

TRANSCRIPT

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**Dr. Steven H. Walker**

**Director, DARPA**

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**DWG:** First and foremost, I want to say thank you to our guest this morning, Dr. Steven H. Walker, the DARPA Director. Sir, everybody in the room appreciates you making the time to come in and talk to us today. Early March is always the best time to have guests, so we're thrilled with the timing.

Dr. Walker, you wanted to run through your priorities at the top here?

**Dr. Walker:** Sure. First off, thank you for inviting me. It's a great opportunity. Jared has typically organized some reporters to come over to the agency sort of after the budget release, and I was invited to this and it is perfect. So I wanted to come here.

For those of you who don't know me, I have been the Deputy Director at DARPA for about the last five years under Arati Prahakar. So I do know the agency well, and I'm excited to take over the reins as Director.

Our mission consistently, over 60 years now, we actually turned 60 years old as an agency on February 7, 2018. We had a little sort of low key event there for employees and alumni. But I wanted to make sure and mention our big event to celebrate DARPA's 60 years of innovation, but also look at what we're doing today and where we're going to go, is going to be September 5-7, 2018 at the Gaylord here in town. So it's called D60. It's going to be looking back at 60 years of innovation but also, as I said, looking at what we're doing today and where we're headed in the future. So please, by all means, look for that. I think registration starts in April, so it would be great to have you there.

Adam mentioned my priorities. I am really focused on three mission areas as I move forward at DARPA, which I'm calling foundations. The three mission areas are defending the homeland. We have a myriad of areas of threats out there, a myriad of different actors, and we need to be vigilant in how we're preparing to defend the actual continental United States and Hawaii and Alaska. So that will be an area of effort.

A second priority area is deterring and prevailing against peer competitors in geographically important areas of the world. So if you've read the NDS and the National Security Strategy that came out you see that we very much acknowledge we're in a competition with countries like China and Russia. That will be an area of focus for DARPA.

A third area is really effectively looking at how we counter insurgency and counter terrorism across the world. We're involved in lots of different areas. And we need to get better at looking at capabilities that are appropriate for those types of conflicts, and how we prepare for those types of conflicts.

The fourth really focus area for me is our foundations, and that is really what DARPA has always done, which is pay attention to where technology is leading us and how we can use that technology to develop, advance that technology to develop future capabilities for the U.S. and national security.

So those are sort of my four focus areas as I look forward to the future in this job. And I'm happy to take your questions.

**DWG:** We had a session about a month ago with General Paul Selva, the Vice Chairman of the Joint Chiefs of Staff. One of the things that he mentioned at the time was that the U.S. has essentially lost the lead in hypersonic to China specifically. And then yesterday Vladimir Putin announced that Russia now has a hypersonic ICBM.

So how far behind is the United States in hypersonics right now? And what is DARPA doing to close that gap or reestablish the lead?

**Dr. Walker:** I'm not going to confirm or deny President Putin's statement. But I think it's been widely reported in the press that China and Russia are active in the area of hypersonics and have been developing capabilities. So sort of that's all I'll say about what they're doing.

DARPA has been developing technology and capabilities in the hypersonics area for a

while. Myself personally, for the last ten years, in my different roles in the Air Force and in DARPA.

I will say that last spring DARPA in our role as [truth teller] at national leadership went to then Deputy Secretary Bob Work and sort of laid out where we thought the U.S. was in hypersonics and where we thought some of our peer competitors were in hypersonics and really tried to convince the department that we need a national initiative in this area. We called it the National Hypersonics Initiative. We did push for a very comprehensive initiative in the budget process this fall. We did receive a budget increase at DARPA and in some of the services to do more in hypersonics. I don't think we got everything we wanted, but it's a good first step.

I'm going to be looking forward to working with the new USTR&E, Mike Griffin, who comes in with an aerospace background, a background at NASA, a background in missile defense. He understands this problem very well. And I've been told by Mike personally that this is going to be his top priority or one of this top priorities as he comes into that job.

I will tell you a little bit about what DARPA's been up to and then where we're headed based on the budget increase we got.

We have over the last five years supported programs in developing hypersonic weapons. These are air-launched capabilities. One is called the Tactical Boost Glide program. Another is called the Hypersonic Air-breathing Weapon Concept, HAWC, program. These are both joint programs with the Air Force, Air Force Research Lab. And these are not going to be just flying propulsion concepts through the air. We did that with the Air Force under a program called X-51 where we achieved over 200 seconds of supersonic combustion in the air.

These are programs that right from the get-go have looked at what do we want to do with these systems, how effective can they be, how affordable can we make them, and how feasible is the propulsion system and the maneuverability and materials that we bring to the table.

We're going to start flying these systems in 2019. You'll see lots of flight tests. We're excited that these will be systems that will be very capable, that we can use from standoff, because that's one of the things hypersonics provides you. The speed provides you a lot of range. So you can use them from stand-off, and we're excited about these two programs.

We're also excited, and we did get a budget increase, to do more flight tests, especially on the Tactical Boost Glide program, and we did help the Air Force get a budget increase to do a follow-on program to TBG which will actually look at developing some operational prototypes.

So I'm excited that we did make some progress in this area with the new budget, and the services are coming on board now.

We are kicking off a new program with the Army called Op Fires, Operational Fires. This will be a joint program with the Army to look at how to increase the range of some of their capabilities in the long range fires area which is one of the Army's top priorities right now. So we used some of the additional funds to do that.

And then we hope to work with the Navy on the Hawk program, and working with the Navy to do a follow-on for that capability.

So things are moving, I would say. And when I say things are moving, I think the services, this is becoming not just an S&T thing, but the services are engaged and interested in moving forward with real capabilities. So I'm excited that DARPA's had a role in that. I think we need to keep it going. Again, as I say, I'm going to work with Mike Griffin to make sure that hypersonics is an important initiative, an important part of our [inaudible].

**DWG:** Before I came [inaudible] yesterday, I [inaudible] a bunch about infantrymen over at the Pentagon. [Inaudible] E3s, E4s. And I mentioned that I was coming to speak with you. And the one question they wanted me to ask is, when are they going to get light sabers? [Laughter.] I guess I'll broaden that to Directed Energy programs.

Another question, I guess an old guy question, would how does DARP work as DIUx?

**Dr. Walker:** Directed Energy. We have, DARPA has pushed the area itself lately, and we have a program we work with the Air Force on called [Heleds] which developed a solid state laser that's actually out at White Sands Missile Range being tested now. We've really gone from that sort of approach, still solid state but into fiber lasers and looking at, because fiber lasers allow you to integrate and move up the power level with a lower size, weight and power system than you typically get with other laser [com sets]. So we're working pretty closely with MIT Lincoln Lab on the fiber laser concept. I can't talk about the power levels here, but it will be significant if we can prove this thing

out over the next year. And it will provide us some pretty good capability in a small package, I guess I'll say that. And we are working with soldiers as well in this technology area.

**DWG:** So they may be getting --

**Dr. Walker:** I don't know if it will be the size of a light saber, but it will be something they can drive around, let's say.

The DIUx, I think DIUx, the idea of creating DIUx to plug in to the commercial sector and what the commercial sector is doing was a good idea. I don't think that's ever been DARPA's problem. I think we have always, we're very much of a program manager centered organization, so we go out and hire the best and brightest folks, we bring them in, and we almost immediately send them out to go talk to everybody in the research community including the private sector. And so we have a good track record of working with very small companies, Silicon Valley, Boston, Austin, all those places you can imagine. And we sort of do that naturally.

I think where DIUx does play a role and can help is maybe with some of the service laboratories that don't necessarily have the ability to get out as much as we do and have people that travel all these places and work with these folks as much as we do.

We have interacted with DIUx. Their chief scientist of technologist, Brenda Johnson, has come to DARPA many times and has interacted with all of our office directors to see sort of the trends, where DARPA's working, and then what they need to go focus on at DIUx [inaudible].

I would say we have, we sort of go directly to the [inaudible].

**DWG:** Thank you. I recall a slide from [inaudible], that [inaudible] hypersonic program has a [inaudible] question about 2020 and something [inaudible] about firing [inaudible] and in 2030 [inaudible]. I wonder if you do support [inaudible]?

**Dr. Walker:** The time scale is relatively accurate. I think the Air Force follow-on program for the Boost Glide System is focused on operational prototype in the '22, '23 time period, so it's close.

We have a program we're working with NASA on called the Advanced Full Range Engine, which is basically developing the combined cycle propulsion system you would

need for a reusable platform. And we're making good progress on that. We expect to test the engine in '19 or '20 on the ground in the NASA Glenn 10x10 facility. We've done some recent tests showing that the full-scale engine required for that platform will fit in that tunnel, and the tunnel will still run. So a blockages test, essentially. So we actually have visibility, we can test the engine on the ground. This is a combined cycle engine, so it's taking a turbine engine, off the shelf turbine, combining it with a scram jet, reusable scram jet, and having the turbine engine get up to about Mach 2-ish. The scram jet comes down about that far, and having that overlap so that you can actually take off like an airplane, fly up to Mach 6, do your mission, then come back down and do it again.

We're on track to test the engine on the ground in like 2020, but whether we actually go do a flight demo, that's not part of the program right now.

**DWG:** Can you describe the role of the Advanced Computer Simulation and [inaudible] in the modeling development of the technology so far? We didn't have [inaudible]. What have you learned about that use of advanced high resolution [inaudible] so far, and what [inaudible] impact the ability forward, and [inaudible]?

**Dr. Walker:** We obviously use highly complex computational fluid dynamics in these programs. The tricky thing about hypersonics is equilibrium flows become non-equilibrium and lots of friction, lots of separation potentially in the flows. So some of your codes break down. They become more guesses than actual reality. So you can use them to sort of define some designs, but I think in hypersonics you'll always have to do the test. And then the other complicating factor with hypersonics is you can only simulate so much on the ground. It's hard to get the velocity, the temperature, the Mach number, all correct as the vehicle would experience in the air at hypersonic speeds. So we do component testing on the ground. We'll do this engine together on the ground. But with hypersonics you've really got to fly, and that's why, that's actually why we went to these air-launched systems because it will be much easier for us to do multiple flight tests and learn, versus putting systems on big ballistic rockets and doing very expensive flight testing.

**DWG:** On the subject of the [inaudible] competition, there's a lot of discussion now about space and the challenge by China especially, and the Air Force is being criticized a lot for not modernizing for these [inaudible], and they need to move faster and what not.

So some people are saying why couldn't DARPA do more of the space programs? Of course you can't do everything. But is there any discussion that you may be taking more of the space portfolio as these challenges continue?

**Dr. Walker:** I wish I could tell you everything we do in space, but I can't.

We do quite a bit now. We tend to be more on the demonstration side, so do a demonstration, see if it works, and then -- but even on some of those demonstrations, we work with the services pretty closely. So we have several programs now with the Air Force and others looking at future capability demonstrations over the next two or three years. But they're, and I can't talk about them here.

The thing I can talk about is I think you're absolutely right, and others have said it, space is becoming more and more contested. I think DARPA actually, again on some of the programs, really about five years, four to five years ago, moved that discussion further along and we brought it again to the attention of senior leadership, all the way up to the White House, that space was changing. Things were getting very contested, and the U.S. needed some programs to counter it.

So that is, those programs are moving along.

We think GEO, we have very exquisite, we and the commercial sector, have very exquisite satellites at GEO. Big systems that are very capable, but they cost lots of money, take a lot of time to build and get up in space.

We would like, and we've been saying this probably for about ten years, but we would really like to pivot from GEO to LEO, Low Earth Orbit, and look at capabilities we could put in LEO in larger constellations to get us some of the same capability or even better capability from an ISR Standpoint, and then use that sort of larger constellation for purposes like command and control, and help actually enable more than just ISR, but enable sort of a battle management system for tactical warfighting on the ground.

This is a space that we've been talking about for a while. The difference now is that technology has moved along to allow you to think about having some pretty capable small satellites that you can put in at LEO in larger constellations.

So we are starting a program called Black Jack which is looking, and we're working with the Air Force on it, which is looking at how do we leverage again, the commercial sector and what's going on there in terms of what they want to do at LEO with large constellations. How do we leverage that? How do we leverage the manufacturing they're going to be doing? The fact that they're going to be able to build these small satellite buses much cheaper than we could. And how do we look putting payloads

we're interested in on those more affordable, small sat buses to do things from LEO in large constellations that will I think be naturally resilient to adversaries, because you're talking about lots of satellites. And cheap to put up. So you're talking about a new paradigm where you're not putting something up for 20 years, you're putting it up to last two years, three years, something you're replenishing.

The other thing that has to come along with that is launch, and we are focused on working with the Air Force to see if they want to participate in a launch challenge that we'll probably announce in the April time frame.

So space is going to be one of my priorities and we are very engaged with the Air Force, with other organizations to change it.

**DWG:** Why do you think the Air Force has a difficult time incorporating commercial technology? Or the services in general. Why is that?

**Dr. Walker:** Well, in fairness to them, they are large organizations that do operations very, very well. And they spend a lot of time training, acquiring, exquisite capability, and then performing with that capability extremely well, better than anybody else in the world. So they do that job very well. But organizations that are large and do operations very well sometimes are wedded to the way they've always done business. So it's true of our services, it's true of other large organizations you can think about.

So DARPA is sort of, was created 60 years ago to be disruptive to that sort of mindset. We try and be disruptive and partner at the same time, and we find that that's much more effective.

I will tell you that this Black Jack concept I mentioned as the idea of moving from GEO to LEO is getting a lot of traction with the services, especially the Air Force. So I am very encouraged and positive that we're going to be driven in that direction together.

**DWG:** Thank you. I wanted to take you back to hypersonics one more time. Two things. You alluded to this a little bit. Do you have the infrastructure you need or is a big part of the boost that's in this budget going to [inaudible] and other things? And [inaudible]?

**Dr. Walker:** Great question. Thanks for asking it.

I would say no. The dollars that were allocated in this budget were great, but they were

really focused on adding more flight tests and getting some of our offensive capability further down the line into operational prototypes.

We do need an infusion of dollars in our infrastructure to do hypersonics. What I really want to do is work with Mike Griffin, again, former NASA administrator, and the new NASA administrator, to develop an infrastructure plan for hypersonics. It's badly needed.

Most of our programs at DARPA are testing in one facility, and that's at Langley right now, that is just, you know, doing all it can to work 24x7 to do this work. If you look at some of our peer competitors, China being one, and you look at the number of facilities they've built to do hypersonics, it surpasses the number we have in this country, and is quickly surpassing it by two or three X.

So they, it is very clear that China has a focus on hypersonics and are making it one of their national priorities. I think we need to do the same, and I'll be working with Mike to do that.

**DWG:** And my other question was, there are so many disparate programs related to hypersonics. Who really is going to be the coordinator, to make sure that DARPA, the Navy, the Air Force, the Army all don't go in the same direction or have overlap or conflicts?

**Dr. Walker:** I think it's going to be Mike Griffin, USDR&E and we're going to do everything we can to help him.

**DWG:** One of the hypersonic issues going back ten years ago when you were the program manager for [Blacksmith], which was really quite ambitious, and I remember [inaudible]. Is there anything in the current budget for the [inaudible] and still have that? Or is [inaudible] program?

**Dr. Walker:** Right now Blacksmith is [running] on component programs, the AFRI program I talked about where we're developing the combined cycle engine is the engine I would have used in Blacksmith. Right now it's an engine program.

**DWG:** Is it more [inaudible], and that was [inaudible] aircraft that was to take off, land, why don't we have that now? A [centrifugal] program, not [inaudible].

**Dr. Walker:** I think we want to see how the engine performs, and then we may have,

if I have anything to do with it, we will have a program.

**DWG:** And the second question, I had lunch recently with a Ukrainian official who talked about that they had DARPA over in Ukraine to look at their [inaudible]. Kind of [inaudible] DARPA [inaudible]. They said DARPA was looking at [their needs]. Did anything come out of that trip? And does that go into that component area you talked about? What is DARPA doing in these types of hybrid warfare, and specifically anything from that Ukraine visit.

**Dr. Walker:** We did have a good visit to the Ukraine. We did get a chance to talk to a lot of their, I went over personally. We did talk to a lot of their industry folks and also their [inaudible] folks and military folks. Yes, we have followed up with them, and through the U.S.-European Command we have started several projects with the Ukraine, mostly in the information space. Not providing them weapons or anything like that, but we're looking at how to help them with information. I can't really say more than that.

But I certainly got a lot out of the visit and was very impressed with the spirit of the Ukrainian people that I talked to.

**DWG:** Are you guys informing or working with people at MDA at all?

**Dr. Walker:** DARPA, because of our expertise in hypersonics, we have, we were called in probably over a year ago by MDA to help inform them on what this hypersonic thing is all about. We did go over and give them all of our data. Data from previous hypersonics programs we have done. We have a good relationship, I'll say, with the intel community in the U.S. in this space, and so we were able to provide, we were able to give MDA a lot of the information about what's going on elsewhere, including what we're doing.

So I think that was a good springboard for them and to the Missile Defense Review, and other work that they're doing to look at defending against hypersonics.

**DWG:** [Inaudible].

**Dr. Walker:** It was, but we definitely, my program managers are involved with their folks. You know, whenever they need us to come look at stuff, we're there.

**DWG:** And then a big picture question, since we're now back in the era of a great power competition, we hear a lot about hypersonics in the area of [inaudible]. AI's [inaudible].

In your mind, are there tech sectors that are [inaudible] that the U.S. is falling behind on? Is there a [inaudible]?

**Dr. Walker:** One I'll point to is biology, actually. I'm actually not, we're looking at the AI thing right now too. I believe we're, at least right now, we're not falling behind in AI. But biology is an area where others are paying a lot of attention and it's one of the reasons why DARPA stood up the Biological Technologies Office about four years ago now.

Biology is a fast-paced field, lots of technology development and innovation happening. And I think certainly you can look at the open literature, open press, and see that China's making a pretty big investment in understanding DNA sequencing and building a DNA database on their population. So this is, they're taking it seriously and they're actually, we've done some looks, began in just open literature, open information, and they've got a lot of new startups in bio and they're looking at a lot of our startups in bio. So they're actually making a pretty good play there.

I think another area I would say is advanced electronics. I don't think we're falling behind, but China, again, is making a large investment in trying to bring, they're a huge market for electronics, obviously, but they're trying to make an investment such that they can bring foundries on-shore and do the manufacturing in country. And I think the number I saw was \$150 billion of investment.

Again, one of the things we're using our budget plus-up for at the Pentagon and the White House really is looking at how we get ahead of that, how we leap frog what they're trying to do there. And so we have started something called the Electronics Resurgence Initiative. In '19 we'll be getting an additional I believe it's \$150 million to look at adding it to programs we already have at about the \$150 million level, to look at new designs, new manufacturing techniques, and new ways to really bridge the gap between our global multinational companies in this country that are at the forefront of electronics and our defense industrial base.

So this is an effort out of our microsystems technology office that is really exciting the community, and we've been able to attract really outstanding program managers to run those efforts. And it's really about okay, China wants to build these foundries with old technology. Great. We're going to go to the next level. So that's DARPA's play in that arena.

**DWG:** Can you give an example of the kind of technology you're talking about?

**Dr. Walker:** One example would be looking at three-dimensional architectures for chips. Right now most everything we do is really at a two-dimensional level. Semiconductor on silicon. We want to go into that third dimension. See how much more capability you can get at a certain size chip. That's one example. There's some interesting work at MIT in that area.

But we have lots of proposals that have come in. We're making decisions on those proposals now, and we'll be announcing winners here in the next month or two.

But I think when we make those announcements you'll see DARPA I'll say bridging the gap between big U.S. multinational companies in this area and the defense industrial base, and working together to move the country forward.

**DWG:** In general, I'm just wondering if DARPA has any [inaudible] projects [inaudible]. You just mentioned China [inaudible]. Do you think they are accomplishing anything more [inaudible] than we are with the Million Veteran Project and the [inaudible]?

**Dr. Walker:** I can't say for sure. I don't know that much about it. I do know we have those efforts. I think they're just, my impression is they're capturing so much more data and they don't have the same privacy laws that we do, so they're building this database of, a large database on their population's DNA, and I just don't think, I think they have access to so much more information potentially than we actually do. Just because of our ethical stand on privacy, which is a good thing.

**DWG:** Are there any other [inaudible] projects [inaudible]?

**Dr. Walker:** Yes. So we have this biological technologies office we stood up about three years ago. It was initially focused on three thrusts: synthetic biology, fighting infectious disease and in neuroscience. And it's still focused on those areas, but I've asked the leadership there to really think about, in the context of my priority of defending the homeland against existential threats, to really think about how we would do better bio surveillance, surveillance of what's going on in the bio sector and what potentially the serious folks would be using it for, and then how to surveil, how to detect, and then how to prevent a biological attack on the U.S.

So the office is really building on the three thrust areas and focused on, so I'll give you one example.

The gene editing area. I'm sure everyone here is aware of the incredible advances being made in gene editing technology, CRISPR Cas9 and other things. Exciting, exciting efforts. Exciting technology that could potentially cure disease in the future. So we're not opposed to it, let's just say.

But it's such a new field and there are so many things that are unknown, that even if you think about what people might do that could cause an accidental gene edit or gene drive, or taking it one step further and an actor doing it on purpose, we have a program we started called Safe Genes, which is looking at understanding how gene editing works. So again, consistent with DARPA's mission of preventing technological surprise. Understanding how gene editing really works, how does it function. But then also developing some counter measures to a gene edit, and then also some ways to reverse a gene edit or a gene drive that maybe was released into the wild. Again, for nefarious purposes or even accidentally.

So this is an example of where DARPA's in this space to prevent technological surprise, but also to protect the nation against something that might happen that we don't necessarily like. That's just one example.

We have another example, I'll say with biology. A program we just released an announcement on called P3 which is really looking at how do we get ahead of these infectious diseases? Even things like the flu. But certainly Ebola, Zika, other things that have arisen.

It takes us a long time to develop vaccines to prevent and to protect against these infectious diseases. How do we develop an infrastructure and a technology to allow us to get some transient immunity to these infectious diseases and get that out to a large sector of the population in a very short amount of time? That's what P3's about.

So the DARPA goal is do all that and be able to protect a significant part of the population in 60 days, versus spending a year or two years, three years, ten years, on developing vaccines to fight some of these infectious diseases.

So it's an ambitious goal, but we have some good folks that I think we just really [inaudible] who's going to be working on that.

While we're working with the obvious folks on that, this is technology that we bring out of a former program called [ADEP] which is basically a nucleic acid treatment that relies

on DNA and RNA methods to allow your own body to generate antibodies against an infectious disease. That's how you get the transient protection and you get it quickly. This is research that NIH and DARPA have been doing for some time. It's now, we're trying to take it to the next step and make it a real capability.

**DWG:** Good morning. You've talked to different specific areas [inaudible]. I'm always intrigued by reports that come out that South Korea wants to create their own DARPA, etc.

Stepping back, if you look from the 30,000 foot level, why do you think DARPA still stands alone at being able to do so many things well, as opposed to other countries trying to replicate that secret sauce?

**Dr. Walker:** We even in this country try to create other DARPAs, right? So one thing I want to make clear is I actually support our allies and partners trying to stand up a DARPA, and I've actually over the last couple of years met with many countries -- South Korea, Japan, UK, France, Germany, to try and help them understand the DARPA model. And then, you know, how it could work for them. Every culture's different, though. And every, so I think one of the reasons why it worked here is, compared to some other countries, we have a risk-taking culture. We have folks who are willing to come to a place, have a job for three or four years, and then get booted out. Which is actually what happens.

You know, we hire program managers to come to DARPA for, it usually ends up being three to five year terms, and then tell them they don't have a job anymore. And it kind of works in this country. It may not work everywhere. People generally know they're going to go from DARPA and get a good job somewhere else.

By the way, that, I think, is a key attribute of how DARPA works and why it works well, is that we get new people in the door with new ideas all the time. We're not bound by 10, 20, 30 year old thinking, which can happen in some places. And it adds to sort of the innovative culture of the place.

People come in and ask why do we do it this way? If it takes this long, why are we doing it this way rather than a different way? I think you've got to accept sort of that hiring mode. I think, the other thing that comes along with that hiring model is people aren't penalized for 20 or 30 years for taking risk because they're going to leave.

So you can take more risk, you can be more creative.

I think the other reason our DARPA is successful, and one of the things I've noticed in talking to others about creating their DARPA is we get a lot of support from the White House, the Congress, the Pentagon, apolitical support, to do the right thing, to take risk, and they give us a lot of freedom. They give us a lot of freedom to make decisions, to think differently, and to start and stop our own programs. And we get very little to-down direction, which I think is, if you want an organization to continue to produce out of the box ideas, projects, to continue to disrupt the status quo and question, and you want that organization to be free to have some autonomy and some flexibility. So that's another key attribute that our --

**DWG:** Isn't that kind of unique to this country as well?

**Dr. Walker:** It is, because when I talk to others about DARPA and how it works, many other cultures say that could never happen.

**DWG:** Thanks for doing this.

You briefly mentioned AI in the context of saying that you don't think we're falling behind our competitors there. I wanted to ask you about opposition to autonomous weapons. What do you say to NGOs who want to ban autonomous weapons or at least place strict limits on them? Do their concerns have merit? And if so, how do you walk the line between addressing those concerns and continuing to stay on par with our competitors in that area?

**Dr. Walker:** When I think about autonomy, someone described it once to me as a good way to think about it is autonomy at rest and autonomy in motion. Autonomy at rest, when I think about autonomy at rest I think about automation more than anything else. So machines that can help humans make decisions quicker.

So we had a challenge we just did in 2016 called the Cyber Grand Challenge, which you may have heard of. That's an example to me of autonomy at rest, where we developed a cyber reasoning system that could look at software code, identify vulnerabilities, fix the vulnerabilities, and then actually go on offense and take advantage of other vulnerabilities in another person's code. This was all sort of focused on, and it's an AI, using AI, first wave AI, first system AI, to help a human do cyber security and do it much quicker than we can do today. So I think all that is good. I mean I think human, machines helping humans do their job better, I like that. I think most of our warfighters like that.

Autonomy at motion is a little trickier. You can think of robotics, autonomous robotics. I think Sharon mentioned autonomous vehicles that DARPA Had a play in. I think all that can be good, and we recently transitioned the autonomous ship we developed to the Navy called the Sea Hunter which is an unmanned ship with, that has the software and sensors on board to follow all the regs of the sea autonomously. So if the Navy really takes that on, it looks like they're going to build another one and experiment with it even more, that could really help them in terms of getting more ships at seas, unmanned/manned teaming, getting their Navy out there at much less cost than building a manned ship.

So that's all good I think too.

Where it gets tricky is making the lethal force decision. We have a pretty clear DoD policy that says we're not going to put a machine in charge of making that decision, and I think that's the right policy. So I think every uniformed four star general that I've heard talk about it agrees with that. So I don't think at least the U.S. is going to ever put a machine in charge of making a lethal force decision in the end.

**DWG:** So that policy you don't think stifles innovation or keeps you from competing with Russia and China?

**Dr. Walker:** I don't think it stifles innovation. I think we continue to look at autonomy in motion. We continue to do some robotics. We did the DARPA Robotics Challenge which I think showed how far away we are from robots being able to do military missions necessarily. At least on the ground. The ground is complicated. The perception you have to have on the ground to do --

**DWG:** did you see the robot skiing competition?

**Dr. Walker:** Well, no, I didn't.

**DWG:** It underscored the reasons that --

**Dr. Walker:** There's room to go there.

So I think we're still continuing to innovate, and I think that's not the issue.

I don't know about the ethics of our peer competitors. I don't know, do they have the

same policy? I'm not sure they do.

**DWG:** Thanks for meeting with us today.

You noted that you're expecting a major increase in funding for hypersonics in FY19. Can you provide a dollar amount on that?

**Dr. Walker:** We'll get you the dollar amount. I don't know the exact figure. I'd hate to say, but it's substantial. We'll get you the dollar amount.

**DWG:** Okay. And you also noted that you're providing information to MDA to help inform their missile defense programs when it comes to hypersonics. Is DARPA doing anything on its own on the defensive end to push forward technology to defend against hypersonics? Not just develop weapons?

**Dr. Walker:** I think the Pentagon pretty much made the decision that MDA's going to be the place to do that. So they've got some significant finds to do that.

**DWG:** Gopal.

**DWG:** Thank you. You said that we're not falling behind in AI. But the CEO of [Inaudible] has been going around the country talking about how China is way ahead of us and [inaudible]. So could you talk a little bit about why [inaudible] not falling behind?

**Dr. Walker:** I think, I don't exactly know what he's said, but what I meant was we have significant investment in AI. I think DARPA helped create the field years ago, all the way back to JC Licklider in the early '60s. We've had programs over the years that have worked on the compute part, graphical processor units used to do a lot of the AI calculations, AI algorithms. We look at AI and we define AI sort of in three waves. First wave, second wave, third wave. And we think we're very much in the second wave right now.

The first wave is really expert systems, so looking at if these inputs come in, what should the machine tell you to do. So think Turbotax, very standard if/then sort of systems.

The second wave, we look at, you can think of all the statistical learning systems that are being talked about now. So the machine learning focus, the machines that are winning in AlphaGo. Those are sort of the second wave, what we consider second wave.

These are still very brittle systems. So they're trained on massive data sets. They do a great job in pattern recognition and looking for images and saying what an image is. They probably do a better job than humans at that function.

But they're still very brittle. If you change the data that they're trained on, if you put new data into the system, into the database, they tend to start to fail. They can be tricked easily. There are lots of folks looking at how you would trick an AI system, starting to look at that.

From the initial things I've seen, it doesn't take a lot to trick an AI system.

So we have more work to do in I think second wave in terms of making them more robust. I have some programs looking at that.

We're very much focused I think, especially in the foundations part of our portfolio, in what we look at as third wave AI, which is really about contextual adaptation. So having a computer or machine understand the context or the environment it's working in, and being able to learn and adapt based on changes in that environment. So AI systems can't do that today. They fail miserably at that.

DARPA has several programs in the third wave foundations, sort of building on that next third wave.

We're working with the commercial sector on that. One of the programs that comes to mind is a program called explainable AI where we're heavily investing in the commercial sector as well as the university world to look at how do we bring these machine learning systems to a place where they can actually tell you why they came up with the answer they came up with, explain to you the thinking, thinking in quotes, that the machine used to come up with that answer.

These are very nascent efforts and basic research efforts, but they're going to be important if you want a warfighter to sit there and trust the machine and trust the answer that the machine is giving the warfighter to help him or her make a decision.

So when I say I don't think we're falling behind, I really mean that DARPA certainly is investing in the next generation of AI pretty heavily, and in terms of applying AI, we are applying second wave AI, machine learning AI, in places where we think it makes sense.

So in controlling the EM spectrum, we have programs looking at how machines would share and collaborate enough to separate out how they work across the EM spectrum. So this is a challenge effort we have ongoing.

We have other efforts looking at how you would apply AI learning systems to electronic warfare, for instance. We operate in a certain part of the spectrum. They operate in a certain part of the spectrum. How do machines deconflict and make sure that we can operate?

So there are, we're heavily invested in applying second wave, and we're heavily invested in building the foundations for third wave.

There are folks talking about a more comprehensive, again, a national approach to AI. I don't disagree that that would make sense, but I think I would put our AI and our country's efforts in these areas up against anybody at this point.

**DWG:** One more question. You said at the beginning that one of the four priority areas was to look at capabilities to deal with [inaudible]. Can you talk about what falls under that bucket?

**Dr. Walker:** Sure. I think we've got to get better as a country in information warfare and how we approach info warfare. I think some people call it gray warfare, hybrid warfare. I think there are capabilities there that we need to improve upon, and DARPA is working in some of those areas.

I think as more populations across the world move to larger and larger cities, we need to be, we need to understand the three dimensionality of cities and how to operate in those very crowded, very three-dimensional spaces, and that's going to become more important in the future. We have a challenge that we have an announcement on called the Subterranean Challenge, SubT Challenge, where we're looking at how to sense without humans underground tunnels, underground infrastructure in a city, underground caves, to better understand how to fight in that third dimension.

Then you know, warrior performance I would put in that category. How do we give our guys and gals the capability to fight in these very extreme environments and to do so at a better level of performance, to spend some time focused on them.

**DWG:** We're down to four minutes remaining and I have four people left on the list at this point. Matthew, Jeff, Dimitry, Josh, so we're going to have to go to the speed round

here.

**DWG:** I wanted to ask about the National Cyber Range. I saw [inaudible]. There's mention of increased operational tempo. So what's behind that operational tempo, and what are our plans for additional national [inaudible]?

**Dr. Walker:** My understanding is we've transitioned that effort, so we're no longer in charge of the National Cyber Range.

**DWG:** Efforts at particularly supply chain, things like Shield, looking at electronics. I'm just wondering about the kind of emphasis that's going on today given what the requirements for electronics that seem to be rising, and where some of these programs are moving today?

**Dr. Walker:** Shield has been a good program for us. What we're trying to do with Shield right now is get the wider world interested in it. For Shield to be successful, we believe the commercial sector's going to have to put that on their [chips]. So we're very much in discussions with them about how to do that.

We do have other projects looking at how to ensure we can trust our supply chain. Most of those are at different levels, but we're very much engaged in that process.

We also think that the Electronics [Resurgence] Initiative could lead to new ways to, new techniques for us to trust our electronics better by developing them in different ways.

**DWG:** I wanted to ask would you please give a reaction of DARPA's projects in [inaudible] non-military applications?

**Dr. Walker:** Sorry. Say that again.

**DWG:** I wanted to ask you to please give a reaction of your projects and DARPA's having non-military applications. I assume some of them do, but I wanted to ask [inaudible]. And if you don't mind, speak very briefly about relatively low tech part of your job, to the extent you are comfortable.

**Dr. Walker:** Low tech part of my job. What do you mean by that?

**DWG:** [Inaudible], you know, something that gets you real excited that you think is

useful and that you can talk about in a public setting.

**Dr. Walker:** Okay. Back to the first question. You asked me, what did you ask me again? Sorry.

**DWG:** Non-military.

**Dr. Walker:** Our mission is breakthrough technologies and capabilities for national security, so everything we do has a military application. Some of what we do spirals into the commercial sector. And we're okay with that because what we think, maybe the military's not ready to take it now, but it goes into the commercial sector, it gets more money applied to it, it's good for U.S. business, it eventually comes back maybe in a different wrapper as a military, as a new capability somewhere down the line. So we've seen lots of examples of that over the years. But everything we do, we set out to do it for the military.

Your second question, a low tech example. Something that excites me.

I'm excited by the people that work at DARPA.

**DWG:** Edible MREs.

**Dr. Walker:** I would just say I feel very blessed and privileged to work at DARPA. And to actually try and lead this organization. It's an organization of really talented people that care a lot about their country and are doing these jobs for less money than they could make elsewhere, because they care.

**DWG:** First of all, thank you so much. This has been great. I appreciate it.

Block chain. You're using it for cyber security. What other potential applications could block chain, crypto technology, [inaudible] have for national security? What are you thinking about?

**Dr. Walker:** I was just talking to somebody the other day. What if we could build a layer to the internet that was completely trusted? A layer that sits on top of the current internet, when you want to take advantage --

**DWG:** I think that was on Silicon Valley.

**Dr. Walker:** Was it? Okay.

**Dr. Walker:** It probably was, but I didn't see it.

Build on, because the internet, DARPA helped create the internet. The ARPANET. There's a lot there. There's an infrastructure that's been built up. But what if you could put a trusted layer on top of it, take advantage of all the technology, using something like block chain to make sure that everybody on that layer was known, was trusted, and you could share information and feel like it was real.

**DWG:** Are you working on that?

**Dr. Walker:** Not yet, but I'd like to, and it's a concept that intrigues me.

**DWG:** How's block chain going [inaudible] cyber security?

**Dr. Walker:** Well, as far as I know.

**DWG:** We are out of time, but this was fantastic, and we'll try to book you for 90 minutes next time.

**Dr. Walker:** Thanks, everybody, for your support and I look forward to working with you.

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