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ADAPTING TO ADVERSARY RADAR, ON THE FLY
In late July, the U.S. Air Force announced a test that serves as a stepping stone toward cognitive electronic warfare — a machine learning and AI process that seeks to automate critical processes in countermeasures across a network. During the test, an F-16C *Viper* fighter jet was able to receive a software update with information on improved countermeasures against adversary radar to its electronic warfare system in mid-flight. With a networked architecture and this remote software updating capability, a sensor near the battlefield could detect enemy radar system types and signal friendly aircraft that they need to receive mid-flight software updates in near real-time. According to Air Force Lieutenant Colonel Zachary Probst, "we believe this is the first time a fighter aircraft has received a software update and gained new capability all while in flight... This is a big deal. There's a tactical need to be able to rapidly update software, especially mission data files because that's what ties into our ability to identify, find, and defend ourselves against enemy threat systems." (*The Drive*, August 2, 2021)

NEW TESTING FOR AIRBORNE DIRECTED ENERGY WEAPONS
The Pentagon is once again attempting to incorporate directed energy (DE) weapons into fighter aircraft, and the U.S. Air Force may have come up with a way to move forward on the technology. Assembling these laser systems into a small package, with sensitive advanced optics capable of sustaining G forces, is a serious technical challenge. To help reduce testing cost and time, the Air Force has built a "four-foot transonic wind tunnel (4T)" that can be paired with a 1:4 scale F-15 fighter and used to simulate speeds of Mach 2 and altitudes up to 98,000 ft (above sea level). The tunnel will help better assess how the DE system handles shockwaves and beam performance during target engagement. The hope is that any gains that can be realized with the scale models can rapidly be scaled up for real world testing and deployment. (*The Drive*, August 3, 2021)

NEXT UP: SOLAR POWERED DRONES?
The U.S. military has been hard at work on keeping aircrafts in flight for increasingly longer durations of time through a variety innovative methods (see *Defense Technology Monitor no. 34*). Currently, the U.S. Navy operates MQ-9A "Reaper" drones that remain aloft for approximately 27 hours, but the hope is to significantly improve that dwell time (to between 30-90 days) by employing a drone propelled by solar power. Aerospace company Skydweller has received a $5 million grant to develop a sun-powered concept vehicle, which has reportedly already achieved multiple flights and is progressing toward autonomous flight. The unnamed craft is said to be outfitted with solar panels on each wing, capable of hosting an 800lb payload, and will be able to provide surveillance, intelligence, reconnaissance, along with national disaster support. (*Slash Gear*, August 10, 2021)

3D PRINTED SMART ARMOR
Body armor continues to evolve as new enhancements are made in 3D printing processes and new material structures are designed (See *Defense Technology Monitors* nos. 50 and 56 for previous innovations). In the latest such innovation, scientists at Singapore's Nanyang Technological University (NTU) and Caltech have developed a technique to 3D print a modern day chainmail — a wearable material using nylon plastic polymers that transforms from a flexible cloth to a hardened material capable of guarding against an impact. A more visual example is "Batman's cape in the 2005 movie *Batman Begins*, which is generally flexible but can be made rigid at will when the caped crusader needs it as a glider," explains *Science Daily*. The material particles switch from being soft to hard through a "jamming transition," which uses a vacuum pressure to stiffen and increase rigidity by a factor of 25. For military applications, researchers say the material could be created using aramid fibers (Kevlar) and they can attempt to enhance the stiffening process by using magnetism, electricity, or temperature changes. (*Science Daily*, August 11, 2021)

OPTIMIZING HIGH SPEED DRONE FLIGHT

There has been ample data highlighting the impressive autonomy of drones, but researchers at MIT are pushing the envelope to help drones fly more nimbly at high speeds. As drones increase their velocity, flight instability increases, leading to crashes. However, a new algorithm that combines computer simulations with real world testing has resulted in drones flying 20 percent faster through obstacle courses. According to Gilhyun Ryou, an MIT graduate researcher, "when you're flying fast, it's hard to estimate where you are. There could be delays in sending a signal to a motor, or a sudden voltage drop which could cause other dynamics problems. These effects can't be modeled with traditional planning approaches." Drones utilizing the algorithm are able to anticipate when to slow down around certain turns, because they have a better understanding of aerodynamics effects during flight. The research, which was partially paid for by the Office of Naval Research, has military applications for surveillance and rescue missions. (*MIT News*, August 10, 2021)
