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Part 1: A Conversation With U.S. Air Force Secretary Frank Kendall

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THE HON. FRANK KENDALL
Secretary of the Air Force
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Part 2: The View From Industry

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P R O C E E D I N G S

MR. O'HANLON: Greetings, everyone and thank you for joining us. I'm Michael O'Hanlon with the Foreign Policy program at Brookings. And we'd like to welcome you to this virtual event on the future of air power. Certainly, in the United States and around the world and not just in the U.S. air force but the U.S. space force, which we'll be talking about today with Secretary Frank Kendall whom I will introduce in just a second.

And also, air power more generally as a technological phenomenon, as a coalition capability and certainly as an arena of warfare that is crucial in any future scenario one can imagine as well as tragically the one that is going on today in Ukraine. But certainly, for American interests, I think you have future deterrence and future possible conflicts central to the American armed forces capabilities as well.

So the way we'll proceed today is that I'm going to have the privilege now of introducing Secretary Frank Kendall and then we'll hear from him for a few minutes with some opening thoughts preceding a conversation he and I will have. If you'd like to try to get into that conversation even though it will be fairly brief, we do welcome emails with questions at events@brookings.edu, again, events@brookings.edu.

And then after about a half hour, we will thank Secretary Kendall and we will follow up his keynote conversation with me with a panel discussion with industry and think tank specialists and go until about 2:30. And again have an opportunity for your questions.

So let me now introduce the Honorable Frank Kendall. And it's really a treat and personal privilege for me to be part of this conversation with him. I've known him for a long time, admired his career, learned a lot from him. Many will remember that he was the Undersecretary of Defense for acquisition technology and logistics in the Obama years. That position now has been divided into two, but he himself has moved on and is now the Secretary of the Air Force which means as most of you will know, but just for clarity, that he

oversees the Department of the Air Force as well as the Department of the space force.

And so, both of those are within the Department. Both those services are within the Department of the Air Force. So again, even old timers like myself can misspeak on this one, but both the air force and the space force, those two services are both part of the Department of Air Force for which Secretary Kendall is the senior civilian.

He has about a half century of experience in defense matters in the private sector, in the think tank world and certainly within the Department of Defense. Trained as a lawyer but before that as a soldier. He went to West Point, served better than a decade in uniform. Taught engineering at West Point and has done countless other things to contribute to the nation's security in and out of uniform throughout his career. And again, in the last 40 years or so as a civilian in various enterprises and undertakings around this city and around the world.

So, Secretary Kendall, it's a privilege to have you here. Thank you for joining us, sir. And over to you.

MR. KENDALL: Thank you, Michael. I'll just take a few minutes to kind of set the stage, I think. And then we can go from there with questions.

I'm back in government largely because of my concerns about the threats that we face and because of the need for change to respond to them. The experience I have includes about 20 years in the Cold War where I ended up being responsible for all of our tactical warfare programs in DOD.

And I know viscerally what it's like to have a peer competitor, if you will, who's working very hard to field the abilities to defeat your forces, and that's what we have today. We have we're trying in particular. We refer to China as a facing challenge. We refer to Russia as the acute threat right now because of what they're doing right this moment. But of the two, I'm much, much more concern about China.

They have the resources. They have the intent. They have the capability and they have had time to mature capabilities that are design to defeat our ability to project power. So I'm much more concerned about China than about Russia, but obviously you can't ignore a country as powerful and aggressive and one that has a nuclear arsenal certainly that Russia does.

So that's the reason I'm back in. And I bring to the table something that almost no one in uniform today has and, in fact, very few career people even. And that is understanding what it's like to have someone trying to defeat you and trying very hard to figure out what your vulnerabilities are and to attack them as effectively as possible, and that's what we've got.

When I first became aware of this in 2010, when I came back to government last time after being out for about 15 years. I looked at the intelligence about what China was now developing and fielding and it was quite clear that their desire was to deny us the ability to project power in the Western Pacific. And it's a mixture of systems that come after our high value assets base to do that. Largely rocket forces of various types, cruise and ballistic missiles from various launchers or platforms as well as the systems that support them.

So that's the problem we still have. It's just that a lot more time has passed and they've moved further down the road. So coming in, I'm very focused on modernization. There's a lot of other things that certainly the air force has to worry about. Many worries both about the space force and the air force and their future as well as their present. And as I'm telling the committees that I'm testifying before right now. I have the Senate Armed Services Committee tomorrow.

The budget we submitted contains a balance that is adequate to deal with current threats and support commanders today, but also a significant investment in

transformational capabilities that we need for tomorrow. And I'm warning the Congress as I go through this that this year, I'm comfortable with what we have. I'm comfortable with the balance we struck, but I can see much harder choices ahead.

And one of the things we did in our budget is double our R&D spending, okay? R&D is a down payment on production and sustainment. And it shouldn't be the size it is in a budget that is continuous and healthy in our budget right now. It's large. It's our biggest account. That tells you that we're doing a lot of work on things we want to buy in the future, but that we're not buying yet.

And so, anyway as I look forward with any kind of budget that we might potentially get, no matter how the policy sort themselves out, we're still going to have hard choices to make. And they're going to often be between current capabilities and future capabilities and how we support the force around the world. And in a world in which getting rid of some of our old stuff that isn't effective anymore is an important part of the equation to free up resources for the future.

So that's it kind of overall. I've organized work in the Department of the Air Force around seven operational imperatives. So these are things we have to do if we're going to project power effectively. And the capability that the Department I'm overseeing now has to field is the ability to stop an active aggression far away from the coast of the United States, several thousand miles away.

Whether it's an aggression on land as we saw in Ukraine or an aggression by sea and in the air as we might potentially see in the Pacific. And space is a component to all of that wherever we operate. Air power is a component of that wherever we operate. If there's one failing that's glaring right now for the Russians in what they've tried to do is they didn't cease the air. They didn't take control of the air and because of that they're having extreme difficulties on the land. That would be true in any theater or any kind of conflict

against any kind of active aggression.

I'm also worried about a problem which looks a lot like the Russian invasion. The expectation of anybody who amounts an act of aggression as if they will have a quick war and a decisive war and it will be over and done. And we have to deter that. And the way to deter that is to be able to defeat it. So that's what the seven operational imperatives are built around.

And I'll run through them real quickly and then we can take questions if you're interested in that. The first one is space. Getting a space orbit battle right. We've changed the strategy in the Obama administration. We started some of the programs we need and more work was done on that during the Trump administration, but we still have some work to do in making sure we're getting the future of space right.

And we've got to have the resilient systems that can survive attack so we can provide the services that we need to, to the joint forces and our allies. But we also have to have the ability to deny the enemy the capability of targeting our forces. We have to protect the joint force, the combined force from that sort of observation. And we're seeing as we watch Ukraine how that kind of thing can make a big difference as well.

So getting space right from both of those perspectives is first. And then we have to get C3 battle management right. This is taking Advanced Battle Management Systems or JADC2, Joint All-Domain Command and Control. Getting at those investments to be sound and to really get us to an operational capability. Yeah, this is -- I mean something we've been talking about for a few years now. And my observation is that we haven't done enough to be concrete about what we're actually buying and what will actually give us operationally. So we're trying to focus that work and move it forward.

The beginning of that is the third one, which is how we target. And if we're going to stop acts of aggression, we have to target both air and ground surface, it could be

ships, moving targets. And the best way to do that as far as I can tell is to do it from space if we can, and if it can be survivable. So getting that right in terms of the technology, the centers that we buy and also very importantly for that doing it with the intelligence community.

A lot of the centers that provide the kinds of information that we're interested for those functions are fielded by the intelligence community, by the NRO and by NGA. And so, we're working very closely on that with them to define that.

Next there's the element of the force that actually does the fighting and ceases control of the air. This is going to be built around the next generation or dominance platform, but it's going to be a family of systems not just a new fighter. But also, uncrewed combat aircraft as well as weapon systems and connectivity for them and relationships to outside support so that that formation, if you will, can function together. Function together very effectively operationally. So we need to get that right.

And the next one is that those aircraft and others have to operate from foreign airfields, which are targets for the opposition. So we have to make sure that that basing is resilient. That means a combination of deception, hardening, defense and other measures that will basically make it harder for the adversary and dilute his forces and make them less effective at trying to keep us on the ground or kill us when we're on the ground. And if we can't solve that problem nor the other stuff that I just talked about it's going to work.

The next part of the -- the next one, the next to last is the global strike capability. And I don't know in the future what our mix of global strike and tactical air forward base, tactical air is going to be, but I want to be positioned so that if we have to shift that balance we can and be as cost effective from the global strike perspective as possible. The B21 is at the heart of that, but again there's room for uncrewed combat aircraft as well as a

mix of weapons and offboard supporting systems that help that culmination operate together as well.

And then finally, all the things we count are going to work. If we're going to have to deploy forces forward, we're going to support them forward. We depend upon any number of information systems. Things like transportation networks, logistics, supply chains, our personnel system, you name it. All of these things matter in terms of the ability to actually mobilize and move the force and then support it. So we're looking at that whole string of things.

And I'm trying to cover that the output of this work, some of the things that contribute to these imperatives are already in the budget. Others are coming as a result of the work we've had ongoing. And I just had a review last week actually of where all those efforts stand and they've teed up a number of things for us to consider as we build our FY24 budget. And so, that's a work in progress and it will be reflected next year when we come back in less than a year from now.

So that's basically what we're doing. That's why we're doing it. One point I want to make to the industry people here is that we need your help. We need your help in a number of ways. We need your technologies. We need your best minds on this. And in addition to what you're used to doing which is responding to an RFP which has a well-defined product in it. We want you to help us solve these operational problems that I just walked through.

So we're going to be asking you and reaching out to you to be involved in that. All the creativity in the world does not live in the Department of Defense, we know that. And so, we want to bring in industry. We want to bring in think tanks, Michael. And others to help us work our way through these problems and get to the right answer. Going fast is really important to us, but just as important is going in the right direction.

So it's critical that we set up things so that we can move quickly, but that we make the right choices early because we're going to live with them for a long time. We're going to live with the consequences of them for a long time. So I'm looking forward to working with the entire community on all of this as we go forward. It's a challenging but exciting time and there's plenty of work for all of us to do. With that I'll stop and I'll be looking forward to your questions.

MR. O'HANLON: Mr. Secretary that's great. Excellent framing and I've got a few questions. And I'd like to mostly focus on as we discussed earlier the bigger picture and the longer terms. You'll spend a lot of time on Capitol Hill I'm sure talking about your fiscal '23 budget proposal.

But I will begin with one broad question about the budget. It really is quite remarkable as you say that the Department of Air Force is spending so much money on research and development tests and evaluation. This maybe the highest percentage ever, at least that I can think of, in its history. Somebody may know the right answer to that, but certainly in modern times.

And I wonder, you alluded to the fact that choices will need to be made and procurement will need to go up in coming years. About when does that start to happen roughly speaking? What is the crossover point where procurement, you know, substantially exceeds RTD&E and you really have largely left the research phase? I realize there's no clean, simple answer but I would be curious just how you would offer a thought on that?

MR. KENDALL: So it's starting pretty quickly. B21, for example, is starting, right, with this appropriation. The next generation are dominance platform and the unmanned combat aircraft are a few years out. There are other programs like JATM, our joint advance air missile. They are a few years out. So they're going to phase in I think as we do the work.

The guidance I've given to the acquisition people in the air force is to set up programs so that they get meaningful operational capabilities in the hands of operators as quickly as possible. I'm not terribly interested in demonstrations or experiments unless they're on that path.

We talked about an unproved aircraft for the tactical air world. I want to go directly to the MD on that. I feel that the technology is mature enough that we can gamble on that, take some risk there and move out quickly. So we're not going to wait for a round of risk reduction experiments. We will conduct them in parallel with the work we need to do to get a platform moving forward.

Now, we're trying to synchronize efforts in things like mission systems that can be upgraded over time and software that can be upgraded very easily over time with hardware which basically forms the basis by which, you know, you can then move forward and incrementally improve. So I think it's more than a minimum viable plot. We want better than that. We want to get in the game with something that makes a difference operationally and then build on that point forward.

MR. O'HANLON: It sounds overall like it's a process that plays out through the 2020s and of course beyond. And therefore, you're not in a hurry to magically create a whole new air force by, let's say, 2027 which is a date some people have suggested. Maybe when China really wants to attack Taiwan or something. You don't feel like you have either the need or the luxury of being quite that, in your term, focused. Am I hearing you correctly?

MR. KENDALL: That's roughly right, Michael. For a new start today, you're several years away from fielding them. When you just lay out what you have to do, right? First you have to get money. And I'd like to ask for the Congress to help with making that more flexible and easy so we can start faster.

But you have to get money and then you have to do the design work which

for a new system is on a three-year process, let's say. And then you have to actually build your test articles and test them. And at some point, when you're comfortable with the risk and your design and you start production, right? You'd like to have that as early as possible. The more aggressive you are with the risk you're taking in the design, you know, the harder it is to be sure you have a stable design. But when you add all that up, you're talking several years.

Now, I've looked recently at the timeframe the Chinese, for example, are using to fuel their systems. It's not better than ours. It's probably not as good as ours. But they started earlier and they've been working aggressively on a large number of things. They're not waiting to see what we do. They're basically figuring out what they need and what technology might offer them to meet their needs, and they're moving forward.

And I mention my Soviet experience. In those days, the Soviets would always ask their leadership or the technical people would say are the Americans doing it? And if the Americans weren't doing it than the Soviets weren't going to do it either because they figured we were so much ahead of them intellectually on weapon systems and such. The Chinese aren't doing that.

If they think something is going to be operational effective, they're going ahead with it whether we're doing it or not. So we have a tougher problem today than we had in the first 20 years of my career, unfortunately.

MR. O'HANLON: So in regard to China, I wanted to ask you a question about Chinese grand strategy. I realize for you in your job, you may be agnostic on the grand strategy. And really just see the capabilities improving and feel you need to match and exceed those.

But I do -- I'm still curious and I think it would be helpful to understand whether you see China as a fundamentally aggressive power that's likely to have greater

and greater strategic appetite as it becomes more powerful?

And perhaps wanting to push us out of the Western Pacific all together? Versus a country that, yeah, would prefer that we not be there but as long as Taiwan doesn't become independent, as long as they have sort of first among equals access to some of their littoral waters, they'll basically be okay. Do you have a defining image of what Chinese grand strategy is likely to be over the next one to three decades?

MR. KENDALL: There are a number of good books on this and I didn't write any of them. So there are a lot of sources, Michael. I think you're well aware of that.

From personal view from what I have read and what I understand, China has ambitions to be the great power on the face of the earth. They have ambitions to be the global great power. And to do that they have to, you know, basically displace the United States. I think their ambitions have changed as their capabilities have increased over time. Initially, I think they were very regional, but I think they've gotten broader than that. The Belt and Road initiatives are a good indicator of where they are, their influence.

A lot of this is economically driven, right? I don't think that they're interested in, you know, grand territorial expansion. But they are interested in having as much influence as possible so that they can set the rules for the economy as much as anything. Their involvement in standards bodies, for example, reflects that.

You're right in a sense in that my job is to provide capabilities. And my fundamental mission is to deter and if necessary, defeat what a potential adversary might do. And so, the immediate and obvious thing that we might be worried about with China is Taiwan. But there are other places such as the Cincocos (phonetic) in the South China Sea where acts of aggression are possible also.

So those are certainly within their, you know, near abroad to borrow a phrase from the Russians. So that's all of concern. Ambitions and intentions can change

quite a bit over time as the balance of power shifts. I think we have already, I think, seen some shifts in the scope of their ambitions. And they articulated some things pretty clearly about where they want to be by mid-century, for example. So I think we have to take them at face value. I made the mistake a few times during the Cold War not believing what the Soviets were saying. It turns out they meant what they were saying. So I think it's safe to say it can be assumed with the Chinese right now.

MR. O'HANLON: I want to ask you one organizational question from the vantage point of the senior civilian in charge of the entire Department of the Air Force, again including the space force and the air force.

And, you know, it's a question that's sort of interesting to put to a retired army officer and a senior civilian and a technologist and business leader because you are both in the air force, running the air force and yet not uniform air force.

And I'm just curious how has the culture evolved as we've now seen this base force be created? Because historically, the air force, you know, began of course as a bomber dominated service coming out of World War II and through famous or infamous Curtis LeMay days and strategic bombardment theories and the Eisenhower administration's new look and so forth.

And then developed ICBMs and space capabilities. But somewhere along the way, at least so the cliché goes, the tactical air force became predominant within it. And has generally produce the Chiefs of Staff at least in modern decades. And now, we have a space force that was created in part because of the opportunities that space offers as well as the vulnerabilities of space. But also, at least if you listen to the word on the street, because some of the space operators who used to be in the air force didn't feel adequately respected or empowered to do their thing.

So how is this all starting to sort out? I know it's early days, but do you see

good dynamics in the uniformed air force and space force within your broad supervision?

MR. KENDALL: That's a great question. Probably didn't give me more trouble than anything else I could do with a (inaudible).

I'll say a few words about that. First of all, I really enjoy the culture that I'm finding here. It's not like the army in some ways. The air force is -- it feels more like a family. And when I came in, I was called by Erin Condren from the Undersecretary. And she said, welcome to the air force family. And I didn't -- I thought it was just a nice thing to say at the beginning, but it actually has that feel to it.

It's a very cohesive organization. People respect each other. They work well together. The space force is very new and very small. And by being separate, they've got the opportunity to create their own culture. And Jay Ramond, I think and his team have done a really good job of that. I made some comments recently about how they need to embrace the fact that they provide a lot of services to the joint force and that the private protection division of the joint force. And I think they take all of that seriously.

But they also take their responsibility for operations in space very seriously as well. So it's evolving. And I think it's off to a really good start. And I'm working very comfortably with both of the services. It is a change for the department. I mean when it was one service in the department, things were a little bit simpler. We didn't have as many service staffs. We didn't -- the secretariats were always a little bit different. So we're sorting our way through all of that. And I think that's going to continue to evolve and it will change a little bit with leadership, I think, as leadership changes as well.

But I think we're off to a good start. And I think it's a healthy culture. It's very respective of people. Respectful of people. And very encouraging of people in their development. A couple of things that I'm working on which I think we need to strengthen is our diversity and our despaired outcomes and a whole number of things need to be

improved upon whether it's military justice or promotions or assignments or anything so we're working on that.

The operational side of the air force is not very diverse at all. And we need to make it more so. And C.Q. Brown and I are very focused on that. The air force like the rest of society has evolved and we're bringing in different kind of people. We're offering terrific opportunities.

I can't tell you how impressed I am with the MCOs in the air force. They're fantastic. And you listen to people who are doing, you know, all sorts of varying working jobs around the air force in cyber and technology and so on. So the mix is changing and I think what was once a pilot dominated culture isn't as much that now.

It's changing as we go because the mix of things we do and the imports of some of those other things besides driving airplanes, I think has become more apparent to everyone. And like our society, the mix within the air force has changed over time. Become much more diverse.

The space force, again, you know, getting started, establishing their own, you know, norms and ethics and so on. Off to a great start and I think I am trying to build up the scientific and technical aspects of both services. The Cold War experience again was that the air force led the way in terms of having a very strong engineering and scientific cadre. And I think some of that atrophied after the Cold War. And so, I'm trying to build that back up.

But overall, it's a very healthy culture. It's a great place to work. The idea that people in the audience you have any children or whatever who are interested in having an exciting and interesting career, the air force and space force is a great place to be.

MR. KENDALL: Absolutely. I want to get back to technology in a second. But I also want to clarify one thing about your priorities budgetarily and otherwise. Because I

remember doing events with General Goldstein when he was Chief of Staff and just a great guy, a great aviator and leader of the air force himself.

And he had a vision that was to grow the air force. It wasn't necessarily his top priority, but as you well know, he decided that just like the navy counts in terms of ships and aspires to a fleet of a certain size that he wanted to aspire to a bigger air force. And decided to count squadrons.

And at the time about a half dozen years ago or maybe five years ago when he came up this vision, the air force at that time had 312 squadrons including guard and reserve. And he wanted to get to 386. Is there any lasting legacy of that idea? Or is it just something that's not affordable or even thinkable when you've got a really emphasize the technology competition with China?

MR. KENDALL: I'm not focused on that. I'm not focused on calling in strength or squadrons or airplanes. I'm focused on the capability to carry out the operations we might have to support. And essentially, it's the ones I talked about earlier, defeating aggression.

If you can't defeat, if you can't deter or defeat the initial act of aggression then you're in a situation like we're seeing in Ukraine with a protective conflict. And nobody knows right now how long they're going to grind away at each other in Ukraine. We don't want to be in that mode.

And having a very large force supports that kind of fighting. But the force that we have really needs first and foremost to deter that act of aggression and if necessary, defeat it. And so, I am more focused on quality than I am on quantity right now.

And an awful lot of the equipment that we have is old. Our average age of our airplanes is 30 years. And it's growing every year right now. And the replacement of the AWACS that we're bringing in is going to dramatically lower the cost of sustainment. So I

rather have that platform which also brings a lot more capability. I'd rather have that platform than the current state even though the current state might be larger.

So size isn't what I think is important to me. It's quality and getting as much quality into the force as I can as fast as I can.

MR. O'HANLON: And along those same lines, if I could? Invoke David Akmatic (phonetic) the former Pentagon official and grand scholar who has written about a suite of technologies that he thinks would be very helpful for stopping China from seizing Taiwan with an amphibious assault. And they include antiship weapons, but they also include potentially, you know, easily launched unmanned aircraft that don't require runways. Therefore, aren't as vulnerable to preemption on the ground. Maybe even unmanned systems that can loiter in the Western Pacific and deploy sensors or antiship missiles quickly.

Do you agree with that kind of a vision? And is there much thinking or much headway with this budget and the budgets to come about developing and deploying those capabilities?

MR. KENDALL: We're thinking very broadly about our capabilities. And some of the things you mentioned are in the budget. Other things are under consideration.

You know, I think C.Q. Brown talked about accelerating change or lose. You know, as I've walked through the operational imperatives and I've looked at the results of some of those study efforts. You know, when I'm talking to people is this is the change we have to accelerate. And I think you have to be willing to let go of some of the long-held assumptions about how we do business and how we put the air and space forces in particular.

So there a transformation nature to all of this. And I think we have to be open minded in our thinking about all sorts of new concepts.

MR. O'HANLON: You talked about the importance of deterring war or preventing successful aggression by an enemy in the early phases, which is very much in keeping with a lot of how I try to look at these problems.

And I wanted to frame a question to you therefore in these terms. As we look at the new technologies that are under development including the famous hypersonic missile systems that are, you know, the talk of the town these days. And various ways of improving lethality. And of course, Secretary Mattis talked about improving lethality and did it at all marines, you know, sort of panache. And it was sort of very appealing and inspiring.

But I wanted to ask you about lethality versus resilience and survivability because sometimes I worry that we need the resilience and the survivability more than we need additional lethality. Obviously, it's not an either/or and you have to do both. But when I worry or look at space systems as you point out in, you know, some of your testimonies largely legacy systems that are now much more vulnerable than when they were put up there.

Are Command in Control systems vulnerable to cyber-attack? To fiberoptic cable interruption? Various other kinds of ways that are -- we can almost be paralyzed, blinded and rendered, you know, sort of down on the mat for a month or two or three during which an enemy hopes to achieve its goals? I worry more about that than I do about the Chinese beating us to some new form of lethality. Am I off base or do you agree with that?

MR. KENDALL: I generally agree with you. I have enormous respect for Jim Mattis. He's a fantastic human being. Very bright. Very abled commander. Did a fine job as the Secretary. But I would say that he was mistaken in his emphasis on lethality. That the problem of the United States has when you look at a competitor like China is survivability.

And it's the fact that we depend upon a small number of high value assets.

Whether they're satellites or foreign air bases or aircraft carriers or logistic C3 nodes. Many of these were fixed or at least they're very predictable in terms of where they're going to be or they're relatively easy to follow on said move across the surface of the oceans or the earth.

So making sure that those things are resilient, you've got to survive to get into the fight. And once you're in it, you've got to survive long enough to be effective. So I put that higher on my list. And it's the animating reason behind most of those operational imperatives. It's the threat or current capabilities that's driving me more than anything else. We do need lethality.

We do need some hypersonic weapons in our inventory and we're working to gain those. We need the ability to engage moving targets particularly. And it's going to be hard to do that from hypersonics. We're going to try.

And you mentioned the (inaudible) I think earlier and our ship capabilities. We are acquiring some of that. The air force can get to the fight more easily than anybody else can. And if it's about stopping a sea more invasion then antiship capabilities are going to be important to us. So we're moving in that direction.

So there is a lethality piece here. I don't want to minimize that, but the thing that animates me more than that right now is making sure that our forces survive so they can get into the fight.

MR. O'HANLON: Excellent. Well, I have three questions from the audience and with your permission, we'll pose those one at a time to finish up. And really again, appreciate very much this conversation.

One begins with sort of a, you know, mundane but very important topic. I'm sure you'll agree. Are the pilot shortage and combat readiness issues in the air force today manageable? And do you have enough budgetary room to prioritize addressing whatever

severe problems you may have in those domains?

MR. KENDALL: We have a shortfall in pilots, but it actually turns out in effect to be a shortfall in rated staff officers. We have people that -- the pilots we have are more than enough to fly our airplanes. But we have a lot of positions that are rated for rated officers so that you have someone who has that experience in staff position officer. So in that sense, it is manageable from the point of view of operational capability.

What we are watching the demographics of that. You know, we're watching what goes on with the commercial world as the economy heats back up and people are, you know, attracted to the commercial aviation. So it's something we have to manage. We came down about 300. We dropped from like I think 1,900 to 1,600 from our shortfall last year. So we're making a bit of progress.

We're changing how we're train pilots. One of the other things we're doing in this budget is starting to divest the T1 because it's going to take people directly. This is our multiengine trainer. We're going to take people directly from their initial primary trainer over to through simulators and then into their objective aircraft that they will be flying for multiengine people basically. And that will actually be more efficient. It will probably get us better pilots actually in the end.

So we're doing some things like that to kind of to help and move the line forward. We are offering some bonuses. So we're doing somethings to address it. It's not a crisis level. I would say it was at a manageable level today. And I think the steps we're taking will probably be adequate to keep this at a reasonable place.

MR. O'HANLON: The second question is about Ukraine. You already mentioned that Russia failed, of course, to establish air dominance and that's really cost it. But the broader question that comes from the audience is what lessons about the use of air power have you learned in the war in Ukraine so far?

MR. KENDALL: Well, the other side of that is that the Ukrainian's use of air defenses was very effective. And to this day, Russian pilots are trying to stay out of the range of Ukrainian air defenses. And this is a mix of older Soviet systems that Ukraine had plus some modern systems. Now, even these are relatively old now, Stingers, for example.

So there are tactics that they use were reasonably good. The Ukrainian side to keep those air defenses alive. Keep them survivable. So being able to suppress air defense is going to be critical to gaining air superiority and having a chance to operate in the air and do the things you need to do so that's true going forward.

It's also true that some of the more advanced capabilities that provide protection for aircraft are going to be important. Jamming suites, countermeasures that sort of thing. So there are some good lessons in there I think for us to learn from, but we've got to be careful. We still have aways to go here and we have to do a lot, and I'll sort it all out.

Another thing that we're seeing and this is not the first time is the effectiveness of drones, this antiarmor capability. This was true in the (inaudible). It's true here in Ukraine too. The Russian armor is taking very high losses due to a combination of ATGMs. Systems like Javelin as well as systems that are unmanned air vehicle delivered.

MR. O'HANLON: And the final question from the audience and I may try to throw in one last one myself if that's okay? But this comes from Colonel Akiteru Makita (phonetic) who's with us this year at Brookings but he's in the Japanese air self-defense forces.

And he's asking, in fact, about Japan's role and other allies. What do you expect from allied air forces to address the China's threat? And in particular also should Japan be acquiring counterstrike capability to help in that regard?

MR. KENDALL: That's a great question. I'm not going to give advice to Japan about what they need for their own defense. But one way to deal with the missile

threats we face is to, you know, attack those threats before they get the chance to launch. So I think it's something that's certainly worth thinking about.

I think increasingly the interoperability of the United States working with us together to ensure the concepts like agile combat employment can actually be done effectively. Or as you work on battle management working with us to be interoperable so that we can share information. One of the things that's true in Ukraine is that the information that the United States and our allies have been able to share with the Ukrainians has made a big difference in terms of their capability to resist the invasion.

And I think we could do much better actually than we're already doing with Ukraine in that regard. We have close allies where we had a chance to really work together and integrate our capabilities. So I think those are things that would be on my list certainly. And commonality in things like munitions, for example. The more we can do to provide the opportunity to work together, effectively operationally and support each other, the better off we're all going to be.

MR. KENDALL: Fantastic. My final question is, sir, just to give you an opportunity to tell us about any new development in technologies that you're particular excited about that's been happening recently. Whether it's in the realm of hypersonics or directed energy or robotics or artificial intelligence.

I'm not asking for a comprehensive assessment across the board. And I know you'll be testifying plenty with a lot of detail Q&A on many of those specifics. But I wanted to just give you a chance open ended to talk about one or two of them where you're particularly enthused or feel it's important for the policy community to be aware of some of the exciting things that are happening.

MR. KENDALL: The one that I would put first on my list and it's one we're going to be vesting in is autonomist behaviors and artificial intelligence decision support.

Again, the gamble that I'm making in the tack air case for sure is that we're going to go ahead with unproved combat aircraft.

We're going to use technologies that are coming out of programs like the DARPA ACE program, like Skyborg, like the Australian Loyal Wingman program and others. And we're going to integrate those into an operational capability and field it. And it will be the first time we've done that. And I expect that those platforms to be able to use carry centers or communication devices or weapons or some combination thereof or maybe countermeasures, self-defense capabilities.

And we're going to open up a whole range of tactical behaviors. And I think the technologies are there to support this now. And I don't think we need to wait for more development on that. It does invoke some really interesting questions about human control and the degree to autonomy you're really willing to tolerate operationally.

The problem we're going to have is that if we don't go in that direction, we're going to lose. As some of our competitors are not going to be as constrained as we are by those things. We need to work those problems as we mature the capability in order to field that. I'm a human rights lawyer. I am absolutely committed to the law of war and the insurance that we follow those rules. But we're going to have to figure out how to embed that capability and hold people accountable for what they do still even though a machine maybe acting as a proxy for the human to some degree.

And put meaningful controls in so that we can control how those systems are used. So there's work to be done there. But I think we're going to move in that direction and I think it's going to happen in general whether the U.S. does it first or not.

Some of the other things on your list, Michael, I'm interested in. I'm watching closely. I've been watching directed energy weapons for about 50 years right now. I've only been watching quantum computing for about 10. There are some applications for

growth in energy now that are interesting and we're pursuing those. But I don't see those as being really panaceas for really the source of such dramatic change on the ballot for those that I'm seeing with autonomy.

And I think it's -- I don't think we're late to the game on autonomy, but we still need to move fast on it.

MR. O'HANLON: Mr. Secretary, this has been great. Packed so much into 45 minutes and a really interesting conversation. Thanks for all your doing over there and thank you for joining us today at Brookings. So best wishes and good luck with Congress and everything else in the days and weeks to come.

MR. KENDALL: Thanks, Michael. Great to be with you guys. Thank you.

MR. O'HANLON: We'll see you. And now everyone else, we will make our transition to our panel so if you're at home, of course you can grab yourself a cup of coffee, but please don't take too long because we're going to launch right in.

I'm going to have the privilege of introducing some friends and colleagues and then we'll ask each to follow up with a little bit of reaction to what we've just been discussing, what I've been discussing with Secretary Kendell. But also, more generally about the opportunities that they see for the future of American and allied air power. And depending on how the Brady Bunch Blocks are lining up on your screen.

``I don't know where Rebecca Grant will be for you, but she's right below me on my screen and she is a remarkable civilian analyst of air power who has been at this business far longer than you would guess by looking at her. But of course, she got her Ph.D. in economics when she was 25 so I guess she's sort of had a head start compared to a lot of the rest of us. And one of the most prolific authors and analysts on the general subject that we're discussing today. So I want to welcome Rebecca. She's going to speak first.

Then we have three remarkable, accomplished executives from industry.

And from three different very important companies making a lot of the technologies that Secretary Kendell was just asking industry to -- first of all, thanking them for what they've already provided. And second, asking for their continued help and their creativity as well as following through on contracts or requests for proposal that DOD may offer.

And on my screen, I'll begin with Steve Mueller. And as you can see, he's with Lockheed Martin. He's a retired air force, three-star general. He was the Inspector General of the air force before stepping down about or almost a decade ago. And now, he directs programs at Lockheed that concern the U.S. Air Force.

By the way, I should underscore that we're talking about air power at large today. And even though I just interviewed the Secretary of the Air Force, your questions and the comments of the panel can certainly extend beyond just the U.S. Air Force and U.S. Space Force to other military services in the United States and beyond.

And then to the upper right on my screen is Kevin Mickey with Northrop Grumman Corporation who is responsible for, as they define it, many of their air dominance related systems.

And so, this certainly involves airplanes like the Super Hornet and the F35 where Northrop has an important role as a partner to Lockheed, but also the B21 and many other systems including Command and Control, some of the resilience of that sort of backbone of our defense sensor and nervous system capability that Secretary Kendall was just talking about. And he is the Senior Northrop Grumman Corporation executive overseeing those programs.

And finally, Mike Moeller, another retired three-star air force general with a great deal of experience in uniform in planning and programming, but also in combat with I think some 670 combat authorities to his name as well as now a remarkable seven years or so of service with Pratt & Whitney. And he's focused there primarily on aircraft engines for

American and allied air forces around the world.

So everyone welcome. Really nice to have you here. Thank you for joining today. And I think I'll go in order just as I laid out your introductions beginning with Rebecca. Let me just begin with a simple question for all of you of what did you pick up on most that you were most struck by that Secretary Kendell talked about that you either want to echo or expound upon or even disagree with as you might wish? But that you find just important for us to add to the debate today about the future of air power? Rebecca, thanks again for joining and over to you, my friend.

MS. GRANT: Thank you, Mike. And let me tell you Frank Kendell never disappoints whether it's his interesting insights on Ukraine and the role of information sharing. His discussion about how that lethality focused from General Mattis wasn't quite the right thing. Or, you know, most of all two things that I got out of this first, his seven priorities, which have remained pretty consistent across his time as Secretary of the Air Force. So I think he really means it.

We really need to get that space order of battle right and then take it all the way through making sure this sustainment is correct. But what struck me today, I say just three things if I can run through them.

Yes, we're watching Russia, but China still remains the facing threat. Next was okay, clearly Kendell is building an entirely new air force behind the curtain. Can't tell us too much about it, but it's going to use space more. It's going to use uncrewed aircraft in completely new ways. It's ready to go almost in the R&D money. And that his forecast about his production money requirements really tells us how close this is to being ready.

And finally, I'm sure all of you as well were struck at his really quite interesting comments about the need to rely on autonomy and then what is the -- you know, not so much the tactical piece of that but what's the operational equation where you keep

that human come in and control at some level, but you absolutely have to go to autonomy. I mean he didn't say it, but really it was autonomy or lose the fight. That's what struck me.

MR. O'HANLON: Excellent. Thank you. Perfect framing to start our conversation. So now, General Mueller, if I could go to you? And then I'll follow up again with Kevin Mickey and then Mike Moeller.

MR. MUELLER: Yeah. Thanks, Michael. And it's always great to be on with this panel and particularly honored to be on with Rebecca as well. She's been a great partner for a lot of years in this industry. And I think we owe her a lot for the words that she puts out there.

But like everybody else, we're always impressed when Secretary Kendell talks. He is eloquent in the way he brings across where and how he's leading the air force from that position. The seven imperatives that he's described. He's been very, very consistent with that. It's very helpful from the industry side to see what I would say is mission focused as opposed to platform focused.

And that mission focus that comes across in those seven operational imperatives helps us on the industry side solve those gaps that are in there. And he alluded to two things. One was mostly transformational, but there's an evolutionary way to solve some of those as well. If you caught some of that it was connecting and using existing platforms as you build towards new platforms, right?

And new capabilities that you bring online, you are still going to have a force that's out there that's going to take many years to transition from. And you have to have that force be effective while you're there. And I think that's a good part that we stay aligned with on that. So those mission solutions, I think are going to be great. And particularly when you look at the very high-end demanding missions that you would encounter in a Chinese scenario. So I'll stop there.

MR. O'HANLON: Thank you very, very helpful. If I could go straight to you, Vice President Mickey?

MR. MICKEY: Thanks, Michael and to the other panelists, a privilege to be on with you today.

As we listen to Secretary Kendell, I'm always encouraged with how aligned the Northrop Grumman portfolio is with his operational initiatives. We play a role in every one of those. And I'm also encouraged by the discussion about the increasing in the R&D budget. That just speaks to me how many innovative ideas are out there for industry to help the war fighter and the DOD solve its toughest challenges.

There's a lot of ideas to bring forward. And as we move into the digital transformation and the digital future, our based system engineering, data analytics, digital design manufacturing to test and employment to operational sustainment. I think that we can move more quickly on the frontend of those things and bring those innovations to solve those seven imperatives to the field more quickly. I'll pause there.

MR. O'HANLON: Thank you. And I'm going to have some follow ups to get into some of these specifics in just a minute. But first, General Moeller, good to see you again. Thank you for joining and over to you.

MR. MOELLER: Thanks, Michael. And like everyone else, I'm really pleased and honored to be on a panel like this. And to be actually see you again, Michael. It's been too long.

You know, I took away the exact same things from that the panel has outlined. But what struck me is that underneath all of Secretary Kendell's comments, it was how he's balancing maintaining our competitive edge in capabilities. And balancing that against the need to increase capability because we know that numbers matter.

From a capability standpoint, his seven imperatives, he really talked about

maintaining and extending our technology overmatch in low absorbables, weapons. He is a big, obviously, proponent of our maintaining our advantage in advanced propulsion, which is of key interest to Pratt & Whitney.

And then talked about disruptors like AI and autonomy. So that from a capability standpoint and then from a capacity standpoint we know that over the last three, four decades that the fleets across all of the services have dramatically shrunk in size. But the way he talked about rebuilding capacity is by rapidly speed to ramp for production, increased weapon systems reliability and then a robust industrial base.

And then his seven operational imperatives, he talks about the collaborative combat aircraft, CCA, as a way to increase capacity so that we've got the numbers we need to sustain a long campaign against a near peer competitor.

So those were the takeaways that I got from the Secretary's speech.

MR. O'HANLON: Thank you. And I'm going to build on that to ask my next question of each of the four of you. Maybe we can stay in the same order as well, if you don't mind.

And that would be -- and you can get into -- excuse me, I've got police car going by on Massachusetts Avenue so I hope this doesn't disrupt too much. But let me put it this way. You can feel free invoke some of the specific things you're doing with your companies or just speak more generally about technology. Where do you see an example of an exciting new development that's going to help us solve one of these seven challenges more effectively than we have been, let's say, in the last five or ten years?

But also, where is there an enduring difficulty or obstacle to making headway that really concerns you from a national security perspective? Where as hard as your companies and your engineers maybe pushing to try to be innovative, it's just a hard problem to solve and it is going to be with us for a while?

So sort of a good and a bad story or at least I should say, a more encouraging one from a U.S. national security point of view. And then an enduring difficulty if that question or that framing makes sense. Rebecca, over to you please.

MS. GRANT: I'm just going to go straight to the really tough problem because it was very central to everything that Kendell wants our air force to be able to do. And that is -- what were his exact words? But basically, it was left of launch. We want to hit those mobile targets before they launch.

How long have I been in this business? And everybody has wanted to do that. I mean, I'll admit it's gotten more critical as we look at the number of mobile targets that are piling up. Whether that's, you know, in China or just any place else.

But I think that remains a very, very tricky thing to do. And I gather from him that, you know, he's looking also to increase the space-based abilities to help with that problem. Good, go do it. Again, that's usually where the magic answer has to come from is from space. But I'll let the gentlemen go ahead and comment from their own perspectives.

MR. MUELLER: Yes. So, Michael, I think a lot of things. If I'm going to pick good, I think is this idea about autonomist and I'll say one of the key to autonomist operations when he talked about crewed and uncrewed teaming is the ability to connect those forces. And I do think like he's said, we're way more closer to that than we are further away from that.

We demonstrate that almost every day right now in our ability to do that. If you look at just the fundamental way that we operate some of our newest fighters like F22s and F35s. They're connecting with each other at levels that were never seen before in previous forces. The idea of extending that to an uncrewed force is really not a big leap. It really isn't.

When you talk about the bad though over that? I'd say we're still stuck in a

bureaucratic community of long test programs and how to change those ideas that you have to actual programmatics. And I said so we've demonstrated this multiple times, but they effect a lot of the existing programs that you have today. So you have to essentially have programmatics in each of those, I'll say, existing force structure to be able to make those things real for the future.

And when you add the burden of test it before you buy it that's where I think our nation is really behind in the test infrastructure to support testing to move faster in these areas.

MR. O'HANLON: Thank you. Kevin Mickey, to you please.

MR. MICKEY: Yeah, thanks. Mike brought up CCA and we've talked about uncrewed vehicles. You know, for Northrop Grumman this is an opportunity to build on a long legacy of uncrewed vehicles from landing on a carrier to aerial refueling and bringing affordable mass to the fight.

So as it's been referred to in some cases as a little buddy. You'll have an operator and you'll be able to bring sensors. You'll be able to bring weapons trucks. You'll be able to bring, in some cases, decoys to the fight without one aircraft having to be everything to all options that you need in the battle space.

So for us that's an exciting opportunity. It's a way to again bring affordable mass to the fight which I think there is some quality or quantity as equality all its own when we talk about these future engagements.

On the hard side, it's just that it needs to be worked on. We're looking at fighting a fight that's at much greater distances than what we've been used to in the past. And so, range, range and range are important for these future aircraft. Couple that with speeds, survivability and the advanced weapons needed to employ in those situations. That's just all technology that is not overly complex but something that we need to bring

together in one package or in this case the multiple packages that we talked about for uncrewed and manned vehicles working together.

MR. O'HANLON: Excellent. General Moeller, over to you please.

MR. MOELLER: Well thanks, Michael. Yeah. I'm really excited because we're on the precipice of a great leap forward. The next leap forward in aircraft propulsion from new engine architectures from power and thermal management, digital controls and a robust industrial base that can sustain this great leap forward.

I think that that is the greatest opportunity. You know, all that enables greater range, more time on station, speed or acceleration along with -- and range at the same time is something that we know that the war fighters absolutely have to have as we look towards the future.

So I believe that it's just so exciting for us. The challenge is as it's very similar to what Steve and Kevin said. It is changing the culture internally and externally. It's very difficult when we're talking about propulsion systems for uncrewed aircraft that really are going to only -- the U.S. air force or the U.S. navy, the services only needed to fly 20 attributables. So they need a propulsion system that is affordable and isn't built for 5,000 hours.

And so, changing the culture internally from our engineering -- especially our advanced engineering force is something that we're laser like focused on. At the same time, we have to have the U.S. government, the services also service partners in that role when we talk about what they call attributables and expendables.

MR. O'HANLON: Let me ask, maybe go in the reverse order this time. But following up on this line of reasoning where you're all making really good points, and largely agreeing with each other.

But what I want to understand what's the top challenge for this kind of

innovation and in making it go faster? And what's maybe a possible way forward? Last week, we did an event involving the Assistant Secretary of Defense for the industrial base as well as John Ferrari from AEI, retired General Ferrari.

And he talked about maybe being willing to buy smaller batches of more systems. Sort of the opposite logic we've seen with a lot of what's happened in the last 20 or 30 years. So for example, you're all involved in the F35 program. I think it's a pretty impressive program, but we certainly put a lot of eggs in that basket and we continue to. And maybe now we're seeing the benefit. I think maybe there have been a lot of kinks worked out of the F35.

But in a sense what John was saying, he didn't directly speak to the F35, but he did say having maybe more programs so you can afford for some of them not to turn out so well. And you can afford for some of them to wind up being more of the first iteration that you learn from rather than depend on fundamentally in combat. Is that part of the answer? If I could start with you, Mike Moeller?

MR. MOELLER: Well, Michael, you know, as I think about it, you know, in a perfect world if I could take the rapid capabilities office in headquarters U.S. Air Force and expand that at large to go forward with acquisition programs, I think that would break the culture of these long, long acquisition programs that with embedded bureaucracy at multiple levels. So that for me on the government side.

On the Pratt side, over three years ago we stood up an organization called Gatorworks, which is -- obviously, we modeled it on the Skunk Works with the idea that this is a separate business unit that operates with -- takes advantage of the power of Pratt & Whitney, but it's an independent business so it's freed up the bureaucracy. And what we found is that -- and willing to take risks. And what we found is that it started very small. Now it has grown. And what we've seen is that that is our change agent. It is generating change

across big Pratt. And so, that we took -- we used the RCO as an example internal to Pratt and then expanded their knowledge.

MR. O'HANLON: Right. Kevin Mickey, same question to you if I could please?

MR. MICKEY: Yeah. Mike used the term several times culture. And he's spot on, right? We have to change the culture of wanting to move at a very measured pace probably thinking about the risks associated with that.

Well, there's a risk in this new paradigm with moving too slowly that we have to consider. And so, there's opportunity I think for digital transformation to move much more quickly than we have in the past through the proof of digital models, through the proof of simulation. It's building a trust using those tools that will allow us to do that in a digital environment. And then bringing those things to the field much more quickly once it has concluded that those are the right solution set.

So I think there's a lot of opportunity in the digital future, design manufacturing, test and fielding and then ultimately operations and sustainment through the digital transformation.

MR. O'HANLON: Great. Steven, please.

MR. MUELLER: So I'm going to start by agreeing with Kevin a little. You know, we can bring things faster with the digital world and that's true. But I'm going to disagree with the premise of more programs and less production.

There's a capacity issue that's always at stake with this. You can spend all your money developing multiple programs and getting good at it, but if you actually don't buy anything the war fighter has no capacity to do that. And so, capacity is a capability all of its own and requires production.

And so, people talk about changing. And you have to look at the whole

spectrum of operations. And you say, you can actually change faster than the war fighter can accept. Think of all the things that go into it. You know, a system whether it's training individuals. And if you're changing that every day, they are not as capable as if they had maybe a little bit less capability, a right rhythm of that.

So I think that's the balance. I think we're off right now. I would say in the last year we spent more time demonstrating and less time producing. And thus, production is one of the things that you look at sort of air force systems in general. They continue to age at a dramatic pace because we're not actually buying the new systems that are out there. So just testing, developing and bringing forward new without production is not an answer in my opinion.

MR. O'HANLON: Thank you. Rebecca, same question to you please.

MS. GRANT: I certainly agree on production, but I'm just going to take this a little differently. I think that Thomas Alva Edison's 400 ways not to make a light bulb is a little bit dated. We don't necessarily need to buy a lot of failed little programs to advance. We can do this so much more quickly now, but I think that two things hold that back.

One is sort of the executive agency of our service secretaries. You know, look, Mr. Kendell clearly really knows what he wants and what he needs. He needs to be able to go and buy that without the albatross of big, joint program bureaucracy. Of course, the prime example the F35.

The other problem, I think is very relevant to how we keep pace with China and that is that our top defense companies need to be in an environment where they are -- their senior management is not risk adverse. We've all been talking all week about Elon Musk. He's putting $40 billion of his own money into or half of his own money and half his finance into buying Twitter because he felt like it, okay?

A tremendous move. I suppose there's a business case behind it, but the

bottom line is he didn't really have to answer to anyone. He was able to make this risky investment because he wanted to, okay? And a lot of times that's a quality that gets lost when you've got a large successful company with primarily a federal customer.

So that federal customer has to say to our top industry because that's where the talent is. Hey, go on. Invest. Do it. You know, it's all right from that monetary side. And that's very, very difficult but we need to shift that culture as well in order to keep our development going as fast as we're really able to do it.

MR. O'HANLON: So I want to come back to the question. I want to talk a little bit about cyber and AI. And there's some questions coming in from the audience as well. And maybe I'll try to weave this into a little bit of a two-dimensional or three-dimensional question. But I hope it coheres enough to be answerable.

I guess part of what we're getting from the audience and it's on my mind is the ongoing vulnerability of American kinetic control and weapon systems to cyber-attack. And I've seen a number of studies as have you over the years on this including, for example, the defense tie in sport in 2017 that said there's basically no system in the U.S. inventory we could totally vouch for, for a cyber resilience.

One part of my question is how much better have we gotten at protecting our cyber systems? You know, the debate sort of looped onto the excitement of AI, but I'm almost more caught up in the old fashion question. It's becoming old fashion because we've had Windows software and whatnot now for decades. Are we really more confident than we used to be that weapons like the F35 won't get hacked? And if so, can you explain that?

I realize all four of you have many areas of expertise and responsibility. You may not be full time cyber experts, but I'm sure you think about this question. So to what extent have we begun to get better at defending our cyber systems? Because, you know, the hackers can get better too. And as we get more elaborate code and put it into

everything we run then in a sense we're potentially increasing our vulnerabilities even as we try to mitigate them in other ways.

And then I guess the related question if you don't mind me packing it all together is how should I understand AI? How would you, to the extent that you've thought about this for your own companies, your products or, Rebecca, in your own research. How do you best advise using this term? Because it's one of these terms that's gotten trendy to mean almost anything.

Like basically, any kind of advance computing is now at risk of being labeled AI or artificial intelligence. But I think the real meaning of the term is supposed to be a little more circumscribed and specific. And so, it's a big bin of digital questions. If I could put to you, to each comment in whatever way you like. But the fundamental thing that keeps me up at night is to what extent are DOD and obviously national infrastructure systems any more resilient? Any more survivable in the face of determined enemy cyber-attack then they might have been 10 or 20 years ago as we first got more serious about this challenge? Rebecca, do you want to try that one to start please?

MS. GRANT: Yes, I do because although I take your point about the cyber vulnerabilities from infrastructure all the way on down. Michael, there's some good news on this front. Somehow, Ukraine has managed to keep complete Command and Control from Zelenskyy all the way down to, you know, Rabizna (phonetic) in the Donbas.

And I think that keeps reminding us quietly of this little fact. I hope we've helped a little or someone has, but the whole -- you know, we thought based on 2014 and 2015 that the Russians would come in with their electronic warfare and that would be it because we did see that happen in Ukraine eight years ago. It got complete Command and Control. So what the heck. I think that's probably good news.

I know others want to comment here so let me talk about AI for a moment. I

remember someone saying, a F22 pilot saying, I've already got AI. I work with it every day in my cockpit, right? So a lot of it is there. What's the key definition? I think it goes to that breakpoint between the operational level of war and the tactical level. We're really talking about AI as enhancing tactical tasks particularly in an autonomous seeking weapon that can also send you BDA. And I think we're looking at -- we can look at a fairly circumscribed definition if we want to. And that's something important in that is that operational piece is not ever going to be AI driven. It's going to remain no matter how good it gets, and it's got a ways to go. It's going to remain something at the tactical level. That's kind of big airy-fairy food for thought so I'll leave that there. Thank you.

MR. MUELLER: If you're going in the same order, I'll jump in there.

MR. O'HANLON: Please. Please do.

MR. MUELLER: So I'm a bit again on the same page. On the cyber vulnerabilities, I think one of the things that I am more confident in than I was in the past is essentially what I'll call assured sources of hardware. And the elements that -- you know, the brains of some of that cyber software, the chips and that.

I feel more confident today that the sourcing of that is better than it ever was before and the understanding of that at the very mechanical level of that, we're a little bit more secure than we were in the past. I do believe you're always going to have a vulnerability for softwares going at.

But I think that advantage that we have today is if you move software faster, your old software becomes obsolete, right? And I think that's one of the things that you've seen in all of these systems is a faster turn in the software development. And that in itself helps you create some of -- delete some of the vulnerabilities that you have of longstanding software that's out there. It's one of the reasons why in the sort of commercial world you see the rapid updates that come out. They make lasting holes obsolete very quickly.

And on the autonomous front, I'm a little bit like I start with that. We had level of autonomy when you flipped on your autopilot, right? That was a certain level of autonomy, very rudimentary level, but, you know, you would have plain new go to a certain place based on what you had preprogrammed into that. And obviously, the more you can program into that with algorithms, the more autonomy that you can build into that.

So the question really becomes about where and how your man in the loop or man on the loop is where you want to have those decisions. And I believe that tactical level, it's very easy to have the man on top of the loop in that. And then when you get to that operational level that's where you're going to have to have the man in the loop in some of those key decisions that move forward with that.

But we're very close in a lot of that in the development of that. And I don't think it's something that's going to happen overnight. You're just going to flip a switch and it's going to be everything is going to be autonomous. We have that. We have some of it today. And I think it's going to be evolutionary as to where and when the individual is making the decisions in that loop.

MR. O'HANLON: Thank you. Kevin Mickey, please.

MR. MICKEY: Yeah, Michael, thanks. You know, cyber is in every conversation these days and everything we do. So I'm encouraged that we can overcome this to the point that was made by Steven. It's a cat and mouse game. It's ongoing every day, but the more quickly we can move, the more quickly we can implement solutions where we find vulnerabilities.

So the encouraging part is I think, you know, to each one of us in the industry. Cyber is in every discussion and we know that that's first and foremost a protection that we need built into our systems. And so, I'm encouraged by that.

On the AAI front, that's going to be a process to your point. AI comes with a

lot of different definitions, but it's how you use it is going to require trust that's built over time. It's going to be a decision-making age to start with. It's going to be optionality. It's going to be choices that are presented to the operator. And as the operator becomes more and more comfortable with using those choices and those options that are presented to them and finds them to be robust and to be the right decisions, the more we can build on the artificial intelligence and the machine learning to make more and more use of that in the future.

MR. O'HANLON: Thank you. And General Moeller?

MR. MOELLER: Well, a couple of things. So I agree with Rebecca and Steve and Kevin that I believe that over the past three to four years our cyber security across the defense industry right all the way through to the supply chain, to the supplier level has really improved.

And it's a combination of focus, resources and an understanding of how grave the threat truly is. And especially, for example, at Pratt & Whitney, our cyber security on the defense side on the military engine side was extremely robust. What we became concerned with was on the commercial side. Would a hacker come in through the commercial side?

So we essentially established cyber security at the levels across all of the company at the same level across all of the company so it encompasses our commercial engines as well. So that's the first.

The second is while engines have always been autonomous. So I'm -- from an autonomy standpoint, I'll just mention that I believe as we move towards more autonomous or AI platforms or capabilities, it just makes Command and Control and battle management even that more important. And so, that's why as one of his seven imperatives, operational imperatives, Secretary Kendell is spot on, on the importance of maintaining that a secure and persistent Command and Control -- it has to be global if we're going to move

into this new world.

MR. O'HANLON: I wanted to ask you each about the overall health of the defense industrial base from your specific vantage point and your companies and also more generally as you look out across the landscape. We know that Deputy Secretary Kathleen Hicks recently talked about the subcontractor base weakening and diminishing. And maybe 40 percent or so of it having been lost in recent years.

We know and I spoke last week with the Assistant Secretary of Defense for Industrial Policy Deborah Rosenblum and others on a panel discussion about recent efforts to make sure that we, as you all have been talking, we get better at vouching for the dependability of our supply chains throughout the weapons development and production process. And that we don't depend for components, for crucial components on overseas actors who may not be friendly.

And there was a specific list of technologies that included kinematics, forgings and casings. And a couple of other specific areas of technology where DOD wanted to get a little bit more concern and focused on mitigating these dependencies. And that I'd also to the extent you'd like to address this at the level of your own companies and the level of the larger American defense companies. And I want to thank all three of you for what you and your companies do for the nation. You support for us at Brookings. Your technology innovation. The fact that you put such excellent equipment in the hands of the war fighter.

But of course, the fundamental health of the defense industry is often debated. And some people think that there's too much profit. And other people think there's too much risk and not enough profit or at least not enough sort of long-term viability in the defense industry that firms can get too vulnerable to a specific program. And if that goes awry or off the rails, they could really be in big trouble.

So it's a broad question about your observations on the health of the defense industrial base. And at any level you want to address that. Prime contractor, subcontractor, foreign producer and supplier or what have you. And maybe Rebecca, I'll start with you if I could please?

MS. GRANT: About 10 years ago, actually there's a study for the air force on the industrial base. And one conclusion that which of course I was never allowed to show anybody. And the results of the data is not.

But one thing that really struck me was how little overlap there was in some of the key tier one suppliers. I thought that, you know, they, the big company, they would all use these. No, there were a few, but, boy, there were a lot of cases. And this was because program managers had developed and cultivated particular sources of supply.

So the only comment I want to make here because I want to hear from our industry gentlemen here is to say, you know, I wish that as DOD evaluates the health of the industrial base, there is one incredible resource. There's a group of men and women who know everything about the health of the industrial base. And those are your key program managers because they have -- these are their suppliers. They have to monitor their financial health, what they're doing, who they're buying from and that is a great untapped resource.

These program managers, they're very busy. They're very low to reveal who some of their suppliers are or to tell the government more about this less they get more regulations slapped on them. But that is a fantastic untapped resource. It's really our program managers are the ones who really know what the policies need to be like. Over to you, gentlemen.

MR. O'HANLON: Thank you. General Mueller.

MR. MUELLER: So, Michael, this is a terrific question and I would tell you

that I know that the Department of Defense is concerned about this, and I think rightfully so.

And I'll say predictably it's not as much from the primes that the problem is here, but it's really at the subcontractor level. And I think our subcontractor level right now for the defense industry is incredibly fragile. And what I mean by that is if you take a look at when it goes back to that discussion on production, right? If I'm doing the development of a new system and I buy ones and twos to develop that. You buy four or five of those articles that doesn't keep a supplier engaged and healthy.

They actually -- a supplier sort of thrives on volume, right? So any time you don't have volume in the system, they're going to struggle and their prices are going to up. And one of the things that we've seen, and it's a combination of the inflationary effect that's happening in our nation, the jobs COVID. We are seeing suppliers that would have initially report a delivery date of something like four weeks now turn to 10 months in terms of delivery.

So it's not a just delay of a few weeks or a few months. It's almost an exponential level of delay and associated with that is a cost increase with that. And so, as we see those costs grow, you know, it's one of those death spirals, I believe with the subcontractors.

And where we really see this acute problem is when you go to very unique suppliers on low volume things. Particularly you see in the hypersonics world where you might have one or two subcontractors that make a particular item. And you're asking them to make five or six of those a year, they're not going to have an ability to maintain a profitability to stay in the business. And so, it really is, I think an acute problem that we have to look at.

I think the primes, Pratt & Whitney, Northrop Grumman, Lockheed, we're fine in terms of the health of our programs. But we depend so heavily on those suppliers

that that's a problem facing our nation that we're going to have to address.

MR. O'HANLON: Thank you. Very clear. Vice President Mickey over to you please.

MR. MICKEY: General Mueller, I guess it's not just us? You characterized those challenges very well. And to your point about production, it really is for those second and third tiers suppliers. It's about production consistency. It's about how you can keep the demand signals consistent for them such that you can get a spot in their factory.

A lot of the challenges that we face are with suppliers that can do work for other industries and they're always looking for the opportunities to build a thousand of something, not a couple of something to the General's point. So we're struggling with that as well. We're rising prices, we're seeing longer lead times.

Another thing that we're seeing from the second and third tier suppliers is as our business is at the prime level and have become so robust and there's such a competition for talent. As you draw some of that talent out of those smaller shops that are more dependent on the people that they have, the tribal knowledge, if you will, that's within their businesses. As some of that talent gets drawn out into the larger industrial base. It gets harder. There's a shortage of talent out there.

And in many ways, we're trading talent amongst the primes. And we're in a different paradigm then we were many, many years ago where aerospace people were aerospace people. Today our systems and the complexity of those systems brings in software people. Brings in AI people. The talent that can cut across aerospace in Silicon Valley like companies. So the talent is a real challenge for us all at every level I would say.

MR. O'HANLON: Thank you. Mike Moeller.

MR. MOELLER: I have just one thing to add and I'll just carry on with the comments from Kevin on talent.

So one of the things that we saw during COVID was as the commercial side drew down, we have a shared engineering cadre at Pratt & Whitney both military and commercial. And we moved them based on where everything is at, where the business is. What we saw during COVID with the collapse of the aircraft production and engine production at the time.

What we found is that we didn't have projects for our engineering teams, advanced engineering teams to work on. So thanks to the U.S. government a lot -- essentially changing the rules during COVID that allowed us to pave forward or work in advance of contracts on advanced programs. We were able to keep that cadre.

But now, what we've seen is that if you don't have that consistent funding in RDT&E and in S&T. And you don't have a promise or at least an opportunity on a larger production program, what we found is it's very difficult for us to retain, as Kevin said, retain that advanced engineering talent at the primes. So that is my one concern about the industrial base at the prime level. And then I completely agree with the other panelists as we look across the industrial base.

MR. O'HANLON: Well, we're nearing the end. And I want to have just one follow up on that same topic but then give each of you the chance to add any final concluding comment you may want to as well as I begin to thank you for this excellent discussion today. Maybe we'll go in reverse order so starting with you, Mike Moeller, because I just heard all four of you make some very important points about the subcontractor base.

And you talked about -- a couple of you converged on the idea of steady, predictable procurement buys as being maybe the single best policy tool to mitigate those dangers and to strengthen the subcontractor base. But is there anything else we need to do as well? I mean is there any requirement for direct subsidies of certain kinds of firms? So

even when we do have an interruption in production, we can keep that firm somehow bought in. It's not a very American thing to say, I know.

We're supposed all be good free marketeers. And you probably don't want to endorse such an idea even if you might have some favorable inclination towards it. But is there anything else? Is there anything else besides just trying to have a healthy and somewhat stable, predictable procurement budget that can be a way to mitigate this risk to the industrial base. Mike Moeller, starting with you please.

MR. MOELLER: Thanks, Michael. I believe that we could take some of the lessons learned on how we essentially managed the defense industrial base through COVID and make the policy. Let's institutionalize those changes especially in high priority areas, for example, you know, hypersonics where the normal acquisition rules are still there but it is under the umbrella of whatever we want to call it, the rapid capabilities development, if you will.

But we essentially loosen the rules that really unleashed opportunities in the defense industry. And I hate to see us go back to pre-COVID where we're under the strict structure without taking full advantage of what we learned.

MR. O'HANLON: Thank you. Kevin Mickey over to you please.

MR. MICKEY: Yeah, thanks. I'm encouraged by the doubling of the R&D budget as Secretary Kendell spoke about. Every company wants to do innovative and creative and contributory work to our defense. They get up in the morning with the same reasons that we do, to serve the war fighter and to be good patriots for the country, and they want to do productive work.

So as we continue to see those R&D opportunities, I think the pride is bringing some of those smaller second and third tier suppliers into your research and development opportunities to keep them creative, innovative and robust as an ongoing

entity. I think can help them both their business and being in partners to us for future technologies.

MR. O'HANLON: Right. Thank you. Steven Mueller.

MR. MUELLER: Yeah. One thing I think is the increased use of the DX rating in the world. Particularly in some of these key components so that like Kevin mentioned. Some of them were competing with commercial industry on some of those capabilities, and we don't have the volume. Being able to get a prioritization out of the Department of Commerce helps with some of that as well for keeping those industries viable for us from the defense side.

MR. O'HANLON: That's essentially defense production that kind of stuff. Being able to prioritize DOD over other things if need be?

MR. MUELLER: Correct. And it's used, but I think it could use some -- in this particular time, more than we're using it today.

MR. O'HANLON: Thank you. And, Rebecca Grant, the final word to you please, my friend.

MS. GRANT: Yes. As the panel talked about. Creativity and bending some of the rules like in COVID and flexibility in the Defense Production Act. Hey, here's the one thing that would really help. Frank Kendell says a lot of this technology is ready to go. So multiyear procurement. The navy does it.

MR. O'HANLON: Excellent point. All of you have been fantastic. Thank you very much. It's really been a rich discussion. I feel very privileged to having been part of it. We're all grateful at Brookings again for all you do for the country and for us. And thank you for the excellent conversation today. So with that I will sign off from Brookings and wish our audience the best as well. And thanks for joining us today in this important discussion.

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