“Achieving Moving Target Engagement at Scale”

Maj. Gen. R. Scott Jobe:

Good afternoon, ladies and gentlemen. Welcome to our panel of distinguished panel members up here on achieving engagement of moving targets at scale.

I'm Major General Scott Jobe, Air Combat Command, A589's plans, programs, and requirements. And sitting to my left, our distinguished members are Mr. Dave Richards, Senior Director of Precision Weapon Systems, Ground Combat and Precision Targeting Solutions, Elbit America. We also have sitting to his left, Mr. Michael Hall, Director of Domain Awareness, Raytheon Technologies. And to his left last, but certainly not least, Mr. Mike Shortsleeve, who is the General Atomics Vice President of Strategic Development.

Welcome to the panel.

So what we hope to have is a robust dialogue this afternoon on Achieving Engagement and Moving Targets at Scale. For the flow, I'm going to basically go to each of the panel members for quickly a two to three minute introduction for opening comments. Give us a view of your world and what you see is happening in this mission space. And then I'm going to go to each of the panel members, present some targeted questions. We'll go each on our own merits. Other panel members can chime in as they see fit. And then we'll try to go around the room in our 40-minute session that we have here. We'll save a few minutes at the end for any questions or comments from the audience. And so we'll kick off without further ado.

So Mr. Hall, let's go opening remarks. How about you go first?

Michael Hall:

Yes sir, thanks and thanks for the opportunity to be here and comment. I'm going to bookend it. Again, Mr. Ferraro sends his regrets. If you saw the picture, our hairstyles might be different, but we think about the problem the same. So we need to track and engage moving targets. You have to do it at scale. That means you need to do it repeatedly, the same mission, have mission depth and in a challenging environment. So all weather far away to stay safe and engage the target. So let's go to the front of the kill chain or the end of the kill chain where you take the weapons, you think weapons first. I think a storm breaker, it's a smart weapon, could engage moving targets in all weather up to 45 miles away. You get that distance. It's currently fielded on the F15E.

We have a lot of those. You start to get your depth. We're testing it on the F18 and the F35. On the F35, you can carry eight storm breakers. So again, engaging at scale, you have the numbers to do that. It's a net enabled weapon. So hope I get a chance to talk more about that. It's really a game-changing kind of capability. So that's the end. Let's go upstream. Where do targets come from? Where do we get the targets in this environment? And I want to talk about ground-based radar. There's a ground-based radar piece of this, specifically a next generation over the horizon radar.

Nobody's made one of these yet. It'll have extra sensitivity, but the tech is there, put it all together. And that investment, that means you're going to be able to track low-flying cruise missiles. Small targets moving fast. So track the weapons along with the platforms. Again, tracking, moving and engaging moving targets at scale. You want to know everything that's there. So it puts the whole picture together and you get really robust battle space awareness. So that's the end, maybe part of the beginning.

It's all about, there's a lot of stuff in between. Integrating everything to work in one motion, that's important. And also industry wise, we're cognizant that we have to lower cost, kill risk, improve the schedule, get these weapons available. How do you do that? Digital transformation, open architectures,

mission engineering, so you can keep the capability in mind and have that as a variable. And again, being a collaborative partner to put the whole thing together to make a robust capability. So beginning and end, that's how we see the problem.

Maj. Gen. R. Scott Jobe:

Thanks. Mr. Shortsleeve.

Mike Shortsleeve:

Thank you. So much of my comments today are going to focus a little more big picture on the entire problem set. So what does it actually mean moving target engagement? Well, for the most part, the Air Force has been doing this for quite some time. You can go back several years, even World War II, they were out there trying to track different targets, whether they were in the maritime environment, the land environment, or in the air. The thing that I find really interesting about this particular operational imperative is what's at the end of that moving target engagement, the at scale, much larger is what the expectation is. So when I look at this problem set, I'm not just solely looking at the specific platform or weapon or any of that, but it all has to come together as a capability.

And in essence, I see four big bucket areas because ultimately I think the goal is you want to be able to outsee, outrange and outshoot the adversary before they can even get a chance to get at you. So the four big areas that I look at is you got to have the ability to actually sense and strike. You got to have the right capabilities that are able to do this. There's no one monolithic, exquisite type platform that's going to do this. It has to be done in multiple fashion with a variety of different platforms and capabilities in all domains to include cyber and space. So getting after this problem set is much more than just trying to target one individual aircraft. We're talking about characterizing a battle space and having to target, which is the second point I would put in is 100s to 1,000s of target sets.

Having had experience being in the AOC at the beginning of OIF, there was a target list that was well approaching that 1,000 mark. And I got to tell you, many of us were like, "Wow, we'll see if we can actually accomplish this." And then once things started happening, those fixed targets that we were going to go after just change the dynamic targeting environment. So this at scale isn't just specifically for certain target sets where they're at, but is being able to adapt as quickly as you can to the way the battle space is changing. The third area that I would focus on obviously is do you have enough of this to do this? The capacity aspect of this? How do you get at the ability to get after all these targets with the numbers of weapons that are going to be required or the numbers of sensing capability or all of that has to be looked at.

And then finally, what I think is probably the most important part of getting after the target set when you talk about moving target engagement. And that is the one thing that is common across the board for sensors, the BMC two, the weapons, the shooters, all the enabling things for the kill chain. And that's connectivity. If you aren't able to connect everybody together to be able to pass that information, you're not going to be able to see where the targets are at or be able to react in a quick fashion. So those are some of the things that I would highlight and I'll talk a little more about those later on.

Maj. Gen. R. Scott Jobe:

Thanks so much. Mr. Richards.

Dave Richards:

Again, thanks for having us. I think both Mike and Mike said a lot of the things that I think are on our minds as well in terms of target engagement at scale. Up in America comes at this problem from over a

decade of building tens of 1,000s of seekers, mostly for primes, our prime partners for the US Air Force, and we know a thing or two about building things at scale and... Excuse me. And being able to do the manufacturing that's required to do that. I think the mission challenges that really emerge and the things that we're tracking as part of this problem set is really that proliferation of the target list.

There's, in the modeling that we've done for other theaters but that we're seeing in real life in Ukraine, the multi-domain aspect, the enhanced SU 4 ISR, the civilian aspect of target at least finding if not fixing, is really going to be driving that volume pretty significantly. And so when we talk about the cost of being able to engage all of those targets, sometimes we talk about bending the cost curve, the reality is it's going to need to be a break in the cost curve. It's going to need to be a significant sea change on all the components. And coming from the secret side, we're really focused on that aspect. So excited to participate in the discussion today and look forward to the questions.

Maj. Gen. R. Scott Jobe:

Thanks for the remarks. All right. So Mr. Hall, we'll start with you. You'd mentioned ground-based over the horizon radars in your opening remarks. So could you touch on how ground-based radars have evolved to tract and detect advanced threats? Specifically maybe things like hyper sonics that threaten our forces as are in the field?

Michael Hall:

Yes, sir. So traditional line of sight radars look out, they have the curvature of the earth problem that gives your adversary a sanctuary. Obviously you'd like to take that away. So HF radars are a little bit different. They're refracting off the ionosphere, come down straight down, don't give anybody a chance to fly under the radar, but modernization, that technology needed to be modernized. So the investments not just in our company, but different agencies in the government internationally, there's been a lot of investments to get that sensitivity up so that over the horizon radar can be something that can see those small targets and stuff. You mentioned hyper sonics and there's phenomena there that make that sensing. There's advantages we won't talk about here to making that detection with a HF kind of radar and hyper sonics, but the sensitivity is needed for those subsonic cruise missile threats too.

So that next generation, you're going to get the sensitivity, you're going to get the detections, you're going to take away the sanctuary of flying under the radar. And again, I'm going to comment too on not just HF Radar, but there's some latent capability and other ground radars that we have in the inventory. We just had the incident with the new targets floating over America, and you heard on the news that they tweaked some radars and they could make that sensing. So we still have latent capability in our existing radars too, to address OI number four, but a new radar that has some advantages with hyper sonics, broad area, long range, and you really start that kill chain out to take care of the moving target situation.

Maj. Gen. R. Scott Jobe:

Thanks. Mr. Shortsleeve, you mentioned your opening remarks a little bit about air operation Center's, command and control obviously tied into that a targeting cycle, which we're well familiar with how we have done it in the past. Could you talk to our need to disaggregate and distribute capabilities in maybe some new and unique ways, things that are going to really dictate how we engage moving targets at scale and get up to that 1,000 magic number that you quoted at the beginning. It's a very complex task obviously. Could you give us some thoughts on that?

Mike Shortsleeve:

Yes, certainly. So I don't think it's lost on this crowd, and certainly most people agree that potential adversaries in the future have been watching us and have been learning for how we do operations. Having done intelligence for over 30 years, early on in my career, I asked an analyst who had well experienced, actually individual, created the indications and warning system. I said, "What do you look at?" And he goes, "Well, you follow the money. People spend money where is most important for what they're doing?" And so when you look at our potential adversaries, they're spending money in areas that are going to negate the advantages that we've had in the past. And one of those certainly is the ability to be able to execute command and control from a central location. We can talk about distributed ops, distributed command and control. There's a wide variety of different terms that exist out there.

But the reality is I think for this moving target engagement at scale, you have to have a spatially distributed architecture. It has to coincide with the way the environment's going to be. So that may mean that you're going to have individuals who may be in an air operation center or a multi-domain operation center, whatever you want to call it. They could be on a boat, they could be a soldier on the ground, they could be in a wide variety of different locations, and they have to have the ability to be able to tap into those capabilities that exist there. Now at General Atomics obviously were we work heavily into the unmanned aircraft arena, and one of the things that we've looked at specifically to look at this problem set, is how would unmanned aircraft, how could they contribute to this environment in a spatially distributed architecture?

Well, fortunately, technology today has gotten to the point that you can do sort of that airborne early warning or air domain awareness capabilities on single aircraft if you need to. But what we have found is that when you put multiple unmanned aircraft working in conjunction with say, an E7 or an E3, you now have the ability to actually provide even more refined awareness. And I will say getting down to the point where you can see specific targets that perhaps you weren't able to see. You can correlate between different entities and different platforms to actually give you a more refined look at what it is. But I think what it really creates more than anything when we look at all our concepts and we've done modeling and simulation, is that it really creates a dilemma for the adversary because no longer is it about taking out one or two single type platforms to disrupt everything.

This is a matter of taking out multiple platforms. And so if you were to take the airborne layer that I'm talking about with unmanned and let's say the E3 and E7, and now you were to layer on a maritime level and you were able to layer on a space level and you're able to layer on a terrain level, now you've really caused the dilemma for the adversary because what you have is gradual degradation. You're still going to get something. And so I think it's very important that in this, what we anticipate to be a future fight in an environment where we're going to have to distribute everything, that the architecture itself should start with the fact that: one it's all domain, two it's got to be connected, and three you're going to have to have it spatially dispersed across the entire battle space.

Dave Richards:

Could I add to that real quick?

Maj. Gen. R. Scott Jobe:

Please.

Dave Richards:

I couldn't agree more, Mike. And I think that the distributed nature of that decision making is going to be absolutely critical. I do also think in addition to that, there is value also to moving some of that decision making and that distribution down to the munition to munition level. There's always going to

be the threat, I think of some form of denial of service at whatever level, depending on the environment and the situation. And being able to abstract some of that decision making down to munition to munition is a real interesting part of the problem. I think it also poses very significant unique challenges when you have to have munitions that are in flight towards the target communicating quickly and then trying to make a decision. So I think that there's an aspect that shouldn't get lost on there, but I couldn't agree with you more. That distribution aspect of it is going to be critically important in the future.

Maj. Gen. R. Scott Jobe:

Thanks. So Dave, you're on the hot mic. Let's keep you on the hot mic. So we've gone through evolutions throughout the Air Force's history, daylight precision bombing, which was arguably less precise than what we would appreciate today with the northern bomb site. Then you get into Vietnam with the first PAVE Way series of laser-guided bombs, beam riders that were very precise, that enabled us to take out key and critical targets we were unable to take out. And then you bring us forward to today where we have a lot more exquisite advanced capabilities. So could you talk about the proliferation of targets in the future battle? What the changes to the economics and con-ops do to that precision target engagement for moving targets?

Dave Richards:

Yes, sure. So we talked a lot earlier on about the proliferation of the target list, and there's always going to be some fraction of that target list that is high priority and absolutely demands the best exquisite capability that we've got both today and what's going to be coming out in the future. So there's no doubt about that, but I think that one of the things that keeps me up at night is, well, what happens to the rest of that list? There's things that are currently serviced by direct attack types of capabilities, have the potential in the future battle to put Airmen in harm's way. How do we prosecute those targets on mass and overcome countermeasures and defense systems that are trying to attract those capabilities?

So as we start to look at that, not only does that have an economic implication, but it also has, I'll say an engagement approach, implication. Our history has been one of pretty much one weapon, one target, a singular engagement. And going back to what you were saying, Mike, I think that that adversaries have looked at that and said, "That's a mode of operation." I think in the future state, one of the interesting things to look at is how can multiple weapons working together, leveraging some of these communication networks, how can they start to exchange information at a rapid rate using that distributed approach? And basically generate more complex engagements that make one plus one equal three.

Not only does that have the possibility if we're able to push the economics of those individual seekers down, our individual weapons down to make the overall engagement less expensive, but it also gives us the opportunity to overcome some of the countermeasures that we're starting to see emerging from the one weapon, one target type of pairing. So I think a lot of interesting aspects to that going forward and something that I know a lot of the things that AFRL is doing in terms of golden horde and various other activities is really moving in the right direction.

Maj. Gen. R. Scott Jobe:

Excellent, thank you. I think we'll follow on with that. Let's stay with that theme for just a second. So can you give us some thoughts and maybe the rest of the panel can comment as well on what industry and the acquisition community inside the government can do to transform and assist to get more affordable weapons at the scale that we need?

Dave Richards:

Absolutely. I think it's a little bit of a different... As we start to say, hey, it's not one weapon, one target anymore. Now it's going to be multiple weapons against multiple targets. And how does that work? What I think it really underlines is the need to be able to really do the operational assessment well on how those algorithms are going to work, how those weapons are going to work, how the threats are going to evolve during the engagement. And it really plays back to model-based systems engineering. It plays back to the digital twin. It plays back to being able to have those approaches, those concepts and technologies in the digital space so that we can develop them and war game them without having to actually go direct to hardware and spend that expense. And I think that that is going to be even more crucial, like I said, as we're going forward and we're starting to change that or look at the effectivity of changing that paradigm a little bit in the future.

Michael Hall:

I'll take a crack at that one too, because I did spend some time on the government side and I was stuck in the current paradigms. Right now, new sensors can just develop volumes and volumes of data and we left that alone back in the day because we didn't have a way to process it to transport it. So now the algorithms are there, now we got to go back upstream, get that data, transport it, and I'd say if we can keep that in mind, the whole kill chain in the moving target indication, that whole kill chain, make sure we're not forgetting about the data that we're leaving on the floor to get it to operate on it so it can be available for the good sensors on the weapons that are going to make an end game out of it.

Mike Shortsleeve:

So the way I would address this from the acquisition standpoint, the way the processes are set up today don't work. I think everybody recognizes that. If you've ever actually seen the chart for the acquisition, it's like the Mayan calendar and it literally is that long. It's like 2,000 years to get something done, and I get it, that's the process. But there are mechanisms and things that can be done, other transactional authorities, things like that, make things a little more rapid. I would also offer that perhaps doing operational evaluations or operational experimentation would be very useful to getting capabilities out to the field as quickly as possible. And that would also mean using surrogates, not necessarily using the exact platform that you may have in the future, but you may want to use a surrogate platform that may be as like it or actually, you control it to where it might mimic what you're going to have in the future.

And that does a few things. One, it will reduce the risk which will bring down some of the cost because you're actually able to play with the system and see it. And certainly we can do a lot of that in the digital and engineering environment and a lot of modeling, simulation based software engineering can help with that. But the reality is sometimes you need to get it in the hands of the operator to go ahead and play with it because that's when things get broken and that's when the things of, hey, this widget doesn't work because that's not the way we really do things. So I would definitely push hard on that using surrogates to do that. And guess what not do. Not only do you reduce the risk, but if that capability really is successful, you just fielded it that much faster to the existing platforms that are out there today. So that's what I would offer.

Maj. Gen. R. Scott Jobe:

Excellent. I'm going to stay on this thread for just a moment because I think it's a very interesting one. As we are now trying to pivot towards innovative, dynamic and rapidly iterating through capabilities. And I'll just open up to any of the panel members. When General Shriever was developing ICBMs, he failed a lot on the rocket launchpad, a lot of things blew up, a lot of things broke, but we learned

forward and we leaned into the problem set. So could you give us some sense of risk, either from the industrial base perspective or from a fielding capability or money perspective or just how we might handle risk of failing and to go fast?

Dave Richards:

I think going back to something Mike was saying about the acquisition process, I think one of the knock on effects of that too is the lead time up to the fielding with new weapon system. It's so long and it's so defined that unless there's this explicit attention paid to putting in an ability to have those types of failures, that there's tremendous economic pressure. It's not necessarily economically viable to risk this entire, almost in some cases decade long acquisition chain or your role in it to have a failure. So I think it breeds a little bit of conservatism in how tests are are arranged and it prevents that fail fast mentality because any failure can derail you from this extremely long acquisition commitment, that's kind of the name of the game today.

Michael Hall:

So I want to make sure the systems engineering process is important, but we probably all agree it doesn't need to take as long as it takes. So things like digital engineering, so you can speed that up, it's good things. But I want to defend our government teams that are trying to get everything right so there's not a big got you, after you spend a lot of money. Sometimes you can go a little slower and you produce the outcome faster. So systems engineering really important. It doesn't mean that it has to go fast or it has to be slow. The other thing I'd say is we're okay with not developing and delivering all the capability right away.

There might be cosmic algorithms that we can use later on if we don't trap data, if we transport the data and we get it into a place, if we develop those algorithms later, that capability can come later and it won't slow the whole process up, you can get on with Fielding. And I think that's one way to get the systems engineering right, get it fielded, but make sure there's that opportunity for capability later too.

Mike Shortsleeve:

So I'll answer it this way. Having had the opportunity to be a Program Manager, when you say risk and you're a Program Manager, what that means to you is you're the one that they point the finger at and you're the guilty party. Unfortunately, that's just the way it is. So it's a cultural thing in some aspects, and certainly there is some legal aspects to how much you could push the risk, but I think in some environments I would encourage the Air Force to look at building these sandboxes. You got a multitude of defense industry out there that spends a lot of their own research and development doing things in house, but you know what? It means a lot more when you're actually able to put it on an aircraft that's owned by the US Air Force. So having some of these aircraft available so that you can actually go out and push your things on there and really get the feel for how this would work in that environment would be really useful.

And again, the risk, hey, it is what it is, how much you're willing to take really determines on how fast you need this capability. If a war were to break out tomorrow, guess what? Risk is out the door for you can fail as much as you want until you get the right thing, but what is that happy medium until we get to that point? And I think some of the ways to get after that is perhaps a teaming effort between industry and the Air Force to build these sandboxes to go out and fly different things.

Maj. Gen. R. Scott Jobe:

Thanks. I want to shift gears just slightly. So Michael, could you give us from Raytheon's perspective, we talked when we're fielding our long range kill chain, which we're actively engaged in, requires a lot of new and innovative technologies, but give us a sense of how industries investing in command and control solutions to provide us better decision aids and identify threats in the contestant environment.

Michael Hall:

Yes sir. And to set up decision aids, we have to set up the data that those decision aids are based on. I think we all know that we have Facebook experiences and internet experience where why did they know I'm interested in that product, we know that those algorithms are out there. So those decision aids to not apply them to our kill chains, moving target in kill chains, we need to do that, but they need data. They need data to act on. So from C2 perspective, as we engineer the new ground sensors that start out this kill chain, again, just going back to what Mike said in his opening remarks, you don't want to trap data. Trapping data, you're not going to use it, you're not going to act on it. So it starts with making sure you know, can get it off the sensor, get it to the right spot. So that's the context, getting the data to the right spot in their C2 construct. Then I know everybody winces when they hear artificial intelligence and machine learning, but it really is a thing.

Again, we experience it in our daily lives. We have that new chatbot that's AI enabled and stuff and we say wow. So I think as Raytheon and other companies approaches that we're saying we need to do more of that. Now again, we need to go upstream, to do that right, you need interfaces, you need a place to do that AI, you need an interface to get the data in, get the bot to help you with the decision and get it back out into your C2 system. So that'll enable the whole kill chain and that's how we see the problem.

Maj. Gen. R. Scott Jobe:

Excellent. Mr. Shortsleeve, could you elaborate a little bit on, you talked about partnering and trying to go a little bit faster. What's your sense of us being able to get after this 1,000 target set at scale that's mobile and dynamic in the environment? Just what's your scale of timeline?

Mike Shortsleeve:

Yes. Well obviously if you follow the Mayan calendar, it'll be 2000 years before we get there. But all kidding aside, I would say that we're closer than most people would think. And I say that because the pieces and parts are there, it's a matter of being able to put them together, play around with it, figure out is this what's really working for us? And so this teaming that I was talking about with the government and particularly the Air Force in this case, is really to start to put the things through the ringer that are already out there. If you really want to accelerate that timeline. It goes back to what I was saying a little bit earlier of fielding it onto capabilities you have today. If you're able to connect some of the things today and start to really flush out what I would call the concepts of operations, your TTPs, you've just fast tracked when that ultimate capability ends up out there, whatever it is, five years down the road or 10 years.

But the fact of the matter is that we've got to look, everybody, defense industry and the Air force in particular, we all have to look at how do we do this differently with what we have today to help get after this problem set? And to be honest with you, when you're spending billions of dollars, which I'm very familiar with how that works when we were in a eight, you're playing with a lot of money there that you don't want to make a mistake in the sense of pouring a bunch of money into something that you're not going to test or even look at and be able to operate 10 years from now. So try to accelerate that is what I would say by using what you have today.

Maj. Gen. R. Scott Jobe:

Excellent. David, we talked earlier about precision engagement and being able to go after both exquisite and non-exquisite target sets. Could you talk a little bit about what's the impact to platforms that are delivering weapons or Con Ops discussion, both from a crude or accrued perspective? Could you give some comments on that?

Dave Richards:

Yes. I think we've kind of touched on it a little bit earlier here too. There's the level of autonomy and collaboration that can occur down at the actual munition level, but there's also the reach back, I think Mike was talking about earlier as well, a little bit of that reach back to manned or unmanned airframes that may have a richer dataset that could add to that engagement. I think it's interesting to think through, there are some engagement modalities, whether they're at extremely long ranges or are otherwise denied, where that won't be available. So you might not be able to rely upon it. But there is definitely, I'll say an engagement Con Ops and a TTP piece that goes along with leveraging those new kinds of approaches.

And I think it goes back a little bit to what we were talking about earlier too, about getting out of the one weapon, one target mindset, how that also is going to drive, I think we just need to be aware that that is also as the potential to drive the employment con ops, the engagement con ops, what authority looks like, how different situations are dealt with, and certainly how it's trained as well. So I think that there's a lot of additional aspects to that type of change that are kind of second and third order effects that might not be, I'll say obvious at the outset, but it's something that needs to be considered holistically along with the employment of some of these new technologies.

Maj. Gen. R. Scott Jobe:

Awesome. Michael, I'm going to pivot back a little bit to sensing and sensing the environment sensing target sets. We know within the department of the Air Force that the United States Space Force is going to provide us a lot of the capabilities we need both from a data transport perspective, but also sensing the environment and developing target sets. Could you give us some sense of as we work to fight in and through and with space from a joint perspective, what does that future look like from a space sensing perspective?

Michael Hall:

Yes sir. And everybody knows there's a contest in space, right? Space is not free, space is not... Without its perils. There's a complementarity between what we do in space and what we do on the ground. So as we look at ground sensors, like Mike was talking about earlier, put your enemy on the horns of a dilemma. If you got two different ways to sense, you put them into the decision space, what are they going to do? So that complementarity between terrestrial and space-based assets very important. There's a cost curve there. The cost curve of space is getting lower and lower. That's a good thing.

Doesn't mean that the cost curve and terrestrial sensors can't be lowered too. So the complementarity number one, then we still got to connect everything like we were talking about earlier, trapping data that isn't going to help. You're going to have to figure out how to transport that. There's a hybridization of space and terrestrial mechanisms we can use to attack it. So I think solving the problem, the moving target indications, is not getting stuck in a mindset that I'm going to do it all one way, combine the strengths of the different modes, put them together, don't trap data, and that's the best place to be using that complementarity.

Dave Richards:

And I think an interesting addition to that too, how does that impact the requirements? That now presents I think a requirements challenge to say, hey, this isn't the sensitivity to this one sensor. When you have these multiple pathways, how does the requirements' community establish kind of the baseline, the expectation of performance when in a given situation there's a lot of different ways that this problem could be solved. So I think again, that's a great area where industry and the government can partner together to define the art of the possible and define things maybe a different way.

Mike Shortsleeve:

One thing I want to add on, we're talking a lot about autonomy and automation as well as AI. One of the things that I certainly think needs to be looked at closely is the ability to present that information to the human. What we don't want is the fusion or the analysis having to take so long between the ears. You need the machine to machine type of interaction, but it's not just the machines talking to each other. It's what exactly are they passing? I don't need to pass tons of data, I just need to pass the specific things. I don't need to tell you about all the characteristics of say a J20 when I've identified it, maybe I just need to send you the coordinates of where it's at and where it's going.

The algorithm looks at it, maybe perhaps looks at patterns of life of previous type activity and is able to tell you as in the cockpit that hey, this aircraft is translating this location and is going to do this to help us make those decisions. Or some of the things that I think we need to get after as well because this is now getting away from machines or tools and now they're teammates. And we really need to think of that from that perspective and make sure that we're refining the data that's out there. Because ultimately I hear a lot of people talking about these data lakes who'll be able to go in and get all this data.

They become data landfills is what they really are. And the only individuals that are in there are those that are actually a picker going in and looking for specific things. But if it just sits there and just continues to build up and build up, it's not helping us. So onboard at the edge processing, going through the information, it's exactly like you said, we don't want the information to get trapped. We need to get only what is needed to the person that needs it. So you got to be smart with that. It's not just about an individual, but it's about how the systems are designed to be able to do that so you can react. So to me it's about the presentation of the data that is really important to be able to act on it. Right.

Maj. Gen. R. Scott Jobe:

Great. Thanks. So we've only got a few minutes left. It's been a great dialogue up to this point, so I appreciate everyone being actively engaged. So what I would like to do now is really to go down the panel, start with you, Dave, about a minute or so, closing comments or any other thoughts or things you wanted to address that we didn't get around to yet?

Dave Richards:

No, I think we covered a lot of the things I think that are at least on my mind for what we're going to be seeing for the future here. Again, I think we talked a lot about a lot of cool features and a lot of new things that are going to be required for the next generation battle space. But at the end of the day, it comes down to you, we got to be able to also do this at cost, at a cost that allows these things to proliferate. And when we talk about costs, it's not just about money, it's also about industrial capacity to be able to manufacture these goods, even if it's cheap, if it takes us a year to build one, that's not going to get the stores filled at a rate that's going to be compatible with what we need to do. So I think while

we're doing all of these things, we got to walk and chew gum at the same time. We got to be innovating, but also making sure that we're doing this in an affordable way.

Maj. Gen. R. Scott Jobe:

Awesome. Mr. Hall?

Michael Hall:

Dave brought it up and I never followed it up, but the whole aspect of net enabled weapons, we talked about getting stuck in paradigms. I'm kind of stuck in the paradigm that you fire a weapon and that's it, but we have this opportunity with net enabled weapons. A storm breaker for example, you fire it, it still talks to the platform, it talks to stuff on the ground. It can make those re-prioritization decisions that Dave talked about, you get mass, you get battle space awareness and you get a lot more value from that fired weapon. So I talked a lot about the beginning of the kill chain. I probably should have talked more about the end that that's an important part of making an end of a moving target as well.

Mike Shortsleeve:

The last piece I would end with is to reemphasize that point I made at the start, which is when you look at the common thing amongst all these components of the kill chain to get after this, it's the connectivity. And one thing I would emphasize is that if you're a student of the mosaic warfare concept, you understand that it's not looking at these as specific F35 or E3 or anything like that. They're nodes because every platform ultimately you want to achieve is it's a producer, a consumer, but it's also a conduit of information no different than your cell phone as you're going through a city, right?

You're going to hit different towers and you don't even know it should be the same way with the information that we're trying to pass. I get it's the panacea and it's hard to get there because we have a Frankenstein system that we're built with, but we can't achieve some of these things I think in localized fashions and just start small and then you build off of that. So I would say that continue to focus on the one piece that's going to make this all work. If you're not connected, guess what? You're never going to know and you're never going to be able to act.

Maj. Gen. R. Scott Jobe:

Well, gentlemen, thank you very much for your time. We appreciate your perspectives and a round of applause please for our panel members.