**AFRL AUTONOMY TRANSCRIPT PART 4**

**Jim Overholt**
Hi! I'm Dr. Jim Overholt, I'm the senior scientist for autonomist systems at the Air Force Research Laboratory, and today I'm joined by Ms. Kris Kearns who's the portfolio manager for autonomous system with the Human Effective Directorate across AFRL, and we're going to talk to you about Air Force Research Laboratory's autonomous science technology strategy.

**Kris Kearns**
So in previous recordings, I think we've talked about what is our strategy, what is our vision, and what is our goal. But today we're going jump into one of them in particular and were going to talk about complex contested environments, but before we jump in let's start back and so let's remind everyone here's what our vision is which is all about intelligent machines seamlessly integrated with humans. And I think we want to emphasize it again, we're talking about machines that have the intelligence capability to make decisions and do things, but not without being integrated and working with a person with an Airman to do a particular mission of the Air Force in the complex contested environments to help optimize the performance of that mission in the environments. And so when we take that vision and we break it down and we say, what are the major challenges? What are the major goals that we need to try to achieve. We've identified four; the first goal was to demonstrate highly effective human-machine teams. The second goal was about teams and machines coming together to work. So again the first goal is humans and machines working together and the second one is machines and machines working together. Our third goal which we'll talk to you about in a moment is about ensuring they can operate in the complex contested environments that they will be operating in. And then the fourth goal is about, how do we demonstrate that they are effective and safe in these environments that we are talking about? So how are we going to test and evaluate, verify and validate that they're safe and effective.

**Jim Overholt**
All very important

**Kris Kearns**
So let's go and jump into the demonstration they operate, can operate in these complex contested environments. And I think what we need to do first explain what we mean by complex and contested environments. So you want to talk about complex environments.

**Jim Overholt**
Yeah complex environments I mean if you think about what we're talking about we've mentioned this before of course the Air Force is going to deal in three domains; space, air, and cyberspace. So complexity you can imagine there's varying levels of complexity all for each of those domains. Take the cyberspace domain and the complexity of thinking about the World Wide Web and being able to operate in terms of doing cyber operations. In that kind of immense complex environment so many different moving parts, so many things to take into considerations when you're trying to do some kind of operations and so complexities certainly grows or we have to be able to work in that kind of environment, cause you know working in a nice benign static environment that's somewhat you know easy for the scientist to do. When you start moving into complexity in adding all these moving parts all these different things you have to consider. It starts becoming a huge technology challenge.

**Kris Kearns**
And I think the other aspect of that goal is contested environments. And I think that most people would think in their mind when they hear contested, they're thinking about from an Air force perspective dog fights, and you know, air to air combat and those kind of things, which we need to think about, but when we say contested there's also how do we get our air platforms into the national air space? Don't necessary

think of that as a contested, but how do these systems operate and maybe they're not evasive maneuvers, but they maneuver so that they're not, you don't have systems running into each other.

**Jim Overholt**
Heck you can think of automobiles on our freeways dealing with a contested environments, certainly so.

**Kris Kearns**
So just kind of give you, were talking about lots of pieces and parts, lots of different platforms potentially operating and needing to come together as well as then being able to maneuver and work around themselves.

**Jim Overholt**
Sounds great.

**Kris Kearns**
So we've identified these enduring problems again, the way we break these down is here's our goal, what are the enduring problems the long terms research challenges were going to have to take on as an organization and a larger community in order to realize this goal of insuring operations in complex contested environments.

**Jim Overholt**
So we broke this down and we looked at two enduring problems for this particular goal. The first one we would consider really is the ability of the autonomous system be able to sense its environment, sense what's around it. That seems to be obvious but really it's not something that's necessarily of a major part of autonomous systems right now, understanding it's environment, understanding the effects it has as it moves around as it operates in these complex and contested environments. A very-very key critical type of technology. The second thing here is being able to develop these technologies which are that are robust and reliable against these changes that we are going to see. So one of the, if you want to call it a hallmarks of a complex contested environment is the fact there is a lot of dynamism happening actually in the environment things are constantly changing potentially that could have a negative impact on the autonomous systems. So the system itself has to be highly reliable and robust to these kind of changes and these are the kinds of enduring problems that if you're going to get into this autonomous systems space that we have to be able to tackle.

**Kris Kearns**
So maybe a good example to kind of to drill home that point is if we think about it, we have satellites on orbit, commercial as well as military, but we have a lot of satellites on orbit. The sun creates solar flares, it creates radiation and that could be harmful to the satellites.

**Jim Overholt**
Absolutely.

**Kris Kearns**
So a satellite that can sense a solar flare happened, here's how it needs to reposition its solar arrays, and its sensors so it can protect itself, and be able to come back online as quickly as possible. Might be an example of something that we would all care about and having more capability, more decision making capability on a platform like that.

**Jim Overholt**
So it had to detect its environment and then it had to be reliable and robust and dynamic in a sense to be able to respond to that detected change in its environment. It's a great one.

**Kris Kearns**
Right, and I think we can take, we all hear about virus attacks and things like, why not have my own home computer, and we all have software protection, but why not have it be able to sense it and protect my computer before I have to do anything and download my next version of whatever protection software that I have.

**Jim Overholt**
And we're starting to see that kind of roll out in terms of software as well.

**Kris Kearns**
So an intelligence system again that can sense something is going on and know how to respond is the kind of things were talking about being able to operate in complex contested environments. And so with that one of the things that we care a lot about that we kind of haven't talked much about so far is the UAV platforms that we have the unmanned vehicle platforms that we have we would really like to be able to fly them for mainly a lot training purposes in the national air space. We have to have them be able to operate, and look and have the feel of manned aircraft so that when, if there were a commercial airline in the same space, that the behavior of that unmanned platform would just appear to follow the same rules that a pilot would be flying if they were flying it too. So how does it fly? How does it behave? How close can it get before it takes a maneuver? It has to understand what are the rules that it needs to operate in once it senses something, and then can respond and do the right thing, or do the expected thing.

**Jim Overholt**
So going back to these enduring problems you're looking at developing technologies that obviously apply to the UAV's that we can use obviously for military applications but like looking at onboard sense and avoid, or looking at traffic collision management systems. These kind of things that we're working on currently at AFRL which are certainly part of the necessary technology for autonomous systems that help in terms of rolling out this potential technology to the commercial, to a commercial aircraft whether it's a civilian aircraft or whether it's a some kind of freight liner. It's all important.

**Kris Kearns**
Which is the next tie because not only is it about operating in the airspace but once these things land, now they have to be able to operate in the terminal, and behave just like you would expect a manned vehicle to behave.

**Jim Overholt**
It's a very difficult it's a complex and contested environment even in the airport. When your actually on the ground and you have to move to your particular destination there's a lot of moving parts going on, and if you're going to have some kind of autonomous system like you were saying before it has to understand the rules of the road and it has to be able to behave in a way as if it were a manned system actually operating it.

**Kris Kearns**
Right! So hopefully we've given you an idea of what we're talking about when we say being able to operate in complex contested environments. I think we kind of wrapped this one up.

**Jim Overholt**
Oh! The only thing I would add to that Kris is this notion of in complex contested environments sometimes some of the links back to the human so this is part of the autonomous system that robustness we talked about, this issue or this notion of being able to still operate under dynamic conditions perhaps when we've lost communications or we've lost some other kind of linkage to the

system, it's important that the system still perform and behave in a way, that us as the designers as the operators intended to do.

**Kris Kearns**
No matter which air space it's operating in.

**Jim Overholt**
Absolutely

**Kris Kearns**
Or if it's on the ground.

**Jim Overholt**
Or if it's in cyber space.

**Kris Kearns**
Yep! Absolutely.

**Jim Overholt**
Exactly! Exactly!

**Kris Kearns**
So with that, I think like you said, I think we wrapped this one up. I think we've given you an example of what we mean by complex contested environments. What do we thing the major challenges are and so with that I think we are going to call it quits on this on goal. Just to remind you though we have recorded and we have gone into the other three goals. Coming up we will also be talking about our test and evaluation verification and validation. That's a mouth full.

**Jim Overholt**
It sure is.

**Kris Kearns**
We'll talk about in our next recording that we do on this.

**Jim Overholt**
Sounds great! Thank you.