

Schweizerische Eidgenossenschaft Confédération suisse Confederazione Svizzera Confederaziun svizra

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

Deftech Scan

March 2021



https://deftech.ch/scans







Dear Reader,

We took our time, but finally decided to dedicate some content to covid19 and how it affected the developments of new military capabilities. Definitely some lessons on how to use a difficult situation to introduce and test new systems.

After lot and lot of reading online conferences and meetings, Tate could finally attend physically some exhibitions... it seems unreal, but yes, he did it! This allows us to bring you direct inputs from the field!

You will once again realize that development and innovation never stop! What were concepts one or two years ago are now prototypes and really close to become the "first generation" of new systems.

We wish you a nice reading

Foresightly Yours,

OTH-Intelligence Group CEO Foresight tate.nurkin@othintel.com

Q_t.

Dr. Quentin Ladetto armasuisse S+T Research director – Technology

quentin.ladetto@armasuisse.ch





Introduction and Executive Summary

This DEFTECH SCAN reports on and assesses occurrences in military technology and capability development taking place from late January 2021 through to late March. It contains reporting on recent activities and announcements in the United Kingdom (UK), United States (U.S.), Finland, Sweden, Australia, Israel, Germany. India, the United Arab Emirates (UAE), Armenia, and the Republic of South Africa.

This report contains also new features that will be incorporated into DEFTECH SCANS going forward. First, where appropriate, it seeks to highlight how defence and security communities are meeting the challenge of Covid-19 both in terms of mitigating the current risks to personnel, societies, and operations and preparing to better meet the biological threats of the future.

Closely related to the increased attention to how technology is supporting defence and security community responses to Covid-19 is the paper's emphasis on the importance of resilience—again, in response to Covid-19 and other biological and environmental threats as well as prioritized military capabilities, such as space architectures.

Finally, the Executive Summary boxes for two sections in this report include descriptions of articles or papers published on topics that are regularly covered in DEFTECH SCANS, but that are not featured in the text of the section. This approach allows for high-level updates of general reporting on key topics—for example, growing interest in hybrid engines—in a more efficient manner.

Other key themes and insights from the report include:

The Return of In-Person Exhibitions: The report also includes coverage of interesting capabilities revealed at two large defence exhibitions, marking a tentative return to in-person industry events. The Aero India 2021 took place in Bangalore from 3 – 5 February. Over 600 companies exhibited at the event including 524 Indian companies and other companies from 14 other countries throughout the world. Another 338 companies exhibited virtually.¹ From 21 – 25 February, the International Defence Exhibition (IDEX) 2021 and Naval Defence Exhibition (NAVDEX) was held in Abu Dhabi, United Arab Emirates. Over 700 companies participated.²

Indigenization and Partnerships: The countries in which these in-

person events were held were not a coincidence. India and the UAE are two of the most important export markets for defence suppliers and both have made indigenization of its defence industry a major national priority. As a result, Aero India 2021 and IDEX 2021 served as critical platforms for these local defence industrial bases not only to display new products—such as the Indian loyal wingman concept or a new family of Emirati loitering munitions—but also to formalize and announce partnerships and technology transfer agreements with defence contractors from outside the region looking to maintain or grow market positions and relationships in these markets.

Covid-19 as a Catalyst: A common theme from across discussion of multiple capability areas covered in this report—especially virtual training and the expansion of drone missions to include vaccine delivery— is that Covid-19 has served as a catalyst to accelerate trends that predated the pandemic as well as of new efforts at innovation to meet challenges and opportunities raised by the pandemic.

¹ Aero India 2021 website, Aero India 2021

² Number of exhibiting companies is derived from lists posted on the IDEX public website, <u>IDEX | International Defence</u> <u>Exhibition & Conference (idexuae.ae)</u>





Energy, Power, and Design

Key Insights:

- The UK Ministry of Defence released a climate change report that stressed the importance of adaptation, resilience, and innovation to defence efforts to manage the effects of climate change and to building considerations of climate change into force planning and operations. Some new energy technologies—such as electrical vehicles and the use of algae to power planes—should be pursued to help improve reduce the environmental footprint of defence activity, particularly military aviation.
- Update on Hybrid Engines: While not explicitly covered in this report, the reporting period also saw further evidence of the building momentum for and investment in hybrid engines, especially in the commercial aviation sector. *Aviation Week* published an in-depth article entitled "Propulsion Providers Hop On Hybrid Power Train" that details the efforts of many of the traditional engine manufacturers, such as Rolls-Royce, Pratt & Whitney, General Electric, Honeywell, and Safran as well as several smaller companies seeking to disrupt the market and fill specific gaps, such as smaller cargo and air mobility applications. Ultimately, the article concludes that *"as interest in larger and more capable electronic aircraft beyond the reach of current battery technology, power providers are stepping up development of hybrid systems that harness the core energy of turbine and piston engines."*

UK Releases Climate Change Report, Stressing Resilience and Adaptability:³ The Ministry of Defence (MoD) of the UK released its Climate Change and Sustainability Strategic Approach on 30 March. The wide-ranging report includes an urgent call to action to develop new approaches, processes, practices, and technologies to reduce the impact of defence activity on the climate and to adapt to the effects of a changed and still changing environment.

The report lays out a series of ways in which environment emergencies create instability through scarce resource competition, mass migrations, health crises, state-to-state competition, civil unrest, governance breakdown, and more frequent environmental emergencies. For MoD, the severest effects of "extreme temperatures, increased flooding, new and unfamiliar reasons for conflict" are "only just beginning to show."

Technologies Enabling Military Resilience in the Face of Climate Change

The UK MoD's Climate Change and Sustainability Strategic Approach lists a series of "deployed military technologies [that] should be fitted for the future." Some of these technologies, such as electric vehicles and smart buildings optimized for efficiency are highly relevant to the discussion of energy, propulsion, and design of military equipment and have been discussed in previous DEFTECH reports:

Part of the response to this challenge will be to develop new processes and practices for reducing MoD's environmental footprint and

supporting the UK government's objective of reaching zero net emissions by 2050. One adaptation mentioned in the paper is the use of "algae, alcohol, and household waste to power aircraft." According to the report, "revised aviation fuel standards published in November 2020 enable up to 50% 'drop ins' from sustainable fuel sources for all military aircraft... Aviation is currently two thirds of Defence's fuel consumption, so any reduction could prove significant in reducing our emissions footprint."

Another key theme throughout the paper is the need for resilience in the face of climate change. The report asserts that "achieving our purpose as defence relies on operational capability being effective and resilient, now and into the future."

³ All references in this section come from "Ministry of Defence Climate Change and Sustainability Strategic Approach (accessible version), Gov.UK, 30 March 2021, <u>Ministry of Defence Climate Change and Sustainability Strategic Approach (accessible version)</u> - GOV.UK (www.gov.uk)





Achieving this ambition will require a series of steps, including providing disaster response support to civilian authority; viewing defence equipment and force design through a "climate lens"; partnering with the rest of government and industry to assist the UK's green industrial transition; investing in innovation, research, and development; and pursuing operational self-sufficiency. Significantly, and as touched on later in the report, the report also stresses the need for further investment in synthetic training, noting that it "offers significant advantages and resilience" and highlights the importance of medical planning, which "needs to adapt as defence grows its understanding of the different psychological disease and injury risks faced."

Human Performance Enhancement and Protection

Key Insights:

- The global Covid-19 pandemic has caused both small and large militaries to consider more seriously the biological threat to personnel—either natural or man-made. The U.S. Defense Advanced Research Projects Agency (DARPA) began a program in February to deliver vaccines and therapeutics for infectious diseases in a matter of days while in the field, enhancing the resilience of forces to biological threats.
- The movement of small and large militaries throughout the world to more fully incorporate virtual / synthetic training continued through the reporting period. While much of the activity captured in this report is focused on virtual weapons training, the broader theme that technology is now enabling the combination of the physical and virtual world has implications for all types of training, including training of defence and security personnel in how to deal with biological threats, natural disasters, and other challenges that are difficult and expensive to simulate in live environments.

Near Immediate Doses of Vaccine, Therapeutics for Infectious Diseases:⁴ The global Covid-19 pandemic has caused both small and large militaries to consider how to manage the risk to their military personnel of exposure to Covid-19.

DARPA announced the establishment of the Nucleic acids On-demand Worldwide (NOW) program in February. The program will develop a mobile medical countermeasures (MCM) manufacturing platform to rapidly produce, formulate, and package hundreds of doses of nucleic acid therapeutics in days—rather than months or years—for deployed personnel to meet emerging or recently identified biological threats.

The system promises to provide significant advancement over current cell-based methods. According to DARPA, the resulting product could allow for end-to-end synthesis of Good Manufacturing Practice (GMP) quality material, even in austere environments. The mobile nature of the platform will enable rapid threat response to infectious disease threats. The NOW program is organized into three phases:

- **Phase 1 (36-months)** will investigate new bio / chemical methods to synthesize nucleic acids and explore downstream purification, analysis, and formulation of newly synthesized material.
- **Phase 2 (12-months)** focuses on system integration to finalize a contained, end-to-end mobile manufacturing platform.
- **Phase 3 (12-months)** involves a human clinical study that directly compares a NOW-derived product with traditionally manufactured material, which will demonstrate full platform functionality while producing an MCM targeting a Department of Defense (DoD) relevant disease indication

⁴ "DARPA Program to Offer Near Immediate Doses of Vaccine, Therapeutics for Infectious Diseases", DARPA, 4 February 2021, <u>DARPA Program to Offer Near Immediate Doses of Vaccine, Therapeutics for Infectious Diseases</u>





The Training Transformation Continues: Several developments related to the integration of virtual and synthetic capabilities into the training capabilities of large and small militaries around the world during the reporting period. Some notable examples:

• **Finland:** A new virtual small arms trainer (VSATs) was installed at Lappeenranta, Finland in January 2021. Previously in late 2020, a VSAT was installed at Hamina. According to the Finnish Land Warfare Centre, the systems are being "used to practice weapons handling, basic shooting

"Synthetic training offers significant advantages and resilience. Simulation technologies, for example, constantly improve, even for land and maritime."—

UK MoD Climate Change and Sustainability Strategic Approach, March 2021

and combat shooting, among other things."⁵ One of the benefits of the system is that it provides "comprehensive feedback to the shooter", allowing for understanding of errors and improvement of performance. Currently the system simulates assault rifles, Glock pistols, and light machine guns.⁶

- Sweden: In February, Swedish defence procurement agency FMV placed a \$15.98 million order with Saab for an undisclosed number of Carl-Gustaf M4 Ground Combat Indoor Trainers (GC IDTs). The system involves use of replica weapons, a virtual environment, and a sophisticated evaluation for realistic and accurate training⁷ and enables simultaneous training of up to 100 soldiers.⁸ Asa Thegstrom, head of Saab Training and Simulation, described the indoor trainer as a "realistic and cost-efficient virtual training solution" and noted that it "replicates the operations and characteristics of the real weapons and ammunition, their ballistics, and terminal effects."⁹
- United Kingdom: UK company 4GD announced in late January the release of two new products designed to provide users with an immersive close- and deep-battle training simulation. The new training packages are known as ECFECTUS, a dismounted close combat data collection and analysis system, and ACIES, an integrated-reality single synthetic training

"The changed environment wrought by [Covid-19 in] 2020 has provided the opportunity for a more considered approach to [Live, Virtual, Constructive] for the [Australian Defence Forces]."—

Tony McCormack, "Covid-19 means live, virtual and constructive training's time has come", Australian Strategic Policy Institute, 10 February 2021, <u>Covid-19 means live, virtual and constructive</u> training's time has come | The Strategist (aspistrategist.org.au)

environment, are designed to integrate into 4GD's existing SmartFacility offering. SmartFacility involves five levels of 4GD products. According to Rob Taylor, founder of 4GD, "Modern technology is now enabling better training and by combining the physical world and the virtual, we create what we refer to as Integrated Reality."¹⁰

⁵ Trevor Nash, "Finland continues training reform, adds VSATs", *Shepherd Media*, 5 February 2021, <u>PREMIUM: Finland</u> continues training reform, adds VSATs - Training - Shephard Media

⁶ Ibid.

⁷ Ibid.

⁸ "Saab to Deliver Carl-Gustaf M4 Trainer to Sweden", Saab website, 5 February 2021, <u>Saab to Deliver Carl-Gustaf M4 Trainers</u> to Sweden

⁹ Ibid.

¹⁰ Trevor Nash, "PREMIUM: 4GD Enhances Mart Facility Training", *Shepherd Media*, 2 February 2021, <u>PREMIUM: 4GD</u> <u>enhances SmartFacility training - Training - Shephard Media</u>





• Australia: Reporting from February 2021 indicates that five protected mobility crew trainers "resembling high-spec arcade machines"¹¹ have been installed at the Battle Simulation Centre at Gallipoli Barracks, Enoggera.

Australian company Applied Virtual Simulation provided the system, which builds on feedback about the version 1 of the trainer produced six years ago. Joel Sansom-Sherwill of Applied Virtual Simulation said that "Version 1 resulted in requests from soldiers for more realistic weapon feedback—vibration or recoil—from the weapon so they know when they're



Figure 1: Forces Command Major Andrew Bone and Signaller Jon Taylor, rear, test the new Protected Mobility Tactical Training System at the Battle Simulation Centre,

firing. We are pleased to say that we have included that in the new version, so you will get a bit of a kick when you fire the weapon."¹² The system provides several layers of value, including allowing for some training that could be unsafe to carry out in real life, such as using damaged equipment—as does take place in a real-life operational context—in a live simulation. It also allows for individuals to get more repetitions because virtual trainings do not require expending expensive or finite resources such as oil and to receive more immediate feedback on their performance.¹³

Cyber and C4ISTAR

Key Insights:

- The development of more robust counterspace capabilities is increasing the vulnerability of space assets for both large and small militaries, placing a premium on building on resilience of capabilities enabled by space-based systems, most notably in navigation in global navigation satellite systems-denied environments. This is not only a priority for militaries. Commercial and civil sector organizations are also increasingly concerned about the vulnerability of global navigation satellite systems (GNSS)
- Supply chains are again a source of acute cybersecurity concern for defence and security communities throughout the world. A previous DEFTECH SCAN discussed the vulnerabilities in software developer supply chains exploited in the Solar Winds attack against the U.S. government. This report highlights a more operational—and more easily detectable—vulnerability in over 100 German military platforms, including two submarines, related to the use of navigation software made in Russia
- AI is affecting defence and security operations in a variety of ways. Perhaps most prominently, it is greatly accelerating the pace of conflict, crises, and decision-making, potentially further reinforcing the need for more AI-enabled capabilities to support decision-making and even target identification.

GNSS-Denied Navigation: Israel's Ministry of Defense and Israel Aerospace Industries (IAI) opened a new research center to develop navigation systems that do not rely on vulnerable global navigation satellite systems (GNSS) such as GPS, GALILEO, GLONASS, and BEIDOU.

The Advanced Navigation Technology Center was established to manufacture highly accurate inertial sensors that "will enable the production of next generation navigation systems" and aid Israel's technological independence in a high-demand technology area. Avi Elisha, general manager for IAI's

¹¹ Captain Jesse Robiliard, "VR sets the scene for new training", Australian Department of Defense website, 18 February 2021, <u>VR sets the scene for new training | Defence News</u>

¹² Ibid.

¹³ Ibid.





electro-optical and navigation systems noted that "only a handful of countries have this technology, which is a game-changer in the field of inertial navigation."

Advances in electronic warfare and cyber capabilities as well as other counterspace capabilities (which have been frequently profiled in previous DEFTECH SCANS) have made the likelihood of disrupted,

degraded, or denied access to GNSS during times of conflict more likely, driving efforts to design and develop new methods of navigation. DARPA's Collaborative Operations in Denied Environments (CODE) program is just one example of programs from militaries around the world focused on operating in environments in which GNSS signals have been jammed or spoofed or access to GNSS has been otherwise degraded.¹⁴

Industry is also exceptionally concerned about the possibility of interference with or denial of GNSS and the need to build resilience of positioning, navigation, and timing (PNT) methods. For example, in December 2020, a coalition of manufacturers and service providers that "have dedicated themselves to providing their customers backups for, and improvements to [Global Positioning System] / GNSS solutions by delivering better signal protection, augmentations and alternative forms of positioning,

The Counterspace Challenge: Defence Against the Dark Arts in Space

Meeting the increasing threat from improved and diversifying counterspace capabilities was the focus of a February report entitled "Defense Against the Dark Arts in Space" from the Center for Strategic and International Studies (CSIS) in Washington, DC. The report offers insight on the nature of the competition taking place in space and growing threat to U.S. and allied space architectures, noting that "rather than fight the U.S. military symmetrically, [U.S. competitors] have invested heavily in counterspace weapons designed to degrade, disrupt, and destroy U.S. and allied space systems."¹

The report details the emerging counterspace threat and includes methods for actively and passively defending space assets and building more resilient space architectures through disaggregation among other techniques.

Source: Todd Harrison, Kaitlyn Johnson, Makena Young, "Defense Against the Dark Arts in Space", Center for Strategic and International Studies, February 2021, <u>Defense Against the</u> <u>Dark Arts in Space: Protecting Space Systems from Counterspace</u> <u>Weapons | Center for Strategic and International Studies</u> (csis.org)

navigation, and timing" formed the Open PNT Industry Alliance to leverage the power of competition to drive innovative solutions. "We believe that an open market, with competition, harnessing the ingenuity of the industry, is going to bring about the best, most robust and most diverse solutions for PNT", said Dr. Michael O'Connor, CEO of Satelles, one of the alliance's members.¹⁵

German Subs Vulnerable to Cyber Intrusions: In late March, German newspaper *Bild* reported that around one hundred military vehicles, including at least two German submarines have been using a navigation system called Navi-Sailor 4100 since 2005 that was made by Russian company Transas. Finnish company Wartsila purchased the company in 2018, though *Deutsche Welle* reports that the defense division of Transas remains "in Russian hands" raising concerns that German military assets could be hacked and their locations easily determined.¹⁶

Reporting claims that "the system's data encryption does not comply with military security standards." *Bild* quoted an unnamed officer as saying that "during a worst-case cyberattack, navigation data could be hacked and the ship could lose operability."¹⁷

While interesting in isolation, the *Bild* story once again reveals—among other things—the layered cyber-related challenges defence and security communities throughout the world are facing in managing supply chains. Certainly back-doors and other vulnerabilities built into software systems by manufacturers constitute a particularly unsubtle

¹⁵ Gavin Schrock, "Industry alliance supports development of GPS backup solutions", *GeospatialWorld*, 20 March 2021, <u>Industry</u> alliance supports development of GPS backup solutions - Geospatial World

¹⁶ "German submarines fitted with Russian technology: report", *Deutsche Welle*, 28 March 2021, <u>German submarines fitted with</u> <u>Russian technology: report | News | DW | 28.03.2021</u>

17 Ibid.

¹⁴ Brandon Knapp, "These drone swarms survived without GPS", C4ISRNet, 28 November 2018, <u>These drone swarms survived</u> without GPS (c4isrnet.com)





threat. However, the ability to hack into networks at lower levels of the supply chain offers a more nuanced approach.

Indeed, the topic of supply chain cyber security was prominently discussed during the International Defence Conference 2021 (IDC 2021) held in Abu Dhabi in advance of the IDEX Exhibition. As one conference panelist noted during a panel on supply chain risks and opportunities, heightened attention to cyber threats in an era of interconnected and digitized supply chains must penetrate into the lower levels of the supply chain that may serve as easier entry points into critical networks and information flows than large traditional defence contractors that have more experience in dealing with cyber threats.¹⁸

AI and "Hyperactive Battlefields": The Commanding General of the U.S. Army Futures Command John Murray made comments in later January that described warfare in 2035 as a "hyperactive battlefield" characterized by incredible pace, ubiquitous sensors, electronic warfare, and explosives, all empowered and enabled by artificial intelligence (AI).¹⁹

Murray's comments largely centered on how AI-enabled C4ISTAR capabilities is speeding up a range of critical tasks, including data gathering, data processing, analytics, and decision-making, providing processed information at a pace well-beyond what can be conceived of currently. "I think decisions will have to be made at such a pace that it's going to be incredibly difficult for a human decision-maker to keep up with it", Murray observed.²⁰

The comments echoed similar remarks made by now-retired U.S. Lieutenant General Jack Shanahan, the former head of the U.S. DoD's Joint Artificial Intelligence Center (JAIC), during a National Security Commission on AI conference in November 2019. Shanahan noted that "we are going to be shocked by the speed, the chaos, the bloodiness, and the friction of a future fight in which this will be playing out in microseconds at a time",²¹ placing a premium on the ability to meet fast-moving, autonomous machine-enabled threats with other automated capabilities such as automated target acquisition that can keep up with the pace of emerging threats.

¹⁸ The author attended the IDC 2021 virtually

¹⁹ Kris Osborne, "Future of War Will Be 'Hyperactive Battlefields': U.S. Army General", *The National Interest*, 30 January 2021, <u>Future of War Will Be 'Hyperactive Battlefields': U.S. Army General | The National Interest</u> ²⁰ Ibid.

²¹ National Security Commission on Artificial Intelligence Conference, Public-Private Partnerships, 5 November 2019, <u>National Security Commission on Artificial Intelligence Conference, Public-Private Partnerships | C-SPAN.org (c-span.org)</u>, 27:40 – 28:35.





Crewed Platforms

Key Insights:

- The UK Parliament released a scathing report on the state of the country's armoured vehicle fleet that included the assessment that "the recent history of the British Army's armoured fight vehicle capability is deplorable." Among the many recommendations to begin to remedy the situation is to determine the utility of some programmes, to speed up others, and to make a decision about UK participation in the European Future Tank Program, which was featured in the January DEFTECH report
- Boeing test flew its F-15EX platform for the first time, ensuring successful delivery of the first two planes later this year. The F-15EX is the most advanced version of the F-15 and is based on the F-15Q aircraft developed for Qatar. It is particularly notable for its open system, agile software, and digital design approach that should help increase the platform's adaptability and flexibility and reduced sustainment costs.
- India's Navy commissioned the third of six submarines as part of its Project 75 programme in partnership with France's Naval Group. The *INS Kharanj* is the first in the series to be made entirely in India and signals another important step forward for the country's efforts at self-sufficiency in defence and for the Make in India approach.

Scathing Report on U.K. Armoured Vehicles: A March 14 report from the U.K. Parliament's Defence Committee issued a scathing rebuke of the current state of British armoured fighting capability.

The first sentence of the report's summary sets the tone: "The recent history of the British Army's armoured fighting vehicle (AFV) capability is deplorable." The report also starkly assesses that "We are astonished that between 1997 and late 2020 (with the exception of a small number or armoured engineering and Viking protected mobility vehicles) the Department has not delivered a single new armoured vehicle from the core procurement programme into operational service with the Army."²²

The report blames "a woeful story of bureaucratic procrastination, military indecision, financial mismanagement and general ineptitude" for deficiencies in the British armoured vehicle fleet and reaches the following harsh—both in terms of judgment and language—conclusion²³:

"As a result, were the British Army to have to fight a peer adversary - a euphemism for Russia in Eastern Europe in the next few years, whist our soldiers would undoubtedly remain amongst the finest in the world, they would, disgracefully, be forced to go into battle in a combination of obsolescent or even obsolete armoured vehicles, most of them at least 30 years old or more, with poor mechanical reliability, very heavily outgunned by more modern missile and artillery systems and chronically lacking in adequate air defence. They would have only a handful of long-delayed, new generation vehicles, gradually trickling into the inventory, to replace them."

The committee also expresses concern that the Defence Equipment and Support (DE&S) lacks sufficient technically qualified staff and the ability to effectively manage the multiple on-going armoured vehicle procurement and upgrade programs, which includes the Challenger 2 LEP modernization effort that was featured in the January 2021 DEFTECH SCAN. There is still considerable uncertainty about whether this program will move forward while the "long-delayed" upgrade of the Warrior infantry fighting vehicle has been abandoned.²⁴

²⁴ J. Kasper Oestergaard, "Scathing Report on the British Army's Armored Fighting Vehicle Capability: 'Deplorable, Obsolescent and Outgunned", Forecast International as published on Defense and Security Monitor: A Forecast International Aerosapce and Defense Blog,

 ²² "Obsolescent and outgunned", U.K. Parliament Defence Committee, U.K. Parliament website, 14 March 2021, <u>Obsolescent and outgunned: the British Army's armoured vehicle capability - Defence Committee - House of Commons (parliament.uk)</u>
²³ Ibid.





Recommendations largely focused on providing more transparency about the status of specific programs (Challenger 2), speeding up timelines (Boxer and FV430), or determining whether programs are necessary (Warrior). It also recommended improved scrutiny of vehicle programs and potentially personnel changes at the senior management level of DE&S, highlighting the importance of organizational challenges to incorporation of new technologies and development of new capabilities. The report also recommended making a decision about British participation in the Main Ground Combat System / European Main Battle Tank program.²⁵

F-15EX Test Flight: Boeing conducted the maiden flight of the F-15EX Advanced Eagle combat aircraft for the U.S. Air Force on February 2 paving the way for the first two of eight aircraft to be delivered in the first half of 2021. The remaining six will be delivered by the end of 2023.²⁶ The F-15EX is replacing the oldest of the F-16C/D fighters in the Air Force's inventory, though over time plans call for between 76 EX platforms and 200.

The plane is based on the Advanced Eagle version currently in production for Qatar and brings several important upgrades in capability, including increased payload capacity and its open mission systems architecture, which will enable rapid integration of new capabilities and upgrades—making the aircraft "adaptable and flexible"²⁷ for rapid changes in mission systems, according to Matt Giese, the test-pilot for the 90-second maiden flight. Giese continued by saying:

"As a pilot, I may see a change required in the cockpit for example, maybe it's a display, maybe I'm not binge presented with the information the way that need to execute the tactical mission. I can relay that back to the engineering teams, and when it's an OMS box, they can rapidly change [it]. I can step to the jet maybe the next day and have that ability to see that new tactical information that maybe I lacked in a previous sortie." ²⁸

The open system and agile software development approach is also expected to greatly reduce sustainment costs of the aircraft. As Prat Kumar, Boeing vice president and F-15 program manager described at the time of the signing of the F-15EX deal in July 2020, "F-15EX brings together benefits of digital engineering, open mission systems and agile software development to keep it affordable and upgradable for decades to come."²⁹

Indian Submarine Programs Progress: On March 10, the Indian Navy commissioned its third (of six) Project 75 diesel-electric submarine based on Naval Group's Scorpene platform. The *INS Karanj* is the third in the Kalvari class license built in India by Mazagon Dock Shipbuilders Limited (MDL).

The Project 75 programme between the Indian Navy and Naval Group is running over six years behind schedule but has helped support India's longstanding objective of improving self-reliance in critical technology areas, especially defence. And while commissioning of the second boat in the series, the *INS Khanderi*, was delayed until September 2019 due to 36 identified deficiencies, the *INS Khana*nj is the first of the series to be entirely made in India. Commanding Officer Captain Gaurav Mehta offered a useful perspective on the ups and downs of India's Make in India approach: "It's like an experiment. A lot of

²² March 2021, <u>Scathing Report on the British Army's Armored Fighting Vehicle Capability: 'Deplorable, Obsolescent and Outgunned' – Defense Security Monitor (forecastinternational.com)</u>

²⁵ Ibid.

²⁶ Gareth Jennings, "Boeing flies first F-15EX for USAF", *Janes.com*, 3 February 2021, <u>Boeing flies first F-15EX for USAF</u> (janes.com)

 ²⁷ Jamie Hunter, "Boeing's Chief F-15 Test Pilot Talks Flying The Air Force's New Eagle On Its Maiden Mission", *The Drive*, 8
February 2021, <u>Boeing's Chief F-15 Test Pilot Talks Flying The Air Force's New Eagle On Its Maiden Flight (thedrive.com)</u>
²⁸ Ibid

²⁹ "Boeing & USAF Ink Historic Deal for F-15EX Fighter Jet", Boeing Media Room, Boeing website, 13 July 2020, <u>MediaRoom</u> - <u>News Releases/Statements</u>





lessons have been learnt from experience and more lessons will be learnt as we move forward on our



Figure 2: A graphic showing the DRDO's AIP module currently under development. (DRDO)

state actors, non-state actors, and criminals."

Weapons Systems and Munitions

Key Insights:

mission to make submarines indigenously."³⁰

The Indian Navy seeks to build its submarine fleet, partially in response to a degradation in capability, but also in response to increasing Chinese naval presence in the Indian Ocean. The next phase in this effort is Project 75I, which aims to produce six additional submarines equipped with air-independent propulsion (AIP). As with the Project 75, the boats will use a foreign design with domestic construction.

• Even the most technologically advanced militaries are acknowledging the challenge posed by small UAVs. For example, the United States Department of Defense released its first counter-small UAV strategy in January that noted that small UAVs are "increasingly capable weapons in the hands of

- Counter-UAV approaches vary. Lasers have become a more popular means of dealing with UAVs due to the low cost of shot and deep magazine associated with laser weapons. However, other forms of directed energy, RF jamming, missiles, and even the use of rocket propelled nets are all being developed as part of layered and integrated counter-UAS systems
- Directed energy and counter-UAV weapons are also seen by technologically sophisticated emerging export markets as a capability area around which to build an indigenous domestic industry capability. As a result, some leading companies in countries such as the UAE are engaging with more established suppliers to co-develop these weapons and to be able to absorb the technology and know-how required to develop them.
- Update on China's Missiles: A March article in *Defense One* by Ma Xiu and Peter W. Singer entitled *What Do We Know About China's Newest Missiles* offered insight into the development and deployment status of six Chinese missiles, all taken from open-source reporting: the DF-26 IRBM, DF-31AG and, DF-41 ICBMs, and DF-21 nuclear MRBM ballistic missiles, the CJ-100 ground-launched cruise missile, and DF-17 hypersonic glide vehicle. The article reveals considerable progress in these missile programs, details deployment activities and plans, and includes the conclusion that "the rundown of China's latest missiles shows not just an immense gain in capability, but also how much can be gleaned about them from open-source intelligence."

High-Energy Lasers: Germany's Federal Office of Bundeswehr Equipment, Information Technology and In-Service Support awarded the consortium of Rheinmetall Waffe Munition (RWM) and MBDA Deutschland a contract for a high-energy laser (HEL) demonstrator for maritime applications on 28

³⁰ "Hailing Make in India' spirit, INS Karanj to be commissioned on March 10", *Indian Express*, 7 March 2021, <u>Hailing 'Make in</u> India' spirit, INS Karanj to be commissioned on March 10 | Cities News, The Indian Express





January. The demonstrator will be developed by the end of the year and undergo trials on the German Navy's F124 frigate Sachsen in 2022. According to Doris Laarmann, MBDA Deutschland's head of laser business development, the demonstrator will be used to test aspects such as the interaction of the sensor suite, combat management system, and effector, as well as rules of engagement.³¹

In addition, during the IDEX exhibition in Abu Dhabi, MBDA and French firm CILAS, a subsidiary of Ariane Group, signed a memorandum of understanding (MOU) with SIGN4L, a subsidiary of Emirati defence conglomerate EDGE to co-develop high-energy laser weapons systems for drone defence.

The MOU calls for each partner to identify a potential axis of cooperation among several domains and activities related to high-energy lasers, such as operational analysis and systems architecture. It also constitutes an important first for MBDA and demonstrates the growing need of Western defence contractors to engage in co-development efforts in many emerging markets to support the development of local defence industry. According to MBDA head Eric Beranger "for the first time, MBDA is engaging in an ambitious cooperation outside of Western Europe regarding high-energy lasers. Collaboration in this field is of a mutual interest since MBDA and CILAS' capabilities and experience working on high-energy laser activities for more than 30 years is complementary to SIGN4L's strong knowledge and expertise regarding them."³²

EDGE's vice president of program management for its electronic warfare and intelligence business Waleid Al Mesmari reinforced the importance of these types of partnerships for the development of local industry over the long-term noting that a main objective of the agreement in this critical emerging capability areas was "to strengthen our local sovereign defence capabilities."³³

New Approaches and Systems for the Counter-Drone Mission: Directed energy weapons such as high-energy lasers are just one of the array of ways in which small and large militaries are trying to cope with the emerging challenge of proliferated small UAVs. There was considerable activity during the reporting period related to the development of approaches, methods, and capabilities to meet the challenge of proliferated drones.

In early January, the U.S. DoD released its official "Counter-Small Unmanned Aircraft Systems Strategy." The report lists its "central challenge" as:³⁴

"The exponential growth of [small UAS or sUAS] creates new risks for the Department. Technology trends are dramatically transforming legitimate applications of sUAS while simultaneously making them increasingly capable weapons in the hands of state actors, non-state actors, and criminals. Small UAS may also pose hazards to DoD operations in the air, land, and maritime domains when controlled by negligent or reckless operators. The Department must protect and defend personnel, facilities, and assets in an environment where increasing numbers of sUAS will share the skies with DoD aircraft, operate in the airspace over DoD installations, and be employed by our Nation's adversaries."

The strategy revolves around three main objectives critical to meeting this challenge: 1) enhance the Joint Force; 2) develop material and non-material solutions (such as new operational concepts) that facilitate safe and secure execution of DoD missions; and 3) build and broaden relationships with allies and partners.

³¹ Nicolas Fiorenza, "Bundeswehr awards Rheinmetall-MBDA consortium contract to develop high-energy laser", *Janes.com*, 2 February 2021, <u>Bundeswehr awards Rheinmetall-MBDA consortium contract to develop high-energy laser (janes.com)</u>

 ³² Agnes Helou, "Mideast, European firms explore collaboration on high-energy lasers", *Defense News*, 1 March, 2021, <u>Mideast</u>, <u>European firms explore collaboration on high-energy lasers (defensenews.com)</u>
³³ Ibid

³⁴ "Counter-Small Unmanned Aircraft Systems Strategy", U.S. Department of Defense, 7 January 2021, <u>DEPARTMENT-OF-DEFENSE-COUNTER-SMALL-UNMANNED-AIRCRAFT-SYSTEMS-STRATEGY</u>





Russia's military and industry also engaged in activity related to the development of counter-drone capabilities. During the IDEX exhibition, Russia's Rosoboronexport held a public presentation entitled "New Approaches to Building an Integrated Counter UAV System." The approach combines electronic warfare and various types of air defence systems, including³⁵:

- UAV jamming systems, which are most effective against light and some medium-class drones.
- The Repellent Patrol electronic warfare system, a long-range system capable of jamming drones at a range of up to 20km
- The Kupol and Rubezh-Avtomatika systems that are engaged in continuous radio surveillance and are able to detect not only by individual aircraft, but also massed or swarmed use from different directions and at different altitudes
- The Pischal electromagnetic gun, a lightweight handheld jamming weapon that can operate at a range of up to 2 km
- A hard-kill component, such as the use of Pantsir-S1M self-propelled anti-aircraft gun/missile system or a Tor-type SAM system

In addition, in March, scientists from the Russian Federal Nuclear Centre – All – Russian Research Institute of Technical Physics filed a patent for a counter-drone system that uses a net deployed from a drone at high speed around an enemy drone while in flight. The relatively low-tech solution is designed to simplify approaches to and help reduce the costs of defeating the small UAS threat.³⁶

Robotics and Uncrewed Systems

Key Insights:

- UAVs continue to play an important role in the efforts of defence and security communities as well as the private sector and civilian government agencies to increase resilience against the Covid-19 pandemic. The virus has effectively catalyzed innovation not only in new enabling technologies but also new missions, such as vaccine delivery
- Several emerging drone manufacturers displayed new loitering munitions at the IDEX 2021 Exhibition in Abu Dhabi. Of particular note was a new family of loitering munitions displayed by the EDGE group of the UAE, but Armenian and South African suppliers also displayed new concepts, including loitering munitions capable of "intelligent swarming"
- India became the latest country to reveal its "loyal wingman" concept at the Aero India 2021. Mockups of the Combat Air Teaming System were displayed at the exhibition, including three separate designs for uncrewed systems that could be released from and controlled by a Tejas mothership.

Uncrewed Systems and Covid-19 Vaccine Delivery:³⁷ Zipline, a company that delivers medical equipment and supplies via uncrewed aerial systems, announced in February that it is building an end-toend cold chain distribution capability to distribute Covid-19 vaccines in Rwanda, Ghana, Nigeria, and rural and remote parts of the United States.³⁸

³⁵ "IDEX 2021: Rosonboronexport unveils integrated counter UAV system combining multiple devices", *Unmanned Airspace*, 23 February 2021, <u>IDEX 2021: Rosoboronexport unveils integrated counter UAV system combining multiple devices - Unmanned airspace</u> and "Russia to feature new integrated counter-drone system at IDEX 2021 arms show", *TASS*, 19 February 2021, <u>Russia to feature new integrated counter-drone system at IDEX 2021 arms show - Military & Defense - TASS</u> ³⁶ "Russian Patents a Rocket-propelled 'Ner' to Ensage Drones in Flight". *Defense World blog*, 10 March 2021. Russia Patents a

³⁶ "Russian Patents a Rocket-propelled 'Net' to Ensnare Drones in Flight", *Defense World blog*, 10 March 2021, <u>Russia Patents a</u> <u>Rocket-propelled "Net" to Ensnare Drones in Flight (defenseworld.net)</u>

³⁸ Catherine Cheney, "In Brief: Zipline announces COVID-19 vaccine drone delivery plans", *Devex*, 4 February 2021, <u>In Brief:</u> Zipline announces COVID-19 vaccine drone delivery plans | Devex



The key challenge associated with drone deliveries of many vaccines is that the vaccines need to be stored and transported in low temperature ranges, requiring dry ice or highly specialized freezers. The company is installing ultra-low refrigeration capacity at its distribution centers and will conduct end-to-end thermal validation to ensure vaccines remain within their required temperature ranges. Zipline expects to be ready to deliver Covid-19 vaccines to the areas where it operates in April 2021.³⁹

Zipline CEO Keller Rinaudo summed up the motivation for this initiative, saying "Where you live shouldn't determine whether or not you get a Covid-19 vaccine. We can help health systems bypass infrastructure and supply challenges through instant delivery."⁴⁰

Zipline's announcement reveals broader efforts to integrate drones into more supply chains that have been accelerated by the need to find innovative responses to the restrictions on movement and close contact caused by the Covid-19 pandemic. In a June 2020 article, Harrison Wolf, director of global aviation policy with Zipline, observed that even at that relatively early point in pandemic response efforts drones had become an crucial to building resilience into stressed supply chains. Wolf also correctly pointed out that the pandemic has also generated innovation not only in technologies, but just as importantly in operational concepts and policies and regulations, which are necessary to optimizing the delivery capabilities of drones.⁴¹

Emerging UAV Suppliers Build Momentum: IDEX 2021 provided a useful platform for several emerging uncrewed systems providers, particularly the UAE's EDGE (and its subsidiary ADASI), which



Figure 3: EDGE Group unveiled its QX family of loitering munitions at IDEX 2021. Source: Agnes Helou/Defense News Staff, <u>Edge Group unveils kamikaze drones at IDEX</u>

launched a new family of uncrewed aerial vehicles (UAVs) during the event. The loitering munition UAV family is known as the QX family and involves four products⁴²:

- QX-1, a micro-UAV
- QX-2, a mini-UAV
- QX-3 a small UAV
- QX-4, a vertical

take-off and landing fixed wing aircraft

EDGE subsidiary ADASI also showed off the Shadow

50 and Shadow 25 loitering munitions, which can carry 50kg and 25kg payloads respectively.⁴³

EDGE has prioritized development of uncrewed systems as a means of building UAE's domestic capabilities in autonomous and AI technologies while supporting one of the most urgent priorities of the UAE defence and security communities as well as other militaries across the region. Faisal Al Bannai, CEO and managing director of EDGE, highlighted the importance of uncrewed systems to the UAE's domestic defence industrial base growth: "With the future increasingly relying on unmanned systems that

³⁹ Ibid.

⁴⁰ Ibid.

⁴¹ Harrison Wolf, "We're about to see the Golden Age of drone delivery—here's why", World Economic Forum, 6 July 2020, <u>We're About To See The Golden Age Of Drone Delivery – Here's Why (forbes.com)</u>

⁴² Agnes Helou, "Edge Group unveils kamikaze drones at IDEX", *Defense News*, 22 February 2021, <u>Edge Group unveils</u> <u>kamikaze drones at IDEX (defensenews.com)</u>

⁴³ Ibid.





provide a higher degree of tactical flexibility, we have invested extensively to fast-track R&D investments in these domains, bringing related products to market with speed."⁴⁴

Also at IDEX, Republic of South Africa company Paramount showed its N-Raven long range UAV system featuring "next generation swarm technologies."⁴⁵ The N-Raven is a multi-mission system, according to the company, including serving as part of "future warfighter engagements where intelligence swarming technologies combined with multiple munition loitering and attack operations have been proven to ensure mission survivability."⁴⁶

The 41kg N-Raven has a loitering endurance time of approximately two hours and can carry 10-15kg payloads up to a range of 250km. The system also provides detection, identification, location, and reportage (DLIR) against different types of targets.⁴⁷

Armenian company Pride Systems also displayed a fixed wing and pentacopter version of a new loitering munition for the first time during IDEX. Both drones can be equipped with high-explosive or highexplosive anti-tank warheads and both are ready for serial production, according to *Shephard Media*.⁴⁸

The fixed wing drone is tube launched and can attack using an autopilot with elements of AI, meaning that it can recognize intended targets from a library of images stored in its memory. Human operation is not necessary for the munition to engage targets. The AI-



Figure 4: The fixed wing version of Pride Systems' loitering munition displayed at IDEX 2021. Source: Pride Systems / Shepherd Media.

enabled autopilot can create a swarm of four drones using a secure communication channel, and the swarm can exchange information and automatically redistribute targets.⁴⁹

India's Loyal Wingman: During the Aero India 2021 exhibition, state-owned company Hindustan Aeronautics Limited (HAL) revealed mock-ups of the Combat Air Teaming System (CATS) family of 'loyal wingman' UAVs.

The CATS program involves three uncrewed platforms—CATS Warrior, CATS Hunter, and CATS-Air Launched Flexible Asset (ALFA). These three UAVs are designed to operate in conjunction with the Tejas Light Combat Aircraft to perform a range of mission-specific functions.⁵⁰

⁴⁴ "EDGE UNVEILS FIRST UAE-MADE FAMILY OF SMART LOITERING MUNITIONS AT IDEX 2021", EDGE Group Website, 21 February 2021, EDGE Unveils First UAE-made Family of Smart Loitering Munitions at IDEX 2021 | EDGE (edgegroup.ae)

⁴⁵ "Paramount launches N-Raven long range swarming UAV system", *DefenceWeb*, 22 February 2021, <u>Paramount launches N-Raven long range swarming UAV system - defenceWeb</u>

 ⁴⁶ Ibid.
⁴⁷ Ibid.

⁴⁸ Leonid Nersisyan, "IDEX 2021: Armenian loitering munitions take a bow", *Shepherd Media*, 22 February 2021, <u>IDEX 2021:</u> <u>Armenian loitering munitions take a bow - Unmanned Vehicles - Shephard Media</u>

⁴⁹ Ibid.

⁵⁰ Atul Chandra, "HAL unveils ambitious air-teaming system centred on Tejas", *FlightGlobal*, 3 February 2021, <u>HAL unveils</u> ambitious air-teaming system centred on Tejas | News | Flight Global





The CATS Warrior is a low-observable UAV that will operate alongside or ahead of the Tejas and serve as a sensor amplifier providing the Tejas pilot with enhanced situational awareness. The Warrior will be equipped with an electro-optic/infrared (EO/IR) payload, active electronically scanned array radar



Figure 5: A mock-up of the CATS system with the CATS ALFA, CATS Hunter and CATS Warrior (from front to back) pictured. Source: Janes / Akshare Parakala

the system are expected to be built in 2022.53

(AESA), inertial navigation unity, and a jammer. It can also carry two shortrange or beyond visual range air-to-air missiles externally.⁵¹

CATS ALFA will be launched from the Tejas (also known as the Mothership for Air teaming eXploitation or CATS-MAX) and will operate as a swarm of weaponized drones while CATS-Hunter will serve as a multi-purpose weapons carriage system.⁵²

Work on the CATS program began in the second half of 2018 and accelerated in late 2019 / early 2020, according to HAL test pilot Group Captain H.V. Thakur. Prototypes of

⁵¹ Ibid.

⁵² Ibid.

⁵³ Ibid.

https://deftech.ch/