CENTER FOR
STRATEGIC AND INTERNATIONAL STUDIES (CSIS)

2010 GLOBAL SECURITY FORUM:
IS AMERICA READY FOR ROBOTS ON THE BATTLEFIELD?

WELCOME/MODERATOR:
KIM WINCUP,
SENIOR VICE PRESIDENT, SAIC
SENIOR ADVISOR, CSIS

SPEAKERS:
REAR ADM. JAY COHEN,
FORMER UNDER SECRETARY FOR SCIENCE AND TECHNOLOGY,
U.S. DEPARTMENT OF HOMELAND SECURITY

ANTHONY TETHER,
FORMER DIRECTOR,
DEFENSE ADVANCED RESEARCH PROJECTS AGENCY (DARPA)

J.D. CROUCH, II,
FORMER DEPUTY NATIONAL SECURITY ADVISOR,
U.S. NATIONAL SECURITY COUNCIL

THURSDAY, MAY 13, 2010
10:50 A.M.
WASHINGTON, D.C.

Transcript by
Federal News Service
Washington, D.C.

KIM WINCUP: Why don't we get started?

In true CSIS fashion, I want to welcome you to this discussion of, "Is America Ready for Robots in the Battlefield?" In many ways, it seems to me the question is, how is America going to handle the inevitability of robots in the battlefield and society?

We have some great people to talk about it. I'm not one of them. My name is Kim Wincup. I have the pleasure of being the moderator. And the only time my name has been used in the same sentence with robots is in discussion of my activities on the dance floor. But we have some really good people, some really exceptionally experienced people to talk about it. In fact, they don't need an introduction.

In this case, it seems to me that that CSIS needs to be recognized for its ability to tee up issues before their time, and this is one I think that is really coming up strong and I think this discussion is extraordinarily timely. In spite of Gen. Cartwright's comments about programs that were really hallucinations, in many ways, it seems to me the hallucinations of Hollywood are the things that we're now seeing to start to develop in the robotic world.

So there's Dr. Tether. Tony Tether will tell us a little bit about that, but obviously lots of momentum in this region. There's the nontraditional battlefield, the movement of technology, the policy impact of casualties – and, really, personnel costs, I think, are going to drive lots of activity.

But even if one wasn't convinced about the seriousness of this issue, you only have to turn on the radio on WTOP in the morning of late and hear ads for robots for the Department of Defense. There is now a robotics caucus on the Hill, which I'm sure will make most of you very comfortable, but it also suggests that there are now constituencies out there for this activity.

But obviously other sorts of momentum: Secretary Gates in a speech recently essentially directed the Navy to use unmanned submarines, a DSB taskforce was appointed in March, late March, to look at the role of autonomy in the Department of Defense; and there was a legislative requirement in the 2006 Defense authorization bill that said by the year 2015, one-third of all operational ground vehicles have to be unmanned.

So there's a lot of pressure out there and much push but obviously a lot of pull. Again, looking at the news, the oil spill, the oil disaster down in the Gulf. There's a lot of robotics being used down on the ocean floor to try and deal with that. And then of course in the mine disaster, robotics could have been well been helpful in terms of – in West Virginia.

So lots of pull but I guess I would say that, again, on the news, some of the technical autonomy that was involved in our trading system, our stock trading system in the last week or so, suggests some of the problems that robotics can introduce in a policy sense.

So great issue, three great panelists to put it in context. The first is going to be Tony Tether, who really doesn't need an introduction, who's going to give us sort of a survey of the technology and the capabilities. Tony is currently the CEO and president of the Sequoia Group but was the director of DARPA from 2001 to 2009 and is kind of an icon in the technology world with a distinguished career in government and throughout.

Second, J.D. Crouch is going to give us a feel for the policy considerations and some of the potential constraints. J.D. is currently the president of the technology solutions group for Kinetic North America. He was an assistant to the president and deputy national security advisor, ambassador to Romania, assistant secretary of defense for internal security affairs; it goes on. A phenomenal career.

And then soon, hopefully, Jay Cohen will be with us. Jay is a principle in the Chertoff Group, maybe is the explanation why he is not with us right this moment. But he was the undersecretary for science and technology at the Department of Homeland Security. He has a distinguished career in the Navy ending up as the chief of naval research for five-and-a-half years, sort of unprecedented, but a great career in the Navy, a great guy.

So we are delighted to have this chance to talk with you. We are very delighted to have the chance to hear your comments about how this is going to go and so I'm going to turn it over to Tony to start.

ANTHONY TETHER: Thank you, Kim. As you know, DARPA is a place that develops technology to make things difficult for policy people – (laughter) – because we do things and then they have to figure out whether we can use it and how to use it.

Ah, here's Jay. I told them you were going to come, Jay.

REAR ADM. JAY COHEN: Well, I only do grand entrances, so – (laughter). But I steer in Dr. Tether's wake. (Laughter.)

MR. TETHER: So I'm going to talk about robots and technology and where they have applied and sort of the current state of the art and what will be the state of the art in the not-too-distant future.

There are basically five physical domains within which robotic technology has been used: space, atmosphere, surface, below the surface, and network computers. And network computers may be something of a little bit of a surprise to you but I'll try to explain that.

All of this has been driven by technology in computers making computers smaller and more powerful; in sensors, in fact our ability now to make sensors that are exquisite but also are very small and don't take much energy; and just mechanical components of being able to make things that act like muscles that, again, are getting closer and closer to the form factor of the human arm.

Those things have really allowed robotic technology to become not just a science fiction. In space, in the beginning, satellites were just transponders. Processing the data was done on the ground. As time went on, computing power and sensor capability greatly increased; more processing including housekeeping for the satellite was being done on board.

In the last 10 years, there was a program at DARPA called Orbital Express, which showed that you could take two satellites made by different manufacturers – in this case, Ball and Boeing – and have these satellites in space and have them find each other and come together and physically attach, transfer fuel, transfer batteries and do this all without any human intervention. In fact, most of the time, it was done out of the sight of a ground station.

I mean, really a fantastically new capability. Now, how this is going to be used is really just limited by our imagination. There's another program because imagine if you can really – you can do this – and we showed it could be done; you no longer have to launch a satellite in one piece.

I mean, think of it. You can take a big satellite, break it up into pieces – a com part, a power part, a sensor part – and launch those all separately and have those pieces come together in space and create a capability in space.

Now, what that does for you is that allows you to use smaller boosters. It allows you to have failures of a component and not lose the whole satellite. It will change the whole way the mission-assurance people think about things.

Mission-assurance people, for those of you that haven't been involved, are the bane of our existence. They worry so much about failure that by the time they get done with you, you'll wish you hadn't started in the first place. And that's all coming. That's space.

In the atmosphere, the first unmanned aircraft were, as with the satellites, controlled by the ground. They had data links from the ground. They were remotely piloted vehicles. As processing and sensor capability increased, more of the processing was done on board the aircraft especially that required to fly the aircraft. Even more of the sensor processing is being done on the aircraft and only the results are now being transmitted to the ground.

The unmanned aircraft Predator and Global Hawk technology development show that aircraft can stay up for long periods of time and basically fly themselves. But unlike satellites, the fuel required to keep them aloft was finite and they were only able to continue flying for a few days without having to come back and land.

And most of the casualties with these robotic systems occur on landing and takeoff. And the cost of them is really driven by the people on the ground as opposed to the aircraft itself.

Within the past five years, it was shown that it is possible to take an unmanned aircraft, an autonomous aircraft like a Global Hawk, and actually have it go up to a tanker and refuel itself.

Now, this was done using NASA. We couldn't get the Air Force to do this. But we got NASA to do it using their F-18s and a tanker, where the F-18 pilots – we put some software on board and a little camera. And this F-18 would come up behind the tanker and we made the pilots hold their hands up in the air – you know, as we pictured them – and fly right into that tanker and hook up and transfer fuel.

With that – I believe there's a program to actually put that on Global Hawk – that'll take Global Hawk from the two-days capability up to several days, weeks. In fact, what will be the constraint will be oil and not gasoline. And I think we can learn how to actually put oil on it while it's flying. And this could all be done at orbit because we believe we can have a Global Hawk tanker refueling another Global Hawk, which means it can stay at altitude. Again, where that's going to go is only limited by people's imagination.

On the surface, which is where we think about it mostly – on ground – the first unmanned ground vehicles, again, were remotely controlled by humans using data links. You know, move a robot along to a point.

And over the past 10 years, however, DARPA had a thing called the Grand Challenge whose objective was to show vehicles, for a prize, that all they had to do was go 150 miles through the desert, meet all kinds of obstacles and the only commands they could have was start and stop.

That has been done. The last attempt was an urban challenge where these vehicles now had to perform in an urban environment along with people-driven cars, obey California driving laws – and I know that, that may not be hard – but they had to literally be able to pass a California driving test.

And this was done. This was done. In fact, when we first let them go, we had the first autonomous traffic jam. They all came to a four-way stop, along with people and all of that. They got into a jam because some of the cars – roboted cars – stalled. But the ones behind – they had a mission to go through; they had a GPS map; they knew where they were – did autonomous three-way turns to go back and find another route to keep that mission going.

It won't be long before – in fact, our thought of its first use was driving convoys. There's no reason why convoys should have people driving them, and if you had people not driving convoys, the IEDs used against them would not be as effective. Oh, it'd still blow up the convoys. But the impact of people being killed would reduce literally its psychological impact. Again, this is all going to happen.

Below surface, a couple of things that have bothered us below surface in caves or underwater, and that is that basically you lose connectivity to GPS, which is a good thing to have because it tells you where you are. So technology, again, however, has made INS systems very small, very accurate, approaching good accuracy, so that now we can have things go into a cave, form a network. So basically, they communicate back out of the cave using each other as a cell tower, if you will.

Same thing underwater, we have formed the first underwater network using UUVs. Now, imagine that. You now have a whole bunch of UUVs, all of whom can't communicate for a very long distance. But suddenly, you have a huge net and every UUV now has the cognitive understanding of that whole area because they're all hooked to the Net. And one of those UUVs may in fact be a submarine with people in it. So again, it's changing the way things look.

Now, the one that I think is going to have the biggest impact are just network computers. By network computers I mean, imagine that when you get your first computer, you are assigned a program whose whole job is to do nothing but learn you; to basically grow up with you, watch you, watch how you like to get data, the questions you answer, the questions you ask, the way you like to see the answers and learn how you do this and then anticipate you.

In fact, our model for this, as all of you remember "M*A*S*H", Radar O'Reilly, he always knew what the colonel wanted before the colonel knew he wanted it and our objective was to have a computer kind of be like Radar who learned what the colonel really wanted to have before the colonel knew it and would feed him things.

Now, imagine the world where we have – every one of us would have our own avatar in cyberspace that was kind of looking out for us. And bring that to the military where now all these sensors and all are being processed by this avatar who's telling the person, the private, hey, watch it over there on the right, I think I see something, or no, no, you don't want to go that way; you want to go this way.

And that is all going to happen. And this is not a robot that has arms and legs but it is a robot more like if you remember Hal. It really is. And that is coming. (Laughter.) Now, it's closer than you think.

The effort was really done through SRI. We had a couple hundred million dollars spent. Most of it went out to universities. This capability has really come a long way to the point where SRI spun off a company called Siri or something like that, who really was coming up with applications that was going to go on your handheld. What bothered me is that just in the last two weeks, Apple bought that company to basically take it off the market so it could control those apps and not have anybody else have it except their iPods.

This is really coming and you'll see more and more of it appearing in your BlackBerrys as your BlackBerry now gets to know you over time as opposed to vice versa.

And that's about all I have. I guess, like I said, our job was to make policy people extremely uncomfortable because now that you have these things becoming smart and doing things on their own, the question is, should they do that? And I guess it didn't bother me but over to you J.D. (Laughter.)

J.D. CROUCH: Well, thanks, Tony. I think we do all unfortunately remember Hal and, of course, so does Dave. (Chuckles.) And that unfortunately – and I say unfortunately because I think our views on it are quite similar – probably does have some inhibiting impact on the development of these technologies.

My approach to this, the question was, are we ready for robots on the battlefield? And of course, as Kim said, we're already there. We already have robots on the battlefield to one degree.

One can imagine the notion that a robot is in fact a fully autonomous system that can act on its own without human guidance. No, those kinds of robots are not on the battlefield and those are the kinds that are often really portrayed in Hollywood, whether it's Robocop or Terminator or whatever.

So the real sort of interesting question from a policy standpoint is, what level of autonomy is permissible in what kinds of environments and how do we in fact even define autonomy? We talk about it a lot but we don't necessarily do that.

So I think, yeah, they're already there. I mean, if we – when you think about the time we went into Iraq, we had a few dozen probably robots with the deployed forces. I think by 2004, there were about 150 deployed. By the end of 2008, there were over 12,000 robots deployed with U.S. military forces now operating in Afghanistan, Iraq, operating with Allied forces.

There are varieties of different kinds of missions. They tend to range around more niche but very important missions that have developed as a result of lack of capabilities; EOD activities, for example, on the ground; route clearance, these kinds of explosive ordinance disposal; these sorts of activities. And what that is doing is exposing a lot of our ground forces to different kinds of capabilities and getting those sorts of capabilities into their hands.

One of the things that's interesting that we'll see as operations wind down over the months or years in these areas is the degree to which the people who have been exposed to these things begin or continue to develop new concepts of operations and new ways to put these ground robotics into different missions.

Of course, UAVs have really come into their own and I think are firmly now implanted in the psyche of not only our Air Force but all the other armed forces. Everyone is scrambling to develop new kinds of capabilities based on UAV technology from the tactical all the way up to the strategic. And through that, I think a lot of the policy issues that have had to be worked through have been successfully worked through.

One of the problems with UAVs, as Tony mentioned, is that it often takes an army of people, if you will – pardon the use of the term – to run single or multiple UAVs. And part of that is driven by the technology but a lot of it is driven by policy constraints, and what you have to have to be able to make positive decisions, particularly in the case of the use of force, for a UAV to engage a target.

And so there will continue to be those challenges as we look at the use of not only UAVs but I think another promising area that is not far behind is in both the UUV – unmanned underwater vehicles – and unmanned surface vehicles. To some degree, both the air and sea

environments I think are less challenging environments both from a policy and a technical perspective.

The DARPA Challenge that Tony mentioned was really amazing in a sense that moving over terrain and going around obstacles, what we as humans do rather naturally and rather simply, is a very challenging thing for robots to be able to do. Both the ocean – open ocean anyway – environment and the environments around the air environment are somewhat easier, although they present their own particular challenges.

Form a policy perspective, I think the key issue will really come down to the issue of autonomy. And let me define it in a different way, which is, what decisions will the robot make and what decisions will humans still have to make?

One end of the spectrum is a completely autonomous decision-making robot. I think we're a long way from that. We may have confidence in it in a laboratory environment. We may be willing to challenge ourselves to develop those capabilities at an R&D level. I think at a fielded level, we're still a very long way away from that. And so the question then is, where will you draw the line?

To look at unmanned ground vehicles, for example, today, the kinds of vehicles that are out there, that are deployed out there, are relatively crude. They have to be guided by an individual out to their mission area. Every aspect of the thing they do is guided, again, by an individual by and large, and then they have to be guided home by that individual. It's a very person-intensive – in fact, you could argue it takes more than one person to do this because while that person is engaged in it, they often have to have a force-protection suite around them to make sure that somebody else isn't going to mess with them because it's a very intensive activity.

But one could imagine in the not-too-distant future robots where they at least could go out and return on their own, that you would have a single operator being able to operate multiple robots doing multiple missions, add on a network layer and you now have the ability for those robots to know what they are doing and to cooperate with one another. And so there are certainly kinds of activities that one might expect that they could do on their own without much human interference.

But what happens when a robot comes upon a person? Is that robot allowed to make judgments about that person? Is it allowed to make judgments about the actions of that person? And particularly, if that robot is armed either with less-lethal or less-than-lethal technology or lethal technology, can we imagine a robot being able to make an autonomous decision to engage a target?

That, it seems to me is, again, an area where people begin to get very uncomfortable and where there is probably a necessity for a man in the loop and a man being able to continue to make those sort of go, no-go decisions.

One of the cultural or perceptional issues with robots out there – and you see this often in the popular press – is that robots on the battlefield are going to make it easier to use force, and

they're going to somehow make it simpler to use force, and that our natural concern about putting people in harm's way will be reduced, and therefore we're more willing to tear through the village, as it were, and not worry.

I would suggest to you that in fact the exact opposite is the case. I think, obviously, the decision to get into a conflict will always continue to be a difficult one. But once there, we find ourselves today in a situation where we're often putting 18, 19, 20-year-olds who are armed in a position where they have to make judgments, sometimes in a split-second situation, about whether or not an action by an individual, likely not an individual in uniform, likely today an individual who blends into the civilian background, whether or not furtive movements and the like are, in fact, threatening or not.

The concept of operations, the rules of engagement we use generally give that 18 or 19-year-old a pretty wide latitude in terms of judgment. If they feel threatened, they are threatened. And if they feel threatened, they can act accordingly.

One of the advantages, I think, of robots in this situation is it gives that same 18 and 19-year-old the ability to be dispassionate about things that are happening around him to some degree, assuming he remains in a protected environment.

And therefore we could imagine a situation where a robot with a fairly wide range of capabilities – the ability to communicate, the ability to deploy sensors and less-lethal or less-than-lethal capabilities and even the ability upon command to engage with lethal force – would not have to make anywhere near the kind of split-second judgmental decisions that an 18 or 19-year-old would have to.

So it seems to me that there are sound arguments on the other side that in fact there isn't really a likelihood that these kinds of robots are going to make force more likely to be used. Indeed, particularly in the kinds of complex counterinsurgency, counterterrorist environments that we think we are increasingly going to operate in, it might provide more of an incentive to stand down.

I think another inhibition in this is the perceptional one of, how will robotics be viewed in the environments in which they are used? Can a robot, in effect, be used in operations, in counterinsurgency operations?

And I remember the scene from one of the "Predator" movies – or not "Predator" movies, the "Terminator" movies – where Arnold Schwarzenegger was the good Terminator in that one, right, and he develops this relationship with the boy. And I remember the person sitting next to me in the movie theater said, oh, isn't that cute, a boy and this Terminator

Are robots going to be able to interact in a counterinsurgency environment, be accepted in a counterinsurgency environment? To what degree will there be cultural perceptions if a robot, particularly an armed robot, is involved in those kinds of activities? And I think this will really come down to how the military thinks about concepts of operations and how they incorporate that technology into the kinds of things that they're doing.

A last point is sort of the perception of these back home will shape to some degree how our military uses them. There will come a day, as there was with UAVs, where a ground robot system will kill another human being intentionally. And I think that will be a news event. It will be something – even if, in fact, which I suspect will be the case, that the actual trigger-puller in that case was a soldier who made a decision to do so.

We've had automatic systems before, of course, to protect fire bases and the like, but this, I think, will be a different circumstance. And how people perceive it back here, how it is messaged back here will be, I think, not determinative but it'll have an impact on the military's willingness to go forward with these things.

Last point, having to do with the military's perception of the use of robotics: As I said, I think they're firmly entrenched in the Air Force and in the air environment. I think UUVs, the challenges – and USVs – the challenge are less, although there will be complications there.

I think ground vehicles have less of a permanence. They're being used in fairly niche capabilities, as I mentioned – EOD teams and the like. But they really have not broken into either – in big ways yet, the logistics area or the combat area, which is the two branches I think where they have potentially – particularly the logistics area – a lot to offer.

How will our Army, Marine Corps principally view these systems as operations wane in Afghanistan and Iraq over the months and years? Will they be incorporated into our doctrine, into our concepts of operations? Will the lessons that we've learned from using robots on the battlefield over the last four or five years, like a lot of lessons learned, get compiled somewhere in a document and then are largely forgotten by the military? And will we sort of fall back on the kinds of traditional things that we're doing to do, that we typically do, and the ways we traditionally do things?

I sort of see a potential a little bit for a "bathtub" period here where the interest in robotics will stay in the R&D area but its interest particularly in the ground forces going forward may wane and stay largely in the R&D phase.

I think we need an effort to try to capture what we've learned about robotics so far in the battlefield. I think we need an effort to begin to develop doctrine. And that means getting the kinds of things that Tony's former organization and the other R&D outfits that support the Department of Defense and the industry – getting those into the hands of the warfighter so that they can figure out new and novel ways to use this tool and to control it and to develop the regulations and policies and procedures that will be necessary for their acceptance not only within the military but within the public at large.

So with that, I think that may be a decent intro to Jay's comments.

REAR ADM. COHEN: Well, thank you so much. I'm a man of few words, so Kim, how much time do I have?

MR. WINCUP: Well, 15 minutes would be just great.

REAR ADM. COHEN: I won't use all of it. I'm just going to stand so I can see everybody and I like the idea of protection – (inaudible, off mike).

I'm honored to be here and before I start, I just would like to say, in a town like Washington which is getting evermore partisan, Dr. Hamre and CSIS under his leadership is truly a voice of reason.

If those of you who were there last night with Secretary Flournoy and the fireside-chat interview, she saw the attempts to do that. I went home and I told Nancy, I said, you know, it's like David Frost meets Charlie Rose. (Laughter.) And so, thank you so much for what you do and your leadership and of course for sponsoring this. And I was honored when Kim contacted me to be with such an august group.

Is America ready for robots on the battlefield? And my sub-portion of that was current programmatic and resource activities and implications evident in DOD. And boy, this is the wild, Wild West. This is a work in progress.

I will work very hard not to repeat almost all the things that I agree with from the two previous speakers, but I will tell you, is America ready for robots on the battlefield, the answer is a resounding yes.

And that's whether you're looking through your rearview mirror or you're looking through the windshield. The question is what battlefield? We have a variety of battlefields and both previous speakers talked about that. You have air, you have land, you have sea, you have surface of the ocean, you have subsurface, and now, ladies and gentlemen, you have the ocean floor.

And today, as we sit here, America is being attacked. The Gulf Coast, the beaches are turning black and the United States Navy is, in my words, impotent to stop the spill. Yet, the commercial industry lives and dies with the thousands of offshore wells that they have using robotics.

How could they be so successful and we're not invested whatsoever? These are big disconnects. Tony alluded to this. We are autonomous in space. And I think space is an excellent model. Now, I'm not sure we can afford all of the quality control and duplicity and backups that we need – duplications, excuse me, that we need; maybe duplicity. (Laughter.)

But I thought I'd start out with sort of two little sea stories that I like. When Adm. Rickover was asked why we stopped naming submarines after fish, his answer was very simple. He said, fish don't vote. (Laughter.) Fish don't vote.

So Kim wanted me to look at the programmatics, where we're going in the DOD budget, what is the bid-up, et cetera, who are the buyers. And oh, by the way, my favorite robot movie is "Wall-E". (Laughter.)

MR. WINCUP: There you go.

REAR ADM. COHEN: I think Wall-E is primo. He's looking for Eva and he has a mission. He has unlimited energy and it ends well. (Laughter.) I'm not sure we're there yet on robotics.

So fish don't vote. Now, if Tony and I were standing here naked – (laughter) – or through one of those whole-body scans, you would see all the scars that we have pushing solutions to the operators. And I'll talk a little bit at the end – Paul, thank you so much for being here and your help. Paul Gido from ONR, with the Gladiator and with the Marines and I'll address some of the issues and tactics, techniques and procedures in killing machines on the battlefield.

But the facts of life are, ladies and gentlemen, until robots salute, until they sit selection boards where officers and enlisted are reviewed and promoted, as long as they are viewed as a threat to the machismo of the military, they will have a very secondary role despite the cost in human blood on the battlefield.

And each service has a different ethos. And I'm reminded of the three D's. The Hill looks at the three services. The Army is dumb. I say dumb like a fox. They say the Air Force is devious. I think that's right. (Laughter.) And they say the Navy is defiant. They also have that right. (Laughter.)

So who is invested in robots? Well, the point man in that squad today, ladies and gentlemen – about 52 percent of all of our casualties occur on first encounter, first encounter. That point man, not a very popular position, really wants that robot. He wants that wingman. He wants that to be the first encounter. So this is a very big cultural issue and there are studies ongoing. There's a DSP that's just been formed for this. I think the whole commentary here is very, very timely.

The next area – and it's been alluded to a little bit. This is about 10 years ago – I'm not going to tell you the members' names, but Northrop Grumman went ahead and displayed the X-47, which is now coming to fruition. It was on the Hill. There was a demonstration; several female congressmen came to look at it. I was there in uniform. They knew me and they looked at it and it said unmanned. Now this is post-Tailhook. And they said, oh Captain, you know, the Navy still doesn't get it.

This is the "defiant." In the late '90s, the Air Force had decided that unmanned was the inappropriate name and they went to uninhabited. Uninhabited. I don't know what an uninhabited vehicle is, but there it is. And they said, why don't you get it? And I said, well ma'am, think about what you're saying. It's unmanned, no-man. Oh, they loved that. That was a wonderful interaction. (Laughter.)

The facts of life are, it is not no-man. We have addressed that. Today, each service views it differently. Let's keep with just aviation: In the Air Force, my understanding is you

have to be a rated pilot. They advertise this on TV in their recruitment. And you get flight hours and flight pay for sitting at Peterson Air Force Base controlling the Predator. In the other services, we don't have those requirements. A sergeant, a private can control it.

For the Navy, which is about to embrace the UCAVN, unmanned combat air vehicle Navy, you have to buy your way onto the flight deck. The only way you buy your way onto that invaluable four-and-a-half acres is to show your value added. It is the dull, the dirty, the dangerous. Not air-to-air combat. I love Tony's comment on refueling because at the end of the day, those are the kinds of roles that will be very quickly adopted.

So what do we need to make robotics a credible sustained force on the battlefield because we're spending $5 billion. Coming back to Kim's assignment to me, in the coming year, Congress will add to that, I'm sure. But it's nearly all high-end stuff. It's Predators, it's Global Hawks, et cetera.

And it's very difficult to find these line items. If you go through the books – Dr. Hamre knows this very well; he's served comptroller; he knows where every dollar is hidden, as hard as we tried to hide it – you will not find – just do the search on the Defense budget for autonomous, unmanned, et cetera. You will be amazed at the dearth of answers you get, which tells you, in the Army, we have unions, we have infantry, we have armor. In the Navy, we have air-surface sub. You're not going to find these in those lines.

So who is supporting it? Who are the advocates? I would tell you – and we've addressed this – intelligent autonomy is critically important and it is those together. It includes sensors, it includes communications, it includes programming and it includes self-learning. And that has been addressed in part.

The next area is persistence. This is a really big issue. This has to do with energy. And we can keep defaulting the batteries. We're now moving into fuel cells. But I've got to tell you, until it can do that 50-mile march along with the squad – and Tony did a lot of this, his little mule, Donkey, you know, that they did that. They got it. And there's solar and all these other things. We're really on the cusp of a lot of these.

It has to be affordable. If at the end of the day, the cost to recruit, train, deploy and pay the death benefits – and I sound very cruel here – of a soldier is less than a robot, and politically we can sustain the casualty, there's no incentive for the robot. If the soldier is there to protect the robot because it's such a high-end investment, we've got it just backwards.

Now, I'm not going to define what affordable is. You get it. And it needs to be disposable. We want the human to not be disposable. We want to exchange the robot for that. Now if you haven't figured I feel pretty strongly about this.

So until we get a constituency absent the R&D community, until the warfighters – and they are demanding it and we couldn't give them stuff fast enough, but I'm not sure it's exactly what they wanted. Lt. Gen. Lynch, and Kim shared this with me last fall; said, hey, he said, my needs in the field in combat are route clearance, persistent stare.

We're using soldiers to look at where IEDs are being planted. We're putting them in harm's way. My God, we can certainly use robots there. Convoy following: We tried to use Silver Fox. We tried to use so many low-end to accompany the convoy; fly ahead of it, behind it, and have the soldier riding shotgun being able to monitor what was happening and look for change-detection, et cetera. I've got to tell you, it wasn't until very late in the conflict, and to Gen. Petraeus' credit, was it incorporated. So the convoy following and then robotic wingman. And Mr. Crouch has very, very well addressed that.

So the missions are out there. Today, as we look at some of the successful programs, in my opinion, certainly on the air side, we are the most advanced. And different models, whether it's on the low end, the Raven, or it's the high end, Global Hawk and Predator – and I want to come back to the culture and I want to come back to the manning.

Do you think that there's anyone in the P-8 community who would trade a P-8 pilot's seat or command of a P-8 squadron for one additional Global Hawk? You find him, he's going to be run out of the Navy, or her, on a rail. That's the reality. So what are the complementary roles? Getting the spot on the deck: dull, dirty and dangerous.

So I'm a big fan of Joe Dyer and iRobot. I have no stock in them; I'm not on their board, et cetera. They're a very innovative group. I brought a picture with me. They said no pictures. This is not an iRobot. This is actually a Chinese rip-off of a Roomba that they've added a WiFi camera, so when you're away from your home and it's vacuuming autonomously, you can see what's happening. And Joe Dyer was very threatened by this.

But Joe shared with me when I was preparing for this, that iRobot has sold 3 million Roombas. My 90-year-old mother-in-law wants a Roomba for Christmas. Okay, she gets it. And they've only sold 3,000 robots – very effective. We talked about it. EOD, other purposes in Iraq.

In Joe's words, one of the very positive things that has come out of future combat system – and I know that's in flux, and I'll end with this – is the PackBot, which is about 30 pounds, et cetera. The soldiers who have been using it, the feedback is, this is the current soldier's Swiss Army knife. It is the right size. It would be nice if it were lighter. It's the right endurance. It has a nice flexibility of sensors, weapons, et cetera.

So Paul Gido and I, probably about six years ago, built and deployed two Gladiators. These, if you're not familiar with them – they never became a program of record – were small. I think they were six-wheeled. It was about waist-high. And they were armed. I don't know if we put a 50 caliber on. And basically, the Marine could control it from behind the buildings, and it had full view and it had full range, et cetera. And it didn't get used. And the reason was the Marine Corps, who's very innovative, couldn't get to the point where they had resolved the tactics, techniques and procedures, the blue-on-blue and the rules of war in terms of using this.

So there are solutions. They've got to be culturally acceptable both to the user, to the population, the world we live in. I would just say, as we go forward – and the solutions are in this room. You represent companies and organizations that are going to make the difference.

This is the wild, Wild West. The future is unlimited. We are going to go in this direction. The Congress has mandated we go in this direction. Listen to the customer, satisfy the customer and everything else will follow. Thank you.

MR. WINCUP: Okay, well Jay, you not only had a great entrance but you kind of finished up our dialogue in a great way, as did all of our panelists.

Now, we need your help to give us some thoughts and add to this dialogue. This is a relatively small room and there's going to be a tendency to kind of want to talk without a microphone, but we have people online. So please, there will be people with microphones and use them before you ask your question.

Who would like to proceed? Okay, Mike?

Q: Thank you. Mike Wheeler, Institute for Defense Analysis. J.D., I'd like to pose the question to you. The battlefield is the Situation Room as well as the physical battlefield we're talking about. The battlefield is the E-ring of the Pentagon. I'm envisioning a future in which the system that Tony Tether talked about is a reality.

The computer is issued to every five-year-old. It learns the 5-year-old. It anticipates the 5-year-old. And 50 or 60 years later, that 5-year-old is now the president of the United States or national security advisory or chairman of the Joint Chiefs or a combatant commander, what have you. The data that's in that computer would be absolutely precious to the enemy, absolutely precious, if the computer is able to do all of the kinds of things we're talking about.

And so in thinking my way forward into that future, the question is, what do we do about that right now? Do we say basically if you want to become a person in that sort of a position, no, you can't go that route? We used somewhat similar kinds of things in the historical past. World War II, if you were a general officer, you were not supposed to be keeping a personal diary because that could fall into the enemy's hands and so forth.

And so in the absence of being able to say that I know that I can absolutely secure the information on that particular personal whatever-we-call-it in such a fashion that it's not available to my adversary in the future, how do I strategically think my way forward into the future?

MR. CROUCH: I would suggest that this problem exists whether or not Tony's vision sees the kind of reality that he described or not. I think about the kinds of information just through social networking systems that we currently have on the Internet – and she's going to be really embarrassed by this, but my daughter is sitting here in the audience and we've had discussions about well, what do you put on your Facebook account? If you want to work for the

government, for example, or you want to be in a position of trust, what kinds of information do you have out there?

And so I think we're faced with this. We live in the age of surveillance, to some degree. We are surveilled by computers. We are surveilled by webcams. We're surveilled by lots of things. The notion of privacy, while it's something that is very important and that we all hold as kind of a point of principle, has eroded as a result of the technology around us.

I think it's going to be a combination of things. I think we're going to have to think our way through the protocols of the kinds of information that computers learn and store about us. We're going to have to be careful about that. Individual are going to have to be, companies are going to have to be, government obviously is going to have to be.

I think we're going to have to develop much more robust – both physical and software – anti-tamper technologies that raise to the next level our level of security, understanding that it will never be perfect and it will always be a cat-and-mouse game.

So over time, I think people are going to have to sort of interact with these devices. It's not going to be a situation – it may be in the future – but where you hand somebody, their 5-year-old their computer and they learn everything that you have. Unfortunately, in some ways it maybe a little bit more insidious than that; that a lot of the information you have about yourself is already on your laptop, it's already on your mobile device and, for many of us, it's already in the cloud. And so it's accessible for people who have the technical expertise to access it.

So I think there are a lot of challenges in that. I think there will be – in some ways, it's not any different than the kinds of ethical issues that we face in biomedical engineering and in some of the other sciences – in nanotechnology and some of the sciences that are pushing out there. How networked do we want to be and how accessible do we want that information about us to be? And how much do we want these robots, in effect, to know about us and to be able to deal with?

But I guess I face that world pretty optimistically. I think that there's more benefit out of it in the long run than probably there will be lost. And I think we as human beings will come up – we will stay in control in the situation and come up with very smart ways to mitigate some of the potential downsides.

I don't know if any of the others have a view on that.

MR. WINCUP: Sir?

Q: Adm. Cohen, I really appreciate your comments about the cultural aspect of the services involved in the decision-making. I recently attended a conference on what now is officially called UASs, unmanned aerial systems. That's the right terminology. And there was a presentation by an Air Force general that talked about RPAs, remotely piloted aircraft. So I don't think he gets it but he's in a position of power and authority.

But my question to you is, since the Navy is pushing UCAS and you look at UCAS and the kind of missions it can accomplish, it kind of makes an F-35 kind of redundant for many of its missions. And as F-35 has escalated in cost from $35 million to $138 million now – I think that's the last price – what role do you think cost is going to have if you want to accomplish the mission on the one hand and to Norm Augustine's advice, or rule, that you can have one aircraft by the end of the day that's going to be shared by everybody because of escalating cost?

REAR ADM. COHEN: Well, I'm sorry that Norm isn't here because the question we would ask him – would that one aircraft be manned or unmanned? Now, listen, cost is everything until you have to win the war. And then it's nothing. So we're in a state of flux here; we are fighting two ground wars right now. We don't know what the world will look like after that and I'm certainly not clairvoyant.

Tony and I did the X-45 and the X-47. I did the X-47 to embarrass Tony because I thought the Boeing X-45 at the time was an ugly duckling – and I'm a very big fan.

So the Air Force, when it made a pact with the devil, otherwise known as the Navy, and gave up the EF-111s and allowed the Navy to fly the EA-6Bs to provide the SEAD, the suppression, the Air Force did that. It was like Philadelphia agreeing to Washington being the capital because it was a swamp and it would never happen.

The Air Force was building F-22s, B-2s. They had F-17s, Stealth, and then Bosnia happened. F-17 got shut down; they realized that they needed SEAD. So they envisioned UCAS flying as the wingman ahead of doing the SEAD but then everything else being manned.

The Navy, on the other hand, for rotational persistence was okay risking a pilot for tactical reconnaissance, bomb-damage assessment, BDA. They'd prefer not to but they really wanted something to be an E-2 Hawkeye replacement because the reason we end up with two carriers deployed is not the cycle of the ops. It's to ensure that you always have an E-2 up to give the battle group the AWAC's low-end surveillance that we need.

And so Tony and I were in a conundrum. How do you satisfy these two fundamentally different missions? It wasn't about landing on an airfield or a carrier. JSF gets us there. And so we thought a lot about it. Tony ended up making this – and I think it was the right thing. He didn't make the decision but DOD said, well let's make it – turn it over to DARPA and make it a joint program. That lasted about, what, two years, Tony? And the divergence of missions was so great that we're back to where we need to be now.

So JSF is a reality. It's a must for the Air Force, unless they're going to restart the F-16 line. I don't think there's any desire to do that. It is a must for the Marine Corps. The V-stall JSF is critical because where they're going with close-air support, F-18s won't get them where they want to go with amphibious battle groups or expeditionary groups.

For the Navy – and Dr. Hamre is very well aware of this – we built in a wedge for F-18s because Jay Johnson, the CNO, said what if JSF doesn't show up on time or we can't afford it? So Navy is actually sort of in a sweet spot here.

I think the bigger issue is not UCAS versus JSF. It's, I think – and I'm sure they're here – Northrop Grumman is on the verge of pricing themselves out of the BAMS mission because of the growth we've seen and the cost – that's just citizen Cohen speaking; I'm no fan of Northrop Grumman – whereas Gen. Atomics has tended to try and suppress or keep low the Predator and not put all the bells and whistles on it.

So your question is a very good question. I've probably given you more information than you wanted. But until UCAS salutes, commands aircraft carriers and sits flag promotion boards, we don't have to worry. It will be in a subordinate role.

MR. WINCUP: Let me just, if I might, follow up on that because both you and Tony have – as you comment about your scars – you also had some successes, I'm sure. So give us some lessons learned on how you have been successful in pushing through the cultures that didn't want it that might be applicable to this arena.

MR. TETHER: Do you have any?

REAR ADM. COHEN: Well, only ones that I inherited from you, sir.

MR. TETHER: (Chuckles.) Actually, I think one of the greater successes, if you define success as it's in use today in the theater, is a little unmanned vehicle called a Wasp – about this big – which we were developing with AeroVironment. And it was to have a little UAV that could fly for over an hour.

And it was really a technology program in the beginning. One of the fellows at DARPA said, look, the problem we have is that the batteries and wings are parasitic. And we build this wing and then we stick a battery on it and it doesn't fly for more than 10 minutes. Why can't we make the wing be a battery or take a battery and make it into a wing? And that was sort of the start of Wasp.

We did that and showed that if you did that, you could have a little UAV that could fly for a couple of hours. Incredible. And then we put cameras on it and things like that and it cut a couple things down to an hour but it still was really a technology demonstrated that you could do something like this.

And until Gen. Mattis came to visit us – he came back from Fallujah and I would always bring him over to people to kind of tell us what happened. And we're in a meeting with him and I asked him a question. I said, look, when you were in Fallujah, what is the one thing that you really wanted to have? And he said, you know what I really want to have, I wanted to have an ISR capability that didn't tell me what was 10 miles away. I just wanted to know what was around the next corner. That's really what I wanted.

I said, well, you know we're making these little Wasps. I'll tell you what I'll do. I'll give you 200 of them. But you've got to promise that you're going to take them and go try them

out. Well, we didn't give him 200. We gave him 100, I think is what he ended up with. But the Marines took them out and they started using them.

Now, I found that – and every time I tried the transition technology, the facts were I ended up being totally wrong in the way the technology was used from what I thought it was going to be used. The way we had this, it would be the backpack. And the Marines had it in Iraq and they created what they call a Wasp's nest where they have one person who flies them and then they get downrange and hand it from iPod to iPod basically and then they bring them back up that way. We never thought that they would do that.

But these are in use today. In fact, Marines won't go out on patrol without a guardian angel now over their heads because now they have this thing flying over their head. You can't hear it. But they now know what's around them. They now know what's on that second block before they get there. And that's probably one of the greatest successes we had.

But it was really because we had a war on. We had a guy like Mattis and the serendipitous meeting where the technology development had gotten to the point where I could literally promise him 100 or 200 and get them to him on time.

There are other examples but I think that's probably really the best example of a true success for something that's being used today, saving lives, killing bad guys, saving people's lives – because they had one incident where they were getting ready to literally have a missile come out of the air. There were these people, trunks open, and they were doing something with these trunks and everybody thought they were changing arms and all that.

The Wasp went over. Remember, you can't see it so they don't know it's there. Great camera on it. And they realized that this was nothing more than a marketplace and that people were just trading food. And those people didn't realize how close they came to being blown away except that little Wasp saved all their lives.

REAR ADM. COHEN: I'll give a very quick one, and Tony and I worked very hard for six years not to duplicate each other; to hand off and be complimentary, et cetera. But at the end of the day – and there are many, many examples, but you may or may not be familiar with these underwater sea gliders.

Now, these are gliders with small wings that use the thermoclines in the ocean to power themselves. They glide down, then they get positively buoyant, they drive to the surface and then they glide at a very long glide slope.

When they get to the surface, of course, they give a burst transmission. And so what we use them for is not just oceanographic research. We use them for what we call persistent littoral undersea surveillance.

Now, when my team – just so you know how things work in Washington, when my team came to me and said, we've got this program ,we think it will work in as little as 15 meters – and

oh, by the way, they do, and they work in the very deep also. They said it's persistent undersea surveillance. Admiral, we'd like your support.

I said, I can't give you my support. They said, what are you talking about? Vern Clark has said the littorals are critically important. What don't you get? Paul may have been in the room. And I said, I cannot support a program whose acronym is PUS. I cannot sell PUS to the Hill. (Laughter.) I said, but if you will agree with me that we can call it persistent littoral undersea surveillance, how can the Hill vote against PLUS? (Laughter.)

MR. CROUCH: Tony's example, I think, underscores something that I think is a lessons learned out of this, which is the pull from the warfighter during a war and the ability through rapid equipping force and the like to get technologies out of the laboratory or out of the breadboard stage and onto the battlefield is very significant.

But it isn't going to last. And, to me, the three most terrifying words in this field are "program of record," all right, because once something becomes a program of record, it will get locked in. And the innovation, the contact with the warfighter, the back and forth of, could you make it do this, or, gee, you didn't think about using it that way but I thought about using it this way.

So some way, somehow we need to inculcate that kind of spiral development I think into these kinds of systems through tech villages or whatever approaches that can be developed so that we get this stuff early into the hands of warfighters so they can develop con ops, they can develop – and they can give feedback to the technology people on what the next spin ought to look like.

REAR ADM. COHEN: J.D., I couldn't agree with you more. The only commander's intent I got from Vern Clark, the CNO, was he said, Jay, I want you to embarrass programs of record. That was his direct order to me.

What he was saying was in a program of record, if you have spiral development where you go, in a sense, from one megapixel to three megapixel to 10 megapixel – and that's not an unreasonable technology roadmap. He said, I want you in S&T to be working on the 100 megapixel sensor. If it fails, it failed in S&T.

The program of record still went from one to three to 10. We still got better. But if you are successful – and he said, when you're shooting for 100 megapixels in S&T in America and in the world and innovation, you're likely to get a gigapixel, which is very often the truth – he said, you de-risk it and then we go from one to three, and then you introduce it to the program manager and we go to 100 or more. He said, that's transformational. We have to take the risk out of acquisition. We've got to do more in S&T.

And it's not about the valley of death. We know how to get across the valley of death. You bring the customer to the table as part of the development process. Tony and I and industry do it all a little bit differently, but we all understand that today. So J.D., I think you are right on the mark.

Q: Hi, Jeff Abramson with the Arms Control Association and I really came for this panel because I knew nothing about the topic. So it's very informative. I guess my questions are around thinking outside of America at this point. This panel is on, is America ready, but a factual question – are other countries doing this and sort of to what extent? And I think you could envision a world where a lot of countries have these things.

J.D., the things you're talking about, well, we need to figure out where the human still needs to make the decision and when the robot can. I think we want other countries to have at least a similar level of concern about when to use force.

So I assume that discussion's probably not happening yet but I guess the question is what's happening internationally? And then, what are some of the international systems that need to be put in place if this moves forward? Or is it just the same existing systems would be fine, or is there something unique about robots?

MR. CROUCH: I think that, generally, to the degree that they're well-understood, the laws of war apply to robots because the robots are in fact instruments of humans. So I don't know that there's a need for sort of a separate international regime.

Similarly, if you imagine things operating in air, there will be air traffic control restrictions that need to be dealt with. On the surface or underwater, there will be the kinds of rules of the road that need to be and have been developed for naval forces and for maritime activities and that sort of thing.

As I pointed out, I do think that there will be a greater challenge with unmanned ground vehicles interacting with humans, and you're maybe even positing the notion of unmanned ground vehicles interacting with unmanned ground vehicles – (chuckles) – in the future which may be the case.

In terms of the international use of these things, a lot of our allies are using these capabilities today, principally in the same areas. I know that U.K. forces, for example, are using small robots in their EOD and route-clearing missions in Afghanistan. There are robots being used in a lot of police environments these days, particularly in SWAT-type situations.

There certainly is a lot of robotic add-on systems that are being used in either explosive ordinance or even things like firefighting and other kinds of dangerous situations, or as Jay said, dull, dirty and dangerous. I expect there will be more. And we will see not only friends but potentially adversaries developing these capabilities. And we may well encounter them on the battlefield.

But again, I think my general answer is – and there may be specific cases that arise at the time but my general answer is – the sort of international legal regimes and norms that govern human behavior that are in place today probably cover most of this set of activities and when those kinds of things develop, it ought to be something that ought to be looked at.

What I guess I would fear is if – because I actually think that these devices have the capacity to reduce the impact on human life in a wartime or even non-wartime environment – is that we would oddly come to the conclusion that we needed to place some sort of restriction on them and therefore have to put that 18-, 19- and 20-year-old in harm's way because somehow that was okay. I think that would probably not be a good outcome in this case.

Q: Paul Gido from ONR. All three of our speakers basically addressed autonomous systems in their own domain. Looking to the future, what do we think about the autonomous systems integrating and coordinating across domains, with a UAS handing off to a UUV or a UGV?

MR. TETHER: In fact, that's really, to a certain extent, done today in the EOD business where the EOD people are using a MAV, a small UAV, which I think was both ONR money and DARPA money. Of course, they use it to fly out of – to go over a suspected IED. And they use it in a strange way – like I say, something we never thought anybody – because it's a fan, so it has a great downwash.

So what they do is they placed it over the IED and blow all the debris away so they can get a good look at it. And then they use that to bring in their ground robot, which it trots along on the road to go over and disarm it. So they are actually being used but in very pedantic ways. It hasn't gotten very sophisticated like you're talking about.

MR. CROUCH: I think there's a great opportunity here. I mean, I resisted the temptation to mention my company, but we actually are developing a common robotic controller that we're doing with the Marine Corps Warfighting Lab which, again, there are a lot of things that a ground robot can see up close that an aerial vehicle can't see. But there are a lot of things that an aerial vehicle can see that the ground robot can't see.

So the user is interested in a solution. He's not interested in thinking about this as a platform. And I think we don't want to fall into the trap of being platform-centric in the robotics area either. So I think to the degree to which we can present him a common operational picture from ground, air, sea, river activities, that's a smart way to do it. And as Tony said, I think there are a lot of people who are working on that and see the vision of that.

The other thing, of course, is networking those things so that they're not only talking back to a controller, but they're talking to themselves and so that they have their own situational awareness and are able to take advantage of their unique location or unique sense and capabilities and feed that into the net.

Q: My question is, do unmanned systems provide an opportunity for increased joint operations? And the example that comes to mind is BAMS and Global Hawk. Basically, the same thing, different sensors on them, but why isn't that just one program to gain some efficiencies?

(Pause.)

REAR ADM. COHEN: Above my pay grade. (Laughter.)

MR. TETHER: Good question. (Laughter.)

REAR ADM. COHEN: Maybe this will be one of the efficiencies that Secretary Gates will find in his search for $10 billion.

MR. TETHER: There are definitely probably – I don't know what they are but I'm sure there are differences between a marinized version of a Global Hawk and the Global Hawk. There probably are differences. Whether it's substantial enough to have a totally separate program, I don't know.

Q: Sir, Chris Banks from the U.S. Navy. Mr. Crouch and Adm. Cohen, you guys both kind of alluded to this, but you talked about the use of robotic systems making a soldier feel less threatened on the battlefield, thereby maybe convincing him that he feels a little safer; he doesn't make an impulsive rash decision or whatnot.

Do you think that the corollary to that or the counter to that could be that that once that Band-Aid is ripped off, that you could essentially increase a level of violence because it essentially becomes too easy to kill because there's not a face to the violence, so to speak?

If you look at the recent history, if you look at the amount of debate that went into the use of Reaper for the first time operationally – at least that what has been widely reported – there was a tremendous amount of debate about the ROE and whether using an unmanned vehicle to kill a terrorist was legal and ethical. Put that a couple of years forward now in Pakistan where we seem to pick off one about every other day or so. If you could just comment on that?

MR. CROUCH: Sure. Well, I think – and that's where I think it really comes down to this question of what kind of decision-making do you allow the robot to take and what kind of decision-making do you still think you need a man in the loop for? So my own view is that where to – a decision on it – the use of lethal force is something that a soldier has to take that decision. And that soldier has to take the responsibility for that decision.

So in a situation where – and obviously the rules of engagement are always unique to a particular battlefield situation – but if it's a situation in a downtown area, the same kinds of restrictions that would operate if a soldier were standing there would operate if there were a robotic robot standing there that was being controlled by a soldier.

In other words, they would have to have some eyes on the target. They would have to be able to make judgments about what the target was doing. They would have to take into account what was around the target, what was behind the target and the like and the consequences to the use of that force would be the same as if there were an 18 or 19-year-old standing there. So the one key difference is that 18 year old or 19-year-old doesn't have to feel threatened themselves. So they can actually allow themselves to be shot at without having to even necessarily fire back.

So I think if you sort of work your way through those situations, you're probably putting – giving that young person more time, a more rational basis on which to make decisions. But at the same time you can't relieve them of the responsibility of those decisions and I think actually that's a pretty good outcome because they're not forced to make things in a split second that they might have to if they were in harm's way directly. But at the same time, they have to be accountable for those decisions they do take. It won't be acceptable to blame the robot.

REAR ADM. COHEN: Well, first, thank you for your service. And it's an excellent question. You talked about basically the level of violence and the gentlemanly aspects of warfighting and it's sort of something we forgot about during the Revolution. We've had this for a while. Sea mines and landmines are indiscriminate. They just are.

They don't happen to be Kinetic bullets or Hellfire missiles, but they're fundamentally the same. So here is a growth area for Kinetic, is as they go forward with these robotic devices, you need a parallel set of robotic JAG officers who can do the robotic court-martials for the violation of rules of engagement that the under program –

MR.CROUCH: We'll pass.

REAR ADM. COHEN: Oh, I'm sorry. I thought it was a good idea.

Q: Hi, Alex Brozdowski, Stimson Center. All of our panelists noted that unmanned vehicles on the battlefield grant to a soldier great capability and they save American lives but cost us dearly in a financial sense, at least with current technology.

So is there a design path or an engineering philosophy that could be pursued to reverse this trend where a robot replacing a soldier or a soldier's job can save us money as they do in, say, private industry instead of costing extra money?

MR. TETHER: Well, yeah, I think in fact a lot of the robots that we made were really for that purpose. If you're driving convoys with a robot, you've obviously taken those people out and now those people can now be used for another function.

I'm not as – J.D. is worried about the future and quite frankly – that we're at war with robotics. I'm not that worried about it because I believe that as these robots get more sophisticated and as the budget pressures come, where the budget pressures are really going to hurt are manpower because that's where most of the money is and one way to reduce manpower but keep your capability is to replace the people with robots.

It's an initial cost but that cost is not recurring. I mean, it's not recurring like a person. So I think that we're very aware. It's really – as in the commercial world, robots are used for productivity increases, which is another way of saying doing more with the same number of people or less people and that's going to be the same in the military, absolutely same in the military.

REAR ADM. COHEN: And if I can compliment Tony, because I think he's got it exactly right. If you have programs of record, if we're trying to take existing trucks and go ahead and automate them, or any number of them in a convoy, that's really a tough grind.

The question you have to ask yourself, we're trying to transport stuff, whether it's to forward operating bases or et cetera, how do you design it from the start to take the man out of that mission.

So I'm a big fan of K-MAX. They keep coming back, God bless them. About every five years they come back with a solution. If you're not familiar with K-MAX, it's a very small helicopter and now they're proposing dual-blade unmanned for forward operating bases to take, I don't know, 500, 1,000 pounds, it's not much.

It's water, it's food, it's ammunition, et cetera, without putting convoys, trucks, et cetera. With an MRAP, I don't know, it's 1,000 to 1 in terms of economic impact from the bad guys on us. An MRAP's 500,000 and less than $500 in spare parts you get an IED, so when you look at the cost, and it's not just about manpower.

Tony addressed that I think very well. The cost to get a gallon of drinking water, a gallon of fuel, a palette of bullets to the pointy end is grotesque.

You start at Long Beach with the tanker. You work your way. It's on the order of $10,000 per gallon. Maybe it's more than that now. So how can – and the risk to manpower and all the other legacy things we have.

This is an area where if you can make the case, as Tony said with robotics, on productivity but equate that to saving lives and more effective use of our resources, including dollars, man, you've got a winner and if you can package that, you're going to do very well.

MR. CROUCH: I agree with what was said. I would just say that one other idea is working autonomy from the ground up and adding – taking as many decisions out of that so that the solider can operate more than one of these things at one time or in fact –

(Cross talk.)

MR. CROUCH: Right, instead of having 10 guys flying a UAV, you've got one guy flying 10 UAVs, right, and that's going to require some cultural and policy work as well as economic and technical work.

But I think there are ways to do that without necessarily trying to create the fully autonomous system which may be out there at some point. So building autonomy from the ground up will help you do that.

MR. WINCUP: Tom, we're out of time, but one quick question.

Q: Thank you. Tony and Jay, you haven't addressed the survivability question and it seems to me that in this next generation of ground combat vehicles we're going to go from a 30-ton Bradley to a 60- or 70-ton ground combat vehicle. Is the survivability cost of putting these vehicles together something that an unmanned robot could do the same kind of lethal mission?

MR. TETHER: Well, Tom, you know, as I think you remember, back in the middle '90s when the Army had these heavy tanks and they were no longer being invited by the COCOMs to come to the war because of the cost, the logistics cost of bringing them there, that really is what started FCS where the idea was to take that big tank, break it up into pieces and so it was the sum of the pieces that could each be transported easily and some of those pieces were unmanned ground vehicles and they were all them going to be connected by a network.

But I think now we're going back to a situation that I think depending on once we're there, with MRAPs that weigh 60,000 pounds and then we find out that nobody wants to bring them because it takes a whole C-17 to bring one of them, we'll be back to sooner or later breaking them up into pieces.

Unmanned ground vehicles will then be used to do the situational awareness part, which is what they were supposed to be for, to give that one vehicle superb situational awareness where the enemy was not allowed to get close enough to hurt them without being taken care of by themselves.

REAR ADM. COHEN: Yeah, I think Tony's got this right. At the end of the day, warfare is about effects, what effect are you trying to accomplish, and I've always gone where you save the person, you sacrifice the platform and in naval aviation, we do that, I mean absolutely.

We build in countermeasures. We build in self-defense, et cetera. But in the end we have an ejection seat and then we spend several billion dollars a year on combat search and rescue so that pilot knows they have a high probability of being rescued.

This is the whole mentality. It's gotten a little way from it of littoral combat ship, the vision for littoral combat ship at $220 million and that was the contract cost, was to have a swarm of these lightly manned operating in a really bad area called the littorals.

And at the end of the day if one was lost the crew would bail out, be picked up, this is the PT boat mentality and it's a good mentality, same mentality we use in ground and they then would continue to fight on and these were cheap enough that we could put them at risk.

Somehow we have gotten away from that where the platform becomes so expensive with the self-armament, et cetera.

So I think you've got to look at a continuum of capabilities and I would tell you in terms of disruptive technology, I sincerely believe, based on the discussions you've heard here, that robotics is the next step change in warfighting. We may not see it during this conflict. But it is the equivalent of change that net centricity has been.

MR. WINCUP: Well, that seems to me to be a perfectly good way to end this discussion. I believe we were signaled that we were done before. Then they sent John Hamre in to really kind of put the nail in the coffin. So folks, let me thank all of our panelists for a terrific discussion and all of you who joined in. Thank you again for being with us.

MR. TETHER: Thank you.

(END)