Lt. Col. Paul Waugh

Deputy Director for the X-47 System

Challenges & Opportunities

Good afternoon, I'm the newest Deputy on the J-UCAS program, thus the last J-UCAS speaker of the day. I think the J-UCAS program exemplifies what we heard for the last three days, a program with many technology challenges ahead and the opportunity to develop innovative solutions to these challenges. In J-UCAS, not the least of the challenges is the program's ambitious timeline, and the requirement for mission versatility. I'm really looking forward to our response to the challenges, since this is the way we will transition modern technology into an operational laboratory. Let me tell you where I believe we most need help from the scientific, technology and engineering communities to make a fleet of UCAV's and a fully functional J-UCAS a reality.

The Joint Unmanned Air Combat System is a system, not just a combat air vehicle. As a system, it needs advanced technology to tie the pieces together. This afternoon, I want to highlight three important technology areas, Communications, Autonomous Control, and Survivability, where we need your help!

These key technology challenges really have their roots in the expectations of our operational users. The timelines are ambitious: an operational assessment is scheduled to begin in fiscal year 08, and of course we must conduct experiments even earlier as we try to understand the real combat value and military utility of the J-UCAS concept. The operational assessment will cover the full spectrum of Joint-UCAS mission: Suppression of Enemy Air Defense, or SEAD missions; providing Electronic Attack support; and generating Surveillance, Reconnaissance

information by means of a persistent SR mission. The operational assessment also provides an opportunity to explore new concepts of operation, and to look at new tactics and new ways of achieving war fighting effectiveness through the unique, system-level features of the J-UCAS. These new missions will expand as we inject new technologies into the system.

Communications holds the key to success of the J-UCAS concept. In J-UCAS, not only the UCAV platform, but the whole "system" depends on communication. We will not always have perfect communication and, in fact, will always have some form of latency. Thus, the system, in all its parts, demands some level of autonomy, which means we will need smart platforms, smart sensors, and smart data processing. Since we have a system of multiple sensors, one of our main goals is to be able to synchronize the control and exploitation of that sensor data. Operational effectiveness will require the simultaneous sharing of data between platforms and operators, while conducting closed loop, data analysis. Only the ability to move and analyze data in distributive networks will make this vision work. At the same time, J-UCAS must address the issue facing many programs; reducing the bandwidth required for moving sensor data over various data links and networks. Several approaches exist to address the data sharing and analysis, and band-width challenges. First, up-front data processing and analysis can reduce the communication requirement. Automatic queuing or automatic target recognition could reduce high resolution data transfers to the important parts, and can be enhanced by sharing sensor data among platforms. Change detection, and other methods to fuse onboard and off-board data to get better situational awareness can also provide a force multiplier, for a better understanding of the rapidly changing battle-space. These capabilities require that data move seamlessly among the multiple systems within J-UCAS.

Today, we have a baseline for our communications capability. However, we recognize that we have entered perhaps the richest, deepest part of that segment of the information revolution that deals with mobile, wireless computing. We want to explore agile, wide-band wireless communications networks and where they might help us in both line-of-sight and beyond line-of-sight applications. We need your help to find ways bring this technology to bare on the communication challenges facing J-UCAS.

Next, let's talk about autonomous operation. We already said that due to communication limitations, J-UCAS subsystems must operate with some degree of autonomy, both individually, and in groups. The further we can push group autonomous behavior, the more flexible our system becomes in its requirement for human intervention. As with all unmanned systems, there exists the possibility for a very different human management paradigm, because the operator no longer resides in the platform. We must develop a very flexible level of human interaction. For example, humans might be involved in offline time-intensive navigation planning using waypoints, but a more favorable mode of interaction has the operators specifying high level commands, such as "provide surveillance of this district" or "provide air superiority in this sector." This implies a language of mission-focused directives that may embody not just one but several air vehicles. To date, we've worked on the ability to control up to four vehicles at a time with a single operator. At the base of this capability lies our understanding of the importance of cognitive issues in the human-systems interface. Specific ideas and or technologies which improve our ability to control multiple vehicles and/or manage the "system of systems" more effectively from a human perspective could greatly enhance system performance. We plan to actively look for new ideas in this area.

Autonomous operation of the air platforms also implies that they will fly in the civil airspace. Early UAV's were designed as near expendable entities and that worked because they only operated on the range or in a war-time environment. As the range and payload performance has become more competitive with manned systems, UAV's now need to use the general airspace. We must solve the sense-and-avoid problem for achieving a manned-like aircraft capability among multiple autonomous aircraft, enabling us to detect and avoid both cooperative and non-cooperative aircraft in the same space. We plan to look for new ways to address the autonomous operation challenge not only for individual air vehicles, but also for teams of air vehicles.

The other technology challenge area that I want to discuss is survivability. As with most air vehicles, the UCAV programs have focused on low observability to provide platform survivability. The J-UCAS program will explore other ways of improving survivability, including cooperative tactics, damage tolerance at the platform and system levels, and graceful degradation. This approach will allow us to develop a more comprehensive suite of survivability tools. Tactics, statistical threat analysis, dynamic behavior, and exploitation of maneuverability have emerged as possible innovative approaches to enhance a fleet's probability of accomplishing its mission, in an expanded notion of an unmanned survivable operation. These approaches would not only move air operations away from a single survivability paradigm, but offer the potential to lower the cost of survivability. Our efforts in modeling & simulation will allow us to try these new approaches and other ideas you bring to us, then pick the best ideas for inclusion in the operational assessment plan.

I've only briefly touched on three technology challenges facing J-UCAS. Other challenges exist in such areas as sensor development, network architecture, common operating system and dynamically adaptive systems. More importantly, many unknown challenges exist and results in

an opportunity for you to help us identify these challenges, and to find a solution, or to develop a new capability and enhance our mission breadth. Earlier, Marc Pitarys announced our intention to issue a broad agency announcement to address the needs that I've discussed, as well as other ideas that might improve the J-UCAS war fighting capability in the near future. Thus, we solicit your involvement with the program.

Our ability to deliver new capabilities on the timelines required depends on our ability to harness the Best of Breed ideas. The use of the Common Systems consortium that Marc Pitarys described will go a long way in helping us compare and integrate various components of the system. You have undoubtedly noticed that many of the technologies that we've discussed for J-UCAS are topics of prior or ongoing DARPA projects. For those ideas and capabilities that are relatively mature, or can be developed rapidly, and fit into the Common Systems arena, we will provide a mechanism for an offerer to join the Common Systems consortium and become a part of that team.

I think that the most exciting part of the J-UCAS program is that it provides an opportunity to bridge a gap, from the novel ideas that you've heard about the past three days, to a warfighting capability based on an operational laboratory; from a past of manned, hierarchical platforms and forces, to a networked fleet of unmanned, autonomous, survivable air vehicles; from a defense based on overwhelming force and deployed might, to an integrated, technology-rich, awesome capability that will surprise our friends and foes.