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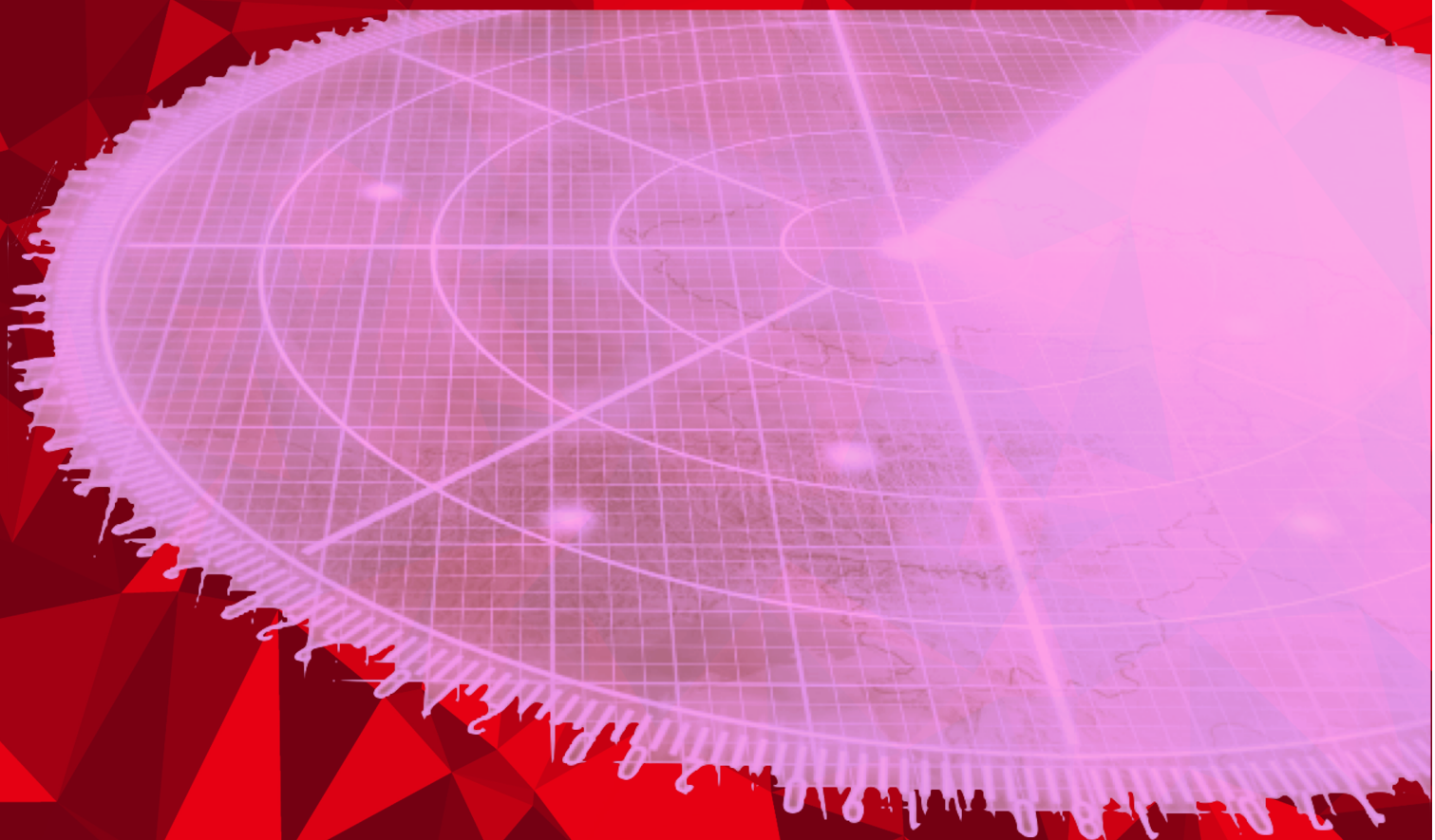
deftech.scan

March 2022



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Dear Reader,

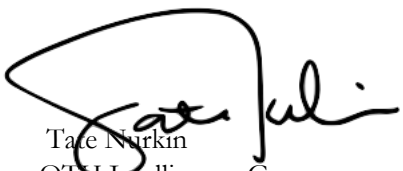
A little bit late for a happy new year, however here we go in 2022!

Better late than never, but so much has been happening that we wanted somehow to cover it all. Thanks to the extensive travelling of Tate, we were able to get unique insights about the latest developments in some key technology areas.

Not entering any geopolitical debate, you will also find some technology-related inputs that could be observed until now during the Ukrainian war. This is not an extensive analysis but in a world in which we take for granted that technology is developing exponentially and will solve everything, we find that reality moves sometimes at a different pace.

We wish you an interesting read.

Foresightly Yours,



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Introduction and Executive Summary

The first deftech.scan of 2022 is released later in the year than planned. It has been an active start to 2022 in terms of the development and demonstration of frequently talked about technologies across the six capability areas, including in technology categories such as quantum computing and directed energy. In addition to the uptick in activity in 2022, the first two-months have also included the author's attendance at the Unmanned Exhibition / Simulation and Training Exhibition 2022 (UMEX / SIMTEX) that was held in Abu Dhabi from 21 – 23 February. And, of course, Russia's 24 February invasion of Ukraine has created a significant amount of potential content for the report as well. But the good news is that the pace and volume of activity to date means that there will be more than ample content to produce the second deftech.scan of 2022 on schedule in late April

This report seeks to balance these three areas of interest and covers events that took place from mid-December through early March. It includes developments related to militaries and security communities in the United States, the United Kingdom, Ukraine, Russia, France, Sweden, Israel, Japan, North Korea, Saudi Arabia, Turkey, and the United Arab Emirates (UAE). Key themes and developments captured in the report include:

The Information War and the Invasion of Ukraine: Many aspects of the Russia-Ukraine conflict have been worthy of inclusion in this report. However, this deftech.scan volume examines the conflict largely through the lens of the offensive – defensive competition that has unfolded in the information domain and the electromagnetic spectrum. These are both domain areas in which Russia has been surprisingly ineffective—at least to date—due to deficiencies in strategy, operational concepts, tactics, and in the quality of equipment deployed in support of the conflict. For example, discipline in tactical communications has been generally lax, opening Russian radio communications to detection, interception, and jamming by even rudimentary Ukrainian communication intelligence equipment.

Directed Energy is Having a Moment: Directed energy weapons have gained considerable momentum in the last year, leading to more ambitious use cases that require more technologically advanced capabilities. Notably, Israel announced during the reporting period that it was seeking to deploy an experimental "laser wall" that would protect the country from the full range of air and missile defence while a US-based company demonstrated the potential of gallium nitride based high-powered microwaves that could be mounted on small drones. These technologies are maturing, but they do not yet constitute a silver bullet technology that will fully abrogate the threat of drone swarms and missile salvos. Directed energy weapons, both high energy lasers and high-powered microwaves, are best conceived over the medium term as an important component of a layered systems of integrated air and missile defence that will also include kinetic intercept capabilities as well as other "left-of-launch" and "just right-of-launch" non-kinetic capabilities.

The Pregnant Threat of Diffusion: This report includes at least two examples of how the diffusion of dual-use technologies is creating novel threats for defence and security communities. While the use of low powered, commercially available lasers against commercial pilots has not yet led to a major crash or other large-scale incident, the number of laser incidents is on the rise. As the number of incidents increases—including against military aircraft as has been detailed in previous deftech.scans—the potential for a grave, if not intended, incident increases as well. Similarly, commercially available drones were used to delay an English Premier League football match during the reporting period. The incident did not cause any harm—beyond 19 minutes of injury time—but, once again, reflects the potential for a more serious, reckless, or intentionally malign use of technologies that are now openly available and easily reconfigurable.

As a result of the prominence of these themes and the author's coverage of the UMEX / SIMTEXT 2022 exhibition this report has a particularly strong focus on **C4ISTAR, Weapons Systems and Munitions**, and **Robotics and Uncrewed Systems** categories of capabilities.

Energy, Power, and Design

Nuclear-Fuelled Propulsion and Space Resilience: Multiple recent deftech.scan volumes have included commentary and reporting on the push by militaries and commercial companies to build resilience in space architectures in and across multiple orbits. The resilience conversation most frequently focuses on building proliferated constellations of small satellite in LEO to complement more expensive, larger, and more vulnerable satellites operating at higher orbits. Proliferated constellations can help ensure redundancy of functions, creating more targets than can be effectively engaged. When combined with affordable rapid reconstitution, proliferated networks and disaggregation of missions can be effective in raising the costs of carrying out either kinetic or non-kinetic attacks against satellites while simultaneously reducing their effectiveness.

The Downside of Proliferated Constellations

In February, the US National Aeronautical and Space Administration (NASA) wrote a letter to the Federal Communications Commission (FCC) expressing concern over Space X proposals to add an additional 30,000 satellites to the 12,000 satellites already planned as part of the company's Starlink communications system.

One problem cited is the increased risk of collision in a suddenly very crowded Low Earth Orbit (LEO). Another concern was that the satellites produce streaks in telescopic images designed to detect space phenomenon and, especially, asteroids that could be potentially dangerous to earth. A report released in January 2022 from the Zwicky Transient Facility documented the high degree of light corruption in images taken since the first Starlink satellites launched in 2019. Over 5,000 images have been affected, especially those capturing the twilight sky around sunrise and sunset.

Source: Tereza Pultarova, "SpaceX's Starlink Satellites Leave Streaks in Asteroid-Hunting Telescope's Images", *Scientific American* and *Space.com,,* 20 January 2022, SpaceX's Starlink Satellites Leave Streaks in Asteroid-Hunting Telescope's Images - Scientific American

Another component of space resilience that was focused on during the reporting period is satellite manoeuvrability. In January, the Mitchell Institute for Aerospace Studies released a policy paper entitled *Maneuver Warfare in Space: The Strategic Mandate for Nuclear Propulsion.* The paper argues that China is already investing in nuclear thermal and electric propulsion for its satellites that enable the transfer between orbits "to conduct offensive and defensive missions" and that the United States should purse a similar course of action. Currently, large US military satellites follow predictable orbits and therefore can be easily targeted.[1]

While nuclear propulsion in space has been explored and even trialed in the past, safety concerns have slowed the progress of research in this area. However, the report points out that nuclear propulsion has several operational advantages over hydrazine, the conventional liquid satellite fuel—including much longer endurance and much higher efficiency.[2]

The report compares the current magnitude of change in the space operations environment to "the time when mechanized armor first showed up on the battlefield in World War I. Old capabilities and ways of carrying out operations that were thought to be central to effective use of military power quickly became outmoded, placing a premium on the development of new technologies and operational concepts. As a result, the authors recommend an embrace of new designs that emphasize rapid maneuver enabled by nuclear thermal or nuclear electric propulsion. Among the report's chief assessments was that space

[1] Christopher Stone, "Maneuver Warfare in Space: The Strategic Mandate for Nuclear Propulsion", Mitchell Institute of Aerospace Studies, Policy Paper, Vol. 33, January 2022, Maneuver_Warfare_in_Space_Policy_Paper_33.pdf (mitchellaerospacepower.org)
[2] Ibid. Also, Patrick Tucker, "The US and China Could Soon Be In Race For Nuclear-Powered Satellites", *Defense One,* January 14, 2022, The US and China Could Soon Be In Race For Nuclear-Powered Satellites - Defense One

nuclear thermal power (SNTP) "will expedite the transition of [the US Department of Defense] space architecture from one dependent on vulnerable satellites locked in predictable orbits to a more dynamic, operationally safe, and survivable force structure."[3]

Human Performance Enhancement and Protection

The Gamification of Training and Growth of the Virtual Training Market: BAE Systems acquired Bohemia Interactive Simulations (BISim), a company that specializes in building high-fidelity training simulations for the military. The two companies entered negotiations on 11 November and the acquisition was finalized for $200 million on 7 March.

A BAE press release projected that the global market for military training and simulation environments and related services is expected to continue growing and surpass $11 billion annually. BISim—which joins BAE as a wholly-owned subsidiary—is among the leaders in applying game-based technology and visualization technologies to military training. They supply these technologies to over 60 countries and have offices in the United States, Australia, the United Kingdom, Slovakia, and the Czech Republic.[4]

The growing focus on virtual training and the gamification of training was on display during the Unmanned Exhibition / Simulation and Training Exhibition 2022 (UMEX / SIMTEX 2022) in Abu Dhabi, which took place between 21 - 23 February.

The author attended the event. Selected examples of the prominent focus on virtual training include the Zen Infantry Weapons Training Simulator, which uses 3D technologies to help improve marksmanship and decision-making in tactical environments. The system resembles a large first-person shooter video game. Also on display were several systems designed to demonstrate the value of virtual reality training to non-military sectors such as firefighters and police.

Figure 1: *The Zen Infantry Tactical Weapons Simulation from India-based Zen Technologies as well as a virtual reality arson investigation tool on display during UMEX / SIMTEXT 2022 in Abu Dhabi. Images: Nurkin*

Pan-COVID Variant Vaccine? Scientists at the Walter Reed Army Institute of Research are working on a vaccine that is effective against COVID-19 and all its variants as well as from previous SARS-origin viruses. The US Army laboratory has been working on the project for nearly two years.[5]

Walter Reed's Spike Ferritin Nanoparticle COVID-19 vaccine (SpFN) completed animal trials in 2021. Ferritin has a unique structure with 24 sides, all of which can have an attachment of a different viral

[3] Christopher Stone, "Maneuver Warfare in Space: The Strategic Mandate for Nuclear Propulsion", Mitchell Institute of Aerospace Studies, Policy Paper, Vol. 33, January 2022, Maneuver_Warfare_in_Space_Policy_Paper_33.pdf (mitchellaerospacepower.org)
[4] "BAE Systems completes acquisition of Bohemia Interactive Simulations", BAE Systems Press Release, BAE Newsroom webpage, 7 March 2022, BAE Systems completes acquisition of Bohemia Interactive Simulations | BAE Systems | United States
[5] Tara Copp, "US Army Creates Single Vaccine Against All COVID & SARS Variants, Researchers Say", *Defense One,* 21 December 2021, US Army Creates Single Vaccine Against All COVID & SARS Variants, Researchers Say - Defense One

protein. By using ferritin in a pan coronavirus vaccine, the nanoparticle can produce an array of varying coronavirus antigens not just from SARS-CoV-2 variants but other coronavirus species and strains.[6]

Dr. Kavon Modjarrad, director of Walter Reed's infectious diseases branch, said that the new vaccine will still need to undergo more extensive and focused human trials. "We need to evaluate it in the real-world setting and try to understand how the vaccine performs in much larger numbers of individuals who have already been vaccinated with something else initially . . .or already been sick", said Modjarrad.[7]

Other institutions working towards creating a universal coronavirus vaccine include the California Institute of Technology, Duke University, University of Washington, Brigham and Women's Hospital in Boston, and the University of Wisconsin, Madison.[8]

Cyber and C4ISTAR

OSINT, Intelligence Releases, and the Information War in Ukraine: The information domain has become a central domain of conflict in the 21st century, a fact that has been repeatedly demonstated over the first two-plus months of 2022.

OSINT and Fighting Back in the Disinformation Competition

In an interview with *Time* magazine, Elliott Higgins, founder of Open-Source Intelligence (OSINT) non-profit Bellingcat, described how the spread and increased acceptance by media outlets of OSINT has begun to effectively refute disinformation efforts, including the false flag efforts exposed by the release of US intelligence in January and February.

According to Higgins, the expanded access to and use of OSINT "have completely shifted the way the information system around it has been shaped. Usually, we'd be running around wondering what Russian disinformation is coming out now. But each piece of disinformation put out is debunked within an hour by the online community, even before its had time to take root."

Certainly, the battle to control narratives has featured prominently both in the lead-up to the Russian invasion of Ukraine as well as the on-going operations taking place in Ukraine. Notably, the Biden Administration's release of select intelligence that thwarted President Putin's efforts to create a false pretext for the invasion.

In January, for example, Pentagon spokesperson John Kirby told reporters that Russia "has pre-positioned a group of operatives to conduct what we call a false-flag operation, an operation designed to look like an attack on them or Russian speaking people in Ukraine as an excuse to go in" to Ukraine.[9]

While the intelligence releases ultiimately did not halt the invasion, they did reduce the fog of the information war by creating clarity about the invented narratives Russia was attempting to use to justify the invasion. This clarity, in conjunction with collaboration among allies and partners on classified intelligence, helped create a more unified front in response to the invasion.[10] US Senator Mark Warner assessed that the strategic intelligence releases did not "only [throw] Putin's plan's slightly off, it's also really helped solidify the NATO alliance."[11]

[6] Hayley Shasteen, "US Army Begins Human Trials of Coronavirus Vaccine", *BioSpace,* 31 January 2022, U.S. Army Begins Human Trials of Pan Coronavirus Vaccine | BioSpace
[7] Tara Copp, "US Army Creates Single Vaccine Against All COVID & SARS Variants, Researchers Say", *Defense One,* 21 December 2021, US Army Creates Single Vaccine Against All COVID & SARS Variants, Researchers Say - Defense One
[8] Hayley Shasteen, "US Army Begins Human Trials of Coronavirus Vaccine", *BioSpace,* 31 January 2022, U.S. Army Begins Human Trials of Pan Coronavirus Vaccine | BioSpace
[9] "Russia-Ukraine: US warns of 'false-flag' operation", *BBC*, 14 January 2022, Russia-Ukraine: US warns of 'false-flag' operation - BBC News
[10] Julian Barnes and David E. Sanger, "Accurate U.S. intelligence did not stop Putin, but it gave Biden big advantages", *The New York Times,* 24 February 2022, Accurate U.S. intelligence did not stop Putin, but it gave Biden big advantages. - The New York Times (nytimes.com)
[11] Ibid.

Swedish Anxiety and Psychological Defence: The information war in Europe did not only focus on Ukraine during the reporting period.

In January, nine, ten, eleven, and twelve-year old children across Sweden reported viewing videos that TikTok was feeding to Swedish children that clained "war is coming" and that Russian forces will bomb their country or even invade. Parents, educators, and children's rights advocates in the country all confirmed that their children had seen the videos and that many had become anxious and scared as a result.[12]

While the makers of the videos are not known, TikTok's algorithms, which are optimized for individualized content feeds, amplified the effects of watching one of these videos by queuing up additional ones for children who had watched one video. Defence analyst Elisabeth Braw observed in *Defense One* that TikTok's algorithms make it "the perfect tool for a country wishing to weaken another country's morale."[13]

The pervasiveness of the information threat, especially coming from Russia, led to Sweden opening the Psychological Defence Agency on 1 January 2022. According to Mikael Damberg, Sweden's Interior Minister, "disinformation is a threat to Swedish democracy, our decision-makers, and to our independence"[14], drawing a bold line under the scale, scope, and impactfulness of the threat posed to free societies by disinformation.

To Remove or Not Remove, that is The Question

The conflict in Ukraine highlighted the complex challenge facing both governments and social media platforms as they calibrate the best means of responding to disinformation campaigns. Certainly, removing content from social media platforms can be an effective step, especially when disinformation places others in imminent danger or is being used to justify conflict. As Graham Brookie, the senior director of the Atlantic Council's DFRLab notes, "in a physical war zone, you have to mitigate online harms that make war worse for humans."

However, there is a cost to taking this information down in other contexts, especially for subsequent efforts to hold the purveyors of disinformation accountable for the harms that their disinformation produces. According to the *Protocol* newsletter, blockchain startup Arweave asked people to collect "whatever they could find related to the emerging conflict and commit it to the blockchain, creating a distributed ledger no platform can touch and no government can censor." In eight days, the team collected 3 million artifacts to "preserve the truth."

Source: *Protocol Source Code* newsletter, 24 February 2022

The initial focus of the agency is to protect the integrity of Sweden's 2022 General Election and "to work to strengthen society's ability to identify and handle misinformation direct at Sweden." Henrik Landerholm, the head of the agency, said that Russia, China, and Iran were three countries known to have launched disinformation campaigns against Sweden in an effort to sow division within society and undermine trust in government and societal institutions.[15]

According to Landerholm, "the first part of the job is threat analysis, the second is assessing the vulnerability of Swedish society to different types of influence, and the third is to build resilience in society."[16]

[12] Elisabeth Braw, "'War Is Coming': Mysterious TikTok Videos Are Scaring Sweden's Children", *Defense One,* January 16, 2022
[13] Ibid.
[14] Richard Orange, "Sweden launches 'Psychological Defence Agency' to counter propaganda from Russia, China and Iran", *The Telegraph*, 4 January 2022
[15] Ibid.
[16] Ibid

Equipment, Encryption, and Discipline: The Multi-Dimensional Failure of Russian Radio Communications in Ukraine:[17] The Royal United Services Institute (RUSI) published a compelling critique of the performance of Russia's communications and other electromagnetic spectrum activity during the invasion of Ukraine entitled "Russian Comms in Ukraine: A World of Hertz."

> "The electromagnetic spectrum, where radio waves reside, is an environment humans cannot appreciate with their own senses. It is invisible, silent, odourless, flavourless and formless. Yet it matters. Commanders and personnel are an army's brain and its strike assets its limbs. Radio communications are its nervous system. Disrupt the nervous system and the brain and limbs communicate with great difficulty or not at all." –
>
> Thomas Withington and Sam Cranny-Evans, "Russian Comms in Ukraine: A World of Hertz"

The authors, electronic warfare expert Thomas Withington and military analyst Sam Cranny-Evans, identified three main challenges to effective Russian radio communications. First, the equipment being used was, for the most part, not high-end radios. While some Russian soldiers have been captured carrying software-defined radios (SDR) such as the R-187P1 Azart and R-168-5UN-2 tactical radios, there is evidence that these radios have not been widely distributed. The authors also reference the possibility that corruption could have hampered the development program, citing reports from last year that Azart's manufacturer and senior military leaders were under investigation for fraud and embezzlement.

According to the authors, "The current operations in Ukraine suggest that Russia does not have as many modern radios in service as it has claimed, and that it may not have adequately considered its communication needs for the range of scale of operations conducted.

The second challenge has been encryption. Because Russian troops have had to rely increasingly on ad hoc means of communication, they have not adequately focused on encryption, opening themselves up to jamming, message interception, and other EW risks by even rudimentary communications intelligence (COMINT) systems. An example was the purported use of a civilian handheld radio, the Chinese BaoFeng UV-82HP, which uses V/UHF wavebands and lacks military grade encryption. Cell phones are also being used because officers have started stationing themselves further away from the fighting, frequently placing them out of range for radio communications.

This last insight points to the third challenge: lax communication dicsipline that has made it even easier for Ukrainians to intercept tactical communications.

Ultimately, the authors conclude that "while Ukranian forces may be numerically inferior on the battlefield, they have an opportunity to be superior in the electromagnetic spectrum."

France Seeks a Quantum Leap for Defence:[18] French cabinet officials launched a national hybrid quantum computing platform on January 4 as part of the nation's quantum technology strategic plan launched by President Emmanuel Macron a year earlier.

An initial €70 million and up to €170 million will be dedicated to the development of the new "hybrid quantum computiing" platform to interconnect traditional systems and quantum computers. Those

[17] Sam Cranny-Evans and Thomas Withington, "Russian Comms in Ukraine: A World of Hertz", Royal United Services Institute, 9 March 2022, Russian Comms in Ukraine: A World of Hertz | Royal United Services Institute (rusi.org)
[18] Vivienne Machi, "Eying military gains, Frances goes big on national quantum technology", *C4ISR.Net,* 5 January 2022, Eying military gains, France goes big on national quantum technology (c4isrnet.com)

quantum-enabled systems will the be avialable for an international community of reseach institutions, start-ups and industry partners to access.

The event included senior government leades, including Minister of Defence Florence Parly who referenced quantum's value in ensuring autonomous navigation and in encryption and breaking cryptographic algrithms as among the leap ahead capabilities that quantum can enable for militaries.

The platform will be managed by France's National Institute for Research in Digital Science and Technology and housed at the country's Alternative Energies and Atomic Energy Commission's (CEA) military-technological focused facilities in Paris, which could attract defence industrial partners used to working with the facility. Parly observed that France needs "to federate a quantum community of start-ups, large groups, scienties and researchers to appropriate these new capabilities, to test their limits in their respective fields of interest and to disseminate the new methods."

Crewed Platforms

Defraying Risk and Increasing Capability in 6th Generation Fighter Development: Japan – UK Collaborate on Future Engines and Sensors: A December 2021 announcement from the UK Ministry of Defence confirmed that the UK has signed a memorandum of cooperation with Japan to develop an engine demonstrator that could be leveraged by the two countries' separate 6th generation fighter programs.

The work will be led by IHI in Japan and Rolls-Royce in the UK and is scheduled to begin in early 2022 following the conclusion of a feasibility study. The UK is spending £30 million on planning, digital designs and innovative manufacturing developments. An additional £200 million is expected to be dedicated to building a full-scale demonstrator power system.[19]

The memorandum brings two main benefits for the UK. Notably, it helps to expand the MoD's interests and defence-based relationships in the Indo-Pacific region, a part of the world in which the UK is attempting to play a more significant role. British Defence Secretary Minister Ben Wallace asserted that "strengthening our partnerships in the Indo-Pacific is a strategic priority, and this commitment with Japan, one of our closest security partners in Asia, is a clear example of that."[20]

[19] UK and Japan to develop future fighter jet engine demonstrator", Press release, UK.gov, 22 December 2021, UK and Japan to develop future fighter jet engine demonstrator - GOV.UK (www.gov.uk)
[20] "UK and Japan to develop future fighter jet engine demonstrator", Press release, UK.gov, 22 December 2021, UK and Japan to develop future fighter jet engine demonstrator - GOV.UK (www.gov.uk)

Table 1: *An overview of UK and Japan 6th generation fighter programs*

Country	Program	Description
United Kingdom	Future Combat Air System Technology Initiative—also known as Tempest	Led by BAE Systems and expected to enter service around 2035 with some related capabilities such as the lightweight affordable novel concept aircraft (LANCA) attritable loyal wingman uncrewed system entering service before then
Japan	F-X	Led by Mitsubishi Heavy Industries designed to replace F-2s beginning in 2035

In addition, the design and manufacture of an engine for a 6th generation fighter is a technological complex task. And, as Wallace, noted, working with allies to help share the financial and technological burden is "vital" as is "building on the technological and industrial strengths" of the UK and Japan.[21]

The UK Director of Future Combat Richard Berthon also articulated the industrial and capability benefits that come with partnering with Japan's industry, which has successfully developed jet engines in the past: "This initiative with Japan is a win-win opportunity to develop world-beating power technologies together. Investing and working together with Japan to demonstrate highly advanced engine systems will boost our national industries and design a cutting-edge military capability."[22]

Two months later, in February 2022, the two countries again announced a development partnership related to their respective sixth generation programs; this time to undertake joint research on a sensor the UK MoD referred to as "a universal radio frequency sensor technology."[23] The new sensor will deliver capabilities such as locating static or moving targets and denying external surveillance.

The project is known as Jaguar and is scheduled begin in April and run for approximately five years. Jaguar is not technically part of the UK's Tempest development program but is expected to be included in the aircraft development.

As with the engine agreement, the joint sensor development, serves multiple objectives for Japan and the UK as they seek to defray risk associated with 6th generation fighter development and the development of world-class defence technologies. Howard Wheeldon, a defence consultant in the UK, offered that "international partnership is at the heart of British future combat air system development. . .. Jaguar is proposed to be a significant advance on existing detection, target and enemy surveillance denying technology, and the joint experience of Leonardo [the British lead on the project and Japanese companies in sensor technology has the potential to ensure development of world leading technology."[24]

Weapons Systems and Munitions

Laser Walls and the Need for Layered Air and Missile Defence: Israeli Prime Minister Naftali Bennett announced in February that the country was planning to deploy a "laser wall" to protect Israel from air and missile threats. According to Bennett, "within about a year, the Israel Defense Forces (IDF) will implement a laser interception system, initially experimentally and then operationally. First in the south, and then elsewhere. . . the laser wall that will defend [Israel] from missiles, rockets, UAVs and other threats. That will essentially take away the strongest card our enemies have against [Israel]."[25]

[21] Ibid.
[22] Ibid.
[23] Andrew Chuter, "New warplane sensor team boosts UK-Japan defense agenda", *Defense One,* February 15, 2022
[24] Ibid.
[25] Gareth Jennings & Yaakov Lappin, "Israel to deploy protective laser wall", *Janes.com,* 4 February 2022, Israel to deploy protective 'laser wall' (janes.com)

As much progress as directed energy weapons research and development has made in the last several years—and Israel certainly has been exceptionally active in directed energy weapons development—there remain operational and cost-related questions related challenges to the efficacy of relying on a laser wall for air and missile defence.

Lasers are limited by weather—cloud cover diminishes their effectiveness—and range—they tend to dissipate at distance. Some commentary around the Israeli effort has included discussion of both a ground-based component and the potential for uncrewed systems carrying lightweight lasers over time, though having perpetual coverage of crewed aircraft will increase costs associated with airborne laser defence.[26] In addition, while lasers are effective in engaging relatively slower-moving, low-flying systems such as uncrewed aerial systems and potentially mortars, their need to spend two to three seconds on target to disable incoming threats makes them less useful against salvos of heavier and faster moving threats such as missiles.

For these reasons, the "laser wall" is being developed to integrate with Iron Dome as part of a layered integrated air and missile defence system. Pini Yungman, the head of air defence at Rafael (the company developing the system), acknowledged that "[militaries] cannot rely on [a laser system] by itself; you need a combination of kinetic kill and energy, a combination of ways to intercept, otherwise you won't be able to intercept threats."[27] Tal Inbar, a senior research fellow at the Missile Defense Advocacy Alliance, agreed, observing that "if it's a complementary defence system, then there are advantages if weather permits for short-range projectiles like mortars. So, the laser is good, but it will [have to] be another part of a whole missile defence system."[28]

This concept of layered air and missile defence to meet the growing challenge of a complex threat environment was also discussed by US Army Major General Sean Gainey, head of the Army's counter-small uncrewed aerial system mission, during the UMEX 2022 Conference held on 20 February 2022 in Abu Dhabi as a prelude to the UMEX / SIMTEX 2022 Exhibition.[29] According to MG Gainey, "one system cannot protect against [the range of air and missile defence threats]" modern militaries face.

A final integration test of the laser systems with Iron Dome is expected in the next few months.

Gallium Nitride Microwave Weapons Open Up New Possibilities for Drone Defence:[30] Previous Deftech.scans have stressed the growing diversity of approaches to the counter-drone mission, including the use of airborne-based directed energy weapons.

In February, US-based company Epirus demonstrated its Leonidas Pod, a high-powered microwave system that can be attached to the bottom of a heavy-lift drone and deployed in a counter-drone mission.

The pod uses gallium nitride transistors to produce microwaves, rather than the more traditional approach of using magnetron vacuum tubes. According to *Defense One* reporting, the switch "from magnetron tubes to solid-state transistors allows you to maintain a durable microwave beam with less power and in a much smaller container." Epirus CEO Leigh Madden also believes that the system's software-defined approach can better discern between enemy "Red" forces and friendly "Blue" forces.

Blinded by the Light and the Challenge of Low-Level Technology Diffusion: Laser Strikes on Commercial Airlines Skyrocket: Eleven commercial airliners were attacked with lasers aimed at the cockpits near Seattle-Tacoma International Airport in Washington state in the span of approximately one

[26] Seth J. Frantzman, "Israel plans 'laser wall', but questions remain about effectiveness and cost", *Defense One,* 16 February 2022, Israel plans 'laser wall,' but questions remain about effectiveness and cost (defensenews.com)
[27] Ibid.
[28] Ibid.
[29] The author attended the conference in person
[30] Patrick Tucker, "Drones Shooting Microwave Rays Could Be the Drone Killers of Tomorrow", *Defense News*, 13 February 2022, Drones Shooting Microwave Rays Could Be the Drone Killers of Tomorrow - Defense One

hour on 7 February. The incidents did not cause any injuries, and the aircraft landed without incident, according to the US Federal Aviation Administration (FAA).[31]

The spate of attacks does not appear to be an isolated incident. A February press release from the FAA shows that there have been over 67,000 laser attacks in the United States from 2010-2021 with a 41% increase in these types of events in 2021 when nearly 10,000 laser events were reported despite the threat of fines that begin at $10,000.[32]

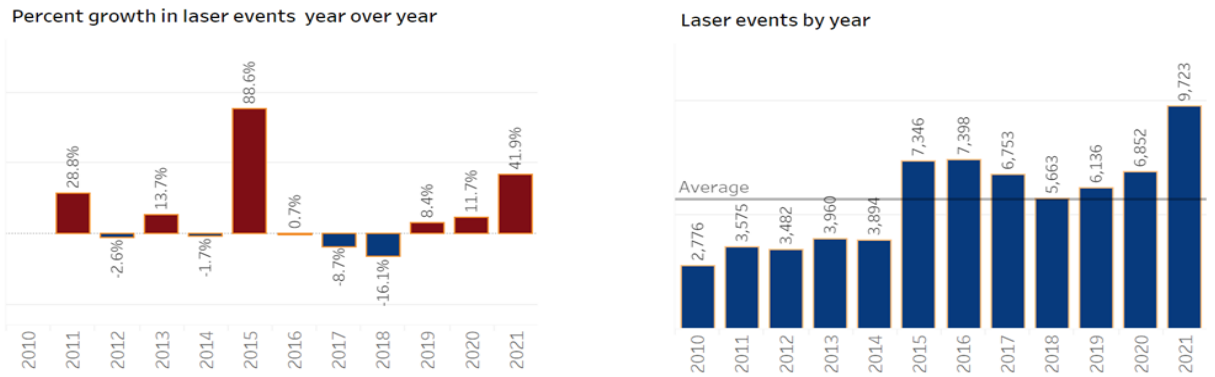

Figure 2: *Charts developed by the US Federal Aviation Administration that show the percentage increase in laser events year-on-year since 2010 and the total number of events by year during that time. Source: FAA*

Ballistic Missiles and the Complex Geopolitics of Strategic Competition: The reporting period also saw news related to more traditional weapons systems, including a new round of missile tests by North Korea. Test launches were conducted on 26 February and 4 March of what several countries in the region and outside believe to be a new intercontinental ballistic missile (ICBM) system capable of reaching the continental United States.

According to US Pentagon spokesperson John Kirby, neither test demonstrated an actual ICBM range or capability. Instead, the tests were designed to "evaluate this new system before conducting a test at full range in the future, potentially disguised as a space launch."[33] The North Korean government has denied the tests were related to a new ICBM capability, claiming they were part of a program to develop a reconnaissance satellite. Both Japan and South Korea responded to the launch. Seoul "strongly condemned" the tests and Japan referred to them as a "threat to peace and security... that can never be tolerated." US officials called the launch a "serious escalation."[34]

Also during the reporting period, reporting emerged that the Kingdom of Saudi Arabia was building its own ballistic missiles in conjunction with China. On 23 December, CNN reported that satellite photos taken by commercial imaging company Planet between October 26 and November 9 show a burn operation occurred at a facility near Dawadmi, Saudi Arabia, according to researchers at the Middlebury

[31] Don Sweeney, "Lasers hit 11 planes in one hour at Seattle-Tacoma International Airport, feds say", *The Charlotte Observer,* 9 February 2022, FAA: 11 airliners hit by lasers near Sea-Tac Airport | Charlotte Observer
[32] Federal Aviation Administration Event Strike Data, Workbook: Laser Events (dot.gov)
[33] Laura Bicker, "North Korea recently tested intercontinental missile system: US", *BBC,* 11 March 2022, North Korea recently tested intercontinental missile system: US - BBC News

[34] Ibid.

Institute of International Studies. The researchers assessed that the images constituted "the first unambiguous evidence that the facility is operating to produce missiles."[35]

The Dawadmi facility was originally built with Chinese assistance and China has not denied supporting Saudi Arabia's indigenous ballistic missile development efforts. In fact, a spokesperson for China's Ministry of Foreign Affairs told CNN in a statement that China and Saudi Arabia are "comprehensive strategic partners" and "have maintained friendly cooperation in all fields, including in the field of military trade. Such cooperation does not violate any international law and does not involve the proliferation of weapons of mass destruction."[36]

As with the North Korean test launch, the news about Saudi Arabia's ballistic missile program complicates an already tense geopolitical environment at a sensitive time. Efforts to engage Saudi Arabia's regional rival Iran on its nuclear program and missile programs will necessarily be affected by the development of a more robust Saudi ballistic missile program.

Ankit Panda, a nuclear expert with the Carnegie Endowment of International Peace assessed that "a robust Saudi missile program would introduce new challenges to constraining other missile programs in the region. To take just one example, Iran's missiles, which are a major concern to the U.S., would be more difficult to constrain in the future without parallel constraints on a growing Saudi program." However, constraining Saudi Arabia's program will be affected by Iran's advancing nuclear weapons program as well as by the fact that China appears to be supporting Saudi Arabia. The United States may be cautious to further alienate Saudi Arabia on an important issue of national security that could push the regional partner into a much closer relationship with China.

Individually and collectively, the two developments reflect the continued relevance of the weapons systems not only as effective weapons systems, but also in affecting the delicate geopolitical balances and pervading tensions that mark the current area of regional and global strategic geopolitical competition.

Robotics and Uncrewed Systems

UMEX / SIMTEX 2022:[37] As noted above, UMEX / SIMTEX 2022 was held from 21 – 23 February in Abu Dhabi. A one-day conference on uncrewed systems preceded the start of the exhibition. Several interesting trends and developments marked the show.

First, the continued advancement of the United Arab Emirates' domestic defence industry was prominently on display throughout the show. Previous Deftech.scans have focused on this development and on the country's defence industry conglomerate Edge Group. During the show, Edge revealed the Hunter swarming system as well as its QX family of loitering munition, which was originally revealed at the IDEX exhibition in February 2022.

The AI-enabled Hunter 2-S tube-launched system can carry 21 Hunter drones. The drones are expected to share information with other for tracking and maintaining positions and engaging with targets. Saeed Al Mansoori, CEO of the Edge subsidiary Halcon that developed the system told *Defense News* that "through a certain algorithm, the drones can communicate with each other through [a] main channel, which communicates to all of the drones, giving each of them a certain mission to fly to the target,"[38]

[35] Zachary Cohen, "CNN Exclusive: US intel and satellite images show Saudi Arabia is now building its own ballistic missiles with help of China", *CNN.com,* 23 December 2022, CNN Exclusive: US intel and satellite images show Saudi Arabia is now building its own ballistic missiles with help of China - CNNPolitics

[36] Ibid.

[37] The author attended the event in-person.

[38] Agnes Helou, "Following first demonstration, Edge unveils swarming drones based on AI technology", *Defense News,* 22 February 2022, Following first demonstration, Edge unveils swarming drones based on AI technology (defensenews.com)

which may include, according to an Edge Group press release, "enemy fighter jets on the tarmac at a military base, or an incoming convoy of enemy armoured vehicles, for example."[39]

Figure 3: *The Edge Group Hunter intelligent swarming system and several of the QX series of loitering munitions. Source: Nurkin*

Edge also unveiled the Scorpio-B uncrewed ground vehicle, which features twin 40mm grenade launchers, pan-tilt zoom cameras, intelligence, surveillance, and reconnaissance sensors, and a 7IS remote controlled weapon station made of 80% 3D-printed material. International Golden Group and Trust International also had large displays at the event.[40]

Second, Chinese companies were prominently involved in the exhibition. Both China North Industries Group Corporation Limited (NORINCO) and China National Aero-Technology Import and Export Corporation (CATIC) displayed several uncrewed aerial and ground systems. NORINCO's stand also included the logo of the China-Emirates Science and Technology Innovation Laboratory, a joint project between NORINCO and the UAE's International Golden Group.

Third, two large combat drones were on display: A General Atomics' Sea Guardian (a configuration of the MQ-9) with an Emirati flag painted on the tail and the Turkish Bayraktar TB-2 medium-altitude, long endurance tactical uncrewed system was also present.[41]

The presence of these two systems highlighted the complex geopolitical realities in which the show was taking place. In January 2021, the UAE agreed to purchase 18 MQ-9s from the United States, but the deal has not been finalized due to the US refusal to sell F-35s to UAE, a provision that was part of the original MQ-9 deal.[42] The full scale TB-2 mock-up was notable not only because it demonstrated the changing nature of once fraught Turkish – UAE relations, but also because in early February—exactly three weeks before the outbreak of the conflict in Ukraine—Turkey signed a deal with Ukraine to produce TB-2 uncrewed systems in Ukraine. According to Ukrainian President Volodymyr Zelensky, the agreement will "'will significantly expand production of unmanned aerial vehicles."[43]

[39] "Edge Unveils Swarming Drones Application for Unmanned Aerial Systems at UMEX 2022", Edge Group Press Release,
[40] Agnes Helou, "Here's what stood out at the UAE's unmanned defense expo", *Defense News,* 25 February 2022, Here's what stood out at the UAE's unmanned defense expo (defensenews.com)
[41] Ibid.
[42] Agnes Helou, "Here's what stood out at the UAE's unmanned defense expo", *Defense News,* 25 February 2022, Here's what stood out at the UAE's unmanned defense expo (defensenews.com)
[43] Tayfun Ozberk, "Ukraine TB2 co-production deal strains Russian-Turkish relations", *Shepherd Media,* 17 February 2022, Ukraine TB2 co-production deal strains Russian-Turkish relations | Shephard (shephardmedia.com)

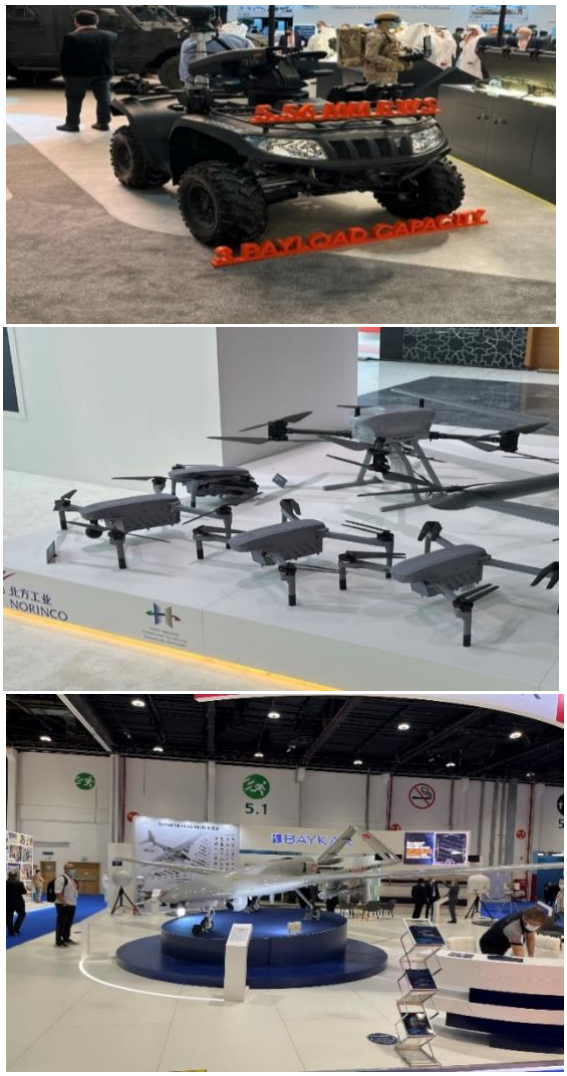

Figure 4: *TOP: The Scorpio-B uncrewed ground vehicle. MIDDLE: Swarming NORINCO drones, BOTTOM: A Mock-up of the Bayraktar TB-2. Source: Nurkin*

In 2019 Bayar Makina, a privately owned Turkish company, won a $69 million contract to sell six TB-2s to Ukraine as well as munitions for the armed UAV. Use of these systems against Russian-backed separatists in eastern Ukraine was a source of contention for Russia before the country decided to invade Ukraine on 24 February.[44]

Controlling Mass:[45] Raytheon Technologies and Northrop Grumman both successfully demonstrated the ability for a single user to control over 100 uncrewed system as part of a swarm in an urban environment. The tests were part of a Defense Advanced Research Projects Agency (DARPA) effort known as OFFensive Swarm-Enabled Tactics (OFFSET), which aims to enable small, dismounted units to amass up to 250 small aerial and ground uncrewed systems in urban combat environments.

The experiment took place in November at Fort Campbell in Kentucky, though reporting about the event was only released in late January. Raytheon's system allowed a single operator to successfully control 130 physical drones as well as 30 simulated drones. Northrop Grumman's system allowed one user to control 174 physical uncrewed systems. Erin Cherry, senior technical program manager of emerging capabilities development at Northrop Grumman released said in a statemen that "combined air and ground behaviours, such as intel recon and area patrol, are some of the swarm tactics employed. Northrop was also able to sustain swarm operations for up to 3.5 hours.

The Raytheon system incorporated a combination of off-the-shelf and custom-built hardware and software, including a virtual reality headset. Shane Clark, the Raytheon principal investigator for the OFFSET program revealed that the company's system "uses that off the shelf hardware to provide a single person with this flexible God's eye view of the environment and all the drones operating within it so that they can manage that larger swarm."

Uncrewed Systems Diffusion and Endless Injury Time:[46] A Premier League match between Brentford and Wolverhampton Wanderers was delayed by approximately 15 minutes when an unauthorized hobbyist drone was spotted above the stadium on 22 January 2022. Players were removed from the field and fans were made aware of the drone's presence. After approximately five minutes of flying above the stadium, the drone left.

[44] Burak Ege Bekdil, "Turkey and Ukraine to coproduce TB2 drones", *Defense News,* 4 February 2022, Turkey and Ukraine to coproduce TB2 drones (defensenews.com)
[45] Mark Pomerleau, "Contractors demonstrate single-user drone swarm at DARPA experiment", *C4ISR.Net,* 20 January 2022, Contractors demonstrate single-user drone swarm at DARPA experiment (c4isrnet.com)
[46] Jacob Whitehead and Tim Spiers, "Brentford vs Wolves halted for more than 15 minutes due to drone flying over stadium", *The Athletic*, 22 January 2022, Brentford vs Wolves halted for more than 15 minutes due to drone flying over stadium - The Athletic

While there were no grave outcomes associated with the incident—other than *19 minutes* of injury time—the incident does reveal the challenges and disruptive potential associated with the diffusion of small and commercial drones.

Nor was this the first time that the use of drones has delayed football matches. US-based outlet, *The Athletic,* reported that "in October 2020, a drone flying above Rotherham's New York Stadium caused a brief postponement to their Championship game against Sheffield Wednesday. Then, in September 2021, kick-off in a World Cup qualifier between Moldova and Austria was delayed by around 30 minutes due to a similar incident."


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