“Global Strike”

Maj. Gen. Doug Raaberg, USAF (Ret.):

Well, good morning everyone. I'm Doug Raaberg, Executive Vice President of your Air and Space Forces' Association. Definitely thank you for joining us this morning to discuss a very important operational imperative that is really near and dear to my heart, Global Strike. Please welcome to the stage and hold your applause till the end, my contestants. To my left, Mr. Willy Andersen, Vice President of Boeing's Multi-Domain special programs and capabilities, Phantom Works, Major General Jon “Stormin” Norman, Vice President of Raytheon's Air Power Requirements and Capabilities, and to my far left Mr. Doug Young, Vice President and General Manager of Northrop Grumman's Strike Programs. Let's give them a big round of applause, please

Let me help set the scene. Secretary Kendall described the Global Strike Initiative as being similar to the next generation air dominance, which identifies all of the components of the B-21 Raider family of systems, including the potential use of more affordable uncured autonomous combat aircraft. Of the technologies are there now to introduce uncured platforms in this systems of systems context, but the most cost-effective approach and the operational concepts for this compliment to crude Global Strike capabilities have to be analyzed and defined. If you go to the Air and Space Forces magazine, go right to the operational imperatives, that's quoted right out of the magazine. Let's remember that in the end, Global Strike is a human endeavor, yet the backbone of our nation's success relies on the innovation and ingenuity of our industrial partners to deliver the transformational capabilities to the war fighters.

So on that note, Doug, let me fire away with a question. I know... And by the way, this is a spoiler alert, we will not be talking classified in this room. So Doug, set the scene for us. In his remarks at the B-21 rollout, and thank you for the invite. This last December, Secretary of Defense, Lloyd Austin commented that this is deterrence done right. He was in fact alluding to a model acquisition program that continues to adhere to cost, schedule and performance. Even last week, the House Armed Services Committee ranking member openly praised the B-21 program. Obviously you were at the rollout. So what has made Northrop Grumman's B-21 program a success?

Doug Young:

Well, thanks for the question, Doug. And yeah, every day, it's a big challenge, but so far, so good and a lot ahead of us and I'll talk about that in a moment. First thing I wanted to do is kind of just step back for a moment, at the strike division at Northrop, we focus on systems and technologies that are dealing with the highly contested environment. So the two programs I can talk about today around that are for Global Strike and I'd like to just restate a quote from yesterday's talk from General Bustier, which many of you I'm sure we're at. But just to focus on these two programs, it's about range, access, and payload to deliver disruptive effects in a contested environment with the mass and the lethality to win against a peer adversary. So with that, our focus on the B2 first off, which is in this division and part of Northrop's legacy around this kind of capability has been all around modernization and making that platform continue to be relevant and effective.

So we focus on comms and bombs if you will. So last year we were able to alter the architecture on that system in order to be able to segregate the mission systems from the flight systems to allow us to more rapidly upgrade and add mission capability, weapons and comms. We also have done a lot of work around low observables to continue to refine them, make them more maintainable and more effective for the mission. And on the weapons side, recently we qualified the [inaudible 00:04:42] last year for B2 and there are a number of other missiles or weapons in the pipeline. So that's kind of the B2, which really until B-21 comes online in numbers is what we've got for this mission. So now switching over to B-

21 and referencing back to the rollout, that was a great day for the company, for the country and for our war fighters, to really get out and have a visible symbol of what the country and what the industry is doing to support the mission for deterrence.

So team was very proud of that accomplishment, but we moved the airplane out of there that night and at five in the morning we were at it again starting to test the airplane. So no rest for the weary. So around B-21 we are testing that airplane, we're doing ground test, we're getting ready to go fly it sometime later this year and first flight's going to be a big deal. But an even bigger deal really is to focus on the second flight because we want to make sure when we fly that airplane that it is not something we're going to have to work on for another two months before we go fly it again. We want to get into a very productive flight test program. So part of that is all around making the trade-offs in the near term on schedule in order to implement things that we know we have to fix so that we can get through a good flight test program. So the second flight's important too, and obviously the subsequent.

We're also ramping up in production, getting ready for that. We rec recently received advanced procurement for the first lot. We're focused on sustainment because when we get to the main operating base with that first aircraft, everything's got to be in place, spares training, all the documentation, all the things required in order to allow the war fighter to support that aircraft and bring capability online quickly. So that's another big focus of the program at the same time as production getting through AMD and into flight test. So with that, that's kind of a summary of where we're at. To finally answer your question, and I apologize for the segue, but I just thought a little background will be good. So what is working well? So it's really starts with the partnership. The partnership we have on this program and it really is built on about 15 years of working closely with the RCO and developing that relationship, that relationship of trust, mutual accountability, transparency is really what provides the resilience for us to be able to get through the challenges that we see every day. I mean, these are hard programs.

We all know that we've all been there and this one is no different. So that elasticity has done us well and has allowed us to execute on a concept that we call active contract management. We don't play by any different rules than anybody else. We work inside the DOD 5,000 system like everyone else. But the way in which we've applied resources to address risks early on the program through active contract mechanisms has allowed us to address those risks quickly and also address things that we see on the horizon that have newly presented themselves that if we address them early will help us have a better system, bring it online sooner and have it be more sustainable and operationally effective. So that's a key element. We also have worked hard to make sure the first aircraft is very representative of the production aircraft. They're essentially identical, so we have haven't cut any corners on that first aircraft. I've read comments in the press about a prototype or whatever, it's not what it is. We're building the first aircraft, just like the first production aircraft, same processes, same people, same tools, same hardware.

So that's been a challenge because oftentimes on a first article you like to be streamlined and do a lot of handwork and so on. We've avoided that in order to ensure that we're really burning down the risk early. Again, it's that moving risk left approach that we've used in order to be effective. Finally, on digital and open architectures, the program wasn't born digital when it started eight years ago. It was not... I'll call it digital in the way we talk about it today, but we moved quickly into that and that was with help with the RCO in many areas, but also just leveraging commercial tools that are now available. So the way I would describe digital is in three elements of physical, functional and operational. On the physical side, it's all about the engineering models. An example there would be we just did a regional structural test of the airframe to ensure it was ready for flight and we were within 5 percent to the good of our models, of our predictions.

So the fidelity of that model was exceptional and it allowed us to really move quickly and address any risk that might have been there before we went to flight. As well in the physical area in the factory, the use of virtual reality, the VER use of hollow lenses to be able to see invisibly through the structure and be able to install elements for the mechanics and make it easier for them to perform their task as well as ultimately into sustainment, being able to use those same tools. Those are commercially available now we've adapted them into this SAP environment and now apply them in a production environment and ultimately sustainment. On the capability side, it's about agile software and DevOps software. Many of you have heard about DevOps and it's really about model-based systems engineering and implementing rapid cycles of software development in line with those models in order to bring capabilities online efficiently and quickly and make changes as required as you discover things.

Ultimately that will serve us well in the field because we'll be able to make changes rapidly because we all know the threat is changing more rapidly every day and being able to alter software quickly is important. Finally, operationally, migrating to the cloud is a fundamental now part of the program in order to manage the amounts of data that are out there for not only sustainment but mission data that allows us to be more transportable around the globe as we deploy and go forward with B-21s in the operational context. So migration to a cloud, again another commercial thing that's been around for a long time, but doing it a weapon system level, multi-level security is a challenge. Just like in DevOps, it's again, it's doing it a weapon system grade implementation has been the challenge we've overcome, which we're very pleased with and software's going very well on the program.

In the airplane world, sometimes you say, airplane's waiting for the software. Well, in this case, the software's going to be waiting for the airplane, so software's going well. We're really happy about that. Finally, OMS and all that in terms of what's working is the requirements have been very stable. So from an acquisition perspective, we've been working to the same set of KPP since 2014, and in fact one of those KPPs was to have an open mission system architecture. So stable requirements has been a big reason why we've been successful. Thanks, Doug.

Maj. Gen. Doug Raaberg, USAF (Ret.):

That's awesome. Especially as the B2 commander, I wish the B2 could have uploaded the software software like a Tesla in your garage and be the most capable going out to fight. And Willy, I'm going to turn to you because this is important. Yesterday, the Global Strike commander, general Bustier really unveiled not only command perspectives, but he, he's really bridging the full operational capability of current systems and about nine modernization programs to the future and getting them to FOC of the future. So let's talk about that Systems. No doubt, modernizing the Global Strike enterprise is vital for our national security posture. So I'd like to take it from a vantage, your vantage point at the Boeing Phantom Works. What do you see as the most critical enablers to the long range strike mission?

Willy Andersen:

Thank you very much for the question and General thank you for hosting this. It's an esteemed honored to be with you in these other two fine gentlemen. Well, first off, from a Phantom Work standpoint, the portfolio that I oversee is one of advanced materials, advanced mission systems, including self-protect, advanced command and control, and we're applying those in very innovative ways for new platforms as well as upgrades to existing ones. In my past military career, I was a flight tester on a B2. So B2 is near and dear to my heart, congratulations to you and your team for B-21. I did a little work with them. It's nice to see that platform out there. When we did the B2, and the platforms of that generation, it was about this individual survivability of the platform, the employment of the platform. It was all about the singular mission aspects of that platform.

Now in the family of systems, we're looking at essentially ecosystems, ecosystems of the Gen six fighter ecosystems of the B-21. And the ecosystem is it enhances your mission effectiveness, it enhances your survivability, and as the Secretary was saying in his opening remarks, it allows us to buy down our mission risk and provides a bunch of different levers. So in terms of critical enablers, it's not trivial to build an airplane, but we know how to do that. Okay, we got a lot of success in history in doing that. The complexity now is okay, you're not just building an airplane, you're working with other partners, other industry partners and folks to create an ecosystem that works well together. It's tightly coupled in a highly contested environment of maybe the employment for Global Strike. The coupling of capabilities of other platforms of support, if you will, has to be very, very tight. There can't be a lot of margin for error.

The timing and so forth is very, very critical. So now you get into CCAs, you're getting into common command and control. The work that General Cropsey is doing in JADC2 is going to be absolutely crucial if this is going to be successful, that element absolutely has to be successful. And now you're coupling in capabilities from space in ways we haven't done before. So that's a key enabler. And then I think the last main key enabler is Global Strike, deep strike, long range, you need fuel. Okay, so in the secretary, it was real nice to hear in his opening remarks. We've been working closely with the Air Force on making sure we have a strong tanker backbone with the KC-46 and now we're working with the Air Force in other to be able to add other functionality, mesh network backbone related to the KC-46 when the secretary announced the new initiative, the end gas.

You can envision if you will, a solid backbone of KC-46s that then are tied to maybe even refueling other tankers that have stronger survivability attributes to them conceptually maybe an MQ-25 lookalike kind of a thing that's going back and forth in a yo-yo effect. I mean range is going to be a key element. I mean there's no denying that to have range. The platforms are extending the range, but they still need fuel. So all of those elements are going to be key enablers related to that family of systems and Global Strike mission set.

Maj. Gen. Doug Raaberg, USAF (Ret.):

It's interesting, during this conference I've come to the realization that managing signatures of multiple stealth, let's say like platforms of the future, especially when you're talking about refueling to a strike platform, that's going to require a lot of partnership with our industry teammates along the way. So thank you for that, Willy. Jon, I'm going to shift on you and [inaudible 00:17:05], and you have a unique background. Obviously each service is fielding its long range strike capabilities. So let's, let's be honest with ourselves, Navy's got its strategic systems program, the SSP, the Army, it's hypersonic program, the AHPO, and of course you over oversaw the Air Force's Global Power programs in SAF/AQ. So I believe you really actually have a unique perspective and now an industry perspective at Raytheon regarding long-range strike. So it's really a double whammy question. So let me hit you with one, first of all, how can digital technologies and modeling and simulation be used to advance long-range strike capabilities? And then follow up real quickly with what do you believe are the unique attributes of the Air Force LRS mission compared to those other service programs? No pressure.

Jon Norman:

Not the easy one. I guess you start with what's the mission. Our mission is deterrence that that's why we have a military. We don't want to fight, but if we do have to fight, then we want to dominate. And that cornerstone of being able to dominate as a nation is to have a safe, secure, reliable capability, whether that's nuclear or conventional and most importantly survivable. And that applies across the platforms and the weapons that we're going to put in there. To your question on the digital engineering, so I think

probably the best use case, and I know we're doing this on Sentinel, I know we're doing it on Radar, we're absolutely doing it on LRS. So we have a digital model of the weapon. We have a digital model of all the threats of various threats through far into the future.

And we run this model every single night with our LRS program, 6 million miles, and we'll change the threat lay down, we'll change the threat capabilities. We'll change attributes on that weapon system to ensure that is survivable into the future. It's an incredible capability, something that we can never do before. We always had to do live tests and you're testing the points and the edges of that capability. Because of model-based system engineering, because of our DevSecOps, we can do that near real time and that greatly accelerates the development timeline. It builds a lot of confidence for the war fighter because ultimately that's who we're all working for to ensure that they can execute this mission if called upon. We apply that same lesson learned with HACM. So it started out as HAWC with DARPA and now it's evolved to a program of record with the Air Force on HACM and it's a hypersonic missile.

It's fast. It's not that different from every other cruise missile that we've developed, but it's that attribute of speed. It gives you a decreased target engagement cycle time. So it lets you hold more targets at risk in a shorter period of time. It lets us penetrate this A two environment from depth and hold those targets at risk to knock the door down. And I would say that long-range strike component of the Air Force is part and parcel to us being able to do that as a nation. The Navy program, the Army program, they're important for their service. They're all part of the joint campaign. We're never going to do this as a single service. But as that critical element, I contend as that leading element of the triad, Global Strike Command has a fundamental impact on our ability to deter as a nation. Our submarine forces, incredibly capable. They're facing a recap that's going to be incredibly costly.

Certainly with Sentinel, incredibly expensive and we're doing not just the weapon system to replace the [inaudible 00:21:00], but also the launch facilities. So they're more survivable and quite frankly, more conducive to the crew environment. It requires the communication. So NC3, it requires ABMS the work. It requires, I'd say more than ever this replacement of the AGM-86 with LRSO so that we have that weapon in survivable and can deter an adversary. The reason that I think this is so important for our nation as that first step in a recap of the triad is it gives our national command authority a very flexible way to escalate to deescalate any tensions with any potential adversary. It's fascinating having worked in different commands in [inaudible 00:21:48], certainly in INDOPACOM and CACOM. If you move a bomber into a theater, everybody notices, I mean everybody notices.

And so without ever firing a shot, just simply that bomber presence can change behavior because of the risk. And for that risk to be credible, we have to provide both a platform that's survivable and we have to provide that weapon that's survivable. And I think that this team is doing an incredible job with that. We're partnered with North Grumman on HACM for the propulsion for that scramjet engine. I'd say what's most critical, and Doug you touched on it's starting in that design with a war fighter in mind, all the way from the weapons load crew to maintainer to the mission planners, to the air crew that are, or it can be an unscrewed plane that are going to be flying that aircraft in the harm's way so that when they hit the weapons release button, it works the first time every time.

We've spent a lot of time with STRATCOM with Global Strike Command at the start and the design of these weapons, whether it's HACM or LRSO, we design those just like you've done with the B-21 program through RCO, to have that first unit off the production line to be designed for manufacturing so we can produce at scale and to be operationally representative. So the first one off the line is the same as the last one off the line. And that's good for the start. It makes the acquisition community happy because you're meeting cost schedule performance. But more important I think to all of us is that total cost of ownership. So throughout the life cycle of whether it's a platform or the weapon, making sure that it's sustainable, that it's upgradable through that open mission system architecture and whether it's

a weapon or the platform that is composable. So if we have a better navigation system, a better self-protect system, a better propulsion unit fielded in the future, we can easily integrate that into the weapon system.

I think Jason Bartolomei is doing a great job with that on the conventional side and certainly at our nuclear, they are absolutely doing that by ensuring that all of the weapons that we're producing that they have that open mission system so there was the most compliant and that it is easy to integrate that with any new platform in the future and it's easy to integrate that upgrade.

Maj. Gen. Doug Raaberg, USAF (Ret.):

Storman, that's awesome. Let's kind of touch on six generation attributes each and every one of you've done... And Doug, you laid it out pretty well. And that's really the open mission systems architecture. We're talking about advanced networks and we're also talking about evolved stealth. The problem is the enemy's doing the same thing, so they want to get ahead of us. So my real question to each and every one of you, starting with you Doug, is internally to be able to maintain and sustain first mover advantages, I call it with technologies, what demonstrations or what early successes each of your companies can you talk about that really help us and definitely the war fighters, stay ahead of the enemy?

Doug Young:

Okay, just two things on that. First off, in terms of being able to adapt to the threat, when we started this program, the requirements laid out in the 2014, 2015 timeframe. The threat looked very different to what it looks like today and to what's being projected for the 2030s. So with some forethought, the architects of the program built into the requirements, this flexibility. So I've mentioned the open mission system architecture, but another key was having the size, weight, and power to be able to add things quickly and not have to completely redesign the internals of a platform. So right up front we had to build all that in so that we'd be flexible. And what we like to say is we're in the process of future proofing the platform. So in addition to completing EMD, doing production and sustainment, we're also working through a roadmap for modernization so that we can start to drop in capabilities as we bring the aircraft online that are going to deal with where we see the threat today.

So to that end, we've been doing a lot of work in terms of demonstrations. General Bustier referenced our OMS demonstration yesterday where we've integrated a third party sensor onto the platform that's also enabled by the way DevOps process, which gives you that flexibility to be able to integrate those things on quickly in a very short period of time compared to former timelines. The second thing is that at the onset of the program collectively we invested in a flying test bed. That flying test bed has been flying since the beginning of the program, in fact, before the program started by the company where we initiated to basically fly the software and mission systems of the platform. So we've been flying the mission systems for the B-21 for a number of years and evolving it over time to the current state of where we want to be when we go and deploy the platform.

So we've exercised the entire kill chain with production hardware, production software, including things like the radar and the mission management systems and the systems. All those things are on that flying test bed. So we can actually go out to the range and fly it as if it was a B-21 and demonstrate that that kill chain is effective and do it for score. So that's a big element of this concept of risk left so that when we get out into flight test, we're only dealing with the unique integration challenges associated with being on the actual platform.

Maj. Gen. Doug Raaberg, USAF (Ret.):

It's tough calculus. Willy, let me throw the question at you too. First, mover advantages out of Phantom Works demos, successes.

Willy Andersen:

Let me parlay off of his response because I think there's an area... And I'll get into the first mover in the demo piece as I go through, but OMS absolutely a hundred percent needs to be at the tier three level where you're driving competition at the box level. Now you're driving costs down, you're driving competition at that level. But an area that I want to actually play out a little bit is in the software side of it. So first mover advantage is going to be how quickly we can get capabilities into the jet integrated test and fielded. That's going to be a lot about software. We've had years, decades about doing software... I won't say wrong because we thought we were doing it the right way, but clearly there's all sorts of scars and bad lessons learned across the industry.

So what we're doing in Boeing is a couple of things. So first off, we have our own software factory. We've been investing in DevSecOps and all the things that all the companies are essentially doing. But in the ecosystem now you're looking at software for CCAs as well as the platforms. And we don't hold the market on autonomy, MUM-T algorithm development and so forth. There's a lot of other companies that have invested a lot more and we want to harness that innovation to be able to bring the change in the capability to the war fighter. So what we're actually doing is we're defining essentially the interfaces we have to protect safety critical elements. We have to be able to do the integration and essentially provide, I'm going to loosely call autonomy dev kit to those houses. So as long as they comply with those, now we can harness that innovation, we can partner up with the industry, we can get new cool capabilities that are out there integrated in a lot quicker.

And then the other element of it is you can envision needing to do a software update in flight. Now I know that sounds like crazy talk because you got to do integration and test and all that ahead of time, but as a B-21 is inbound long, long way to go before it gets in, it may need new threat file, it may need some new software. So just last week at Emerald Flag, we actually took software from our Boeing factory all DevSecOps compliant, and that whole thing, took it from the factory and we actually transferred over a SATCOM CommLink to an airborne platform and it uploaded inflight, everything went smoothly and so forth. So from a demonstration standpoint, it's looking at those kind of key enablers software, multi-domain capability, common command and control. And quite honestly, it's not going to be about a single company. It's going to be about partnering across the industry, working together to be able to accelerate that innovation to the work life.

Maj. Gen. Doug Raaberg, USAF (Ret.):

Yeah, my experience, especially as an air component commander deputy is that's a tactical imperative. The future means we have to upload inflight even inbound to the target. Storman.

Jon Norman:

Yeah, I think it's more foundational than diving into the technical side of it. So it's setting the requirements right from the start. You hit on it. RCO hasn't changed the fundamental requirements of B-21. Global Strike Command, now under General Newberry, this is the third new weapon center PO, we have not changed the requirements for LRSO since we started this. So that helps industry, whether we're still in a competition, early down select helps accelerate a program, but having those threshold requirements the first time, so leaning on the war fighters, get that right in thinking towards the future so that as we set those requirements, we're designing a system that is upgradable and this is where we need to not be so bold to think that we're the only ones with a good idea.

Now look to our adversaries. So let's look at the Chinese, what they've done with the PL series of air-to-air missiles. They're not that fundamentally different. They're composable missiles. That's how they're able to iterate and change rapidly and test, fail fast, and field fast. That comes back to the next major point. So for us to be able to work fast as industry talked about the requirements, but for us to be able to field fast, we have got to be in a partnership with the SPO and we've gotten to be in a partnership with the PEO and that partnership has to extend out to the operational war fighters so that as we're doing the design, as we're doing the iterations, we're not missing the mark and we are keeping that end user in thought and we're delivering that capability right at IOC that they need to execute the mission.

It has got to be a partnership. It cannot be an evaluation, from the SPO. And I think that's why these programs are so incredibly successful because we've kind of turned that whole acquisition program upside down. And then it goes back to how do we do this execution in that design phase. And this is where I think it's real easy to jump on the platitudes of model-based system engineering, DevSecOps. And if I put myself back in uniform days, my eyes just roll in the back of my heads and I go, ah, I don't care. Do your acquisition stuff, give me what I need. Stop with the prototypes, slap the table. We've taken enough strategic risk. I need weapons in the MUNs storage area. I need capacity. And we can deliver that for you and we absolutely will deliver that for you. I would suggest to you though that there is a significant benefit for the war fighter with what we're doing with the model based system engineering and these models that we're developing.

It's not just going through the iterations and design. This is something that you take as a war fighter afterwards so that you can run these mission rehearsals in a campaign with very, very accurate models of every platform and every weapon and of every threat. And you can do this until you find that best combination, that best pairing of weapons and platforms to achieve the best success. And then that leads to your comment about that C2. So the AMBS... Yeah. In the future, here's the panacea. I can sit back in my easy chair back in the [inaudible 00:34:02] 2000 miles away with my coffee, and I can watch this air war occurring in front of me. I can see every threat. I've got total SA and I can just pair the right platform to the right target set and the right weapon to that right threat coming in.

So I win the first time every time. I look at it a little bit differently, I want that war fighter, whether it's an accrued or uncured platform at the tip of the spear that's actually exposed to have that type of global assay. And I want that war fighter that's at the tip of the spear to be able to receive that change of here's the new target priority. I want them to see to receive that digitally so that it's not a 12-hour mission planning process on jumps. It's coming across as an ASCII file and it's downloaded to the weapon. They got the new pairing and that weapon goes. For my C2, I want that C2 back there to be able to see what platforms at what location with what weapon so that I can make that smart decision, and I'm not dumping the situational awareness of the war fighter out at the tip of the spear. I think that this revolution that we're going through both an industry and with our acquisition community is going to give the war fighter to that capability in the future.

Maj. Gen. Doug Raaberg, USAF (Ret.):

I started my remarks with. This is a human endeavor. We're going to end on the human endeavor loop. Willy, I'm going to start with you and then I'm going to, Doug, you complete the loop here please. We've got about five minutes remaining. So quick thoughts, what about the human in the loop? We're talking about collaborative combat aircraft, we're talking about autonomous systems, we're talking about hypersonic, blistering speed weapon systems and you're in the cockpit or you're on the ground. What from the Phantom Works, from the Boeing side, and let's go Raytheon into Northrop Grumman. How do you account for this entirely new dynamic environment that you have to deal with? Let's try to keep it to the weapons system level.

Willy Andersen:

Well, there's a number of different areas that I could go down with that one honestly enough. But when we're looking at again that Global Strike ecosystem, from a weapon, from a CCCA aspect of it, that command and control element of it gives the human in the loop the ability now to be able to make adjustments, real time, mission-based, that's there. So you can envision long-range weapons being shot off an F-15EX, expanded the load out and so forth, and now they're just on the edge and they're just firing the heck out of them and shooting them into the area. Those weapons then are netted. And so through ABMS and your commanded control system, you've got your ABMers. Now they could be on a E-7, they could be in the back of a KC-46, they could be on the ground, but all the weapons now are all netted together and they're talking, they're communicating amongst themselves.

And if they get to a target and that target's already been struck, they can roll to the next target. And so that's going to be the ability to be able to provide mass, the fog and friction of war. I mean that's an element of that ecosystem that increases survivability, that increases mission effectiveness across. That's what I think when I think of your question.

Maj. Gen. Doug Raaberg, USAF (Ret.):

Awesome. Thank you Willy. Storman, human in the loop.

Jon Norman:

I think you have to keep it simple. So from the weapons, they need to be easy to mission plan, they need to be easy to employ. For the sustainability, it's starting at the very beginning. So as you're designing a weapon or you're designing a platform, go up to Minot, go there in the middle of the winter. Don't go there in the summer when the Airmen are out there in cold weather gear and they get these horrendous mitts on, hopefully we've got them equipped with the right gear and let them work on the platform or on the weapon. Can they do it? Put that weapon into the [inaudible 00:38:10], can you move it in and out easily? And then for our AMC team, can we transport it easily? And more importantly, can we integrate these very quickly onto the new platforms, whether they're crude or uncrude? It starts with the Airmen it and it ends with the Airmen. If we're doing this right, we've made their job easier and we've given them incredible capability that they can employ.

Maj. Gen. Doug Raaberg, USAF (Ret.):

You bring up a key point before I touch you, Doug, and that is the human in the loop also goes from ground to command and control. Obviously everything's going to be rapid machine to machine in some cases to be able to make decisions. So bring us home. Human in the loop.

Doug Young:

Yes, sir. From a human in the loop perspective, I'll come at it from two angles. First of all, one of the reasons the program is successful is because of the embedded nature of Global Strike in our program from day one. General Bustier, thank you for the amazing support that we get from Global Strike every day. They're embedded throughout the program, certainly in the program office, but we have 12 pilots from Global Strike that have been working with us over the last few years on the pilot vehicle interface. So we've gotten a lot of great feedback from other stakeholders of the ease and simplicity by which the information is displayed and which enables rapid decision making, informed decision making.

And to the point of the fact we're really in an information age, it's the people that are coming through schools and some of them that are still playing video games are going to be flying this airplane. And so they need to have a vehicle interface that really represents the state-of-the-art as far as that ability to

manage the flight, but also manage that mission, which will be complex. So that Global Strike engagement at the pilot vehicle interface spreads all across everything we do. Our Global Strike is involved in our maintainability and sustainability studies. We have people in our labs in Melbourne, Florida where they work with us on the software and then out in Palmdale, we have folks that are working with us on the flight line as we get ready to go fly this airplane.

So Global Strike is a big part of that and I think that's really a big aspect of the human piece that needs to be involved right from the beginning. And then finally, from a human perspective, I just really want to acknowledge the 8,000 people around the country that wake up every day to deliver this radar capability online. Those are 400 suppliers in 40 states and Northrop employees across the country working with our government counterparts to bring this online as quickly as we know how. And we're committed to that and we work at it every day. So thank you for the opportunity to speak today.

Maj. Gen. Doug Raaberg, USAF (Ret.):

So let's wrap it up by going back and looking at what this is all about as we talk about the human endeavor of Global Strike. I think you three gentlemen just hit the home run of the day. And that is, let's not forget the war fighters are actually in industry and they're creating new approaches at Boeing and Raytheon, at Northrop Grumman and others. And this is a tough problem, but not one insurmountable. I guarantee you the Chinese are going to be watching this video over and over and over. So Willy, thank you. Storman, I appreciate it. And Doug, thank you very much. One shameless plug, please go to the shop AFA store. I've already bought my bomber T-shirt, it's got the B-21 in the front and every aircraft that I've ever flown them on the backbone. So please and thank you. Let's give these gentlemen a round of applause, please.