

Q&A: Vice Chief Gen. Allvin and the Evolution of JADC2 07

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Raider Revealed

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KC-46A TANKER

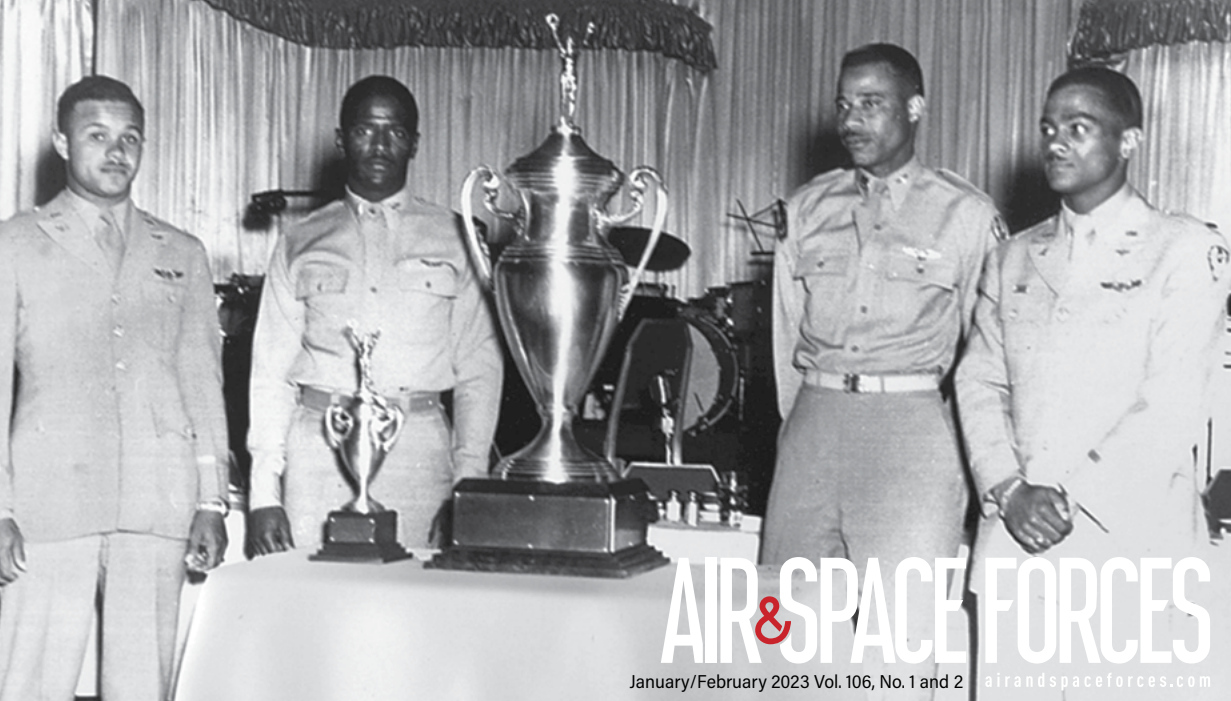
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Tuskegee Airmen from the 332nd Fighter Group—(from left) Lt. Halbert Alexander, Lt. James Harvey, Capt. Alva Temple and Lt. Harry Stewart—pose with their "Top Gun" trophy during the awards ceremony for the First Aerial Gunnery Competition at Las Vegas Air Force Base in 1949.

ON THE COVER



USAF

The B-21 Raider was unveiled to the public at a ceremony Dec. 2, 2022, in Palmdale, Calif. Designed to operate in tomorrow's high-end threat environment, the B-21 will play a critical role in ensuring America's enduring air power capability.

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By Tobias Naegele

Ready or Not

Americans are waking up to the fact that our military is not as ready or as capable as it needs to be. Just two years ago, 62 percent of Americans thought U.S. military strength was “about right” and 25 percent thought it was “not strong enough,” according to the Gallup organization. Last year, the number saying our military was about right plunged to 44 percent, while the number saying it was not strong enough surged to 42 percent.

How strong the U.S. military needs to be, however, is difficult even for experts to gauge, let alone the average citizen. That’s why a recent series of wargames held by the Center for Strategic and International Studies is vitally important.

CSIS ran 24 iterations of a wargame simulating what might happen if China attempted to seize Taiwan, much as Russia seized Crimea from Ukraine in 2014. Unlike government games, however, these results were made public. And while the U.S. and its allies prevailed in most of the games, the cost of victory was staggeringly high.

“The United States and its allies lost dozens of ships, hundreds of aircraft, and tens of thousands of service members,” write CSIS authors Mark Cancian, Matthew Cancian, and Eric Heginbotham in their report on the games. “Taiwan saw its economy devastated ... [and] the high losses damaged the U.S. global position for many years.”

Over the past 30 years, Americans have gained a skewed perspective of wartime losses. While some 7,000 American service members and at least as many contractors died in support of operations in Afghanistan and Iraq, U.S. military units never faced peer threats. Improvised bombs planted in the roads and other insurgent tactics spread out over two decades were responsible for most of the losses. In the Russian-Ukraine war, the Russians have lost over 100,000 people in 10 months, and Ukrainian losses are not far behind.

The U.S. Air Force hasn’t endured aerial combat losses since the Vietnam War, when it lost more than 3,300 fixed-wing aircraft; in all, U.S. forces lost more than 10,000 aircraft in that war. The U.S. Navy lost more than 350 ships from December 1941 to September 1945; it’s lost fewer than 30 ships since then, mostly due to accidents. The last U.S. ship sunk in combat was the *USS Bullhead* on Aug. 6, 1945, the same day the Air Force dropped the first atomic bomb on Hiroshima.

“Is the United States ready as a nation to accept losses that would come from a carrier strike group sunk at the bottom of the Pacific? We have not had to face losses like that as a nation for quite some time. It would actually create a broader societal change that I’m not sure we’ve totally grappled with,” asks Becca Wasser of the Center for a New American Security and a participant in the CSIS wargames. “We need to prepare for some of the worst-case scenarios to effectively deter in the Indo-Pacific, and that requires us making changes now.”

What does that mean in practical terms?

To deter China and, when necessary, fight and win against China, the Defense Department must:

- Strengthen the Air Force’s ability to project power globally. The new B-21 Raider long-range bomber (p.35) is the most critical component of that global reach. The Air Force plans to build at least 100. The nation cannot afford to buy less.

- Modernize the fighter force faster. The Biden administration last year asked for just 33 new F-35s for the Air Force, along with 24 F-15EXs. Lawmakers added funding for another 11 F-35s, bringing the total to 68 new fighters. The Air Force needs at least 72 new fighters annu-

ally, however, just to stop growing the average age of its fighter force which is now at 29 years. If this nation is serious about accomplishing its defense strategy, USAF fighter production must greatly increase.

- Build back aircraft production capacity. If the Air Force lost a dozen jets tomorrow it would take years to replace them. The cost and complexity of these jets is such that we will never again crank out aircraft as we did during World War II. But production capacity and consistent productivity is essential to being able to replace aircraft when needed, to supply allies and partners, and to manage and contain costs.

- Build up strategic reserves of precision weapons. Stockpiles of critical weapons are too small, and production orders too inconsistent, to ensure adequate supplies in wartime. According to Lt. Gen. David Deptula, a participant in the wargames, “the stockpile of LRASMs, as well as other munitions, both air-to-air as well as anti-ship, are currently inadequate for any kind of Taiwan contingency.”

- Shore up supply chains. The COVID-19 pandemic made the world aware of how fragile our global supply chains can be. The U.S. has made strides to reduce dependence on Asian-Pacific suppliers for semiconductors, but it will take years to insulate fully against that risk. Other supply chain concerns are less understood. More must be done to ensure the U.S. and its allies have access to critical weapons components when they need them. The supply chain is only as good as its weakest link.


- Build up space capability and make intentions clear. Much has been said about increasing the resilience of U.S. space-based assets, both hardening them against cyberattack and increasing our volume of space assets to eliminate single points of failure. The Space Force must go further and faster, however. The Space Force needs the means to rapidly refuel and replace satellites in orbit; the ability to fight in and through space if necessary; and to establish operational norms in order to avoid accidental conflict and make clear expectations for how the U.S. will respond to provocations.

- Modernize the entire fleet. The average age of Air Force bombers is 48; tankers average 50, falling sharply thanks to the acquisition of new KC-46s; and trainers 35. These are not sustainable numbers. One of the reasons military weapons programs are so frequently behind schedule and over cost is because we do not develop and buy weapons consistently. Continuous production and competition will yield a younger Air Force and a more effective industrial base. That’s a win-win for the nation.

- Help our allies. Some on both the right and left political fringes have argued against major investments in arms for Ukraine and continue to hold back on providing Ukraine the full range of offensive capabilities, such as F-16s for example, that might help them more forcefully fight off the Russian aggressors. Arming Ukraine, however, is an investment in deterrence.

In the waning days of the 1930s, as the Nazi war machine was gearing up, many Americans wanted to maintain an isolationist stand. A little-known, first-term senator from Missouri argued for military “preparedness.”

“I am of the opinion we should not help the thugs among nations by refusing to sell arms to our friends,” then-Sen. Harry Truman argued. A World War I combat veteran, Truman understood what was at stake long before the U.S. entered World War II.

The thugs are still with us. We can deter them now or fight them later. The choice seems obvious. 

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AFA's Mission

Our mission is to promote dominant U.S. Air and Space Forces as the foundation of a strong National Defense; to honor and support our Airmen, Guardians, and their Families; and to remember and respect our enduring Heritage.

To accomplish this, we:

- **Educate** the public on the critical need for unrivaled aerospace power and a technically superior workforce to ensure national security.
- **Advocate** for aerospace power, and promote aerospace and STEM education and professional development.
- **Support** readiness for the Total Air and Space Forces, including Active Duty, National Guard, Reserve, civilians, families and members of the Civil Air Patrol.

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Leaders by Example

I have enjoyed all the excellent articles on Chiefs of Staffs of the Air Force, especially the last two. I was privileged to work directly under both Gen. Larry D. Welch and Gen. Michael J. Dugan when they were colonels. It was obvious then that both were destined for stars and upper USAF leadership roles.

I have a couple of thoughts on the event that cut short Dugan's tenure as CSAF. I have never read the job description of the CSAF but am pretty sure it contains a line something like, "... the No. 1 proponent of USAF air power." In his remarks to reporters, Dugan was doing just that. Nothing he said was classified or endangered national security. Nothing was untrue. Nothing demeaned the other services.

He simply emphasized the importance of air power in the current situation. And four months later, the wrath of the very effective air campaign was unleashed on the forces of Saddam Hussein, bringing him to his knees in a month and likely saving the lives of hundreds, if not thousands, of ground troops.

The Secretary of Defense's response to a pouting Chairman was hasty. Had he not done so in his "Ready, FIRE, Aim" style, the USAF would have continued to benefit from Dugan's exceptional leadership and been spared the dubious, unnecessary, and costly reorganization of the USAF by CSAF #14.

I still retain a copy Dugan's hand written departure note: "To the men and women of the Air Force—Your mission—providing air power and space

power to the nation—is enduring and essential.

I bid you farewell with my head high, my mach up, and my flags flying. Good luck, good hunting, and God speed to the greatest Air Force in the world."

Now that is a high class leader who had just taken a severe gut punch.

Col. Jack Sanders,
USAF (Ret.)
Ashburn, Va.

History has shown us that our elected leaders don't always listen to the advice of our flag officers during military conflicts. It seems at some point the politicians stop thinking about winning the conflict and become more concerned with their next election.

Once the politicians take over managing the conflict, there is not much chance of wining; i.e., Vietnam. It seems that politicians are intimidated by flag officers. Officers are proven professionals that choose honor and integrity as a way of life.

Most politicians have problems with both concepts. In the '70s and '80s ... flag officers as a group seemed to become sensitive to politically sensitive political concerns. The politicians are more comfortable with these 2.0 officers.

I'm glad to say that I served in Gen. Michael J. Dugan's Air Force. He was the last warrior and paid the price, unfortunately.

CMSgt. Leon T. Jarrett,
USAF (Ret.)
Surprise, Ariz.

Drone Threat

After reading many articles in the Air & Space Forces magazine and its pre-

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WRITE TO US

Do you have a comment about a current article in the magazine? Write to "Letters," *Air & Space Forces Magazine*, 1501 Langston Blvd, Arlington, VA 22209-1198 or email us at letters@afa.org. Letters should be concise and timely. We cannot acknowledge receipt of letters. We reserve the right to condense letters. Letters without name and city/base and state are not acceptable. Photographs cannot be used or returned.

decessor for the past 50+ years, I find myself wondering what new innovations exist to counter the not-so-future growing threats and “new” weapons. Of concern is the imminent threat of a series (or swarm) of miniature drones, unlike the UAVs, Global Hawk, Raptor, Predator, Pioneer, Hunter, Dragon Eye, etc., mostly used for surveillance with limited hunter-killer capabilities.

Mini-drones have been used as precise flying machines for the past several years, as we have seen in festival and holiday displays throughout the world. China used them in the Olympic opening ceremonies, we’ve seen them by the hundreds in Washington, D.C., for the Fourth of July, and have seen the damage they can do as Kamikaze strikes in Ukraine.

Just to mention a few articles in the November issue, “The New National Defense Strategy,” “B-21 Raider: The Indispensable Bomber,” even “F-16s Intercept Russian Bombers Near Alaska.” Maybe they couldn’t work it in, or there’s just a lack of vision of the capability of a wall of synchronized drones as a threat. Could they get through undetected, or by overwhelming numbers?

As the Heritage Foundation’s 2023 “Index of U.S. Military Strength” rated the service “very weak,” perhaps a rethinking of real and upcoming threats, and counterthreats could add to our strength equation.

If the articles above (any many more), included the real threat (and employment) of relatively cheap and disposable drones en masse, dancing in precision and blanketing the sky, we might not have to spend mega-billions of dollars developing, deploying, maintaining, and replacing soon-to-be technologically obsolete, outmatched weapon systems for which we can’t find enough qualified pilots to fly anyway. Or, maybe that’s too far out of the box.

Col. Alan K. Booker,
USAF (Ret.)
Beavercreek, Ohio

Weighted Comments

Maj. Gen. Douglas A. Schiess, Commander, Combined Force Space Component Command, US Space Command; and Vice Commander, Space Operations Command commented in a discussion about space operations (ASC22, Sept. 19): “Some of our satellites are the fat kids in gym class.

We need to make sure that we have a resilient force and not so many fat kids—although those are really capable fat kids.” [Verbatim, “Give it All You’ve Got,” November 2022.]

I really don’t know the context in which this statement was made, but the reference to “fat kids” reminds me of when I entered Active duty in 1967. I noticed then that many general officers and colonels were overweight but it never bothered me since I assumed they gained weight over time.

Then, a “fat boy” policy was instituted. There was no weight and height chart to follow. The basic policy was if you looked overweight, you were placed on the “fat boy” program to lose weight. Amazingly, overweight senior officers and general officers disappeared. Following the leadership, overweight personnel were back in shape, not allowed to reenlist or did not receive another assignment.

Lt. Col. Russel A. Noguchi,
USAF (Ret.)
Pearl City, Hawaii

‘Committing Truth’

If I read the articles on the Chiefs of Staff Interviews, three did not serve out their term. As devastating as I know it had to be personally, I am reminded of a GM14 with whom I worked in my next-to-last Air Force assignment. Whenever he saw a senior individual relieved of his/her command (civilian or military) due to putting their integrity above career, he said simply, “That person committed truth.” Enough said about my admiration for those three heroic Chiefs.

Second topic is one I think about often—Air Force acquisition. Most of my military career was in one way or another tied to or working within the Air Force acquisition community, as a budget officer, cost analyst estimator, and strategic analyst.

The article entitled, “Acquisition Reform Takes on a Sense of Urgency” [November, p. 39] caught my undivided attention—regrettably for the article and Air Force acquisition leaders. Nowhere in this article did I see the words affordability, design for manufacturing least cost processes, or design for least cost sustainability. Looking at the current Air Force aircraft being procured provides good examples of the absence of these cost-conscious thoughts or their implementation.

The F-35 has continued to cost

more than anticipated, as has the KC-46. Furthermore the field usage sustainment costs of the F-35 have been astronomical (according to past Air Force Magazine articles), and the KC-46 design is barely complete and I anticipate there will be many cost sustainment challenges on that aircraft as well. It is obvious that neither Boeing nor Lockheed worried about less costly manufacturing processes or sustainment cost containment during their designs—and thus we have cost growth in both areas on both aircraft.

I wonder just how many cost estimating, cost process, manufacturing cost educated and experienced experts in these areas either the U.S. defense industry has or the Air Force. My guess is, not many if any. I suggest that without people who have these skills, virtually every aircraft the Air Force buys in the future will continue to be a budget buster. And this becomes a critically important issue particularly with the need of a large quantity of B-21 bombers. How soon the Air Force leadership seem to forget what the lack of affordability did to the Air Force’s purchase of B-2 aircraft when it was killed at only 20 produced aircraft.

Lt. Col. John Bredfeldt,
USAF (Ret.)
Dawsonville, Ga.

Air Force Power?

Air & Space Forces Association and Air & Space Forces Magazine. I cheered the creation of our separate Space Force. The change will serve the country well.

Now I look forward with much anticipation to the creation of a separate Space Force Association/Magazine, and the rest of us can get back to talking about airplanes and air power.

Lt. Col Dale Hanner,
USAF (Ret.)
Loveland, Colo.

Pegasus Lives on

I read Greg Hadley’s article, “AMC Investigating Class A Mishap That Damaged KC-46 Boom, Fuselage,” in the December 2022 magazine [p. 31] with great interest and got exactly what I expected. The ongoing issues with the KC-46 should be valid concerns for those that have manufactured it and more importantly those that must fly and maintain it.

While the investigation is ongoing, and a cause has not been determined, if a stiff boom contributed to the incident this would be unfortunate since this was a problem recognized early on. This is one of several issues with the platform that have not been fully resolved and the aircraft has not been declared fully combat capable. Hopefully once the investigation is complete, whatever the issue is, it can be resolved quickly without compromising safety or inflating the cost of the aircraft.

The KC-135 had a boom refueling system with over 60 years of practical/successful experience. Transitioning the proven system to the new aircraft without all the bells and whistles would have eliminated many of the problems the Pegasus is currently experiencing and will experience in the future, but time will tell.

I have over 15 years' experience on tanker aircraft, and they are critical to the Air Force's mission. Pegasus hasn't quite lived up to the legacy of its predecessor. Maybe one day soon it will.

Chief John Fedarko
Xenia, Ohio

From the Editor: *Please see this month's feature on efforts to solve the KC-46 deficiencies on page 48.*

Just Say No to Politics

The AFA website describes Air & Space Forces Magazine as "the monthly journal ... and among the world's foremost publications on defense, aerospace, and air power (emphasis added).

On a higher plane, the website defines AFA's mission, "to promote dominant U.S. Air and Space Forces as the foundation of a strong National Defense; to honor and support our Airmen, Guardians, and their Families; and to remember and respect our enduring Heritage" (emphasis added).

Further, three mission strategic pillars are listed:

- Educate the public on the critical need for unrivaled aerospace power and promote aerospace and STEM education ...(emphasis added)

- Advocate and promote aerospace power... (emphasis added)

- Support Airmen, Guardians, and the families ... (emphasis added).

With all that as perspective, please explain what "Democratic Republic," a

letter by retired Major James L. Tippins, published in the November issue of Air & Space Forces Magazine, has to do with any of that?

I hope you would agree that for any military-related organization and its journal to be both relevant and respected, it must first and foremost be scrupulously apolitical—indeed, a bedrock requirement and characteristic of the force itself. That standard should apply equally to reasoned letters chosen for publication in the journal, as well as the substantive articles.

It is with disappointment that I've observed in the Letters section of the magazine, a creeping descent into our national morass of culture wars noise. The decision to publish letters such as this, which have nothing whatsoever to do with the boldfaced items above, is an excellent example.

Col. Dan Koslov,
USAF (Ret.)
Alexandria, Va.

Hidden Truths

"The Near Nuclear War of 1983" by Brian J. Morra in the December 2022 issue [p. 47] of Air & Space Forces Magazine is important for both its overview and an implication.

Morra notes the events were kept in the shadows "until around 2015, when some government papers were finally declassified." The passive voice glosses over how the declassification occurred: a small group of researchers used the Freedom of Information Act and Mandatory Declassification Review process to doggedly pursue release of key documents. He also claims the President and other opinion leaders forgot about the 1983 war scare. But that is not quite correct because it is impossible to forget what one never knew.

The close call in 1983 remained largely unknown and unexamined because key documents remained classified far beyond the time required by any compelling need. Accordingly, an implication of "The Near Nuclear War of 1983" is the need for a muscular declassification effort to inject more historical material into the public domain, and that is best accomplished with robust institutional support.

Contrast today's anemic declassification efforts with this quote displayed at the beginning of a series of 1950's films titled "The Air Force Story:"

"It is the job of all the people to know

and understand what the Airman has done and is doing today ... for only with full public knowledge and understanding can we have the support we need to carry out our mission. It is a big mission and an important one. It involves the future wellbeing of every American—the peace of the world."

The 1983 Able Archer exercise is probably not the only Cold War incident that remains obscure. With the pending budget fights, the Air Force could benefit from all the public support it could get, and public support will be easier to obtain when our proud historical record of success is accessible.

Lt. Col. Allan G. Johnson,
USAF (Ret.)
Fairfield, Calif.

More than Tech and Data

The article "Refining the JADC2 Concept," in the November 2022 issue [p. 48] addressed very well the "tech and data" issues of this important defense initiative. I believe there is a third, equally important, component of JADC2, and that is "personnel"—smart, joint trained, joint experienced, joint focused!

Regardless of uniform, it is essential to an effective JADC2 that commanders and staff know and maintain a joint perspective—"Think Joint." With the limited defense resources we have today and the growing threats we now face, JADC2, with trained and experienced personnel having a joint perspective, is even more important to maintaining a viable strategic deterrence and war fighting capability.

It is important that the Air Force be at the forefront of this initiative and recognize the critical importance of joint service experience, which has not always been the case. I served in multiple joint service assignments in intelligence, initial digital geospatial data development, and digital advanced weapon/command and control system development, at the start of the "digital revolution," during my 25-year Air Force career, from 1964 to 1990.

Joint service experience began to be important to the Air Force, but is exponentially more important today. Additionally, "Intelligence" remains the key and should be properly recognized as such and included in the expanded acronym "JADC2I."

Lt. Col. Stephen P. Pedone,
USAF (Ret.)
Naples, Fla.

Rocking the Joint: JADC2 is All About Speed

Gen. David W. Allvin is Vice Chief of Staff of the Air Force, overseeing the Air Staff and serving on the Pentagon's Joint Requirements Oversight Council and the Deputy's Management Action Group. A former airlifter and test pilot, he helped write America's Air Force: A Call to the Future in 2014 and the Air Force Future Operating Concept in 2015. Those were critical precursors to the multi-domain operations vision advanced by Gen. David L. Goldfein when he became Chief of Staff, a theme that evolved into a shared adoption among the services of the Joint All-Domain Command and Control operating concept. Air & Space Forces Magazine's Editor in Chief Tobias Naegele caught up with him in December.

Q: You were sort of in on the early stages of conceiving of multi-domain operations and what has come to be known as joint all-domain command and control. How did that come about?

A: So for me, the journey starts in early 2013, when then-Chief of Staff [Gen. Mark] Welsh had made the statement, "I'm tired of orbiting around the flame of the POM [program objective memoranda], I want to look to be more strategic." ... I worked with Chief Welsh in writing sort of a strategic framework document, ... "America's Air Force: A Call to the Future." And really, that was designed [in 2014] to set out what the Chief thinks the future of warfighting is going to look like and how the institution of the Air Force needs to be better prepared for that.

And the key phrase in that document is, the ability of the Air Force to continue to adapt faster than our adversaries. That is the key in the future. ... The next thing was, how do you write the operating concept? How are we going to warfight in this future environment? So ... then came the "Air Force Future Operating Concept" [in 2015], and that was really where we started breaking down what are the elements of the way the Air Force fights? And how do we perceive we're going to do that in the future? ... We understood we're not going to have ubiquitous air supremacy like we have [had in the past], it's going to be regional, it's going to be local.

Q: And momentary?

A: Right, and momentary. The idea that you're going to be able to do it at the time and place of your choosing—you couldn't sustain it. ... We didn't have the resources and the environment wouldn't allow that. So that's when we started looking at multi-domain command and control within the context of this [Future Operating Concept]. ... But to be truthful, we were thinking of the three domains that the Air Force is really focused on: air, space, and cyberspace. Only as we started to evolve the writing of



Master Sgt. Jodi Martinez

Gen. David Allvin helped frame the discussion about multi-domain operations beginning about 2014, with the publication of "America's Future Air Force: A Call to the Future." Now that future is here—and more "joint" than he could imagine at the time.

this, did we understand it has to be able to move beyond just the domains that the Department of the Air Force was responsible for ... that we had to be able to leverage the capabilities and the awareness that are resident in other domains, in order to be able to have the agility that we need to move from here to there. So it was the move from agility to having better awareness of sensors and shooters in all domains that started this multi-domain command and control idea. ...

General Goldfein was really advocating and articulating, more eloquently than we did, that these things need to be joint ... [to where] audiences were starting to internalize the idea that we really do need to have more multi-domain and cross-domain solutions. That's how it got to where we had the service chiefs look at JADC2 as not only just an interesting thing to do, but something that was required to adapt to the changing character of war.

Q: In your view, what's the difference between "multi-domain operations" and joint all-domain command and control?

A: What "joint all domain" does is it forces new people into the conversation. To my point earlier, when we said multi-do-

main, we thought of it as multiple domains within the Department of the Air Force. The Army could have looked at it and said, 'Yes, multi-domain, I'm going to need things from space, so my multi-domain is leveraging space to do Army things.' The Navy similarly. There's a thought process and a perspective, that sort of shows, 'I'm going to leverage the other domains to do my domain's work.' Whereas when you think of "joint all domain," it puts you more in a frame of mind of joint force work. That allowed it to jump from multi-service for single-service purposes to actually directly supporting the joint force.

Q: Air Force Secretary Frank Kendall has his seven Operational Imperatives, one of which is Operationalizing the Advanced Battle Management System. How is that advancing?

A: Within our Air Force, we were experimenting with ways that we could fuse data, doing these experiments that showed that you could actually cross domains and be able to get a better solution and do it faster. There was widening recognition of the changing character of war, that speed is a thing, and speed of decision could be one of the more impactful factors in joint warfighting in the future. ... Then Chief [of Staff Gen. Charles Q.] Brown comes in and says, 'Hey, we've got to get on the ball here and go a little faster' with his Accelerate Change ... or Lose. And then Secretary Kendall ... says, 'Okay, it's time to actually build something.' We have to put something together to operationalize this Advanced Battle Management System.

Q: To deliver "meaningful operational capability in the hands of the warfighter as soon as possible?"

A: Exactly. That's ingrained in our brains now—which is great, the Secretary is really driving that home—but what Secretary Kendall has done is forced us from the conceptual (because we haven't had a shortage of imagination) to design the architecture, build the pieces, synchronize those in order to get discrete functions in warfare. That's where this Operationalizing Advanced Battle Management System Operational Imperative has come into play. And I think, that's where we're now starting to take all of the ideas, having a better understanding of what works and what doesn't, and [are] starting to put the architecture together.

Q: Each of the services is doing this on their own—the Army with Project Convergence, the Navy with Project Overmatch. How do you make sure that you're actually speaking the same language and connecting?

A: There always is the tendency, absent any other intervention, that the services think first of how [something] is going to help support what they believe they're supposed to do. ... But when you come to recognize that what I'm supposed to do is help my fellow other service in the joint force, then you can start to change that perspective. Between the Advanced Battle Management System, Project Convergence for the Army, and Project Overmatch for the Navy there really was a different fundamental approach. It was starting off to be able to help us service our own kill chains, for lack of a better term. ...

In the Air Force, we leverage that in order to be able to complete our kill chain, the F2T2EA [find, fix, track, target, engage, and assess] construct. There's no denying that was the starting point. But the awareness [among] the Joint Chiefs—I think the relationship between them—is why Chief Brown felt comfortable to call that meeting in June, where he asked the other service chiefs to all come together, to make sure that ... we don't give into our service-centric tendencies, and make sure that all of these efforts have a convergence point, to where we're going to build something that is usable by all the services.

There was some discovery there: some great areas of alignment, and [also] some other areas where there was divergence. ... [But] the more experiments that we do, and participate in each other's experiments, [the more they become]... validations to create capability. It just requires reps and sets with each other. ... But we need to be honest with ourselves. This is going to take constant vigilance, because—we don't do it out of malice, but we aren't in practice of doing this sort of thing, of developing something that is fundamentally transformational—I believe—in the way one can conduct joint warfare. And doing that with the joint lens on, first, before the service lens on? I don't know that that's actually achievable—to start from joint.

So where I think we're going now, which is useful, is that, while we are creating it to ensure we're doing the things that they expect Airmen to do, you always have to look over and make sure that it's compatible, that they can connect. Because you're going to be suboptimal without it. And I think one of the great things that we've noticed is space. You can't do any of this without space, none of it.

Q: Do you think that, as you get better at this, you can begin to break down service walls?

A: I do think that there's a possibility to do that. And here's why. ... As we're developing our support to the National Defense Strategy, and developing a joint warfighting concept, one of the things we're understanding is if the pacing challenge ... is China, and if one is envisioning the types of conflicts that one might get engaged in with China, the Army has a different role. Because in that particular case—the scenarios in which we envision—it's not all about seizing and holding territory. There is a different role for the Army to play, maybe more along the lines of fires rather than maneuver. ...

In fact, if you can envision the nirvana of joint all-domain command and control ... there would be joint command and control at the operational level. With the proper sensors, and decision-making, and fusion of intelligence and context, you might be doing cross-domain solutions in real time. ... So if you think about it that way, then everybody has skin in the game in making sure that we're sharing the right information.

Q: We still have air operation centers and ground operation centers. Do you see us getting to a joint operations center rather than domain-centered centers?

A: When you look at what the future of operational command and control is, it's almost domain agnostic as to where those centers sit—if they have the right individuals in there, receiving the right type of data. And so, if you have an operations center, and I'm trying to keep it from the AOC, or TOC, or JOC—just an operations center—that is receiving fused data from all domains—from space, all-source information, publicly available information—fused to provide situational awareness—that data can come from anywhere.

If the architecture is there, it doesn't matter whether that particular operations center is on a capital ship, is in a fixed location in the rear, is in an aircraft, or is in a surface trailer. [Getting] the data to the right place where the right decision-makers are making that call starts to make you see, hey, maybe if I'm looking to be more resilient, and survivable, maybe I focus more on different places where I can have that data, rather than robusting a fixed, massive piece of infrastructure.

Q: So does that mean that whether airborne or shipborne or on land that everybody has everything? Or that you become more centralized, so the Joint Task Force Commander



is actually pulling all the strings and calling all the shots for everyone? There are already a lot of people in an AOC, so when you start multiplying that, it seems mind-boggling.

A: The question really is, are some of the things that some of those people are doing automatable? How many of those [jobs could be automated to do] the collection, aggregation and fusion, to where it keeps the humans doing what only humans can do? That's sort of an open question. But to your earlier point, can it be all aggregated and homogenized? I think you need to build it with the opportunity for that to happen, but not necessarily as your first goal.

The first thing needs to be to have something that's meaningful that can do what you're expected to do, what you know how to do now. But as you build that, you make sure you build in the modularity and the interoperability to where that [future joint vision] could become a possibility. Because we don't want to have to build this thing twice. We don't want to a joint all-domain command and control structure designed with the service silos hardened in it, because then you will find it will be easier to regress. You enable yourself to do that [higher-level jointness] now.

Q: As Vice Chief, you have some joint roles in which you get to look at the other services, their requirements, their capabilities. Are you all singing from the same choir book on this? Or is it a continuous effort just to try to stay on key?

A: As we look at the JROC, or the Joint Requirements Oversight Council, to ensure that those things are JADC2 friendly, they have to have the attributes that will enable a more robust JADC2. I also sit in and attend some of the principal meetings at the DMAG, the Deputies Management Action Group, which is chaired by the Deputy Secretary of Defense. And I will tell you, the Deputy Secretary of Defense and the Department of Defense has really embraced getting after and accelerating the maturation of JADC2.

Because when you think about JADC2 beyond just operational and tactical battle management, and you think about it in the context of combatant commanders either making decisions or preparing potential decisions for the Secretary of Defense or the President, you find that there's an interesting cross section of data. You may need the same types of data that you are using, or you may need to leverage the same sensors to get different data. ... So there's an effort underway that really synchronizes how we gather that data and use it with the different attributes that it has to have. ... [Again], it's about decision speed.

Q: Another one of the Secretary's Operational Imperatives, one of Chief Brown's priorities as well, is Agile Combat Employment. JADC2 may be a bit wonky for some Airmen to understand, but ACE is something that they're actually doing. How do you tie JADC2 to ACE?

A: If you attempt to do agile combat employment, without a responsive and dynamic all-domain command and control, you can be moving a lot of places and have no idea whether they are the right places or not, right? Agile combat employment is sort of disaggregating to survive and aggregating to create effects. So in order to know to where one might need to rapidly move, where you take that agility, and leverage that to go to some of these hubs and spokes—well, which spokes do I go to? I don't know unless I understand the context of the environment, how the rest of the operational plan is going. Without operational command and control that leverages all domains ... you may be dropping into exactly the wrong place. So in order for agile combat employment to work, you have to have this joint all-domain command and control.

The other piece is to understand ... the idea that we can no

longer assume that communication will be continuous and reliable. So leveraging [JADC2] to get all the information that you can when you can get it because there may be periods when you're disconnected. ... Without a functioning joint all-domain command and control, it would be very difficult to be able to stay ahead of the adversary, to keep that decision advantage.

Q: The attacks on communications and energy clearly relate here. How has the war in Ukraine informed this discussion?

A: It's actually reinforcing that we're headed the right direction. Because traditionally, one could say the way you do resilience is you harden the heck out of it. How we used to defend our networks: Well, we just need to make sure we had a better firewall, a bigger firewall, a thicker firewall, a taller firewall. When, in fact, what that means is if they ever get inside, you're still just as dead. And you haven't done anything to defend the inside, because you spent all your time building up the wall. So, as we move to things like zero trust, you have the assumption [that the network is] going to be penetrated.

It's the same sort of thing with this proliferated architecture in space. That's the way of doing resilience, rather than spend a lot of money on a few more satellites. ... Now you can do it totally differently. Now, you can proliferate it, and you can actually regenerate a lot faster. ... You think about kill chains—links in the chain—and now you hear, of course, "kill webs." What does that mean? It means I have more than one way to get to the destination. There is your resilience.

Q: The Air Force just rolled out the B-21, which is typically discussed as "a family of systems." But there's not a lot of clarity about exactly what that means—traditional hardware or maybe some associated capabilities. How does the B-21 family tie into the joint warfighting discussion?

A: So the B-21 could be the delivery platform or there could be other roles that it could play, whether it be sensor, or whether it be accompanied with different types of collaborative combat aircraft. It has the capability to do some very unique things, and those unique things may not fall into the traditional "put bombs in the bomb bay, go as deep as you can, and drop bombs" [playbook]. There are other things that it can be a part of that could help leverage the agility and the speed that we need to stay ahead of the adversary.

It is a system that was designed before we came up with this construct, which is why when the Secretary came in and said, let's think about this a little bit differently, not as just the next B-2, but as a part of a family of systems, that allowed us to use our imaginations. ... Doing that really allows you to re-imagine, taking the attributes that it has, and seeing where it can best operate and how it can best operate as part of another system. Between that and where we're heading with Next Generation Air Dominance (NGAD), it really is a re-imagining. There's no longer a single platform that just matters.

Q: How much will those two systems, B-21 and NGAD, overlap and integrate?

A: As much as possible. ... We look at things in terms of fires and targets. And so how one combines to hit the right targets at the right time in the conflict ... that doesn't necessarily have to mean, this platform is going to go after all those assets, and this platform is going to [do something else]. There is a mixing of these that will enable you to leverage all the capabilities. You have to focus in on the targets—joint targets, mind you—in a way we really hadn't imagined when you just had command and control by domain.





U.S. Air Force F-16 Fighting Falcons from the 51st Fighter Wing join with South Korea F-35A Lightning IIs to escort two U.S. B-1B strategic bombers entering the Korean Air Defense Identification Zone and conduct a combined flight in a formation over South Korea, in November 2022. The training demonstrated the South Korea-U.S. combined defense capability and posture based on the alliance's overwhelming power and the U.S. ironclad commitment to providing extended deterrence in defense of the Korean Peninsula.



The Aircrew of an HC-130J Combat King II conduct a Forward Arming and Refueling Point mission with an MQ-9 Reaper assigned to the 361st Expeditionary Attack Squadron at an undisclosed location, Southwest Asia, Dec. 11, 2022. This is the first successful FARP executed with an MQ-9 in a combat mission.



U.S. Air Force Airmen assigned to the 437th Aircraft Maintenance Squadron prepare a C-17 Globemaster III for de-icing at Joint Base Elmendorf-Richardson, Alaska, Dec. 7, 2022. Mobility Airmen consistently train to execute agile combat employment concepts, to strengthen DOD's scheme of maneuver and lethality.

Airman 1st Class Caleb Parker



Ukrainian Military Television

Drone Wars

"Two main developments are going to impact future war. The proliferation and availability of combat drones for longer-ranged, more-sophisticated operations, and the absolute necessity to have cheap tactical drones for close-support operations"

—**Samuel Bendett**, analyst at the Center for Military Analyses, on the use of drones in the Russia-Ukraine war [Washington Post, Dec. 2].



Ukrainian Ministry of Defense / Facebook

Bargain Hunting

"War is an economy. It's money. And if you have a drone for \$3,000 and a grenade for \$200, and you destroy a tank that costs \$3 million, it's very interesting."

—**"Graf"** (military call sign), a Ukrainian soldier in charge of a team developing special drone-dropped grenades to kill Russian tanks [The New York Times, Jan. 7].

Resiliency Isn't Free

"We should be applying concepts of 'anti-fragility' to the whole industrial base ... so when there are shocks to the system [such as COVID supply chain problems or the Ukraine crisis], they do not damage or stop the system from operating. Some of the tools [to do that] are multi-year production contracts for expendables, such as munitions, but we need to go beyond that. We need a significant reduction in the number of single-source suppliers for key components ... and procurement and maintenance of the tooling and capacity you need to quickly move two standard deviations above what peacetime production rates are ... in a short amount of time. Those are things I know the government is looking at now, but we need to fund those. Resiliency isn't without cost."

—**Jim Taiclet**, CEO, Lockheed Martin, at the Reagan Defense Forum [Dec. 3, 2022].

Proxy Fight?



Ukraine Ministry of Defense / Facebook

"There's a push and pull between the administration and Congress in trying to give the Ukrainians what they need; not just to match the Russians but to overmatch the Russians. And I have had this stance for a very long time, that for heaven's sakes, we should be pounding the bloody hell out of the Russians, through the Ukrainians, so that they can't pop their head back up and come back in another 5 to 10 years. ... And I think so many of us [in Congress] feel very strongly about this. If we're not helping the Ukrainians win and win decisively, what happens next with Taiwan [or] another hotspot?"

—**Sen. Joni Ernst** (R-Iowa), speaking at the Reagan Defense Forum [Dec. 3, 2022].

INAPPROPRIATE

"Are they going to let us pass the defense bill? They tried to stop us the last four years but we were in charge, so we had the votes, we were able to get it done. They're going to undoubtedly stop us from passing a defense appropriations bill, because they're going to stop all appropriations bills. ... There's a long-term impact, that we now have a group of extremists effectively in charge of the House of Representatives who want to stop us from doing even our most basic work, including protecting this country. That's something that everybody should be very alarmed about."

Rep. Adam Smith (D-Wash.) on the potential threat posed to defense spending by a small group of Republicans in the new Congress, Jan. 5, 2023.



Taiwan Military News Agency

Helping Hand

"We are going to help you pay for weapons, stow weapons for you to access, give you presidential draw-down authority from U.S. stocks, and work together to plan and exercise."

—**U.S. Navy Rear Adm. Mark Montgomery (Ret.)**, commenting on Congress passing \$10 billion in financing and grants in weapons sales to arm Taiwan and authorize the potential transfer of arms from American military stockpiles in the event of a Chinese attack [The Wall Street Journal, Dec. 16].



Staff Sgt. Jerreht Harris

PLAYING SANTA CLAUS

"It is a very challenging task. But I told this to many people, and I am not lying when I say that this is the best thing I've ever done in the Air Force, the most rewarding thing I've ever done. When you drop those bundles, and then you see the children running to it and waving, it is just a feeling unlike any other thing I've ever had. It's incredible"

—**Capt. Andrew Zaldivar**, Operation Christmas Drop mission commander [Air & Space Forces Magazine, Dec. 22].

By John A. Tirpak

Adapting to China's Long Game

China is speeding its efforts to build a nuclear triad on a par with that of Russia and the United States, and it's building its own version of America's still-nascent joint all-domain command and control (JADC2) system, according to the Pentagon's congressionally mandated annual report on the Chinese military. The Pentagon is now taking a longer view of Beijing's military plans and development, shifting from a near-term focus to mid-century, when China plans to be the world's dominant superpower.

The latest installment of "China Military Power" came out in late November, less than a week after the release of the long-delayed National Defense Strategy, which officially anointed China as America's "pacing military threat," rather than a "global competitor."

The 170-page Pentagon report acknowledges that the People's Republic of China (PRC) has a multi-decade plan to become the world's greatest nuclear and conventional military superpower, first by achieving parity with the U.S. circa 2035, and becoming unchallenged by mid-century. The Pentagon had been measuring its ability to deal with China by the capabilities each side would have circa 2027, when it's expected that China would have the means to make a quick and successful invasion of Taiwan.

However, a senior defense official, briefing the press on the report in December, said the Pentagon does not expect an invasion of Taiwan in the near term.

"I don't see any imminent indications of an invasion," the official said.

Instead, the Pentagon is focused on China's "intimidating and coercive military behavior," such as large-scale aviation incursions into Taiwan's Air Defense Identification Zone, he said, or its island-building projects to establish physical control over disputed areas of the South China Sea and elsewhere. There are also tactical provocations "we would highlight as being dangerous," he added, including unsafe aircraft intercepts, close passes by Chinese military ships, reckless use of lasers, and generally "unprofessional behavior" in the international commons.

The report delves into China's "intensified" all-of-government campaign to invoke Sun Tzu's principle of winning without fighting. Beijing is applying not only political and military pressure against Taipei, but economic and media pressure to "legitimize PRC coercive actions against Taiwan," by convincing the world the U.S. and China agree that Taiwan is merely a breakaway province from the mainland. By convincing the world that China's "One China" policy is essentially the same as the U.S. policy by the same name, it hopes to convince others that the United States is an aggressor for supplying Taiwan with weapons and offering to come to its military aid.

For the long term, China has been overt in recent years saying it seeks to "revise the international order in support of Beijing's system of government and national interests," the report noted, meaning that China plans to reshape the world to its own benefit, and using its more powerful military as a backstop to that effort.

Challenging boundaries and military exercises meant to threaten adversaries are part of China's "new normal," the defense official said. Consequently, the U.S. military must seek to deter China on a decades-long basis.

A DASH FOR NUCLEAR PARITY

China is rapidly building silos for intercontinental ballistic missiles



Lin Jiayu/China Ministry of Defense

China's People's Liberation Army amphibious infantry fighting vehicles assault a beachhead during a joint exercise with an army brigade and an aviation brigade on June 16, 2022.

(ICBMs), and may have about 1,500 nuclear warheads by 2035, the Pentagon said. Compared to 2020, that represents "a dramatically accelerated pace" of nuclear weapons construction, the senior defense official said: a "rapid buildup" that is "too substantial to keep under wraps."

China's inventory of about 400 nuclear warheads is only a fraction of that wielded by the U.S. and Russia, which have about 3,700 and 4,500 nuclear warheads, respectively. But the PRC has added some 100 warheads in the past year or so, and shows no sign of slowing down, the report notes. The PRC has indicated repeatedly that it has no interest in joining U.S.-Russian strategic arms treaties. China likely won't even entertain the idea until it has achieved rough parity in nuclear arms.

China recently built some 300 new ICBM silos. In 2021, China test-launched 135 ballistic missiles, more than the rest of the world combined. To complicate its deterrent threat, some of China's ICBMs will be road-mobile.

Chinese nuclear activities "exceed" its previous efforts "in terms of the scale, the numbers, and also the complexity and technological sophistication of the capabilities," the official said.

China is fielding its first nuclear-capable bomber, the H-6N, which will be able to refuel while airborne, the Pentagon said. While the H-6N is derived from a 1970s-vintage Soviet design, China is also developing a stealthy long-range "flying wing" bomber, the H-20, with a range nearly as great as the U.S. Air Force's B-2. It is also developing smaller, medium-range stealth bombers and submarines capable of launching nuclear weapons.

China is also making strides in cyber, space, and electronic warfare weapons, the Pentagon said. Senior defense officials have acknowledged that China is ahead in electronic warfare and, broadly, in "full spectrum" and "information" warfare.

A JADC2 FOR THE PLA

A new PLA (People's Liberation Army) doctrine, or "core operational concept," published in 2021 is "multi-domain precision warfare." Clear-

ly patterned on the what the U.S. military now calls joint all-domain command and control, the new construct calls for more elaborate sensor-to-shooter networks, and the use of artificial intelligence to identify key targets and strike them with whatever weapons are best positioned and suited to achieve the desired effects. By linking capabilities across the surface, subsurface, air, space, and cyber domains, China aims to impose targeting problems on its adversaries, just as JADC2 does for the United States.

China's concept is also called "systems destruction warfare," the U.S. official said, and it seeks to target vulnerabilities in the American kill chain.

"Basically ... they're thinking about looking across domains to identify vulnerabilities in an adversary's operational system," and exploit those vulnerabilities with both kinetic and nonkinetic means "to cause its collapse," the official explained.

Pentagon acquisition and sustainment chief William LaPlante said last fall that China has become "really good" at modern warfare.

"They can do the kill chain," he told attendees at a Potomac Officers Club seminar in October. "They've figured that out."

The U.S. military has touted JADC2 as the key capability in a potential conflict with a more robust Chinese military. If China also deploys such a system, many American command and control advantages could be negated.

Perhaps more explicitly than the U.S. National Defense Strategy, China is seeking all-of-government approaches to achieving its objectives in a "coordinated and mutually reinforcing" way to achieve "the ambitious objectives Xi Jinping has laid out" for 2049, the official said. Economic, political, social, and military capabilities will be used "in pursuit of [China's] regional and global ambitions," he added.

CHINA'S MILITARY SPENDING CONTINUES TO GROW

China's stated military spending—along with undisclosed investments—continues to grow. China increased defense spending 6.8 percent in 2021, to \$209 billion, or about 1.3 percent of its gross domestic product. This "continues more than 20 years of annual defense spending increases" and makes the PRC the second-largest military spender in the world after the U.S., according to the assessment. Indeed, from 2012 to 2021, China's defense spending doubled.

China does not disclose spending on military espionage, investment in its defense industrial base or research and development, or its foreign weapon procurement spending. Nor does it disclose military space investment, among other secret aspects of its national security program. And because China spends a fraction of what the U.S. spends per service member on pay and benefits, it can spend "far more ... for training, operations and modernization."

The Pentagon estimates that Chinese military spending growth will plateau and perhaps decline in the coming decade, with annual increases in the 4 percent range rather than 6 percent or more as in recent years. By 2025 or so, China will not only have solidified its position as the world's second-biggest defense spender, but it is more likely to be at parity, given the lack of transparency in its total defense investments.

MILITARY AVIATION

The People's Liberation Army Air Force (PLAAF) and Navy (PLAN) are making significant gains in military aviation, the Pentagon noted.

"The platforms they're developing" are improving, as are the air-to-air missiles that go with them, and integrated air defense systems, the official said.

The report noted that after years of struggling with indigenous engines for military aircraft, China is switching out the Russian-made powerplants in the J-10 and J-20 fighters in favor of Chinese-made WS-10 high-bypass turbines. The report predicted that China will largely switch to domestic engines in the next few years.

China is also in production with its Y-20 transport, a look-alike to the U.S. Air Force C-17.

"We're seeing improvements in all those kinds of areas," while at the same time the PLAAF and PLAN are "trying to make their training and exercises more sophisticated, more realistic," he said. The Chinese are finally succeeding at this after years of less-than-successful attempts, he said, and they are on track to achieving a "world-class air force" by 2049.

The PLAAF is "progressing on all fronts, from equipment to the training to the quality of pilots and other personnel," the official said.

The report noted that China's missile systems—including its cruise and ballistic missiles—"are comparable in quality to systems of other international top-tier suppliers." China tested "a new hypersonic weapon system in 2021, building on previous progress, and in 2020 "fielded its first missile with a hypersonic glide vehicle, and advanced its scramjet engine development," which has application to a range of new systems.

SPACE ADVANCES

A hypersonic transport aircraft may also not be too far off, the report notes.

"In 2021 and 2022, China conducted flight-tests of a reusable suborbital vehicle believed to be part of a plan to build a hypersonic transport system that could take people and cargo anywhere on Earth in less than an hour." As quoted from a China Academy of Launch Vehicle Technology report, the system "will feature winged aircraft that can take off and land like ordinary aircraft, but cruise at five times the speed of sound at high altitude."

The U.S. Air Force Research Laboratory is exploring its own "Rocket Cargo" system that could achieve similar results, one of its "Vanguard" technology initiatives. But U.S. technologists predict such a U.S. hypersonic transport is easily a decade away.


China has tested two uncrewed spaceplanes—"Shenlong" and "Tengyun"—which seem to be analogous to the U.S. X-37B experimental space platform, the Pentagon reported. The second such craft was orbited in 2022 for "an extended period of time," which also mirrors the operational mode of the X-37B.

The Pentagon noted that China's civilian space success, on a first try each, of landing and operating scientific exploration rovers on the moon and Mars in the last few years, along with the rapid construction of a space station initial testing of crewed lunar exploration craft is indicative of the strides made by its space technology enterprise. The report also noted that in addition to state-run space launch companies, China has created—in the last two years—pseudo-private rocket companies analogous to SpaceX and Blue Origin, which have already lofted satellites successfully.

In ground vehicles, China is advancing rapidly "in nearly every category," from tanks to infantry fighting vehicles, mobile air defense systems and artillery "at or near world-class standards." A new main battle tank is being tested, however, "quality deficiencies exist" with some of the equipment, and this has hampered China's defense exports in ground equipment.

RISK OF MISCALCULATION

As China grows its military and capabilities—and uses its increasing power to intimidate—the risk grows for potential miscalculation, the defense official said. The two nations need direct means of communication between the Chinese and U.S. military leadership, and to practice that to drive toward peaceful coexistence.

"Even as strategic competition intensifies, that doesn't mean that confrontation or conflict is inevitable or unavoidable," he said. The U.S. wants to manage its competition with China "responsibly," he said. Both nations should do what they can to ensure the competition doesn't "veer into conflict unnecessarily." 



Architect of the Capitol

The 2023 National Defense Authorization Act included a 4.6 percent pay raise, the largest in 20 years.

DOD Scores a Record \$858B Defense Budget

By Greg Hadley

Congress closed out 2022 with a bang, passing a \$1.7 trillion omnibus spending package that included a record \$858 billion for defense—up 10 percent from 2022.

After nearly three months operating under continuing resolutions that extended 2022 spending levels, the funding measure finally opened the way to new spending, just in time for the start of the fiscal year's second quarter. Days earlier, lawmakers passed the annual National Defense Authorization Act, the law that authorizes programs and policies affecting national defense.

"It's gratifying to see strong bipartisan support for the Department of Defense," said AFA Chairman of the Board Bernie Skoch. "AFA is particularly pleased that with this legislation Congress is increasing our nation's investment in national defense, and in particular in our Air and Space Forces. We encourage President Biden to sign this bill into law and to continue improving, modernizing, and strengthening our armed forces in the year to come. Never

"Never has having a ready and capable military been more critical to our nation."

—Air & Space Forces Association Chairman of the Board Bernie Skoch

has having a ready and capable military been more critical to our nation."

AFA also praised the Chairmen and Ranking Members of the two Armed Services Committees, Sen. Jack Reed (D-R.I.), Chairman of the Senate Armed Services Committee and Sen. Jim Inhofe (R-Okla.), the Ranking Member; and Rep. Adam Smith (D-Wash.), Chairman of the House Armed Services Committee, and Rep. Mike Rogers, (R-Ala.), Ranking Member. The 2023 NDAA was named for Inhofe, who retired at the end of this term.

Between them, the authorization and appropriations measures funded major increases in pay and allowances, including:

- A 4.6 percent pay raise, the biggest in 20 years. Congress asked DOD to direct an external study to review "the value of basic pay for members of the Armed Forces," and reassess the underlying model used to determine basic pay. DOD must report back to Congress on its progress in April, December, and again in 2024, lawmakers said.

- A record increase in the Basic Allowance for

Housing to keep up with inflation by tacking on an extra 2 percent to rates. Separately, lawmakers asked the Pentagon to report back on the “efficiency and accuracy of the current system used to calculate BAH,” which is based on surveys of about 400 rental markets nationwide and offer potential alternatives.

■ Increases in the Basic Allowance for Subsistence, the military food allowance, by 11.2 percent. The new enlisted rate is \$452.56 per month, while the rate for officers reaches \$311.68. That’s the biggest year-over-year increase since 2002.

■ Expands eligibility for the new Basic Needs Allowance, which can supplement the pay of junior service members with large families to keep them from relying on other public benefits. The measure opens eligibility to any service member whose gross family income is up to 150 percent of the federal poverty guidelines, based on family size.

The measures also fund additional aircraft purchases over and above those sought in the 2023 President’s Budget Request, cleared the way for some of the aircraft divestments the Air Force had sought, and blocked some other such moves. For example, the measures fund:

■ Up to 44 new F-35A Lightning II jet fighters, an increase of 11 over what the 2023 request. The NDAA did not specify a number of F-35As, instead authorizing a dollar limit of \$4.09 billion; appropriators added another \$150 million to that total. The Air & Space Forces Association campaigned hard for such an increase throughout 2022.

■ An extra \$2 billion over the 2023 request for classified programs, which include advanced weapons and platforms, including the Next-Generation Air Dominance family of systems.

■ An additional \$600 million over the request for the service’s HH-60W Combat Rescue Helicopter program. USAF had planned to cut its planned fleet from 113 aircraft to 75, but Congress objected.

After years of clashes over Air Force attempts to retire older aircraft—a strategy dubbed “divest to invest” in order to fund the development of new weapons platforms—Congress relented in the 2023 NDAA on several fronts.

In response to the Air Force request to retire 21 A-10s, Congress reduced its mandate to retain 171 A-10s by 18, dropping the required number to 153. And to enable the Air Force to retire 13 aging KC-135s, the NDAA reduces the minimum number of aerial tanker aircraft from 479 to 466 planes. And Congress agreed to eliminate a 2019 mandate to maintain at least six E-8C Joint Surveillance Target Attack Radar System (JSTARS) aircraft, enabling the service proceed with its plan to retire eight of 16 remaining E-8s in 2023 and four more in 2024.

But when it came to retiring the Air Force’s early-model Block 20 F-22 Raptor fighters, Congress refused to go along. Those F-22s are used for training today, and are not equipped

to operate in combat as the more advanced versions are. Congress considered plans to upgrade the Raptors to the combat configuration, but opted not to when the projected cost went over \$1 billion. Instead, it ordered the Air Force to maintain its 184 Raptors and develop a “strategy and execution plan ... for conducting formal training for F-22 aircrews,” including the reestablishment of one or more F-22 Formal Training Units. The bill also directed the Air Force comptroller general to report back on precise costs and a potential timeline for upgrading the aircraft.

The NDAA also blocked divestment of F-15 fighters until the Air Force reports back on details of that plan, including detailing where it will locate new-build F-15EXs.

The NDAA would also block any retirement of E-3 AWACS aircraft, contrary to the Air Force’s wish to retire 15 of the 31 airplanes in the fleet. However, the bill includes exceptions that would let the service retire some, depending on its progress in acquiring the E-7 Wedgetail, the planned replacement for AWACS.

Once the Air Force submits an acquisition strategy for the Wedgetail approved by its acquisition czar, it can cut its number of E-3s down to 21. If the service awards a contract for the procurement of E-7s, it can cut the AWACS fleet down to 18.

Congress rejected plans to retire a dozen Air National Guard C-130H and requires the Air Force to maintain a C-130 fleet of at least 271 aircraft. Congress also rejected the plan to retire the C-40 Clipper, used to transport senior military commanders, Cabinet officials, and members of Congress.

“AFA will continue to advocate for the strongest Air and Space Forces possible,” Skoch said. “We are pleased that Congress is taking steps to properly equip our Airmen and Guardians so they can do their jobs to the best of their abilities and return home safely to their families.”

AFA’s efforts to increase budget transparency by eliminating the practice of funneling some \$33 billion in intelligence funding through the Department of the Air Force budget were less successful in Congress. Appropriators barred any modification to how

the Pentagon structures or presents funds for the National Intelligence Program—which accounts for the so-called “pass-through” spending. But the budget package did not shut down the initiative entirely, specifying that the Secretary of Defense and the Director of National Intelligence can “study and develop detailed proposals for alternative financial management processes.”

While such a study would need to account for counterintelligence risks and be certified by affected intelligence agencies, lawmakers appeared open to a plan that would “help achieve auditability, improve fiscal reporting, and will not adversely affect counterintelligence” according to the budget law. ★

Basic Allowance for Subsistence

With the largest increase in memory, the food allowance has now nearly doubled in 21 years.

YEAR	OFFICER	ENLISTED	PERCENTAGE CHANGE
2023	\$311.68	\$452.56	11.20
2022	\$280.29	\$406.98	5.30
2021	\$266.18	\$386.50	3.70
2020	\$256.68	\$372.71	0.90
2019	\$254.39	\$369.39	0.00
2018	\$254.39	\$369.39	0.30
2017	\$253.63	\$368.29	0.00
2016	\$253.63	\$368.29	0.10
2015	\$253.38	\$367.92	2.90
2014	\$246.24	\$357.55	1.50
2013	\$242.60	\$352.27	1.10
2012	\$239.96	\$348.44	7.20
2011	\$223.84	\$325.04	0.36
2010	\$223.04	\$323.87	0.00
2009	\$223.04	\$323.87	10.00
2008	\$202.76	\$294.43	5.20
2007	\$192.74	\$279.88	2.80
2006	\$187.49	\$272.26	1.90
2005	\$183.99	\$267.18	5.00
2004	\$175.23	\$254.46	4.80
2003	\$167.20	\$242.81	0.50
2002	\$166.37	\$241.60	

What the 2023 Budget Funds for USSF

By Greg Hadley

Congress added more than \$1.7 billion to the Pentagon's Space Force budget request for fiscal 2023, including nearly \$770 million extra for research, development, testing, and evaluation, and more than \$447 million for procurement, on top of a record \$4.08 billion request. Operations and maintenance accounts got a plus-up of \$150 million.

Lawmakers pressed the Space Force on its already high priority of making U.S. military satellites more resilient in the face of growing threats in space. The NDAA requires the Secretary of Defense, in consultation with the Director of National Intelligence, to make publicly available the department's strategy for protecting and defending satellites in orbit. It also demands the Space Force must develop "requirements for the defense and resilience of the satellites" before any major satellite acquisition program achieves Milestone A approval—the earliest milestone in the process.

In a related requirement, lawmakers directed the Space Force to expand plans to develop "tactically responsive space capability"—the ability to quickly launch new satellites as needed. Congress has pressed for such a program for several years, emphasizing the need this year not only not to be able to launch satellites quickly, but also sustain and control satellites once in space.

Congress wants the Secretary of the Air Force to provide long-term continuity plans for such tactically responsive capabilities through the Future Years Defense Program, which looks five years into the future, and to oversee development of "tactics, training, and procedures" for tactically responsive operations. It requires an annual plan delivered to Congress through 2026.

Lawmakers also asked the Secretary of Defense to look into "whether the Space Development Agency should be exempt from the Joint Integration and Development System in order to speed overall fielding of proliferated space systems." The SDA's aggressive, commercial-style approach to developing a proliferated constellation of satellites in low-Earth orbit, dubbed the National Defense Space Architecture, has gained attention for its apparent progress, but some question whether it should have to follow the same joint oversight required of most other Defense Department acquisition programs.

STRUCTURE

As in years past, the NDAA includes several provisions giving the Chief of Space Operations the latitude to vary end strength, both for the entire service and for specific ranks, as needed. With the Space Force still accepting interservice transfers and recruiting highly trained personnel from industry, the exact



Senior Airman Thomas Sjöberg/USSF

The Space Force budget will reach \$26.3 billion in fiscal 2023, thanks to major plus-ups from Congress. Funding will help deliver more capability to space, such as this Atlas V rocket carrying two Geosynchronous Space Situational Awareness Program (GSSAP-5/6) satellites into space in January 2022.

numbers and ratios of Guardians are still stabilizing.

Efforts to establish a Space National Guard did not succeed; the Biden administration has opposed that concept, endorsing instead a hybrid "Space Component" with both Active-duty and Reserve components integrated as one, enabling the service to employ both full-time and part-time Guardians. While the NDAA did not endorse that concept, it did task the Secretary of Defense to report to Congress with details on how such an integrated organization might work, including how promotions, changes in duty status, and retirement might work. Likewise, Congress wants insight into what laws might need to be changed to support this approach, and a review of impacts on budget, diversity, and risks over conflicts of interest for part-time Guardians working for Space Force contractors.

Lawmakers also expressed concern about the new National Space Intelligence Center, currently run by Space Delta 18, because it is subordinate to the service's Space Operations Command, "rather than a field operating agency aligned to the Director of Intelligence, Surveillance, and Reconnaissance of the Space Force." The question is whether there are any "perceived mission misalignment, potential mitigating measures, or other structural organization concerns" related to this structure.

Finally, the NDAA questioned "the manning required to fully staff the current and planned cyber squadrons of the Space Force." The Space Force currently has a number of cyber-focused squadrons, some within Space Delta 6 focused on defensive cyber operations for space systems and others nested within the Space Force element in the National Reconnaissance Office.



Brooke Army Medical Center Auxiliary staff present a special basket to Air Force Master Sgt. Chelsey Barnes, Tech. Sgt. Sydney Barnes, and their newborn son for being BAMC's first baby of the year on Jan. 1, 2023, at 12:40 a.m.



Robert Whetstone/DOD

PERSONNEL

The Air Force's New 12-Week Parental Leave Policy

By Greg Hadley

Airmen and Guardians may now take up to 12 weeks of paid parental leave under the Pentagon's new Military Parental Leave Program (MPLP) as a result of a change authorized by Congress a year ago and effective Dec. 27, 2022.

The new policy covers births, adoptions, and long-term care requirements for new foster children.

Under the prior policy, in place since 2018, a new child's primary caregiver could take an additional six weeks of leave after convalescent leave, while the secondary caregiver could take three weeks. The new leave policy doesn't put a specific time frame on convalescent leave, instead leaving it up to the recommendation of the birth parent's health care provider "to address a diagnosed medical condition." Convalescent leave begins the day after the new child's birth, or after the birth parent is discharged from the hospital, whichever is later.

After that, both primary and secondary caregivers have a year to take their 12 weeks of leave, which may be taken in increments of seven or more days, and need not be taken all at once.

As long as a service member had unused caregiver leave as of Dec. 27, they'll be allowed to take the full 12 weeks of leave. So if an Airman had completed two weeks of secondary caregiver leave as of Dec. 27, leaving one week under the old policy, he or she is now eligible for an additional nine weeks, bringing

The new policy, now more in line with other federal guidelines, aims to help retain and attract talent.

the total leave to 12 weeks. Similarly, a Guardian who had taken five weeks of primary caregiver leave as of Dec. 27, leaving one week to go before returning to work, is now eligible for an additional six weeks, again for a total of 12.

Airmen and Guardians who returned to work before Dec. 27 and gave up parental leave are out of luck this time around. Having used up or forfeited parental leave under the previous policy, there is no chance now to gain the added time off. But any Airman or Guardian in the middle of their six weeks of convalescent leave authorized under the previous policy will be allowed to finish that leave and then take 12 weeks of parental leave.

While the services require all leave be taken within 12 months of a birth, adoption, or foster child placement, members deployed for military operations can defer parental leave until their deployment is completed. To request leave under the new policy, Airmen and Guardians must use LeaveWeb, which was updated Jan. 6, or AF Form 988. Separate requests are now necessary for convalescent and parental leave, as they are now treated as distinct and separate events.

Advocates say the new leave policy will help the Pentagon retain and attract talent amid a historically competitive job market, putting military parental leave policies more in line with the rest of the federal government and making them arguably more generous than most private employers. ★

No More Tape Test: Air Force Announces New Body Composition Program

By Greg Hadley

The Department of the Air Force unveiled its new body composition program Jan. 9, more than two years after dropping the unpopular abdominal circumference measurements from fitness assessments. The new assessments will begin in April.

Now, instead of getting a score based on a single waist measurement, Airmen and Guardians will divide their waist by their height in inches. An Airman who stands 69 inches tall and has a waist of 36 inches, for example, divides 36 by 69 to calculate a waist-to-height ratio of 0.52. Any ratio below 0.55 is deemed a low or moderate risk and within standard. Ratios equal to or greater than 0.55 are considered a high risk and out of standard.

For service members deemed high risk, a yearlong “informal, self-directed Body Composition Improvement Program” is in store, including a referral for medical evaluation and “assessment for additional risk factors.” There are no disciplinary implications during this period, the Air Force said, but if the member is still not meeting standards after a year, a mandatory formal self-directed program will be imposed.

“That may result in consideration for administrative action, including separation for continued failures,” according to the Air Force release.

“The goal of the new program is to empower Airmen to take charge of their health and fitness through lifestyle enhancement to optimize readiness,” said Lt. Gen. Caroline Miller, deputy chief of staff for manpower, personnel, and services, in a statement.

In the Space Force implementation, high-risk Guardians will be referred to Guardian Resilience Teams, including “human performance subject-matter experts with different specialties,” such as preventive care, performance optimization, mental health care, and spiritual assistance. This policy follows the Space Force’s holistic health program, which includes a fitness program without annual tests.

The Air Force stopped using waist measurements for its fitness test in 2020, amid the pause in PT testing at the height



Airman 1st Class Jackson N. Haddon

Airman 1st Class Zahir Douglas, a commander's support staff Airman assigned to the 56th Air Refueling Squadron, measures the waist of an Airman during physical fitness assessments.

of the COVID-19 pandemic. The department noted at the time, however, that Pentagon policy still required the recording of body composition. In November 2021, the Air Force surgeon general settled on waist-to-height ratio as the service's new measurement method, and in March 2022, DOD changed its policy to give the services more latitude in measuring body composition.

Critics of the old waist measurements said the measurement was a simplistic means of guessing at individuals' body fat percentage. Body builders in particular suffered under a system in which they could excel in the tests only to be suspect based on the measuring tape. The new body composition program is separate from the PT tests, erasing that connection. ✪

0-5, 0-6 Promotion Boards Will Now See Which Candidates Have Advanced Degrees

By Greg Hadley

Officers are about to get credit where it's due, at least for their academic achievements: For the first time in years, Air Force and Space Force promotion boards will be able to see which majors and lieutenant colonels vying for promotion have advanced academic degrees.

The move to “unmask” advanced degrees went into effect Jan. 1 by order of Air Force Secretary Frank Kendall, reversing an eight-year-old policy that hid those details from promotion board members. In a memo explaining the change, Kendall cited the value of advanced expertise in countering growing military threats from China and Russia.

“To do this effectively, we need leaders and supporting staff throughout the DAF at all levels who have deep expertise in emerging technologies and their applications to military operations,” Kendall said. “We must also have leaders with expertise in the cultures of our potential adversaries. Such expertise and associated critical thinking skills are developed from many sources and experiences, including advanced academic degree programs.”

Advanced degrees are required for promotion to colonel, and Kendall acknowledged that including those credentials in past reviews for advancement to major or lieutenant colonel had effectively raised the bar. Before that change, “an advanced

degree, any advanced degree, was considered necessary for promotion to major or lieutenant colonel,” he said.

That perception was not based policy, however, which is why advanced educational achievements were removed from board consideration in 2014. At the time, then-Chief of Staff Gen. Mark A. Welsh III said his aim was to reinforce the importance of job performance for and ensure “the decision to delay completion of an advanced academic degree will not affect [an officer’s] ability to serve a full career in the Air Force.”

In reversing the policy, however, Kendall emphasized that advanced degrees are “neither a requirement for promotion to major or lieutenant colonel nor a guarantor of promotion.”

“The DAF will continue to value both operationally and educationally derived experience and expertise and will always value high levels of performance,” he added.

Kendall also urged officers not to pursue advanced degrees to “impress a promotion board or check a perceived box.” He said he would instruct promotion boards to value “specific” degrees and military training and operational experience.

According to the most recent Department of the Air Force data, more than three-quarters of Active-duty majors and 97 percent of lieutenant colonels in the Air Force and Space Force possess at least a master’s degree, compared to just 40 percent of captains. But not enough of those advanced degrees are in science, technology, engineering, and math (STEM) fields.

A recent report by the Air Force Research Laboratory found that half of all department jobs requiring advanced STEM degrees were either vacant or filled by someone with a lesser credential. The report also noted that there are fewer general officers with advanced STEM degrees today than at any point in the past 30 years.

Pentagon and Air Force policy leaders have warned this lack of technical expertise poses a long-term threat to military capability, noting that the U.S. military neither competes effectively for talent with the private sector nor competes numerically with international competitors like China, which has placed greater emphasis on developing a technically skilled workforce.

Former Air Force chief software officer Nicolas M. Chaillan wrote in September 2021 of his frustration with the service’s practice of putting officers inexperienced in software development in charge of large information technology projects and missions. He said their lack of background inevitably led to problems.

“Please stop putting a major or [lieutenant colonel] (despite their devotion, exceptional attitude, and culture) in charge” of technical projects affecting millions of users, Chaillan wrote, “when they have no previous experience in that field. We would not put a pilot in the cockpit without extensive flight training; why would we expect someone with no IT experience to be close to successful” running a major IT program?” ✦

RUSSIA / UKRAINE

DNI Skeptical of Russia Spring Offensive

By John A. Tirpak

Russia’s ability to refit and reconstitute for an expected spring offensive in Ukraine is in some doubt, because of its inability to domestically produce the weapons it is using, according to Avril Haines, the Director of National Intelligence. But she also doesn’t see any evidence that Russian President Vladimir Putin will give up his ambitions of “controlling” Ukraine.

In a Dec. 3 interview with NBC’s Andrea Mitchell at the Reagan Defense Forum in Simi Valley, Calif., attended by Air & Space Forces Magazine, Haines said U.S. intelligence expects the current “reduced tempo” of the Ukraine conflict, with Russia withdrawn to the far eastern portions of the country, to continue into the spring.

“Then, once you get past the winter the ... question is: what will the counteroffensive look like?” Haines said.

The Intelligence Community expects both Ukraine and Russia to go into a “refit, resupply, ... reconstitute” mode, “so they’re prepared for the counteroffensive.” However, “we actually have a fair amount of skepticism as to whether or not the Russians will be, in fact, prepared to do that,” Haines said. Rather, she is more optimistic for the Ukrainians.

“I think Putin was surprised by his military’s ... lack of performance.”

—Avril Haines, Director of National Intelligence

Russia’s stockpile of weapons is in question, Haines explained.

“I can’t give you precise numbers in this forum, but ... it’s really pretty extraordinary, and our own sense is that they are not capable of indigenously producing what they are expending, at this stage.”

That’s why Russia has been “going to other countries ... to try to get ammunition and ... we’ve indicated that their precision munitions are running out much faster [than that of the Ukrainians] in many respects.” Russia is known to have solicited weapons from North Korea, China and Iran, which would be compatible with Russian systems because their original design was Russian.

So far, Russia has not gotten “a lot” of artillery from its client states, she said.

The size of Russia’s weapon stockpiles and how much is available for them “to use in different conflicts ... are obviously all questions that we look at quite carefully with our allies and partners,” Haines said, hinting that Russia may have significantly limited military options for conventional action beyond Ukraine.

Haines is not certain that Vladimir Putin truly understands what’s happening in Ukraine and may be getting sugar-coated reports from underlings unwilling to anger him.



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For over seven decades, U.S. Air Force aircrews have taken to the skies, and Rolls-Royce has proudly supplied thousands of engines to keep them aloft. While our history unites us, it's our future with the Air Force that encourages Rolls-Royce advancements in the U.S., including our developments in hypersonics, directed energy, micro-reactors, and sustainable propulsion solutions. So from Rolls-Royce to the United States Air Force, congratulations for 75 years of aerospace innovation. We are happy to continue the ride into the wild blue yonder!



Ukraine Ministry of Defense/Facebook

A destroyed Russian tank at an undisclosed location in Ukraine on Oct. 2, 2022.

"This has obviously been an issue that's been discussed pretty widely. ... What I can say is, I think Putin was surprised by his military's ... lack of performance" in Ukraine, Haines offered.

"I do think he is becoming more informed of the challenges that the military faces in Russia, but it's still not clear to us that he has a full picture at this stage of just how challenged they are," with regard to "shortages of ammunition, ... morale, supply issues, logistics, a whole series of concerns that they're facing."

While Putin's grasp of Russia's poor status in the war may only now be dawning on him, he's not changing his plans, Haines said.

"He has not changed his political objectives; at least we don't see evidence of that," she said.

If his objective is to retake control of Ukraine, "there are a lot of interpretations of what that means," Haines added—Putin continues to say Ukraine is part of Russia's sovereign territory, but "what does that mean for his near-term military objectives? Are they going to be as expansive as they were at the beginning? Or does he at some point recognize that he's incapable of doing what it is he intended to, originally, and ... downscale what it is that he's willing to accept?"

American intelligence believes "he may be willing to do that on a temporary basis with the idea that he might then come back at this issue at a later time."

Haines said that Russia's campaign of strikes at Ukraine's power infrastructure may be hurting, but isn't having the desired effect of breaking the country's will to resist.

"As we watch ... the population fight for their country and then see the just outrageous illegal attack on civilian infrastructure, such as the grid [and] gas ... heating [and] a variety of other things ... we're not seeing any evidence" of Ukrainian will to resist "undermined ... at this point." The strikes are also calculated to "affect Ukraine's capacity to ... prosecute conflict," which may have an effect long-term, especially on Ukraine's economy, which is "obviously suffering very badly."

Iran has given or sold unmanned aircraft to Russia and has

ham-handedly tried to avoid responsibility for the results, Haines said. Iran first denied it, then "said, 'Well, these were given before the war.' ... They had a variety of different excuses." Russia is also seeking other kinds of precision munitions from Iran, she said. "That will be very concerning," she added, but declined to discuss the issue further.

Haines declined to offer estimates of Russian casualties but said both sides are taking fewer losses as the pace of operations slows.

As to China's role in supporting Russia, Haines said President Xi has been trying to "play ... both sides of this game. ... They are continuing to work with Russia on a variety of things. They continue to ... have meetings, find ways to support [Russia] in international fora to help them manage ... efforts to expose what the Russians are doing or provide condemnation. And they are providing different forms of assistance."

While China has not provided Russia "anything that is determinative of military assistance, ... there are things on the margins ... [that] concern us and we'll obviously keep watching this." She added that there's "no evidence" that China has been responsible for reigning in Putin's recent rhetoric on using nuclear weapons.

However, "I think it is fair to say, from our perspective, that Xi's voice on this is going to be obviously among the most compelling to Putin on this issue."

Asked if Putin's position is becoming more precarious, with more outspoken protests about the war—some even coming from oligarchs—Haines said, "We've seen increasing ... dissent among the elites," big-city mayors and "more significant figures in Russia" offering "more critical views of the war ... than you have in the past." However, none of it "amounts to likely regime change."

The dissent from the elites "could shape some of his decision-making," and the U.S. is trying to understand this dynamic better, she said. Protests in the street don't seem to influence Putin, she added.



US to Supply Ukraine with Bradleys, New Air Weapons in Latest \$3B Aid Package

By Chris Gordon

The Biden administration announced a massive new aid package for Ukraine on Jan. 6, totaling over \$3 billion and including armored infantry fighting vehicles, Zuni rockets, and other weapons once considered off-limits.

The Pentagon will send 50 Bradley fighting vehicles, which American defense officials said will help Ukraine push Russian forces back and regain territory in the east and south of the country, as part of a \$2.85 billion package from Pentagon stocks. The U.S. will also send \$682 million to countries on NATO's eastern flank, which have depleted their own arsenals to come to Ukraine's aid. An additional \$225 million will be given to Ukraine to "cover wartime requirements" and support the sustainment of previously provided weapons systems, according to the State Department.

The latest package also includes new air capabilities. In a bid to bolster Ukraine's air force, the U.S. will send 4,000 Zuni rockets, which can be fired at ground targets. The U.S. also recently announced it was sending Joint Direct Attack Munitions (JDAMs) to Ukraine. Previously, the Pentagon had focused on sending AGM-88 High-speed Anti-Radiation Missiles, which could attack Russian surface-to-air missile sites. However, the Zuni and the JDAMs give Ukraine's air force a new strike capability.

"In terms of providing Ukraine with capability for their aircraft, it's actually something we've been working on for a while," Laura Cooper, deputy assistant secretary of Defense for Russia, Ukraine, and Eurasia, said in a briefing at the Pentagon. "This is really just the latest in efforts to help them to make their existing aircraft fleet as effective as possible."

Cooper said the Zuni rockets could be mounted on fixed-wing or rotary-wing aircraft.

"It's air to-ground, but it's at fairly close range," she said.

The Zuni rockets have laser-guided and unguided versions, and it was not immediately clear which type the U.S. was

providing. When asked how Ukraine would employ rockets designed for American aircraft onto aircraft designed in the Soviet Union, Cooper cracked a wry smile.

"I trust our engineers, and I definitely trust the Ukrainian engineers," she said. And "It is something that is possible."

In the latest effort to help meet Ukraine's air defense needs, the U.S. will also provide RIM-7 Sea Sparrow missiles that will be modified for use in Ukrainian Buk launchers.

"It is a creative solution that did require some engineering finesse," Cooper said of using American surface-to-air missiles in Russian-made launchers. "But we're very pleased that it will work for the Ukrainians."

Ukraine has come under attack from Russian drones, cruise missiles, and ballistic missiles, and the U.S. and its allies have scrambled to provide better air defenses.

In a move lauded by the Biden administration, Germany recently announced it would provide an advanced Patriot battery, a system that costs hundreds of millions of dollars and can help protect key areas of Ukraine as Russia seeks to pummel the country into submission from the air during winter. The U.S. pledged one of its prized Patriot systems in December.

"We will continue to support Ukraine's urgent requirement for air defense capabilities to defend against Russia's brutal attacks," Cooper said. "Ukrainian forces are showing an undiminished will to fight to defend their country. Ukraine will continue fighting through the winter with the backing of a large coalition of nations, and we continue to encourage allies and partners to make additional donations to bolster Ukraine's combat and air defense capabilities."

The M2A2 Bradley is a tracked vehicle that can carry around half a dozen soldiers into battle. The U.S. will also support the Bradleys with 500 TOW anti-tank missiles and 250,000 rounds of 25-millimeter ammunition, as well as self-propelled artillery for the first time.

The U.S. is still declining to provide tanks to Ukraine, but Pentagon Press Secretary Brig. Gen. Patrick S. Ryder argued

Soldiers with the 3rd Armored Brigade Combat Team, 1st Cavalry Division zero the 25 mm canon on a Bradley fighting vehicle at a range in Poland. The U.S. is giving Ukraine 50 of the armored vehicles to help fight Russian forces.



Staff Sgt. Charles Porter/USA

the Bradley is “not a tank, but it’s a tank-killer.”

The latest U.S. package includes:

- 50 Bradley infantry fighting vehicles with 500 TOW anti-tank missiles and 250,000 rounds of 25 mm ammunition;
- 100 M113 Armored Personnel Carriers;
- 55 Mine Resistant Ambush Protected Vehicles (MRAPs);
- 138 High Mobility Multipurpose Wheeled Vehicles (HMMWVs);
- 18 155 mm self-propelled Howitzers and 18 ammunition support vehicles;
- 70,000 155 mm artillery rounds;
- 500 precision-guided 155 mm artillery rounds;
- 1,200 155 mm rounds of Remote Anti-Armor Mine (RAAM) Systems;

- 36 105 mm towed Howitzers and 95,000 105 mm artillery rounds;
- 10,000 120 mm mortar rounds;
- Additional ammunition for High Mobility Artillery Rocket Systems (HIMARS);
- RIM-7 missiles for air defense;
- 4,000 Zuni aircraft rockets;
- Approximately 2,000 anti-armor rockets;
- Sniper rifles, machine guns, and ammunition for grenade launchers and small arms;
- Claymore anti-personnel munitions;
- Night vision devices and optics;
- Spare parts and other field equipment.



AIR POWER

F-35 Flies for the First Time with Tech Refresh 3

The developmental test team from the 461st Flight Test Squadron at Edwards Air Force Base, Calif., flew an F-35 fitted with Technology Refresh 3 (TR-3) in January, the first flight with the critical upgrade.



F-35 Joint Program Office

By John A. Tirpak

Advances to the F-35 are coming on several fronts. The first F-35A fitted with the Tech Refresh 3 update flew Jan. 6 from Edwards Air Force Base, Calif., the Joint Program Office announced in early January. A new radar is also in the works, according to Northrop Grumman, which builds both the current unit and the more advanced version.

Tech Refresh 3 includes more powerful processors and memory, and is the enabling upgrade on which most of the planned F-35 Block 4 improvements depend. The Block 4 version of the F-35 will have new electronic warfare capabilities, new sensors, and capabilities for new weapons, as well as improved interoperability with both fourth- and fifth-generation fighters.

The Air Force has sought to slow its F-35 purchases in recent years, wishing to wait for the more advanced Block 4 jets, and

avoid costly retrofits of older models. But the TR-3 has been delayed by technical problems, driving up F-35 development costs by some \$330 million, according to a report from the Government Accountability Office. In April, 2022, the GAO also reported the Block 4 to be three years late. The first production-model F-35 with TR-3—but not the full Block 4 suite—is now scheduled to be included with Lot 15 jets now in early phases of construction.

Air Force Lt. Gen. Michael Schmidt, program executive officer for the F-35, hailed the first flight of TR-3 as a “significant achievement.” The TR-3, he said in a press release, “is the F-35’s critical computer processing electronics upgrade that will continue to provide all our pilots with the capability they need to be successful against any adversary.”

The F-35 Joint Program Office said, “The TR-3 program has overcome technical complexity challenges with hardware and software and is now on-track to deliver capability to the U.S. and

its allies starting in 2023,” when the first Lot 15 jets will roll off the production line. The government-industry team continues “to find innovative ways to ensure delivery of critical capabilities to defeat future threats. Lessons learned in the execution of the TR-3 program will be applied across the entire Block 4 modernization program.”

A developmental test team from the 461st Flight Test Squadron conducted the first flight of the TR-3-equipped aircraft at Edwards Air Force Base, Calif. The aircraft was AF-7, one of the Air Force’s designated F-35 test airplanes, instrumented to record actual performance so it can be compared with computer predictions.

Maj. Ryan Luerson, an Air Force test pilot, flew the 50-minute hop, which reached an altitude of 35,000 feet and a speed just below Mach 1, to test airworthiness and stability of the software. Air Force Lt. Col. Christopher Campbell, commander of the 461st Flight Test Squadron and director of the F-35 Integrated Test Force, said TR-3 “modernizes the computational core of the F-35 air vehicle.” The new TR-3 hardware and software “affect nearly every aircraft feature. Today’s event was just the start of a comprehensive flight test campaign that will both verify and improve the safety, stability, and performance of the whole F-35 weapon system in this new configuration,” he said.

Lockheed Martin aeronautics F-35 Vice President and General Manager Bridget Lauderdale said the flight “is an important step in enabling future capabilities to ensure F-35 remains unrivaled across the globe. We look forward to continued collaboration with the JPO and industry partners to deliver TR-3.”

PRODUCTION PLANS

DOD and prime contractor Lockheed Martin struck a \$30 billion production deal for Lots 15 and 16—with options for Lot 17—as 2022 ended. The agreement calls for 145 aircraft in Lot 15, 127 aircraft in Lot 16, and up to 126 in Lot 17, which will include the first jets delivered to Belgium, Finland, and Poland.

The open-ended Lot 17 allows for 23 more F-35s than the Pentagon originally planned, but when the “handshake deal” on the three lots was announced in July 2022, Pentagon acquisition and sustainment chief William LaPlante said it was “based on” as many as 375 jets. Either way, deliveries are declining—the Lot 12-14 deal, inked in 2019, covered 478 aircraft. The drop aligns with the desire to slow production while waiting for Block 4 to be production-ready. The agreed Lot 15-17 numbers average 132 airplanes per year; well below the 156 per year predicted by Lockheed Martin CEO Jim Taiclet in an investors’ call a year ago.

In a statement announcing the deal, Schmidt said the deal “strikes the right balance between what’s best for the U.S. taxpayers, the military services, allies, and our foreign military sales customers.” The unit cost of the fighters will average about \$75 million a copy, without the Pratt & Whitney F135 engine. With the engine, the last three-lot deal achieved a unit cost below \$80 million per jet. The JPO did not provide Air & Space Forces Magazine an all-up cost for the fighters in Lots 15-17.

For the airframe and mission equipment only, the Lot 15-17 cost of F-35s ranges “from \$70.2 million to \$69.9 million for the F-35A, \$80.9 million to \$78.3 million for the F-35B, and \$90 to \$89.3 million for the F-35C,” a Lockheed spokesperson said. Lockheed has been warning for two years that Lot 15 and later lots would cost more due to the greater capability being built into the jet, as well as pandemic-related supply issues and inflation.

Besides TR-3, Block 4 includes some 75 changes, include new or additional weapons, communications and networking

upgrades, electronic warfare improvements, cockpit and navigation enhancements, and “radar and [sensor] fusion updates,” a Lockheed spokesperson said.

NEW RADAR COMING

Northrop Grumman is building the F-35’s new radar, designated the AN/APG-85, which the company calls the “cornerstone” of the F-35’s future sensor suite. The new unit replaces the AN/APG-81, the active, electronically-scanned array (AESA) radar Northrop builds for today’s F-35s. Although Air Force budget documents have referenced the AN/APG-85 since last year, Northrop hasn’t been allowed to discuss the program until now.

“The capability of the F-35 advanced radar will enhance the DOD’s ability to execute the National Defense Strategy in the future,” the JPO said in response to an email query from Air & Space Forces Magazine. “Therefore, certain information will continue to be protected by enhanced security measures due to the critical nature of the technology.”

It added, “We do not disclose technical information on operational capabilities.”

Northrop said the new radar is an “advanced multifunction sensor that will be compatible with all variants of the F-35 aircraft and will be capable of defeating current and projected adversarial air and surface threats.” It’s not yet clear if it will be retrofitted to existing models of the fighter.

The new radar will probably be available in time to equip seven jets at the tail end of the Lot 17 F-35 contract, with delivery anticipated as soon as late 2025 or early 2026. The AN/APG-85 “will incorporate some of the latest technologies available and help ensure air superiority,” Northrop noted.

“This advanced sensor will provide unparalleled battlespace situational awareness that translates into platform lethality, effectiveness, and survivability.” Neither Northrop nor the JPO would comment on the degree of commonality between the two radars, or whether the new unit will completely replace the old one or if only certain elements will be changed.

The current AN/APG-81 can be used to target enemy fighters and ground threats, can track and shoot uncrewed aerial vehicles and cruise missiles, can conduct bomb damage assessment, perform a ground moving target indicator (GMTI) function and provide synthetic aperture radar ground mapping. Presumably, the AN/APG-85 will go beyond those capabilities, with greater resolution and even less susceptibility to jamming and spoofing.

Government and industry officials have also spoken of the F-35’s future radar being able to conduct electronic warfare, offensive directed energy operations and cyber warfare.

The new radar will be developed and built at Northrop’s Linthicum, Md., facilities, where the AN/APG-81 is built now. It will be one of the piece of equipment for the Block 4 F-35 many new systems.

The need to provide power and cooling for these new systems is one of the reasons the Air Force is in the throes of deciding what engine will power future F-35s. One option is an all-new engine based on one of the Adaptive Engine Transition Program (AETP) powerplants; the other is an upgrade package of the existing F135 engine, being touted by Pratt & Whitney, which is its sole maker.

In revealing the new radar, Northrop noted that it’s already a major partner to Lockheed on the F-35, contributing the center fuselage and wing skins, “several sensor systems,” avionics, mission systems and mission-planning software, pilot and maintainer training systems, and “electronic warfare simulation test capability,” in addition to the radar and overall stealth capabilities.

What Could be Part of the B-21 ‘Family of Systems?’ New Report Offers Insight

An artist's illustration depicts an Air Force B-21 Raider escorted on a mission by armed, uncrewed drones.



Mike Tsukamoto/staff; Greg Davis/USAF

By Greg Hadley

With the unveiling of the B-21 Raider, speculation and interest in the new bomber have reached a fever pitch, with a first flight still to come in mid-2023.

But the B-21 won't just be about the large, flying wing aircraft that rolled out in Palmdale, Calif., on Dec. 2. Air Force officials have frequently spoken about the Raider becoming the lead element of a so-called “family of systems,” and Air Force Secretary Frank Kendall has made defining that family of systems one of his seven “operational imperatives” for the department.

What exactly will be included in that family remains unknown, but a new research paper from the Mitchell Institute for Aerospace Studies, informed by an unclassified workshop that gathered Air Force leaders, planners, and operators along with industry partners, offers some insight into what might be considered.

“What we haven't heard much about is the family of systems that is going to accompany [the B-21]. Just dribs and drabs of information. So this report might actually help ... get a handle on some of the capabilities that might be in that family of systems, including weapons, that could help reduce risk and increase the effectiveness of our combat forces,” said retired Col. Mark Gunzinger, the Mitchell Institute's director of future concepts and capability assessments and a co-author of the paper.

The three-day workshop, held this summer, was meant in part to develop concepts for what the Air Force calls “autonomous collaborative platforms (ACPS)” —relatively cheap drones that can fly alongside manned aircraft, operating with some level of independence.

The most high-profile example of these ACPs has been the Air Force's planned collaborative combat aircraft, intended mainly for fighters. But Caitlin Lee, one of the workshop's leads and co-author of the paper, noted that in discussions with the Air Force Research Laboratory, officials have said they envision “a whole family of potential capabilities and a range of different mission sets that this could actually involve.”

The workshop was aimed at exploring one of those mission sets—the long-range penetrating strike mission that the B-21 will take on. Three teams of experts were tasked with designing up to three kinds of unmanned aircraft to aid the bomber in strikes against an air base, a maritime threat, and a transporter erector launcher in a hypothetical conflict with China in 2030.

In all three cases, no constraints were put on what kind of aircraft the teams could create, but none of them opted for an “exquisite unmanned fighter” or “exquisite unmanned bomber” that could match the B-21's range, Lee noted. That's in line with Kendall's own comments this past July that the department had determined that a long-range uncrewed escort for the B-21 was cost-prohibitive.

Instead, the three teams created a mix of UAVs, most with a range of a few thousand miles, a few launched from other bombers. And the capabilities given to each varied as well—some designed to provide defensive counterair; others as intelligence, surveillance, and reconnaissance platforms gathering data; others for suppression of enemy air defenses; and still others as escorts.

“Two-thirds of the teams design ACPs for counterair, which really speaks to the need for survivability for these penetrating strike packages, where they're operating in this highly contest-

ed air environment,” Lee said. “... And then ISR was another really important mission. Three of the ACPs had a primary role for that, but I think all ACPs had sensors of some kind or another, because that tracking, especially mobile targets, in contested airspace is a real challenge.”

Just as notably, the teams sought large quantities of ACPs and were willing to trade off some capability for quantity, Lee noted.

“If the Air Force is able to buy larger numbers of lower-cost ACPs, that could really drive down risk,” Lee said. “And it’s all about the modest platforms in large numbers versus trying to put more sophisticated capabilities to get that operational advantage.”

The exact rundown of the intended missions and numbers of drones the teams in the workshop decided on are as follows:

MARITIME THREAT

- ACP 1: Defensive counterair, 40
- ACP 2: ISR, communications relay, 10
- ACP 3: Strike, 20

TRANSPORTER ERECTOR LAUNCHER

- ACP 1: Escort, suppression of enemy air defenses, 10
- ACP 2: ISR, Suppression of enemy air defenses (SEAD), offensive counterair, 144 (24 per bomber)
- ACP 3: ISR, SEAD, offensive counterair, 120 (20 per bomber)


AIR BASE ATTACK

- ACP 1: Escort, 8
- ACP 2: SEAD, 16 initially, increased to 32
- ACP 3: Jamming, 8

In all three cases, the workshop experts determined that the addition of these uncrewed teammates reduced risk for the missions. But the authors did note that for the air base attack, in particular, the risk wasn’t driven down as much because the current class of precision-guided munitions require bombers to fly extremely close to targets, assuming a permissive environment.

“So that is a collateral finding and recommendation from this effort—that the Air Force needs to develop those mid-range weapons that will optimize the strike power and lethality of our penetrating assets,” Gunzinger said.

Indeed, some of the ACPs designed by the teams in the workshops were essentially loitering munitions—designed to fly above targets and then attack, only to be used once. And as the B-21 continues to develop, new kinds of munitions could very well join that family of systems, too, Lee noted.

“This family could have all kinds of different capabilities in it, whether it’s space assets, munitions, and potentially ACPs,” Lee said. 

Air Force RC-26 Fleet Heading to the Boneyard

By Chris Gordon

The Air National Guard is retiring its entire fleet of 11 RC-26 Condors, the Air Force said Jan. 6. The twin-prop plane had an often under-the-radar, but sometimes controversial role as a reconnaissance aircraft used for both counterdrug and homeland security missions.

A converted civilian airliner, the aircraft attracted unwanted attention several times recently, and for years the Department of Defense has sought to retire the aircraft in favor of cheaper platforms such as drones.

Those efforts had been blocked by advocates on Capitol Hill, most vocally former Rep. Adam Kinzinger (R-Ill.), an RC-26 pilot in the Air National Guard. In both the 2020 and 2021 National Defense Authorization Acts, there were provisions preventing the Air Force from using funds to retire the Condor.

No such provision made it into the 2023 National Defense Authorization Act, though, and the Air Force said that without a need or funding for the aircraft, the plane will finally be out of service.

“There are no Air Force specific-RC-26B validated requirements nor dedicated funding to support sustainment of the weapons system,” an Air Force spokesperson told Air & Space Forces Magazine.

The Wisconsin Air National Guard concluded operations on Dec. 28, it announced. Representatives for the Air National Guard did not say whether all RC-26 operations have ceased—Alabama, Arizona, California, Iowa, Mississippi, New Mexico, Texas, West Virginia, and Washington all have the aircraft as well.

The Air Force said all 11 RC-26 aircraft will head to the Boneyard at Davis-Monthan Air Force Base, Ariz.

While the Air Force sees no requirements for the RC-26, the Wisconsin National Guard touted the aircraft’s usefulness in



Senior Airman Sean Campbell

The 141st Operations Group RC-26 sits at Medford Airport in southwest Oregon Sept. 2, 2017.

its release.

“Officers, civilians, suspects, families and regular citizens who have no idea that the reason that they are alive is because those guys were experts at their jobs, helped chase down and arrest drug dealers, in ways that could not have been done in any other platform,” Lt. Col. Benjamin West, the Wisconsin Air National Guard’s program manager, said in a statement.

“Having spent a large time of my policing career in narcotics work, I can tell you that this mission saves people’s lives,” added Army Col. Paul Felician, director of the Wisconsin National Guard’s counterdrug program. “The stuff that this aircraft enabled law enforcement to do took more drugs off the street and kept people safe from having to go into the direct risk of harm—it’s a sad day to see it go away.”

But the RC-26’s use in law enforcement missions was ques-

tionable at times, according to the Air Force's own accounting. The aircraft monitored protests and relayed information to law enforcement in Minnesota, Arizona, California, and Washington, D.C., after the murder of while George Floyd in police custody in the summer of 2020. Congressional concerns prompted an Air Force Inspector General investigation, which concluded that the National Guard Bureau erred in its deployment of RC-26s in some cases.

The aircraft were directed to fly "overhead imagery Incident Awareness and Assessment (IAA) missions in support of law enforcement and/or National Guard units responding to destruction of property and violence" after Floyd's murder in 2020, the report said.

"Properly approved missions can support civilian law enforcement, but there is no scenario in which it is acceptable or permissible to use DOD assets to deter demonstrations and protests, assuming they remain lawful," the report said.

The National Guard Bureau didn't have "a clear authorization" approved by civilian leaders before RC-26s began flying

the missions, according to the IG report, and some of the missions over protests were, in the inspector general's view, implausibly done for "training" purposes.

Air National Guard leaders have said the platform should be retired because cheaper platforms such as drones could fulfill counternarcotics and homeland security functions. Lt. Gen. Michael A. Loh, Air National Guard director, said the cost to keep RC-26 in the fleet—\$30 million per year—could be used to field and invest in newer systems.

"It's an old aircraft, and there's current language right now that says I can't retire that fleet or even expend money to prepare to retire that fleet," Loh said in 2021. "And so, each year, I'm spending millions of dollars to keep a fleet alive that quite frankly has run its useful life, and I need to actually get out of those to get into something new.

"We've actually had better technologies out there to take care of the mission, so even if I needed to do the mission today, I can [do] it with better technologies that are cheaper to operate," Loh said at the time. ☆

SPACE

STARCOM Hosts Space Flag Exercise, Focusing on Europe

By Greg Hadley

Space Training and Readiness Command (STARCOM) hosted its largest-ever Space Flag exercise at Schriever Space Force Base, Colo., from Dec. 5 to 16, with 165 participants exercising potential strategies for a European conflict.

Every Delta from Space Operations Command had a representative at Space Flag 23-1, which also drew participants from the Space Force Element of the National Reconnaissance Office, the U.S. Air Force, and partner nations Canada, Australia, and the United Kingdom.

"This Space Flag focused on a [U.S. European Command] scenario, so we wanted to present the problem in that theater and exercise our ability to win it based off of various problems that we presented to the team," said Lt. Col. Albert Harris, commander of the 392nd Combat Training Squadron, in a briefing for reporters. "During that conflict, we had the opportunity to practice our orbital warfare techniques, our electronic warfare techniques, our space domain awareness techniques, and intelligence command. We didn't just do that with the U.S. forces, we had an opportunity to do that with the coalition, as well."

Harris didn't offer details of the European scenario, saying only that it offered unique issues for Guardians to address.

"The challenges are different ... because the threats are different, a different landmass," Harris said. "You've got water on one side, land on the other, just a different approach to the problems that are in that specific area."

A STARCOM spokeswoman said the exercise involved "theater-specific problems along with strategic and operational guidance. The training audience then developed mission plans including possible courses of action based on realistic threats."



Judi Tomich/USSF

U.S. Space Force 1st Lt. Laura Drapinski, 2nd Space Warning Squadron, front, and Spc. 4 Ariana Gonzalez, 11th Space Warning Squadron, monitor missile indications at SPACE FLAG 23-1.

Russia poses the greatest threat in any European scenario. Space assets have played a major role in Europe's and Ukraine's response to Russia's invasion of Ukraine, providing the Ukrainians internet access despite jamming and also providing access to intelligence.

That's brought new Russian threats about potentially targeting satellites. Coming after Russia's anti-satellite test last November, which created a massive debris field in orbit that still threatens other satellites, those threats are ominous.

The U.S. Space Force has been standing up component commands in major operating theaters since November and

will stand up a European component some time in 2023, matching the units established within U.S. Indo-Pacific Command and U.S. Central Command.

Space Flag also involved an element of cyber warfare. Maj. Gen. Shawn N. Bratton, commander of STARCOM, has been vocal about integrating cyber into the exercises, and participants said they learned to utilize it throughout this edition.

"It took me until the third period of our execution to know that what I was in charge of was affected by something [the cyber team] did," 1st Lt. Colleen O'Hara, a member of Space Delta 4, said. "I had no idea, I didn't do any planning that was associated with it until someone told me 'Hey, you are reliant on cyber, you need to pay attention and look at this.' We were able to mitigate some issues that were going to take place if we hadn't thought about utilizing their capability."

As with cyber, the exercise was also one of the first the Space Force has held with international participants.

Flight Lieutenant Adon Lumley of the Royal Australian Air Force, said that from his perspective, "to come and share and learn from our special allied friends—the Americans, Canadians, and the British—it's a unique experience to learn and develop." He added: "What I get to take home is an incredible network of incredible people from across the world, who have got amazing talents that I can leverage in any future problem or challenge."

Both U.S. and allied participants said the exercise helped reinforce the importance of resilience, both for equipment and personnel.

"We started with one of our [positioning, navigation, and timing] personnel being taken out due to being sick," Capt. Eries Thompson of Space Delta 8 said. "And so the SATCOM side had to step up and not only learn all about PNT but be able to brief it and be able to answer questions and to also

be able to defend PNT as well. So taking into account not only our assets but our personnel as well and learning about our coalition partners, what they can bring to the table ... and understand how we all work and how we are all glued together really helped us in this exercise."

Moving forward, Thompson said exercise participants "can be challenged to see how we can take our resiliency a step further," though she added that "up to this point, we were able to meet our objectives and do what we needed to based on the way that our systems are set up right now."

Space Flag is the Space Force's premier training exercise, based in part on the Air Force's series of Red Flag exercises. It was first held in 2017, before the Space Force even stood up, and in 2020, it was held for the first time under the Space Training and Readiness Delta Provisional, which officially became STAR Command in August 2021.

In June, Space Flag was accredited by the Joint National Training Capability initiative, joining a small group of exercises across the Department of Defense to receive such recognition, giving it access to joint funding and support and better allowing the Space Force to integrate with joint partners as part of the exercise.

It is also one of a series of exercises the Space Force is planning as STARCOM ramps up its efforts to give Guardians more and better training. And for the younger Guardians in this exercise, it was an especially valuable experience.

"Being the only second lieutenant in the exercise, I was one of the more junior members," said 2nd Lt. Tyler Johnson of Space Delta 7. "And I would say before this, going into it, I'm still learning my systems—I work in space electromagnetic warfare. But I don't think I had an overall picture until I came to Space Flag, and I think it was a good opportunity to see how all of ... the packages fit into each other because nothing operates by themselves." ☆

Space Lab Construction Continues at Kirtland

By Amanda Miller

A new lab building at Kirtland Air Force Base, N.M., will house some of the Air Force Research Laboratory's "irreplaceable" equipment for testing how electronic spacecraft parts will likely stand up against radiation in space.

The FORTRESS lab—short for Facility for Radiation Tolerance Research on Electronics for Space and Strategic Systems—will contain testing equipment such as the sources of radiation with which the lab douses the electronic parts. It will be part of the Space Vehicles Directorate's larger Radiation Effects Laboratory.

Some 95 percent of U.S. spacecraft are "enabled by electronics produced or researched by this team," said Erin Pettyjohn, deputy director of the Space Vehicles Directorate, in an announcement.

Several "irreplaceable" pieces of testing equipment made in the 1960s to 1980s will go into the new FORTRESS lab, Kenneth Bole, acting chief of AFRL's Spacecraft Technology Division, said in an email to Air & Space Forces Magazine. The manufacturers that made the precious articles have since gone out of business, been acquired, or stopped making parts needed to upgrade, maintain, or calibrate the apparatuses.

Researchers availed themselves of some of the equipment in the MISSE series of 16 orbital tests. In the Materials International Space Station Experiment, they first evaluated building materials on the ground, exposing the samples to radiation then

analyzing them with processes such as spectroscopy, atomic force microscopy, and electrical conductance before sending them to the space station for testing in space.

Bole said AFRL doesn't anticipate any new equipment for the FORTRESS lab right now but that the building can accommodate potential future needs such as "additional accelerated space lifetime sources, a linear accelerator, and wafer probe stations."

The new \$4.5 million, 6,200-square-foot building is going in next to the Deployable Structures Laboratory. That \$4 million, 7,000-square-foot lab opened in 2020 to test other spacecraft elements besides electronics.

Also this year at Kirtland, the Space Vehicles Directorate opened the 72-acre Skywave Technology Laboratory including a \$3.5 million, 3,500-square-foot office and indoor lab facility near existing radio antennas on a remote part of the base. The Skywave lab studies conditions in the near-Earth space environment.

Meanwhile the new simulation-focused RAPID lab for small satellites—Rapid Architecture Prototyping and Integration Development—will offer a collaborative venue for internal and external organizations. The \$7.3 million, 14,000-square-foot facility opened this year as well.

Bole said the frequent openings haven't been part of a larger strategy but instead "driven entirely by mission need and building construction." He said the "AFRL facilities team has been extremely successful in seeking various sources of funding, such as FLEX-4 and the MILCON process." ☆



B-21 SHAPE OF THE FUTURE

With the B-21 rollout, the Air Force begins recapitalizing the bomber force.

Eric Lee/staff

By John A. Tirpak

A new era in long-range strike began Dec. 2 as the Air Force and Northrop Grumman pulled the wraps off B-21 Raider No. 00001; the first new American bomber in 34 years.

Seven years in development, the B-21 will make its first flight sometime in 2023. Northrop describes the new stealth jet as the “first sixth-generation combat aircraft,” and it will be the Air Force’s principal strategic strike asset for the bulk of the 21st century, according to Defense Secretary Lloyd Austin III, the featured speaker at the Palm-dale, Calif., unveiling.

The curtain parted on the highly classified aircraft as Northrop begins outdoor engine runs, taxi tests, and works toward first flight. Other details—its expected performance, range, weapons capacity, and other capabilities, even the number of engines beneath its stealthy skin—remain withheld, to keep adversaries guessing.

WHAT WE KNOW ABOUT THE B-21 RAIDER

The unveiling of the new B-21 bomber was staged to keep many of its innovations under wraps, but more than 34 years of technological advances since the B-2's 1988 rollout were clearly in evidence.

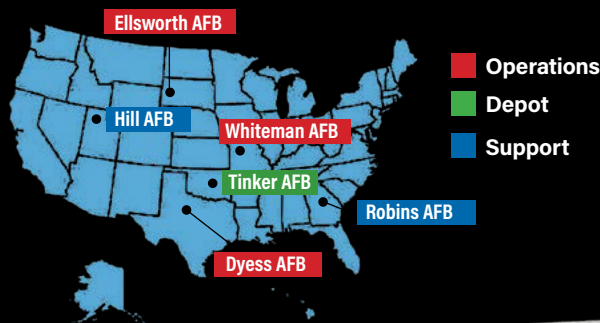
First Flight date

The Air Force says the B-21 will fly in "mid-2023." The B-2 first flew July 17, 1989, about nine months after rollout.

Crew

The B-21 has an aircrew of two. The contract requires the plane to be "optionally manned," but it is unclear when or whether that capability will be delivered.

B-21 selected bases



Payload

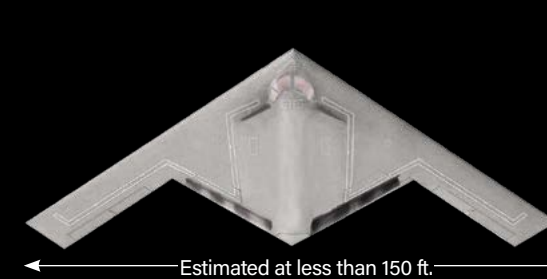
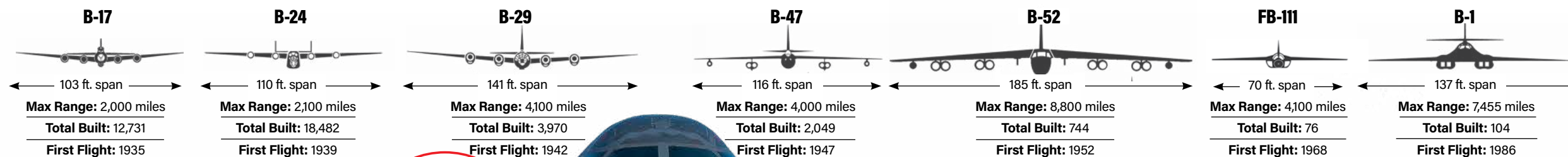
Classified. A B-21 precursor, the canceled Next-Generation Bomber, was planned to have a 30,000 lb payload. The B-2 weapons payload is rated at 60,000 lbs.

Engines

Pratt & Whitney (a division of Raytheon Technologies) is the engine supplier, but the number and type of engines has not been disclosed. The B-2 has four General Electric F118-GE-100 turbofan engines.

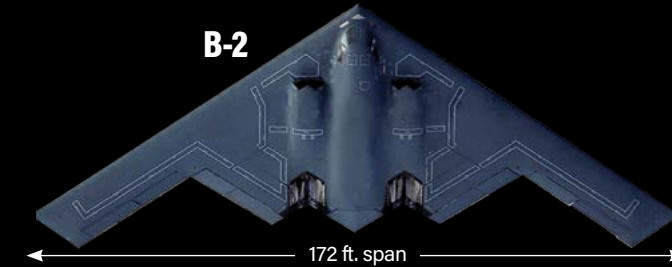
Long-Range Strike Through the Years

Production bombers with the greatest range of their era.



Wingspan and Tail

Illustration: The tail of the aircraft remains a secret. Previously released artwork shows the overall planform is simpler than that of the B-2, eliminating two large sawtooth features on the trailing edge. The precise size of the B-21 remains classified, but comparisons with the B-2 suggest a wingspan of about 150 feet—about 15 percent less than the B-2's 172-foot wingspan. The angle of wing sweepback in the new aircraft is not known, making it difficult to estimate the span with precision.



Nose

The B-21 has a longer, flatter "hawk's beak" nose than the B-2, set further ahead of the windscreen.

Markings

On the main gear doors, the B-21 bears the tail code "ED," for Edwards Air Force Base, Calif., where testing will take place. On the nose gear door, serial number 00001 is stenciled, and the stylized wing symbol of Northrop Grumman flight-test appears under the nose. Low-visibility shields are stenciled aft of the cockpit windows of Air Force Global Strike Command, Air Force Materiel Command, and the 412th Test Wing.



Cockpit windows

The B-21 cockpit features twin trap-ezoidal forward windows and two long side widows that are contiguous with the airplane's solid surfaces. The cockpit is somewhat further back from the nose than on the B-2.

Color

The B-21's paint scheme is lighter than AMS36118 "Gunship Gray" paint on the B-2. The color, possibly AMS36375 "Light Compass Ghost Gray," may aid in reducing its visual and infrared signature in the daytime.

Range

Classified. But Defense Secretary Lloyd Austin said the B-2's range exceeds "that of any other bomber." That suggests a range greater than the B-52's stated range of 8,800 miles.

B-2

Intakes

The B-21's slender air intakes have a much lower profile than the taller, scalloped intakes on the B-2. Slimmer intakes minimize the bomber's radar signature, as does hiding the engine fan blades deep within the aircraft body.



Keel depth

The B-21's keel appears proportionally deeper than that of the B-2 to accommodate additional fuel and weapons.

Landing gear

The aircraft sits higher on its two-wheel landing gear than the B-2 does on its four-wheel bogeys perhaps to ease weapons loading and engine maintenance. The geometry of its gear doors is simpler than that on the B-2.

B-2

Cost per plane

2010 dollars
2022 dollars

\$550 million

\$692 million

The B-21 contract set a cost ceiling of \$550 million a copy in 2010 dollars—about \$692 million today. The Air Force has said the cost will be lower than that.

B-2

Max Range: 6,900 miles

Total Built: 21

First Flight: 1989



Revealed to the public at a ceremony Dec. 2, 2022, in Palmdale, Calif., the B-21 Raider is designed to operate in tomorrow's high-end threat environment and play a critical role in ensuring America's enduring air power capability.

The nighttime rollout at Palmdale was stage-managed to keep the bomber's details hidden in plain sight. Everything from the lighting, the aircraft's proximity to the invitation-only crowd, the types of cameras and lenses photographers were allowed to use, and the angle they were allowed to shoot from were designed to limit the insights experts could glean about the new airplane.

The Air Force plans to acquire at least 100 B-21s to replace its 45 B-1s and 20 B-2s over the next decade or so. Including the 75 re-engined and upgraded B-52s, the bomber fleet will then number at least 175 aircraft, although Air Force Global Strike Command leaders have voiced a requirement for as many as 250 bombers overall. The service has long held to the comment that the first B-21 will be available for combat use "in the mid-2020s."

Standing before the sleek new B-21, Austin said its range will exceed that of any other bomber.

"It won't need to be based in-theater. It won't need logistical support to hold any target at risk," he said. Its stealth is based on "50 years of advances in low-observable technology," he added. "Even the most sophisticated air defense systems will struggle to detect the B-21."

The Raider will be able to deliver conventional or nuclear weapons "with formidable precision" and support joint and coalition forces "across the full spectrum of operations," Austin said.

Built with resilience in mind, Austin predicted the Raider will be "the most maintainable bomber" the Air Force has ever owned.

Air Force Chief of Staff Gen. Charles Q. Brown Jr. told re-

porters at a press conference the B-21 will be "a high-cycle aircraft, flying missions with "great frequency," unlike the B-2, which requires hundreds of man-hours of maintenance to maintain its low observable features after each combat mission.

The airplane's open-system architecture makes it "highly adaptable." Northrop said the B-21 abandons the conventional "block upgrade" approach in favor of "continuous improvement."

That approach is consistent with modern software development, which seeks to rapidly push out updates as they are ready. As a result, Austin said the B-21 will be able to employ weapons "that haven't even been invented yet." Its sensors and electronic capabilities will make it a "multi-functional" aircraft able to gather intelligence, conduct "battle management," and integrate with allies and partners "seamlessly, across domains and theaters and across the joint force."

Numerous U.S. allies sent representatives to the event, underscoring the importance of U.S. bomber capacity to coalition operations. Among them were Royal Australian Air Force Chief Air Marshal Robert Chipman, and U.K. Royal Air Force Air Chief Marshal Mike Wigston.

Austin thanked Congress for bipartisan support of the B-21, and lauded Northrop workers for "getting this big job done" without missing a beat during COVID lockdowns.

Although top Air Force leaders were present for the rollout, none spoke at the unveiling. Air Force Secretary Frank Kendall told Air & Space Forces Magazine later that, because of his business involvement with Northrop before taking on his present job, he recuses himself from actions



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related to the program. But Kendall also said Austin wanted to underscore that the B-21 is a joint, national program, and not simply a new Air Force asset. Bombers are both a long-range capability that can advance U.S. and allied aims conventionally, as well as part of the nation's nuclear triad.

One senior defense official noted it may not have been a coincidence that the B-21 rolled out just a few days after the latest official Pentagon assessment of China's military power, which detailed:

- A rapidly increasing Chinese arsenal of intercontinental ballistic missiles,
- A potential new stealth bomber for the People's Liberation Army Air Force, and
- China's lack of interest in joining existing strategic arms treaties.

The Raider is named in honor of the Doolittle Raiders of WWII fame, who delivered the first counterstrike of the war against Japan. The attack shocked Japan's leaders, who believed they were geographically beyond threat. The Doolittle Raiders showed "the reach of American air power," Austin said, saying the B-21 will do the same when it becomes operational.

The new bomber was developed in high secrecy by the Air Force's Rapid Capabilities Office (RCO), in a streamlined acquisition program with limited oversight and direct reporting to USAF's senior leadership. It has been held to a tight unit price estimated around \$700 million—substantially less than the inflation-adjusted cost of the B-2—and has been described by congressional leaders on both sides of the aisle as a well-run program that is delivering the required capability under cost and on schedule. Digitally engineered from the start, Northrop has developed a "digital twin" to facilitate changes and upgrades.

Brown said the accuracy of the digital models should translate into fewer verification flights, requiring fewer live-fly test points.

Northrop Grumman CEO Kathy Warden said the B-21 design was optimized from among thousands of digital designs developed in a compressed period of time, which will permit "rapid technology insertions" as new capabilities emerge.

USAF acquisition executive Andrew Hunter said that while the B-21 contract called for an aircraft that could be "optionally manned"—meaning it can fly with or without an aircrew—"clearly, the focus" is on crewed operations—at least for now. The B-21's stealth advantage over its competition was the key factor in its selection, he said.

Despite the airplane being presented in a way that revealed as little as possible about its capabilities, a few characteristics showed that the B-21 is not, as some wags have called it, the "B-2.1." While it shares a general resemblance to the B-2, there are key differences.

- Its wingspan is smaller than that of the B-2, though not as much as has been suggested previously. The wing angle of sweep could not be determined, however.

- Its keel is significantly deeper and broader than that of the B-2, presumably leaving lots of room for additional weapons and fuel. The pronounced "beak" on the B-2 is longer and flatter on the B-21.

- Its air intakes are far smaller than the scalloped clamshell intakes on the B-2, and almost organically blended into the B-21's upper surfaces. This reduces the bomber's radar cross section and hides the engine fan blades. An aerodynamicist told *Air & Space Forces Magazine* the B-2 likely makes use of the "Kutta effect," by which airflow up and over the leading edge of the aircraft clings to the surface and enters the intake, instead of flowing over it.

- Although the B-2 is exactly smooth, the B-21 surface is smoother still, its appearance evoking a finely sanded surface with no raised seams, not even around its canopy windows. Program officials said Northrop has dispensed with the tape and caulk used to smooth out the B-2's surfaces in favor of new materials that are both stealthier and easier to maintain.

- The B-21's trapezoidal forward windows and unusual side windows suggest they were shaped to exacting calculations necessary for a sharply diminished radar signature. The side windows may assist in aerial refueling operations, the Air Force has said, but may also be intended to help the pilots gauge distance from the ground on takeoff and landing.

- The bomber seems to sit higher on its landing gear than the B-2, likely making loading weapons and maintaining the engines easier. Its gear are also more centered under the fuselage than on the B-2.

- While the B-2 is painted an overall dark gray—specifically, AMS36118 "Gunship Gray," which is good camouflage for nighttime operations—the B-21 is painted a light gray, possibly AMS36375 "Light Compass Ghost Gray," indicating the Air Force plans to fly it more frequently in the daytime and at high altitude. Air Force shields were painted behind the cockpit, but in low-visibility paint, and it could not be discerned what organizations they represented. They likely include the RCO and Air Force Global Strike Command.

In the factory behind the B-21 on display, five more Raiders are in various stages of construction. These six aircraft will form the B-21 test force, according to Hunter, who also noted that after the flight-test program, they are expected to join the operational force.

At least two weapons for the B-21 are known. One is the

B61-12 nuclear gravity bomb, and the other will be the AGM-181 Long-Range Standoff (LRSO) missile. The Air Force has disclosed little about LRSO; developed by Raytheon Technologies, it will initially be fitted to the B-52, but will later equip the B-21, providing it a stealthy, standoff capability as adversary technologies evolve.

Northrop's description of the B-21 as a "sixth generation" combat aircraft has no official definition. Fifth-generation aircraft are acknowledged to be stealthy and equipped with advanced sensors and processors able to fuse incoming data to produce unprecedented situational awareness. "Sixth-generation" presumably ups the ante on the degree of stealth, as well as the capability of sensors, digital processing, and integration. Sixth-generation could also suggest other capabilities, such as the ability to operate without an aircrew and possibly use directed-energy weapons, such as lasers or high-power microwaves.

Since the program's inception, the Air Force has said the B-21 will be the centerpiece of a long-range strike "family of systems," which has come to be regarded as a series of off-board platforms or networks that collect battlespace information and enable the B-21 to fly its mission. What these are is not clear; they could range from satellite capabilities to bomber-launched decoys, jammers, and intelligence-gathering drones, which might fly ahead of the aircraft to fool or suppress enemy defenses.

The new bomber probably would have been named the B-3, but in 2016, then-Air Force Secretary Deborah Lee James named it the "B-21" to underscore its distinction as America's first 21st century bomber, and "Raider" to honor the Doolittle Raiders.

The B-21 in many ways is the result of the premature end of the B-2 program. The Air Force planned to build 132 B-2s, but Congress halted funding at 20 (later 21) aircraft in 1997, in light of the receding Russian conventional threat and rising costs of the aircraft, due in part to Northrop being contracted to build a high-capacity factory to rapidly build the airplanes. When the program ended, there were only one-sixth as many aircraft against which to amortize those tooling costs.

Northrop continued to develop stealth technologies for the B-2, however, and the Air Force began working on a new program, called the Next-Generation Bomber (NGB), to leverage those investments. This new aircraft was also known as the "2018 bomber, because various studies and bomber roadmaps confirmed the need for a new bomber in that year, given the aging of the rest of the fleet and the advance of adversary air defenses. Defense Secretary Robert Gates canceled the NGB in 2008, however, saying it had grown too "exquisite" in its capabilities, and wouldn't be affordable in the needed numbers. Gates directed the Air Force to start over; this time, setting unit cost as a key performance parameter. The 2018 in-service date was dropped.

The next program was dubbed the Long-Range Strike Bomber (LRS-B), with a baseline requirement that it cost less than \$550 million per copy in 2010 dollars. In 2015, Northrop beat a Boeing-Lockheed Martin team for the LRS-B contract.

William LaPlante, then the Air Force acquisition executive and now undersecretary of defense for acquisition and sustainment, announced at the time that the new bomber would actually cost \$515 million per copy in 2010 dollars so long as the Air Force built 100 aircraft.

To save money, Northrop toolled to build B-21s at a far less ambitious rate, said to be no more than about 15 bombers

per year. LaPlante said this would insulate the program against potential sharp cuts in the annual buy. LaPlante said this plan would make the program "resilient" against budget swings.

Northrop also agreed to incentives that will reduce profits substantially if cost and schedule targets aren't met. The development program is under a cost-plus-type contract, but the first production aircraft will be built on a fixed-price basis.

In 2010 dollars, the development program was set to cost \$21.4 billion. In the Pentagon's 2023 budget request, the Air Force said it will spend \$19.536 billion on B-21 production through 2027. The funding profile calls for \$108 million in fiscal 2022 (enacted by Congress), \$1.8 billion in FY23; \$3.5 billion in FY24; \$4.4 billion in FY25; \$4.6 billion in FY26, and \$5 billion in FY27. A production ramp has not been disclosed.

Only the Air Force Chief of Staff can order a change in requirements on the B-21, and since contract award, no chief has done so. The "open architecture" approach obviates the need for requirements changes, since improvements can be added over time.

Northrop said the B-21 benefits from "more than three decades of strike and stealth technology" developed at Northrop. Besides the B-2, these include the YF-23 fighter prototype; the NGB, the AGM-137 Tri-Service Standoff Missile, the Tacit Blue stealth demonstrator, and numerous other presumed classified programs. The company said it's using "new manufacturing techniques and materials to ensure the B-21 will defeat the anti-access, area-denial systems it will face."

At the rollout, Northrop also showcased its current programs, displaying an F-35 fighter—for which it builds the center fuselage in partnership with Lockheed Martin—the E-2C Hawkeye airborne warning and control aircraft for the Navy; the Navy MQ-4C Triton, a derivative of the Air Force RQ-4 Global Hawk uncrewed ISR aircraft; the B-2; and the X-47, an uncrewed, stealthy-looking flying wing demonstrator which conducted autonomous operations off an aircraft carrier.

Northrop has also reportedly built a stealthy, high-altitude ISR aircraft to succeed the Global Hawk called the RQ-180, said to resemble the B-21.

Although the arrival of the B-21 indicates that the B-2 is on its way out, Northrop officials stressed that the B-2 has enough structural life to fly into the 2050s, and that it could be retrofitted with many of the technologies in the B-21, as manufacturing spools up and components become less expensive.

AFA's Mitchell Institute for Aerospace Studies has argued that premature retirement of the B-2s is an unnecessary risk. The Air Force should retain as much bomber capacity as possible, Mitchell argues, to counter China's increasingly formidable threat.

"To build the force structure needed for the 21st century, the Air Force should consider retaining and modernizing its legacy force of B-1Bs and B-2s until it can procure B-21s in larger numbers and key mission capability and capacity parameters are met," Mitchell said in a recent study.

Having the B-21 in production offers a "pathway ... for the Air Force to grow its bomber force," the think-tank said, by "retaining and modernizing the B-1B, B-2, and B-52, with B-21s procured additively." Mitchell said the Air Force should shoot for an inventory of at least 270 bombers to meet the requirements spelled out in the National Defense Strategy. ☼



The 332nd Fighter Group's three fighter squadrons trained at Tuskegee Army Air Field, Ala., until the spring of 1943, when they moved to Selfridge Field, Mich., for further training before deploying overseas. Pictured are (left to right) Lt. Dempsey Morgan, Lt. Carroll Woods, Lt. Robert Nelron Jr., Capt. Andrew Turner, and Lt. Clarence Lester, who were among nearly 1,000 Tuskegee Airmen to complete pilot training during World War II.

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The Tuskegee Airmen, Heroes of War and Peace

The Air Force's first African American Airmen helped win World War II, then helped integrate the Armed Forces.

By Daniel L. Haulman

The Tuskegee Airmen are best known as the first African American pilots in United States military service. Flying P-39, P-40, P-47, and P-51 fighters, they refuted any notion that Black men lacked the ability to fly advanced aircraft successfully in combat. Indeed, their excellent performance in World War II contributed to the racial integration of the armed services in 1948. From their ranks came the Air Force's first three African American generals.

Other African American pilots preceded the Tuskegee Airmen, but they were either civilians or served in foreign air forces. Eugene J. Bullard, the first African American military pilot, served in the French Air Service during World War I, for example, and John C. Robinson later served in the Ethiopian armed forces in the 1930s.

The U.S. Army acquired its first military airplane in 1909, and for the next 30 years, Blacks were not allowed to fly. An Army War College report issued in 1925 reflected the Army's attitude at the time: It claimed Blacks were inferior and should be restricted

Of the 992 Tuskegee Airmen pilots who completed advanced flight training at Tuskegee Army Air Forces, eight were still alive a year ago. Now nearly a century old, their ranks are dwindling rapidly. Four died in 2022—Charles McGee, Alexander Jefferson, William Rice, and Christopher Newman—and one more, Harold H. Brown, died in January 2023. At this writing, just three of those who flew red-tailed P-51 Mustangs survive: Charles W. Cooper, George E. Hardy, and Harry T. Stewart Jr.

to subordinate positions. To be a pilot was to be an officer, and the Army of the time did not want Black officers commanding White enlisted men. The U.S. Navy and Marine Corps maintained the same position. In fact, neither the Navy nor the Marine Corps had a single Black pilot until after World War II.

The breakthrough came during President Franklin D. Roosevelt's 1940 re-election campaign, in which he sought an unprecedented third term. Roosevelt promised to let African Americans train to be pilots in the U.S. Army Air Corps. After winning the election that November, Roosevelt's War Department announced in January that the Army would train Black pilots at Tuskegee, Ala. In March, the 99th Pursuit Squadron (later renamed the 99th Fighter Squadron) was established as the United States Army Air Corps' first Black flying unit. The squadron had no qualified pilots yet, but it would soon. They would become known as the Tuskegee Airmen.

Tuskegee was chosen for a number of reasons. Its climate allowed more days of good flying weather than airfields farther north, and the Tuskegee Institute had already trained Black civilian pilots there.



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Fewer than 1,000 of the more than 14,000 Tuskegee Airmen were pilots. Most of them were ground personnel, including these armorers with the 99th Pursuit Squadron, the first-ever Black combat unit. Others were mechanics, navigators, bombardiers—the full range of jobs Airmen needed to fill to run a combat unit.

Its leaders lobbied for the military pilots to be trained there, as well. The War Department wanted to keep flying units segregated, and in Alabama, racial segregation was the norm. Instead of training at bases all over the country, as White pilots did, the African American pilots would complete primary, basic, and advanced flight training only at Tuskegee. Nearly 1,000 African American men completed that course.

The term Tuskegee Airmen refers today not only to the military pilots who trained at Tuskegee, but also thousands of ground personnel who served in those same units, such that in the end there were well over 14,000 Tuskegee Airmen in all. Yet only a small fraction of the tens of thousands of African Americans who served in the Army Air Forces during World War II were Tuskegee Airmen. There were also some White Tuskegee Airmen; the first commanders of the Tuskegee Airmen units were White, as were the majority of the flight instructors at Tuskegee Army Air Field. However, the overwhelming majority of Tuskegee Airmen were Black.

Flight training at Tuskegee took place in three phases. The first phase, primary flight training, took place at Moton Field, owned by the Tuskegee Institute, and operated under contract with the Army Air Forces. Primary flight training took place in PT-13 and PT-17 biplanes and PT-19 monoplanes, just like primary flight training for White aviators in other parts of the country. Almost all the flight instructors in the primary phase of flight training at Moton Field were Black. Some of them had trained civilian pilots at Tuskegee Institute before America's entry into World War II. The most famous among them was Charles Anderson, called "Chief" Anderson because he was the chief pilot instructor for Tuskegee Institute. Chief Anderson had taken Eleanor Roosevelt, the President's wife, on a flight over Tuskegee during civilian flight training there, just after the War Department constituted and activated the 99th Pursuit Squadron at Chanute Field, Ill., which later was renamed the 99th Fighter Squadron and relocated to Tuskegee, where it was assigned its first pilots.

It took nine to 10 weeks to graduate cadets from primary flight training at Moton Field. Then they went on to train at the much larger, Army-owned Tuskegee Army Air Field several miles to the northwest. Basic flight training, which began with the BT-13 monoplane, lasted another nine to 10 weeks and was followed by advanced flight training, still another nine to 10 weeks, in AT-6 traubers for future fighter pilots, and AT-10 twin-engine aircraft for future medium bomber pilots. Eventually, advanced fighter pilot students flew P-40 aircraft at Tuskegee Army Air Field, and advanced bomber students flew B-25s.

The commander of Tuskegee Army Air Field during most of World War II was Col. Noel F. Parrish, a White officer from the South who, unlike his immediate predecessor, integrated the base facilities. Tuskegee Airmen pilots remembered Parrish as a fair man who was genuinely interested in their success. He enforced strict flying training standards, such that only about half the cadets who entered flight training completed it. But those who did were fully qualified for the combat missions that lay ahead of them. Many who "washed out" became B-25 bomber crewmen.

A total of 44 classes of pilots graduated from advanced flight training at Tuskegee Army Air Field. Colonel Parrish became an early advocate of a racially integrated Air Force.

After graduation, the new pilots were assigned to military units including the 99th Fighter Squadron and the 332nd Fighter Group and its three fighter squadrons, the 100th, 301st, and 302nd. All of those units served at Tuskegee Army Air Field until the spring of 1943, when the 99th deployed overseas and the 332nd Fighter Group moved to Selfridge Field, Mich., for further transition training, before eventually deploying overseas in early 1944. Replacement pilots for the 332nd Fighter Group, after it deployed overseas, were trained at Selfridge and later at Walterboro, S.C.

Future bomber pilots went to the 477th Bombardment Group and its four bombardment squadrons: the 616th, 617th, 618th, and 619th, which was activated at Selfridge when the 332nd Fighter Group vacated the base. Col. Robert Selway, a White

officer who earlier had commanded the 332nd Fighter Group, took command of the 477th. By the time the Tuskegee Airmen organizations went overseas, they were all Black.

Yet the most important commander of the 99th Fighter Squadron was a Black officer, Col. Benjamin O. Davis Jr., a graduate of the United States Military Academy at West Point who was also in the first class of Black military pilots to train at Tuskegee. Davis took the 99th overseas in the spring of 1943 and eventually also became commander of the 332nd Fighter Group, just before it deployed overseas. The son of the first Black general in the U.S. Army, Davis went on to become the first Black general in the U.S. Air Force, following World War II.

The 99th Fighter Squadron was not originally assigned to the 332nd Fighter Group. After it left Tuskegee Army Air Field in the spring of 1943, it voyaged first to North Africa, where it was attached to various White fighter groups, since there was not yet a Black fighter group overseas to which it could be assigned. It flew P-40 fighters for the 12th Air Force, to support surface forces such as Allied shipping in the Mediterranean Sea. It also flew strafing missions against enemy-held islands such as Pantelleria and Sicily, in concert with the White fighter squadrons, which also flew P-40s. During their first six months operating overseas, the Tuskegee Airmen shot down only one enemy airplane. That was understandable, given its mission was mainly to support surface forces and to destroy enemy targets on the ground. The first African American pilot to shoot down an enemy airplane was 1st Lt. Charles B. Hall, on July 2, 1943. It would be six months before there was another. Lack of opportunity, rather than lack of skill, was the reason.

Bias was also at play. Col. William W. Momyer, commander of the mostly White 33rd Fighter Group, to which the 99th Fighter Squadron was attached, tried to take the Tuskegee Airmen out of combat, claiming the 99th performed poorly in comparison to his group's White squadrons. His recommendation was forwarded up the chain of command, with endorsements, all the way to

the head of the Army Air Forces, Gen. Henry H. "Hap" Arnold. But when the War Department launched a study comparing the 99th Fighter Squadron, under Colonel Davis, with the other P-40 units in the Mediterranean Theater of Operations, it concluded that the pilots of the 99th Fighter Squadron flew just as well as their White counterparts, and found no justification to remove the unit from front-line combat. Indeed, in January 1944, the 99th Fighter Squadron outperformed some of the White fighter squadrons over Anzio, shooting down more enemy aircraft in a two-day period.

When the 332nd Fighter Group and its three fighter squadrons, the 100th, 301st, and 302nd, finally deployed from Selfridge Field to Italy, in early 1944, it was flying P-39 aircraft. Like the 99th Fighter Squadron which was already in Italy flying P-40s, the 332nd Fighter Group flew missions for the 12th Air Force, supporting ground forces. Designed to destroy targets on the ground, its P-39s weren't suited for air-to-air combat.

In the summer of 1944, the 99th Fighter Squadron was reassigned to the 332nd Fighter Group, making it the only fighter group in World War II combat with four, rather than three squadrons. That same summer, the 332nd was reassigned to the 15th Air Force, which also flew four-engine B-17 and B-24 heavy bombers. Their new mission: Escort those bombers to and from their targets, to protect them against enemy airplanes. For the new mission, the 332nd Fighter Group traded its P-39s for P-47s, and eventually P-51 Mustangs, which were faster, more maneuverable, and offered longer range than the earlier models. Now able to fly combat missions deep into enemy territory, the opportunity to square off against enemy airplanes and shoot them down increased. In the middle of 1944, the 332nd Fighter Group moved to Ramitelli Airfield in Italy to fly its bomber escort missions. It would also continue to fly some strafing missions.

The 15th Air Force had 21 bombardment groups, each with four bombardment squadrons. But it had just seven fighter groups to escort those bombers, four of them flying P-51s, and



James Sheppard/USAF

Ground crew work on a 332nd Fighter Group P-39 Airacobra at Montecorvino Aerodrome, Salerno, Italy, in 1944. The P-39s were designed for air-to-ground operations rather than air-to-air combat. The 332nd would soon trade its P-39s for P-47s and later the faster, more maneuverable P-51 Mustang.

By 1944, the 332nd Fighter Group's 100th Fighter Squadron was operating long-range P-51s from Cattolica Aerodrome in Rimini, Italy. With their distinctive red tails, the Group became famous for its daring and skill, flying 179 bomber escort missions and losing just 27 bombers to enemy fighters. By the end of the war, 95 Tuskegee Airmen had earned 96 Distinguished Flying Crosses.



James Sheppard/USAF

three flying P-38s. All four of the P-51 Mustang groups, including that of the 332nd Fighter Group, had distinctively painted tails. The 332nd Fighter Group's P-51 tails were solid red. The 52nd Fighter Group's tails were yellow, the 31st Fighter Group striped red, and the 325th Fighter Group were black and yellow checkerboards. The distinctively painted tails helped fighter and bomber crews identify friend from foe.

These were the missions for which the Tuskegee Airmen became famous. Of the 312 missions they flew for the 15th Air Force, 179 of them were bomber escort missions. Most were highly successful. In fact, the Tuskegee Airmen would lose escorted bombers to enemy fighter pilots on just seven of those missions, losing a total of 27 bombers in those missions. By contrast, the average number of bombers lost to enemy fighters by each of the other 15th Air Force fighter escort groups was 46 during the same period. The Tuskegee Airmen lost significantly fewer escorted bombers to enemy aircraft, on average than the other groups over the same period.

Enemy anti-aircraft artillery proved more dangerous to bombers than rival fighters, but the fighter escorts could do nothing to protect the bombers against flak.

At the end of December 1944, bad winter weather forced 18 B-24 bombers of the 15th Air Force to land at Ramitelli, home base of the Tuskegee Airmen. The 332nd Fighter Group welcomed some 180 White bomber crewmen, sharing their shelters, equipment, and supplies for most of a week. During those few days, the Black and White Airmen interacted cordially, and after, many of the White bomber crews remembered with gratitude the hospitality they were shown. Most of the White bomber crews had never before met the Black fighter pilots who sometimes escorted them, and afterward, some bomber crews requested the red-tailed P-51s of the 332nd Fighter Group be their escorts.

It is very possible that one reason the 332nd Fighter Group lost fewer bombers to enemy airplanes than the other escort groups is that its pilots were ordered not to leave the bombers to go chasing after enemy fighters; that would have left the bombers more vulnerable to attack. There is some evidence to support this thesis. While the other fighter groups lost more bombers, they also each shot down significantly more enemy fighters in

comparison to the Tuskegee Airmen. It could be that the other groups shot down more enemy airplanes because they were more willing to leave the bombers to chase enemy fighters that posed only an indirect threat.

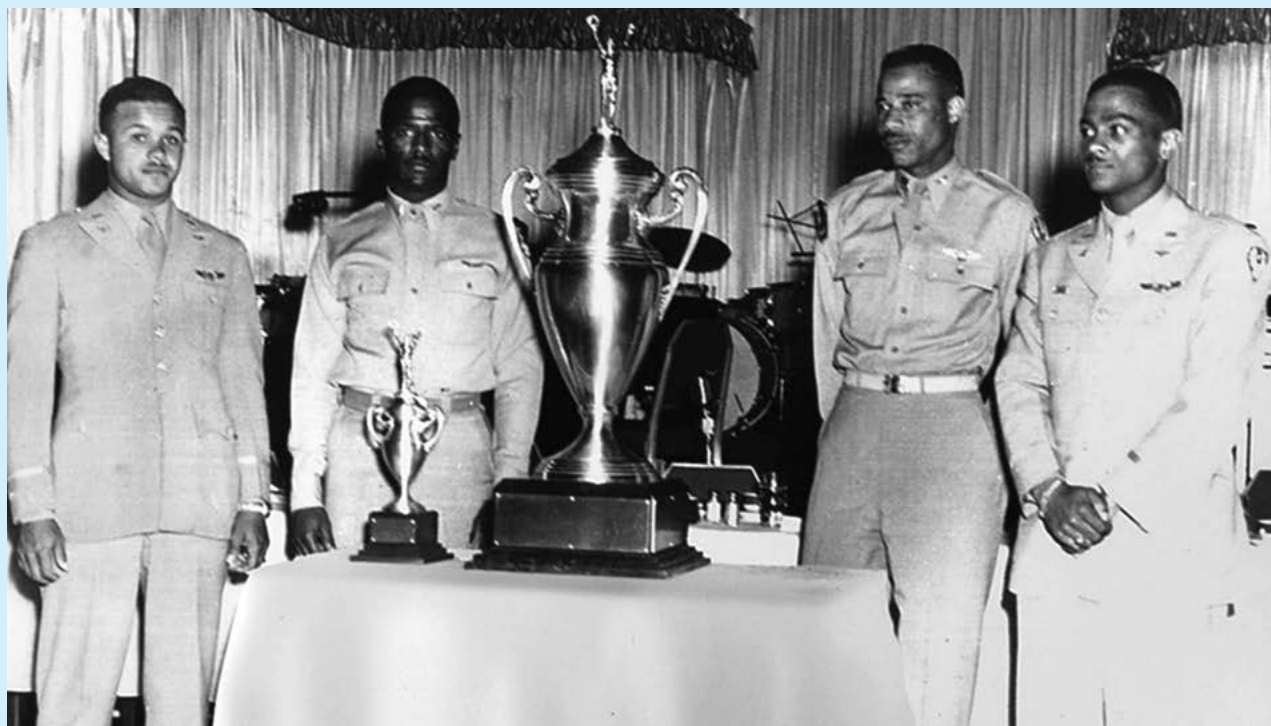
On March 24, 1945, the 15th Air Force flew its longest mission of the war. Germany's capital, Berlin, was normally a target for the 8th Air Force, based in England. But for this mission, five of the seven fighter groups, including the Tuskegee Airmen of the 332nd Fighter Group, flew to Berlin. Two of the groups, the 31st and the 332nd, shot down German Me-262 jets, including three by the 100th Fighter Squadron. It was the first time the Black pilots had shot down German jets, but the victories came at a cost: three of their escorted bombers were shot down by enemy airplanes.

The 332nd Fighter Group flew many strafing missions for the 15th Air Force between early June 1944 and the end of April 1945. On one memorable mission, on June 25, 1944, eight of the Tuskegee Airmen pilots strafed a German warship and claimed to have sunk it. The only German warship attacked at the same time and place was the TA-22, the former Italian destroyer Giuseppe Missouri. Naval records show that the TA-22 did not sink that day, but was decommissioned later, and then scuttled in 1945. While they may not have destroyed the ship that day, the Tuskegee Airmen did enough damage to put it out of action. Other strafing missions destroyed German rail traffic and other ground targets.

By the end of the war in Europe, 72 Tuskegee Airmen pilots had shot down 112 enemy airplanes. That includes the 99th Fighter Squadron before it joined the 332nd Fighter Group, and missions of the squadron and the other squadrons of the 332nd Fighter Group for both the 12th and 15th Air Forces. No Tuskegee Airmen shot down the five enemy airplanes to be labeled an ace, but three of the Black pilots came close, shooting down four enemy airplanes. Four others shot down three enemy airplanes in a single day. Together, they also destroyed numerous enemy airplanes on the ground during strafing missions.

Of the approximately 1,000 Tuskegee Airmen pilots, 355 deployed overseas and engaged in combat operations. More than 100 Tuskegee Airmen were reported lost on missions,

Air Force Magazine and the 1949 USAF Gunnery Meet



The four winning Tuskegee Airmen from the 332nd Fighter Group—(from left) Lt. Halbert Alexander, Lt. James Harvey, Capt. Alva Temple, and Lt. Harry Stewart—pose with their “Top Gun” trophy during the awards ceremony for the First Aerial Gunnery Competition at Las Vegas Air Force Base, Nev., (now Nellis AFB) in 1949.

The Air Force's first gunnery meet pitted “12 three-man teams representing virtually every fighter group in the country” in a shootout in the Nevada desert “for top honors in five fields.” So reported *Air Force Magazine* in its June 1949 edition.

“The competition was spirited—no one held anything back,” the magazine reported. “Scores were good when compared to wartime scores (about 100 percent better in fact), but somewhat disappointing in that the meet averages failed to come up to intra-group scores.”

Jets were still new in 1949, and the competition featured both jets and “conventional fighters.” They competed in “all types of fighter offensive techniques,” including “skip bombing, dive bombing, strafing, rocketry, and aerial gunnery.”

The article identified the winning team in both the jet class and the conventional class, and displayed photographs of both teams: The 4th Fighter Group, an all-White unit flying F-80s, won the jet category, its team including Capt. Vermont Garrison, 1st Lt. James Roberts, and 1st Lt. Calvin Ellis. The 332nd Fighter Group, an all-Black unit flying F-47s, was victorious in the conventional category, its team comprised of Capt. Alva Temple, 1st Lt. Harry Stewart, and 1st Lt. James Harvey.

Both groups were recognized in the awards ceremony. There was no overall winner, since there were five events in the propeller aircraft class, and only four events in the jet aircraft class.

The trophy commemorating these events disappeared over time, eventually coming into the hands of the Smithsonian Institution in Washington, D.C., and later the National Museum of the United States Air Force at Wright-Patterson Air Force Base, Ohio. It was discovered in the archives in the early 2000s, and in a 2022 interview with CBS News, Harvey related that a museum staffer had allegedly asserted “this item will never be on display.”

The trophy is on display now, including a small brass plaque on its base identifying all the winners of the 1949 and 1950 competition, including the three Tuskegee Airmen who won the conventional class in 1949. The plaque must have been engraved after the 1950 event, as it identifies several of the 1949 winners (both White and Black) at higher ranks than when the 1949 event took place.

In 1991, *Air Force Magazine*'s then-editor, John Correll, added a section to the magazine's annual Almanac under the heading “Records, Trophies, and Competitions.” But in its listings of winners of the “Gunsmoke” competitions, it listed the winners of the 1949, 1950, and 1954 events—no gunnery competition was held in either 1952 and 1953—as “unknown.” The 1992 edition identified only the “4 FIW” as the 1949 winner, leaving out mention of the 332nd Fighter Group; not until 1995 were all the winners listed. Then, from 1998 on, the magazine stopped listing the early winners, instead only identifying winners from 1981 onward, the date at which the “Gunsmoke” name became the official title of the competition.

Over the years, questions have arisen over whether that omission was intentional. It is impossible to know for sure what drove these decisions, but the evidence suggests otherwise. Leaving out the 332nd Fighter Group, while including the 4th Fighter Group, in three annual almanac issues (1992, 1993, 1994) did obscure the achievement of the all-Black 332nd Fighter Group. But the same could be said of leaving out the all-White 27th Fighter Escort Group in listings for 1950's winners, in the 1994, 1995, 1996, and 1997 editions. That suggests that the omission of the 332nd Fighter Group from 1992 to 1994 was not racially motivated.

—Daniel Haulman and Tobias Naegele

though many eventually made it home. Scores of 332nd Fighter Group fighter pilots did not return, however, but were killed by enemy fire, either from rival aircraft, flak, mechanical failure, or accidents.

Thirty-two Tuskegee Airmen became prisoners of war in Germany. Two of them, Alexander Jefferson and Harold Brown, wrote books about their experiences. They were placed in racially integrated camps where the prisoners were segregated not by race but by rank, the officers in one place and the enlisted personnel in another. Ironically, the Tuskegee Airmen POWs found themselves in a more racially integrated environment in their camps in Nazi Germany than they had been in parts of the United States.

Their success could not be ignored. By the end of the war in Europe, 95 Tuskegee Airmen earned a total of 96 Distinguished Flying Crosses (one earned an oak leaf cluster, by getting the award twice). The 99th Fighter Squadron earned three Distinguished Unit Citations, two of them while flying with White fighters, and one while flying with the 332nd. The group and its other three squadrons earned a Distinguished Unit Citation for the Berlin mission.

Multi-engine bomber pilots who trained at Tuskegee served in the 477th Bombardment Group and its four squadrons, the 616th, 617th, 618th, and 619th. That group never deployed overseas or took part in combat, but its story is important in the history of civil rights. At Selfridge Field, Mich., and later at Godman Field, Ky., and Freeman Field, Ind., its personnel struggled against segregated base facilities. In April 1945, at Freeman Field, some 120 Black officers were arrested, in two waves, for attempting to integrate a White officers club, or for refusing to sign a base regulation demanding segregated facilities on base. Some of the 61 arrested in the first wave were arrested also in the second wave of 101. Eventually, all but three of those arrested were released, but only after receiving written reprimands. The controversy attracted national attention. Two of the arrested Tuskegee Airmen were found not guilty at court-martial, and only one, Roger Terry, was convicted. He was fined and given a dishonorable discharge.

The War Department ultimately solved the integration prob-

lem by making the 477th Bombardment Group all-Black and assigning its White “trainer” officers to other units. Replacing Col. Robert Selway as group and base commander was Col. Benjamin O. Davis Jr., who arrived in June 1945, after the war in Europe had ended. Davis, who had commanded the 99th Fighter Squadron and then the 332nd Fighter Group in combat overseas, became the first Black commander of an Army Air Forces base. Just after the war, the 477th Bombardment Group, renamed the 477th Composite Group, moved to Lockbourne Air Force Base, Ohio.

In 1947, the same year the U.S. Air Force was established as a separate military service, the 477th was inactivated, and the 332nd Fighter Group, which had been inactivated at the end of World War II, was re-activated at Lockbourne. The group was assigned to a newly established and activated 332nd Fighter Wing, also at Lockbourne, under Davis’ command.

WINNERS IN VEGAS

In 1949, the Air Force held its first gunnery meet in Las Vegas, Nev. The 332nd Fighter Group won the propeller-aircraft category and the 4th Fighter Group won the jet aircraft category. This proved the last hurrah of the 332nd Fighter Group, because later that same year, the group, its like-numbered wing, and its squadrons were all inactivated. President Harry S. Truman issued Executive Order 9981 in 1948, integrating all the armed forces. Instead of assigning White personnel to the Tuskegee Airmen units, Black members of those units were reassigned to formerly all-White units. Every all-Black flying unit was inactivated. Segregated training had already been phased out. The Air Force began training Black and White pilots together at Williams Air Force Base, Ariz., after the closure of Tuskegee Army Air Field in 1946.

The Tuskegee Airmen experience lasted from 1941, when the first Black flying unit was constituted and activated, until the middle of 1949, when the last all-Black flying units were inactivated at Lockbourne Air Force Base. Many of the Tuskegee Airmen elected to remain in the Air Force after 1949, some of them flying combat missions in Korea and Vietnam. Among them were Col. Charles McGee, who died last year at age 102,



When the all-Black 477th Bombardment Group were sent to Freeman Field, Ind., they found themselves on an integrated air base with segregated facilities. Attempts to integrate the all-White officers club and refusals to sign statements supporting the base's segregation policies resulted in the arrests of some 120 Black officers. The unit came together late in the war, and never deployed.

Master Sgt. Harold Beaulieu Sr. via Library of Congress



USAF

Maj. Charles McGee earned a Distinguished Flying Cross in Korea in 1951. In 2019, McGee was on hand when then-Acting Secretary of the Air Force Matt Donovan announced that the new T-7A trainer would be named the Red Tail in honor of the Tuskegee Airmen. The following year, at the age of 100, McGee received an honorary promotion to brigadier general.

having been promoted to the honorary rank of brigadier general in 2020. McGee flew 409 fighter combat missions in three wars. Lt. Col. George Hardy flew in the same three wars, flying fighters in World War II, bombers in Korea, and gunships in Vietnam. The future Gen. Daniel “Chappie” James, who served with the 477th Bombardment Group (477th Composite Group) during World War II, likewise served in combat in Korea and Vietnam,

eventually becoming the Air Force’s first Black four-star general. The first three Black generals in the United States Air Force were all Tuskegee Airmen.

Other Tuskegee Airmen went on to play key roles in the civil rights movement, in politics, and other fields of endeavor. Among them was the first Black mayor of Detroit, Coleman Young. In terms of civil rights and the integration of the United States armed forces, the Tuskegee Airmen played a revolutionary role. The integration of the American military was the first step in the integration of American society.

It was never easy. The Tuskegee Airmen encountered obstacles and endured humiliating racial injustices, but their story is not just what White men did to try to hold back Black men. It is also the story of what Black men and White men did for each other—and what they did together—against a common enemy. There is no telling how many 10-man heavy B-17 and B-24 bomber crews owed their lives to the Black pilots who escorted them through enemy fighter attacks, and there is no doubt those Black pilots received most of their basic and advanced flight training from White flight instructors at Tuskegee Army Air Field.

We should remember the Tuskegee Airmen story as a Black and White story, a story of American military personnel who served their country and furthered the great principle that all men are created equal, established at its founding. The ideal had not yet been achieved by 1949, but the Tuskegee Airmen took great strides toward it then. Their achievements should never be forgotten. ★

Daniel L. Haulman, former head of the organizational histories branch of the Air Force Historical Research Agency, is the author of several books on the Tuskegee Airmen, including “*The Tuskegee Airmen, an Illustrated History*” (with Jerome Ennels and Joseph Caver), “*The Tuskegee Airmen Chronology*,” and “*Eleven Myths About the Tuskegee Airmen*.” His next book, “*Misconceptions about the Tuskegee Airmen*,” is due to be published in February.



USAF

Air Force Gen. Daniel “Chappie” James Jr., a veteran of the 477th Bombardment Group, went on to fly in the Korean and Vietnam wars. James, who would eventually become the Air Force’s first Black general, flew 88 combat missions in Vietnam, including the infamous Operation Bolo, in which seven MiG-21 jets were destroyed by U.S. F-4 Phantom IIs.



Dale Greer/ANG

A U.S. Air Force KC-46 Pegasus from the 305th Air Mobility Wing at Joint Base McGuire-Dix-Lakehurst, N.J., performs an aerial demonstration over the Ohio River in downtown Louisville, Ky.

Eyes On the Boom: Re-visioning the KC-46

Boeing's RVS 2.0 is getting closer to reality, but it's still years away from delivery.

By Greg Hadley

Upgraded cameras that can support refueling under covert conditions. A projection display incorporating a curved mirror to create a more immersive experience for boom operators. Enhanced processing power and new fiber-optic cabling. Boeing lifted the veil from its long-awaited Remote Vision System 2.0, offering a glimpse at enhancements for the KC-46 tanker, even as delivery of the new optical systems remains years away.

Boeing, Air Force, and Collins Aerospace officials shared the vision with a small group of reporters at Boeing's Everett, Wash., facility in December, divulging a prototype RVS 2.0 display, diagrams detailing the planned system, and side-by-side video comparing the RVS 1.0 and 2.0 cameras. The video comparison suggests the new camera system overcomes the issues that plagued the original camera system, including

"The dynamic range of these cameras is phenomenal. ... They're able to adapt to that changing environment!"

—Boeing Test & Evaluation, chief boom operator Ernest Burns

blurriness and distortion, a lack of depth perception under certain conditions, and blackouts and whiteouts caused by sudden changes in lighting. Boeing funded the visit by Air & Space Forces Magazine.

Lt. Col. Joshua M. Renfro, from the Air Force's KC-46 Cross Function Team, hailed RVS 2.0 as "the future" and a "quantum leap" in camera technology. But the Air Force and Boeing acknowledge that future is still far off. In October, they announced another 19-month delay, pushing operational use of RVS 2.0 to October 2025. By then, it will be more than five years after Boeing and the Air Force agreed on the plan for fixing the troubled Remote Vision System.

RVS 2.0 must still complete its critical design review and win Federal Aviation Administration airworthiness approval. The preliminary design review was completed in April.

Details of what costs Boeing or the Air Force will bear also remain unclear. Boeing Vice President and

KC-46 program manager James Burgess said only that the two sides have “reached agreements.” Burgess said the upgrade is “a much more advanced system for sure,” and noted that “computing technology has come a long way over the last 10 years.”

CAMERAS

The changes in RVS 2.0 start with the cameras on the boom itself and the panoramic camera on the fuselage. The original RVS used black-and-white cameras. Those on the boom were positioned at an angle, resulting in distortion at the edges of the image. The new system will have two, 4K color cameras. Distortion is eliminated and the change will not affect the aircraft’s mold line, officials said.

The new cameras will be able to adjust as needed to changes in light and shadow, ensuring operators see a clean, well-defined image, officials said. “The dynamic range of these cameras is phenomenal,” said Boeing Test & Evaluation chief boom operator Ernest Burns. “They’re able to adapt to that changing environment. Air refueling is always a changing environment. You never have the same conditions.”

That dynamic range means no more “whiteouts” or “blackouts” under difficult conditions. In addition, both the boom and panoramic views will also have upgraded Longwave Infrared (LWIR) cameras, able to detect and capture infrared radiation. Boeing calls this a “game-changer,” because it enables “covert refueling” without the use of visible light.

“If we tried to have external light, visible light on with the receiver coming up on vision goggles, it would bloom up the goggles, it just doesn’t work that way,” Burns said. “To have the boom operator wear night vision goggles and try to refuel, you would not have the depth perception required. They just don’t make night vision goggles with that kind of depth perception. So the best way to do that is to have LWIR cameras and a covert capability in the airplane with zero visible lights on using the LWIR cameras.”



Staff Sgt. Timothy Hayden/ANG

Master Sgt. Mike Windy, boom operator with the 157th Air Refueling Wing, conducts an aerial fueling on a KC-46 Pegasus in the sky.

Boeing officials shared video from the LWIR camera and let reporters wear night vision goggles to experience the KC-46’s infrared lights from the perspective of a receiver aircraft.

While the LWIR camera lacks some of the contrast and clarity of the color cameras, Burgess said the new LWIR cameras have three times the resolution of the original night-vision cameras, which Air Force officials have said lack the fidelity to conduct refueling operations in blackout conditions.

It’s not yet clear, however, if the Air Force will certify RVS 2.0 for covert refueling. There are still “operational restrictions” on the technology as it exists today, according to Boeing officials.

The Air Force has not yet validated the upgrades. “We have



Boeing

An image from Boeing depicts an operator refueling an F-16 using the boom operator’s remote viewing system in the KC-46 Pegasus.

to see RVS 2.0 in the Air Force testing system,” Renfro said. “Boeing’s done a lot of work in that, but we haven’t seen on the Air Force side through developmental tests or IOT&E. So until we get to that point, I can’t really say what it’s going to deliver us in terms of combat capability. But we’ll put it through the paces, and I have every confidence it’ll bring us quite a bit.”

BETTER VISION

Improved image processing is part of the package. A second video processing unit, fiber optic connections, and a new, larger Aerial Refueling Operator Station (AROS) enhance the boom operator’s experience.

At the most basic level, what the screen operators will look at is larger and in color. Whereas the current system shows images smaller than their real-life size—about a 0.65-to-1 ratio—the new one will display at a 0.96-to-1 ratio, Burns said.

But it won’t just be a bigger screen. The monitor will be mounted higher and at an angle, facing the same way as the boom operator, who then looks at a curved mirror that reflects the image, wearing the same 3D glasses that operators use for the current system.

“What we have in 1.0 is a direct view. So you’re looking directly at an LCD monitor, which is projecting in 3D,” Burns said. The 2.0 version uses a projection system and a curved mirror to “reflect that LCD in three dimensions off of that mirror to provide that immersive experience for the operator.” The payoff is more pronounced depth perception.

Boeing and Air Force boom operators “chose this type of design together,” Burns said. “We all looked at multiple different concepts: direct view, indirect view, projector, LCD, all of that. And we all came together, it was unanimous, really, we absolutely love this.”

The higher-mounted screen expands the space needed to accommodate the boom operator. Boeing is adding a center console between the two main operator seats, providing operators with more storage space, which they had asked for. To make room, Boeing and the Air Force agreed to remove a third seat from the station.

“It was a deliberate trade-off,” Burgess said. “Air Force engineers and operators said, ‘Hey, we’d rather have the added functionality in the AROS station than that third seat.’”

Other tweaks allow boom operators to adjust positioning of their seat and controls. Collaboration between the Air Force and Boeing teams has been exceptionally close, Burns noted. “We have been lockstep [since] Day One designing the AROS,” he asserted. “It started literally with cardboard mock-ups, then we advanced to Styrofoam mock-ups, we cut out the panels in paper, and we literally pinned them on the Styrofoam mock-ups and redesigned how the station would look.”

Now as the they wait on FAA certification, the tanker team must also overcome supply chain issues. “A big part of the delay just had to do with availability of hardware ... to build up the cameras and display boxes that are required for lab testing,” Burgess pointed out. “The hardware that goes into the lab, the electronics that go into the labs ... it’s early versions of the hardware that go on an airplane. ... It requires a pedigree of hardware to go into the lab that’s close to the pedigree required for flight, just because it’s all part of the chain of certification.”

With lab and flight-testing still to come and the actual fielding of the system several years down the road, several key details about RVS 2.0 remain unsettled, such as whether the Air Force will prioritize delivery of new KC-46s with the system or retrofits of already-fielded aircraft. Renfro said that question is still under consideration.

Meanwhile, boom operators have found workarounds to make RVS 1.0 effective, allowing Air Mobility Command to declare the aircraft ready for operational taskings worldwide. Those solutions won’t have an impact on the upgrade, however.

“RVS 2.0 is part of the long-term vision for this tanker. It’s where we need to be,” Renfro said. “I’m not going to presume to understand all of the pieces and parts that go into making it a reality. But I know that it will show up, and it will be amazing, and we’re going to employ it to the max extent possible. Until then, we’re going to keep using the KC-46 along the methods that we’ve used so far and give combat capability to the warfighter.”

A KC-46A Pegasus from Pease Air National Guard Base N.H., with a mixed crew from four major commands refuels an F-16 Fighting Falcon assigned to 138th Fighter Wing, Tulsa Air National Guard Base, Okla. Aircrews from McConnell AFB, Kan., Altus AFB, Okla., and Pease combined their efforts to plan a Weapons System Council to execute a three-ship local KC-46 sortie.



Airman 1st Class Zachary Willis

Solving the Other KC-46 Deficiencies



A KC-46 Pegasus refuels an A-10 Thunderbolt II with 1,500 pounds in 2016. The mission was the last of all flight-tests required for the tanker's Milestone C production decision.

John Parker/Boeing

While Boeing and the Air Force inch forward on the new KC-46 Remote Vision System 2.0, they are also making progress on other deficiencies that have thus far limited the aircraft in certain missions.

Boeing is tweaking the design of the actuator at the base of the tanker's boom so that it will operate with the thrust-limited A-10 Thunderbolt.

The Pentagon Inspector General characterized the problem as a "stiff boom" that "would not extend or retract during flight-testing unless subjected to more force" than the A-10 could muster. Rather than a full "boom redesign," Boeing KC-46 Program Manager James Burgess said the fix is a new actuator.

Speaking to reporters at Boeing's Everett, Wash., plant, Burgess explained the challenge this way: The actuator "drives the boom out in the telescope direction, and then when a receiver connects with it, the receiver drives the boom back into sort of a nominal refueling position." The original actuator requires about 1,400 pounds of pressure to enable refueling, Burgess said. But when at high altitude and fully loaded with weapons, the A-10 is "a very thrust-limited receiver aircraft; it had trouble pushing it up to that 1,400 pounds and then keeping it compressed at that force."

Indeed, A-10 attack aircraft still cannot refuel from the KC-46, even after Air Mobility Command announced in September that the KC-46 had been cleared for worldwide deployments and combatant commander taskings.

The new actuator will be able to better regulate the force needed. Boeing shared a 3D model of the new design in the boom assembly facility.

"What it does is control force as a function of rate, so as the receiver pushes harder on it, it pushes back harder on the receiver," Burgess said. "If the receiver doesn't push as hard on it, it doesn't push as hard back. So it's a little bit more conducive to lightweight, thrust-limited receivers like the A-10."

The new actuator is smaller than the current one, and simpler, as well, with only one torque motor rather than two.

"It turns out [the current actuator] was probably a little overdesigned initially in terms of redundancy," Burgess said. "That has nothing to do with the deficiency. But Boeing and the Air Force worked together to take advantage of simplifying

the design as part of the redesign. The relief manifold assembly ... goes away, and it's replaced with what's called a PQ valve."

A working version of the new actuator is currently going through lab tests at Boeing Field in Seattle, Burgess said. Delays, however, continue to mount: An Air Mobility Command spokesperson told Air & Space Forces Magazine in November that the fix, referred to as the Boom Telescoping Actuator Redesign (BTAR), "is experiencing delays due to issues getting a compliant actuator from Boeing's subcontractor, Moog."

AMC said its most recent projection has flight-testing ending in late 2023, with retrofits for the existing fleet starting in late 2025. Delays could push that still further into the future.

The "stiff boom" is just one of several non-RVS deficiencies in the KC-46 identified by the Air Force. Another is related to leaks in the fuel system that were first identified in March 2020. Reports indicated seals designed to "flex" and move with the aircraft were insufficient to the task. Burgess said the problem was due to the difficulty of installation, and that Boeing has since redesigned the valve seals to make it easier to install them. As a result, "far fewer" fuel leaks have been reported, Boeing and Air Force officials noted during the plant visit.

Officially, the leaking seal deficiency has not yet been resolved, but Burgess said that was more of a formality at this stage, the result of infrequent meetings of the KC-46 deficiency board.

Other deficiencies have been resolved. Burgess touted during the tour the redesigned cargo pallet lock, which now includes a safety feature to ensure the lock stays fully engaged. The previous design sometimes unlocked when twisted during flight, leading the Air Force to restrict the aircraft from carrying cargo or passengers for a few months in 2019.

All in all, Air Force officials projected optimism, both in the KC-46's current capabilities and the future fixes coming.

"If we had to go to war today, we would take this airplane with us," Lt. Col. Joshua M. Renfro, from the Air Force's KC-46 Cross Function Team, told reporters. "And we'd be fantastically confident in its capabilities in order to deploy it. However, long term, there's always things that we can leverage—emerging technologies, and that partnership [with Boeing]—to acquire what the long-range vision for this tanker needs to be."



Office of the President of Ukraine

A video screen capture shows Ukrainian President Volodymyr Zelenskyy standing next to a downed Russian Shahed-131 loitering munition. The weapon was built in Iran.

Cheap UAVs Exact High Costs

Russia's use of inexpensive Iranian drones in Ukraine imposes a costly bill for defending against low-cost weapons.

By Chris Gordon

One of Russia's most formidable weapons in its punishing invasion of Ukraine is a noisy, slow-flying, propeller-driven kamikaze drone manufactured in Iran.

The Shahed-136, and its smaller sibling, the Shahed-131, is a far cry from Russia's advanced Avangard hypersonic glide vehicle, Iskander ballistic missile, or other high-tech weapons that Russian President Vladimir Putin showcased before his February 2022 offensive. That show of capability was intended to dissuade the United States and its partners from coming to Kyiv's aid.

Ukrainian forces say they have shot down most of the Iranian drones, but enough have gotten through to pummel much of Ukraine's electrical grid. The unmanned aerial systems (UAS), deployed to operate like loitering munitions, have tied up much of Ukraine's patchwork air defenses and added to Russia's firepower as its supply of long-range strike systems has dwindled.

"Rare and expensive became cheap," Bernard Hud-

"Historically, there's a lot of mistrust between Russia and Iranians, but they need each other right now."

—CIA Director, William Burns

son, the former director of counterterrorism at CIA, said at Harvard's Belfer Center in October. "Air power is no longer tied to airfields."

The most worrisome developments may be yet to come. The White House has warned that Russia's acquisition of the drones could be the first step in a "full-fledged defense partnership" that may lead to the establishment of a joint production line on Russian territory and two-way security cooperation.

A Russian move to provide technical support to Iran's forces would be an ominous and unanticipated twist in a war that has already led to the destruction of more than 1,000 Russian tanks, killed thousands of civilians, and strained Western arsenals.

It could add to Iran's ability to threaten U.S. forces and their allies and partners in the Middle East. It could also help Tehran better endure the international sanctions Washington and its allies have imposed because of Iran's nuclear program.

"Historically, there's a lot of mistrust between Russians and Iranians, but they need each other right now," said CIA Director William Burns on PBS' NewsHour

Biden Gives Ukraine Patriots and JDAMs

The United States agreed to send a Patriot air and missile defense system to Ukraine and provide precision-guided munitions, a major step in arming Ukraine as its war with Russia approaches the one-year mark since Russian forces invaded in February 2022.

Amid a Russian barrage of drone, ballistic missile, and cruise missile attacks on Ukrainian infrastructure targets, Ukrainian President Volodymyr Zelenskyy visited Washington, his first trip abroad in 10 months, wearing his signature tactical green sweater and trousers, and expressing gratitude and a plea for still more help.

The State Department said the U.S. was making its "first transfer of Joint Direct Attack Munitions (JDAMs), which will provide the Ukrainian Air Force with enhanced precision strike capabilities against Russia's invading forces." In January, the U.S. upped the ante with Bradley Fighting Vehicles. But while Congress has authorized the training of Ukrainian pilots on U.S.-made F-16s, the U.S. has yet to offer those weapons out of concern that such long-range capability would be viewed as escalatory by the Russians.

The \$1 billion Patriot is an integrated air defense system, consisting of interceptors, radar, command and control, and other support elements. It takes about 90 people to man such a battery. However, it will be several months before Ukraine can field the system.

"Patriot is one of the world's most advanced air defense systems, and it will give Ukraine a critical long-range capability to defend its airspace," a senior U.S. defense official told reporters. "It is capable of intercepting cruise missiles, ballistic missiles, and aircraft. It's important to put the Patriot battery in context for aired defense. There is no silver bullet. Our goal is to help Ukraine strengthen a layered, integrated approach to air defense that will include Ukraine's own legacy capabilities, as well as NATO standard systems."

U.S. military aid to Ukraine has surpassed \$21.5 billion in total weapons and other security aid provided by the U.S. since the start of the war in February.

Providing JDAMs signals a significant move to strengthening Ukraine's Air Force. The U.S. did not disclose the exact munitions it would provide, how many aerial munitions, or the monetary value of those weapons. JDAM kits are fitted to unguided bombs.

Much of the aid has come by drawing down existing U.S. arms under Biden's Presidential Drawdown Authority (PDA), while the balance comes from other accounts, such as the Ukraine Security Assistance Initiative (USAI).

The U.S. aid marks a significant step in its plan to improve



White House photo

Ukrainian President Volodymyr Zelenskyy and U.S. President Joe Biden at the White House, Dec. 21, 2022.

Ukraine's air and missile defense, fulfilling a long-standing request from Kyiv. Patriot is America's most advanced tactical air and missile defense system, and each interceptor missile costs more than \$4 million. Ukraine has been pummeled by Russian missiles, many of them launched from Russian aircraft. The Patriot provides a long-range defense capability Ukraine has not previously had.

The Biden administration has refrained from providing long-range systems to Ukraine in an effort to prevent escalation. While it has provided the High Mobility Artillery Rocket System (HIMARS), for example, it has so far declined to provide the longer-range Army Tactical Missile System (ATACMS) for HIMARS.

Ukraine has carried out bold attacks into Russian territory with its own weapons. It blew up a bridge connecting Russia to Crimea, which Russia occupied and annexed in 2014. An air base deep inside Russia was targeted and several of Russia's strategic bombers were damaged in an attack Ukraine has not denied. American officials maintain Ukraine is free to make its own military decisions with non-U.S. origin weapons.

The U.S. said it was not concerned about any escalatory effect of providing the Patriot battery. "This will be an air defense capability among others that they're being provided as part of an integrated air defense system," a senior military official said. "It is by default, by nature, a defensive system."

Dec. 16. "I think it's already having an impact on the battlefield in Ukraine, again, costing the lives of a lot of innocent Ukrainians. And I think it can have an even more dangerous impact on the Middle East as well, if it continues. So, it's something that we take very, very seriously."

Iran's drone program began in the 1980s during its nearly eight-year war with Iraq. Iran was the largest international consumer of U.S. military equipment in the 1970s, with a modern air force equipped with U.S.-made F-4 Phantoms, F-5 Tigers, and F-14 Tomcat fighters.

But the overthrow of Mohammad Reza Pahlavi, the pro-West-

ern Shah of Iran, in 1979 shattered U.S.-Iranian ties. The revolution, the storming of the U.S. embassy, and the hostage crisis that resulted froze out Iran from Western arms markets.

As the years went by, Iran developed its own ballistic missile capabilities along with drones.

"UAVs (unmanned aerial vehicles) are Iran's most rapidly advancing air capability," a report from the Defense Intelligence Agency warned in 2019.

That year, Iranian drones attacked the oil processing facility at Abqaiq, Saudi Arabia. The U.S. charged that Iranian drones were behind an attack on a tanker ship, the *Mercer Street*, off the coast

of Oman in 2021. Iran also provided drones to militias in Syria, Iraq, Yemen, and Lebanon. Iranian-made drones were used to attack U.S. and allied forces at Al-Tanf Garrison in southeastern Syria and Erbil, Iraq, in multiple strikes since 2021.

“Iran does not have the capabilities to build its own air force that could compete with ours,” said Ryan Brobst, a research analyst at the Foundation for the Defense of Democracies. “Nor was it able to purchase sufficient aircraft from China or Russia, and this forced Iran to turn to other asymmetric ways to compensate. The way they did so is ... by using drones and ballistic missiles to achieve the same results, which is hitting targets from long ways away without the use of conventional aircraft. And they also had to do this efficiently and cheaply, because they have a much smaller economy.”

THE GAMBIT WORKED

Drones “present a new and complex threat to our forces and those of our partners and allies,” USMC Gen. Kenneth F. McKenzie Jr., who was serving as commander of the U.S. Central Command at the time, told the Senate Armed Services Committee in 2021. “For the first time since the Korean War, we are operating without complete air superiority.”

As the drone threat grew, the U.S. and allied forces in the region have fired air-to-air missiles from fighters to blast the drones out of the sky, a costly but necessary solution to protect lives. The low-cost drones impose serious costs on the U.S. and its allies this way, as the cost of an air-to-air missile far exceeds that of the drones. Training to counter these small UAVs has become one of the military’s top priorities and a way to supplement ground-based defense like Counter-Rocket, Artillery, Mortar (C-RAM) rapid-fire guns.

“AFCENT’s strategy for dealing with the threat of Iranian unmanned aerial systems begins with deterrence,” said Lt. Gen. Alexis G. Grynkeiwich, the commander of Air Forces Central, in an emailed response to questions. “By maintaining robust, ready and lethal forward forces, alongside our partners throughout the region, we deter Iran and its proxies from attacking U.S. and partner forces with UAS. Our diverse intelligence collection detects UAS production, shipping, and storage.”

Air Forces Central regularly conducts counter-UAS exercises, including sometimes missions flown by the commander himself.

One of Grynkeiwich’s top priorities—other than flying missions in support of the allied forces as part of Operation Inherent Resolve, the anti-ISIS campaign—is counter-UAS exercises as part of a broader push for better integrated air and missile defense in the region coordinated with U.S. allies and partners

“We maintain a range of kinetic capabilities designed to deny and delay UAS attacks, including both nonkinetic options and shooting down UAS using armed aircraft, both of which we train for routinely across the joint force and with our partners and members of the coalition,” Grynkeiwich said. “Finally, we defend personnel and installations with a range of systems which create a layered defense, synchronized with interdisciplinary, multinational teams to maximize efficiency and effectiveness. The UAS threat is constantly evolving, and so too are the ways and means by which we mitigate this threat. Like the threats from theater ballistic missiles and land-attack cruise missiles, no country or force operating in the Middle East region can completely mitigate the UAS threat alone—this is why regional integrated air and missile defense is my top focus area and a key focus area for the combatant command as well.”

But unlike U.S. forces and their allies in the Middle East, Ukraine does not have the kind of comprehensive air defense that AFCENT relies on, nor the firepower to back up a deterrence strategy.

The Shahed-136 and Shahed-131, or Geran-2 and Geran-1 in Russian nomenclature, are able to change targets in mid-flight, but are of only limited utility against hardened military targets. They are effective against soft infrastructure targets, however, such as in the case of attacks on Saudi oil infrastructure and the Mercer Street tanker.

“They don’t have very big warheads,” according to Michael Knights, a Middle East military and security expert at The Washington Institute. “They’re quite accurate, but they’re also quite easy to shoot down. So what you’re ideally hitting is an undefended, valuable target.”

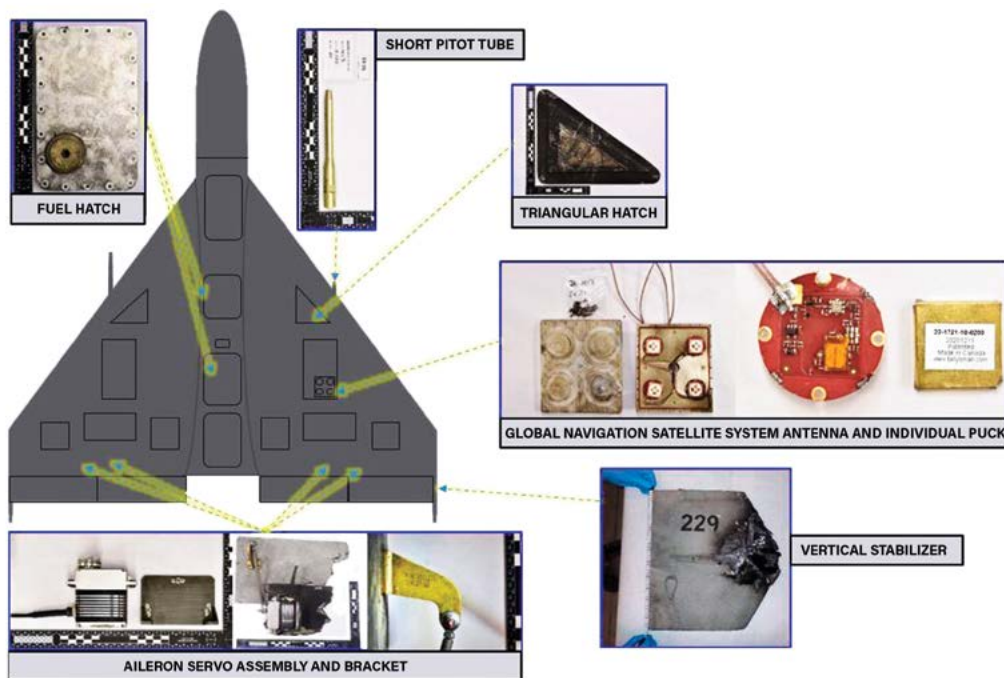
The Biden administration says that Iran has provided Russia with hundreds of drones and has also sent technical experts from its Islamic Revolutionary Guard Corps to Crimea to provide technical support and to train the Russians in how to use them.

“There are a number of benefits for Iran seeing how they do in a little bit more modern battlefield,” said John Hardie, a security expert at the Foundation for the Defense of Democracies. “With



Sgt. 1st Class Theresa Gualdarama/HANG

Brig. Gen. Kenneth Hara, Hawaii Army National Guard Deputy Adjutant General, along with other leadership, took cover as the Counter-Rocket, Artillery, Mortar (C-RAM) weapon engaged a simulated air attack during C-RAM operations training for Hawaii Army National Guard Soldiers in 2019.



A graphic identifying specific debris fragments collected by a U.S. Navy explosive ordnance disposal team shows how the collected fragments indicate the unmanned aerial vehicle that attacked the commercial tanker was an Iranian-made Shahed-136.

USN Graphic

Iran, its various drones and missiles, it's proliferated, it's always a learning opportunity. That's No. 1. Number 2 is perhaps status. It's legitimizing for the regime and for the revolution. Number 3, poking the West in the eye and distracting the United States and its Western allies, and perhaps drawing their attention away from the Middle East."

According to a report by the Royal United Services Institute, a British think tank, the Shahed-136 has a range of more than 600 miles and usually cruises at a speed of about 100 miles per hour, slower than a basic Cessna. The drone has inertial guidance and satellite navigation receivers. The drone is best at hitting fixed targets. The Shahed-131 is a smaller but visually identical version of the Shahed-136, according to the U.S. Army's Training and Doctrine Command.

According to Conflict Armament Research, wreckage of the Iranian-made drones it inspected in Ukraine found that they "include high-end components, such as semiconductors and tactical-grade inertial measurement units, that have been sourced outside Iran."

On Oct. 10, Russian forces used drones, Kalibr cruise missiles, and Iskander ballistic missiles to carry out a new strategy that has focused on targeting Ukraine's electrical grid and power stations. The aim has been to deprive millions of Ukrainian civilians from heat and electricity.

By launching the drones along with cruise and ballistic missiles, Russia's aim has been to overwhelm Ukraine's air defenses. Russian strikes have been carried out from Crimea, or from Russian airspace or ships in the Black Sea. Russia is also launching many attacks in the middle of the night to catch Ukrainian defenders off guard and make it hard for air defense teams to spot their targets.

Those launching sites are generally beyond the range of Ukrainian weapons, meaning Russian forces have had a sanctuary. The U.S. has refrained from providing Ukraine with long-range ATACMS missiles that could strike deep into Russia, a policy that Biden administration officials say is aimed at reducing the risk that the Ukraine conflict could escalate into a direct U.S. and Russian confrontation. It has also extracted a commitment from Kyiv that the HIMARS launchers it has provided with GM-LRS (Guided Multiple Launch Rocket System) rockets won't be

used to strike Russian territory.

As long as Russia can launch drones, it is extracting a steep cost from Ukrainian forces.

Experts such as Knights and Hardie reckon the drones are relatively cheap and cost around \$20,000—though putting a precise monetary figure on Iranian and Russian military cooperation is difficult.

"There are lots of things the Russians have got that the Iranians want," Knights said. "When it comes to technology, when it comes to joint production of materials, when it comes to nuclear research. Iran's other friends include North Korea. If you're the Iranians, and you're highly isolated, Russia gives you a U.N. Security Council veto-holding friend."

The relatively crude Iranian drones present a difficult cost imposition on Ukraine even if its air defenses are at their best. The estimated cost of each missile fired, for example, by Ukrainian ground-based air defenses such as the indigenous S-300, is up to \$1 million. Even less advanced systems, such as U.S.-made Stinger man-portable air defense system (MANPADS) launchers, still cost tens of thousands of dollars per missile.

"As a competitive strategy, where you force your opponent to put a lot of their effort into blocking something that's very cheap for you to do, it's very effective," Knights said. "It imposes costs on your opponent—higher costs than you're paying."

Ukraine has a patchwork collection of surface-to-air missiles, manned aircraft with air-to-air missiles, MANPADS, anti-aircraft guns, and other defense methods such as electronic warfare.

"There's a lot of counter-UAS going on in Ukraine right now," said Tom Karako, an air and missile defense expert at the Center for Strategic and International Studies. Russia's drone attacks are essentially a war of attrition. Karako points out that air and missile defense is an area that even the U.S. admits it has little excess capacity even for its own needs.

Karako said advanced, expensive surface-to-air missile systems are not ideal for taking on small, slow, inexpensive drones. Instead, the better solution would be electronic warfare to disable the drones, or less costly anti-aircraft guns, Stingers, and Avenger systems, which use Stinger missiles mounted on a vehicle.

"The cost per kill is a challenge," Karako said of counter-UAS efforts. "This is a universal problem." ★



Raytheon illustration

Space is Indispensable for JADC2

Space is the key to unlocking the potential of Joint All-Domain Command and Control.

Space-based sensors and connectivity will enable the accelerated decision-making and sensor-to-shooter integration promised by Joint All-Domain Command and Control.

By Tim Ryan

Warfighting in the space domain will determine the outcome of future conflicts. Success in war will go to the side that possesses superior battlespace knowledge, makes better decisions, directs forces more effectively, and closes kill chains faster. Technologies on orbit are pivotal in securing this advantage, especially when it comes to sensors and connectivity.

Realizing the importance of information and decision advantage, defense leaders formulated the Joint All-Domain Command and Control (JADC2) concept. It envisions an enterprise in which data is collected from a broad array of multi-domain sensors, rapidly transmitted across vast distances, processed into actionable information, and provided to consumers on a demand-relevant basis to empower smart decision-making across the tactical, operational, and strategic command realms.

Importantly, this concept is not a singular program or capability. It comes down to using a mix of capabilities to get relevant information to each warfighter at the right time to achieve the desired effects, all at a global scale. As the Department of



Tim Ryan is a senior resident fellow at the Mitchell Institute for Aerospace Studies. Download the entire report at <http://MitchellAerospace-Power.org>.

Defense's official JADC2 strategy explains, the goal is to "produce the warfighting capability to sense, make sense, and act at all levels and phases of war, across all domains and with partners, to deliver information advantage at the speed of relevance."

Space-based technologies are essential for manifesting this vision—especially the global communication links able to move data from all sensors. As the U.S. Space Force's doctrine emphasizes, "One key distinction of warfare in the Information Age is that many weapon systems rely on external sources of information to function." Space is the ultimate high ground, affording an extremely broad view for sensor data collection. This vantage also enables forces separated by tremendous distances to connect, which is particularly important in the critical Indo-Pacific region.

As former Chief of Space Operations Gen. John "Jay" Raymond explained, "Our ability to sense from the space domain, transport and make sense of data, and then get that data into the hands of our joint warfighting partners on land, in the air and at sea, is what the Space Force delivers to JADC2. Space capabilities underpin modern warfare."

Manifesting this vision requires a new suite of sensor capabilities and a robust space transport data

transmission layer scaled for global operations. For JADC2 to be the operational commander's pathway for creating effects in the air and on the ground, its orbital assets must be resilient and defended. This reflects a major paradigm shift in the way the U.S. national security establishment views the space domain.

Anyone questioning the necessity of JADC2 should reflect on the Battle of Britain in the summer of 1940. It is a classic example of how information and decision superiority can be the deciding factor in conflict. Having just occupied France, Germany was set on invading the United Kingdom, and an air offensive was the first component of their campaign. Royal Air Force (RAF) combat aircraft were badly outnumbered by more than 7-to-1. When the Luftwaffe raids commenced, over 3,500 German combat aircraft were massed across the English Channel. The RAF possessed only 446 operational fighters. In the 10 days between Aug. 8 and Aug. 18, 1940, the RAF lost 154 pilots, with only 63 green Airmen available from training squadrons to backfill casualties. Yet British forces prevailed because their information and decision superiority enabled them to direct their Hurricane and Spitfire fighter aircraft more effectively and efficiently against the more numerous Luftwaffe. The system allowed the posturing of fighter aircraft at the right time and place to best defend the homeland while avoiding zones of undue risk.

While technology, systems, and processes have changed in the decades since the Battle of Britain, information and decision superiority remain vital military attributes, especially when a force is stretched thin—exactly the circumstances facing the U.S. military. As Deputy Secretary of Defense Kathleen Hicks explained in March 2022 as part of the Pentagon's JADC2 implementation plan, "Command and control in an increasingly information-focused warfighting environment has never been more critical."

There is no question that space capabilities will be critical to realizing the JADC2 concept. However, what specific systems and capabilities are needed, how many, and at what cost remain undefined. While many technologies may already be available, many are still on the drawing board. Moreover, there is no clear path for procuring and fielding these capabilities. Confusion regarding the ultimate scale and scope of the JADC2 construct has not helped these efforts. Overarching operational concepts and strategies directing their use must be defined, especially those related to JADC2 functions on orbit.

EVOLVING C2

The United States' comparative military advantage has deteriorated significantly, both quantitatively and qualitatively.

America's adversaries have carefully studied core strategies, operational concepts, and technologies favored by the United States for over three decades. America's successes in Operation Desert Storm and the Kosovo and Iraqi Freedom campaigns taught them about the war-ending effectiveness of the U.S. ability to rapidly deploy, sustain forces, and conduct precision strikes. On the other hand, they also learned about the U.S. military's total reliance on its C2 infrastructure. The military modernization pathway of other nations reflects the implementation of these lessons learned, and they have specifically molded strategies and forces to counteract the U.S. ability to achieve the same effects of the Desert Storm campaign in the same way. Today, much like the Battle of Britain challenge that faced the Royal Air Force in 1940, the U.S. military risks being overwhelmed by a highly capable adversary. Warfighting success will depend upon ensuring combat assets are employed at the best time and place to secure desired effects while mitigating points of vulnerability.



Imperial War Museum

Information and decision superiority proved the decisive factor during the Battle of Britain in the summer of 1940. The Royal Air Force was outnumbered 7-to-1 by the German the Luftwaffe, but British forces prevailed because superior information and decision-making made up for the shortfall. This Group Operations Room at Middle Wallop, in Hampshire, U.K., shows how the RAF maintained situational awareness by moving wooden blocks across map tables to understand the relative position of various aircraft.



Staff Sgt. Jessica Montano

The Combined Air Operations Center at Al Udeid Air Base, Qatar, shows the size, scale, and complexity of modern-day command and control. Space is critical for intelligence and communications and will become more so as Joint All-Domain Command and Control (JADC2) accelerates the speed of information and the need for rapid decision-making.

Existing force structure, already too small given post-Cold War cuts and anemic modernization efforts, will also be diluted in the expanse of the Indo-Pacific. Fighter and bomber aircraft will have low sortie generation rates due to long transits from distant U.S. bases. Consider the example of B-52s flying from Anderson Air Force Base in Guam during the Vietnam War. The round-trip B-52 flight between Guam and Vietnam spanned nearly 6,000 miles and lasted 12 to 14 hours. Potential targets in a China fight might expand those distances even further. Without exquisite and timely off-board intelligence feeds, such distances render these platforms irrelevant against modern mobile targets. This contrasts with recent operations in Iraq and Syria, where a single jet could turn multiple sorties in that same period and remain in constant contact with its principal command and control element. This challenge is not restricted to air power, with ships and ground forces similarly spread thin by the realities imposed by the theater's geometry. Combat assets need highly efficient direction to meet campaign objectives while avoiding areas that present undue risk. Consequently, U.S. forces require information and decision advantage.

The U.S. defense enterprise must adjust to the new battlespace realities if it is to secure and maintain information and decision superiority—it is vital to prevailing against its adversaries.

Several key principles will be crucial for JADC2 architects to follow. JADC2 is only as effective as the data empowering it. Data inputs are the backbone of information and decision superiority. Sensors must be positioned at the right time and

place to secure necessary insights regarding adversary activities, force composition, and points of vulnerability. Data is also important when seeking to command and control U.S. and allied forces, secure key infrastructure, and track incoming adversary threats. The scale and scope of the Pacific region will demand a new generation of sensors to gather the data necessary to empower smart decision-making. This includes systems that can penetrate, see, or sense deep behind enemy lines and provide persistent observations.

JADC2 must move information at the speed of need. Mobility and speed have always been imperatives in warfare. Historically, however, the focus has been on how operators or platforms could leverage these advantages physically. In the Information Age, successful military operations increasingly depend on the abilities of sensors, processing power, and human actors in the decision sphere to understand the battlespace. This includes finding and fixing military targets to best secure desired effects while reducing vulnerability. That's the crux of the modern era of warfare—the tools of the Industrial Age still matter—the planes, ships, tanks, satellites, and fielded forces—but now, information superiority is of equal if not greater importance. Existing assets need to be directed to execute operations at the best time and place while avoiding undue risk to maximize force efficiency. That requires situational awareness and connectivity.

SPACE POWER'S CONTRIBUTIONS TO JADC2

Effects delivered through the space domain are crucial in delivering JADC2. Sensors, processing power, and C2



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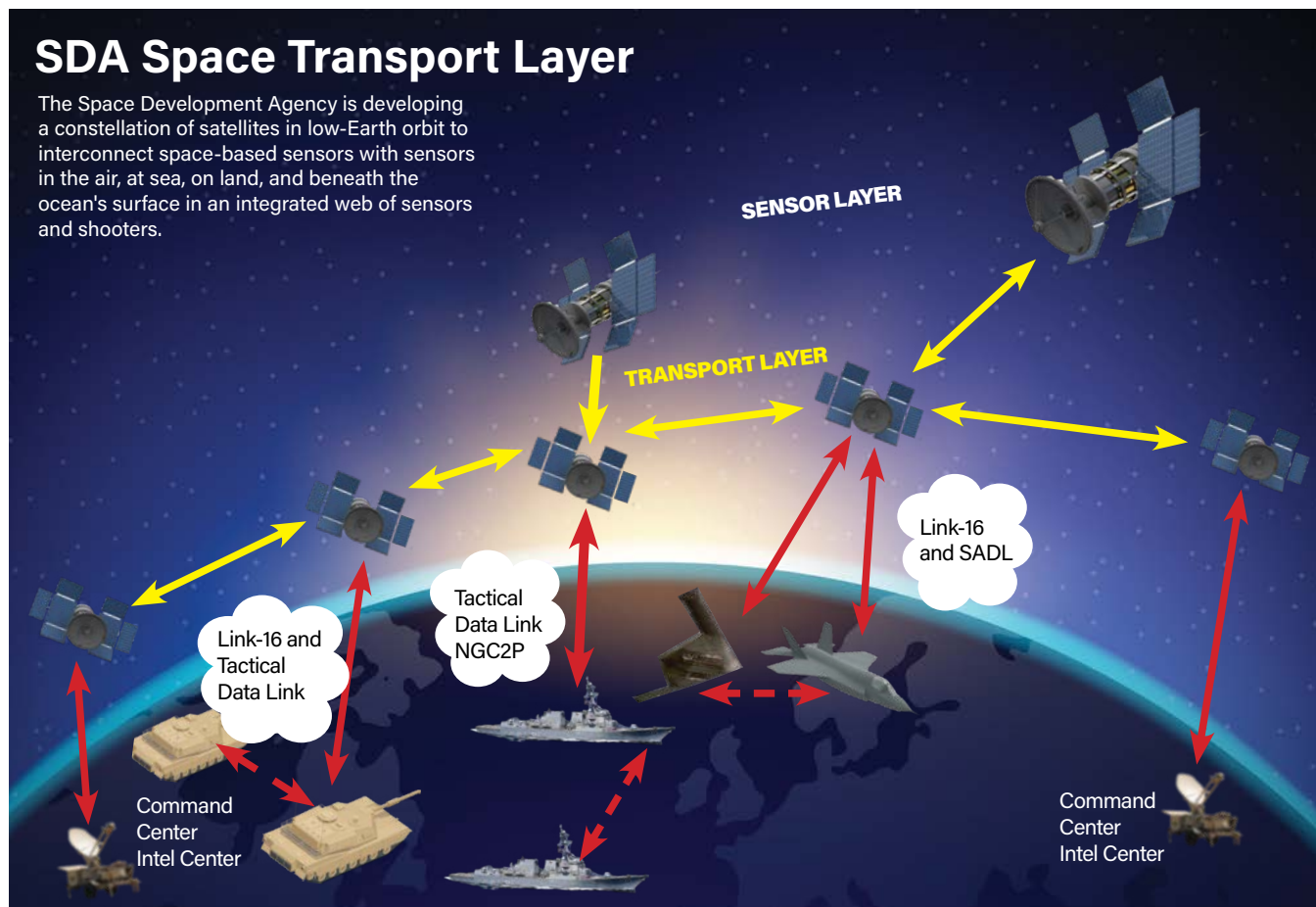
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SDA Space Transport Layer

The Space Development Agency is developing a constellation of satellites in low-Earth orbit to interconnect space-based sensors with sensors in the air, at sea, on land, and beneath the ocean's surface in an integrated web of sensors and shooters.



Source: Mitchell Institute

expertise all linked by robust connectivity are the keystone elements that comprise this vision. The space domain affords distinct advantages in all these areas, but space is particularly important when it comes to sensors and connectivity.

SENSING

Data collection is a critical component in JADC2. It all comes down to placing sensors in the right place and time to gather desired inputs across the battlespace—from friendly lines to deep over enemy territory. In the past, these collection functions were largely executed from the air, which afforded the ability to rapidly span large swaths of territory and observe areas of interest with the advantage of altitude. While the National Reconnaissance Office provided overhead ISR as well, its tasking was based on priorities for the overall intelligence community and not adequate to support the needs of operational commanders.

Today's air domain is not only increasingly contested and denied over enemy peripheries, but air-based data collection capabilities must also transit extremely long distances from U.S. and allied bases to reach the front lines. While the air domain will still be important in this regard, data-collection missions will increasingly transition to space. The ability to cover vast portions of the Earth with rapid refresh rates and constant coverage, avoid traditional air defenses, and do so without having to sustain large rotations of mission aircraft to net the desired result is a tremendous advantage afforded by systems on orbit.

Space sensors, whether moving target identification or other types, must also be designed as nodes in a broader multi-domain sensor net. It all comes down to gathering

disparate flows of information, fusing them into a whole that reveals more actionable knowledge of the battlespace than can be provided by any individual source. While space-based sensors will obviously yield crucial inputs, sensors located in the air, on land, or at sea could also prove equally valuable. The real power is achieved through fusing inputs from all these sources in a highly dynamic, effects-oriented fashion to best achieve mission results.

SPACE TRANSPORT LAYER

Operating and managing the global JADC2 space transport layer and associated infrastructure is a critical mission the Space Force will accomplish in the next few years. Sensors in space and other JADC2 nodes offer significant potential, but the entire enterprise must be connected to deliver desired results. While a range of terrestrial networks will remain important, an overarching global communication backbone is required to fully connect all the various elements of the JADC2 enterprise in a dependable, high-speed, seamless, resilient fashion. That is a requirement that can be met best through space-based capabilities due to their global perspective, global persistence, and global information connectivity.

A better set of capabilities begins with a distributed, resilient architecture involving far more SATCOM satellites than are currently on orbit. This will increase resilience, responsiveness, and functionality. To make up the sheer quantity required, the JADC2 space transport layer will likely be a combination of government and commercial space systems distributed over many orbital regimes and evolve over time to emphasize different link technologies, satellites, and orbits. Said more simply, this is a far more numerous, distributed

Dash Parham, Mike Tsukamoto/Air and Space Force Magazine/Adobe Stock

set of satellites that will empower the JADC2 transport layer in a way that helps avoid single points of failure and that will also bring more modern capabilities to orbit.

The Space Development Agency (SDA) will launch a constellation of low-Earth orbit (LEO) satellites integrating the services' tactical networks to create the transport layer of a meshed network. The SDA views the transport layer as primarily an integration problem—integrating multiple service efforts into a cohesive whole. As such, the SDA is working with the individual services on specific integration requirements.

As the Space Force designs the JADC2 space transport layer, it must employ wide-band array capabilities, enabling users to send and receive from multiple satellites on multiple frequencies in multiple orbits. Nodes would thus operate like a modern cellphone, which is able to rely upon numerous proprietary networks in a way that appears seamless to the user and provides an encompassing range of service.

Space Force leaders fully understand the importance of on-orbit communication capabilities in realizing the JADC2 vision. As Vice Chief of Space Operations Gen. David “DT” Thompson explained, “JADC2 is an absolute priority for the United States Space Force. Enabling JADC2 by connecting the joint force through space may well be our greatest contribution to joint operations in the next decade.” No matter how much DOD invests in sensors, processing power, C2 centers, or front-line assets, none will really matter without the ability for robust, rapid, and resilient space-centric communications.

SPACE FORCE'S COMBAT ROLE FOR JADC2

The U.S. Space Force must be prepared to defend sensors on orbit and in the space data transport layer. Key elements required to achieve this include:

1. A survivable JADC2 enterprise composed of hardened, proliferated networked systems (made of military, commercial, and alliance assets) across multiple orbits (LEO, MEO, GEO, and cislunar) to enhance system resilience, complicate adversary simultaneity of targeting and attack, and provide defense in depth (to include rapid reconstitution).

2. Robust Space Domain Awareness, including space-based ISR platforms (such as the Geosynchronous Space Situational Awareness [GSSAP] spacecraft) for LEO, MEO, GEO, and cislunar orbits to detect and identify adversary threats and prevent attack.

3. Space weapons to defend and defeat active attacks on the JADC2 architecture and the space transport layer's lines of communication. These will need to be both offensive and defensive as well as all-domain.

CONCLUSION

A stark reality faces the nation: the United States is at risk of failing to deter its adversaries, especially in the Indo-Pacific, because its Air Force and Space Force currently lack the lethality and capacity to prevail in a peer conflict. This does not have to be the case. One approach to achieving a war-winning level of combat power with today's forces is to transform how DOD commands and controls its future operations in all warfighting domains. Creating a C2 structure that exploits superior decision cycles and levels of information will enable America's combatant commanders to seize the initiative. Possessing an information and decision advantage is an instrumental precondition to a credible deterrent capability.

Operation Desert Storm was a success because the United States fielded technologically advanced forces that exploited superior C2 systems to offset numerically superior forces in the Cold War. In the current era, JADC2 is a conceptually parallel path to regaining a dominant warfighting posture for the U.S. military.

Current Department of the Air Force leadership understands the import of these efforts, as Gen. C.Q. Brown said in June 2022, “We cannot afford to lose a day in this effort. Speed, agility, and resilience are essential to decision-making and battle management in future highly contested environments. The progress we make in JADC2 will be determinate in our success as a joint force.” We cannot afford to wait on this imperative; JADC2 and space will be critical to this effort. ✪



The Raytheon Multi-Program Testbed, or RMT-727, was one of the more unusual participants in Valiant Shield 22, where U.S. military service components were given the opportunity to execute their own vision using current technology to turn concepts into reality. This aircraft, a testbed for new avionics, included unusual grafting on an F-15 Eagle nose.



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FACES OF THE FORCE



Airman 1st Class Ricardo Sandoval

At Eielson Air Force Base, Alaska, **Staff Sgt. Matthew Romano** of the 354th Maintenance Squadron approached **Tech. Sgt. Brian Kolk** with a problem—the trailers used to transport the canopies for the bases' F-35 fighters were “virtually impossible” to use in the snow, a problem six months out of the year at Eielson. In just a few days, Kolk was able to design a way to attach pneumatic tire axles to the original canopy transport trailer, and the two connected with a local vendor for supplies and materials. Now, the “winter configuration” trailer adapter ensures they can keep the F-35 ready to go in any conditions.



Giancarlo Casem/USAF

Capt. Samuel “RaZZ” Larson is taking over as commander and pilot of the F-22 Demonstration Team, after Air Combat Command boss Gen. Mark D. Kelly certified the team ahead of the 2023 air show schedule. An experienced aviator with more than 750 flying hours, Larson has flown the T-6 Texan, T-38 Talon, and F-22 Raptor since he began his Air Force career in 2015. Now, he'll be responsible for leading the demonstration team in showcasing the unmatched maneuverability of the Air Force's fifth-generation air dominance stealth fighter, as well as highlighting the history of the Air Force's service through heritage formation flights.



Senior Airman Alexcia Givens

Airman Emma Gantner, a military postal clerk with the 786th Force Support Squadron, earned the prestigious gold German Armed Forces Military Proficiency Badge recently, acing the famed test that includes five events ranging from a swim to a run and first-aid test within the allotted time. In this round of testing, Gantner was one of 22 recipients from NATO countries, and the only woman to participate. She earned the top possible overall score of A+++, and can now wear the badge on her uniform—it is one of a few foreign military badges authorized to be worn by U.S. Air Force, Army, and Space Force members.



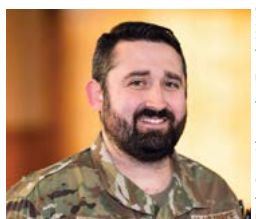
Tech. Sgt. Victor Caputo

In a special ceremony Nov. 15, **Tech. Sgt. Juwon Williams** received a Stripes for Exception Performers promotion to the rank of technical sergeant at Holloman Air Force Base, N.M. The STEP program authorizes commanders to directly promote a select few members performing at a level beyond their current rank without going through the usual Weighted Airman Promotion System, a significant accomplishment for an enlisted member. Williams serves as the 586th Test Squadron Munitions Systems NCO, helping Airmen from different career fields work together.



Airman 1st Class Devlin Bishop

Maj. Michael Madden, an HH-60G Pave Hawk pilot from the 563rd Rescue Group, was awarded the Distinguished Flying Cross with Valor in a ceremony at Davis-Monthan Air Force Base, Ariz., on Dec. 12, along with eight other Airmen from the unit being honored for their actions in Iraq and Afghanistan in January 2020 and August 2021. Other HH-60G aviators were also awarded the Air Medal with Valor, and a pair of pararescuemen from the 355th Wing were awarded the Bronze Star Medal.



Tech. Sgt. Alexander Frank/ANG

Staff Sgt. Kyle Mergeler, of the Oregon Air National Guard's 142nd Wing, was driving to a drill in early November when he was flagged down. Turning around and getting out of his car, Mergeler saw an unconscious man on the sidewalk and performed five minutes of life-saving CPR before emergency medical service personnel arrived to help. He helped first responders ensure the man was OK. Mergeler, a Religious Affairs Airman, was later recognized by Oregon Adjutant General Maj. Gen. Michael Stencil and Oregon ANG Commander Brig. Gen. Donna Prigmore.



USF

Tech. Sgt. Jake Harris, a member of the 328th Weapons Squadron in the Space Force's Space Training and Readiness Command, made history in November as one of the first four recipients of the Polaris Awards, a newly formed program comparable to the Air Force's Outstanding Airmen of the Year Awards. The Polaris Awards are based on the Space Force core values: Character, Connection, Commitment and Courage, and Harris received the “Commitment” award. As a member of the Space Force's weapons school, he helped develop and graduate weapons officers and advanced instructors.



Senior Airman Alexander Merchak

On his honeymoon in Hawaii, **Staff Sgt. Harris Belmonte** was taking photos with his spouse in early November when they heard screams for help. Rushing over, Belmonte, a critical-care shift lead with the 60th Inpatient Operations Squadron, saw bystanders trying to help an unconscious man but were performing incorrect CPR techniques. Stepping in, he utilized his training in critical situations and rendered several rounds of CPR, attaining a pulse and weak breathing from the patient that first responders were eventually able to maintain.



C. Arce/USAF

Airman 1st Class Zachary Rodriguez an F-35 Mechanical Apprentice Crew Chief at Luke Air Force Base, Ariz., got a special opportunity one day in late December to work with the military working dog trainers at the 341st Training Squadron—and honor his own father's service. Army Sgt. 1st Class Gregory Rodriguez was a Special Operations dog handler and was killed in Ana Kalay, Afghanistan, on Sept. 2, 2008. He said, “I [did] like to see and follow my dad's footsteps and see what he did.... I think this was a really cool experience.”



Courtesy photo

Members of the Space Force's **Space Delta 6** were gathered for a hike and morale event at Manitou Springs, Colo., on Nov. 9, when they noticed smoke early on in their climb. Inspecting further, Capt. Justin Ditter, 1st Lt. Nathaniel Akers, Master Sgt. Kristopher Chesslo, Tech. Sgt. John Mendoza, Sgt. Dominick Cuervo, Sgt. Daniel Shanks, Sgt. Kavion Wee, and Ashley Anacker discovered the start of a wildfire, with flames starting to grow. The Guardians used water bottles, sports drinks, and even dirt to keep the fire contained for more than an hour until first responders arrived.

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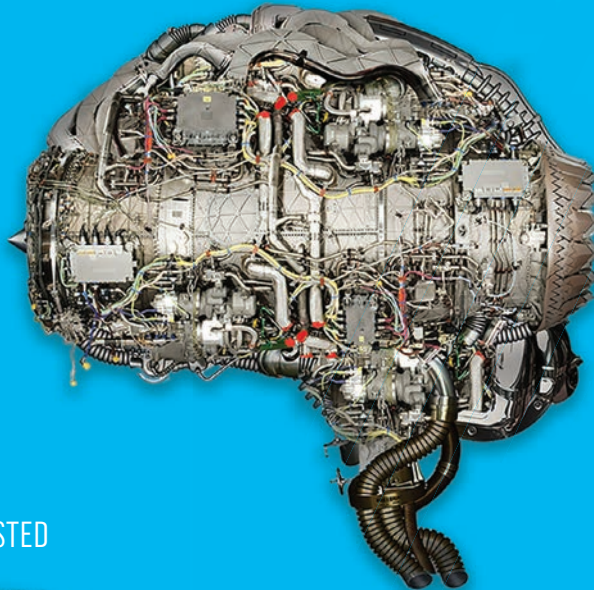
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