Opening Statement

Of

Kirk Evans, Ph. D.
Director, Mission Support Office
Homeland Security Advanced Research Projects Agency
Science and Technology Directorate
Department of Homeland Security

Before The Senate Committee on the Judiciary Subcommittee on Immigration, Border Security and Citizenship
&
The Senate Committee on the Judiciary Subcommittee on Terrorism, Technology and Homeland Security.

April 28, 2005

Introduction

Good afternoon, Chairman Cornyn, Chairman Kyl, Ranking Members Kennedy and Feinstein. It is my pleasure to come before you today to share our vision for and progress in developing sensor and information systems in support of the Border Patrol's mission.

BTS S&T Mission and Objectives

At the Science and Technology Directorate, the mission of the BTS portfolio is to develop and transition capabilities that improve the security of our nation's borders and transportation systems without impeding the flow of commerce and travelers. We consider the operating arms of DHS as our customers, and seek to work with those customers in a collaborative and cooperative environment.

In pursuit of that mission we have the following strategic objectives:

- Prevent entry of terrorists, criminals and illegal aliens
- Interdict terrorist instruments and contraband at the earliest opportunity
- Improve the security of U.S. transportation systems
- Facilitate flow of commerce and travelers – identify, disrupt & dismantle entities that threaten the United States

The new security environment requires us to completely secure our border and transportation infrastructure, not just stem the tide of illegal activities. That is a far more difficult goal and there will never be enough officers to cover the vast areas that must be secured. The key to improving our border and transportation security capability is to instantaneously be alerted when a threat presents itself at our borders or in our transportation system, and provide all relevant information to the appropriate decision makers and security forces so that they can mount an effective response. To carry that out, our goal is to develop a system of systems engineering view for overall view and develop an architecture and a set of technology programs that will gather, process and distribute real-time knowledge of the border and transportation situation. The systems should also provide decision support tools and labor saving devices for our security forces.

Background

Chief Aguilar is far more capable in describing for you the mission and operations of the Border Patrol. In what follows I will describe how we look at the Patrol's operations through the admittedly simplistic eyes of technologists. Today the Border Patrol employs both surveillance and tactical concepts of operations. Surveillance provides an operational picture and cueing that alerts the user to areas of likely activity and interest. Acting on cues, the tactical operations locate, identify, and detain (if appropriate) people or vehicles crossing the border illegally.

For surveillance or the cueing function the Border Patrol typically uses intelligence and "sign-cutting" – patrolling the border and finding the tell-tale indications of cross-border activity. For "tactical" detection the Border Patrol typically uses a combination of unattended ground sensors and cameras. In discussion with the Border Patrol, it is the surveillance or cueing mission that appears to most technically challenging, and the one with which the Border Patrol would like us to focus our efforts.

Key Technology Challenges:

To support the patrol we in S&T have 3 technical challenges. First is the magnitude of the area to surveillance. The second is finding sensor technology that will provide the cueing necessary for efficient and effective Border Patrol operations across those expanses. The third challenge we are pursuing is developing and integrating technologies for information networks to give field personnel connectivity and situational awareness in their rugged environment.

To understand how the size of the border area and the sensor performance issues are interrelated we can address the southern border, which is approximately 1500 miles long, and some of the considerations it would take to develop an "electronic fence" to span that stretch. It is probably not sufficient to just have a magic line along that border, some depth to the detection zone is needed, for two reasons: first, to develop at least some form of track (are the Items of Interest coming into or out of the country?), second, to have sufficient time within the field of view of the sensor to enhance detection and reduce false alarm rates. Consider covering the southern border with a ½ mile wide detection zone that has a probability of detection of 50%. If we were to use ground sensors with a 10 meter detection range we would require approximately 3,000,000 sensors. With a sensor detection range of 450 meters, we would require approximately 1,335 sensors. With a sensor detection range of 1600 meters (a mile) we would require approximately 375 sensors, and with a 5 km sensor detection range would require approximately 160 sensors. Clearly, for surveillance of the borders, sensor detection range is a major factor.

False alarm rate is a second factor. Consider the statistics if the Border Patrol manpower allowed them to respond to a false alarm rate of four per day along the southern border (not unreasonable if the Border Patrol has to respond to each alarm). For the 10 meter detection sensor that corresponds to one false alarm per sensor every 2,000 years – not achievable. For the 1 mile sensor, that is one false alarm per sensor every 90 days – perhaps achievable.

Arguably, we would like to have a sensor capable of detecting a person at one mile, with a low false alarm rate (one per 90 days), a field lifetime of a year, and a per unit cost much less than $30,000. Such a sensor does not now exist.

In all our programs, an over-riding factor is the operational utility and suitability for the Border Patrol. That is: do the technologies we develop and test fit within the Border Patrol concept of operations? Are they suitable in terms of ruggedness, maintenance requirements and training? Are they cost effective?

Technologies:

The following is by no means a complete or exhaustive list of technologies that could be brought to bear. It is, however, one that has our interest in terms of potential long-term payoff.

Radars:

Present radar systems that have been tested are mono-static (that is using the same transmitter and receiver antenna). Two Ku and Ka band radars have been tested in the Arizona Border Control Initiative with some success. For the wavelengths we are considering, any radar's detection range is limited by its line of sight, thus it needs to be placed on a tower or other elevation for maximum detection range. Detection ranges for the Ku band radar (mounted on a self rising tower) were on the order of 5 km and 300 m for the Ka band (ground mounted). These radars had limitations with shadowing due to topography, ground cover and vegetation. The state of technology for conventional Ku and Ka band radars is relatively mature, with the possible exception that additional signal processing may be applicable to enhance target recognition, penetrate vegetation, and reduce false alarms. The major costs for this class of radars, in addition to the radar itself, will be the elevation mechanism (either permanent or mobile) required to give them and advantageous field of view.

Bi-static or multi-static radars are systems that use separate transmitters and receivers. Multi-static technology has been developed for air defense purposes, and could have a number of advantages for detecting the intrusion across our borders. One form of multi-static is passive coherent localization (PCL) which utilizes one of a number of transmitters of opportunity (typically commercial TV, cell phone tower, direct broadcast satellite, and radio signals) with multiple receivers to detect moving targets. PCL has been effectively demonstrated for aircraft targets but its capabilities against marine targets, vehicles or humans have not been thoroughly evaluated. PCL has a number of attractive advantages. First, by using locally ambient signals, it does not give away the sensor operation as would conventional radar. The detection is through the Time - Doppler modulation of the energy reflected off a moving target in the field of view of the transmitted signal and the receiver antenna. The availability of some signals with sufficient strength and bandwidth for detection of small targets in all border areas may be an issue (depending on the signal used), but for areas with such coverage, the systems costs could be much lower than a conventional radar. The receive array may be relatively small (although would have to be elevated) and be easier to install than a conventional radar. There is a PCL system in place at Bolling AFB for detection of aircraft entering National Capitol Region. While PCL has considerable potential for marine, vehicle and human detection (if it worked it might meet the 1 mile, $30,000, 90 day criteria listed above); it has not been tested in this application. A technology testing and development effort is required to fully understand the phenomenology for surface targets (ground clutter and low velocities complicate matters), the signal and noise characteristics for a variety of signals (FM, HDTV, DBS, Cell Phone), the receive antenna requirements, and the signal processing needed to pull vehicle and humans out of the background clutter.

Fiber Optics

I understand you will be offered written testimony concerning the use of a long optical fiber, buried in the ground, to detect the vibration caused by a person walking. There have been a number of fiber optic concepts proposed; some with a sensor attached to the fiber every few tens of meters, and others which use the backscattering properties of the fiber itself. An above ground fiber optic sensor was prototyped in the ABCi along the Nogales border fence with some success. Although for most border applications the fiber cable must be buried, a consequential expense, such systems could offer some intriguing advantages. First, they are hidden and passive. Second, once the system is installed the maintenance and operating costs should be low. Third, apart from malicious damage, the system should have a lifetime on the order ten years or more.

The system concept consists of a fiber optic line, a laser source, and a light detector. A laser pulse is injected into one end of a fiber optic line, and disturbances to the fiber optic line generate backscatter, or reflections that returns to the light origin and is measured by the detector. The backscatter is measured for time of arrival, intensity, and, in some cases, phase change to determine the disturbance distance from the source and detector. The trick is in the specific detection mechanism used.

With the fiber optic line buried several inches to a couple feet under ground, a highly sensitive system has the ability to detect walking personnel from several meters or more away. Because of their sensitivity, the systems need to be buried in order to reduce background noise from the surrounding environment, and limitations originate from soil-to-fiber optic coupling and soil densities. Less sensitive systems are capable of being mounted above ground and on fences and are less susceptible to background noise. They are able to locate disturbances to a fence such as people climbing or cutting. Limitations include lack of concealment and ease of tampering.

If one could envision a 200 mile long sector of the border with a buried fiber "fence", it might have three parallel fibers (for redundancy, false alarm and tracking) with an amplifier every 10 miles and electronics (power, transmitter and receiver) every 50 miles (at each station). Such a system could have a price tag, exclusive of burial, below $10M. Because of its potential lifetime, this may be a very attractive option for long remote stretches of our borders, (where the topography and geology allow).

However, the technology needs to be further understood, improved and developed. First, there are a number of competing signal detection mechanisms and cable configurations. Second, the coupling between the cable and the ground, in particular achieving the maximum signal gain, is not totally understood. Third, there remains significant signal processing, particularly for signal enhancement, automatic detection and alerting, that needs to be developed and tested.

Unattended Ground Sensors

Unattended ground sensors are autonomous units deployed covertly or overtly by Border Patrol Agents. The sensors used include: magnetic, seismic, passive infrared, pressure mats, and contact closure devices. Detections are relayed by radio frequency communications to portable and fixed infrastructure.

The Border Patrol is currently using a number of sensors based largely on Vietnam era technology. While these sensors have flexibility in operational applications and low acquisition cost to added benefit ratio, manufacturers are no longer supporting many of the systems. Deployment can be difficult with large out-dated sensors that require large holes for burial and frequent attention for battery replacement. Covert deployment is difficult when large holes are required to hide the large environmental boxes and the need to replace batteries every thirty-days or so constitutes the continuous need to dig-up and rebury the systems. The America's Shield Initiative will be implementing new surveillance systems in the near term, and DHS S&T looks to assist in developing and assessing the technologies that will be used.

As a part of the ABCi, five different ground sensors were tested in the Tucson Sector. One system, built by Monitron, is in essence a replacement to the current Sparton technologies used by the U.S. Border Patrol, and used seismic sensors (point and line string configuration), magnetic sensors, and passive infrared sensors; and is an upgrade in processing and protocol from its predecessor. Fifty systems were installed in the Douglas station (east border area of Arizona close to New Mexico). As a result of the tests, this system was purchased and will be retained by the U.S. Border Patrol. This system is not considered a new technology but rather an upgrade to current systems.

The Army (at CERDEC) is developing a family of sensors and sensor network architecture, the Multi-Functional Intelligence Remote Sensor System (MFIRSS), which connects together ground sensors and imaging devices. Sensors, which include seismic / acoustic, infra-red, magnetic and radio frequency, day, low light, and infra-red imagers are imbedded in an end-to-end, open architecture system and much of the technology being developed. This is a technology development we intend to follow and look for technology transition opportunities for the Border Patrol. The technology areas of most interest include: new sensors, alternative power and energy management, covertness (low probability of intercept), near ground connectivity in foliage and terrain, data fusion, size, power, weight reduction and fiber optic sensors. The Army has a fiber-optic sensor concept that uses an array of fiber sensors and should be able to detect personnel at 75 meters and vehicles at twice that distance.

Airborne Sensors

Airborne sensors have the advantage of height of eye, thus giving excellent range for line of sight sensors. The two classes of platforms for these sensors are manned aircraft and UAV's.

UAV operations were demonstrated during ABCi showing that UAV's can provide the Border Patrol with strategic and tactical advantages, especially with the UAV an excellent tool for tracking vehicles. The UAV system was outstanding for giving ground agents situational awareness and allowed the Border Patrol to track and observe suspected vehicles carrying contraband that might otherwise be a risk to law enforcement officers. In ABCi, S&T funded two Hermes 450 UAVs, one primary aircraft and a back up, for a three-month period that started June 18 and finished September 30, 2004. The sensors on the UAV include EO/IR (visual and infra-red cameras) down linked to the ground control station. Missions nominally consisted of 14 hours of flight, mostly at night, and involved un-alerted surveillance, cued response, and directed search operations (much of the illegal activity along the border occurs in the evening and continues under the cover of darkness).

UAV's, however, are limited in the size and power available for sensors, thus limiting their sensor range. In addition, UAV's have a number of FAA flight restrictions which can make their operations limited.

A desired airborne platform sensor combination should include EO/IR sensors, multi-spectral sensors for classification of targets, and synthetic aperture radar with Ground Motion Target Indication. For example, the Army is developing a VHF/UHF foliage penetrating (FOPEN) SAR radar, for application to manned aircraft and medium sized UAV's. Such a system could be incorporated into an existing CBP P-3 aircraft or a Dash-8. Flying at 20 – 30 kft altitude, it has a 13 to 20 km standoff range, allowing visibility not only along the border but over the border. The dual band VHF/UHF SAR penetrates foliage, non-metallic structures, and has robust wide-area change detection capabilities. An integrated payload with the SAR / FOPEN radar plus EO / IR sensors connected to a real-time on-board data exploitation and dissemination station could be prototyped using a payload in the bomb-bay of the CBP P-3 aircraft. Then following proof of concept, it could be miniaturized for smaller DHS aircraft (Dash-8) or medium sized UAV's. Such an integrated airborne sensor suite would provide both surveillance, plus an immediate tactical follow-up capability.

High Altitude or Space Based Sensors

Another area of interest is high altitude (above commercial airspace) or space based passive sensors. In particular, sensitive infra-red and multi-spectral imaging techniques may be capable of detecting border crossing routes, people gathering just across the border, or actual movements. In addition to satellites (both national and academic) as platforms for such systems, there are serious concepts being developed for semi-stationary unmanned lighter than air ships operating at 65,000 feet – primarily for broadband wireless coverage. Such a system, if developed, would be very interesting as a high quality EO/IR platform. Three or four such systems could cover the entire southern border.

Automated Scene Understanding

With increasing number of sensor systems, particularly EO / IR systems, having enough skilled operators to monitor and detect becomes problematic. Throughout DHS sensor technologies, there is a growing need for automated scene understanding technologies that will allow computers to detect and identify targets in real time, alerting operators for further analysis and follow-up. In no case is this more acute than with Remote Video Systems (RVS). RVS systems are real-time remotely controlled force enhancement camera systems, which provide 24/7 coverage along the northern and southern borders.

The RVS systems significantly enhance the Border Patrol's ability to detect, identify, and respond to border intrusions. There are 269 completed sites in operation (200 along the southwest border and 69 along the northern border), and an additional 216 installations are in progress. While the RVS provides central monitoring capability, it is still very labor intensive. DHS S&T is pursuing technologies which will automatically scan large areas looking for events of interest (while requiring a small number of cameras to cover large areas), maintain a domain-wide view for situational awareness and bring only targets of interest to operators' attention, keeping them focused only on the events that are important. Such a capability must be easy to configure and setup, allowing operators to specify exactly what types of targets/events are worth knowing about. The concept of operations is to have the software scan for moving objects (controlling cameras and searching zones for moving objects at high zoom), examine interesting targets, and have intelligent software classify any threats and alert the Border Patrol Agent. The technology to make this a reality is being pursued by DHS S&T for port security, transportation security as well as Border Patrol applications.

BTS Net

To support Border Patrol operations in the field, we developing and integrating technology through BTS Net to give field personnel connectivity and situational awareness in their rugged environment. BTSNet is an information management network test bed. It comprises it a set of hardware and software components that deliver information to the Agent in the field, provide a situational awareness, and provide for a federated database query. The overarching BTSNet goal is to provide information crucial to the BTS user's mission, whether field agent/officer, field station, sector command and control center, or national level agencies. The effort will integrate technologies developed under other programs as well as within the BTSNet program into a coherent system and insure performance goals are met through pilot deployments and rigorous testing.

Specific requirements are as follows:

An initial increment of this multi-spiral development will be demonstrated in the Tucson, Arizona area in late 2005. It is envisioned that Tucson Sector will be established as the BTSNet test bed where additional spiral will undergo developmental and operational testing, and, if proven out, incorporated into ASI as CONOPS are developed and new technologies vetted. Specific capabilities include:

- Capability to Query Across All BTS / USCG and LE databases providing reach back and correlation across all BTS / CG and relevant LE databases in real time and from the field,

- Interoperable, reliable, OTH, wide band, data, video, secure, covert, mobile and fixed communications between operational elements, and

- Tactical Situational Awareness, providing local/sector common picture of real time location and status of operations, units, threats, and surveillance from multiple sources.

In the initial spiral, BTSNet will deliver to the US Border Patrol Douglas Station four hand-held digital assistants for field agent use and install a mobile data computer in four selected vehicles designated by the Douglas Station. Two workstations plus a server will also be installed the Douglas station. Appropriate communication infrastructure will be installed in key locations (RVS towers) within the Douglas area of operation in order to maximize communications coverage.

We will complete installation, site integration and test, and be ready to conduct an operational demonstration by mid October 2005. SPAWAR Systems Center-San Diego (SSC-SD) will coordinate with station technicians on the installation and integration as well as provide training to Sector personnel on the field and station equipment operation. The operational demonstration would span a two week period with field agents operating the equipment. If accepted as an operational asset by the Sector, all equipment would remain in place for Douglas Station use, and to provide on-going user feedback for input to subsequent spirals. BTSNet will provide maintenance support during the course of the development process.

Continuous user input in the BTSNet development process is essential to the successful deployment of BTSNet, accordingly, we continue to interface with Sector personnel, on a not to interfere with operations bases, and extend an open invitation to Sector and Headquarters personnel to attend program reviews and/or testing.

Conclusion

Developing and maintaining complete awareness and control of what and who approaches our land, sea and air borders is a key component of our security strategy since 9/11. This is a mission that the Border Patrol has faithfully carried out since 1924, but with heightened immediacy since the war on terror. As described by Chief Aguilar, in the America’s Shield Initiative, the Border Patrol has in advanced planning, a systems architecture and framework for the enhancement and upgrade of Border Patrol capabilities in sensors, networks and information systems. The role of DHS S&T is to provide key technology capabilities that can be incorporated into ASI, both immediately and over time as technology upgrades. In supporting the Border Patrol and ASI, we are concentrating on advanced sensor technologies such as advanced radars, airborne sensors, fiber-optics and automated detection algorithms plus prototyping advanced networking and scene awareness capabilities in BTS Net. We are working with the Border Patrol in a collaborative manner, in particular using the Tucson Sector and the Arizona Border Control Initiative as a prototyping testing ground.

This concludes my prepared statement. With the committee's permission, I request my formal statement be submitted for the record. Senator Cornyn and Senator Kyl, I thank you for your attention and will be happy to answer any questions you may have.