Tailored Tactical Surveillance
Dr. Larry Corey

Good Afternoon,

Dr. Alving has introduced our vision of tailored tactical surveillance, which will allow us to provide the unprecedented surveillance capability through all phases of conflict with minimum in-theater logistical support. Three of the sensors we are introducing you to today will greatly contribute to this vision.

The UAV based LAASS system that Greg Duckworth discussed will be able to locate, target, and assess battle damage for "pop up" command and control sites during the dynamic combat phase of the conflict.

Our space-based ISAT program, which you will hear about from Michel Zatman later this afternoon, will track moving ground targets anywhere in the word throughout all phases of the conflict without any in theater logistical requirement.

Now you're going to hear about a new airship-based sensor called ISIS with capabilities optimized for the Intelligence Preparation of the Battlefield through the Stabilization and Support Operations phase. ISIS will have unprecedented surveillance capabilities with no in theater logistics tail.

To illustrate the <u>near-magical surveillance capability</u> ISIS will provide, let's consider an example from the fictional Harry Potter books. Harry and his fellow students are often sneaking around the grounds of Hogwart's School for Witchcraft and Wizardry. Of course, they run the risk of being caught by teachers who are always on patrol. Fortunately Harry discovers a magical map of the school grounds.

This fantastic map dynamically shows the position and identity of every person on the school grounds. With map in hand, Harry can move freely around the grounds with no danger of detection. Today, Harry's map is fictional, but imagine if we could give a real version of this map to our Special Operations forces.

Wouldn't it be nice if the battlefield commander also had a big picture map showing everything moving for hundreds of kilometers, and the air defense commander had a map of everything moving in the air?

What if all of this information could be sent on wideband communications links directly to the users on the battlefield?

We are just beginning our ISIS program that will enable our forces to have this surveillance capability at all times without needing to carry their own sensors to the battlefield. ISIS will provide a dynamic, detailed, real-time picture of all movement on or above the battlefield: friendly, neutral or enemy. With ISIS, battlefield commanders can guard against friendly fire, coordinate forces, get lost vehicles back on track, and know the current location of POWs.

Air defense commanders can observe all activity within hundreds of kilometers. The tracking accuracy will be so good that they will not need any other radar systems to complete engagement of hostile targets.

ISIS is a sensor integrated into an unmanned stratospheric airship. The stationary platform gives ISIS the stability to see slow moving targets such as dismounted troops. The seventy thousand foot altitude allows ISIS to persistently track targets at very long ranges.

From a single base in the U.S., ISIS units can deploy anywhere in the world without any need for local support personnel or infrastructure. Each unit will stay on station for one year.

ISIS will use wideband communications links to get tailored information directly to users on the ground and in the air. This real-time data allows each soldier to respond effectively to the changing battlefield situation.
***To put the ISIS challenge into perspective, consider that tracking large numbers of low flying targets at hundreds of kilometers requires a radar with the capability of the largest ballistic missile defense radars

These are ground based, the size of large buildings, and need their own power plants to function. ISIS must get similar radar capability while constrained by the limited lift capability of a stratospheric airship. ***

The best way to reduce the system weight and power requirements is to exploit the airship's size, roughly fifty meters in diameter.

ISIS will have a phased-array antenna that is nearly as large as the airship itself. Since radar performance depends on the power-aperture product, the extremely large antenna aperture size allows us to significantly reduce the transmit power. This greatly simplifies the onboard power and cooling systems allowing us to replace the conventional, heavy, high power antenna with a larger but lighter low-power-density antenna.

However, this solution faces several technology challenges.

First, weight is still a critical problem. The lightest space-based X-band active radar antennas weigh approximately twenty kilograms per square meter. Even if next generation space-based technology weighs in at only three kilograms per square meter, it will still be too heavy to realize the full ISIS potential.

The ISIS program must develop phased-array antennas lighter than any space-based technology. To do this, ISIS is exploiting several inherent advantages the airship platform provides. Unlike a space-based antenna, the ISIS antenna does not need to be stiffened to survive launch or stowed to fit in a small cargo bay and then deployed. Nor does it require radiation shielding. In fact, a stratospheric airship environment should enable the use lightest antenna technology ever developed.

The second challenge introduced by an extremely large and lightweight antenna is electrical calibration to compensate for the inevitable flexing and distortion of the huge aperture. The phased-array will consist of millions of elements. The position of each element must be known to within a millimeter. We absolutely need ideas on how to dynamically measure, model, and calibrate such a large system.

The third challenge faced by the large phased-array antenna is beamformer complexity. The huge antenna will be constantly reconfiguring itself to adapt to changing battlefield conditions. The aperture will be made up of thousand of small subarrays. All subarrays will be combined together with the proper time delay to form one large array to track an airborne target at the horizon. A milli-second later, the subarrays will be regrouped into multiple horizontal strips to simultaneously track many ground targets at closer range. New light weight and low power consuming beamformer concepts are needed, perhaps digital or photonic to allow for this flexibility. If you have other ideas, we'd love to hear them.

The fourth challenge faced by the huge antenna is a new level of integration complexity. A single ISIS system will be both sensor and airship. The antenna will be nearly as large as the airship itself. Therefore, we cannot separately develop a platform and a payload. Innovative functional integration across subsystems can allow each bit of mass to serve multiple sub-system functions. Here lies another huge development opportunity. How do we most efficiently integrate the sensor, structure and power sub-systems into a multi-functional airship?

Once we solve the antenna weight, size, and integration challenges, ISIS must contend with the fifth challenge, annual wind storms. These can last for several days and exceed 80 knots in some locations. This will challenge the airship's ability to stay on station. The propulsion power scales as the cube of the wind velocity, so we must find a way to store large amounts of energy in reserve for use during peak winds. We will need technologies with ten times the specific energy density of today's lightest batteries.

The airship itself presents another challenge. The airship's ability to lift mass scales in proportion to its volume, but the wind drag and propulsion power only scale in proportion to its cross-sectional area. Therefore, as the size of the airship increases, the lifting ability grows more than its drag. If the airship can be made large enough, the severe mass limits on the antenna and the energy storage systems can be relaxed.

Conventional airship concepts are limited to about ten million cubic feet, due to ground handling issues. We are open to new ideas for airship and ground handling concepts that overcome these limits and allow the airship to grow much larger.

The final challenge is to take full advantage of the unique features of ISIS which have never been available in any previous radar system. For example, ISIS will have an extremely narrow beamwidth and operate from a fixed location continuously for a year or more. This means that ISIS can deal with clutter in a totally new way.

We have entered the final phase of the Knowledge-Aided Sensor Signal Processing and Expert Reasoning program (or KASSPER). KASSPER makes use of a significant amount of information about site specific details and prior sensor collects. KASSPER uses this information to get a much better estimate of the clutter competing with the target returns.

Focusing on airborne GMTI systems, KASSPER incorporates a "look-ahead" process where the critical information is sent to the radar high-speed adaptive processors for real-time use in clutter estimation.

We have a demonstration set-up at the SPO booth where you can see the dramatic improvement KASSPER provides in radar performance. As an example, SAR imagery can be used to locate the large, stationary scattering points. This can reduce the false target detections by 12dB over conventional space-time adaptive processing algorithms. If we can get this kind of performance improvement for a relatively small radar, constantly moving over different terrain, just think what we might be able to do with ISIS!

We would like to hear your ideas for how we can take advantage of ISIS's unique persistence capability to extend the KASSPER concept to provide even better performance in high clutter urban areas.

A one year feasibility study is just beginning. It is important for us to get the best ideas from many different disciplines in order to make the ISIS program a success. Therefore, toward the end of the year, we will be hosting an ISIS workshop to bring interested system integrators and component developers together to discuss the ISIS concept and technology challenges

Early next year we will put out a BAA for the ISIS technology development and objective system design. As I have already discussed, careful attention to the integration of every subsystem is critical; therefore we will require that teams be formed to address the total design and development of ISIS.

ISIS will have sensor capabilities never before achieved. It will have unprecedented sensitivity, an extremely narrow beam and continuous year long persistence from a single location ant 70,000 feet.

My challenge to you is this – think about ways to address the following: weight, calibration, beamformer, integration, power, and signal processing issues.

I further challenge you to go beyond that and think of ways to use ISIS capabilities to enable new classes of IFF, target identification, communications, intelligence or something else completely new. If the idea is innovative enough, we may even consider starting a whole new program to address it.

Bringing you back to our overall vision of tailored tactical surveillance, I hope you can now begin to see how using satellite platforms, through ISAT, in conjunction with stratospheric airship platforms, through ISIS and UAV platforms, through LAAS, along with new sensor technologies, will allow us to dramatically simplify and improve our surveillance requirements. We will be able to minimize the logistical support required while dramatically and seamlessly increasing our situational awareness and targeting capability through all phases of the battle. I challenge you to bring us your good ideas and help make this vision a reality.

I thank you for your time.

You will now hear from Paul Benda about Assured Urban Operations.