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Unmanned Combat Air Vehicle (UCAV)

Unmanned air systems will transform the battlefield of the future, and DARPA's unmanned combat air vehicle (UCAV) is at the tip of the groundbreaking spear that will be the framework pioneer for all that follow. The evolution of the UCAV Program is a major success story for DARPA and our U.S. Air Force and Boeing partners.

Good afternoon. I'm Colonel Michael Leahy, Program Director for the UCAV System Demonstration Program (SDP) in DARPA's Tactical Technology Office. I came to DARPA 5 years ago to work with another visionary to develop and execute an innovative program that would take our concept for a UCAV from innovative thought to operational reality. We're not all the way there yet, but the first iteration of the vision has flown, and we're well along the funded path toward putting a real weapon system in the field for early operational evaluation by 2008.

As I address many of you for the last time as program director, I will highlight what we have accomplished so far and describe our formula for continued success. But first I want to acknowledge the other partners on this collaborative team.

Although I wear a U.S. Air Force uniform, I represent DARPA as a member of the Tactical Technology Office. From the very beginning, we realized that only a truly joint program with the Air Force would bring UCAV to reality. Therefore, we enlisted the support of the warfighters at ACC and the technical and funding support of the Air Force Research Laboratory. As the program has matured, we've brought on engineering support from the Aeronautical Systems Center, which is ramping up to assume program management responsibility next summer. The NASA Dryden Flight Research Center provides X-45A flight test support, and Boeing is our industry partner under a Section 845 agreement.

The UCAV Program paradigm has stood the test of time. The objective remains: to develop and mature the critical and key technology processes and the system attributes that enable a UCAV weapon system to carry out 21st Century SEAD and strike missions effectively and affordably.

People first introduced to the program always ask why we went after the SEAD mission first, at least those who realize how hard it really is. We went after SEAD precisely because it is the most demanding air-to-ground mission. DARPA doesn't take on the easy problems. We knew that if we could tackle the SEAD mission, the knowledge gained in that effort could be applied to a host of other less-demanding missions. Also, it is a mission that doesn't directly threaten the white scarf crowd, but enables them to better perform their primary mission of air supremacy.

A key point is that UCAVs augment the force structure. The real transformation is not from unmanned systems alone, but from a synergistic combination with manned systems—the ones with the shoulder-mounted computers. Together we will change the battlefield.

With a demanding mission defined, the next step was to bring together a group of bold thinkers who would challenge the conventional wisdom and produce an operational vision to perform the UCAV mission effectively and affordably. In other words, the mission team would "buy" its way into the force structure through extensive studies and constructive analysis to build a business case so powerful that funding would be secured to turn the vision into reality.

With the vision established, the next step was to identify the technologies and system attributes needed for the foundation of the vision. That task was balanced against available funding, and a series of roadmaps was established to evolve, systematically, an initial high-risk solution into a low-risk acquisition program.

That's the heart of the UCAV paradigm—use constructive analysis and solid engineering trades to define the effect you want to achieve on the battlefield, identify the demonstrations needed, and systematically reduce

the risk and mature the technologies. Furthermore, the paradigm develops roadmaps that go past initial funding, even when people scoff at the idea. Ideas are powerful. With the right one and a sound roadmap, you can get full funding for your whole roadmap even before you fly—and we are the proof.

The UCAV Program is on a maximum acceleration schedule that can be defined as a series of overlapping and interrelating spirals. In Spiral 0, where we are right now, we've fabricated two X-45A demonstrators and their container and mission control console. We are proceeding through multiple blocks of progressively maturing software and functionality that we need for our UOS vision.

In Block 1, we just completed initial flight testing, demonstrating that we can fly and control a single vehicle. In Block 2, which will be next summer, we will flight demonstrate the core of what makes UCAV transformational: multivehicle, coordinated control. Demonstration of that capability will culminate in a graduation exercise highlighting the technical feasibility of all aspects of the preemptive SEAD mission.

In Block 3, we will start to migrate into the air vehicles themselves intelligence that until now has been only in the ground control station. Parallel with that, we've started the next turn of the spiral, Spiral 1, with the design and development of the X-45B and the system software needed to complete the last two blocks of the demonstration program that will culminate in a joint exercise.

Finally, we are doing the deep planning for Spiral 2 with a goal of 14 air vehicles fielded for early operational assessment by the end of 2007. The three spirals have two major objectives:

- Demonstrate technical feasibility, military utility, and operational value.
- Rapidly put those capabilities into the hands of the warfighter.

When people ask how we're doing, we divide the answer into the four major parts of the program:

- Initial check-out flight demonstrations
- Critical multivehicle demonstrations
- Design and development of the X-45B
- Acquisition planning that underpins all that

For the remainder of my presentation, I will answer "how we are doing" in each of the four prime areas.

Many of you are aware that we completed a very successful first flight in May. Damn, that was a great day!

But as you are also probably aware, in the UAV business, the second landing is what is most important, and we are happy to say we accomplished that critical initial milestone in June. Both flights were conducted at the NASA Dryden flight test facility at Edwards Air Force Base. Our system check-out flights were designed to build on one another until we cleared the heart of the envelope.

Remember, this is not an air vehicle program alone; it is a system demo program. So the X-45As won't be pushed to the edge of flight "performance-wise" but rather "smarts-wise." We've incorporated the lessons from the first two flights into another major software build that is completing system verification testing at this time. Also, the flight test team is training on the third flight mission plan. We expect to conduct our third flight, the first with the gear up, within the next couple of weeks, with the remaining SCO flights continuing through the fall. At that point, we will end the checkout phase and move into the Block 1 demo phase.

Here are some video clips that highlight the results of those initial first flights.

TPSA maturation is not just flight tests. Along with the flights, we're in the midst of ongoing ground demonstrations and simulations with about 40 discrete demonstrations complete to date.

Befitting our system emphasis, we've demonstrated everything from weapons loading to 3-D modeling of maintenance repair and simulation. We've shipped the vehicles in their containers on both C-5 and C-17 aircraft. We've actively involved Air Force maintainers, five from the 412th squadron out of Edwards AFB, who'll work on a daily basis with the jet and feed those lessons back into the X-45B design process. We've also got Seek Eagle and other AF experts involved as we've gone through our weapons buildup and loading

processes and demonstrations. And we've started to do mission simulations, moving away from the software that just does the flight operations in early testing for the test operators and moving into the battle management situational awareness software that operators will use in the future to prosecute the attack. We have a steering group of folks who have flown bombers, some who have flown SEAD missions, and even some who haven't flown at all. The important point here is that it is crucial to us to have early and sustained Air Force involvement. It is one of the key aspects of how we are able to proceed through the program and learn our lessons from past activities.

With first flight completed, we're in the process of turning more of our attention to the critical demonstrations that will occur next summer. As a football fan, I use the analogy that the Block 1 demos are the fullback who opens the hole for the Block 2 demos—the halfback—to run through and score. We need both to win. This program is not about settling for a field goal. It isn't UCAV until the Block 2 multivehicle operations are demonstrated in flight. That's the heart and soul of what makes the UCAV and why we began this journey of discovery. It is the key enabler for both this program and the other DARPA unmanned systems programs that Dr. Adler talked about.

We will do a series of tests to show multivehicle, coordinated flight between ourselves and our T-33 surrogate, proving that we can bounce control off a satellite from Edwards back to Seattle, that we can communicate using Link 16, and that we can send an update to dynamically retask one of them. Finally, we'll demonstrate that the vehicle can fly into a zone, take a real emission, react to it, make the maneuvers necessary to obtain a synthetic aperture radar (SAR) image, send that compressed SAR image back, and get authorization from an operator to put a weapon on a target.

When we have completed that demonstration at the end of Block 2, we will have shown the technical feasibility to prosecute the preemptive SEAD mission. A little later that fall, in Block 3, we will conduct the first flight demonstrations in the evolution of intelligence from ground to air. The graduation event will be two air vehicles hunting for a known target in an unknown location. Working together—without aid from an operator—they will cooperatively find and prosecute the target, proving the ability to autonomously handle predicted events in unpredicted time.

The operator, of course, will still be in there to interject and override in a supervisory role if necessary. But we will demonstrate the first critical step in moving the smarts, if you will, onto the air vehicle. It is crucial to our end concept that the vehicles themselves have the ability to go in and work together to prosecute and attack. Last summer, one of the key things that we looked at was refining the operational vision I mentioned earlier. A lot has happened both off and on the program in the last 3 years. Working collaboratively with the warfighters and developers, we took the lessons learned from ours and other programs and refined our vision and the demos needed to mature it. We have just put on contract the remaining tasks to complete the system demonstration program.

One of the key aspects of that program is the air vehicle piece. From the beginning, we realized that the X-45As would not be the ultimate end vehicle. They were the initial tools—pure demonstrators—that provide a cost-effective means to complete the first blocks of flight demos. They don't have any residual operational value, nor can they operate from Edwards and validate military utility and operational value.

The X-45B is the vehicle for that. The design and development of the X-45B allows us to take the next step in UCAV weapon system evolution, to continue to learn from doing before reaching the crucial acquisition program decision. The X-45A will take us through the Block 4 early demonstration, but then we need a more operational air vehicle—and that's the X-45B. It's going to be primarily the tool to complete the demonstrations and incorporate all lessons learned from flying the A model. By Block 2, we will have proven that we can command and control a vehicle in flight, so the challenge will shift to proving that capability with the low observable (LO) apertures and antennas within our bandwidth.

The X-45B will be an LO vehicle designed to demonstrate maintenance of its LO materials. It is critical for our O&S concepts to be two generations beyond where we are today, and we have to demonstrate it. Our open architecture will port and it gives us a tool to be able to prove all the critical aspects of our CONOPS.

Uniquely, as we evolved through time, the X-45B has moved from being just a simple prototype that would feed into a developmental program to a robust baseline for an operational aircraft.

Our challenge is to make this a prototype that can be fielded and produced in years ahead. It will have a refined airframe in the new UOS shape. It will have the GE F404 engine, and it will have provisions to take on things that aren't in the main demo program now, such as a SAR, multi-ship ESM, MILSTAR, and air refueling. It will lead the way for incorporating those benefits in a cost-effective manner in subsequent spirals.

A technology challenge of the program is to realize fully the technical feasibility of the vision for multivehicle flight operations so the vehicle can fly out and hunt for the target on its own; dynamically replan and automatically route around threats; talk to its buddies; and prioritize on who's got range, weapons, and the ability to attack.

Finally, we will fly one of the B models in a graduation exercise that will be as realistic as we can make it. We will engage in a Red Flag exercise, load the vehicle, deploy to an airbase, get them ready to fly, get an order, parse it, fly a mission in cooperation with manned assets, come back, and repeat it again.

When we've done that, we will have demonstrated the technical feasibility, military utility, and operational value of this transformational weapons system. It will then be ready for production and operational fielding—and we will have changed the battle theater forever more.