology to train U.S. warfighters in the unique combat skills they need in the urban environment, such as tactical language skills and avoiding ambushes. DARWARS Ambush! is a PC-based trainer that teaches Soldiers how to recognize, manage and recover from convoy attacks. DARWARS Ambush! has spread throughout the Army: Fort Lewis, Washington uses the technology to train up to 400 Soldiers a month; over 300 DARWARS Ambush! systems are in use by the Army in Europe; and, last summer, 800 West Point cadets used the tool to train in dismounted infantry operations. The system is also being delivered to troops in Iraq and Afghanistan.

DARPA's Tactical Language and Culture Training systems are now teaching Soldiers, Marines and Airmen to speak basic Iraqi Arabic or Afghan Pashto through a computer-game-like interface. The tool was created to teach a bit of the culture, gestures and mission-oriented vocabulary. Eight-hundred copies of the tool have been set up at bases everywhere from stateside to Iraq and Afghanistan. Now, anyone with a ".mil" email address can download Tactical Iraqi for use on personal computers.

These digital tutors have proved to be very useful. We are also updating the systems to teach Soldiers how to troubleshoot information technology systems and reduce the need for information technology specialists.

Advanced Manned and Unmanned Systems

Unmanned systems provide autonomous and semiautonomous capabilities that free Soldiers, Sailors, Airmen and Marines from the dull, dirty, and dangerous missions which might now be better executed robotically. And they enable entirely new design concepts unlimited by the endurance and performance of human crews. The unmanned aerial vehicles in Afghanistan and Iraq have been demonstrating their transformational potential.

DARPA's efforts have been focused in two areas. First, DARPA seeks to improve individual platforms so that they provide new or improved capabilities, such as unprecedented endurance or survivability. Second, we are expanding the autonomy and robustness of robotic systems.

Progress is measured in how well unmanned systems can handle increasingly complex missions in ever more complicated environments. Autonomy and robustness are improved by networking manned and unmanned systems into a more tightly coupled combat system that will improve our

knowledge of the battlespace, enhance our targeting speed and accuracy, increase survivability, and allow greater mission flexibility.

One miniature airborne sensor ideally suited for small unit operations (both in the open terrain and the urban environment) is the Wasp micro air vehicle, a small, quiet, portable, reliable, and rugged unmanned air platform designed for front-line reconnaissance and surveillance over land or sea.

Wasp is capable of flying in excess of one hour, with a speed range of 20-40 miles per hour, and provides real-time imagery from relatively low altitudes. With only a 16-inch wingspan, weighing about two-thirds of a pound, and fitting in a backpack, Wasp serves as a reconnaissance platform for the company level and below by virtue of its extremely small size and quiet propulsion system. Wasp prototypes are currently under extended evaluation in-theater by the U.S. Marine Corps and the U.S. Navy.

The Oblique Flying Wing program is demonstrating a transformational design concept for a new class of efficient supersonic aircraft. At supersonic speeds, the oblique flying wing flies with one wing swept forward and the other swept backward, and has lower supersonic wave drag than conventional symmetrically swept wings. And at low speeds, the wing (really the entire plane) pivots to an unswept design for better subsonic efficiency, because at low speeds an unswept wing is more efficient than a swept one.

This flexibility will improve range, response time, fuel efficiency, and endurance for supersonic strike, intelligence, surveillance and reconnaissance missions, and transport missions. The goal of the program is to prove out the stability and control technologies required for an oblique flying wing with an X-plane that will demonstrate an asymmetric, variable sweep, tailless, supersonic flying wing. We have completed the baseline X-plane design and conducted initial low-speed wind tunnel testing in January.

One of a pilot's more complex and dangerous tasks is midair refueling. DARPA has developed technologies that can do this for unmanned aircraft and could be applied to manned aircraft to improve safety and efficiency. The Autonomous Airborne Refueling Demonstration program is demonstrating this technology on a modified F-18. During the demonstration, the pilot watched – literally with his hands and feet off the aircraft's controls – the automated system successfully

perform rendezvous, station-keeping, separation, emergency override maneuvers, and fully autonomous aerial refueling.

Just as air vehicles have moved toward both increased mission complexity and increased environmental complexity, we are also trying to increase both the mission and environmental complexity for autonomous ground vehicles.

From our testimony last year and news reports, you probably are familiar with our successful Grand Challenge, held in October 2005. Five autonomous vehicles completed a 132-mile course across the desert – four of them under the required 10 hours – and the fastest, "Stanley" of Stanford University, was awarded a $2 million prize.

It was an important step to have autonomous ground vehicles that can navigate and drive across open and difficult terrain from city to city. But the next big leap will be an autonomous vehicle that can navigate and operate in traffic, a far more complex challenge for a "robotic" driver. So this November we are very excited to be moving from the desert to the city with our Urban Challenge. The Urban Challenge is designed to accelerate the development of autonomous ground vehicles that can navigate in an urban environment and operate safely among other vehicles. Prizes of $2 million, $1 million, and $500,000 will be awarded to the first, second, and third place teams that complete the Urban Challenge's 60-mile course in six hours or less.

Detection, Characterization, and Assessment of Underground Structures

Our adversaries are well aware of the U.S. military's sophisticated intelligence, surveillance, and reconnaissance assets and the global reach of our strike capabilities. In response, they have been building deeply buried underground facilities to hide various activities and protect them from attack.

While large, developed facilities have long been recognized as strategic threats, there is increasing need to find and characterize small underground structures. These include caves that serve as hiding places and tunnels for smuggling weapons and infiltrators across borders. Caves and tunnels provide secret entry into sensitive areas, such as Baghdad's International Zone, and might even contain prisons, weapons laboratories, or nuclear power plants.

To meet the challenge posed by the proliferation of these facilities, the Counter-Underground Facility program is developing a variety of sensor technologies and systems – seismic, acoustic, electromagnetic, optical, and chemical – to find, characterize, and conduct post-strike assessments of underground facilities.

Our program is working on tools to answer the questions, "Where is the facility? What is this facility's function? What is the pace and schedule of its activities? What are its layout, construction, and vulnerabilities? How might it be attacked? Did an attack destroy or disable the facility?"

To answer these and other questions, DARPA is developing ground and airborne sensor systems with two-orders-of-magnitude improvement in sensor system performance, with emphasis on advanced signal processing for clutter rejection in complex environments.

Our Low-Altitude Airborne Sensor System (LAASS) is demonstrating the use of airborne electromagnetic, acoustic, and gravity sensors to rapidly find underground facilities and map out their backbone structure. In proof-of-concept testing, LAASS exhibited excellent performance, and DARPA has begun prototype development.

The LAASS unmanned aerial vehicle sensor prototype has undergone successful developmental flight tests on a UAV. We have begun a new effort to specifically address the small tunnel and bunker threat using active electromagnetic and gravity signature sensing. It is likely that these technologies could also help in the battle against improvised explosive devices.

One of our warfighters' unmet needs is knowing their location in underground facilities and tunnels while conducting search, attack, and rescue missions. DARPA's Sub-Surface Navigation program is conducting underground tests of a small, lightweight GPS-like capability that uses very low frequency earth-penetrating signals to provide real-time self-location to our forces on underground missions. Our goal is to make our warfighters as aware of their position while underground as they are on the surface.

Space

DARPA began as a space agency, when the shock of Sputnik caused Americans to believe the Soviet Union had seized "the ultimate high ground." DARPA maintains an ambitious effort to

ensure that the U.S. military retains its preeminence in space by maintaining unhindered U.S. access to space and protecting U.S. space capabilities from attack.

There are five elements in DARPA's space strategic thrust:

- *Access and Infrastructure:* technology to provide rapid, affordable access to space and efficient on-orbit operations;
- *Situational Awareness:* the means for knowing what else is in space and what that "something else" is doing;
- *Space Mission Protection:* methods for protecting U.S. space assets from harm;
- *Space Mission Denial:* technologies that will prevent our adversaries from using space to harm the U.S. or its allies; and
- *Space-Based Support to the Warfighter:* reconnaissance, surveillance, communications, and navigation to support military operations down on earth – extending what the United States does so well today.

The Falcon program is designed to vastly improve the U.S. capability to promptly reach orbit. It includes developing new, low-cost, small launch systems that could be used to launch hypersonic test vehicles and satellites. These new systems will enable affordable and responsive launch for payloads in the 1000-pound class and reduce launch costs by over 50 percent. One of the systems is designed to bypass bottlenecks at ground launch sites by using a C-17 transport aircraft to carry an air-launched rocket to altitude. Last July we conducted the third successful air drop test of a 72,000 pound, 66 foot-long test article from 29,500 feet, the largest and heaviest object ever dropped from a C-17. By the end of 2009, Falcon will also have conducted flight tests of hypersonic test vehicles, spurring progress in this critical area.

DARPA's Orbital Express program promises to fundamentally change on-orbit satellite operations with technology to refuel satellites and replace their electronics on-orbit. This offers a way to dramatically improve the life span, maneuverability, and self-protection of orbiting satellites. Two satellites, NextSat and ASTRO, are now in orbit to demonstrate such key functions as proximity operations and rendezvous, refueling, and electronics replacement.

The F6 (Future Fast, Flexible, Fractionated, Formation-Flying Spacecraft) program takes a technically aggressive approach to combining separately launched space payloads and spacecraft subsystem elements. F6 will develop methods for satellite payloads and subsystem elements to operate in close formation, dividing mission requirements between nodes of the formation.

Satellite systems could be repaired or upgraded by placing a new, wirelessly connected node into the formation. The systems could be less vulnerable to attack or failure because the components are physically separated. This concept also promises improved reliability and reduced risk from launch failures.

The Space Surveillance Telescope (SST) program will demonstrate rapid, uncued search, detection, and tracking of faint, deep-space objects, such as small, potentially hazardous debris objects and future generations of small satellites. SST's optics has passed a significant milestone, separating the primary and secondary mirror blanks from a single 3.6-meter diameter Zerodur blank. SST is the first implementation of recent advances in curved focal plane technology, enabling the design of a novel, wide field of view, rapidly scannable, three-mirror, 3.6-meter telescope.

Our Deep View program is developing a high-power, high-resolution, ground-based radar to image and characterize small objects in both low-Earth (LEO) and geo-stationary (GEO) orbits. Imaging objects in deep-space requires very large antennas and very high radar power, so Deep View is developing transmitters capable of providing the required power to image at deep-space ranges over full bandwidth, using antennas that maintain the necessary shape over a very large aperture. In FY 2008 we will support demonstration of a low-power system to demonstrate a LEO-only imaging capability. Then we will proceed to a full power Deep View system to demonstrate the capability to image objects in both LEO and GEO. Deep View technology, planned for transition to the Air Force in FY 2009, will be used both to classify unknown objects, such as space debris, and to monitor the health and status of our operational satellites.

DARPA's Integrated Sensor Is Structure (ISIS) program is the most capable U.S. moving target indicator radar for air and ground targets ever conceived. Using the enormous platform surface area available on a stratospheric airship, ISIS will incorporate an extremely large antenna (approximately 1600 square meters) directly into the structure of the airship. A single ISIS stationed over Baghdad today would provide total airspace knowledge and unprecedented ground vehicle tactical tracking across more than 80 percent of Iraq. Work is proceeding on ISIS component development, including the solar-regenerative power system, the active electronically scanned aperture X-band radar, and the lightweight hull structural material.

Increasing the Tooth to Tail Ratio

We previously called this thrust "Cognitive Computing," but we have recently brought other research areas under this thrust and renamed it to better communicate its fundamental purpose: getting a larger proportion of our forces into the fight.

Information technology can reduce the need for large numbers of clerical and administrative personnel. By using and improving information technology, we can reduce the layers and numbers of personnel supporting military operations (the "tail") relative to the number of fighting forces in the field (the "tooth"), while enabling warfighters to do new things.

The major themes of this thrust are:

- *Cognitive Computing* – Reducing manpower by providing information systems that "know what they are doing" and whose functionality improves through user interactions;
- *High Productivity Computing Systems* – Speeding up the development and deployment of new weapon systems by more complete and rapid design and testing; and
- *Language Processing* – Improving our global operations by providing local knowledge and interaction with the local population by removing language and culture barriers through superb machine language translation, thereby reducing the need for human translators.

Cognitive Computing

Computer systems are essential to military logistics and planning, command and control, and battlefield operations. However, as computing systems have become pervasive in DoD operations, they have also become increasingly more complex, fragile, vulnerable to attack, and difficult to maintain. The computing challenges facing the DoD in the future – autonomous platforms that behave reliably without constant human intervention, intelligence systems that effectively integrate and interpret massive sensor streams, and decision support systems that can adapt rapidly – will depend on creating more flexible, competent, and autonomous software.

DARPA has embarked on an ambitious mission to create a new generation of computing systems – cognitive computers – to dramatically reduce military manpower and extend the capabilities of commanders and warfighters. Cognitive computing systems can be thought of as systems that "know what they're doing." DARPA's cognitive computing research is developing technologies that will enable computer systems to learn, reason and apply knowledge gained through experience, and respond intelligently to new and unforeseen events.

Success will have enormous benefits for our military. In the real-time environment of military operations, cognitive systems that can learn, reason, and draw on their experience to assist their user will make a huge difference. Cognitive systems will give military commanders and their staffs better access to a wide array of rapidly changing information, reduce the need for skilled computer system administrators, and dramatically reduce the cost of system maintenance.

For example, today's computers handle low-level processing of large amounts of raw data and numeric computations extremely well. However, they perform poorly when trying to turn raw data into high-level actionable information because they lack the capabilities we call "reasoning," "interpretation," and "judgment." Without learning through experience or instruction, our systems will remain manpower-intensive and prone to repeat mistakes, and their performance will not improve. The DoD needs computer systems that can behave like experienced executive assistants, while also retaining their ability to process data like today's computational machines.

The Personalized Assistant that Learns (PAL) program is creating revolutionary technology for commanders and warfighters – the first comprehensive system that will enable commanders to understand, at a glance, all aspects of the current military situation. PAL will radically reduce manpower and labor required in command posts and in the field, and will automate the massive number of administrative and analytical tasks of today's command centers. PAL systems will automatically adjust to new environments and users; help commanders adapt to evolving situations and priorities; and enable new command center personnel to become effective more quickly.

PAL combines the efforts of 21 universities and research laboratories across the United States, and has already produced a wide range of research breakthroughs in machine learning, knowledge representation and reasoning, communications and interaction, and computational perception.

Because cognitive assistants must learn in order adapt to new situations without reprogramming, PAL is also driving great improvements in the area of computer learning. Recent formal tests of a fully integrated PAL prototype demonstrated remarkable performance improvements in learning capabilities, doubling the system performance over the previous year.

PAL technology is being transitioned to the U.S. Army's Command Post of the Future (CPOF) system to support shift changes, delegation, and other tasks where the user needs to describe the significant activities to the next shift. Working with CPOF, PAL learns significant battlefield activities, organizes them, and locates them on maps. An officer returning from Iraq remarked, "PAL could be an incredibly powerful tool for Tactical Operations Center operations. It has the potential to save countless man-hours by performing routine, repetitive tasks... Those man-hours could then be reallocated to other tasks ... or even free up Soldiers to conduct combat operations." This prototype capability will be ready for evaluation by the Army CPOF program office shortly.

DARPA is fostering the computer science for this century, computer science that will enable computing machines that are much more flexible and useful. These will be computers that can learn and adapt to their situations and think about them analytically with flexibility, adaptability, and insight, while retaining the precision and persistence of current computers. We are striving to achieving computers that have more of the qualities of good staff, while maintaining their traditional virtues of machine precision.

Our drive to build computers that reason and learn is directly tackling the most fundamental problems in computer science.

High Productivity Computing Systems

The High Productivity Computing Systems (HPCS) program is the Federal Government's flagship program in supercomputing. HPCS is pursuing the research, development and demonstration of economically viable, high productivity supercomputing systems for national security and industrial users.

But the story is more than just achieving enormous computing speeds. We are looking into what makes computers *productive*. HPCS emphasizes programmability, portability, scalability, and robustness – as well as high performance goals of achieving multiple petaflops and thousands of global updates of memory per second. We are focusing on issues like how long it takes to develop new software, how easy it is to port legacy codes, can these machines run code correctly in the presence of processor failures, and other usability factors. In November, DARPA announced its two performers for the next phase of HPCS to build prototypes.

The performers will demonstrate substantial improvements in both the time that it takes to write new software and the actual time it takes to run that software on the petascale machines. Specifically, they will demonstrate the capability to reduce the development time of new, large software to one tenth of the time that it takes to develop applications today, with the goal that the applications run in less than one percent of the execution time required on today highest performing machines.

Language Processing

Real-time language translation would help U.S. forces better understand the adversary and the overall social and political context of the operational area. This improved awareness would decrease costly operational mistakes due to misunderstandings, thus improving the chances of operational success.

Today, linguists translate important information, but it is a slow process because we have too much raw data and not enough linguists. We want to dramatically reduce the need for linguists at both the strategic and tactical levels with machine translation capabilities that are revolutionary.

The Global Autonomous Language Exploitation (GALE) program is designed to translate and distill foreign language material (e.g., television shows and newspapers) in near real-time, highlight the salient information, and store the results in a searchable database. Through this process, GALE is able to produce high-quality answers to the type of questions that are normally provided by bi-lingual intelligence analysts. GALE is working to achieve this very ambitious goal by 2010. Initial capabilities developed in the program were deployed to two sites in Iraq, where they are translating Arabic speech and text into English.

GALE has dramatically improved the state of the art in machine translation, virtually doubling accuracy rates that were previously thought possible. The translation accuracy of structured Arabic into English increased from an average of 55 percent to a minimum of 75 percent for 90 percent of the documents translated from text, and from an average of 35 percent to a minimum of 65 percent for 80 percent of the documents translated from speech. Just as impressive are the numbers for Chinese, in which the accuracy increased from 35 percent to 65 percent for text, and from 20 percent to 65 percent for speech. The objective translation goal

for Arabic or Chinese into English is a minimum accuracy of 95 percent for 95 percent of text and 90 percent of speech for material rated by the Interagency Language Roundtable scale to be of Skill Level 3 to 4. Translation accuracy is measured by editing machine translation to reflect the meaning conveyed by a gold standard translation, which is created by three translators, two quality assurance translators, and an adjudicator. The number of edits divided by the number of words in the English document determines the error rate, and the accuracy is determined by subtracting the error rate from one.

Overall, GALE's translation of structured speech and text (e.g., over broadcast news and newswire) has improved to the point that it produces "edit-worthy" text, where it is more efficient for a translator to edit it directly rather than retranslate the material.

At the tactical level, there are not enough translators for each patrol or vehicle checkpoint. Our warfighters also need automatic, on-the-spot speech translation to work with Iraqi units, or use what they might be told by locals about insurgents or suspicious activities.

DARPA's Spoken Language Communication and Translation System for Tactical Use (TRANSTAC) program has successfully demonstrated the first two-way speech translation to translate Baghdadi Arabic, a dialect spoken by most of the population in central Iraq, into English, and vice versa. This technology is now on laptop computers and has a vocabulary of approximately 70,000 words. Accuracy rates achieved are 70-80 percent in a laboratory environment with conversations confined to a specified subject area.

Sixty-five prototype TRANSTAC units are being field-tested in Iraq. Feedback from these tests will be used to improve the performance and usability of the system. The goal is hands- and eyes-free systems that can be used outdoors.

Bio-Revolution

DARPA is mining new and fundamental discoveries in the life sciences for concepts and applications that could enhance U.S. national security in revolutionary ways.

The Bio-Revolution thrust has four broad elements:

- *Protecting Human Assets* refers to DARPA's work in biological warfare defense (BWD) and combat casualty care. Advances in BWD will protect warfighters not only from biological warfare agents, but also from the infectious diseases they regularly encounter overseas. We

are also developing advanced combat casualty care technologies to greatly improve the chances of our wounded surviving battlefield injury.

- *Biology to Enhance Military Systems* refers to creating new systems with the autonomy and adaptability of living things by developing materials, processes, and devices inspired by living systems. The idea is to let nature be a guide toward better engineering.
- *Maintaining Human Combat Performance* is aimed at maintaining the warfighter's peak physical and cognitive performance once deployed, despite extreme battlefield stresses such as heat and altitude, prolonged physical exertion, and sleep deprivation.
- *Restoring Combat Capabilities after Severe Injury* describes the revolutionary technology DARPA is developing to restore full function after severe injuries. Examples include techniques to accelerate healing and revolutionary new prostheses for combat amputees.

In the BWD arena, current drug and vaccine development takes years or even decades, requiring the current biodefense strategy of stockpiling therapeutics based on the latest threat projections. One DARPA Future Icon is working to accelerate the development and production of vaccines and other medical therapeutics.

Once a basic vaccine, antibody, or immune enhancer has been identified and has undergone pre-clinical evaluation, our Accelerated Manufacturing of Pharmaceuticals program is looking at ways to manufacture millions of doses in 12 weeks or less – instead of the 12 years (and often much longer) required today – at pennies per gram. We are looking at leveraging the large-scale, mass-production industrial processes used in enzyme manufacturing, as well as other techniques such as bacterial fermentation, and "pharming" mushrooms and shrimp to produce large quantities of specific proteins quickly and cheaply.

Now let me turn to the area of *Protecting Human Assets*.

Our PREventing Violent Explosive Neurological Trauma (PREVENT) program is a basic research program looking for the mechanisms of neurological injury – particularly brain injury – caused by blast, such as from an improvised explosive device.

We do not have a good enough understanding of the mechanisms behind the symptoms we are seeing. It used to be thought that peak overpressure was the primary mechanism for blast injury, but that does not appear to be the case for many of the neurological symptoms in today's wounded. PREVENT is an aggressive program to fully characterize the harmful components of blasts, including the brain effects of repeated small blasts that individually might not seem

harmful. Once we better understand the physical mechanisms of neurological injury, we can design specific technologies to protect our warfighters against them.

In the area of *Maintaining Human Combat Performance*, one of the most important things we could do for our troops is reduce their pain when they are injured or wounded. Under our Soldier Self Care program, DARPA is pursing a radically different way of treating acute, severe pain. The current best treatment is morphine, which reduces pain quite well – but because morphine acts on the central nervous system (CNS), it also impairs cognition and can dangerously depress body functions. Instead, DARPA is pursuing capabilities to protect cognition by blocking the pain receptors right at the injury site to prevent them from firing and sending a pain signal to the CNS. This will help a Soldier remain alert in dangerous situations.

This research is progressing well. We've shown the treatment is safe, and, at this point, even more effective than morphine – but without morphine's side effects. The next step is for a pharmaceutical company to fund the trials necessary for FDA approval.

Another program in this area is Preventing Sleep Deprivation. During extended operations, where our warfighters receive limited sleep, they are challenged to remain alert to dangers. The difficulty is that, while one can stay awake, the resultant sleep deprivation degrades cognition and the ability to make good decisions.

We have been looking for ideas to keep the brain functioning at alert levels during periods of sleep deprivation. The research has led to drugs that are used for Alzheimer's disease called "ampakines." Ampakines seem to mitigate the effects of fatigue so that test subjects can stay mentally sharp after an overnight period of work, without using any of the current generation of stimulants.

In the area of *Biology to Enhance Military Systems*, we are researching how to use lessons from biology, or even the power of biological systems themselves, to improve our military systems.

Our brains are the finest processors of visual imagery that we know of. No machine yet devised even comes close to the brain at visual pattern recognition.

Our Neurotechnology for Intelligence Analysts (NIA) program seeks ways to harness the unique capacity of the brain for visual pattern recognition to vastly improve the productivity of our imagery analysts and allow them to spend more time on actual analysis.

Not only is the brain the best visual pattern recognition system that we know of, it turns out that the visual pattern recognition part of the brain actually spots things faster than your consciousness can register it. We can now noninvasively detect that the visual pattern recognition system of your brain has spotted something of interest before you consciously know it. This key scientific fact underpins NIA.

One of the first things that imagery analysts must do is actually spot something interesting among the tremendous amount of largely boring, non-interesting imagery they review. This methodical process of going through large volumes of imagery looking for items of interest is aptly nicknamed "mowing the lawn." Our NIA program has shown that, by noninvasively monitoring the brain's responses, we can detect the images of interest three to five times faster. This reduces significantly the time required to find targets and, thus, provides analysts more time to focus on analyzing the items of interest.

Our flagship programs in *Restoring Combat Capabilities after Severe Injury* are the closely related Human-Assisted Neural Devices (HAND) and Revolutionizing Prosthetics programs.

HAND is a basic research program broadly aimed at understanding how the brain processes motor control and sensory signals from the level of individual nerve cells to the level of local and regional brain networks to the level of the whole brain itself. One important component is deciphering how the brain encodes and decodes information to and from normal human limbs to support our effort in revolutionizing prosthetics. There are two separate problems. The first is decoding motor commands in the brain, so we can get those commands out of the brain to run an external device. The second is getting feedback from the external device back into the brain so the brain can actually sense what the device is doing and exercise what is called "closed-loop control."

While things like improved body armor and medical care are saving more wounded, we have more people surviving that have lost limbs. Current prosthetic leg technology is advancing. However, prosthetic arm technology is much more difficult, since it involves so many more

joints and movements, as well as the combined abilities to touch, sense, and manipulate fine objects.

DARPA's goal is to revolutionize upper extremity prosthetics, specifically arms and hands. Today, individuals experience such prosthetics – to the extent they can use them at all – like a *tool*, not like a limb. We are striving for a prosthetic arm that people can control with their brains and use just like they can control and use a natural limb. It is a major scientific and engineering challenge to integrate new science from HAND and many technologies – materials, power, control systems, sensors and actuators – to build a vastly improved upper limb prosthetic.

The program will deliver a prosthetic in about a year for clinical trials that is far more advanced than any currently available. This device will enable many degrees of freedom for grasping and other hand functions, and will be rugged and resilient in all environments. It will enable the amputee to have a three-fold improvement in abilities required for daily independent living. And we are making rapid progress: the performers fitted and attached a prototype arm in January. Within hours and with minimal training, the user was able to control the arm in all seven degrees of freedom, including a powered shoulder.

Program plans are to deliver a prosthetic in three years for clinical trials that has function almost identical to a natural limb in terms of motor control and dexterity, sensory feedback, weight, and environmental resilience. This device will be directly controlled by neural signals. Our goal is to give our warfighters that are upper limb amputees the chance to return to active duty as fast as possible.

Core Technologies

While the eight DARPA strategic thrusts described earlier are influenced by national security threats and opportunities, a major portion of DARPA's research emphasizes areas largely independent of current circumstances. These core technologies are the investments in fundamentally new technologies, at the component level, that historically have been the technological feedstocks that lead to new systems and significant advances in U.S. military capabilities.

Quantum Science and Technology

Until recently, quantum effects in electronic devices did not have overriding significance. However, as device sizes shrink, quantum effects can influence device performance. DARPA is conducting research aimed at technology built around exploiting quantum effects to achieve revolutionary new capabilities.

One example is DARPA's "Slow Light" program. Researchers are using quantum effects that influence the passage of light through materials under special conditions to actually control the speed of light and slow it to a faction of its normal speed. If light can be slowed practically without losing the information it carries, it can be stored and switched, much as we store and switch the electric charges in electronics today. This technology opens the door to a revolution in ultra-high-speed optical information processing.

Bio-Info-Micro

For the past several years, DARPA has been exploiting and developing the synergies among biology, information technology, and micro- and nanotechnology. Advances in one area often benefit the other two, and DARPA has been active in information technology and microelectronics for many years. Bringing together the science and technology from these three areas produces new insights and new capabilities.

The Fundamental Laws of Biology program is working to develop a new basis for doing biological research by bringing an increased mathematical discipline to biology, including creating new mathematics to reveal unanticipated features and relationships. The goal is to discover the fundamental laws of biology that extend across biological scales, and that can be used to make accurate predictions about repeatable performance, just as physics-based theories enable performance predictions. We are making progress developing new and rigorous mathematics to describe such phenomena as evolution of microscopic organisms, the growth of supporting structure within plants and animals, and the behavior of large groups of animals moving in groups, such as schools of fish, and scaling laws that connect microscopic dynamics to macroscopic patterns.

Materials

DARPA continues to maintain a robust and evolving materials program. DARPA's approach is to push new materials opportunities and discoveries that might change how the military operates. In the past, DARPA's work in materials has led to such technology revolutions as high-temperature structural materials for aircraft and aircraft engines, and the building blocks for the world's microelectronics industry. The materials work DARPA is supporting today continues this heritage.

DARPA's current work in materials includes the following areas:

- *Structural Materials and Components*: low-cost and ultra-lightweight materials designed for structures and to accomplish multiple performance objectives in a single system;
- *Functional Materials*: advanced materials for non-structural applications such as electronics, photonics, magnetics, and sensors; and
- *Smart Materials and Structures*: materials that can sense and respond to their environment.

DARPA's Prognosis program has developed physics-based materials damage models that accurately describe damage accumulation from flight operations in both aircraft and engine structures. By combining these models with sensor and usage information, we will have much better predictions of the safety and remaining life of aircraft. This will make operations safer and improve overall readiness by minimizing the groundings needed for inspection. Prognosis models have been shown to be robust and applicable to the Navy's EA-6B and P-3 aircraft, and to the F-100 and F-110 engines. Prognosis also demonstrated the ability to diagnose and predict the progression of previously undetectable damage in gearboxes of Army and Navy helicopters.

Our Evaporative Cooling Turbine Blades program is developing innovative technology to cool gas turbine engine blades, which holds the promise of reducing specific fuel consumption. In an area where efficiency improvements of tenths-of-a-percent are considered dramatic, if our preliminary results are borne out in upcoming engine tests, the fuel savings will be significant.

DARPA has demonstrated a titanium production process that offers the potential for radically reducing the price of titanium to less than four dollars per pound for military-grade quality metal. This program, one of DARPA's Future Icons, is advancing from the feasibility stage to a

prototype operation. This technology will create a true paradigm shift in the use of titanium, as occurred once aluminum was no longer a precious metal but could be produced economically.

Power and Energy

Portable sources of electric power are critical to today's military. To Napoleon's dictum that an Army moves on its stomach, today's warfighting forces could add, "...and on energy."

Developing portable, efficient, and compact power supplies has important ramifications for increasing our military's reach, while at the same time decreasing material logistic requirements.

DARPA has been active in this area for several years. The Palm Power program is one example, which, among other things, developed portable solid oxide fuel cell technologies that are now being used in intelligence applications and are being further explored by the Air Force.

The Very High Efficiency Solar Cell program is aimed at developing photovoltaic devices with efficiencies exceeding 50 percent. The program has a novel design architecture that integrates previously incompatible materials technologies to maximize performance across the solar spectrum. The optical system at the heart of this new design has recently achieved breakthrough efficiency – a huge step towards our goal of a solar cell with an overall efficiency of 50 percent.

To help reduce the military's reliance on petroleum-based fuels to power their aircraft, ground vehicles, and ships, DARPA's BioFuels program is working to develop an affordable surrogate for military jet fuel (JP-8) derived from oil-rich crops, such as rapeseed, or produced by either agriculture or aquaculture including, but not limited to, plants, algae, fungi, and bacteria. DARPA recently selected three performers to demonstrate converting these renewably produced oils to JP-8 with a minimum process efficiency of 60 percent, and an ultimate goal of 90 percent.

Microsystems

DARPA is shrinking ever-more-complex systems into chip-scale packages, integrating microelectronics, photonics, and microelectromechanical systems (MEMS) into "systems-on-a-chip" that have new capabilities. It is at the intersection of these three core hardware technologies of the information age that some of the greatest challenges and opportunities for DoD arise. The model for this integration is the spectacular reduction in transistor circuit size under Moore's Law: electronics that once occupied entire racks now fit onto a single chip

containing millions of transistors. There is also a second law that could be stated: the nonlinear increase in transistors per chip has also led to a nonlinear increase in the capital required to build a plant or set up a production line.

An example of the move to integrated microsystems is the 3-D Electronics program. Conventional 2-D circuits are limited in performance by the long signal interconnects across ever larger circuits and by existing circuit architectures. By moving to three dimensions, we can shorten the signal paths and introduce additional functions in each layer of 3-D stacked circuits that will change the way designers can exploit circuit complexity.

This increasing integration will change system architectures. The Vertically Interconnected Sensor Array program is revolutionizing how focal plane arrays are coupled to their readout electronics by putting the electronics directly behind each pixel. New wafer-level processing technology makes it possible to construct these 3-D stacks, which will dramatically increase the performance and reduce the footprint of the focal plane.

DARPA is tackling one of the most important roadblocks to increasing chip integration: heat dissipation. As both the number of transistors on a chip and their clock frequency increase, the waste heat generated rises sharply. Today, some chips radiate as much heat per square inch as a hotplate, and as a result, faster chip clock speeds can not be used, hence threatening to break Moore's Law of continued performance improvement through transistor scaling and increasing clock speed.

DARPA is pursuing three ways to push through the heat dissipation roadblock.

First, we are looking at an entirely new type of transistor, called a tunneling transistor, that would operate at lower voltages – ¼ volt instead of today's 1 volt – thereby greatly reducing the active heat dissipation, which is proportional to the square of the voltage.

Second, we are working to reduce the standby heat dissipated when a transistor is nominally "off," but still leaks a small amount of current. This problem has increased in recent years as transistors have become smaller. One possible solution is nanoelectromechanical switches that would physically disconnect, or "unplug" a transistor when it is off, preventing leakage current that generates waste heat.

Third, DARPA is working to reduce the heat dissipated by the interconnects, or wires, that connect the active devices within a chip – another important source of heat. The model here is what we have done with our telecommunications systems: for the long-haul circuits we have replaced electric wires with optical fiber. Similarly, to limit the heat from wire interconnects in integrated circuits, DARPA is pursuing replacing some of the longer metal wires with optical interconnects, which will generate far less heat.

DARPA is also working to lower the costs of the integrated circuits and microsystems the DoD needs.

It is very expensive to develop the masks needed for the typical process of printing application specific integrated circuits. This poses a particular problem for the DoD because, while high volume production can amortize the high cost of such masks across many chips, DoD generally needs only low volumes. This means that the upfront costs for a mask can make DoD-specific chips extremely expensive and threaten to limit DoD use of leading-edge microelectronics.

In response, our Maskless Direct-Write Nanolithography for Defense Applications program is developing a maskless, direct-write lithography tool that will address both the DoD's need for affordable, high-performance, low-volume integrated circuits and the commercial market's need for highly customized, application-specific integrated circuits. This program, based on writing circuits versus printing them, will also provide a cost-effective manufacturing technology for low-volume nanoelectromechanical systems and nanophotonics initiatives within the DoD. DARPA has entered into a cofunded joint development agreement with an integrated circuit tool manufacturer to produce a direct-write, maskless lithography tool. When installed in the Trusted Foundry and in commercial foundries. this would enable state-of-the-art microelectronic circuits to be used in new military systems and the cost-effective upgrade of legacy military systems.

More generally, DARPA is working to lower the cost of microsystems by making it possible for more of the elements of such systems to be made much like silicon-based electronic integrated circuits are made. The idea is to integrate more types of devices onto chips so that they can follow the Moore's law curves that have helped make silicon integrated circuits inexpensive. In short, we are getting Moore's law to apply to more things.

Our 3-D Microelectromagnetic Radio Frequency Systems (3-D MERFS) program should decrease the cost of millimeter-wave radar and communications systems by 100-fold. The key to this is that the coaxial connectors, couplers and resonators that link the active radio frequency devices will now be printed along with the devices.

Similarly, our Electronic and Photonic Integrated Circuits on Silicon (EPIC) program has focused on integrating photonics with silicon. Recently, EPIC has found a way to generate laser light on silicon, a profound development which could have a revolutionary impact on microelectronics. By having lasers that are an integral part of the low-cost silicon used in electronic circuits, the laser light can be directly coupled into the silicon – instead of having to build lasers separately and then piping the light onto the silicon. This promises revolutionary benefits from silicon-based, on-chip optical data processing that is ubiquitous, ultra high-speed, and very low-cost. And our wide band gap semiconductor programs have been moving that type of semiconductor toward lower cost production techniques by improving the materials, so they can be processed in economically sized wafers, and improving the processing techniques themselves.

Information Technology

DARPA's work in information technology is integrated with the strategic thrust to increase the Tooth to Tail Ratio. It is a core technology that supports a broad set of opportunities.

A key area in information technology is embedded systems: special purpose computer systems contained in the device they help control, enabling advanced intelligent functionality such as flight controls, radar, and electronic countermeasures. Embedded computing is critical across a broad range of military applications, such as handheld devices used in the field, intelligent weapon systems, and airborne information and command centers.

Current DoD embedded computing systems are point-solutions, tailored to a specific, static, and inflexible set of mission requirements. These implementations lead to one-of-a-kind systems that are costly to develop and unable or extremely expensive to adapt to changing requirements.

DARPA is pursuing technologies to overcome these limitations. This includes technologies for efficiently designing embedded systems for high performance, flexible embedded processing, and for recovering and maintaining investments in software. These technologies are essential to

providing embedded systems that can be efficiently implemented and adapt to changing missions. In its Polymorphic Computing Architecture program, DARPA is developing a class of flexible processors which can reconfigure dynamically, as required by the mission.

Mathematics

Our current mathematical themes include topological and geometric methods, inverse methods, multiresolution analysis, representations, and computation that are applied to design and control complex systems, extract knowledge from data, forecast and assess risk, develop algorithms, and perform efficient computations. Potential Defense applications include signal and image processing, biology, materials, sensing, and design of complex systems.

For example, DARPA's Topological Data Analysis (TDA) program is developing mathematical concepts and techniques to determine the fundamental structure of massive data sets, along with the tools to exploit that knowledge. Just as a set of data points in a plane can be represented by a simple line "fitted" to the data, the vastly more complex, multi-dimensional data that describes real physical systems can also be represented by a fit – not to a line, but to a high-dimensional geometric shape around which the data clusters. The geometry of this shape contains information, and this program's analytic methods tell us how to extract that information from the shape's properties.

Example applications of TDA's tools and techniques include improving predictions of the survivability of critically ill Soldiers; understanding statistical microstructural variations in materials for improved, controlled delivery of therapeutics; and improving image recognition.

Other branches of mathematics are being applied to model electromagnetic propagation and investigate radar cross sections of vessels and planes, and for fluid dynamics, including weather and climate modeling.

Manufacturing Science and Technology

The DoD requires a continuous supply of critical, defense-specific materiel and systems. To ensure reliable, robust, and cost-effective access to these items, manufacturing technologies that can meet DoD's needs must be available in the DoD industrial base.

A key program here is our Maskless Direct-Write Nanolithography for Defense Applications program, which I discussed earlier.

Lasers

Lasers have multiple military uses, from sensing to communication to electronic warfare to target designation. And since the technology was first demonstrated, DoD has maintained a steady interest in lasers for a wide range of speed-of-light weapon applications. Starting in the early 1960s, DARPA has been involved in lasers and laser technology development for the DoD, and continues its work today in this crucial area.

For example, DARPA is currently working on lasers to protect platforms. The High Energy Liquid Laser Area Defense System (HELLADS) program is a Future Icon that is developing a high-energy laser weapon system (~150 kilowatt) with an order-of-magnitude reduction in weight compared to existing laser systems. With a weight goal of less than five kilograms per kilowatt, HELLADS allows new and innovative capabilities, such as being used on tactical aircraft systems for effective self-defense, against even the most advanced surface-to-air missiles.

This year, the program demonstrated 15 kilowatts of multimode laser output power. If successful, HELLADS will lead to a truly practical, small-size, low-weight tactical laser weapon that will transform operations, and provide a tremendous advantage to U.S. forces.

DARPA has also been working to improve the performance of laser component technology. For example, the Super High Efficiency Diode Sources (SHEDS) program has achieved 70 percent electrical-to-optical efficiency in generating light from stacks of semiconductor diode laser bars, a dramatic improvement over today's 50 percent efficient diode laser technology.

Summary

In closing, I want to return to a subject I mentioned last year – computer science. As you've seen, DARPA has bold goals in information technology and computer science, but we remain concerned about the declining pool of talent and the lack of interest from high school and college students in computer science studies. Between 2000 and 2005, the portion of incoming freshman

interested in majoring in computer science dropped by 70 percent; in Fall 2006, only 1.1 percent planned to major in computer science. These are not the signs of a healthy discipline.

We feel that a major reason for this decline is the lack of new, exciting ideas that would attract more bright students into this field.

DARPA recognized this and responded by starting programs whose purpose is to generate new ideas of value to DoD, but which would also attract new students.

Our Computer Science Study Group (CSSG) program is aimed at educating a select group of extremely talented early-career academic computer scientists on DoD's needs, and then asking them to use the knowledge they've gained to propose ideas for basic research that are relevant to DoD. The program plans a three-year cycle for each class of about 12 participants. In the first year, they obtain a Secret clearance and are familiarized with DoD and its challenges through group visits to DoD's labs, bases, defense contractors, and operational settings. The visits occur during two week-long trips in the summer. In the second year, the participants' ideas are competed, and the best proposals may be awarded up to $500K to conduct basic research of interest to DoD. In the third year, they may be awarded an additional $250K for their research, provided they match the funds from another source.

We believe this overall approach to cultivating a focus on DoD problems in academic disciplines will prove so effective that we've just started a similar program in the area of microsystems.

We have now selected two classes for CSSG, and the first class will soon begin their research projects. As an example, one of the research projects will look at novel ways to automatically identify individual speakers within a huge array of communications and other acoustic data, and then use that data to infer information about the networks of people associated with the speakers. This has obvious counterterrorism applications.

Our Computer Science Futures program is another effort aimed at attracting and cultivating talent to computer science, in this case linking up world class computer science researchers and interested high school students. Here we ask a panel of young computer science professors to propose five "Grand Challenges" for computer science – problems that are important, hard, and exciting to tackle. The professors must then brief their ideas to high-school students, where the students are asked which of the Challenges are exciting and would draw their interest to study

computer science. This year, the first year of the effort, the high school students ranked three of the five as interesting. We've asked the professors to work on the projects with high school students from their local community.

One of the ideas the students liked is Programmable Matter. It is an important idea that is of significant relevance to DoD. The challenge is to build a solid object out of intelligent parts that could be programmed so that it can transform itself into other physical objects in three dimensions. It would do this by changing its color, shape, or other characteristics. A simple example is an antenna that would change its shape based on the communication system to which it is connected. The computer science challenges are to identify the algorithms that would allow each element of the object to do its job as the object changes, while staying well coordinated with the other elements and functioning as an ensemble.

These two programs by themselves cannot reverse the declining trends in computer science, but we do hope that they will be useful and help make people more aware of the talent problems in computer science, and some of the things that could be done about it.

I hope my remarks today have given you a sense of our programs and our ambitions. Thank you for this opportunity to appear today. I would be pleased to answer your questions.

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THE HOUSE ARMED
SERVICES COMMITTEE

STATEMENT OF

DR. JAMES TEGNELIA

DIRECTOR,

UNITED STATES STRATEGIC COMMAND CENTER FOR

COMBATING WEAPONS OF MASS DESTRUCTION

AND

DIRECTOR,

DEFENSE THREAT REDUCTION AGENCY

21 March 2007

BEFORE

SUBCOMMITTEE ON TERRORISM, UNCONVENTIONAL THREATS

AND CAPABILITIES

HOUSE COMMITTEE ON ARMED SERVICES

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Introduction

Mr. Chairman, it is an honor to be here today to address the mission of Combating Weapons of Mass Destruction or "WMD." I will limit my remarks, but request that my entire statement be made part of the record.

I serve concurrently as the Director of the Defense Threat Reduction Agency or "DTRA" and the Director of the United States Strategic Command Center for Combating WMD or the "SCC-WMD." My statement reflects these dual responsibilities and will address the nature of the WMD threat; our response in terms of strategy, roles and responsibilities, and capabilities; and the unique contributions that the Commander, US Strategic Command and the Defense Threat Reduction Agency are making. Additionally, as you requested, I will also address the accomplishments of the Counterproliferation Program Review Committee, or "CPRC". Lastly, since the DTRA mission is so broad and involves multiple appropriations accounts, I will also provide an overview of the Agency expressed in terms of campaigns that support national and DoD goals and capabilities. I believe that describing the Agency through the use of campaigns is the easiest way to quickly gain an appreciation for the Agency's contribution and potential.

The WMD Threat

The threat of infectious diseases to warfighters and the civil population, and the use of poisons, toxins, and asphyxiating gases in war are not new threats. The Black Death of the 14th Century, for instance, killed at least 75 million and set back European society for generations. When George Washington sent his first contingent of troops into Boston after the British evacuation of that city, he chose men who had survived smallpox and were thus resistant to the disease. World War I was a chemist's war, introducing massive numbers of chemical weapons on the battlefield. Artillery was the big killer, but roughly a quarter of all American battlefield casualties in that war were directly due to chemical agents. The 1918 influenza pandemic also killed millions. World War II was a

physicist's war, introducing radar, ballistic missiles, the jet engine, and nuclear weapons. It was a technical competition that set the stage for the Cold War and the threat of nuclear annihilation. That threat is much less likely today, but the threat of limited use of nuclear weapons remains. Many also fear that biological threats are the wave of the future as advances in life sciences progress at a stunning rate and as the forces of globalization make the prospects of a global pandemic of massive proportions frighteningly possible. Add to this modern radical terrorism and proliferation of Weapons of Mass Destruction (WMD) to regional powers hostile to American interests and it is fair to say that the world has never been at more risk to WMD, or the WMD-like effects of a global pandemic.

Combating WMD (CWMD) is a uniquely challenging mission because the threats are of catastrophic proportions and are evolving rapidly. There are no simple solutions. National expertise is limited and must be nurtured. International partnerships are vital and must be expanded. The situational awareness needed for a global pandemic, for instance, overlaps with that needed to detect a major bioterrorist campaign. Significant knowledge, technology, and capability gaps exist in CWMD. Resources are finite and stretched thin. This is an area where the enemy has to win only once; we have to win every time. And time is not on our side.

Strategy and Capabilities Transformation

For obvious reasons, national guidance places a high priority on combating the threats posed by WMD. National strategy seeks to reduce, contain, and prevent the further proliferation of WMD; to counter the WMD challenge offensively and defensively where it is present; and to achieve the capability to operate through and recover from WMD attacks. Within the Department of Defense, the three pillars of Combating WMD - nonproliferation, counterproliferation, and consequence management - are supported through eight Military Mission areas: Security Cooperation and Partner Activities; Threat Reduction Cooperation; Interdiction; Elimination; Offensive Operations; Active Defense; Passive Defense; and WMD Consequence Management.

In recent years, the department has been shifting its focus from traditional warfighting capabilities and nuclear-centric deterrence to capabilities more responsive to the irregular, catastrophic, and disruptive threats that characterize warfare in the 21st century. The 2006 Quadrennial Defense Review (QDR), 2006 Strategic Planning Guidance, and other departmental guidance emphasize the need to defeat terrorist networks, defend the homeland in depth, prevent the acquisition and use of WMD, and shape choices of countries at strategic crossroads.

From the perspective of CWMD, it is imperative that efforts in all these areas be integrated and synchronized to maximize the full national and international potential. Indeed, the key to successfully meeting the WMD threat is to harness all elements of government, academia, industry, and international partners into a single, coordinated effort. We are developing a streamlined, collaborative process that will lead to shared situational awareness, a common operating picture, rapid and accurate analyses and threat anticipation, a full range of improved capabilities, efficient use of resources, and timely, executable courses of action.

We are on the path to achieving this, but much work remains to be done. We are approaching this with a sense of urgency and full commitment.

Counterproliferation Program Review Committee (CPRC)

DTRA provides support to the Office of the Assistant to the Secretary of Defense for Nuclear and Chemical and Biological Defense (ATSD (NCB)) for activities of the Counterproliferation Program Review Committee (CPRC). The CPRC was chartered by the 1994 National Defense Authorization Act (NDAA). A requirement, established initially with the 1995 NDAA, requires the Department of Defense (DoD), Department of Energy (DOE) and the Intelligence Community (IC) to report annually on technology capability development, requirements, priorities and funding for countering the proliferation of Weapons of Mass Destruction (WMD).

CPRC activities have enabled information sharing among its member organizations for efficient and effective use of government resources for

counterproliferation technology capability development. The annual report has provided information on investments for capability developments for the upcoming fiscal year, requirements they support and remaining shortfalls in capabilities to guide future research and development (R&D) investment planning. The report addresses over 200 DoD, DOE, and Intelligence Community programs every year.

Since the CPRC was established, much has happened in terms of technology and capabilities to address threats, capability needs for a changing world situation, and in government organizations contributing to WMD proliferation threat reduction. Over the last year, there were many R&D products delivered that will be in included in the May 2007 CPRC report.

In the Passive Defense Area, developmental detection, protection, and decontamination systems have matured for delivery into the field. Specifically, the Automatic Chemical Agent Detection Alarm (ACADA) has gone into full rate production; the Joint Biological Agent Identification and Diagnostic System (JBAIDS) has achieved Initial Operating Capability with 64 systems delivered in Fiscal Year 2006 with additional systems planned for Fiscal Year 2007; 101 vehicle-based and 11 ship-based Joint Biological Point Detection Systems (JBPDS) were configured in Fiscal Year 2006; and we began fielding the Joint Biological Standoff Detection System (JBSDS), which detects aerosols at five kilometers and discriminates at one kilometer.

In the Protection Area, the Joint Protective Air Crew Ensemble (JPACE) has entered full rate production, and the Joint Services General Purpose Marks (JSGPM) is to enter full rate production in the third quarter of Fiscal Year 2007.

In the Offensive Area, recent accomplishments include accreditation of Version 6 of the Integrated Munitions Effects Assessment (IMEA) code for improved capabilities in holding tunnel facilities and hardened bunkers at risk; and advanced signal intercept and warning sensors achieved full rate production mode for use on attack and guided missile submarines.

The CPRC has also encouraged the participation of non-members, including the Department of Homeland Security (DHS), Department of Health and Human Services

(DHHS), and the Environmental Protection Agency (EPA), in CPRC activities. In addition, the CPRC has worked to ensure proper representation from the Intelligence Community after the establishment of the Director for National Intelligence and resulting changes in responsibilities within the intelligence community.

This need to bring other government organizations into counterproliferation planning and reporting activities highlights the fact that the current law does not include new organizations and new responsibilities important to counterproliferation activities. Additionally, the report requirement in the law does not cover the activities that have emerged relative to CWMD areas. In short, the existing law has been overtaken by events and the Department, with the approval of DOE and the Central Intelligence Agency (CIA), has met with committee staff to discuss alternatives.

We have recommended that Congress consider the new organizations, relationships, and responsibilities that have emerged since 1994 including: the creation of the DHS and the transfer of related R&D programs from DOE to that new Department; the establishment of the Director of National Intelligence (DNI); and the stand-up of the National Counterproliferation Center (NCPC) and the National Counter Terrorism Center (NCTC). Within DoD, there have been significant changes relevant to CWMD responsibilities with the creation of the Assistant Secretary of Defense for Homeland Defense; the establishment of the US Northern Command (NORTHCOM) as a new regional Combatant Commander for the Continental United States; and the assignment of Commander, US Strategic Command (STRATCOM) as the lead Combatant Commander for the CWMD mission. We recommend that these also be taken into consideration.

Any new legislation should also consider the many interagency activities that have been established to reduce the threat of WMD including: the National Proliferation and Arms Control Technology Working Group (NPAC/TWG) to share technology development information in support of nonproliferation and arms control agreements; and the Counterproliferation Technology Coordination Committee that assesses technology development activities across the US Government (USG) to identify capabilities and gaps in technology development programs. We believe that there are many overlapping

interagency activities that could be harmonized better through simplification of coordination activities and reporting processes and inclusion of all critical organizations in those efforts.

Lastly, the Department believes that the current requirement for annual reports should be modified to require less frequent reporting (e.g., every two years) to allow the interagency process to focus more of its time on opportunities to strengthen the planning, execution and assessment activities (vice reporting). This also would strengthen synchronization with the RDT&E Reliance process. We believe that, with the increased communication between the two branches, a report every two years is sufficient to provide the comprehensive program details that Congress needs.

USSTRATCOM Center for Combating WMD

As the integrator of DoD's global warfighting capabilities, the Commander of the US Strategic Command (USSTRATCOM), General James E. Cartwright, USMC, is the lead Combatant Commander for the DoD Combating WMD mission. He is responsible for integrating and synchronizing the Department's CWMD efforts and for coordinating them with interagency partners.

General Cartwright's primary Combating WMD mission enabler is the US Strategic Command Center for Combating WMD or "SCC-WMD." This center is the primary functional enabling capability for assisting USSTRATCOM in integrating and synchronizing combating WMD within both the DoD and the US Government (USG). More specifically, the SCC-WMD will anticipate potential WMD-related events that may necessitate a DoD, USG, and/or internationally coordinated response; develop courses of action through knowledgeable Joint Interagency Group integration and synchronization; reduce reaction time; assess USG and international capabilities; identify needs and requirements; and recommend solutions for integrating and synchronizing CWMD capabilities.

In its supporting role, the SCC-WMD is developing the annexes for the global plan to integrate and synchronize planning for CWMD (Concept Plan 8099).

Additionally, the SCC-WMD is providing planning assistance to all combatant commands that are developing regional CWMD plans and updating their deliberate plans related to CWMD.

The SCC-WMD is organized similar to a Joint Functional Component Command and is staffed by both USSTRATCOM and DTRA personnel. The center was established at DTRA to best leverage DTRA's long-standing subject matter experts and experience, which spans all eight military mission areas.

Although it is a relatively new organization and still growing toward its full potential, the SCC-WMD already has made several notable contributions. These include:

Joint Elimination Coordination Element In response to a task from the 2006 QDR to expand the Army's 20th Support Command's capabilities to enable it to serve as a joint task force capable of rapid deployment to command and control WMD elimination and site exploitation missions by 2007, the SCC-WMD developed the Joint Elimination Coordination Element (JECE). The JECE provides joint planning and WMD subject matter experts specifically organized, trained, and equipped to support command and control of the WMD Elimination mission. In addition, the JECE supports day-to-day operational and tactical level CWMD elimination planning, training, and exercises with the Regional Combatant Commanders, the Services, and other USG organizations.

Joint Integrating Concept The CWMD Joint Integrating Concept provides a common vision of Joint Force Commander CWMD operations 8-20 years in the future and will guide follow-on capabilities based assessments as well as force management, experimentation, and Science and Technology development decisions by CWMD capability providers and users.

Proliferation Security Initiative and WMD Interdiction On December 16, 2006, the Commander, USSTRATCOM appointed the SCC-WMD as the USSTRATCOM lead for the WMD Interdiction mission and for the Proliferation Security Initiative (PSI). This

will enable the department to maximize the use of its limited assets and resources, and assist and support our foreign partners' efforts to integrate and contribute meaningfully to the PSI. The SCC-WMD leverages the interrelationship among the USSTRATCOM Global Operations Center, SCC-WMD, the DTRA CWMD Operations Center, and other USSTRATCOM Joint Functional Component Commanders to increase support to regional Combatant Commanders in targeting and surveillance requirements for ships of interest during Maritime Interdiction Operations. Support is being provided to the training and equipping of foreign partners through programs such as the International Counterproliferation Program and the WMD Proliferation Prevention Initiative so that WMD and WMD components may be interdicted at borders. In addition to providing support to the interdiction planning and operations of regional combatant commanders, the SCC-WMD is developing and will codify processes for providing those commanders WMD-focused technical reachback support from DTRA. Lastly, the SCC-WMD has been an active participant in the National Counterproliferation Center's CWMD planning and synchronization efforts, providing an operational perspective to this intelligence focused group as well as leading USSTRATCOM participation in DOD PSI activities.

Defense Threat Reduction Agency

DTRA is the only DoD organization with a dedicated, fulltime, and integrated CWMD focus. It is home to DoD's leading edge scientific, operational, and intellectual WMD expertise in nonproliferation, counterproliferation, and consequence management for Combatant Commands, the Services, and other DoD and US Government organizations. DTRA is also a "Combat Support Agency" tasked with providing Combating WMD solutions to the Joint Chiefs of Staff and Combatant Commanders, the Office of the Secretary of Defense, and other US Government agencies. DTRA has been designated as the primary combat support agency for the US Strategic Command in its efforts to integrate and synchronize CWMD efforts for the department. While the Agency has multiple operational "bosses," it reports administratively to the Under

Secretary of Defense (Acquisition, Technology, and Logistics) through the Assistant to the Secretary of Defense for Nuclear and Chemical and Biological Defense Programs.

Although the Agency was created in October 1998, it has a legacy through predecessor agencies and programs. On the nuclear side, that legacy dates to the Manhattan Project of World War II that developed the first atomic bomb. Additional expertise in non-nuclear weapons effects, particularly against hardened and deeply buried targets, and force protection was developed. On the chemical and biological side, the defensive Science and Technology (S&T) program and the operational concepts have been under development since the First World War. The Agency operates in a network of international networks and institutions that grew from a nuclear-centric focus during the Cold War to full-scope WMD coverage today. Cooperative threat reduction programs have also become important tools for CWMD. Today, DTRA works the full range of the CWMD mission space – chemical, biological, radiological, nuclear, and high yield explosives (CBRNE), as well as nonproliferation, counterproliferation, and consequence management capabilities. Its capabilities continue to transform and expand to meet the catastrophic, disruptive, and irregular challenges of the 21st Century.

DTRA accomplishes its mission through a unique blend of WMD-oriented research and technology development, combined with Combating WMD operational support for the warfighter. The Agency manages and implements several important departmental programs to include the Joint S&T part of the Chemical and Biological Defense Program (CBDP), the Cooperative Threat Reduction Program, DoD Nuclear Surety and Stockpile Stewardship, and Arms Control Treaty and Agreement implementation. DTRA's Research, Development, Test and Evaluation (RDT&E) portfolio (distinct from the CBDP) primarily consists of CWMD Applied Research ("6.2") and Advanced Technology Development ("6.3"), augmented by a CWMD Basic Research ("6.1") program. The Agency is requesting a new WMD Defeat Capabilities ("6.5") program as part of its Fiscal Year 2008 budget request. This new program provides the funding authority to complete the maturation of emerging technologies and to transition counter-WMD innovations from the laboratory to the field.

DTRA also provides operational support in the form of arms control treaty and agreement implementation; proliferation prevention; theater engagement plans for shaping the choices of countries at strategic crossroads; technical reachback that supports US military forces and enables others protecting the US homeland; Combatant Commander planning and conduct of operations; exercise support; and related training.

Well down the path of transformation to meet the threats of the 21st century, DTRA was selected by the Office of the Secretary of Defense as one of the first components to implement the National Security Personnel System (NSPS). This is an essential tool in helping us build the workforce needed to meet what is clearly going to be an enduring threat. It is also imperative that we achieve integrated and simplified business practices and secure, reliable, global information sharing capability.

DTRA's resource portfolio for Fiscal Year 2007 totals $2.67 billion. This includes DTRA's core RDT&E, Operations and Maintenance, Procurement, and Cooperative Threat Reduction Programs, as well as funding for Base Realignment and Closure initiatives. Also included is external funding from the CBDP and other external organizations. DTRA manages the CBDP S&T Program, and serves as funds manager for all CBDP program funding.

We are an organization of just under 2,000 civilian and military personnel, headquartered on Fort Belvoir, Virginia. DTRA field offices are located across the globe in Albuquerque, New Mexico; Mercury, Nevada; San Francisco, California; London, England; Moscow and Votkinsk, Russia; Kiev, Ukraine; Darmstadt, Germany; Yokota, Japan; Tblisi, Georgia; Baku, Azerbaijan; Astana, Kazakhstan; and Tashkent, Uzbekistan. DTRA also has liaison officers stationed at all Combatant Commands; US Forces, Korea; NATO Headquarters; the Joint Staff; the National Guard Bureau; and the Federal Bureau of Investigation.

DTRA Campaigns

DTRA uses campaigns to support national and departmental goals, guide our current program, integrate efforts across the Agency, and identify future priorities.

Campaigns seek to develop and provide relevant, integrated operational and technical solutions for warfighters; enhance Agency and partner capacity; foster innovation; and develop and sustain agile business processes. They provide the underlying framework to shape the Agency's investment strategy. Campaigns are the link between capabilities and supporting programs. The Agency's current campaigns are:

- Situational Awareness
- Control WMD Materials and Systems Worldwide
- Defeating the Threat of Lost or Stolen (Loose) Nuclear Weapons
- Protect the Warfighter from WMD
- Protect the Homeland from WMD
- Transform the Deterrent
- Business Excellence

Situational Awareness The goal of this campaign is to build continual situational awareness of worldwide WMD activities in order to support DoD, US Government, and allied efforts to prevent the acquisition, proliferation, threat of use and/or use of WMD against the US, its interests, and its allies. Key supporting DTRA activities and programs include integrating intelligence and WMD knowledge; defining pathways to WMD proliferation; and development and fusion of open information centers; providing a Common Operating Picture. In addition to making progress in each of these programs over the past year, we successfully demonstrated Global Situational Awareness capabilities in seven major exercises that involved the Chairman, Joints Chief of Staff; the Commanders of the US Strategic, Space, Northern, and Southern Commands, as well as US Forces Korea; and other agencies of the US Government.

Control WMD Materials and Systems Worldwide The goals of this campaign, in concert with interagency partners, are to improve control over WMD and position ourselves for rapid response and integrated nonproliferation operations; reduce the size

and shape of the WMD threat and prepare to respond quickly, anywhere, to WMD situations; implement treaties and agreements; encourage friendly states to counter WMD by increasing their capabilities and integrating our combined capabilities; and identify, develop, produce and integrate concepts and technology that will enable the Combatant Commands and Military Services to perform their interdiction and elimination operations. Key supporting DTRA programs and activities include: arms control and confidence and security-building treaty and agreement implementation; International Counterproliferation (ICP) and Small Arms/Light Weapons (SA/LW) Programs; Cooperative Threat Reduction (CTR) program execution; and CWMD doctrine and plans development. Through the CTR program, we have completed security upgrades on twelve Russian nuclear weapons storage sites, are providing upgrades at twelve additional such sites and are eliminating Albanian chemical weapons. We have also completed demilitarization of a former anthrax production facility in Kazakhstan. With our interagency and international partners, under the ICP program, we conducted integrated exercises in Armenia and Bosnia-Herzegovina. We expanded our SA/LW activities in support of Combatant Command and State Department priorities. In addition, we accomplished a joint inspection exercise with our Republic of Korea counterpart agency to assist the development of that agency's basic arms control operational capabilities.

Defeating the Threat of Lost or Stolen (Loose) Nuclear Weapons

This campaign focuses on eliminating the threat of nuclear terrorism from existing or improvised nuclear weapons and weapons grade nuclear materials. It includes providing the following counter-nuclear WMD capabilities called for in the QDR: finding, fixing, containing, and securing WMD, their delivery systems, and related materials; and, detecting fissile material, such as nuclear devices, at stand-off ranges. DTRA will achieve these capabilities by combining S&T investments with comprehensive warfighting training, tactics, and procedures into systemic solutions. Key supporting DTRA programs and activities include: development, with the Defense Intelligence

Agency (DIA), of a capability to determine if and when a nuclear device is removed from a secure location; increase the detection distance for nuclear materials for a variety of active and passive technologies; develop a nuclear forensics capability to support attribution of a nuclear or radiological event; provide national decision makers additional interdiction options to secure loose nuclear weapons and limit potential consequence management impacts; and develop and exercise supporting doctrine and plans. Recent achievements include: development of new waterproof and shockproof detection equipment which is resistant to extreme conditions without significant operational degradation; initial demonstration of DoD's global ground sample collection capability for National Technical Nuclear Forensics; and improvements to planning, doctrine development, and exercise capabilities.

Protect the Warfighter from WMD The goal of this campaign is to employ a systems approach with DoD, interagency and international partners to provide DoD with operational capabilities, research and development, and technical subject matter expertise across the WMD threat spectrum for passive defense, installation protection, consequence management, and system survivability. Key DTRA supporting programs and activities include: development for broad-spectrum medical countermeasures against genetically modified biological agents through the Transformational Medical Technologies Initiative; development of technologies for military systems to perform in combined nuclear and natural radiation environments through the Radiation Hardened Microelectronics Program; and assessment of installation preparedness to deter, detect, defend, mitigate and recover from terrorist attack (including the use of WMD) through Joint Staff Integrated Vulnerability Assessments (JSIVAs). Recent accomplishments include continued planning and coordination for DoD exercises and the Department of Energy's Exercise DIABLO BRAVO 08 , to expand DoD and U.S. Government capabilities for managing a nuclear weapons transportation incident; the completion of 87 JSIVAs (anti-terrorism vulnerability assessment of DoD installations) and twelve Balanced Survivability Assessments (to identify vulnerabilities for command, control, computers

and intelligence systems); development of 90 nanometer Radiation Hardened (RH) technology, further advancing the state of the art beyond the current RH of 150 nanometers and the addition of CBRNE planning, response and mitigation into the Mobile Training Teams of the Defense Threat Reduction University.

Protect the Homeland from WMD This campaign's goal is to provide crisis and consequence management support to DoD and civil authorities to prevent and/or mitigate the consequences of WMD attacks on the homeland, and to enhance defense support of civil authorities by sharing training, planning, technologies, tools, exercise expertise, and operating concepts with national and international partners based upon national and DoD policy goals. Key supporting DTRA programs and activities include: development of the Defense Threat Reduction University as a consortium of multinational, federal, state, local and non-governmental partners in Chemical, Biological, Radiological, Nuclear, and High Explosives Capable of Mass Destruction education, training, and research; providing one-stop, single-entry point for Agency CWMD training and education; exploration of a Technology Innovation Consortium to bring together ideas, technologies, and needs as a catalyst for innovation; integration of DoD training and exercise support with national partners to improve the implementation of the National Response Plan and the National Incident Management System in consequence management response to and recovery from multiple domestic WMD events; and expanding support to the Defense Critical Infrastructure Program assessments and to the Nuclear Regulatory Commission site survey program.

This campaign recently assisted two major exercises. The ground-breaking 'A Kele exercise, held by the State of Hawaii, tested civil-military emergency response procedures following the simulated detonation of an improvised nuclear device. VIGILANT SHIELD 07, sponsored by the US Northern Command, incorporated a nuclear weapons accident exercise with local (City of Tucson and Pima County), State of Arizona, and federal (DoD, Department of Homeland Security, and other agencies)

participation. In both exercises, the various governmental organizations forged enduring bonds as they solved multi-jurisdictional challenges while focusing on the exercise of emergency response plans.

Transform the Deterrent This campaign's goal is to support the warfighters' ability to hold WMD and associated infrastructure and leadership at risk through offensive means. All aspects of offensive operations, including intelligence, conventional and nuclear weapons, and combat assessments are supported by this campaign through technology research and development, concept development, and operational support to help shape the tailored deterrent. Key supporting DTRA programs and activities include: development and coordination of a concept for the WMD Threat Research and Analysis Center (WTRAC) that will strengthen the intelligence and RDT&E linkage; enhanced Intelligence, Surveillance, and Reconnaissance capability against WMD threats using a wide-range of manned and unmanned platforms; development of conventional weapon and special operations capabilities to defeat WMD-related threats; and operational support to the Nuclear Command and Control System and the nuclear stockpile. Recent accomplishments include the formation of the WTRAC Working Group with DIA to examine collaboration opportunities and planning for several proof of concept pilot projects. We also have made advancements in enhanced unattended aerial vehicle sensors by demonstrating electric propulsion and real-time video.

Business Excellence This campaign integrates all aspects of DTRA business support for mission execution in the most flexible, ethical, and efficient manner. In addition, this campaign positions the Agency for the implementation of the Defense Agency Initiative Financial Management System and other DoD-wide system mandates. Key efforts include: integration and simplification of business practices; delivery of state-of-the-art information operations capabilities to support mission evolution and global operations; and sustainment of a skilled, diverse workforce to support mission execution.

DTRA is one of the pioneer organizations for the implementation of the National Security Personnel System (NSPS). Business Excellence campaign goals for Fiscal Year 2007 include full implementation of NSPS; strategic workforce planning to include civilian, military, and contractor workforce; process, system, and acquisition preparation for implementation of the Defense Agency financial system initiative; and developing and implementing information infrastructure improvements to enhance situational awareness, facilitate knowledge and information sharing, and support mission operations whenever and wherever needed. Efforts will continue to integrate and streamline business practices to maximize efficiency and generate savings for reinvestment in expanding missions and transformational business improvements.

As these campaigns mature, we may learn that some change in their direction, focus, or investment may be warranted. However, we believe that these current campaigns provide a good beginning.

Conclusion

Mr. Chairman, I would like to conclude by offering several key points. First, the danger posed by WMD is real and growing. Second, no single department or organization or solution will ensure success. We are facing a long-term threat that continues to evolve and grow. Successfully meeting this threat requires the integration and synchronization of the full national and international expertise and capability, with the CPRC fulfilling a key role. Third, the Commander, US Strategic Command, through the SCC-WMD and with the assistance of DTRA, is responsible for the integration and synchronization of that effort within DoD, as well as for the Defense Department's coordination with other national and international partners, as directed. Lastly, DTRA is at the crossroads of DoD, interagency, and international efforts to counter WMD. Our scientific, operational, and intellectual WMD expertise provides much of the capability and potential behind these efforts.

DTRA's vision is to make the world safer by combating weapons of mass destruction. These are not merely words. They are our conviction; our rallying cry at this time of great danger to our nation. I look forward to working with you in meeting the challenge, ask for your support of our budget request, and would be pleased to answer your questions.

STATEMENT BY
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BEFORE THE
SUBCOMMITTEE ON TERRORISM,
UNCONVENTIONAL THREATS AND CAPABILITIES
COMMITTEE ON ARMED SERVICES
UNITED STATES HOUSE OF REPRESENTATIVES
ON DEFENSE SCIENCE AND TECHNOLOGY
IN SUPPORT OF THE WAR ON TERRORISM,
TRANSFORMATION AND BEYOND

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INTRODUCTION

Mr. Chairman and Members of the Subcommittee, thank you for the opportunity to describe the fiscal year 2008 Army Science and Technology (S&T) Program and the significant role Army S&T has in creating, adapting, and maturing technologies to enable the future force, while simultaneously seeking opportunities to enhance the current force.

We want to thank the Members of this Subcommittee for your sustained support of our Soldiers who are now at war and for funding the investments that will provide Soldiers with the dominant capabilities they will need to defend America's interests and those of our allies throughout the world. Your continued advice and support are vital to exploiting the potential of technology to speed victory on the battlefield.

S&T CONTRIBUTIONS TO THE GLOBAL WAR ON TERRORISM

Army technology developments and our scientists and engineers have been and are supporting our Soldiers deployed to fight the Global War on Terrorism (GWOT). We have responded rapidly to a broad range of their needs in three ways: 1) leveraging past investments adapted for current operations, 2) exploiting ongoing technology development for rapid transition opportunities, and 3) using scientist and engineer expertise to develop new technology or create

novel solutions that improve the performance of currently fielded equipment. The following paragraphs provide examples of solutions of our responses for GWOT.

1) Leveraging past investments. We are creating new capabilities from past investments by seeking opportunities to rapidly field mature technology to Soldiers. For example, the Lightweight Counter Mortar Radar (LCMR) was adapted from previous efforts to provide capabilities to detect mortar rounds and rockets and to locate shooters for counterfire or other response. Initial fielding started in 2004, and an improved version of LCMR was delivered in 2006. Over 130 LCMR systems have been built to date.

2) Exploiting ongoing technology development. We are exploiting the potential of new technologies that are emerging from our current investments. For example, the Joint Precision Air Drop System (JPADS) was demonstrated in Afghanistan in August 2006. It is a product of a joint Army and Air Force Advanced Concept Technology Demonstration (ACTD). The JPADS is a "GPS-guided" cargo parachute delivery system developed by the Army combined with a common laptop mission planning weather system developed by the USAF. It enables aircraft to deliver essential supplies within 100 meters of the intended point from 25,000 feet and at standoff ranges of up to 10 miles. Currently, JPADS can deliver up to 2,000 pounds of food, water, or ammunition. We are continuing development of technologies to enable payloads of up to 10,000

pounds. The JPADS improves logistics efficiency while enhancing aircraft cargo and ground Soldier survivability. The Unattended Transient Acoustic MASINT System (UTAMS) technology program improved capabilities to detect and locate enemy mortar and rocket fires. A prototype system with software and hardware used with LCMR and the Acoustic Mortar Detection System (AMDS) provided a system-of-systems solution.

3) Using scientist and engineer (S&E) expertise. Our S&Es have demonstrated the knowledge and the ability to provide rapid technology developments and adaptations for many applications in support of GWOT. Examples include the work done by Army engineers to adapt existing armor technology to design effective levels of crew cab protection for the Army's family of heavy tactical trucks (M915 trucks) and enhanced armor protection for the gunner's cupola. Another example is the work to protect personnel by designing ballistic and blast protection technology as well as the methodology to apply effective protection measures for buildings and interior structures. Specific techniques developed included designs to pre-detonate rocket/mortars and defeat ballistic fragments to provide overhead cover, compartmentalization, and sidewall protection. Within 48 hours of testing, laboratory personnel and field engineers were able to begin implementing effective protection modifications at deployed sites. We have developed Projectile Detection and Cueing technology and worked to integrate it on the Common Remotely Operated Weapon Station (CROWS) acquisition program. This system demonstrated the technology to

detect incoming gunfire, automatically slew and aim a CROWS weapon at the shooter. The system also updates the aiming commands while the platform is on the move.

To accelerate development of new and novel solutions for Soldiers in the field, the Army has also benefited from the Agile Integration Demonstration and Experimentation (AIDE) program approved by Congress in 2006. Through the AIDE program, most recently, we have developed a low-cost acoustic gunfire detection system. This year, the AIDE program will demonstrate the UTAMS acoustic detection enhanced with a counter-sniper capability by improving technology to detect individual rifle fires.

FORCE PROTECTION

It is imperative that we provide our Soldiers with the most effective technologies to protect them. Our S&T investments in Force Protection technologies are the single largest investment area in our portfolio. Major investments in Force Protection include development of technology to provide lightweight ballistic protection for Soldiers; active and passive protection for lightweight vehicles and rotorcraft; lightweight armor for tactical vehicles; active protection countermeasures against Kinetic and Chemical Energy munitions for combat vehicles; and active and passive protection against rockets, artillery, and mortars for installations.

SOLDIER SYSTEMS TECHNOLOGY

Our investments in Soldier technologies seek to provide individual Soldiers with "platform-level" capabilities. These include greater protection, networked communications for shared local and extended situational awareness, as well as connectivity to exploit joint lethal fires. The goal is to seamlessly link Soldiers to sensors and platform-based lethality capabilities in real time, to accurately identify and engage targets in less time, and with greater precision lethality. Key Soldier technology investments include advanced body armor, lightweight novel power sources including fuel cells, and next generation chemistries for batteries.

MEDICAL

Our investment in medical S&T provides the basis for maintaining both the physical and mental health as well as performance of Soldiers. To assist in the fight against injuries sustained from improvised explosive devices and other sources of blast-related wounds, the Army is leading a joint medical program to prevent, mitigate, and treat medical blast casualties, and has begun an investment in tissue regeneration research with the ultimate goal of developing technologies that will lessen the impact of severe and debilitating wounds. Other medical technology is also being exploiting for immediate war-related needs such

as the "Battlemind Training" system which was designed by our behavioral health scientists and already being used before and after deployments to mentally prepare Soldiers to deal with the rigors of battle. Army medical research and development investments continue to serve a critical role in ensuring the safety and well being of warfighters wherever they are deployed.

UNMANNED SYSTEMS

The Army S&T program is pursuing technologies to enable unmanned and robotic capabilities that include: unmanned aerial systems (UASs), unmanned ground vehicles, and unattended sensors. These systems' capabilities will be modular in design for spiral technology insertion into the current force based upon priority needs and adaptation for future force applications. Unmanned Systems provide unique capabilities while reducing risks to Soldiers as well as reducing the deployed footprint of the force. In 2006, the Future Combat Systems (FCS) Program Manager (PM) selected the Micro Air Vehicle (MAV), a 13 inch ducted-fan platform for small unit reconnaissance and surveillance and the robotic demonstrator co-developed by Defense Advanced Research Projects Agency (DARPA) and the Army as the baseline capability for FCS Class I UAV. Evidencing the Army's strategy to "spin-in" technology to the current force, the MAV is currently being fielded with the 25th Infantry Division which also conducted the ACTD evaluation. We will continue to explore opportunities to

field unmanned technologies into the current and the future force to provide new capability and reduce risks to Soldiers.

NETWORK-CENTRIC TECHNOLOGIES

The S&T investments in this area seek to enable truly network-centric operations. We are pursuing an unprecedented synergy between traditional "stand-alone" communications, command and control, and sensor technology developments. The networked enabled force will be empowered by sensor-based "knowledge" systems for collaborative real time mission planning, on-the-move operations, and decisive networked lethality. Specific technology investments include software and protocols for secure, mobile, ad-hoc networks; third generation infrared (IR), and multi-functional radars for extended range detection, and identification in foliage, urban areas, through walls as well as individual targeting and tracking. For example, Army scientists and engineers developed a Multi-Purpose Broadband Antenna (MPBA) which has been demonstrated in both communications and intelligence systems. The MPBA provides multi-band capability in a single structure. This technology reduces organization and installation signatures by eliminating the need for separate antennas for separate radios and saves platform design space for other systems.

BASIC AND APPLIED RESEARCH PROGRAM

The Army Basic and Applied Research programs seek to ensure that the Army has overwhelming land-warfighting capabilities against future adversaries. This is accomplished by incorporating new scientific fields into traditional disciplines to advance knowledge. The Army invests in research areas judged relevant to the Army mission with an objective of discovery, invention, and innovation related to physical, chemical and biological phenomenology to enable revolutionary advances and paradigm shifts in operational capabilities. Key research areas include nanoscience, bio-inspired system science, autonomous systems, network and information science, human performance, and energy. In 2008, we will be starting a new Collaborative Technology Alliance on Micro-Autonomous Systems Technology (MAST) that has the potential to provide unprecedented force protection technology for our Soldiers through sophisticated hand-held intelligence, surveillance, and reconnaissance. Some examples of recent progress in Army research include: bacteria based methodology to produce self-ordered materials with the potential to form higher energy density, thin, and flexible lithium ion batteries compared to conventional thin film batteries; creating an avatar (virtual human) by incorporating speech recognition, natural language processing, dialog management, perception, cognition, emotion, animation and cultural attributes; ultra-sensitive sensors to enable technology for accurate robot-integrated detection of explosives; and materials with a negative index of refraction that could lead to smaller, lighter, and better lenses and have

potential for "cloaking"; and quantum molecular control that has the potential to revolutionize the remote detection and identification of chemical and biological agents as well as advance chemistry and chemical processes.

SCIENCE AND ENGINEERING WORKFORCE

To maintain technological superiority now and the future, we need top quality scientists and engineers in the Army Laboratories and Research, Development, and Engineering Centers. We recognize this challenge as the Army must compete to obtain its future workforce. We have taken important steps to attract and retain the best science and engineering talent. Our laboratory personnel demonstrations have instituted initiatives to enhance recruiting and reshaping the workforce such as pay banding that is unique to each laboratory allowing the laboratory directors the flexibility to establish a pay-banding scheme that takes into consideration administrative, organizational, and position management; and separate career group for scientists and engineers that allows a dual career track for scientists and engineers and greater competitiveness with academia and private industry. Finally, we have long recognized that a scientifically and technologically literate citizenry is our nation's best hope for a diverse, talented, and productive workforce. To achieve this goal, we have created the Army Educational Outreach Program to leverage the numerous resources across our programs and DoD to engage America's youth in science, mathematics and engineering.

TECHNOLOGY TRANSITION

Successful transition of Army S&T products is central to enabling the Army's transformation and accelerating new technologies into the current force. We use Technology Readiness Level metrics to assess and communicate the estimated maturity of a technology to the acquisition PMs, who buy the systems that are provided to our Soldiers. The S&T community's outcome-oriented approach to technology development has yielded significant progress over the past few years. Examples of successful S&T efforts that have transitioned to programs of record include:

Small Arms Protective Inserts Plates. Army S&Es defined the technology metrics to achieve the lightest weight to defeat specific small arms threats, and tested solutions to determine the most effective technology applications that would meet stringent weight requirements. Ceramic-based Small Arms Protective Inserts (SAPI) plates are made from the latest composite materials and consist of a ballistic nylon spall cover, ceramic tiles, and Kevlar™, Spectra®, or other reinforced plastic backing material. Various compositions of Kevlar, fiberglass, Spectra, and aluminum are used. We also focused Manufacturing Technology (ManTech) to achieve a significant reduction in production costs for SAPI plates resulting in a cost avoidance of more than $150 million based upon an investment of less than $500,000 in ManTech.

FCS Engine. The FCS Engine technology program was focused on developing a high power density compact engine for the FCS manned ground vehicles. This technology program transitioned to the FCS program in 2005. The program increased the power density from three to six sprocket HP/cu-ft to meet FCS weight, space and mobility requirements. This effort provided increased vehicle speed, mission range, maneuver responsiveness and dash speed compared to current equivalent class combat vehicles. The smaller volume of this new engine technology provided more space for fuel, ammunition, and mission equipment.

Non Line of Sight Launch System (NLOS-LS). The Networked Fires weapon technology demonstration designed, developed, and demonstrated a platform-independent, container-launcher (CL) system and two missile variants. The program was executed by DARPA and the Army with joint funding. This program successfully transitioned technology in fiscal year 2004 into the NLOS-LS System Development and Demonstration. The NLOS-LS is part of the unmanned Future Combat Systems core program for spin-out one.

120mm Line-of-Sight/Beyond-Line-of-Sight Gun. The 120mm gun technology was transitioned to the FCS program in 2004. This light weight gun weighs 2,600 pounds less than the 120mm gun on the M1 Abrams Tank which was needed to meet FCS weight requirements. The Army developed new

fabrication techniques for high strength steel to yield 20 percent higher strength than current cannon tube technology.

Tactical Command and Control protection algorithms to PM Future Combat Systems. Tactical Wireless Network Assurance (TWNA) technology program integrated tactical public key infrastructure (PKI) components into FCS's System of Systems Common Operating Environment (SOSCOE). The TWNA program also transitioned an intrusion detection technology to SOSCOE for its automated intrusion detection and response component. These technologies will reduce FCS system and network vulnerabilities.

CONCLUSION

With the continued support of Congress, the Army will be able to maintain funding for a diverse S&T portfolio that is adaptive and responsive to unanticipated needs in the current force and to exploit technology opportunities for the future force. The Army's scientists and engineers are expanding the limits of our understanding to provide our Soldiers, as well as our Joint and coalition partners, with technologies that enable transformational capabilities in the ongoing war on terrorism to ensure that the Army remains a victorious, relevant, ready land component of the Joint Force. The Army S&T community is the "engine" of change seeking to accelerate the Army's transformation.

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HOUSE ARMED SERVICES COMMITTEE
TERRORISM, UNCONVENTIONAL THREATS AND CAPABILITIES SUBCOMMITTEE

STATEMENT OF
REAR ADMIRAL WILLIAM LANDAY, UNITED STATES NAVY
CHIEF OF NAVAL RESEARCH

BEFORE THE
TERRORISM, UNCONVENTIONAL THREATS AND CAPABILITIES SUBCOMMITTEE
OF THE
HOUSE ARMED SERVICES COMMITTEE
ON
DEFENSE SCIENCE & TECHNOLOGY POLICY AND
THE FISCAL YEAR 2008 BUDGET REQUEST

MARCH 21, 2007

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Introduction

It is an honor to appear before you today to update you on the progress of the Science and Technology (S&T) efforts within the Department of the Navy and to discuss how the President's Budget Request for FY 2008 supports the Navy and Marine Corps team.

The Naval S&T challenge is to enable revolutionary operational concepts that support the vision for the Navy and Marine Corps as laid out by the Secretary of the Navy, Chief of Naval Operations and Commandant of the Marine Corps. They envision a force that is expeditionary, distributed, persistent, forward deployed and capable of defeating a competitor in major combat operations or in various scenarios in the global war on terror.

We place particular emphasis on joint operations in blue, green, and brown water environments, as well as on any shore environment where U.S. Marines may be called to serve. Leveraging innovative concepts, advanced technologies, and new business practices to increase war fighting effectiveness, we will use enhanced, networked, joint Sea Basing to operate without restriction. The Office of Naval Research (ONR) S&T portfolio is a critical element of the Navy and Marine Corps' vision and strategy for the future.

S&T Overview

Our S&T enterprise must focus on developing not only tomorrow's Navy/Marine Corps but also the one after that – yet be nimble enough to rapidly address critical problems facing today's fleet and force. We must do three things exceptionally well: First, we must focus on areas that provide the biggest payoff to support the Navy/Marine Corps of the future. Second, we must be innovative in our thinking, our science, and our business processes – because every dollar spent on "overhead" is a dollar not spent on science and technology. Third, we must continually improve our ability to rapidly transition S&T into acquisition programs and into the Fleet.

The President's Fiscal Year 2008 Budget requests $1.667 billion for an S&T portfolio that accomplishes what I just described. This reflects a 2% growth in constant year dollars over the President's FY 2007 budget request.

S&T Strategic Plan

An updated Naval Science and Technology Strategic Plan was recently approved by Navy and Marine Corps leadership. It ensures alignment of Naval S&T with Naval missions and future capability needs. It will ensure that S&T has a long-term focus but is responsive to near-term needs. It will communicate our S&T vision and approach to decision makers, S&T partners, customers and performers.

The S&T Strategic plan identifies 13 key areas where S&T investment will have high payoff in supporting the Navy and Marine Corp vision and needs. Those focus areas are:

In executing this plan, we must address 5 key tenets:

- We must have the ability to monitor, assess and leverage emerging science and technology in a global manner. The increasingly rapid movement of technology and innovation around the world, demands that we be able to take advantage of emerging ideas and science regardless of where they originate.

- In order to achieve that flexibility, we will focus the majority of our investments on external performers – those outside the naval R&D system in order to tap into the full spectrum of innovative thinking and discovery.

- While the majority of our investment will be external, we need to preserve and nurture the world class skills and innovation that exists in specific Naval focused areas within our lab system, especially at the Naval Research Lab.

- We must build an investment portfolio that is balanced between the long range scientific discovery that comes from the Basic Research program and the nearer term, focused, product nature of the 6.3 programs. We must focus on delivering value to today's Sailors and Marines, while ensuring the well of new and novel technology development remains deep in support of the next generation of Sailors and Marines.

- We must focus our efforts on eventual transition of technology and innovative concepts to the war fighters. We are not about S&T, but rather we are about S&T in support of our Sailors and Marines.

Executing the Strategy

We execute our Basic Research (6.1) thru Advanced Technology Development (6.3) funds as a continuum of S&T development, breaking them into four key areas – Discovery and Invention (D&I), Innovative Naval Prototypes (INP), Future Naval Capabilities (FNC) and Quick Reaction S&T.

Discovery & Invention

Discovery and Invention (D&I) is basic research and early Applied Research (6.2) work that focuses on areas in which we have unique naval needs or support capabilities that we consider essential to the naval mission. We believe that a strong investment in this area is necessary to ensure we can maintain our technical advantages in the Navy after next.

41% of our investment is in our D&I program. We allocate that money across the core research areas through a rigorous analytical process to weigh relevance, impact on the Navy/Marine Corps mission, and potential for innovative performance to select the best mix of research areas and projects. This forms the foundation of our S&T portfolio, developing a broad and deep base of scientific knowledge and innovation from which our FNC, INP and quick reaction efforts are formed.

One of ONR's D&I successes is the Multi-disciplinary University Research Initiatives (MURI) program to develop long lasting, high temperature resistant, Thermal Barrier Coatings (TBCs). TBCs are used to insulate metal components from very hot gases in aircraft and shipboard turbine engines. For many years, TBC durability was limited due to the lack of understanding of the fundamental materials properties of these coatings and their failure mechanisms at high temperatures. The MURI TBC program and follow-on Applied Research efforts resulted in accurate coating life prediction models, alternative materials with superior performance, and improved TBC deposition processes. Improved engine performance and cost savings as a result of the TBC program will be significant. Expected payoffs include higher turbine engine power density, reduced specific fuel consumption, longer range, reduced maintenance, and increased combat readiness. An industry transition pathway for these coatings and processes has already been established.

Another D&I success involves Human Behavior Modeling. The goal of this program is to develop instructional systems and models of human cognition and performance to support the design of advanced, simulation-based, Naval training systems. Accurate modeling of individual behavior currently poses only moderate technical challenge, but the computational modeling of groups, teams, crowds, and organizations is highly challenging and involves modeling communication/co-ordination, group cohesion, and cultural influences. This program seeks to develop realistically behaving synthetic crewmates and adversaries to provide challenging training for Navy and Marine Corps warfighters with an effectiveness and affordability far exceeding what is currently possible. One element of this program, the modeling of synthetic insurgent forces for Marine Corps urban warfare training, is expected to transition to the U. S. Marine Corps (USMC) Deployable Virtual Training Environment Program during FY 2007.

Still another D&I success involves Information Assurance and Security. Naval operations rely on assured, affordable, secure, and safe interoperable information and communication systems that can satisfy hard real-time, fault tolerant requirements and can repeatedly withstand sophisticated, malevolent attacks. The Information Assurance and Security Program enables the production of safe, secure, dependable software systems that meet Naval requirements and minimize cost by maximizing the use of Commercial Off The Shelf (COTS) and open source products that are not designed to meet Naval needs.

Research conducted under this program will explore the science of concealed knowledge in text, images, and speech to detect covert communication and to prevent leakage of information when, for example, Intelligence data is downgraded for dissemination across C2 networks for operational use. It will investigate techniques and develop tools to discover dependencies in complex distributed software and ensure that these systems satisfy critical safety, real-time/fault-tolerant properties. It will also develop algorithms, secure protocols, architectures, protection mechanisms and procedures, software tools, languages, and design and development methodologies to enable the development of affordable high assurance systems. Finally, it will develop certification technologies, standards, and guidelines that enable the secure, safe, and timely certification, accreditation, and deployment of technology by the Navy and DoD

Innovative Naval Prototypes

Our Innovative Naval Prototype (INP) program has begun to hit its stride in FY 07 and the FY 08 investment will keep them on track. Seven percent of our total budget request is focused on INPs. These INPs are disruptive technologies that have the potential to enable breakthrough or game changing capability. INPs invest in S&T projects intended to achieve levels of maturity suitable for transition to acquisition programs within 4-8 years. The budget request continues support of four such programs – Electromagnetic Rail Gun, Persistent Littoral Undersea Surveillance, Tactically Responsive Space and Sea Base enablers. I would like to highlight two of the successes in our INP program:

Electromagnetic Rail Gun – This program is moving ahead very aggressively and has already achieved a number of notable successes. In 2006 we opened our large scale test facility at the Naval Surface Warfare Center in Dahlgren Va. This facility enables us to conduct tiered testing of rail configurations and materials by leveraging the broad spectrum of small scale testing being conducted at various universities and DOD labs. The most promising advances move to large scale testing at the Dahlgren facility, which has one of the largest known rail guns of its type (8MJ muzzle energy). Additionally we have completed the design and began fabrication of a 32MJ laboratory launcher, which will be installed in late summer of 2007. This will allow us to conduct firings at power levels not available anywhere else in the world. Additional achievements include: progress in extending barrel life through use of lubricants, and a multi shot test using specialized materials.

Pre-engineering activities are competitively developed with industry to ensure a future industrial base for multiple configurations. Both BAE and General Atomics have completed concept trade studies for advanced rail gun barrels and are six months into a 30 month technology development

and preliminary design effort. Additionally, Draper Labs and Boeing completed projectile concept trade studies, which identified critical component options.

Although these projects will remain in S&T for 4-8 more years, we are working directly with the acquisition programs that will implement the technologies. In fact, to ensure seamless and efficient transition when the technology is ready, the deputy S&T project manager is a Naval Sea Systems Command (NAVSEA) acquisition program manager.

In addition, our efforts are closely tied to the Army rail gun program in order to leverage development, coordinate resources, and eliminate duplication. Army and Navy program managers meet monthly and attend each other's key meetings and reviews to identify future joint development opportunities. It is particularly notable that Army donated the launcher and capacitor bank that enabled Navy's initial 2006 test at Dahlgren

Persistent Littoral Undersea Surveillance (PLUS) – This program is developing a revolutionary approach to Anti-Submarine Warfare using autonomous, mobile, controllable networks of undersea sensors and vehicles to provide surveillance of large areas over long periods of time. The system will be capable of adapting to its environment, persisting clandestinely for months, and self-deploying from long range. PLUS reverses the current asymmetry of using high-value capital warships in one-on-one engagements against quiet diesel submarines. Instead, it uses large numbers of relatively inexpensive unmanned vehicles and sensors to find, track, and if necessary engage threat submarines.

PLUS builds on a legacy of component technologies developed in ONR's D&I program. Component technologies include: 1) inexpensive unmanned mobile platforms adapted from glider technology developed for oceanographic research that can travel over long ranges and persist in the environment for months, 2) systems using a variety of sensing mechanisms with significant detection range in compact packages capable of being carried by a small undersea vehicle, and 3) the ability to communicate underwater using acoustics, at significant data rates over meaningful distances. Significant technical challenges remain. We need a system that is highly autonomous, with high probabilities of detection, and low false alarm rates. Integration of component technologies is a major challenge. Although we can do a lot in the lab, there is no substitute for taking technology to sea to find out if it really works. For PLUS, we've already started the process, through a major experiment in Monterey Bay last summer and another experiment planned in the San Diego area at the end of FY 07.

Future Naval Capabilities (FNCs)

One of our highest priorities continues to be improving the transition of deployable S&T products, more rapidly and with less risk to the acquisition program managers or directly to the end users. We are building regular, early partnerships between scientists and acquisition program managers in an effort to improve that transition. It is critical that the acquisition managers understand what capabilities and technologies are on the way from the S&T portfolio and that they have already determined how they can best fit into their program of record, well before they arrive. It is equally important for S&T managers to understand factors driving acquisition managers, and be particularly sensitive to when the acquisition manager is best able

to handle new technologies and when the window for inclusion of new ideas is closing. In the past, that relationship was often established too late in either process for us to be as effective as we could be.

While not the only means for S&T to transition to the Fleet, our Future Naval Capability (FNC) program is the most critical component of our transition strategy. FNC Program investments were restructured in early 2005 to better align this "requirements-driven, transition-oriented" portion of the S&T investment portfolio to Naval Capability Gaps identified by OPNAV and Marine Corps Combat Development Command (MCCDC) through its Naval Capabilities Development Process.

As opposed to high-risk/high-payoff INP projects, FNCs involve more near-term projects. Approximately 30% of our S&T investment in the 2008 budget request is invested in the FNC Program. The FNC process delivers maturing technologies to acquisition program managers for timely incorporation into platform, weapon, sensors, and process improvements efforts.

FNCs are projects that are based on earlier investments in the D&I portfolio, where the technology has matured to the point that they can achieve a Technology Readiness Level (TRL) of 6 or better within the next 3-5 years. The FNC projects selected address specific capability gap needs, selected annually through an established process with final prioritization approved by a 3-Star Technology Oversight Group (TOG) representing OPNAV/USMC, Commander Fleet Forces Command (CFFC), Assistant Secretary of the Navy for Research, Development and Acquisition (ASN-RDA) and ONR. The Enabling Capabilities (ECs) selected represent the highest Navy/Marine Corps priorities.

Once approved, all technology products are required to have Technology Transition Agreements that document the commitment of the resource sponsor, acquisition program office, and ONR to develop, deliver and integrate those products into new or upgraded systems that can be delivered to the Fleet/Force.

Each year, every FNC product's progress and transition status is reviewed. Products that no longer have viable transition paths are terminated and residual funding is used to solve unexpected technology development problems within existing ECs, or start new ECs, in strict compliance with established DoN priorities.

There are currently 141 FNC projects underway in various stages of their 3-5 year development. 49 are expected to complete and transition in 2007. The FY2008 budget request continues funding for the remaining projects and initiates an additional 25. The FY07 transitions include technology in human strength amplifying technologies, corrosion control techniques to reduce operations and maintenance, technologies to protect surface ships from torpedo salvos, and in-stride/stand-off technologies to breach mines and obstacles in surf and beach zones.

We plan to complete and transition an additional 24 projects in FY 08. They include algorithms and computer programs for integrating real-time sensor data and non-real time data to reduce target track and identification conflicts; integrating object recognition and tracking algorithms, machine vision, multiple network video streams, geospatial data and operational context to flag

atypical activity and recognize known threats; and a robust active Rocket Propelled Grenade (RPG) defense capability to detect and initiate countermeasures and subsequently defeat RPG warheads.

The critical measure of success of this program is whether the technology met its technology requirements and exit criteria, and whether the acquisition program manager has transition funding within his or her program plan to accept and integrate the FNC product into their programs. As you can see from the table below, we have had good success in this effort and continued to improve our transition rate from 2005 to 2006. We expect equally strong performance in 2007 and 2008.

FNC Transition Summary	FY05		FY06	
	# Products	% Plan	# Products	% Plan
Products Planned to Complete	30		27	
S&T Completed or Near Complete with Manageable Risk	28	93%	26	96%
S&T Completed or Near Complete and Transition Funds Programmed	20	67%	25	93%
S&T Completed or Near Complete and Transition Funds Planned	4	13%	0	0%
S&T Completed and No Transition Funding	4	13%	1	4%

Increases and Decreases in FNC Funding Levels

When the FNC Program was restructured in 2005, funding was realigned within ONR's Applied Research (6.2) and Advanced Technology Development (6.3) Program Element (PE) lines so that all technologies associated with each Enabling Technology were funded as a unit. This eliminated situations where component technologies were pulled from multiple PEs, making it extremely difficult to track investments. FNC investments are now aligned to the most appropriate 6.2/6.3 PE lines. This change will enhance visibility of these investments.

Because these investments are not level funded, but rather focused on the most pressing capability gaps identified each year, they generate movement in funding levels for the associated PEs from year to year. Since FNC investments mature and develop technology products over a 3-5 year period, the Technology Readiness Level (TRL) of the underlying products moves from 6.2 PEs to 6.3 PEs. Typically, but not always, the first year of an EC is predominantly 6.2; the final year is predominantly 6.3 – with a mix of 6.2/6.3 in-between. Furthermore, in any given year, as products are delivered and transition to Advanced Component Development and Prototypes (6.4) funding, the new FNC projects that are beginning are frequently not in the same PEs as those that just completed. These changes can appear to be PE program growth, when the changes actually reflect realignment of funds in response to successful technology transition – coupled with reprioritization based on evolving Naval needs and requirements.

Current S&T Program Highlights

Within the broad structure of the naval S&T portfolio, there are a wide range of S&T projects either entering the fleet or poised to do so within a short time. I have included some examples of

those efforts with respect to the direct impact they will have on Sailors and Marines, both today and in the future.

Counter-proliferation

Mr. Chairman, before turning to the portion of my testimony describing ONR's contribution to the Navy's overall S&T program, I know that you and other members of the subcommittee are interested in counter-proliferation, particularly with respect to how all of us are working to solve some of these problems. For ONR and NRL, the principal focus of our efforts is combating weapons of mass destruction (WMD). The Navy's contributions to these efforts are detailed in the 2007 CPRC Report to Congress. Specific ONR contributions include development of an Agent-Based Modeling Disease Spread Planning Tool for General Medical Officers that accurately depicts human behavior and assesses the impact of communicable disease spread in civilian and military populations with specific bioterrorist agent modeling applications. We also have a Multi-Disciplinary University Research Initiative (MURI) Project involving Novel Therapies for Pneumonic Plague Targeting Quorum Sensing Components and Novel Antibiotics to develop antibiotics and vaccines that have the potential to avoid or defeat development of drug resistance by targeted pathogens.

ONR has also increased our emphasis in areas such as Weapons of Mass Destruction (WMD) detection to develop tools for use by Navy boarding teams and Large Vessel Stopping. The Navy WMD detection program will develop technology to protect the U.S., our forces and allies from smuggled nuclear weapons and WMD materials in the maritime environment. Free electron laser technology will play an important role in this effort. Our research benefits from a continuing partnership with the Defense Threat Reduction Agency (DTRA), which assigned a member of the Senior Executive Service (SES) to work at ONR on specific Naval applications. Similarly, terrorist use of ships with hazardous cargoes is a hazard scenario in the homeland security preparedness standards developed by the Homeland Security Council. The Large Vessel Stopping program will develop non-lethal technologies to provide the Navy with the capability to stop and/or restrain uncooperative large marine vessels to support search, interdiction, and counter-terrorism operations. As referenced elsewhere in this testimony, ONR and NRL are teamed to provide innovative technology to provide solutions for counter-proliferation and counter-terrorism wherever required – and to keep our hands on the pulse of foreign scientists with whom we engage around the world.

Manpower, Personnel, Training and Education (MPT&E)

For FY 08, ONR's Capable Manpower Program is focused on development of innovative technology-based products to enable transformation in Navy/Marine Corps Human Capital programs. These include manpower/personnel, training, and human systems integration products that enable ships, air, and warfare systems program managers to optimize system performance, minimize ownership costs, and ensure systems are built to accommodate characteristics of the Sailors and Marines that will operate, maintain, and support warfighting systems. New approaches to selection, classification, distribution, assignment, training, performance support, and system design are necessary to ensure that future combatants and related sea-service components are properly staffed for optimal readiness.

ONR is partnering with the Army to develop an Integrated Whole Person Assessment which would integrate a set of five tools for whole person assessment, to significantly reduce early attrition from service careers, while providing a monitoring and forecasting system for factors that influence career intentions and decisions.

We are developing incentive-compatible resource allocation tools to analyze tradeoffs between readiness, cost, and risk – and to provide flexible, capabilities-based planning tools in support of the total force.

We are working to improve human performance in Network-Centric Operations by developing and integrating critical anti-submarine warfare (ASW) training, mission rehearsal, and execution-support tools. Components of this research include providing force-level ASW training, knowledge management and distributed workflow systems, as well as collaborative tools to improve decision support and situational awareness.

We are developing Immersive Technology for Training to demonstrate and evaluate the integration of core technologies that support low cost, deployable individual and team training in simulated environments that are realistic as possible and focus on critical, high risk, costly tasks. We are also developing training to provide game-based learning environments for critical tasks, as well as systematically evaluate learning and performance results.

We are working to improve training for Expeditionary Warfare by developing and evaluating company/battalion-level command and control (C2) performance support systems, automated performance assessment, real-time/model-based performance diagnosis and training strategies. This will support multi-tasking in team environments, provide system assistance based on dynamic monitoring of user-state and system-state, and increase skill proficiency and retention.

Marine Mammals and the Environment

A significant effort is dedicated to effective and responsible stewardship of the marine environment, and this specifically includes the impact of national security requirements and activities on fish and marine mammals. Our goal is to mitigate any impact of the Naval presence on the marine environment, and marine animals and fish while maintaining the ability to train and operate as required to support the naval mission. Navy is a leader in marine-mammal research, spending approximately $10 million annually on research to understand how marine mammals may be affected by sound. This investment represents a majority of the dollars spent on this research in the U.S., and nearly half spent worldwide.

The Navy collaborates with universities, institutes, industry, conservation agencies, and independent researchers around the world to understand what combinations of ocean conditions, geography, and sonar usage patterns could potentially impact marine mammals and the environment. Congress has been generous in support of these programs and I look forward to continued partnership in achieving the goal of better protecting the marine environment.

Marines in the Urban Environment

Through Navy's SBIR program, ONR supported development of anti-terrorism/force protection decision support software by 21st Century System, Inc. The Hi-Resolution Situational Awareness (HiRSA) system provides wireless distributed asymmetric threat detection, reporting, and situational awareness. This product is a commercial-off-the-shelf, open-architecture, modular software package that can be used as a stand-alone system or integrated with existing systems. It provides an efficient, cost effective means to improve security, with significantly fewer sentries and support manpower. HiRSA is being used by the Marines at Camp Fallujah for perimeter security operations command and control and sensor management.

Marines on patrol may find themselves in situations where they need to "see around the corner." To meet that requirement, ONR developed Dragon Runner, a tactical unmanned ground vehicle employing advanced robotic technologies. Invertible, tossable, and remotely operated, Dragon Runner gives small units the ability to "see around the corner" with real time imagery, and is capable of carrying an array of sensor packages and lethal payloads. Developed in conjunction with the Marine Corps Warfighting Lab, Dragon Runner transitioned to the Joint Robotics Programs Office for further development and fielding.

Marines in urban environments are highly susceptible to short-range electro-optically guided munitions. In 2006, ONR field-tested a Multi-function Electro Optical System (MEOS) that will automatically detect multiple optical systems, including a direct view optical sight from anti-tank guided munitions at 250 meters.

An ONR 07 FNC delivered a prototype system providing automatic detection, location, identification and engagement of hostile fire sources in constrained, dispersed and urban environments, in near real-time, with a high degree of precision. The effort will provide fire detection and counter-fire capability that will be transitioned to robotic applications.

Improvised Explosive Devices (IEDs)

Working closely with the Joint IED Defeat Organization (JIEDDO), ONR funds a variety of IED prediction efforts involving dynamics of terrorist movements, analysis of human activity associated with placement, uncovering support networks, tracking factory locations and events, bio-forensic profiling for tracing place of origin, and dynamic analysis of suicide bombing. We are committed to research complementary to other DoD and U.S. efforts and foster collaboration with allies in the war on terror.

In addition, Counter-IED projects sponsored by ONR include development of non-contact sensor systems to detect a broader range of explosives. ONR is also working on computational heuristics, validation methods and dynamic cultural preparation of the battle space to improve prediction methods. These projects anticipate future threats. as well as put us in a better position to respond as conditions change.

Near-term IED program initiatives include the Marine Corps Advanced Technology Development efforts to neutralize IEDs through improved countermeasures. Warfighter

Protection Advanced Technology Development efforts include modeling the human torso in a thermobaric blast environment, modeling physical and cognitive effects of blast exposure and conditions arising from traumatic brain injury.

Mid-term IED program efforts include Force Protection Applied Research to develop improved warfighter extremity protection, explosive sensors using engineered proteins, and multifunction toxin decontamination coatings. Common Picture Applied Research is working to provide mobility in adaptive sensor networks, an automated face recognition system, and dynamic network analysis for terrorist networks.

Through Navy's SBIR program, ONR partnered with the "DoubleShot" company to develop the In-Vehicle Geo-Referenced Video Imaging System to acquire and retrieve GPS based video to enable a user to detect roadside hazards. It allows mission training and planning, route reconnaissance, intelligence gathering, and IED threat detection. In addition, DoubleShot's system demonstrated the capability to provide full integration of gunshot detection with a remote weapon station to enable counter-sniper capability for Stryker, HMMWV and LAV. Positive evaluations from Marines in Iraq led to issuance of an Urgent Universal Need Statement, and over 100 systems have been ordered.

Support for Naval Expeditionary Combat Command

The Naval Expeditionary Combat Command (NECC) was established in January 2006. Beginning in March 2006, ONR initiated meetings to determine what assistance we could provide to address NECC's near term S&T requirements. NECC's "Top 5" S&T requirements were for development of 1) a Small Backpack Vertical Take-Off and Landing (VTOL) Unmanned Ariel Vehicle (UAV), 2) a Larger Fixed Wing UAV (Tier II), 3) an Unmanned Surface Vehicle (USV) with a Mounted Gunslinger System, 4) a Vehicle Mounted Gunslinger System, and 5) a Ground/Air Target Sensor. Based on these requirements, the Navy Expeditionary Over-watch (NEO) Program, funded by ONR Swampworks, was created in order to develop a USV with Gunslinger Sensors and Gun Mount, a UAV with Sensors and Control/Display Systems and C2/Data Relay, and a Truck Mounted Gunslinger III System with Counter-fire Capability.

The NEO Spiral 1 program was initiated in August 2006, with an industry contract awarded in January 2007. As a result, Gunslinger Feasibility Studies are in-progress, while Weapon Placement and Configuration Analysis, Preliminary Safety Hazard Analysis, Sensor and Weapon Performance Analysis, and Evaluation of Non-Lethal Weapons, Self Protection Methods, and Other Sensors have all been completed. As part of the Spiral 1 effort, ONR will coordinate to provide training, operational test and evaluation, demonstration, and deployment into theater of all NEO systems. For FY 08, an NEO Spiral 2 program is being evaluated in order to provide NECC with additional operational capabilities, including: 1) expanded UAV capability for airborne ISR, 2) expanded multi-spectral sensor SA capability, 3) Force Protection FP Ashore to include IED detection, perimeter security, etc., and 4) USV counter-fire capability.

In a parallel effort, ONR conducted an NECC S&T Capability Gap Development Workshop in August 2006. The Workshop was designed to identify required S&T capabilities within NECC's

Expeditionary Echelon operational concept for Joint Task Force (JTF) commander support, capability gaps and S&T solutions to mitigate operational risk to NECC subordinate forces, enabling capabilities, and other areas of concern which could potentially be addressed by ONR. The Workshop report was published in October 2006, with a second Workshop scheduled for April 2007 with the purpose of refining the results from the first Workshop and publishing a Navy Expeditionary Combat Enterprise S&T Strategic Plan.

Vertical Lift

ONR has teamed with industry (Boeing & Bell) to develop a Reconfigurable Rotor Blade that when applied to tilt-rotor aircraft (like V-22 Osprey) has potential to significantly improve efficiency by changing blade twist in-flight, increasing aircraft performance over a conventional blade.

Relatively simple to retrofit or forward fit, this technology employs a lightweight, solid-state, electronic actuator within the rotor blade, providing an affordable, reliable means to significantly increase payload and mission radius and reduce fuel consumption. This is the first application of this technology in such a high gravitation environment as the rotor blade. Implementation reduces vertical flight penalties normally associated with design compromise in rotors or prop rotors, enabling new mission profiles for rotorcraft and tilt-rotorcraft.

This year sees an increased commitment to basic research in vertical lift technology. Our long-term vision for Vertical Take Off and Landing (VTOL) aircraft combines improved Naval mission effectiveness, increased affordability, maintainability, reliability, and unprecedented levels of safety and survivability for aircrews. To achieve these breakthroughs we have partnered with universities and Navy labs, and are leveraging Army, Air Force, and NASA research investments in vertical lift technology.

Power Projection and Time Critical Strike

Revolutionary Approach To Time Critical Long Range Strike (RATTLRS) is a model of Navy, Air Force, NASA, and OSD interagency cooperation: RATTLRS is a high speed non-afterburning turbine, Mach 3 flight demonstration program for a future expendable hypersonic weapon system with access to space options. Lockheed Martin Aeronautics, Advanced Development Programs, is the prime contractor and Rolls Royce – Liberty Works is developing the unique engine. RATTLRS has achieved or exceeded technical and program milestones on or ahead of schedule. Lockheed Martin is projected to achieve first flight 9 months ahead of schedule. This will be the first non-afterburner high-Mach turbine accelerator flight demonstration. Following the flight test, RATTLRS will be ready for SDD.

While still under development, RATTLRS has generated interest, support and transition to advanced applications. For example, the Air Force Research Laboratory (AFRL) and DARPA, have transitioned the RATTLRS core engine to further development in the joint HiSTED (High-Speed Turbine Engine Demonstration) program and will ground test the engine at Mach 4 and above in 2007.

Additionally, the DARPA/USAF FALCON (Force Application and Launch from CONUS) Program is developing a two-stage (turbojet/scramjet) propulsion vehicle that can be scaled up for the next generation long-range bomber. The FALCON Program plans to use RATTLRS core engine for its turbine accelerator, as well as RATTLRS airframe fuselage and control surface manufacturing techniques.

Fighting at the Speed of Light

We see significant progress in directed energy programs. Research in developing a Free Electron Laser (FEL) System shows promise as an effective, affordable point defense capability against surface and air threats, anti-ship cruise missiles, swarms of small boats, and other asymmetric threats. With ONR-Joint Technology Office sponsorship, a significant milestone on the path toward weapons grade FEL was recently achieved with the highest FEL output power ever, 14kW, at Department of Energy's Jefferson Laboratory.

In addition, ONR and Naval Aviation are supporting development of High Energy Laser (HEL) technology such as Solid State Fiber Lasers and Beam Control concepts for tactical airborne HEL missions. Fiber Lasers improve efficiency while reducing weight and volume, characteristics critical for tactical platforms. Fiber laser technologies are also being developed by ONR and NRL for ship based asymmetric threat engagement.

Affordable Ships

ONR efforts such as the Navy Manufacturing Technology (ManTech) program contribute to affordable acquisition programs throughout the Navy. ManTech has a history of working with acquisition programs and industry to address weapon production issues. In 2006 ManTech efforts were shifted to initiatives in affordability of four platforms: DDG 1000, CVN 21, Littoral Combat Ship, and VIRGINIA Class Submarine.

To identify opportunities for cost reduction, ManTech is focusing on Ship Construction areas involving schedule compression, production engineering, distortion, outfitting, neat erection, and materials and process improvements. In Electronics, ManTech is focusing on radar and communications, sonar and navigation, integrated power and propulsion. ManTech is also making recommendations to industry and acquisition programs with respect to potential cost reduction approaches in overall business operations.

Protection from Enemy Submarines

Antisubmarine warfare in coastal waters is a difficult challenge. ONR research efforts focus on enhancing our ability to detect, track, classify, and engage enemy submarines by using a layered tactical approach. Our objective is to understand, predict and manipulate the environment faster than our enemy.

Ocean sensing is a critical component of littoral warfare and the focus of our Littoral ASW Multistatic Project (LAMP) for submarine detection in shallow to deep water. It includes development of Compact Deployable Multistatic Sources and Receivers, Coherent Waveform

Processing, and Over the Horizon Communications. It will reduce flight hours for patrol aircraft, enhance reliability with field-level performance equivalent to Improved Extended Echo Ranging systems, and supports the requirement for a rapidly deployable distributed system for a transiting Battle Group.

In addition, we conducted initial deployment of the Network Centric Interactive Multi-Sensor Analysis Training (IMAT) ASW Training and Performance Support System – providing integrated training, planning, operations, and feedback for multi-platform ASW. This is a component of the ASW portion of Composable FORCENet systems currently in use at 7th Fleet, CTF-74 Theater ASW Operations Center, aboard USS Ronald Reagan, CVN-76, and other Carrier Support Groups and Expeditionary Support Groups.

Electric Power

ONR is investing in advanced technologies for high efficiency electrical systems and equipment to meet the increasing electric power requirements for advanced weapons, launchers and defense systems aboard ships and submarines. ONR programs focus on technologies and system architectures to increase power and energy densities and energy efficiency, with the goal of reducing the impact of high-power electrical power systems on ships. These efforts directly support the Naval Sea Systems Command and Program Executive offices for Ships, Submarines and Aircraft Carriers.

ONR partnered with industry to develop the High Temperature Superconducting AC Synchronous Motor, a high power density, lightweight advanced 36.5 MW propulsion motor and drive system suitable for possible Naval application. The potential payoff is reduced weight and volume for a ship electric propulsion system, increased survivability, and fuel savings. The prototype is expected to complete factory acceptance tests in FY07.

In coordination with the OSD focus on energy security, we initiated a Naval Future Fuels effort to investigate the impact of new fuel formulations on Naval machinery.

Radar Development

Another example of how ONR investments anticipate future Naval requirements is illustrated by advances ONR developed in high power solid state amplifiers for Naval radars in anticipation of the increasing capability required to deal with missile threats.

Beginning in the 1960s, research to demonstrate viable solid state GaAs transistors culminated in current GaAs technology used by all high performance radars – such as MFR, VSR, and JSF radars. This enables order of magnitude improvement in reducing clutter, as well as significant improvement in maintainability. These technical advances resulted in unanticipated breakthroughs that provided the genesis of today's cellular telephone industry.

Realizing that threat detection continues to grow in difficulty requiring even more powerful radars in the same footprint, ONR initiated research in next generation high power amplifiers, including growth of wide band gap semiconductor SiC. This material provides thousand fold

improvements in clutter rejection, and the research produced the baseline technology for the UHF E2D radar, as well as an option for the CGX S-Band ballistic missile defense radar.

Finally, appreciating the limitation of SiC technology, and realizing the need to go to higher frequencies, ONR initiated research in GaN wide-band gap amplifiers. This research is beginning to show the progress necessary for it to be considered for future high frequency radars and EW systems. It also led to a new form of lighting which is six times more efficient than incandescent lights – and lasts fifty times longer.

A related issue is the number of topside apertures on Navy ships increased significantly in the past decade. As the number of apertures increased, the need to reduce signatures, enhance performance of critical Electronic Warfare (EW) and communication functions, and resolve EMI issues has also increased. With the goal of reducing Radar Cross Section, deckhouse size, weight, and cost, ONR has programs to develop innovative apertures that combine functions while improving overall performance.

The architecture of these systems is based on a modular open systems architecture approach to allow for implementation of ship system designs at less cost; scalability across multiple platforms; facilitate rapid, affordable upgrades to meet future threats, and enable the commander to tailor optimal use of all RF power available to meet the demands of any battlespace environment. Several of these programs are transitioning now or are slated to transition to DDG-1000. ONR is leveraging these efforts into an overall program, the Integrated Topside Naval Prototype, to provide a systems level engineering approach to developing integrated topside that is optimized, open, and scalable to meet future requirements.

Understanding the Sea

Highly capable research vessels are critical to the success of our basic and applied programs in ocean sciences. Since 1972, ONR has partnered with the National Science Foundation and other agencies in the University National Oceanographic Laboratory System (UNOLS) to allow joint scheduling and operations of a fleet of research ships used by the academic oceanographers. Navy is proud to have supported the academic oceanographic community's ability to go to sea for the past 60 years.

The FY2008 Budget request continues the refinement of initial operational and science mission requirements for the next generation of Ocean Class vessels in conjunction with UNOLS. This year's efforts will include development of documents needed for a successful project Milestone A decision.

Workforce Development and Human Capital Strategy

Developing and refreshing our S&T workforce is a key emphasis this year as it has been in the past. While each of the Naval Research Enterprise (NRE) centers and labs recruit and maintain their workforce through a variety of locally managed programs, ONR assists them relative to the S&T subcomponent of the NRE's larger Science & Engineering population pool. For example, the Naval Research Enterprise Intern Program (NREIP) is open to students enrolled at one of 69

NROTC colleges, universities, or affiliates. This program offers full-time summer appointments at sponsoring Navy Labs, including the Naval Research Laboratory (NRL).

There are a number of Defense Scholarship Programs the NRE community uses to attract students to the defense industry. The National Defense Science and Engineering Graduate (NDSEG) Fellowship/Scholarship Program is an example of a traditional program. A newer tool is the Science, Mathematics, and Research for Transformation (SMART) Defense Education Program authorized by congress in FY 06. This education and scholarship program allows the NRE to recruit new talent as well as provides an opportunity for current employees to pursue advanced degrees in highly specialized critical skill shortfall areas. One measure of interest in the program is number of applications submitted: FY 07 saw over five times more applications than the number submitted in FY 06.

Collaboration between Navy and the National Science Foundation (NSF) continues. Navy and NSF are partners in a program to fund collaboration between academic researchers and Navy scientists working on difficult problems of naval interest. This program, the NSF-Navy Civilian Service (NNCS) program, is a "service payback" scholarship awarded to a small number of researchers who agree to work for the Navy at one of the NRE Laboratories and Centers.

Each Naval Research Enterprise Center conducts a variety of community outreach programs. For example, last year the Navy supported a pilot program to stimulate interest in science and engineering among middle-school children in Virginia. The Virginia Demonstration Project achieved participation from 1600 students in middle schools from three participating counties. The program culminated in a June 2006 summer camp that included 300 students, 24 teachers, and 12 Navy civilian scientists and engineers.

Conclusion

I want to thank you again for the opportunity to discuss initiatives undertaken by Naval S&T and your Navy/Marine Corps team and your strong support of our effort in the past. The FY 2008 President's Budget request is about both prevailing in today's wartime environment and bridging to a successful future. Building that bridge requires careful S&T investments that will protect this nation and our war fighters long into the future.

We have a near term focus on Iraq and a long term focus on strengthening the Navy's ability to meet any challenge and to adapt to any security environment. We are moving away from stove-piped roles and responsibilities and toward greater integration of capabilities, more effective partnership between the research and acquisition worlds, and a broader vision of how to achieve shared goals with DARPA and the Army and Air Force research organizations. This is evidenced by new directions in the Navy S&T Strategic Plan, by real increases in the President's FY 2008 S&T budget, and by the fact that approximately 10% of our research portfolio involves ONR partnerships with these and other organizations. In short, we are getting better by being smarter.

I believe the state of our S&T investments is sound, represents careful stewardship of taxpayer dollars, and will make significant contributions to our war fighters as they serve in defense of the United States, both today and well into the future. Thank you again for your support.

DEPARTMENT OF THE AIR FORCE

PRESENTATION TO THE HOUSE ARMED SERVICES COMMITTEE

SUBCOMMITTEE ON TERRORISM, UNCONVENTIONAL THREATS AND CAPABILITIES

UNITED STATES HOUSE OF REPRESENTATIVES

SUBJECT: Fiscal Year 2008 Air Force Science and Technology

STATEMENT OF: Mr. Terry J. Jaggers, SES
Deputy Assistant Secretary
(Science, Technology and Engineering)

March 21, 2007

INTRODUCTION

Mr. Chairman, Members of the Subcommittee, and Staff, I am pleased to have the opportunity to provide testimony on the Fiscal Year 2008 Air Force Science and Technology (S&T) Program. As the nation adapts to a new security environment filled with unconventional and non-traditional threats, so the Air Force adapts to fight the global war on terror and proliferation of weapons of mass destruction (WMD). The Air Force continues to rebalance and focus its core S&T competencies to anticipate, find, fix, track, target, engage, and assess anything, anywhere, anytime. The Air Force is aggressively pursuing high payoff technologies focused on countering these new threats today, while modernizing our systems for tomorrow. Air Force leadership recognizes the value of its S&T Program to provide a wide range of technology options to enable us to achieve our vision of becoming an integrated Air, Space, and Cyber Force capable of rapid and decisive global engagement anywhere, anytime.

The Air Force Fiscal Year 2008 President's Budget request for S&T is approximately $1.9 billion, which includes $1.7 billion in "Core" S&T efforts with the remaining funds supporting the devolved efforts High Energy Laser Joint Technology Office and the University Research Initiative. These investments sustain the strong and balanced foundation of basic and applied research and advanced technology development needed to support future warfighting capabilities. This S&T investment portfolio provides Air Force leadership with opportunities to respond quickly to the threats of today and anticipate those of tomorrow. Continued Air Force leadership support of S&T is exemplified in this year's budget request, which reflects a $66M increase over the Fiscal Year 2007 request. This represents a real growth of 1.6 percent.

FOCUSING INVESTMENTS TO COUNTER UNCONVENTIONAL THREATS

Created in response to the Quadrennial Defense Review, our Air Force technical vision guided many of the counterterrorism and counterproliferation initiatives in this budget request. Born from the Air Force kill chain to find, fix, track, target, engage, and assess the enemy in a traditional theater, we have added "anticipate" to the front of this kill chain to capture the need to develop new technologies that predict our enemy's intentions before they act, and "anything, anywhere, anytime" to the end of the kill chain to focus more research in "24x7" tagging, tracking, and locating of terrorists and WMD in what is now a global theater of war.

Anticipating enemy actions is a difficult challenge. Working with the U.S. Special Operations Command, our Human Effectiveness Directorate has a program underway to apply mathematical techniques from economics, psychology, sociology, and market science to quantitatively assess and optimize the impact of information operations in an effort to anticipate enemy leadership intentions. They are conducting basic research to investigate the role of culture on cognition and behavior, applied research to create cultural research tools, and advanced technology development to demonstrate the decision-aids, models, and simulations required by the warfighter. The research goal of the program is to develop tools, techniques, and methods to enable high-fidelity predictive modeling of individuals, groups, organizations, and societies. Our Sensors and Information Directorates are working on near-term efforts to improve Command and Control, Intelligence, Surveillance, and Reconnaissance closed-loop simulation capabilities to better predict our adversary's actions. Focused on object tracking and identification sensor exploitation, plus multiple sensor dynamic management, cross-queuing and global change detection where input from two images is compared to identify differences, the goal is on predictive tracking of space, air, and ground vehicles with automated high confidence

identification. In the near-term, the Predictive Awareness and Network-centric Analysis for Collaborative Intelligence Assessment effort will transition a work station in Fiscal Year 2008 that will integrate multiple analysis, correlation, and fusion systems into a single operator-focused, multi-intelligence fusion and reasoning system. In Fiscal Year 2011, the Commander's Predictive Environment will provide the added capability to predict adversarial strengths, capabilities, and vulnerabilities in order for us to create high fidelity courses of action to continuously shape the battlefield. In the far-term, efforts funded within our basic research program at the Air Force Office of Scientific Research (AFOSR) are already yielding exciting results in our ability to anticipate threats. AFOSR started funding a University of California San Diego effort in Fiscal Year 2002 to study photoluminescence quenching effects in certain polymers to understand how these effects might be used in integrated nanosensors to strengthen our warfighter's ability to anticipate threats. A by-product of this basic research was a low-cost and robust Improvised Explosive Device (IED) detection sensor, currently being commercially marketed for use in field settings such as security checkpoints, stadiums, and amusement parks. We will continue to leverage our knowledge and competencies across the Air Force Research Laboratory in cognition, cultural, and human behavior modeling, sensors, and information to further our understanding of the challenges associated with anticipating the intentions of terrorists and our adversary's leaders…before they act.

Equally challenging is the ability to prosecute the kill chain against "anything, anywhere, anytime." This requires research in tagging, tracking, and locating terrorists or WMD anywhere on the globe "24x7." One project that could facilitate tracking by Unmanned Aerial Vehicles (UAVs) is called Synthetic Interface Research for UAV Systems, or SIRUS. This research in human effectiveness provides visualization methods for decision-making and trend analysis, intuitive control/mission management, and

seamless switching between UAVs. It is expected to be completed in Fiscal Year 2008. A similar effort Augmented Reality for Collaborative Decision Support –is also expected to complete in Fiscal Year 2008. It uses three-dimensional synthetic overlays allowing users to insert their own tags to automatically track moving objects. In our basic research program, efforts to exploit terahertz frequency radiation are leading to applications in detecting chemical explosives and biological agents to track the proliferation of these materials. This technology can detect hidden objects underneath cardboard, clothing, plastic, and wood, and has the potential for use in searching the contents of containers or searching for hidden devices under clothing. Continued sensors research is leading to development of a multi-sensor modeling database that will provide automatic target recognition and combat identification enhancements to improve Blue Force tracking, as well as the capability to enable future covert targeting and tracking by Fiscal Year 2011. One significant research project begun in Fiscal Year 2006 that will continue in Fiscal Year 2008, identifies distinguishing patterns of behavior characteristics that comprise behavior signatures to enable us to track individuals by their unique behavioral fingerprints, thus aiding in the anticipation of enemy actions. In addition, the Air Force S&T budget request continues to support development of a human measurement and signatures intelligence system for human tracking, targeting, and identification that was started last year. This project will culminate with a demonstration in Fiscal Year 2013 aimed at helping track terrorists remotely, in any terrain, without any direct contact with the individual.

We are also very excited about our research in biotaggants as a transformational technology to counter proliferation and acts of terrorism. Biotaggants attach either a passive identifying material (or taggant) to a biological warfare agent that can then be read by line-of-sight spectroscopy or an active taggant that is activated by radio frequency

energy so it can be read through walls. The use of these new biotaggants will revolutionize our ability to track WMD around the globe. In response to warfighter needs, our Sensors Directorate rapidly developed the Angel Fire electro-optical staring array. Planned to deploy in April 2007, Angel Fire is an airborne wide-area (city-sized), image gathering, persistent electro-optical sensor array that distributes real-time imagery straight to the warfighter. Angel Fire will allow the warfighter to zoom in and observe more closely any area within the collected image cone, as well as allowing playback of significant events, essentially providing a "Google Earth, TIVO-like" capability to monitor areas of interest. Providing a similar capability using radar sensors with an all-weather/nighttime capability, the Goals, Objectives, Technical Challenges, and Approaches-based (GOTChA-based) Synthetic Aperture Radar sensor algorithm development will continue in an effort to provide "24x7" all-weather capabilities to track and identify moving targets by Fiscal Year 2015.

GAME CHANGERS FOR THE NEW SECURITY ENVIRONMENT

The Information Age presents many new threats and requires a new theory towards warfare. Network Centric Warfare, which involves human and organizational behavior, as well as the connectivity of capabilities to achieve effects, provides a new way of thinking - a new mental model. The Air Force is investing in technologies to ensure individuals and systems are linked, or networked, so the right information is delivered to the right person at the right time in the right format. For example, Interim Capability for Airborne Networking, an airborne networking technology recently transitioned to the Joint Surveillance Target Attack Radar System (JSTARS), is being used in current operations as chat rooms between JSTARS and our Joint and coalition warfighters on the ground. The Information Age also has the Air Force embarking on technologies for a new warfighting

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medium – the cyber domain. Due to the low entry costs for cyber adversaries, the cyber arena is dynamic with rapid prototyping and fielding of new cyber threats. On September 6, 2006, the Secretary and Chief of Staff of the Air Force directed the establishment of a new operational command for cyberspace. The cyber technologies we are developing within our Information Technology Directorate will provide this new command with similar capabilities as those developed for conventional Air Force employment, such as strike or reconnaissance systems. Technologies being developed will assist in the new command's Network Warfare and include cyber platforms with the mission of destroying incoming worms or viruses, thus bolstering our information assurance capabilities. An example of this is the Lab's Defensive Cybercraft, which essentially acts as a defensive Intelligence, Surveillance, and Reconnaissance (ISR) asset. Additionally, we continue to research game changing technologies that locate and track terrorists in cyberspace. While the Information Age opens up Pandora's Box for unconventional cyber threats, we continue investment in traditional cyber technologies to provide Command and Control, Electronic Warfare, and ISR capabilities.

The Air Force is currently pursuing game changing research to strengthen our nation's aerospace power. One involves reducing the Department of Defense's (DoD's) dependence on foreign oil. As DoD's leading consumer of jet fuel, the Air Force burned 3.2 billion gallons of jet fuel last year or 57 percent of DoD's total consumption. We are currently leading the evaluation of alternative fuels and engine technologies that may lead to greater fuel efficiency and significantly reduce our dependence on oil. The Air Force is supporting development of a synthetic fuel, based on a domestic source, to ensure a stable energy supply regardless of political uncertainties in oil-producing countries or supply disruptions spurred by natural disasters, such as Hurricane Katrina. Our goal is to have 50 percent of our aviation fuel coming from alternative fuel sources by Fiscal Year

2016. As a result, we are currently working to certify Fischer-Tropsch (F-T) fuel for military aviation use. The Air Force recently performed flight tests on a B-52 using a blend of JP-8 and a synthetic fuel derived from natural gas using this Fischer-Tropsch process. By working together, the military and civil market will expand the demand for synthetic jet fuel and make it more economical to produce. The Air Force is also looking at ways to increase aircraft fuel efficiency, including advanced computational fluid dynamics tools to improve aircraft design optimization and reduce drag, and various efforts exploring lighter aircraft structures. In addition, the Highly Efficient Embedded Turbine Engine (HEETE) program is developing fuel efficient engine technologies that support future ISR, tankers, mobility, and unmanned combat air vehicle extreme endurance and range requirements with embedded engines buried behind serpentine inlets and exhausts. Estimated benefits of utilizing these technologies, relative to state-of-the-art Calendar Year 2000 engines, include a 25 percent improvement in fuel efficiency. Another program promoting engine efficiency is the Adaptive Versatile Engine Technology (ADVENT) program. ADVENT is a variable-bypass ratio turbofan engine technology concept that allows efficient engine operation at both subsonic and supersonic speeds. It provides supercruise thrust without after-burner, all using a fixed inlet and/or fixed exhaust configuration. Estimated benefits of this engine, relative to a state-of-the-art Mach 2.5 engine, include a 50 percent increase in engine thrust/weight, with 25 percent subsonic and 35 percent supersonic reductions in specific fuel consumption. Another game changer being explored for lighter aircraft structures involves advancements in composite structures. These advancements are planned to shorten the development time for the next generation cargo aircraft, as well as improve strength, weight, and mission utility over current legacy aircraft. Within our Air Vehicles Directorate, we are challenging the current paradigm of extensive system development time and expense, and we are pushing

the envelope to produce and flight-demonstrate a prototype, sub-scale cargo aircraft in less than two years.

Finally, directed energy is also seen as a game changing technology and includes multiple technologies, both near- and far-term, that will allow several new Air Force applications and missions. Among these technologies are various solid state lasers permitting high energy lasers in small-/medium-sized platforms for offensive and defensive applications, advanced optics to allow high resolution space object imaging and the long-range transmission of laser beams at various power levels, and high power microwave devices and antennas for non-lethal covert electronic attack. The Air Force is currently developing and demonstrating the enabling component technologies required for an airborne non-lethal directed energy weapon. This is a follow-on to the highly successful Active Denial System Advanced Concept Technology Demonstration. We are developing a test capability to enable final validation of a full-power source for this airborne application and efforts will continue to refine existing beam control/antenna concepts to meet airborne requirements to include addressing issues related to propagation and air breakdown. Supporting technologies such as new materials for power and millimeter wave sources; and multi-megawatt, lightweight power generation for these potential directed energy devices are also being developed. Development and transition of these exciting directed energy technologies will continue to provide our warfighters with the best capabilities to defeat the enemy in this new era of irregular warfare.

At the same time, we are focused on combating traditional threats with developments such as improved interoperability between manned and unmanned vehicles; responsive, tactically significant space capabilities; and durable, hardened materials and electronics. The Day/Night EO/IR [Electro-Optical/Infrared] Tracker Countermeasures (DETCM) effort provides aircraft the capability to detect and/or counter passive EO/IR

tracking systems increasingly used by surface-to-air missiles. DETCM would employ laser scanning to detect these threats and incorporate an improved laser-based Closed-Loop Infrared Countermeasures (CLIRCM) technique to defeat the tracking function of the surface-to-air missiles. Successful implementation will significantly enhance aircraft survivability and battlespace awareness. In our Munitions Directorate, we also have efforts in Focused Lethality Munitions (FLM). Conventional bombs pose risks for civilian casualties and infrastructure damage in urban environments. FLMs would allow a highly localized lethal footprint to support military operations in urban terrain. This Secretary of the Air Force high interest item would give the Air Force more flexibility in engaging and prosecuting targets where collateral damage is to be minimized. Additionally, with the increasing numbers of UAVs of all sizes operating in the same air space as manned aircraft, it is imperative that all these aircraft operate safely and without impeding each other. To address this issue, the Air Force is currently developing advanced flight control automation and adaptive algorithms for UAVs; improved aircraft design that will result in less drag, better engine performance, and reduced fuel consumption; photonic sensing and flight controls; and joint air space management and deconfliction software.

We recognize that other nations are developing capabilities that threaten our space assets. Since space dominance has provided an asymmetric advantage to the United States, we are developing technologies to detect these threats, understand the capabilities and intentions of those threats, and protect our space systems from them. One example is the Experimental Satellite System-11, or XSS-11 – a highly mobile, proximity operations effort. XSS-11 is the first fully autonomous microsatellite designed for orbital navigation and inspection around another resident space object. Our microsatellite activities have led to new satellite acquisition concepts, leveraging small satellites to deliver essential capability to the warfighter earlier. The Tactical Satellite-2 (TacSat-2) successfully

launched on December 16, 2006, and future TacSats will add pioneering capabilities, linking the ultimate high-ground closer to the tactical warfighter, and offering solutions to disruptive and catastrophic space threats. Other efforts, such as Airborne Active Denial: protective materials for platforms, sensors, and humans against directed energy weapons; and bio-inspired materials are also being investigated to address emerging disruptive threats as well. An example is the Battlefield Laser Detection System, or BLADES, which allows real-time detection and characterization of battlefield laser threats, including rangefinders, designators, guidance, and blinder threats.

One last area that I'd like to highlight is nanotechnology. Our nanotechnology research involves understanding and controlling matter at dimensions of roughly 1 to 100 nanometers, where unique phenomena enable novel applications. The ability to build things atom-by-atom and molecule-by-molecule will provide for new classes of structural and electronic materials. Nanotechnology will enable Air Force systems to be lighter, stronger, smarter, cheaper, cleaner, and more precise. For example, in nanoelectronics, basic research seeks to understand the techniques needed to control growth of self-assembled quantum structures, connections to the structures, and combinations of both, which will lead to development of quantum computing systems and nanosensor detector systems capable of collecting, processing, imaging, and communicating massive amounts of data with minimal size, weight, and power consumption. In our Materials and Manufacturing Directorate we are developing nano-enabled materials - engineering materials at the nanoscale - that will enable new or dramatically improved functionality for electronic, magnetic, photonic, and structural materials. Our researchers have developed and tested innovative coatings that prevent aircraft corrosion, which will likely decrease life cycle costs, reduce maintenance, and increase readiness by limiting equipment down time.

AIR FORCE S&T GUIDING PRINCIPLES

In 2005, I established five guiding principles for the Air Force S&T Program. Committed to maintaining world-class in-house military and civilian intellectual capital, our number one guiding principle is to value our people. This commitment is reflected in the use of the various flexibilities afforded the Air Force under the Laboratory Personnel Demonstration program or Lab Demo. Additionally, the Scientist and Engineer (S&E) Career Field Management team is developing new leadership development tools and initiatives to vector S&Es into exciting career paths. This team also managed to preserve all Fiscal Year 2007 S&E advance academic degree quotas during a major downsizing activity within the Air Force. In addition, the Air Force considers its involvement in the National Defense Science and Engineering Graduate Scholarship and the National Defense Education Programs (Science Mathematics and Research for Transformation program follow-on) critical towards building our nation's intellectual capital and supporting the growth of future Air Force technical leaders.

Our second guiding principle is to ensure a balanced portfolio between near-, mid-, and far-term S&T investments. As a goal, no less than 15 percent will be allocated to our core 6.1, basic research efforts to ensure we bring to bear the most innovative thoughts to push technology in areas to which we haven't even defined the problem or concept of operation. Alternatively, as a goal, no less than 30 percent of the portfolio will be allocated to 6.3, advanced technology development efforts to increase technology transition successes and real-time support to the warfighter.

Our third guiding principle is to focus our S&T investments, allowing us to demonstrate and deliver technologies that directly meet stated warfighter capability objectives. To ensure a harder link to our capabilities-based planning process, we

continue to build on our new planning framework called Focused Long-Term Challenges, or FLTCs. In their infancy last year, the Air Force has baselined eight FLTCs. While guided by our Air Force technical vision for this budget, these eight FLTCs will serve as the framework to guide most of our 6.2, about 40 percent of our 6.1, and roughly 80 percent of our 6.3 investments on mid- and far-term S&T demonstrations to directly satisfy the needs of the Combatant Commanders and their Components.

Honoring commitments is our fourth guiding principle. We are committed to leveraging and synergizing our S&T investment through our Memoranda of Agreement and similar commitments with our sister Services and Defense Agency partners. Our commitment to the Office of the Secretary of Defense's new Reliance 21 process provides an improved avenue for the Services and Defense Agencies to benefit from each other's S&T investments. In addition, our commitment to collaborations such as the Versatile, Affordable Advanced Turbine Engine (VAATE) program provides innovative cost-share relationships with industry and other agencies such as the Department of Energy. VAATE activities are expected to provide 15 to 25 percent improvement in turbine engine fuel efficiency that not only benefits DoD, but the commercial sector as well. Whether our commitments are with others in the Air Force, our sister Services and Agencies, the Office of the Secretary of Defense, industry, the North Atlantic Treaty Organization, or Congress, you have my word that we will deliver on our commitments.

Last, but not least of our guiding principles is to find new and improved ways of transitioning technology. The Applied Technology Councils, or ATCs, foster top-level user involvement in the transition of technology from the laboratory to the system developer to the operational user. Commissioned by the ATCs, Advanced Technology Demonstrations (ATDs) provide a formal transition path for fielding technology. Integrated Product Teams are now required for each ATD and team members include

users, program offices, and functional organizations, such as Logistics and Test and Evaluation, among others. While the ATD process represents transitions centered on our planning and programming process, we have codified a new method in the laboratory to rapidly prototype and deliver capability to warfighters in a matter of months versus years. This new core process at the Air Force Research Laboratory rallies cross-functional expertise and an innovation center to meet immediate problems in theater. For example, we have conducted work this past year to develop a technology solution to counter helicopter brownout/dust-out conditions (no/low visibility approach for helicopters). Our solution, the Photographic Landing Augmentation System for Helicopters (PhLASH), was recently installed on an MH-53 helicopter and conducted a successful initial flight on February 17, 2007. In the past 25 years, Air Force Special Operations have lost 20 aircraft and 60 lives to mishaps with no/low visibility as a factor. We believe the PhLASH capability will significantly improve the safety of our troops.

In addition, our efforts in the Small Business Innovation Research/Small Business Technology Transfer (SBIR/STTR) and the Manufacturing Technology (ManTech) programs are further examples of programs where we are seeking to improve technology transition. We have made good progress in the SBIR Commercialization Pilot Program and expect significant improvements in the transition of technology, products, and services developed under SBIR. The Air Force appreciates the opportunity provided by Congressional direction authorizing the SBIR Commercialization Pilot Program and we are well on our way to making this program a huge success. The ManTech program recently established a Manufacturing Readiness Level (MRL) "center of excellence" capability that focuses on identifying, tracking, and mitigating manufacturing risks across the acquisition cycle. Coupling these efforts with a focus on more disciplined Systems Engineering in the pre-acquisition planning phases is strengthening the Air Force transition

process, resulting in acquisition programs with the latest technology and more mature technical planning and credibility.

CONCLUSION

The initiatives that I've described will not be without their challenges. Air Force S&T is in a time of great change as we reshape our S&E workforce, retool our processes under the Secretary's Air Force Smart Operations 21 initiative, understand the S&T required as we incorporate cyber defense into the Air Force mission, and move towards a capability-based planning construct using focused long-term challenges. Despite the challenges facing us in Air Force S&T, we are emboldened to tackle these head-on as we prosecute the global war on terror and counterproliferation, as attested to by our Air Force Technical Vision. Our Fiscal Year 2008 budget builds on past S&T successes, a future technical vision with a clear focus on the new security environment, and reflects my five guiding principles. Today's Air Force leaders have shown their commitment in supporting an Air Force S&T Program that has served the Air Force well for over sixty years and has positioned itself to meet the challenges of our new security environment. This commitment is clearly shown through the Air Force Fiscal Year 2008 President's Budget request, which consists of over $1.7 billion in "Core" S&T efforts and represents real growth of 1.6 percent.

Mr. Chairman, thank you again for the opportunity to present testimony and thank you for your continuing support of the Air Force S&T Program.

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