Space Resiliency

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Maj. Gen. Stephen G. Purdy, Jr.:

Well, good afternoon, class. We're going to talk about space resiliency on this particular panel, and so I'd like to welcome everyone here. I am Major General Steve Purdy. I'm the military deputy to the Assistant Secretary of the Air Force for Space Acquisitions and Integration, which means I'm a deputy and my boss owns all the space acquisitions. So let's talk resiliency. So resiliency is an interesting term. No one really knows how to define it. We all know we want it, and it's hard to tell if you have enough of it. So we're going to tease out resiliency in a couple of different big pieces, but I also want to look at it through a couple of different lenses. So chief of space operations has unveiled last year his competitive endurance theory of success. So the main thrust there, he talked about it yesterday and I think today, avoid operational surprise, deny first mover advantage and conduct responsible counterspace campaigning.

But also my boss, Honorable Calvelli, talks about his acquisition tenants. Some of the key tenants involve minimize non-recurring engineering, small ground systems, repeatable buses, fixed-price contracting, rapid production times. So we're going to talk on resiliency in light of these few areas. But on this note, let's introduce our panel here, who's actually going to do all the talking. So first I want to welcome Colin G. Mitchell. Colin is the vice president and general manager of RS Systems Division at L3Harris Technologies where he provides strategic direction for programs in position navigation and timing, space antennas, space protection and control and ISR. So thank you for joining us.

Next is Kyle Rice. Kyle is the federal chief technology officer of Virtualitics, an AI startup focused on applying commercial AI capabilities and defense challenges. Then finally, Matt Brown. Matt is a principal engineering fellow and the technical director for Air & Space Defense Systems at Raytheon where he is recognized for his work on space protection, service oriented architectures, satellite C2 mission management and small satellite technologies. So thank you very much, panel. Okay, we're going to start with some rapid fire questions. So I want you all to answer yes or no. You can start here closest to me and go to the end, and no waffling here. So number one, should the U.S. government use open source software? Yes or no?

Colin Mitchell:

Yes, absolutely.

Matt Brown:

And we can't afford not to.

Kyle Rice:

Yes.

Maj. Gen. Stephen G. Purdy, Jr.:

Would you consider the current state of open source software to be resilient?

Colin Mitchell:

No. Just because that's a big bucket that you outlined there, but the path to software resiliency is through an active code base that gets managed, used, rehearsed and maintained.

Matt Brown:

Absolutely not.

Kyle Rice:

I'd say some are, some aren't.

Maj. Gen. Stephen G. Purdy, Jr.:

Some are, some aren't. All right. In the near future, can the United States mass produce satellites and launch them in less than a month?

Colin Mitchell:

Yes, absolutely. Not only because we have to, but we can and that should be our goal based on the Space Force vision.

Matt Brown:

Waffle, define near term.

Maj. Gen. Stephen G. Purdy, Jr.:

Less than a month.

Matt Brown:

Oh, how soon, I think the challenge is how soon we'll be able to do that-

Maj. Gen. Stephen G. Purdy, Jr.:

Yeah, a couple of years.

Matt Brown:

... but I think in the future, yes.

Maj. Gen. Stephen G. Purdy, Jr.:

Yeah.

Kyle Rice:

I'm going with a hard yes.

Maj. Gen. Stephen G. Purdy, Jr.:

A hard yes. Very good, says the software guy. All right.

Kyle Rice:

What do I know about these things?

Maj. Gen. Stephen G. Purdy, Jr.:

Speaking of software guy, is AI mature enough for U.S. government use?

Colin Mitchell:

Yes. What are we waiting for?

Matt Brown:

Yes, we're using it in some places right now in deployed systems.

Kyle Rice:

Hard yes, on this one, yes.

Maj. Gen. Stephen G. Purdy, Jr.:

All right. Does the United States government even know how to use AI?

Colin Mitchell:

Does the United States government know how to accept AI? What does a DD-250 look like for AI?

Maj. Gen. Stephen G. Purdy, Jr.:

Right back at me, very good.

Matt Brown:

I would say industry can help here. I think this is where we can help.

Kyle Rice:

I'm going to go back to my some do, some don't situation.

Maj. Gen. Stephen G. Purdy, Jr.:

Ah, waffling, okay. Do you think you understand your company's supply chain?

Colin Mitchell:

Yes, despite the way you worded the question that implies that we don't.

Maj. Gen. Stephen G. Purdy, Jr.:

Do you really think that?

Matt Brown:

I'll say I started doing some research if I knew this question was coming and the answer is no, not completely.

Kyle Rice:

I'll go with a yes 'cause as a software company it's a little easier for us.

Maj. Gen. Stephen G. Purdy, Jr.:

Yeah. Is the U.S. supply chain resilient?

Colin Mitchell:

No, it's constrained and oversold and not big enough for the vision.

Matt Brown:

It's huge, so no.

Kyle Rice:

And no, we've used globalization for cost reduction but not resiliency.

Maj. Gen. Stephen G. Purdy, Jr.:

Finally, does the U.S. government understand its supply chain?

Colin Mitchell:

In silos, there's pretty good knowledge, different acquisition agencies and certainly you've gone deep on studies. But in terms of a holistic updated picture and understanding risks, I don't think that the government does.

Matt Brown:

Yeah, I think it's a big risk management problem, so the answer's probably not completely.

Kyle Rice:

I'm going back to my some do, some don't situation.

Maj. Gen. Stephen G. Purdy, Jr.:

Yep. All right, so let's get into the more long-form discussion and here we'll just have a conversation. I'll aim the question at one of you and then we'll just jump in as needed. One of Honorable Calvelli's acquisition tenants is building smaller satellites as part of that smaller ground systems, minimizing non-recurring engineering. Matt, with your experience, you want to start us off, do you have any thoughts on smaller ground systems and minimizing the NRE in terms of resilience?

Matt Brown:

Yeah, I'm really excited to be here just to talk about space resiliency. My background prior to this current position was about seven years working in space protection. I would say when you talk about smaller ground systems, we're doing this for the Space Force now in some of our classified areas. What that really means is using new acquisition approaches like 804 acquisitions, prototyping, minimum viable products, we recently delivered a system where we went that whole process of defining... The requirements actually came as informational in the contract, if you can believe that. Then we worked as one team with the government, with the CDAs to define what is a minimum viable product for this system. Then we were able to deliver that system actually five months ahead of schedule based on that working together as one team. It wasn't just the smaller ground system piece, it was also the fact that for a classified system, one of Mr. Calvelli's other tenants is, minimize over classification.

So we had to design an architecture where 95% of the work could be done unclassified, 5% was classified. So that 95% allowed us to actually complete the program, like I said early, but that was through COVID. So those are the types of things where those tenants actually can drive us to these

smaller systems that we have to deliver using agile software development techniques, DevSecOps, that allows us to continue to redeliver new capabilities every few months on top of that MVP, but you really do have the capability to deliver that small initial ground system. The last thing I'd say is back to talking about using open source software. On that program I was the chief engineer. I had a whole deputy chief engineer and team making sure that the software was resilient and that we could actually use that, but we would've never finished that program unless we had that open source software. That was the key.

Maj. Gen. Stephen G. Purdy, Jr.:

Colin, any thoughts from your perspective?

Colin Mitchell:

Sure. Buying down to NRE, we've learned from many small set disaggregated missions that we build at L3Harris, the power of reuse and the power of inventory. So I think a couple of things I'll say up here are some fairly nerdy statements about supply chain strategies and acquisition strategies. But to meet timelines to deliver a system like we have for SDA T0 Tracking from a blank sheet of paper to a launch hopefully this week in under three years. It takes some forethought, it takes some risk. It takes managing your supply chain through inventory, buying parts ahead of time to make that supply chain robust. Then reuse, of course, is the golden goose when it comes to buying back time. As we all know, time is the most expensive element on any bill of materials and the biggest element of risk to the theory of success that's been outlined.

Maj. Gen. Stephen G. Purdy, Jr.:

Kyle?

Kyle Rice:

So what I really like about what Space Force leadership is talking about here is it's all about procurement improvements and getting things in the air faster and how to streamline that. Why that excites me from an AI perspective is one of the areas of AI that's getting a lot of uptake around DOD is around project assessment, which is essentially using AI techniques to look at the data that we're collecting. We collect so much data in terms of how we build things, in terms of the procurement docs and in terms of the financial documents, in terms of the delivery schedules. When you run models against those, you can really get good feelings for what are the attributes that make systems successful, make projects successful?

So in a situation like this, that's a super interesting use case there because one, you can do tactical things like "Hey, this project may be getting off the rails 'cause it's doing certain things that are not associated with successful on-time delivery." But also at the leadership level, what that does is it gives you oversight things. These are the kinds of characteristics we want in our projects 'cause they generally means they'll be delivered on time and on schedule. So I love that you're capturing that kind of data so we can do some good stuff with it.

Maj. Gen. Stephen G. Purdy, Jr.:

Let me throw an ad hoc add-on to what you were talking about. So on the minimizing NRE and more rapid satellite production, you've mentioned government being involved and surely, that would be a requirement from a requirements owner and requirements modification, but how much should the government be involved in that? Do you find that helpful or do you find that more painful and actually a limiter? I'll let either one of you fight for that one.

Colin Mitchell:

With friends like these. The government should be involved. I think when you look at an acquisition organization like SDA who's one of their tenants or one of the purposes or what they're trying to achieve is to expand capacity in the industry through short-cycle acquisitions, through rapid development and deployment, that's a top down approach. But we're back to the power of inventory, the power of reuse, a bottoms-up approach of focusing on components that don't need any development, making sure there's an industrial base, making sure it's available.

To use a nonspecific component, everybody sees a picture of a satellite, it has solar panels on it, easy to understand and not a real-life example. But solar panels, they should be built ahead of time. Not a ton of development has to happen in solar panels, but we tend to do it a lot for each mission. I'll tell you, if we're designing a system or there's a fast mission requirement, we'll pick the built solar panels every time to cut six months out of our timeline. Those need to be available, and I think the government can foster commodity markets or commodity availability. Right now, each contractor, each satellite integrator is doing it on their own.

Matt Brown:

Yeah, I think there always will be NRE, and really, when we talk about working together as one team, it's the acquisition, the war fighters all coming together to say, "Okay, this is what I think I need. What does that mean in terms of how hard it is to accomplish that requirement?" So working together, I think that was, in the previous experience I was talking about, was really the key where we would have those discussions together and evaluate that and say, "Is that part of what we have to have for this mission or not?" So coming together to make those decisions, understanding there will always be NRE and then deciding where is it worth investing the effort that need to meet the threat that we have against us.

Maj. Gen. Stephen G. Purdy, Jr.:

Kyle, from the software side, have you found the government to be helpful or more painful as you're trying to get faster?

Kyle Rice:

Absolutely love the government. Come on, now. The one thing I really do like about the government aspect is that, from an AI perspective, there are certain things that really are governmental-only functions, things that the government is much more interested in than other pieces. One of these I would say, is explainability of AI, the ability to actually understand what's going on behind the covers. Because of the peculiarities of the government mission, that's often much more important in this space. So that's an area that's not always invested as much from a pure industrial piece, but that's something where the government can help to drive those pieces forward.

Maj. Gen. Stephen G. Purdy, Jr.:

Okay. Let me switch slightly, I'll stay with Kyle here for this one. From a software perspective, and if you all want to jump in on a hardware perspective, but we use the term MVP in software all the time, minimum viable product. It's a good thing when you're trying to achieve speed, but there's a natural tension related to resiliency. This panel's about space resiliency, and so if you want deep resiliency, MVP may not apply as much, so there's a natural tension there. Do you think MVPs are a greater path to resiliency? Is it just a step one? What are your thoughts on MVP versus resiliency from the software side?

Kyle Rice:

So from the software side, this is a little bit selfish, but I absolutely love MVPs. The reason why is 'cause you get more things happening more quickly. If you think, what I mentioned earlier about the project assessment piece, if you're in a situation where you're launching one satellite a year, there's not a lot of trending we're going to be able to do on that. But when you get in a true MVP environment where you're putting up dozens and dozens and dozens of these things, really, you can figure out what matters. You can figure out what really is the minimum viable level. So what that means is over time, we can algorithmically help you to get to a more resilient effort to say, "These are the things you really need to do, these are the things you don't," and you can get that resiliency trending upward.

Maj. Gen. Stephen G. Purdy, Jr.:

Okay.

Matt Brown:

Yeah, I agree. From an MVP perspective, a ground system is a perfect example of that. Finding what those critical requirements are and then continue to use agile development, DevSecOps to add functionality on top of it, it's really a great pattern. I think the trick is making sure you understand what the MVP is. That's where you have to really come together to bring everyone together to decide what those are. It is harder on the hardware side because you're talking about it's less easy to be agile from that perspective. You're a lot more focused on what's available, what's off the shelf. But I think it fits really well from the ground system perspective and from a software development perspective.

Colin Mitchell:

Yeah, I'm pretty passionate about the MVP concept. I think it's good for three things in a hardware context. It's good for proving a new mission or proving performance if there's doubt about that, getting something up there, proving you can do that mission for space, number one. Number two, it's good at setting expectation for a development team to stay out of tech development hell, or H-E double hockey sticks that we all grew up on the industry side and government side. It's useful for getting something up there. When it comes to MVP or resilient architectures, the weapon system is more than just the space layer. The space layer is the easiest thing to think about because it's what we focus on or the physical component of a weapon system. But I'd urge us all to think about MVP in other respects. The ground's a little bit easier, but when it comes to training, fielding, rehearsing, simulating, MVP is a concept that applies. You learn quickest through using, so get to using quicker and then iterate.

Maj. Gen. Stephen G. Purdy, Jr.:

That's a really good point on the, it's not enough just to launch the satellite and have a piece of hardware, it's the whole end-to-end system. So I'm glad you brought that up. Okay, let's switch to topic two, AI. One of General Saltzman's three tenets of competitive endurance is avoiding operational surprise. So a huge portion of that is obviously space domain awareness. As we mentioned, it's more than just the hardware in space or on the ground, it's really about the data and the analytics. As data growth in this area, you could argue is if it's not exponential, it seems like it's headed in that direction, there's really a limit to our ability to make sense of all that data. So Kyle, can you give some thoughts on this particular problem set from an AI perspective? Maybe give a quick AI 101 from a government perspective and then dive into it.

Kyle Rice:

Absolutely. No, I completely agree with you. The data volume is what's driving this in this direction. So I guess what I'll do, let me give you a quick overview, fairly brief on the four different types of AI that we're currently deploying within Space Force and Air Force. Then I'll pivot to how we're applying those to improve a resiliency situation. Keep in mind, the overall trend with a lot of this is you got a whole bunch of data. You're trying to figure out, "What do I care about? What's going to cause me problems in the future? How do I learn from that?" So that's the overlying talk track here. So for this, imagine you've got a bunch of satellites up there, a bunch of space debris and so forth, you're trying to see what's where and how that lays out. The first technique you'll likely use would be unsupervised learning techniques, and that's basically clustering techniques, it's graph techniques. It's basically, "How do I go from hundreds of thousands of things down to a few clusters that I can noodle through more efficiently?" So based on velocity, location, whatever, things of that nature.

So that gets you through that and gets you down a little quicker. The second technique you'll probably use at that point would be a supervised learning technique because generally speaking, you have some idea what you care about. In this case maybe you care about, "How do I keep comms my satellite?" "How do I predict when I'm going to lose comms with a particular asset?" So you want to cluster that by this is weather effects over here, this is based on other assets in the proximity. Over here it's based on maybe over flights, whatever, to see those because those are all important but to different types of people. So once you have that, then you can switch over to other techniques, neural nets, things of that nature where you can make predictions going forward. So I can say, "How do I determine in the future, these are the kind of characteristics that mean there's going to be a manmade event that will probably make me lose comms with my satellite?" Something like that.

Both of those techniques deal primarily with supervised, I'm sorry, with structured data. The third technique that we often use is natural language processing because a whole lot of data is unstructured. Really, all this is doing is tokenization terms and so forth to extract that out, put it in a more structure so we can use these other techniques against it. Key point about all this, all three of those are, again, what we call explainable AI techniques. What that means, you get your result, you can back it up. You can figure out why did the model suggest these things. Obviously, for certain use cases in DOD, that's very, very important. That brings us to the fourth type that we're using, which is generative AI techniques. Traditionally large language models is what we're using in this space. Basically, since ChatGPT came online a little over a year ago, we're all aware of the big changes that have happened throughout a lot of society, and there's been really some significant advances in terms of how we do work.

As an example, my wife is a high school math teacher. Don't tell her this if you see her, but she no longer writes college recommendations any longer. All she does now is proofread college recommendations, so significantly more efficient, also generally higher quality. So it's a fabulous thing and there's lots of good things you can do there. The one reasonably significant downside is this is not an explainable technique. You get to the end and at any reasonable scale, you don't actually know how you got there. There's no way to back that up. For some use cases that's bad. For some use cases, it doesn't make any difference. That's why we have this spectrum, in this case, these four and there's a few others we use as well, but that's why you have all these things in the toolbox to bring you forward here. So with that as a background, one example of where this is working actually very well at Air Force Global Strike, so we've been working with them for about three years, originally came in to apply AI to improve operational readiness.

Additional stages were mostly around maintenance, "How do I improve and understand what I need to work on?" Rapidly became clear as we modeled through that, that as you might expect, readiness is much more than just things that need to be fixed. It's a significant logistics component around parts and around supply and inventory, significant personnel aspects, "Do I have the right people? If I don't, can I get them trained by the time I need them? Do I have the right specialized equipment?" Point is, all these

complicating factors and there's all this data that rolls together, but with the models it's not that hard. So what we do for them is we knit this out and say, "These are the things you need to do." It's been quite successful. They're testing it at the MAJCOM level over the last year, and they've had really good back testing results, so they're pushing it down to the wings now. So basically 500 maintainers are going to get access to this, which will be super exciting 'cause that's really when you see the value of the models and get the go, no go on the resilience there.

Maj. Gen. Stephen G. Purdy, Jr.:

Hey, quick ad hoc follow on. So you mentioned the different types of AI and you mentioned generative AI, so ChatGPT is an example. There's many kinds of LLMs. One of the fears and issues with those is hallucinations, false, positive, et cetera. Can you explain, do you have those kinds of issues in those other examples of AI or other similar kinds of concerns in those areas?

Kyle Rice:

So that's the distinction between those four types that I mentioned is generative AI is reasonably unique in the fact that it will create things. That's a lot of its strength is there is just a random nature to it, which is by design, that's why you generate something new, but sometimes what you generate is not actually accurate. You get those trade-offs, which is why you want to make sure you use that in spaces where you have an expert that can validate that. If you don't have that, then that's where you compare that. You use the other types of AI where it is more deterministic and you could say, "This is actually how we got here." You can back that up and you can understand every step that the algorithm has made. So it's kind of a delta.

Maj. Gen. Stephen G. Purdy, Jr.:

Okay, thanks. Then, Matt, you mentioned AI earlier. Do you want to explain what you all are doing?

Matt Brown:

Yeah, absolutely. So when we talk about this from a mission perspective, if we're trying to avoid operational surprise, we're really trying to shorten the F2 T2 EA loop. We're trying to do the fine, fix, track earlier, and so what does that mean? How can we do that? Well, one of the major challenges with AI is that data in a lot of these systems that we're trying to bring together are coming from a lot of different systems at different classification levels. How do you solve that problem to bring the data together so that you can use these different tools that we're talking about? That's really a challenge that we've had to attack in multiple places already. But on top of that, when you're trying to shorten that loop, what you're really saying is, "How can I automate steps in this process and make those decisions in a more automated fashion?"

Really, going back to the first three of those different AI technologies that we were talking about, how can I have what an analyst might look at, make a decision, have software make the decision about what it's seeing and then respond to orchestrate a system to maybe add an additional sensor to get more data. Those kinds of stacking those decisions together, you can do that in a decision support role where there's still a human on the loop and they say, "Yep, I agree, but then you can start to automate that and further reduce that timeline so that you can respond quicker and avoid that operational surprise.

Maj. Gen. Stephen G. Purdy, Jr.:

Colin, any other thoughts from your perspective or...

Colin Mitchell:

Sure. AI is in a category of tools. It's a productivity tool. It's an amazing productivity tool. I haven't written an award citation or some forms of emails since these tools have been available to us. Like you said, I'm just proofreading those things. I cannot wait for the day that I can teach Microsoft Office, our company and customer style guides and then just talk to my laptop like it's the Star Trek computer, saves so much time. I think from a resiliency perspective, what we need to get our arms around fast is how we... the tools are only as good as the data set and how much we audit and proofread the outputs we need to get through what is the first operational acceptance of one of these productivity tools in a mission-critical application? How do we do that? I don't think we necessarily have a way. Everybody's just doing it from scratch on their own trying to figure it out. So how do we accept one of these productivity tools and make it part of a resilient architecture?

Maj. Gen. Stephen G. Purdy, Jr.:

I'm actually going to throw another ad hoc on there, 'cause I'm really intrigued by what you said. So you actually use LLMs quite a bit is what it sounded like. Are you allowed to use those on your company computers or do you do that on your own-

Colin Mitchell:

No, I do that on my own.

Maj. Gen. Stephen G. Purdy, Jr.:

... computer systems?

Matt Brown:

Personal systems-

Maj. Gen. Stephen G. Purdy, Jr.:

Personal systems.

Matt Brown:

... say the same thing.

Kyle Rice:

In our case, we can use them on our company computers because-

Maj. Gen. Stephen G. Purdy, Jr.:

Company computers.

Matt Brown:

That makes sense.

Kyle Rice:

That's-

Maj. Gen. Stephen G. Purdy, Jr.:

The AI startup is using-

Kyle Rice:

... sort of our schtick.

Maj. Gen. Stephen G. Purdy, Jr.:

... company computers. Yep, there you go. No, that's actually interesting. So it would be nice to be able to use it at work. Okay. Let's switch to our third topic, our broad third topic here and supply chain. So it's not just enough to build the hardware or build the software. There's a whole supply chain that goes on behind it. When I was in my last job, I was the commander down at Patrick, and we were starting to get ourselves involved in supply chain, both of the space ports and the launch vehicle companies. We pondered a theory about supply chain analysis. A lot of times in supply chains we'll just go do a report and an analysis and just look at it and maybe we'll go action a few things.

But I started to wonder about operationalizing supply chains. Should we have an op center that's constantly looking and delving into the supply chain to understand dynamic effects around the world, geopolitical events, weather events and foreign competitors that are getting in seven layers deep and buying a company suddenly one day? So with that as a backdrop, Colin, I'll just start with you, and if you just want to walk down the line, any thoughts or insight you have on your supply chain and how you handle one-off understandings of it versus going all the way down to raw material and understanding on any second and any day what's going on?

Colin Mitchell:

Sure. So we come from a place where we have brute force, blunt tools, supplier rating systems. The government has CPARS and award fees and contractor responsibility watch list. You have these broad tools, but they don't give you that detailed level look. At different acquisition agencies and different stovepipes, I think that the program managers, KOs, et cetera, have fairly robust knowledge of where the links in their supply chains, where the weak links are, pertaining to different programs. I'm curious from an industry perspective, we absolutely look at the holistic. We know what types of parts we buy, we know what types of parts we're going to need, getting to a place on a material front where we can double or triple stock so that we don't spend any time 'cause again, time is the most expensive part of your bill of materials.

Those systems exist, but again, just a stovepipe for my company, I think the government has access to all of this data. I think that the government can come up with a fairly robust picture of just which piece parts are the most constrained in the entire space architecture. Sounds like a big problem, but I actually don't think it is. I think with some ORSA help or with some data analytics folks, you can get to a holistic picture and then even more interestingly, get it to a picture that updates itself. I think you'd find pretty quickly what parts of your supply chain need massaging and need attention and need an action, and it's not necessarily going to be expensive. Some of the things that hurt us the most on schedule are not expensive parts. They're just constrained parts or things that people aren't looking at.

Maj. Gen. Stephen G. Purdy, Jr.:

So let me follow that up if you don't mind, Matt, before you jump in. So you mentioned the government. Do you think the government has a role in the supply chain, and where is that line from you and your company and your activities understanding your supply chain versus the government, understanding either mandating or tracking, et cetera?

Colin Mitchell:

We use the word industrial base, sometimes it gets misused, but I think the government has a vested interest and also has a responsibility for industrial base, especially where it's hurting our missions and attriting the vision of the chief. These things are real things, and we have time-based problems. So absolutely there is a role in the government not only understanding but acting upon it. When it comes to interfacing with industry, it could take the form of advice, "Look over here." That happens now, but it's one-off knowledge. I think a better approach would be something like if you have weak links in the supply chain, what can the government do to qualify alternate suppliers? What can the government do to source an inventory supply base that is available or sponsor that for suppliers? Like I told you before, if the part is available, I'm going to find a way to design around it because it's just going to save us so much time and cost. So much reuse is extremely valuable for what we're trying to achieve here.

Maj. Gen. Stephen G. Purdy, Jr.:

Interesting. Okay. So Matt, can you talk supply chain from where your head is at? Then also, can you touch on this question about where you think a company and industry begins and ends and the government begin and ends?

Matt Brown:

Yeah. Absolutely. I think when you're talking about just from a Raytheon perspective, there's 14,000 companies that are suppliers for us, that's a huge problem to get your hands around it. So you start looking at data analytics to provide data because you can't get your hands around it unless you use something like that as a tool to find these, where we have single sourcing issues where we have fragility in the supply chain, where we need to scale up for our factories so we need more of those components. Without looking across the breadth of that, you're not going to see those very easily. I think what we're talking about when you bring in the U.S. government to that, you've now scaled that even wider.

You can find those problems more broadly across the entire industry base. So where does the U.S. government fit in? Well, it almost is a opportunity to share the problem. How do we get industry and the U.S. government together to get data sources? It all comes back to data when you talk about AI, right? I hate to sound like Matthew McConaughey in the commercial about the gold of the future of the Wild West is data, but that data coming together in as many ways as possible will give us tools to be able to leverage AI to know where the problems exist sooner across that broad base, and I think that's an opportunity.

Maj. Gen. Stephen G. Purdy, Jr.:

I'm going to do one follow on before I ask Kyle an interesting question, but for Matt and Colin, again, I'm interested on the government piece. Do you think it's the government's role to map out and understand the entire U.S. industrial base and have that in a massive database that supports industry or do you think it's an ad hoc as problems arise sort of piece?

Matt Brown:

I think it's an opportunity I would say. Each different supplier has that opportunity and each company does, how can we leverage that? Is really what I'm saying. Is there an opportunity to leverage that somehow? Is that something where we partner together either with industry or with the government to do that?

Colin Mitchell:

I want to go bigger on the answer and say your question earlier in the rapid fire about one satellite a week, the implication mandates that you have to understand your supply chain. You can't get there if you don't have the understanding and then the action to support it. We can all cite examples in the hardware realm of single source parts that have failed or you have a discovery later which derails multiple programs. This impact is real. It's out there. The risk is out there. Mitigating it now and understanding it now is key to the timelines we're talking about.

Maj. Gen. Stephen G. Purdy, Jr.:

Yeah, I appreciate that. That's really interesting. So Kyle, what does supply chain mean to you from a software perspective? I'm curious on your thoughts.

Kyle Rice:

Yeah, so the biggest thing is talking to Matt and Colin, I'm glad I don't do hardware cause this is significantly harder, but-

Colin Mitchell:

Do you have any software jobs?

Kyle Rice:

So I will say from the software perspective, supply chain and tying that together is one of my favorite areas to deal with from an AI perspective for a couple of reasons, two main reasons. One is because of the inherent complexity of what you're talking about. There's so variables, 14,000 suppliers, it's the seven-layer dip of how they all knit together. There's no way a human can look through that and so you need models to look at that. You need models to knit through that. So it's a very fulsome place to dive in, and so I love that part. The second reason why I really like applying AI into the supply chain areas is it avoids the killer robot problem.

Essentially, as you're likely aware, in DOD, we have this strange situation. James Cameron and Terminator did us no favors here in terms of using AI at the tip of the spear is always very, very fraught. For good reason, for bad reason, it doesn't matter. It just means that societally, that's a hard sell for many times. But this is an area where no one can object to, "Hey, if I can use AI and it means my war fighter gets the supplies they need at the right time in a secure manner," no one can object to that. So what that does is you can rapidly increase the value, increase our war fighting ability, call this automating the rear essentially by things that are not going to trigger these societal issues. So from an AI perspective, I think supply chain is a wonderful area for us to dig into.

Maj. Gen. Stephen G. Purdy, Jr.:

So it's a good area to explore into and use AI tools to look into and support on the hardware side, but I'm going to poke again. From a executing AI, creating AI, creating the algorithms, do you have to think about supply chain concepts as you're just performing that activity and developing?

Kyle Rice:

Now I see where you're going. Yeah, 100%. We have similar sorts of issues on the software side because it's the same issue. If you pull in an algorithm from some state you're not supposed to have used, obviously that's a very, very bad thing to have done. Particularly when you get back to what I was talking a bit earlier about some of the lack of explainability on large language models and things of that ilk, and

if you've trained using things that you don't have the genesis on, yeah, that can be a tremendously bad situation.

Maj. Gen. Stephen G. Purdy, Jr.:

Okay.

Matt Brown:

To bring us back to what we talked about at the beginning, that's exactly what we were talking about with open source, right?

Maj. Gen. Stephen G. Purdy, Jr.:

I was just going to go there.

Matt Brown:

You're tying that exactly back to that's why open source is a challenge. We have to have it to go fast in the software world. It is an important aspect, but you've got to make the right decisions on what you use in what you don't. That means investment of time and people and cost to make that happen. But it's still going to be faster than trying to write that or have every one of your software developers write all that code again on their own.

Kyle Rice:

Actually, just to circle back on that, that's exactly the reason why I was some open source projects versus others kind of situation. There's a wild difference between the enterprise open source, the red hats of the world versus some fly by night where the project may go out of business. If you treat that all as open source, yes, technically it is all open source, but there's significant resiliency differences between those two extremes.

Maj. Gen. Stephen G. Purdy, Jr.:

So in our last few minutes, I'm going to just follow up on, you mentioned people a little bit there, Matt. So from a people perspective and just bringing it home to space resiliency, how do you inculcate all of these lessons and these ideas from hardware, mass production, new ways of doing development, AI tools, software tools, supply chain? How do you prepare people in the younger set with these kinds of concepts so you can be successful?

Matt Brown:

I think some of it's the opposite. I think how do you help the old guys like us to make sure we can understand what's going on? I think we have an opportunity to leverage that. I think we should be leveraging some of the strengths of those students that are coming out of college and they have been using Alexa and Siri and they have been using ChatGPT to write their papers, not write their papers, but to check their papers for many, many years. They understand maybe a little bit more about the opportunity with those different capabilities, and so how do we leverage that? I think we want to bring those folks in, we want to listen to them. We want to leverage what they bring into--

Maj. Gen. Stephen G. Purdy, Jr.:

Well, let me double down on that. How do you not crush their soul when they come in and they know all this stuff and they're trying to do it and your corporate philosophy puts them down? How do you handle that?

Matt Brown:

We blame it on the government. No, I'm just kidding. You wouldn't really do that. We just have to go back and say, "This is where we're going." You know what? I'll tell you what we have done, we leverage things like IRAD. We leverage our own investment to say, "How can we build on..." We have programs where we'll go to individual engineers and say, "Here's some money for you to leverage that concept and turn it into something real." I think those kinds of programs are critical to be able to have those engineers not only continue to build the skills, but feel like they're an important part of what's coming into the technology in the future. Eventually, we'll be able to leverage those things, I think, into the business.

Colin Mitchell:

You talked about crushing souls. I'll tell you what inflates souls, and it's a bit of apple pie. Getting people into space is the challenge, but losing people from space work rarely happens because the missions are motivating. It's cutting-edge technology. Right now, we're in an inflection point where the capacity of whether it's from a budget base, whether it's the money pouring in on the commercial side or whether it's the government needs, budgets are bigger than ever. We talked about the industry being oversold and constrained just because from a capacity perspective, it's about getting people into space jobs, converting them, having them do a side-by-side with people who are experienced. It's the way we've always done it because it works. But getting people into space, they are motivated by the missions that we have. They're motivated by our hard problems, and once they get there, they stay.

Maj. Gen. Stephen G. Purdy, Jr.:

I will agree with you on the space excitement. That is certainly a helper. Kyle, finish this out here our last few minutes. From a startup perspective, someone has to fight Silicon Valley and all the other startups. How are you getting after talent?

Kyle Rice:

Yeah, no, I'm going to parrot something that both of you just said there. So personally, I follow these same inflections where I'll be in a big company for a while and eventually, I will get semi frustrated and I'll go back to startups. So I keep having this thing, and obviously I'm way older than the young folks who we're trying to attract, so I do share some of that. But I think Colin hit it on the head, which is, what we can offer is so different and so unique. Yeah, we're a Silicon Valley startup. We're competing against lots of other folks in that space. We are heavily, heavily focused on defense.

You would be amazed at the different type of people you get for that. You don't get everybody that way, but you will get certain folks where it's like, "There's no place I would rather work besides here." So you can get super smart folks because of that mission. I think sometimes we downplay that. We get stuck up in the bureaucracy or whatever that sometimes government can be slow moving, but we do things that no one else does and no one else can even conceive of. The more we lean into that, the more you will get the young talent that wants to be here.

Maj. Gen. Stephen G. Purdy, Jr.:

So just to follow-on real quick, do you recruit specifically saying, "Hey, we do defense programs and this is the benefit?" And you find that to be an advantage for you?

Kyle Rice:

Oh, 100%. Yeah. That's one of the things that helps us differentiate. We're like, "Hey, if you want to come serve your country and help serve an actual mission," that is a great recruiting pitch, 100%.

Maj. Gen. Stephen G. Purdy, Jr.:

That is awesome. All right, any last comments from the panel? All right, so space resiliency. So build hardware fast, flow NRE, train your people, use some AI, maybe use open source. Watch it carefully, right? Understand your supply chain, but tap the government to help-

Colin Mitchell:

And focus on every link, not just the easy space layer.

Maj. Gen. Stephen G. Purdy, Jr.:

Easy space layer, that's right.

Matt Brown:

Don't forget the mission. The most exciting thing I've done in my career is deliver a system to a war fighter that can provide capability. That mission is exciting.

Maj. Gen. Stephen G. Purdy, Jr.:

We will end on that note. It's all about the mission. Thank you very much for attending the Space Resiliency Panelists. Thank the panel members.