Dr. Amy Alving, Director
Special Projects Office
Office Overview

Good morning, and welcome to the Special Projects Office portion of DARPATech. I am Amy Alving and I'm the Director of SPO, one of the "systems offices" at DARPA.

There have been a number of changes to the office since the last DARPATech, and I appreciate the opportunity to share with you the vision of where we are heading. Our theme for the week is "Future World." We chose that because it reflects our focus on providing technological solutions to a variety of emerging threats.

As a nation, we have long focused on defeating a peer adversary and, over the last half of the 20th century, we built up an unsurpassed capability to win decisively in a force-on-force engagement. Our adversaries have learned that lesson. The adversary of the future—whether state actor, transnational group, or isolated small—cell will study our strengths and learn to avoid them or figure out how to turn them to our disadvantage.

The Special Projects Office is focused on developing solutions to a handful of those emerging threats, and over the next 90 minutes we will tell you about our activities in the categories shown here: underground facilities, defense against chemical and biological weapons, counter GPS jamming, low-end cruise missiles, and the infrared class of air defense systems.

During a separate session, Dr. Joe Guerci, the Deputy Director of SPO, will tell you about our activities in the space arena; there, we are focused on providing support to the tactical warfighter.

The first category of threat is that posed by underground facilities. One very effective way to avoid being targeted is to hide. Our current and potential future opponents in the last decade have greatly increased their construction and use of deeply buried underground facilities and bunkers.

These might be used for a variety of critical functions, including command and control; ballistic missiles; and the production, weaponization, and storage of weapons of mass destruction.

In the last two wars we fought in Kosovo and in Afghanistan, underground facilities and caves were the most serious impediments to our operational dominance.

DARPA is especially interested in the "characterization" part of the problem: determining what any individual underground facility is for, what its pace of operations is, and where its targeting vulnerabilities are located.

This is a very tough problem, since underground facilities are specifically designed to hide this very information. It is often described as a no silver-bullet problem: no single approach is likely to be successful because the signatures we are searching for are so small.

Instead, we must exploit the spatial and temporal information from a variety of sensors—seismic, acoustic, electro-optical, and radio frequency—and combine the signals, coherently where possible, to provide the information required for characterization.

A few years ago, under the leadership of Dr. Dan Cress and Dr. Steve Buchsbaum, we embarked upon an ambitious set of activities to do this. Steve will tell you more about the progress of this program later this morning.

Another major focus area within SPO is the defense against chemical and biological weapons. From Iraq's use of chemical weapons against its Kurdish citizens during the 1980s, to the post-September 11 anthrax letters here at home, the use of these weapons is on the horizon. We need to develop new defenses.

Let me put SPO's activities in the bio arena into context. One of the most insidious aspects of biological warfare is the delay between the exposure to an agent and the presentation of symptoms. Unlike most kinds of warfare, the first and most important thing is to recognize that an attack has taken place.

What makes this even more difficult is that the initial symptoms are likely to be nonspecific—such as headache, fever, and malaise—and easily mistaken for the flu. The more unique symptoms that are specific to the particular biological warfare agent and that, today, are required for diagnosis, take longer to appear.

At the same time, the best opportunity to treat the victim is in the earliest stage of the disease. Thus, the longer the attack goes unrecognized, the higher the fatality rate will be. In addition, for those agents that are contagious, person-to-person transmission typically begins around the same time the agent-specific symptoms appear.

Clearly, warning systems that rely solely on these symptoms are not optimal for preventing retransmission. For these reasons, DARPA, with other Government agencies, is investing in techniques that enable early diagnosis of disease. These may be based on new medical tests done on patients; for instance, screening the blood of patients with flu-like symptoms for markers specific to biowarfare agents. Or they may not rely directly on patients at all, but be based on other indicators, such as a surge in the sale of certain over-the-counter medicines used for self-treatment of the early, nonspecific symptoms.

You will hear about programs looking at these types of medical and non-medical approaches from the Defense Sciences Office and the Information Awareness Office, and these are important elements of our national defense.

Within the Special Projects Office, we are investigating how to detect and respond to releases of biological warfare agents before the victims begin to show symptoms. This requires environmental sensing rather than medical diagnostics.

This approach brings many challenges that must be overcome, but the benefits can be significant. By sampling the environment directly, rather than waiting for the human body to mount its immune response, we can detect the fact of the release much more quickly.

We can determine what was released and select the appropriate course of treatment. We are also more likely to be able to determine where the release took place; this gives us an indication of who may have been exposed. This serves the dual purpose of helping get treatment to the victims early, when treatment is most effective, and helping prevent the spread of disease for contagious agents.

All these benefits fall in the category of "detect-to-treat”; that is, environmental sampling can be beneficial even if it does not prevent exposure to the agent, but simply provides notice when exposure happens. Detect-to-treat sensors enable protective architectures that exploit these aspects of early warning, and Mr. Tom McCreery will describe some ideas we are pursuing in this area.

At the most challenging end of environmental sampling, we look for so-called "detect-to-protect” sensors, which are fully automated and sufficiently fast and reliable that we can use them as part of protection architectures to prevent people from being exposed to whatever agent is released.

Today's sensors are not up to this challenge for most nonbattlefield applications. But you will hear today about our biological agent time of flight (TOF) mass spectrometer program, which is developing such a detect-to-protect sensor, as well as other investments we intend to make in very fast sensors.

One example of a protective architecture that would exploit such sensors is our Immune Building Program. Here, we are developing the components, system, and strategies required to prevent the inhabitants of a building from being exposed to an agent released inside or outside the building. Mr. Roger Gibbs will tell you more about that set of activities.

The third threat area concerns our reliance on the sophisticated sensors and information systems that enable our operational dominance. This dependence on accurate and timely information can, itself, become a vulnerability for our enemies to exploit.

A particular area of concern is the GPS timing signal, which has become such a critical part of today's navigation and guidance infrastructure. We have been working on this problem for several years, and one of the key drivers has been our requirement that any solution we develop must limit the modifications needed in the GPS receivers to software alone. This is because we don't want our antijam solution to require the replacement of our large inventory of fielded receivers.

We have developed a system around a set of airborne platforms that provide a robust and powerful timing signal to overcome the jamming signal. This approach is called "pseudolites" and, in the coming year, we will finish demonstrating this capability. Lt Col Greg Vansuch will update you on the status of this activity. In addition, he will describe some of our other interests in the navigation and guidance area.

Another threat on the horizon comes from cruise missiles. Here I refer specifically not to the high-end, high-tech missiles that are fast, stealthy, maneuverable, and equipped with self-protection measures, but instead to the low-end version, either low-tech missiles, or weaponized UAVs, or even small airplanes modified with a remote-control kit. Such technologies are available off-the-shelf, so we must be prepared for them to be used against us. They bring challenges and solutions different from those associated with more sophisticated threats. DARPA has been developing a low-cost solution to this problem and has invested in reducing the seeker cost by eliminating gimbals and by using MEMS technology.

In the RF Systems portion of this session, Dr. Larry Corey will bring you up to date on these activities, including work we are doing on maturing MEMS technology to make the devices more reliable and to reduce their packaging cost. He will describe a new set of activities targeted against this and related threats, in which we are extending very low-power density modules of the sort developed for commercial applications to military uses for surveillance and tracking.

Finally, a new class of air defense system is proliferating that does not use RF signals to detect and home in on aircraft. Instead, they use optical or infrared guidance systems to target our aircraft. Therefore, they are not detectable by our RF-based protection assets. Our aircraft often choose to fly higher to minimize exposure to this threat.

We recently started a program called "MEDUSA" that will restore U.S. air dominance by developing our own optical systems to detect and defeat these threats before they can launch an anti-aircraft weapon, and/or by enabling reactive countermeasures against such weapons.

During the Optical Systems portion this morning, you will hear from Dr. Robert Hauge about this program. He will also tell you about other ideas we are pursuing in the area of novel optical systems.

So far, I have described SPO activities in terms of the threats we are addressing and the prototype systems we are developing to defeat those threats. To meet these challenges, we must invest in a number of component technologies, and SPO has many technology development efforts underway.

During the presentations this morning, you will hear about those technologies in the context of the threats to which they are most directly related. By their very nature, these component technologies can be used in a variety of ways.

I give you two examples here.

Within the Navigation and Guidance portion, you will hear about some inertial navigation systems that are very small, lightweight, and accurate. These can be used in a variety of ways to supplement or replace GPS guidance and they soon will be ready for transition.

Within the RF Systems portion, you will hear about new work we are doing in signal processing. Here we are looking at how to best exploit a priori information about the environment such as digital elevation and terrain information, road networks, or the location of competing emitters such as television towers. These things affect the way our sensors behave, but today we do not account for their effects when trying to interpret the sensor returns. We are investigating how to best predict these effects and to process them out of the sensor returns early in the signal processing chain, so we can do a better job of picking out moving targets with MTI radar and stationary targets with synthetic aperture radar.

In summary, we have a number of exciting activities leading toward development of systems solutions to these emerging threats, as well as maturing the component technologies that are key enablers to these systems. The program managers will now describe their activities in more detail and describe opportunities for collaboration either as a performer or as a transition partner.

We will lead off with Dr. Steve Buchsbaum and the underground facilities problem.

Thank you.