Dr. Allan O. Steinhardt
Information Exploitation Office (IXO)
Sensors

Combat used to be simple. Opposing armies would face each other and use brute strength until someone was overwhelmed.

Intelligence gathering was equally straightforward. Spies were dispatched to scout out the enemy. If they returned, you had information. Otherwise you were out of luck.

Who was the enemy? Identifying him was also simple—if he was unknown and he moved he became a legitimate target.

While there might have been some attempts made to differentiate between combatants and non-combatants, the means to do so were unsophisticated and unreliable.

In tomorrow's conflict the appetite for collateral damage will be greatly reduced, as will the signature differential between validate targets and civilians.

Today I will address these changes and how one particular field of technology—the sensor—is shifting gears to meet new demands. I will outline a bit more specifically the nature of the threat. Then I will discuss how the commercial telecommunications revolution has led to new opportunities for fielding and exploiting sensors. Next I will describe the sensor demands presented by new threats. Finally I will close by describing some current IXO programs and show how these are a first step towards addressing these threats.

The world has migrated from the old "brick and mortar" office complex to virtual offices. It makes no difference where we work today. What seems to matter is customer interface and networking rather than server location or physical infrastructure. The past decade has seen the rise of a myriad of technologies that are so commonplace that we can scarcely imagine life without them: compact cell phones, two way pagers, wideband satellite and cable modems, portable GPS.

The wireless communications needs for DoD are different than those of the private sector. However the lifestyle-defining aspects of information ubiquity and managerial telepresence have a profound impact on military planners. It is now acceptable and even encouraged thinking about sensor placement apart from site location. So we see that new opportunities arise, which allow massive dispersement of sensors and subsequent re-assimilation of sensor data to support the surveillance mission. Many of the IXO sensor programs would be untenable without this shift to a "sensor web" based paradigm.

If we encounter an enemy in the field, we can be sure he, along with his equipment, will seek cover and concealment. All of this makes it imperative to find these targets and destroy them at a time and place of our choosing. We can expect him to take advantage of the terrain and man-made features. We call these natural measures, and the most common are trees and other foliage, caves, bridges, tunnels, culverts, and buildings. In urban environments we can expect him to best conceal himself by blending in with a crowd of people. Sometimes these natural measures are insufficient, and he is forced to supplement these with artificial measures such as smoke, fog, netting, chaff, thermal blankets, and special paints. His movements will be well-disciplined, kept to a minimum, and only occur when he can take advantage of concealment.

We currently are developing a suite of sensors to respond to the various challenges outline above. Depicted here are ongoing efforts at DARPA/IXO to address some of our sensor challenges.

First is the Forester effort that seeks to penetrate foliage and detect and track moving troops and equipment. Forester brings the ability to acquire fixed targets in foliage, developed in the Counter CC&D program, to mobile under-canopy threats. The ability to find targets on the move, stripped of the sanctuary of foliage, will have huge implications for maintaining total situational awareness, anywhere, anytime. Forester combines the superb minimum detectable velocity available with a rotocraft, with the penetrating ability of low

frequency radar to expose targets on the move below trees. As we saw earlier identification is a major challenge in future conflicts. Forester and Counter CC&D will find and track targets but they need a companion to confirm, and geolocate, prior to weapon release.

Jigsaw fills this role. Jigsaw produces a 3-dimensional image of targets under foliage (a hologram) using the penetration of laser energy between gaps in the trees. It will be mounted on organic air vehicles or the tactical UAV and is a short-range system. It exploits the timing information resident in an active optical source to separate leaves and camouflage from targets. E-3D is a companion exploitation program, which supports Jigsaw, and looks at novel means of conducting unambiguous exploitation on holograms. Jigsaw, E-3D, Counter CC&D and Forester combine to provide the ability to detect and kill targets in foliage. As such they promise to emulate the success of AMSTE and HRR, two IXO programs that are successfully demonstrating radar technology to target and kill movers in the clear.

We have another laser program, SPI-3D, that produces holograms of targets at long range. Such a system, when cross-cued from a wide area search radar, or Elint system, will allow superb confirmatory target identification even under very strict rules of engagement, over very wide areas in the clear. This will allow us to enjoy the high search rate of a radar, coupled with the precision of an optical sensor. By use of holographic technology cloud, smoke, and dust penetration, and day/night operations, will lead to new performance heights, and flexibility, heretofore unimagined for optical means.

While passive optical systems have been around for quite some time we believe there are further developments that can significantly enhance their robustness. To this end Eyeball is a passive optics program that is addressing performance estimation and algorithm development for polarization in the optical domain.

Tactical sensors is a program devoted to developing an unattended ground sensor that allows for tracking and identification of ground vehicles using acoustic, seismic, and EO/IR. A key feature is that an entire field can be rapidly deployed at standoff to allow insertion without manual emplacement. These sensors excel at long endurance sensing at choke points, and allow an orthogonal sensor measurement greatly enhancing acuity and reliability at the fused C4ISR level.

As we mentioned earlier we must reduce fratricide. This can be accomplished through sensor augmentation in the form of blue force tagging. The digital RF tags program is a means of effecting such tagging and exploiting existing radar waveforms and communications infrastructure to allow for an effective, robust, affordable, and secure means of relaying blue force position.

Note there is no magical, omnipotent sensor that can do it all. Some need to be cued but can collect distinctive features. Others can provide multiple "looks" from diverse viewing points that can peer under foliage.

What we look for are systems that are adaptable and reflect contractor innovation, not DoD requirements. They should be multifunctional, robust, and maintainable. They should have good interoperability, not only among our services but also among potential coalition forces.

To summarize, the end of the Cold War has produced an arena where threats are amorphous and evasive. It is not easy to attack the threats because public and international tolerance for "civilian casualties" is declining. The need for unambiguous, precise identification has never been more important. Further, robust targeting is required, and that should come from a collection of orthogonal sensor modalities.

Communications and processor technologies have allowed for sensor proliferation and all-source fusion. This implies that one can identify target and propagation phenomenology and match them with dedicated sensors with less concern about platform hosting and data dissemination than in previous years.

Concurrently, corporate merging in the industrial sector, combined with "requirement-free" procurement and "spiral development," allows for unprecedented acceleration in sensor insertion.

In conclusion, the emerging, distributed, wireless "virtual presence" and ubiquitous information energized by the commercial sector has military value, mainly in network centric warfare. The sensor challenges before us are daunting, but the technology opportunities are fresh and staggering. The future for war fighter sensors is now, more than ever before, limited only by our imaginations.