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Federal Department of Defence, **Civil Protection and Sport DDPS** armasuisse Science and Technology

Deftech Scan

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https://deftech.ch/scans







Dear Reader,

We do hope that not only "the summer is magic" but that "your summer is magic"!

For the ones who have been reading the deftech scans from the beginning, you have experienced different formats. It has been 3 years already that we changed from a pure "technology-only scan" to the present version which tries to capture not only advances in technology, but also the context in which this happens, and the changes these advances enable.

3 years and 15 reports down the road, it is for sure a good time to ask how we could do this "newsletter" more attractive and more insightful to YOU!

It will take you only 2 min to answer our small survey; this is not much to trigger some changes that will benefit you and the deftech community!

https://fr.surveymonkey.com/r/X7H7NPJ

Thank you very much in advance!

We wish you a nice reading.

Foresightly Yours,

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Introduction and Executive Summary

This DEFTECH SCAN reports on and assesses occurrences in military technology and capability development taking place from mid-May to mid-July. It contains reporting on recent military, security, and industry activities and announcements in Australia, the United Kingdom, the United States, Japan, Finland, Russia, Ukraine, China, Germany, and NATO. Key insights and themes from the reporting period include:

Conflict as a Test Bed: The report also includes three stories on new Israeli technologies or capabilities, all of which are related in some way to either the 2021 or 2006 conflict in Gaza. Much like Russia's efforts to test weapons in Syria—Defence Minister Sergei Shoigu acknowledged that the Ministry of Defence trialled 320 weapons systems in Syria in July¹—these conflicts, regardless of one's perception of their political justification, have served as useful test for new technologies and operational concepts and for better understanding of possible future vulnerabilities.

National Security Strategies Released; Stress Environment, Covid-19, and Societal Resilience: On 2 July, President Vladimir Putin approved the first Russian national security strategy since 2015. The document is largely focused on the importance of societal resilience in the face of mounting information operations and cyber threats. But commentary about the paper² also notes that its emphasis on the environment and need to adapt to climate change.³ The intersection between climate change and national security was also a prominent theme of the annual *Defense of Japan* white paper released on 13 July, which observes that "the impacts of climate change can threaten the stability of vulnerable nations." The paper also underscores the need for resilience in several aspects of the Self-Defence Force's mission: in responding to natural disasters, protecting the cyber domain from China, Russia, and North Korea, and in supporting Covid-19 pandemic response.⁴

Industry: While not explicitly covered in this report, *Defense News* released its annual Top 100 biggest defence industry companies based on the defence revenues these companies reported for 2020⁵. Some observations:

- 1. **The United States still at the top:** The top five spots on the list were occupied by US-based defence contractors: Lockheed Martin (\$62.6 billion), Raytheon Technologies (\$42 billion), Boeing (\$32.4 billion in defence revenue), Northrop Grumman (\$31.4 billion), and General Dynamics (\$29.8 billion).
- 2. China's defence industry moving up the list: Seven of the top 20 companies listed were Chinese state-owned enterprises, including three of the top 10, reflecting China's intensifying military modernisation effort, the on-going consolidation efforts in China's traditional defence industrial base as well as steady exports. China's seven in the top 20 was second only to the US' eight companies in the top 20.
- 3. Consolidation: The list also reflects the impact of broader trends toward consolidation across the global defence industry with two of the top 10 companies listed as being "new" to the list due to recent mergers and acquisition. Raytheon Technologies, which resulted from the merger of Raytheon Corporation (5th in 2020) and United Technologies Corporation (10th) was listed as the second largest defence contractor while China State Shipbuilding Corporation Limited (10th on this year's list was formed by the merger of two Chinese state-owned enterprises China Shipbuilding Industry Corporation (14th in 2020) and China State Shipbuilding Corporation Ltd (24th in 2020). In addition, the Edge Group, the United Arab Emirates recently formed defence conglomerate, made its first appearance on the list in a tie for 23rd.

¹ "Over 320 types of weapons tested in operation in Syria—Russia's defense minister", *TASS*, 14 July, <u>Over 320 types of weapons</u> tested in operation in Syria — Russia's defense minister - Military & Defense - TASS

 $^{^{2}}$ The paper was released in Russian, and the author has been unable to locate a reliable English translation. As a result, analysis of the paper's content is taken from a cross-section of English-language commentary about the strategy

³ Dmitry Trenin, "Russia's National Security Strategy: A Manifesto for a New Era", *Carnegie Moscow Center*, 6 July 2021, <u>Russia's National Security Strategy: A Manifesto for a New Era - Carnegie Moscow Center - Carnegie Endowment for International Peace</u> ⁴ Defense of Japan 2021, English language pamphlet, 14 July 2021, 防衛2021_別冊_EN.indb (mod.go.jp)

⁵ "Top 100 for 2021", Defense News, <u>The list is here: Find out how global defense companies performed in FY20 (defensenews.com)</u>





Energy, Power, and Design

Key Insights:

- Scaling materials science: Research on new materials by academic and applied research institutions could help shape design and manufacture of aerospace and defence platforms and systems over the next decade. The discovery of a zero thermal expansion material by a team in Australia shows some of the progress being made in materials science. The nature of the component elements also hints at the main challenges associated with actually incorporating these materials into platforms: scaling production of sensitive, costly, and rare materials and their components.
- The revolution will not be televised—it will be available in virtual / augmented reality, though: The digital design, manufacturing, and services revolution is proceeding (in some places slowly, in others more rapidly) as the advantages in development and certification time, design flexibility, and cost are more fully recognized. The technologies core to the factory floor of the future—sensors, the I-o-T, cloud enablement, 5G connectivity, machine learning and computer vision, and virtual / augmented reality, open architecture, and additive manufacturing—are all part of a connected continuum that can drive more efficiency when they operate together.

Zero Thermal Expansion Material Discovered, May Need to Invent a Better Name: A "basic rule" ⁶ of chemistry and physics is that when materials are heated, they tend to expand.

However, researchers at the University at New South Wales (UNSW) in Australia have invented a material that does not change size when it experiences extreme temperature changes. The "zero thermal expansion" material known as orthorhombic $Sc_{1.5}Al_{0.5}W_3O_{12}$ combines scandium, aluminium, tungsten, and oxygen bonded together in a crystalline structure. The UNSW team tested the materials at temperatures ranging from 4 to 1,400 Kelvin (-269 to 1,216 Celsius and -452 to 2,059 Fahrenheit).⁷

The implications for aerospace and space—where materials and components are exposed to extreme cold in space and extreme heat at launch or re-entry—could be significant. Reporting from *New Atlas* relays how the SR-71 Blackbird was designed to expand so much at its Mach 3.4 top speed that it would "liberally drizzle fuel on the runway at ground temperatures"⁸ and that "the fuel tanks wouldn't even fully seal until they heated up." The new material could also affect the design of hypersonic vehicles, potentially offering a solution to material integrity at hypersonic speeds, one of the main challenges associated with hypersonic flight.

Crucially, production of the new material could be scalable given that aluminium, tungsten, and oxygen are widely available. Team member Neeraj Sharma believes that even the challenge of sourcing the more expensive and rarer scandium could be overcome through experimentation "with other elements that might be substituted, and the stability retained."⁹

The Digital Engineering Tempest and the Factory Floor of the Future: The United Kingdom's Tempest sixth generation fighter program is prominently incorporating digital design and engineering processes as well as additive manufacturing and open architectures as part of efforts to de-risk technology, reduce costs and timelines associated with development and production, and to create a flexible, upgradable, affordable, and exportable aircraft, according to reporting from *Aviation Week* in June.¹⁰

⁶ Ellen Phiddian, "Material with zero thermal expansion", *Cosmos*, 15 June 2021, <u>Material with zero thermal expansion - Cosmos</u> <u>Magazine</u>

⁷ Loz Blain, "Extraordinary new material shows zero heat expansion from 4 to 1,400 K", *New Atlas*, 11 June 2021, <u>Extraordinary new material shows zero heat expansion from 4 to 1,400 K (newatlas.com)</u>

⁸ Ibid.

⁹ Ibid.

¹⁰ Tony Osborne, "Radical Digital Approach To Cut Cost From Tempest Development", Aviation Week, 9 June 2021, <u>Radical Digital Approach To Cut Cost From Tempest Development | Aviation Week Network</u>





The *Aviation Week* article provides insight into how Tempest partners BAE Systems, Leonardo, MBDA, and Rolls Royce are incorporating a "wholly digital approach" that uses digital platforms to expedite qualification and certification.

Developing and testing subsystems and integrating them into a given platform is now being synthetically modelled in a digital environment before parts are produced allowing engineers to try multiple configurations and understand how subsystems work together or what possible unexpected challenges emerge from their interactions. As Michael Christie, BAE Systems' head of Future Combat Air Systems (FCAS), told *Aviation Week* "you don't need to take everything into the air" to effectively test it.¹¹



Figure 1: The future of design and manufacturing is increasingly relying on novel technologies. These technologies are being understood part of an interconnected process through which data and information is collected, stored, transmitted, processed, and visualized in the virtual world to make real-world development and manufacturing more efficient. Source: Tate Nurkin, 13 July 2021 "Future of Warfare" briefing at Center for Strategic and Budgetary Assessments (CSBA), Washington, DC

The impacts of digital engineering are being amplified by the incorporation of open architecture software and other advanced and emerging technologies that enable low-cost production of small numbers of parts.

The use of virtual and augmented reality to help train and support factory floor workers and allow them to visualize complex systems is also an important component of the digital transformation of the factory floor. Again, according to Christie, "we see the future a bit like synthetic training for a pilot. We would like to get to a point where the first time an operator actually picks up the tools, they have already been able to rehearse that."¹²

The use of digital design,

manufacturing, and services is not limited to the Tempest program. Previous DEFTECH Scans have highlighted U.S. Air Force use to produce an experimental aircraft in the real world within twelve months, though questions remain about what was achieved in that timeframe.

However, interest in digital design and manufacturing is increasing. Covid-19 and the resulting reliance on remote working environments and digital technologies has helped to drive some of this heightened interest. Airbus Helicopter CEO Bruno Even highlighted the trend in June, saying that "digital was a trend that was there before the crisis. The pandemic has reinforced that", though he also added that it will be process of incorporating digital engineering and manufacturing across the company's product lines that could take up to five years.¹³

¹¹ Tony Osborne, "Radical Digital Approach To Cut Cost From Tempest Development", Aviation Week, 9 June 2021, <u>Radical Digital Approach To Cut Cost From Tempest Development | Aviation Week Network</u>
¹² Thid

¹³ Tony Osborne, "Airbus Helicopters CEO Discusses Digital Transformation", *Aviation Week*, 18 June 2021, <u>Airbus Helicopters</u> CEO Discusses Digital Transformation | Aviation Week Network





Human Performance Enhancement and Protection

Key Insights:

- The invisibility cloak jumps from Middle Earth to actual Earth: An Israeli company has developed a new camouflage system that makes it difficult to see personnel and also hides their thermal signature. The catalyst for the development of the system was one of the inventors' experience in the 2006 Israel-Hamas conflict in which he believed the Israeli Defense Forces had insufficient deception and counter-detection capabilities.
- **People are our most important assets:** Defence communities around the world are enhancing their focus on human capital as capabilities become more reliant on technology rather than manpower. The ability to recruit, retain, and train the right mix of human capital to effectively operate new technologies and the capabilities they enable has become a priority. The focus on human capital is also a response in some countries, such as Japan, that face deleterious demographic trends like low birth rates and an ageing population. Getting the most out of military personnel is essential to the operational efficacy of these forces, a point made repeatedly throughout *The Defense of Japan 2021* white paper released in July.

Now You See Me, Now You Don't: The Invisibility Cloak Breaks Cover: Israeli company Polaris Solutions have unveiled a new camouflage system known as Kit 300 in conjunction with the Israeli Ministry



Figure 2: TOP: An image of the Kit 300 in action, concealing a soldier holding binoculars on the left of the photo. Source: Maya Margit via the Jerusalem Post. BOTTOM: Another image of the Kit 300. Source: Informative YouTube channel Israeli camouflage tech makes soldiers 'invisible'

of Defence. *Janes* originally reported on Kit 300 in December of 2020.¹⁴ The kit received considerable attention from various global media outlets in mid- and late-June.

The Kit 300 is made of thermal visual concealment material that combines metals, microfibres, and polymers to reduce both the thermal and visual detection of military personnel.

Gal Harari, head of detectors and imaging technology with the Israeli Ministry of Defence, described the material as being so effective that "someone staring at [soldiers] with binoculars from afar will not see soldiers."¹⁵

The sheet weighs around 500 grams (a little over 1 pound) and can be folded up into a compact bundle. It is envisioned as supporting a wide-range of missions,

including counter-surveillance.¹⁶

Polaris co-founder Assaf Picciotto said that the vision for the Kit 300 stemmed from his experiences in the 2006 Lebanon War in which, in Picciotto's view, there "were big gaps in the survivability parts" for the Israeli

¹⁴ Yaakov Lappin, "New Isaraeli camouglage sheet unveiled", *Janes Defence Weekly*, 15 December, 2020, <u>New Israeli camouflage sheet</u> <u>unveiled (janes.com)</u>

¹⁵ Ibid

¹⁶ Kyle Mizokami, "Israel found a way to make soldiers invisible", *Popular Mechanics*, 30 June 2021, <u>Israel Figured Out a Way to Make</u> <u>Soldiers Invisible (popularmechanics.com)</u>





Defence Force during that conflict.¹⁷ The MoD is reportedly planning to procure an unspecified number of the systems. Polaris is also working with special operations forces in the United States and Canada.¹⁸

"The Defense of Japan 2021": The Importance of Human Capital and Covid-19 Response: On 13 July, Japan released its annual Defense of Japan white paper along with an English language summary. The paper provides a detailed Ministry of Defence (MoD) assessment of the current and emerging security environment facing Japan as well as a review of important Japanese Self-Defence Force (JSDF) priorities, activities, capabilities, and missions.

The report contains many important, even provocative, insights, such as an atypically candid reference to the relevance of Taiwan's sovereignty to Japan's security and deteriorating balance of military forces between

China and Taiwan.¹⁹ Much of the on-line discussion of *The Defense* of Japan 2021, though, has centred on the report's cover art, which clearly signals a more aggressive posture for Japan in the face of China's increased assertiveness in the region (see Figure 3).

The English language summary of the report also provides insight into Japan's human capital concerns and its efforts to maximize and protect its



Figure 3: The 2020 (left) and 2021 (right) covers of the Defense of Japan white paper. Source: Japan Ministry of Defence

investments in its military personnel in light of what the paper refers to as "a shrinking and ageing population."²⁰

Among a list of "Core Elements Comprising Defense Capability" is the category of "Enhancement of Human Resource Base and Medical Function",²¹ which entails the JSDF seeking to reinforce its human resource base through active recruitment and more effectively employing the human resources they do possess in order "to handle increasingly sophisticated defense equipment." Interestingly, the document calls out the need to "promote automation and manpower savings that leverage technological innovations such as artificial intelligence" as well as efforts to increase gender diversity and improve mental health resources available to JSDF members.²²

The white paper also stresses the need to improve the medical functions of the force, including continuing to serve as an important resource in the government's on-going efforts to manage the Covid-19 pandemic. For example, from February 2020 through 31 March 2021, JSDF hospitals have treated 1,708 Covid-19 patients and the JSDF has opened large scale vaccination centres in Tokyo and Osaka on 24 May 2021.²³

¹⁷ Ibid.

¹⁸ Ibid.

¹⁹ Mike Yeo, "Japan's new defense whitepaper issues warnings over Taiwan's security, climate change", *Defense News*, 13 July 2021, Japan's new defense whitepaper issues warnings over Taiwan's security, climate change (defensenews.com)

²⁰ Defense of Japan 2021, English language pamphlet, 14 July 2021, <u>防衛2021 別冊 EN.indb (mod.go.jp)</u>

²¹ Ibid.

²² Ibid.

²³ Ibid.



Cyber and C4ISTAR



Key Insights:

• The importance of cyber / C4ISTAR: Most DEFTECH Scans have particular an emphasis on one of the six chapters / capability categories. This is not always intentional. More often it is indicative of the nature of the activity taking place during the reporting period. For this July 2021 report, the primary emphasis is on activities related to cyber security and C4ISTAR. In addition to the four stories included in this section, a majority of the "cutting room floor" material not included in this report was related to this domain, including the use of an AI tool in a UK / NATO military exercise, efforts to hold China responsible for cyber theft of data, and new ways to spot deepfakes. The pace of developments in the cyber / C4ISTAR category is accelerating with, as each of the stories included below hopefully reveal, real implications for economic, strategic, and societal stability both within individual countries and internationally.

Watch This Space: SpaceX Launch and Experiments of Novel Technologies in Space: On 30 June, SpaceX's Transporter -2 rideshare mission successful launched from Cape Canaveral, Florida one day after the mission had been scrubbed 12 seconds before launch due to an unauthorized aircraft entering restricted airspace.²⁴

Transporter-2 carried 88 separate payloads into space for government, commercial, and international customers. The Falcon 9 launch vehicle used during the launch—booster B1060—was conducting its eighth

flight and had been in service for one year, having first launched on 30 June 2020. After carrying Transporter-2 into space, the booster then returned to the SpaceX landing zone at Cape Canaveral. It was the first SpaceX return to launch site (RTLS) landing since December 2020.²⁵

The mission—which was the 20th orbital launch of a Falcon 9 rocket in 2021 and the 35th launch over the last 12 months—was notable in part due to the continued successful demonstration of reusable launch vehicles and SpaceX's rideshare program in which multiple customers defray the costs of launching payloads into orbit.



Figure 1: Top: The SpaceX Transporter-2 rocket lifts off from Cape Canaveral, FL on 30 June 2021. Bottom: The published payload manifest for the Transporter-2 rideshare mission. Source: <u>NASA</u>

The nature of several of the payloads added to the launch's significance for defence and security communities. The US Department of Defense's Space Development Agency (SDA) had five satellites on board Transporter -2, including two pairs of small satellites involved in separate demonstrations of free space laser communications between satellites, also known as optical intersatellite links (OISLs)

General Atomics' Laser Interconnect Networking Communications System (LINCS) uses two satellites equipped with optical terminals that will test in-space communications and also attempt to demonstrate space-to-air optical links between a satellite and specifically developed optical communications pod on an MQ-9 Reaper uncrewed aerial vehicle.²⁶

²⁴ The author attended the 29 June scrubbed launch

²⁵ Danny Lentz, "SpaceX successfully launches Transporter-2 mission with 88 satellites", NASA, 30 June 2021, <u>SpaceX successfully launches Transporter 2 mission with 88 satellites - NASASpaceFlight.com</u>

²⁶ Sandra Erwin, "Space Development Agency celebrates launch of its first satellites", *SpaceNews*, 30 June 2021, <u>Space Development</u> <u>Agency celebrates launch of its first satellites - SpaceNews</u>





SDA is also working with the US Defense Advanced research Projects Agency (DARPA), SA Photonics, and the US Air Force Research Lab (AFRL) on the Mandrake-2 mission, in which two satellites will test the

Organizing for Space: Germany Establishes Military Space Command

The German military announced the creation of a separate space command on 13 July during a ceremony at the Space Situational Awareness Centre in Uedem. As reported in *Defense News*, the ministry also released a statement saying that the establishment of the command was in response "to the increasing significance of space for our state's ability to function, the prosperity of our population, and the increasing dependency of the armed forces on space-supported data, services, and products."

The focus of the command will be on protecting German's space infrastructure and providing space situational awareness (i.e., tracking space traffic and space debris in order to avoid collisions).

With the announcement, Germany joins a growing list of nations seeking to organize around space operations, including the United States, Japan, India, and China, among others.

Sources: German Bundeswehr sets up space command center, *Deutsche Welle* and Germany establishes new military space command, *Defense News* pointing, acquisition, and tracking algorithms that allow optical terminals to establish and maintain high-speed communication links.²⁷

Optical communications are central to SDA's future vision of a National Defense Space Architecture that includes hundreds or even thousands of small satellites operating in Low Earth Orbit (LEO) both to track high-end threats such as the launch of hypersonic missiles and to rapidly communicate large amounts of data securely across the architecture and over time from space to the ground. Dr. Derek Tournear, the head of SDA, noted that "SDA is relying on optical communications terminals to get massive amounts of data off of sensors and into warfighters' hands faster than has ever been possible."²⁸ Laser comms also are considered more secure than RF communications.

SDA's fifth payload deployed from Transporter -2 is the Prototype On-orbit Experimental Testbed (POET) designed to demonstrate edge processing in space; that is, the capacity to integrate data from multiple sources on a computer onboard a satellite. POET's software suite was developed by Scientific Systems Company Inc.²⁹

The Revolutionary Material Changing Satellite Construction? Plywood: The European Space Agency (ESA) certified for flight the plywood WISA Woodsat satellite developed by Finland-based Arctic Astronautics, Ltd on 9 July. Satellite development

was sponsored in part by Finnish forester UPM, which released a press statement celebrating that "the world's first wooden satellite is now certified fro a rocket ride and the final pre-launch phase can begin."³⁰ WISA Woodsat is expected to launch into space from New Zealand before the end of the year.

Plywood constructed satellites will be useful in mitigating the challenges associated with space debris that will grow more pronounced as both government and commercial entities place hundreds of small satellites into LEO (and beyond) in coming years.

Satellites with a birch and plywood outer shell construction will burn up after losing power and falling back to earth rather than staying on orbit in an increasingly crowded space environment or leaving environmentally damaging particles in the Earth's upper atmosphere as they reenter the atmosphere. According to Takao Doi, a professor at Kyoto University, which is also pursuing its own wooden satellite: "We are very concerned with the fact that all the satellites which re-enter the Earth's atmosphere burn and create tiny alumina particles

²⁷ Ibid.

²⁸ Ibid.

²⁹ Ibid.

³⁰ Tara Copp, "Plywood Satellite Cleared for Space Launch", *Defense One*, 14 July 2021, <u>Plywood Satellite Cleared for Space Launch</u> - <u>Defense One</u>





which will float in the upper atmosphere for many years. Eventually it will affect the environment of the Earth."³¹



Figure 2: The 10×10×10 cm WISA Woodsat. Source: WISA via <u>European Space Agency</u>

While most of WISA Woodsat is made of burch and plywood, its edges and camera boom are built out of 3D-printed light metal plates. The panels under the wood will be constructed of small electronic boards. These components are also expected to burn up upon reentry into the Earth's atmosphere leaving minimaltal trace. ³²

One challenge associated with the system is that at altitudes of up to 600 kilometers, the plywood will be hit with hihly corrosive atomic oxygen that can damage the surface of the satellite. The plywood will release vapors in a process known as outgassing that could affect the performance of the satellite's instruments. Riccardo Rampini, head of ESA's Materials' Physics and Chemistry section, noted that as a result the life expectancy of the satellite will be relatively short: "The first couple of months will be the most interesting months for

the outgassing because this is where you have the highest peak. If it survives two years, that would be good."³³

Japanese firm Sumitomo Forestry is also reportedly working with Kyoto University to develop and launch a wooden satellite into space, though the investment of UPM and ESA seems to have pushed Arctic Astronauts' offering ahead in terms of being the first to actually launch. *Nikkei Asia Review* reported in December that the Kyoto – Sumitomo wood satellite will be launched by 2023.³⁴

Isn't it Ironic? Russia's National Security Strategy Bemoans Efforts to Undermine Societal Cohesion: On 2 July, Russian President Vladimir Putin approved a new national security strategy. It was the first release of a national security strategy since 2015.

Commentary on the new strategy has focused on the strong emphasis it places on information security, domestic cohesion, and protecting "traditional Russian values" from an on-going assault by Western nations trying to undermine Russian domestic stability.

Dmitri Trenin of the Carnegie Moscow Center assessed "the central feature of the strategy is its focus on Russia itself: its demographics, its political stability and sovereignty, national accord and harmony, economic development on the bases of new technologies, protection of the environment and adaptation to climate change and—last but not least—the nation's spirtual and moral climate."³⁵

Trenin also believes the new strategy constitutes a "manifesto for a new era", one in which the Russian government sees Western hegemony as being in terminal, but prolonged and dangerous, decline. In the view of the strategy, "Russia's traditional values and historical legacy are under attack; in domestic politics, Russia has to deal with foreign machinations aimed at provoking long-term instability in the country."³⁶

For many commentators, the new national security strategy offers a clear articulation of a long-standing perception among Russia's leadership of being victimized by the West in myriad ways, epsecially via

³¹ Justin Harper, "Japan developing wooden satellites to cut space junk", *BBC News*, 29 December 2020, <u>Japan developing wooden</u> <u>satellites to cut space junk - BBC News</u>

³² Tara Copp, "Plywood Satellite Cleared for Space Launch", *Defense One*, 14 July 2021, <u>Plywood Satellite Cleared for Space Launch</u> - <u>Defense One</u>

³³ Ibid.

³⁴ Hiroyasu Oda, "World's first wooden satellite to be launched by Japan in 2023", *Nikkei Asian Review,* 24 December 2020, <u>World's first wooden satellite to be launched by Japan in 2023 - Nikkei Asia</u>

³⁵ Dmitry Trenin, "Russia's National Security Strategy: A Manifesto for a New Era", *Carnegie Moscow Center*, 6 July 2021, <u>Russia's National Security Strategy: A Manifesto for a New Era - Carnegie Moscow Center - Carnegie Endowment for International Peace</u> ³⁶ Ibid.





information operations, misinformation, and cyber attacks. As Samuel Bendett, an advisor at CNA Corporation in Washington, DC told *Defense One*, "Russia sees itself as a target of persistent and ongoing information operations by the West against Russian Federation targets like the military and security organizations along with crtical infrastructure. This new national security strategy officially elevates these information and cyber threats to the level of an existential challenge to Russia's long-term survival."³⁷

Some Western observers also see a certain degree of irony in Russia's emphasis on inbound threats to Russian societal cohesion, given the role cyber and information operations have played in Russia's own hybrid warfare campaigns in Crimea and Ukraine and in both documented and alleged efforts to undermine the polities, societies, and economies of many Western states.

An indicative example of the perception of Russian activities is seen in a March 2021 US National Intelligence Council report on foreign efforts to interfere in the 2020 US Presidential election that assessed, "President Putin and the Russisan state authorized and conducted influence operations against the 2020 presidential election aimed at . . . undermining public confidence in the electoral process, and exacerbating sociopolitical divisions in the US."³⁸

In addition, only six days after the release of Russia's new national security strategy, Ukraine's defence ministry announced that hackers linked to the Russian government had attacked the website of the Ukraininan Naval Forces and published fake reports about the international Sea Breeze-2021 military exercise taking place in the Black Sea.³⁹ In March, Ukraine's State Security Service (SBU) announced it had prevented a large scale cyber attack designed to steal large amounts of classified government data.⁴⁰

Regardless, Russia's new national security strategy offers useful insight into the world-view of Russia's leadership and the nature of their concerns about the future of Russia's domestic stability, security, and values. It also offers one more data point demonstrating how activity in the cyber and information domains combined with geopolitical competition is for many countries raising awareness of domestic vulnerabilities and generating a pressing need for these states to developp new ways of building and maintaing societal and political resilience that can withstand frequent, directed, and clever cyber and information operations.

More Black Sea Drama: NATO Ships Spoofed:⁴¹ Tracking data of two NATO ships operating in the Black Sea was spoofed to indicate that they were within two nautical miles of the Russian Black Sea fleet headquarters at Sevastopol in Crimea on 18 June. At the time, both ships--the UK Royal Navy's HMS *Defender* and the Royal Netherlands HNLMS *Eversten*—were actually 180 miles away in the port of Odessa, Ukraine.

The automatic identification system (AIS) signals for both ships were faked to show them sailing directly toward Sevastopol even though webcams from Odessa that are broadcast on YouTube by *Odessa Online* show the ships in port in Odessa, as do other third-party websites.

There is no formal indication of who was responsible for the faked data or what the intent might have been. But for scenario planners and fiction writers, the incident also demonstrates one more creative means for state or non-state actors to instigate a crisis, conflict, or military contingency or create "facts" to support a specific narrative of provocation or sovereignty.

³⁷ Patrick Tucker, "Information Warfare Looms Larger in Russia's New Security Strategy", *Defense One*, 13 July 2021, <u>Information</u> <u>Warfare Looms Larger in Russia's New Security Strategy - Defense One</u>

³⁸ US National Security Council, "Foreign Threats to the 2020 US Federal Elections", 10 March 2021, <u>ICA-declass-16MAR21.pdf</u> (dni.gov)

³⁹ "Ukraine says Russian hackers hit its Navy website", *Reuters*, 9 July 2021, <u>Ukraine says Russian hackers hit its Navy website</u> <u>Reuters</u>

⁴⁰ "Ukraine accuses Russian hackers of new cyber attacks", *Reuters*, 16 March 2021, <u>Ukraine accuses Russian hackers of new cyber</u> <u>attack | Reuters</u>

⁴¹ HI Sutton, "Position of Two NATO Ships Were Falsified Near Russian Black Sea Naval Base", USNI News, 21 June 2021, Positions of Two NATO Ships Were Falsified Near Russian Black Sea Naval Base - USNI News





Crewed Platforms

Key Insights:

- **Cats and traps:** Commercial satellite imagery of China's Type-003 aircraft carrier show progress has been made on the third carrier in China's growing fleet. The ship is bigger than the previous two carriers and also will be fitted with a catapult assisted take-off but arrested recovery capability, which should enable the use of heavier planes and payloads.
- A crowded fighter market just got more so: Sukhoi displayed its Checkmate light tactical aircraft at the MAKS air show outside Moscow. The aircraft is designed to be a manoeuvrable, low-observable fighter that appears to be aimed at the export market. The plane's design appears to trade lower speeds for increased manoeuvrability.

"Arresting" Images of China's New Carrier: Information about the People's Liberation Army Navy (PLAN) under construction third carrier was released during the reporting period, further demonstrating the advancing capabilities of China's navy as well as a commitment to protecting its overseas interests and investments.

Commercial satellite imagery from May and June reveals that China has made progress in the construction of its third aircraft carrier—known as the Type-003—since work began at Jiangnan Shipyard in Shanghai in 2018.⁴² The Type 003 will be the largest ship in the PLAN and much larger than the first two aircraft carriers in the Chinese fleet, the Liaoning and Shandong.

These two vessels measured 304.5 meters in length.⁴³ The Type-003 is approximately 320 meters long though its width of 73 or 74 meters, depending on the source, is consistent with the size of the previous two carriers. By way of comparison, the new carrier is smaller than the current US Ford class carriers, which is 333 meters in length, but still constitutes a "super carrier"⁴⁴ of a similar size to the Kitt Hawk-class of carriers that the U.S. Navy operated from the 1960s through the 20000s.⁴⁵

The most notable design and technological advancement of the Type-003 is the employment of a flat flight deck and a catapult assisted take-off but arrested recovery (CATOBAR) system similar to the Electromagnetic Aircraft Launch System (EMALS) used on the Ford-class.

⁴² Matthew Funaiole, Joseph Bermudez Jr, Brian Hart, "China's Third Aircraft Carrier Takes Shape: CSIS", *CSIS*, 16 June 2021, <u>Center for Strategic and International Studies (CSIS)</u>

⁴³ Ibid.

⁴⁴ HI Sutton, "China's New Super Carrier: How It Compares To The US Navy's Ford Class", *Naval News*, 2 July 2021, <u>China's New</u> <u>Super Carrier: How It Compares To The US Navy's Ford Class - Naval News</u>

⁴⁵ Matthew Funaiole, Joseph Bermudez Jr, Brian Hart, "China's Third Aircraft Carrier Takes Shape: CSIS", *CSIS*, 16 June 2021, <u>Center for Strategic and International Studies (CSIS)</u>





Figure 6: Commercial satellite imagery of China's Type-003 aircraft carrier being constructed at Jiangnan Shipyard in Shanghai. Source: <u>Center for Strategic and International Studies (CSIS)</u>



Previous DEFTECH Scans have covered the challenges that the US Navy has experienced with the EMALS systems on the Ford-class carriers, though there is some sense that these issues are being resolved. Analysts at the Center for Strategic and International Studies (CSIS) believe the catapult system constitutes a "major upgrade from the less advanced ski jump-style system used on the Liaoning and Shandong" and will enable the use of aircraft with heavier payloads and more fuel.46

Other features of the Type-003 design include a smaller and more advanced island, leaving more room on the flight deck for planes. It is also expected to be conventionally powered.

Checkmate: Sukhoi MAKS Its Move: The Sukhoi Checkmate light tactical fighter was revealed in the runup to the MAKS air show being held at Zhurkovsky air base just outside Moscow from 20 – 25 July. The

aircraft's appearance at the show was teased by a promotional video posted by Sukhoi parent company Rostec on YouTube on 13 July. The video shows only shadows of the aircraft flying over water and is clearly designed to attract attention from potential export markets in UAE, India, Vietnam, and Argentina.

Some mystery around the aircraft was lessened after images of the uncovered aircraft being set up at the Rostec display at MAKS. While it is unclear whether the aircraft is a non-flying mock-up or flyable demonstration aircraft, analysts from across the internet immediately began discussing key elements of the single engine aircraft's design.



Figure 7: The Sukhoi Checkmate on display before the start of the MAKS show outside of Moscow. Source: ANDREAS RUPPRECHT via <u>Forbes</u>

Much attention has been paid to Checkmate's low-observable design components such as chiselled nose and fuselage, V-shape tail control surfaces, and internal weapons bay. However, the aircraft also includes a chin inlet with "a noticeable underbite", which resembles the Lockheed Martin developed diver-less supersonic inlet (DSI) developed in the 1990s. The inclusion of what could be a DSI may indicate a design trade-off of simplicity and manoeuvrability while sacrificing some speed as DSIs "probably limit a jet's top speed to slower than Mach 2, whereas complex side inlets can produce top speeds exceeding Mach 2."⁴⁷

⁴⁶ Ibid.

⁴⁷ David Axe, "Russia's New Fighter Breaks Cover—Its Got 'Stealth' Written All Over It", *Forbes*, 18 July 2021, <u>Russia's New Fighter</u> <u>Breaks Cover—It's Got 'Stealth' Written All Over It (forbes.com)</u>





Beyond serving as an exportable low-observable fighter, it is unclear whether Russia intends to procure the Checkmate, which is designed as a lighter, more manoeuvrable aircraft. The aircraft is expected to fly in 2023 with production schedule to begin in 2026.⁴⁸

Weapons Systems and Munitions

Key Insights:

- Merging of capabilities and concepts: Militaries around the world are seeking a variety of ways to increase the range, lethality, speed, flexibility, and agility of their strike assets. The result is a blurring of distinctions between previously separate capability areas, such as conventional missiles, loitering munitions, and drone swarms or between artillery and missiles.
- More counter-drone capabilities: The successful demonstration of an airborne high-power laser in a counter-uncrewed aerial system (UAS) role further demonstrates the progress being made in technological approaches to meeting the small UAS challenge. While not covered in this report, several other technological and conceptual approaches to meeting the UAS challenge were also tested, including the use of high-powered microwaves by DARPA to engage drone swarms while Australian company DroneShield reported that it is integrating its DroneSentry-C2 command-and-control system and a miniaturized radar into tethered UASs as part of its c-UAS system.
- Russia testing systems in Syria: As referenced in the Executive Summary, Russian news agency TASS reported in mid-July that Russia has tested more than 320 types of different weapons during the conflict in Syria. Defence Minister Sergei Shoigu also noted that it had learned critical lessons about how to improve Russian systems including developing longer-range helicopter-launched weapons to deal with the MANPADs threat in the region.

Networked Missiles, Loitering Munitions, or Drone Swarms? And Does It Really Matter? The British Ministry of Defence awarded ± 3.5 million (\$4.8 million) to the Defence Science and Technology Lab (DSTL) to develop missile systems capable of communicating with one another as part of the Co-operative Strike Weapons Technology Demonstrator (CSWTD) program.⁴⁹

The programme is designed to upgrade software for the UK's missile systems to enable these systems to respond to in-flight to changes in the operational or tactical environment. Missile systems are largely constrained to flying pre-determined missions that may lose relevance if adversaries take sudden or unexpected countermeasures or the situation on the ground changes while the system is in-flight.

⁴⁸ Gleb Stolyarov, "Putin inspects new Russian fighter jet unveiled at air show", *Reuters*, 20 July 2021, <u>Putin inspects new Russian</u> fighter jet unveiled at air show | <u>Reuters</u>

⁴⁹ £3.5-million investment for smarter missile systems, UK.Gov, 1 July 2021, £3.5-million investment for smarter missile systems - GOV.UK (www.gov.uk)





As a DSTL scientist identified only as Charlie said in a DSTL video: "Currently, missiles can communicate with the launch platform but not each other. The aim of this program is to investigate how inter-missile communication and cooperative behaviours can be technically achieved to solve UK military challenges."⁵⁰



Figure 8: Cooperative missile technology will increase the flexibility and agility of UK forces by allowing them to respond to changing operational and tactical environments. The screen shots above are taken from a DSTL YouTube video describing the cooperative missile program and show how networked missiles strike the initial target and also are able to respond to the introduction of a new threat during flight. Source: <u>DSTL</u>with editing from Tate Nurkin

By adjusting the network to allow missiles to communicate with one another during flight, DSTL seeks to enhance the flexibility and agility of the UK's strike options and, as a result, their effectiveness. Another benefit to the effort to change the network / software is that it allows for a relevant upgrade in capability much faster and at lower cost than developing new high-performance missiles. DSTL anticipates completing the demonstrator in 2023 and, if the program proceeds as anticipated, to field the capability within five years.⁵¹

Shephard Media pointed out in its reporting on the contract that the program is similar to the US AFRL Golden Horde Vanguard program begun in 2019.⁵² Golden Horde is attempting to "integrate datalink radios and collaborative behaviours on inventory weapons systems to demonstrate them on existing weapon systems to demonstrate mission effectiveness of networked collaborative missile systems for warfighters."⁵³

These efforts to create semi-autonomous weapons that can—with human guidance and within the parameters of set rules of engagement—observe and react to adversaries in real-time are another indicator of a broader trend toward the blurring of lines between previously distinct concepts and capabilities as militaries prioritize the need for mass, speed, lethality, and, especially, flexibility, and agility to meet fast-moving threats.

Specifically, the development of networked missile systems appears to blur the line between traditional missile systems and loitering munitions. Certainly, there remain distinctions in how these weapons systems will be deployed. However, the function of both collaborative missiles and loitering munitions is largely the same: increasing the flexibility and agility of militaries to respond to changing environments and engage targets of opportunity. Moreover, the US Air Force overview of the Golden Horde programme refers to "networked collaborative weapons [that] share data, interact, develop, and execute coordinated actions or behaviours"⁵⁴, which is language that could be cut and paste from a description of many types of drone swarms.

⁵⁰ Ibid.

⁵¹ Ibid.

⁵² "UK seeks smarter collaborative missile operations by mid-2020s", *Shephard Media*, 5 July 2021, <u>UK seeks smarter collaborative</u> missile operations by mid-2020s - Shephard Media

⁵³ US Air Force Research Lab, "Golden Horde" description, <u>GOLDEN HORDE – Air Force Research Laboratory</u> (<u>afresearchlab.com</u>)

⁵⁴ Ibid.





Another indication of this blurring of distinction between strike capabilities is seen in on-going US Army efforts to extend the range of its artillery through incorporation of both design and propulsion approaches commonly associated with missiles, such as adding lift surfaces like fins and by exploring the use of ramjet engines to propel a shell once it leaves the barrel. Nick Berg, the project manager for the US Army's Extended Range Artillery Munitions Suite told *Breaking Defense* in late May that "We really have focused on lifting surfaces to increase your glide, but then we've looked at solid fuel ramjets as a post-launch propulsion mechanism to boost you out to extended ranges."⁵⁵

Israeli Airborne Laser Successfully Demonstrated: The Israeli Ministry of Defence announced on 21 June that it had successfully intercepted multiple drones during a test of an airborne high-powered laser weapon. The demonstration was carried out by the Israeli Air Force's "Yanat" missile test unit, Israel's Directorate of Defence Research and Development, and Elbit Systems. The laser system was deployed on a Cessna 208 Caravan.⁵⁶



Figure 9: LEFT: A screen shot from a YouTube video of the demonstration of Israel's use of an airborne laser to interdict a uncrewed aerial system (UAS). The system is seen toward the back of the Cessna 208 Caravan. RIGHT: A screen shot of the laser penetrating the target drone during the Israeli test Source: Israeli Defence Ministry via The Drive

In the recent test held over the Mediterranean Sea, the system shot down drones from within a range of about 1 km. Israel hopes that over the next two years it will be able to deploy a ground-based system with a range of 8-10 km that can intercept rockets, mortar rounds and drones.

Brigadier General Yaniv Rotem, head of military research and development at the Defence Ministry, hailed the test as a major step forward for Israel's air and missile defence capabilities: "The ability to intercept and destroy threats from the air is ground-breaking, Israel is among the first countries to use such capabilities."⁵⁷ The demonstration was an initial test, and the system is not expected to enter service for several years.

Previous DEFTECH SCANS have documented international interest in ground-based and hand-held directed energy systems for the counter-UAS and broader air and missile defence missions. As research into these systems develops, some militaries are also investing in aerial-based laser systems that bring several advantages over ground-based system such as mobility and minimizing distortions of the laser beam by atmospheric interference. Aerial laser systems also offer the ability to hit weak points in drones—for example on top of the system—rather than hardened or protected areas that are frequently located on the bottom of the aircraft.⁵⁸.

⁵⁵ Sydney J. Freedberg Jr, "Ramjet Shells Could Triple Artillery Range", *Breaking Defense*, 24 May 2021, <u>Ramjet Shells Could Triple</u> <u>Artillery Range - Breaking Defense Breaking Defense - Defense industry news, analysis and commentary</u>

⁵⁶Brett Tingley, "Israel Has Shot Down Drones With An Airborne High-Power Laser", *The Drive*, 21 June 2021, <u>Israel Has Shot</u> <u>Down Drones With An Airborne High-Power Laser (thedrive.com)</u>

⁵⁷ Judah Ari Gross, "In Test, Defense Minister Shoots Down Drone With Plane-Mounted Laser", *The Times of Israel*, 21 June 2021, <u>In</u> test, Defense Ministry shoots down drone with plane-mounted laser | The Times of Israel

⁵⁸ Interview with directed energy specialist at the Center for Strategic and Budgetary Assessments, 16 July 2021



Robotics and Uncrewed Systems



Key Insights:

• More firsts renew the need to build trust and evaluate UAS ethics and safety: The reporting period saw two more firsts for the applications of advanced uncrewed aerial systems (UAS), including the deployment in combat of the first ever intelligent and networked drone swarm by Israel in Gaza. The velocity of demand for UASs, in particular, but also uncrewed systems in other domains, is driving innovation and now demonstration of capabilities in a growing variety of missions. As these systems deploy on new missions and in new roles, though, they are underscoring key non-technical issues that will affect the future trajectory of UAS development and deployment: building trust in human-machine teams and the ethics and safety associated with autonomous systems and swarms, even drone swarms that do not launch munitions.

Uncrewed Aerial Refuelling First:⁵⁹ The US Navy and Boeing conducted the service's first ever aerial refuelling performed by an uncrewed tanker on 4 June. The exercise involved a remote-controlled Boeing MQ-25 Stingray test vehicle refuelling a Navy F/A-18E-F Super Hornet.

The MQ-25 is designed to operate from aircraft carriers and is expected to "greatly increase the range and endurance of the future carrier air wing", according to Rear Admiral Brian Corey, the program executive officer for uncrewed aviation and strike weapons. Overall, the test lasted four-and-a-half hours and included several dry connects in which the fighter connected to the UAS' refuelling equipment without any fuel being passed through. The first refuelling took place at 10,000 feet altitude and passed 300 pounds of fuel between the MQ-25 and the Super Hornet. A second refuelling of 25 pounds of fuel took place at 16,000 feet.

The demonstration also revealed one of the most persistent and prominent challenges associated with the efforts to team highly trained humans and technologically advanced machines in operational contexts: establishing trust. Before the first dry connect, the Super Hornet pilot fly within 20 feet of the MQ-25 to take measurements and observe features of the UAS. Dave Bujold, the Boeing MQ-25 program manager, said that the pilot "wanted to see how stable it was to be flying in close proximity to the aircraft. They wanted to observe officially, using their trained eyes, the behaviour of the air refuelling store and the basket. [It is] very important to see stability and [have] confidence that when they approach it, it's not going to hurt them."

Drone Swarms Deployed in Combat, Signalling New Risks: May's DEFTECH Scan reported that the age of lethal autonomous weapons systems (LAWS) had arrived with the United Nations' report detailing the use of Kargu-2 drones to autonomously identify, target, and strike humans in Libya in 2020.

This report details another important first—and certainly not last—in the use of uncrewed systems in combat. In July, several media outlets reported that Israel used AI-enabled drone swarms during the May conflict with Hamas in Gaza "dozens of times."⁶⁰ There is no indication that the Elbit Systems UASs were used to fire munitions. Rather, the systems were used to collect information and monitor Hamas-held territory.⁶¹ When rockets or mortars were fired from the territory, other crewed and uncrewed assets launched attacks against the targeted area.

A commander with the Israeli military identified only as Major "Mem" explained that "after a year of preparation and exercises, the situation came and the aerial detection system is able to find the enemy and destroy it and bring the operational achievement we are looking for." The Major continued by noting that the

⁵⁹ Megan Eckstein, "US Navy, Boeing conduct first-ever aerial refueling with unmanned tanker", *Defense News*, 7 June 2021, <u>US Navy</u>, <u>Boeing conduct first-ever aerial refueling with unmanned tanker (defensenews.com)</u>

⁶⁰ Judah Ari Gross, "In apparent world first, IDF deployed drone swarms in Gaza fighting", *The Times of Israel*, 10 July 2021, <u>In</u> apparent world first, IDF deployed drone swarms in Gaza fighting | <u>The Times of Israel</u>

⁶¹ Zak Kallenborn, "Israel's Drone Swarm Over Gaza Should Worry Everyone", *Defense One*, 7 July 2021, <u>Israel's Drone Swarm Over</u> <u>Gaza Should Worry Everyone - Defense One</u>





Israeli Defence Forces "conducted more than 30 sorties with the drone swarms, which collected precise intelligence and assisted other drones to carry out attacks on the targets."⁶²

Regardless of the specific application of the Israeli swarm, its deployment has kicked off a debate over the ethical and safety issues surrounding the deployments of drone swarms and whether and how governments around the world can work to regulate their use.

Zak Kallenborn, a frequent author on the risks of drone swarms, authored an op-ed in *Defense One* in which he described the development as "a significant new benchmark in drone technology" that should give the world pause and catalyse thinking about how best "to mitigate the risk these weapons create for national defense and global stability."⁶³

The concern around expanded use of networked, autonomous drone swarms is partly that state actors may deploy them in irresponsible or reckless manners or that they could be used to more effectively disseminate chemical and biological weapons. There is also concern that as more militaries (and commercial industry) develops autonomous swarming capabilities, the systems will proliferate to non-state actors who could subsequently use them to overwhelm defences of critical infrastructure nodes such as airports or power plants or could use them to target large groups of people or even to assassinate world leaders. Kallenborn argues that "drone swarms create risks akin to traditional weapons of mass destruction" and that as the size of swarms expand, the degree of human control over these swarms will necessarily diminish.⁶⁴

Whatever one's perspective on either LAWS or drone swarms, reports of their use in combat environments signals the need for more research on the ethical and stability risks these systems pose and how both counter-technologies and, critically, collaboration between militaries / security communities, industry, and academia might help mitigate some of these risks.

⁶² Judah Ari Gross, "In apparent world first, IDF deployed drone swarms in Gaza fighting", *The Times of Israel*, 10 July 2021, In apparent world first, IDF deployed drone swarms in Gaza fighting | The Times of Israel

⁶³ Zak Kallenborn, "Israel's Drone Swarm Over Gaza Should Worry Everyone", *Defense One*, 7 July 2021, <u>Israel's Drone Swarm Over</u> <u>Gaza Should Worry Everyone - Defense One</u>

⁶⁴ Ibid.

https://deftech.ch/