

DEFENCE PROCUREMENT INTERNATIONAL

WINTER 2021

**SAAB'S
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A DIFFERENT
DESIGN
PHILOSOPHY

STEPPING OUT
NIMR TALKS EXPORTS &
NEXT-GENERATION VEHICLES



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Welcome to the Winter 2021 edition of *Defence Procurement International*. In this issue,

we're back in live event mode, with IDEX and NAVDEX 2021 scheduled to go ahead as planned in Abu Dhabi from the 21–25 February. It is the first major event on the international defence calendar after many were forced to cancel or move online last year, due to the coronavirus pandemic.

Like many companies, the UAE's largest armoured vehicle manufacturer, NIMR, was forced to slow production in order to put measures in place to keep employees safe. It used that time to focus on building out the next generation of its AJBAN and HAFEET wheeled armoured vehicles, which are due to be unveiled at IDEX, and to seek out new export opportunities in Europe and Saudi Arabia, one of the biggest defence markets in the region. In our interview with NIMR's CEO Abri du Plessis, he says being part of the EDGE Group, a conglomerate which was formed in November 2019, bringing together more than 20 different defence subsidiaries in the UAE, has forced it to think about how it embraces digital transformation and technologies like Augmented Reality and Artificial Intelligence.

The EDGE Group is the first Middle-East company to be ranked in SIPRI's Top 25 largest companies in global arms sales. The formation of groups like EDGE has put the West on notice that the "UAE wants to be a major force in this shifting geopolitical heat map of defence spend." Tareq Abdul Raheem Al Hosani, CEO of Tawazun Economic Council talks about a UAE that wants to diversify economically, in a post-pandemic world, and that seeks partnerships with international defence companies, which not only advance national security interests,

but also the UAE's ambitions to become a "knowledge-driven economy." The benefits of these partnerships need to be felt across the country, and in every sector, he writes.

This presents both opportunities and challenges for international defence companies, as well as those organisations within the Emirate eager to gain a stronger foothold in both domestic and international defence markets.

PwC estimates that countries in the GCC spend \$130 billion every year on defence. Most of that money currently goes to international defence contractors in the West. Russia and China, and Turkey to a lesser extent, are also competing for a slice of the Middle-East arms pie. These countries are not constrained by ITAR restrictions or political pressures back home, which may prevent them from selling certain types of weapon systems to Middle-East countries.

The geopolitical landscape has certainly shifted significantly since former US President Donald Trump made a point of visiting Saudi Arabia on his first foreign trip in 2017. During that visit he signed a billion dollar arms deal with the kingdom. Now, under a new Joe Biden administration, the US has more pressing domestic matters to contend with. This certainly leaves the door open for other less constrained countries to come in, and gives the GCC region even more reason to continue to build a local defence industrial base. ■

Best wishes,

Anita Hawser
Editor

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UAE Armed Forces

A soldier in desert camouflage gear, including a helmet, sunglasses, and a tactical vest, is aiming a rifle. The soldier is positioned on the right side of the frame, facing left. The background is a dark, industrial-looking environment with vertical metal beams. The lighting is dramatic, highlighting the soldier's gear and the rifle.

THE MIDDLE EAST ARMS MARKET

WANING WESTERN DOMINANCE?

The battle for the fastest-growing arms market in the world has stepped up a gear, as Russia and China compete with the West for a slice of an ever-growing pie. Countries in the region are also looking to produce more weapon systems locally.

By Peter Antill

Caracal, which is part of the UAE's EDGE Group, makes small arms for the UAE's Armed Forces
(Photo courtesy of EDGE Group)

The Middle East has long been a contested region, with conflicts erupting over natural resources, territorial boundaries, religion, ethnicity and governance. In 2019 alone, there were 10 state-based conflicts in the region (one interstate war, five civil wars and four internationalised civil wars).¹

Several of these conflicts (Libya, Iraq, Syria and Afghanistan) have endured for years, if not decades, and fuelled rising demand for military weapons and equipment, both in terms of domestic development and production, as well as systems imported from foreign sources. From 2012 to 2013, the amount of money spent by the United Arab Emirates (UAE) on small arms more than doubled from \$71 million to \$168 million. In Saudi Arabia, the region's biggest importer of military weapons and equipment, spending almost tripled from \$54 million in 2012 to \$161 million in 2013. During the same period, Qatar's imports increased eightfold from \$2 million to \$16 million.

Between 2016 and 2020, the UAE's annual defence expenditure was an average \$26.6 billion per year, which is forecast to increase to \$37.8 billion by 2025. But many countries in the region are less than transparent about their arms trade, Saudi Arabia and Iran being among the least transparent, according to a Transparency Barometer compiled by the Small Arms Survey. This raises questions as to the rigour with which states assess the potential for future transfers to be diverted from their intended use, leading to destabilisation or human rights violations. For example, ammunition that was originally sold to Qatar was later found in Libya, in an apparent breach of Qatar's agreement not to re-export it without the permission of the manufacturing country.²

The first major arms exports to the Middle-East region date back to the mid-19th century when western powers, upgrading to modern breech-loading rifles, looked to export older small arms (like



Chinese UAVs such as the Wing Loong II, pictured here at the 2017 Dubai Air Show, may not be as sophisticated as US drones, but are a more cost effective and readily available alternative for Middle-Eastern buyers. (By Mztourist - Own work, CC BY-SA 4.0, <https://commons.wikimedia.org/w/index.php?curid=65076724>)

muskets and rifled muskets) to feuding tribes, which created a ready-made export market. That market for military equipment still exists today, and continues to be dominated by western arms manufacturers, but their dominance is increasingly being threatened by countries like Russia and China. At the Dubai Air Show in November 2019, a Russian executive from the company Rostec (an

organisation which handles exports for Russia's defence industrial base) estimated that Russian arms sales in 2018 had reached an all-time record of \$13.7 billion, helped in part by its willingness to sell almost anything to anybody. This was in direct contrast to western states, who often encounter problems domestically in selling weapon systems to countries with mixed human rights records.



Most conflicts, but especially the war in Syria, have afforded an opportunity to showcase Russian weapons. The Chinese, also unconstrained by domestic political sensitivities, have tried to muscle in on the action as well. All of this, alongside the move by many countries in the region to establish their own defence industrial base, means that the battle for the fastest-growing arms market in the world is hotting up.³

The large western military equipment manufacturers have traditionally relied on domestic markets to generate revenue and ensure profits. For example, exports account for less than a third of Lockheed Martin's revenues. However, this is likely to change for two reasons. Firstly, since the end of the Cold War, defence spending in the West has declined as a percentage of GDP. For example, between 2002

and 2017, European defence budgets on average fell from 1.56% to 1.35%⁴, thus limiting the opportunities there.

Secondly, the global export market for arms is getting bigger and is increasingly attractive to many arms exporters. In 2019, SIPRI's Arms Industry Database estimated that arms sales by the world's 25 largest arms-producing and military services companies (arms companies)



Crown Prince of Saudi Arabia and Minister of Defence, Mohammed Bin Salman: Saudi Arabia is the third largest defence spender in the world (Photo by Senior Master Sgt. Adrian Cadiz)

totalled \$361 billion, an 8.5% increase in real terms compared to 2018.

The Middle East accounts for a growing share of the global arms export market, with the flow of arms to the region increasing by 87% between 2009 and 2014, according to SIPRI. From 2014–2018 the main recipient country for global arms sales was Asia and Oceania (40% of total global imports), followed by the Middle East on 35%. In 2018, Saudi Arabia spent \$68 billion on military equipment, according to SIPRI, making it the third largest spender behind China and the US.⁵ During this period, the Middle East bought half of all US exports, 60% of the UK's, 44% of France's and 25% of Germany's.

Much of this money was spent by Saudi Arabia on air power. Procuring, equipping,

running and maintaining a fleet of combat aircraft is expensive. Saudi Arabia has acquired the eighth largest fleet of combat aircraft in the world. For example, a deal in 2011 to procure 84 new F-15 aircraft and upgrade 70 existing aircraft was worth an estimated \$24 billion to Boeing and its partners, which included Raytheon and the UK's BAE Systems.⁶

CHEAPER EQUIPMENT

However, there are threats to western dominance of the Middle-East arms market. Firstly, there are just some things that the West cannot sell, as international armaments treaties ban the sale of certain categories of weapon systems, such as ballistic missiles, and certain types of cruise missiles and armed unmanned aerial

vehicles (UAVs). China, which has avoided signing many of these treaties, faces no such constraints and has expanded its exports massively, no longer being content to merely supply revolutionary movements with small arms.

Geopolitical rivals like India (which happens to be the world's second-biggest arms importer behind Saudi Arabia) and the US, will not touch complete Chinese systems, although many Chinese-made components and sub-systems have found their way into western equipment, worrying some in defence circles as to the reliability of these components.

China's defence industrial base is also making forays into Africa and the Middle East, especially with armed UAVs. Although they are not as advanced as UAVs manufactured by US companies, Chinese-made drones can be just as effective. In 2018, the UAE used a Chinese-made UAV to kill a Houthi rebel leader in Yemen, where it is fighting a counter-insurgency war in a Saudi-led coalition. Secondly, China's equipment is significantly cheaper than that of its western counterparts. With domestic orders for arms in decline since 2016, Russia too is interested in getting its hands on a piece of the Middle-East arms market. Like China, Russia's equipment is cheaper and less advanced than top-of-the-line western equivalents, but it is perfectly adequate for many country's requirements.⁷

Another factor working in China and Russia's favour is that western arms exports are constrained by domestic political considerations. For example, several Western countries, including Canada, Germany and the UK, have come under pressure in recent times to place arms embargoes on Saudi Arabia over its conduct of the war in Yemen and the murder of dissident journalist Jamal Khashoggi. For the UK, a potential \$6.5 billion deal to supply 48 additional Typhoon jets was in jeopardy.⁸ The Canadian deal, worth approximately

\$14 billion, involves General Dynamics supplying Light Armoured Vehicles (LAVs) to the kingdom. The deal had been on hold since 2018, but both parties eventually came to an agreement, including a renegotiated contract, in mid-2020. Canada cited concerns over the prospect of having to pay billions in damages and risking thousands of jobs in its defence supply chain if the deal didn't go ahead.⁹

The flip side of the coin to the Middle East importing weapon systems, is to build them domestically, which also presents a threat to western dominance. Major

defence contracts typically involve joint ventures with local companies. These are usually designed to enhance the customer's indigenous defence industrial base and to help them develop more complex weapons systems themselves. Australia, Pakistan, South Korea and Turkey have all developed local defence industries from scratch, partially through offsets, but also as a result of policies geared towards helping domestic suppliers. In November 2019, the UAE launched the EDGE Group, a consortium of 25 UAE defence firms, including

companies such as NIMR, maintenance, repair & overhaul firm AMMROC, Al Tariq, Halcon, Horizon and weapons manufacturer Caracal. Caracal's portfolio includes the Caracal EF pistol, the CMP9 sub-machine gun and the CAR 814 / 816 / 817AR assault rifles. The CAR 816 assault rifle is the standard issue rifle for the UAE Armed Forces. Interestingly, Caracal owns Merkel, a German company in Suhl, which manufactures hunting weapons. Merkel owns C. G. Haenel, whose MK 556 assault rifle was shortlisted in January 2019, alongside Hechler & Koch's HK 416



A growing defence industrial base on show at the 2019 Dubai Air Show (Copyright Dubai Air Show)



The CAR 816 Assault Rifle (Copyright Caracal Brasil)

and HK 433 assault rifles, to replace the Bundeswehr's G36 assault rifle.

In September 2020, the Bundeswehr unexpectedly chose the Haenel rifle,¹⁰ but less than a month later, the order

was cancelled after an appeal by Heckler & Koch, leaving the procurement in limbo. In addition, Caracal had signed a deal with the Indian Army in 2018 to supply more than 93,000 CAR 816 assault

rifles, a replacement for its ageing 9 mm Sterling submachine guns. The deal has since stalled as India is keen to maximise domestic production. So Caracal has offered to make the weapons in India under the "Make in India" initiative to get the deal moving again.¹¹

It may be a while before Russia and China can make serious inroads into the Middle East arms market or local arms companies can directly compete with their western counterparts, but the days when the west could sell outdated muskets to the sheikhs have long gone.

ABOUT THE AUTHOR

Peter Antill graduated from Staffordshire University in 1993 with a BA (Hons) in International Relations and gained an MSc Strategic Studies from Aberystwyth in 1995 and a PGCE (Post-Compulsory Education) from Oxford Brookes in 2005. He worked at Cranfield University at Shrivenham from June 2009 to 2019. His interest lies in examining defence procurement and logistics within the realm of military history. ■

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STEPPING OUT

Production at NIMR's Abu Dhabi factory slowed in 2020, as a result of the Covid-19 pandemic. But the company continued work on the next generation of its AJBAN and HAFEET wheeled vehicles, and is looking to new export horizons.

By Anita Hawser



It is the week before Christmas 2020 and Abri du Plessis sounds surprisingly confident about the future for the CEO of a company whose order book and supply chain was severely disrupted by the coronavirus pandemic. The South African took the helm of the largest military vehicle manufacturer in the UAE, NIMR, on January 12, 2020, just before Covid-19 hit global supply chains, forcing manufacturers to rethink any grand plans they may have had to significantly scale their business.

“Coming from South Africa where defence is in decline, I was really excited to be part of the industry in the UAE and the EDGE Group where the focus is really on being disruptive and using cutting-edge technologies,” says du Plessis.

But 2020 — NIMR’s 20th anniversary year — turned out more to be a year of “consolidation”, says du Plessis, with its factory in the Tawazun Industrial Park in Ajban, just outside of Abu Dhabi, slowing down production as the company implemented measures to keep employees safe. “We were fortunate in a way,” he explains, “as our volumes were down [in 2020] so we didn’t have to run at 100% capacity in our factory all of the time. That helped us put measures in place to prevent the spread of the disease.”

“Not being able to revert to normal recruitment, we had to find innovative ways to augment our capacity, which we did by creating satellite offices in South Africa and India.” These offices provided the additional manpower required for NIMR to move forward with its engineering and product design work on the second generation of its AJBAN 4x4 and HAFEET 6x6 vehicles, which it will unveil at the IDEX exhibition and conference from February 21–25 2021 in Abu Dhabi.

INTERNATIONAL COMPETITIVENESS

At IDEX in 2017, NIMR walked away with a significant contract for the supply

vehicles to the UAE Armed Forces. Du Plessis and his team will be hoping to build on that success at IDEX 2021, the first major defence exhibition to take place globally after most events were forced to move online in 2020 due to the pandemic.

Khaled Al Zaabi, Chief Commercial Officer at NIMR, says the Mk II versions of the AJBAN and HAFEET are a major step up in capabilities since the vehicles were first launched. The Mk II version will be initially offered to the UAE Armed Forces and long-standing customers such as Algeria. “We’re in the midst of a few RFPs for these vehicles,” says Al Zaabi, “but the first users to receive them will be UAE forces.”

Du Plessis says 2021 will be a year to build on plans he has had since becoming CEO 12 months ago to grow the company’s customer footprint and deliver its next generation of vehicles. “We want to get the newer versions of the AJBAN and HAFEET to a level that they are proven and ready to move into production. We also want to start executing contracts that we’ve recently signed and are about to sign to get the factory going again. We’re busy with efforts to land these contracts.”

Having come from Denel Vehicle Systems in South Africa, where the level of new defence acquisitions was reduced due to budgetary constraints, du Plessis knows only too well the vagaries of defence markets. In the UAE Armed Forces he has a sophisticated and demanding customer, he says. “We are a national company, and being as close to the customer as we are, they can knock on our door at any time. This proximity is, however, mutually beneficial since it gives us the direct feedback needed to continuously improve our products.”

Outside NIMR’s front door is not just the customer, but also the harsh sweltering heat of the Arabian desert. “Having our factory in the desert is a big advantage,” says du Plessis. “We can drive out of the gate and do testing in harsh environments,



NIMR's factory in Ajban

which benefits us and the end user.” But it is not just the UAE Armed Forces that NIMR has its sights set on. With recent visits to its factory by a delegation from Saudi Arabian Military Industries (SAMI), Al Zaabi says exports of its wheeled armoured military vehicles are an important badge of honour for NIMR. “They validate the success of the company,” he explains. “Having the UAE Armed Forces as our most important customer has enabled us to develop vehicles that are internationally competitive and attractive in many regions round the world. Now we need to build on that.”



ADDRESSING OBSOLESCENCE

In its 20-year history, NIMR has produced in excess of 2,500 vehicles, largely for its main UAE customer, but its vehicles are also deployed by international users including Algeria, Bahrain, Egypt and Turkmenistan. In 2017, it inked partnerships with Thailand's FicoTechnology and Engineering and Malaysia's DefTech to support the sale of NIMR vehicles into southeast Asia. It looked set to crack open the Central and Eastern European (CEE) market after signing a strategic partnership with the

Czech Republic's VOP CZ to build more than 1,000 armoured vehicles for the European market. But these partnerships haven't necessarily resulted in actual vehicle sales for NIMR, at least not yet.

Al Zaabi believes its chances of success in CEE and other international markets will be boosted with its second generation of vehicles. "We are working on finding a local partner in Europe," he says. "We're in discussions with current partners in the Czech Republic and Romania, that could complement our efforts there." Al Zaabi says NIMR is bringing its vehicles up to

a standard that will allow it to compete in markets where it hasn't gone before, like Latin America, for example. MkII versions of the HAFEET 6x6 and AJBAN 4x4 vehicles build on lessons learned from the UAE's experience of operating the first generation of these vehicles in theatres such as Yemen. "We've worked closely with the UAE Armed Forces' General Maintenance Corp to capture feedback from a lifecycle management perspective," says Al Zaabi. "This has, for instance, led to significant reductions in the time foreseen to replace a MkII's

“

Having our factory in the desert is a big advantage. We can drive out of the gate and do testing in harsh environments, which benefits us and the end user. ”



NIMR's Anechoic Chamber for electromagnetic compliance (Photo courtesy of NIMR)



power pack — down from 10 hours to just 20 minutes.” The MkII versions also feature a completely new electronic architecture to ensure a high level of commonality between vehicles and to allow customers to easily integrate new systems and equipment. “Smaller disruptive players are forcing all of us to think differently about our platforms,” says Du Plessis. “We have to look at the current requirements of customers servicing and maintaining their fleet of vehicles and constantly strive to find innovative solutions that address obsolescence challenges, whilst at the same time develop next-generation vehicles that are both innovative and affordable.”

Al Zaabi says NIMR is actively pursuing aggressive business development across all regions, not with the same portfolio of vehicles, but with products that fit the requirements of customers in these markets. “We’re in the midst of developing mature concepts for brand new vehicles beyond the AJBAN and HAFEET,” he says.

Prospective markets like the Kingdom of Saudi Arabia (KSA), which is looking to indigenise its defence industrial base, present significant opportunities for NIMR. “We’re engaged with all important stakeholders in the kingdom (Saudi Arabian Military Industries, the General Authority for Military Industries, the Ministry of Defence) and are working with them to fulfil whatever requirements they have to leverage our portfolio, whether it is existing vehicles or developing specific vehicles that meet their requirements,” says Al Zaabi. “The 4x4 armoured station wagon variants that NIMR jointly produces with Algeria is a model that is also on the table for KSA. We’re also offering the kingdom vehicles that are battle-proven. We’ve already participated in trials.”

Saudi Arabia’s ambition is to produce more than 50% of its military equipment indigenously by 2030. Du Plessis says NIMR could develop some form of localisation programme involving the transfer of technology to the kingdom. “We can either partner with someone

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Abri du Plessis CEO, NIMR

to localise most of the work or form a joint venture,” he says, adding, “We have experience with joint ventures in other countries such as Algeria.”

HYBRID ELECTRIC DRIVE

NIMR has also spent the last 12 months building an impressive array of in-house testing capabilities for its vehicles, such as

its Anechoic Chamber for electromagnetic compliance (EMC), blast and ballistic facilities, and a comprehensive mobility test track. “We pride ourselves on having everything we need in-house for prototyping the capabilities of our vehicles,” says du Plessis. “We’ve developed our own mine blast and drop test facilities. It’s not just about technical improvements. We’re also

improving the payload and maintainability of our vehicles, and reducing weight. We’re doing all of this whilst maintaining an attractive price point, which is extremely important.”

Helping NIMR on that journey is its parent company, the EDGE Group, which comprises more than 25 companies from within the Emirate, that offer everything from electronic warfare and cyber defence systems, to missiles, weapons, systems integration and mission-support services. Being part of the fast-moving and progressive EDGE Group, which is the first Middle-East company to feature in SIPRI’s ranking of the Top 25 arms producers, has allowed NIMR to think about how it embraces digital transformation and potentially leverages technologies like Augmented Reality and Artificial Intelligence.

Working with some of the companies within EDGE’s portfolio, du Plessis says NIMR is looking at integrating autonomous driving capabilities. Another company in EDGE’s portfolio that works in munitions and explosives helped NIMR develop a facility for testing its vehicles against land mines. Hybrid electric drive propulsion is also an area NIMR is investing heavily in. “This is not a capability we’re developing by ourselves,” says du Plessis, “but we are working with a specific technology partner, to be revealed moving forward, on jointly developing a hybrid electric drive system to run on our vehicles.”

Fully electric military vehicles will not be practically deployed in significant numbers any time soon, says du Plessis. But he believes hybrid electric drive provides concrete benefits to forces: these vehicles can operate quiet, when needed, and provide extra torque. “Our thinking is to have the same vehicles that run on normal combustion engines also operate using hybrid drive,” he explains. “The logistic complications of the required battery systems might dissuade users, but if we can deliver power on demand and stealth for the same price point, that would be a compelling proposition.” ■

FIT TO FIGHT

A major shake-up in armoured vehicle mobility is on the cards as the UK Ministry of Defence turns to the world of motorsport and Hybrid Electric Drive to deliver future wheeled vehicle platforms that can move at speed, and contribute to a greener planet.

By Anita Hawser

Soldiers from the 1st Battalion Royal Irish aboard their Foxhound Patrol Vehicles (MoD/Crown Copyright)



Alongside armour and firepower, mobility is one of the all-important sharp ends in the “iron triangle” armoured vehicle manufacturers like to harp on about. In the wheeled armoured vehicle space, the art of the possible is being explored, with the view to increasing operational mobility, deployability and terrain accessibility in future vehicle platforms.

In 2019, the UK’s Defence, Science and Technology Laboratory, Dstl, announced a £3.2 million investment into the latest vehicle technologies to boost the performance of the UK’s Future Ground Combat Vehicles. The project, which is led by QinetiQ, in partnership with academia, military vehicle suspension specialists and Formula 1 motorsports engineers, will focus on innovative solutions for ground vehicle mobility, and is expected to exploit the potential provided by hybrid electric-drive systems.

A wide range of technologies will be investigated, including active suspension, advanced tyre technologies, and terrain scanning and sensing. However, Dstl told this magazine the main emphasis is on exploiting electric drive and advanced suspension solutions and bringing technologies together at a total system level. “Some very exciting active suspension concepts that provide long travel and optimised geometries have been identified,” the spokesperson says, “but remain at low technology readiness level. As well as the basic mechanical engineering aspects; sensors, control software and certification remain areas of challenge that are being addressed.”

Last August, the UK Ministry of Defence awarded a £3 million contract to NP Aerospace to demonstrate Hybrid Electric Drive (HED) systems on Foxhound and Jackal vehicles. Dstl will play a key support role in the delivery of the Army’s HED demonstrator project on existing platforms using electric axle drive hub motors and inboard motors respectively. The project seeks to demonstrate the feasibility and show the benefits of vehicle



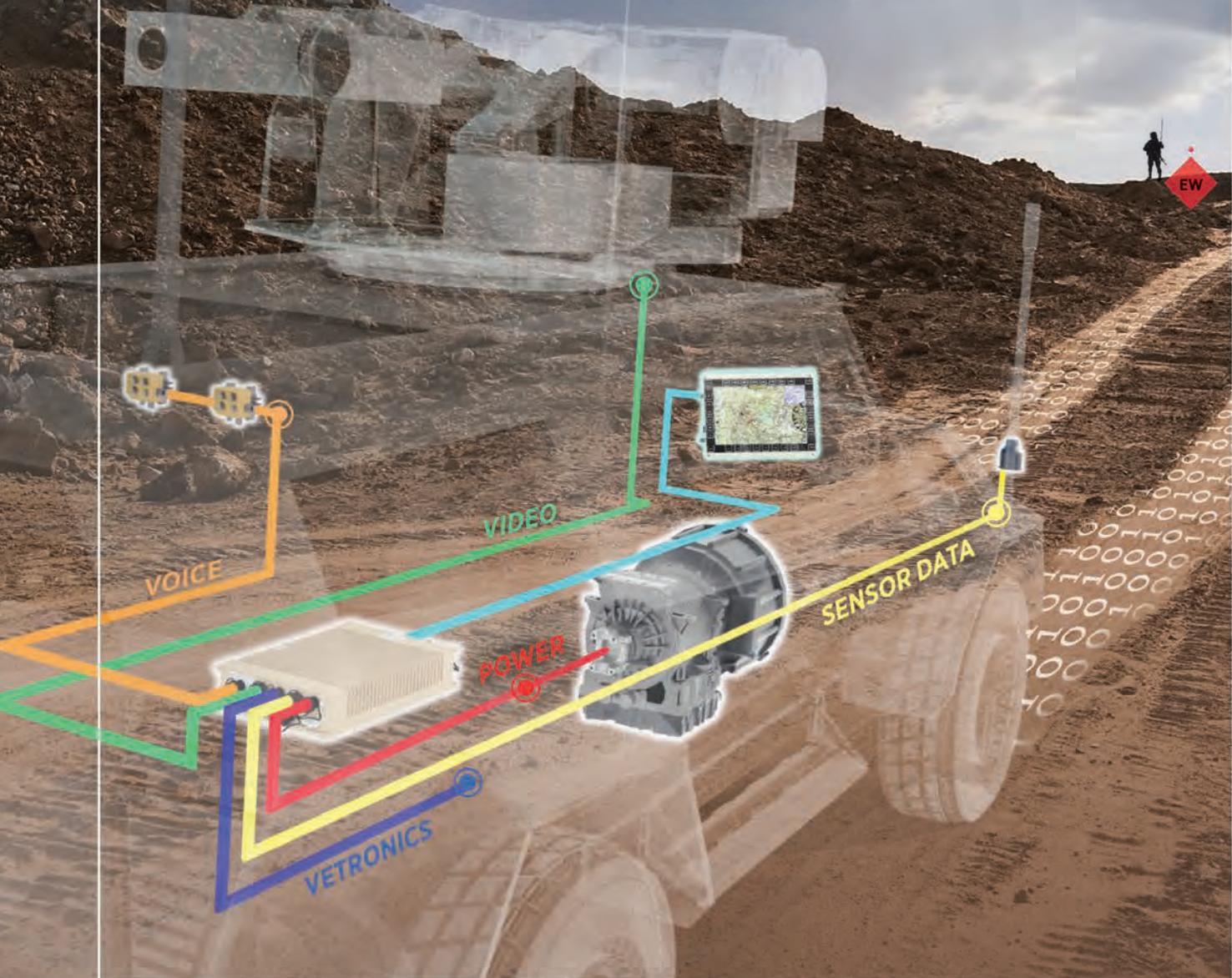


A Jackal vehicle on a desert track: Wheeled vehicles have good operational mobility on roads, but they lack the terrain accessibility of tracked vehicles (MoD/Crown Copyright)

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electrification and HED technologies and, hence, inform future capability requirements.

Although wheeled vehicles have good operational mobility on roads, Dstl says they lack the terrain accessibility of tracked vehicles due to higher ground pressure and lower traction. Mechanical direct drive train solutions and traditional suspension systems also limit their gap and step-crossing capabilities. Vehicle electrification as a technology concept opens up new possibilities when it comes to vehicle form factor, drive train, control and suspension solutions.

“It is expected that significant improvements in mobility and automotive performance can be achieved by exploiting electric drive, traction control and advanced suspension solutions,” a spokesperson for Dstl says. “However, the key issue is developing technology options that are affordable and robust. The ultimate goal is to deliver a number of technology options that have the ability to increase overall mobility performance of wheeled platforms. Significant improvements are expected in off-road terrain accessibility, vehicle speed, stability

and gap/step crossing capability.”

In addition to improving mobility, gains are also expected to be made in logistic support requirements and environmental impact by developing more reliable and fuel-efficient vehicles. Lighter wheeled platforms that can self deploy at speed, removes the need for separate heavy equipment transporters and reduces the logistics footprint of the vehicle fleet, whilst retaining good cross-country capabilities.

With armoured vehicle crews spending longer periods of time inside the vehicle during operations, increased emphasis is also being placed on crew fatigue and comfort. “The issues do not revolve around comfort for its own sake, but ensuring the crew remain fit to fight and can operate complex vehicle systems whilst travelling at speed across all terrains,” says Dstl.

Hybrid Electric Drive technology will also reduce the Army’s reliance on fossil fuels, which is in line with the UK government’s ambitions to reduce its carbon emissions to net zero by 2050. Lt. Gen. Richard Nugee, who is leading the MoD’s ongoing Climate Change and Sustainability Review, stated last year

that the Army testing electric vehicles would benefit not only its world-class personnel, but also our planet. “This goes to show how seriously we are incorporating sustainability into our operations, while simultaneously pushing the boundaries of military innovation,” he stated.

As well as working with traditional defence suppliers, Dstl has turned to the world of motorsport for inspiration. Companies it is working with include, Prodrive, which has transferred skills it learned in championship-winning race and rally cars to defence, and Formula One motorsport specialists, Williams Advanced Engineering. Dstl hopes to exploit their understanding of advanced suspension systems, traction control solutions, materials and other technologies to inform the design of future vehicle concepts.

Currently, Dstl’s work is focused on design studies, modelling and the building of a sub-scale novel suspension systems demonstrator. Requirements for future prototypes will be shaped by the Army strategy for Future Ground Combat Systems, which is expected to start full development around 2030. ■

CLUBBING TOGETHER

Armoured vehicle manufacturers often talk about being responsive to customer demands and incorporating lessons learned from the battlefield in their vehicle's design. But few probably enjoy the ongoing dialogue that BAE Systems Hägglunds in Sweden has with users of its CV90 Infantry Fighting Vehicle (IFV). Hägglunds' CV90 Club, which consists of representatives from the seven user nations: Sweden, Finland, Denmark, the Netherlands, Estonia, Norway and Switzerland; meets several times a year, and at least once a year in Örnsköldsvik,

Sweden, where the CV90 is manufactured.

Other armoured vehicle OEMs operate similar clubs, but Dan Lindell, director of combat vehicles at BAE Systems Hägglunds, says what sets the CV90 Club apart is that it is governed by users, not industry. A different country chairs the club every two years. Norway is scheduled to take the chair from Sweden this year. CV90 member nations also frequently contact one another for advice regarding the vehicle. Lindell says it is not unusual for him to get a call at any time of the day or night from a user eager to share their experiences

or ideas for building on the vehicle's existing capabilities. "CV90 users are at different stages in the vehicle's lifespan," he explains. "Some are new owners, while others have had CV90s that have fought in several conflicts. There is a huge knowledge base for users to draw on, as well as other benefits such as the bundling of spares and logistics for the vehicle."

It is not just the users that benefit from these shared experiences; Hägglunds too can use the feedback from club members to improve the CV90 platform, which benefits all user countries. "If we come up with a good idea, they will start a

User demands have shaped different iterations of the CV90 IFV (Copyright: BAE Systems)



Regular customer feedback via BAE Systems Hägglunds' CV90 Club, has made the Infantry Fighting Vehicle a platform that really is designed for the warfighter, by the warfighter.

By Anita Hawser

discussion which users can contribute to,” says Tarkan (last name withheld), user representative/2nd IC qualification and production manager for the Dutch CV90 Mid-Life Upgrade project team. Tarkan has worked with BAE Systems Hägglunds on the CV90 since 2003, prior to the vehicle entering service with the Royal Netherlands Army in 2008.

SHAPED BY ITS USERS

Different user demands have clearly shaped various iterations of the CV90. The Mk I featured a new two-man 30 mm turret designed to meet a Norwegian

requirement. The Mk II paved the way for a new fully digitised combat vehicle based on a Swiss requirement for a Health & Usage Monitoring System (HUMS), which automatically detected faults on board the vehicle. “Then in the early 2000s, the Dutch came along wanting the most lethal and survivable IFV,” adds Lindell. That gave rise to the CV9035 Mk III, which featured a new weapon system, the 35/50 mm Bushmaster III cannon, with an integrated ammunition programmer for air burst munitions. “Together with the Dutch, we designed a semi-autonomous system, which aids the gunner,” Lindell

explains. “The gunner selects target type and fires and the computer does the rest in terms of selecting the type of ammunition and how many rounds are fired, burst patterns etc.”

Tarkan worked closely with BAE Systems Hägglunds on designing the human-machine interface (HMI) for the CV90 — what functions the Dutch needed and where they were located inside the vehicle. “They allowed us to arrange the inside and the use cases — the software side of the HMI — of the vehicle the way we wanted it,” he says. “They saw it as a huge learning curve; both parties got



their ideas implemented, which resulted in the most desirable set up for current and future CV90 customers.”

One of the biggest benefits of being a member of the CV90 Club, says Tarkan, is the shared user experiences. “Other countries may have a particular way of using the vehicle that does not match ours, but we can still learn from them and them from us.” With the Dutch having decided on all the HMI, the 30 mm to 35 mm cannon and armour for the Mk III version of the CV90, the Danes bought the same vehicle a bit later on. “The Danes call me or mail me telling they are experiencing something and asking how we dealt with it,” says Tarkan. “It

could be a problem with a box inside the vehicle. If we have the same problem, we can go to Hägglunds and ask them to look at it.”

More than 1,280 CV90s across 15 variants are currently in service with the seven user nations. Norway, Denmark and Sweden have fielded the vehicle in combat operations in Afghanistan. “It is a system for the warfighter, by the warfighter,” says Lindell.

AHEAD OF ITS TIME

In addition to the seven user countries that already operate the CV90, the IFV is also a contender for a multibillion dollar contract to supply the Czech Armed

Forces with more than 200 IFVs. The CV90 is up against General Dynamics European Land Systems' ASCOD and Rheinmetall's Lynx for the prestigious contract, but is still awaiting a decision from the Czech Ministry of Defence.

Lindell says the CV90's electronic architecture and autonomy, which aids the crew's decision-making, means the vehicle is well placed to accommodate future demands for optionally manned fighting vehicles and manned/unmanned teaming. “The CV90's digital architecture has as many IP addresses and nodes as a medium-sized enterprise,” says Lindell. “It's more advanced than that of the Gripen fighter jet.”

At the moment, however, all eyes are



“Our users appreciate the CV90's mobility, which is designed for the soft soil and deep snow in the north of Sweden,” says Dan Lindell of BAE-Systems Hägglunds

on the Netherlands' €500 million Mid-Life Upgrade of its CV9035NL fleet, which will see its vehicles fitted with rubber tracks from Soucy and Elbit Systems' Iron Fist Active Protection System. "The Dutch are integrating world-class systems and additions that will benefit other CV90 users," says Lindell.

When the Dutch selected the CV90 Mk III back in December 2004, against other vehicles such as the Ulan IFV and Rheinmetall's Puma, Tarkan says it demonstrated the most growth potential. "It was way ahead of its time back then with its fully electronic architecture, required firepower and mobility. We used the Swiss MKII as an example to start

from, which at that time, already had a good digitised electronic structure. It gives you power when you need it and it drives like a car."

By moving from steel to Composite Rubber Tracks, the Dutch Army hopes to further improve the CV90's mobility, as well as reduce crew fatigue and vibration inside the vehicle. Having recently returned from Skövde in Sweden where the Dutch conducted Rubber Band Track durability trials over a distance of 2,000 km, Tarkan says the move from steel to rubber is not a just a straightforward swap. "The sprockets, road wheels and idler wheels on the vehicle need to be changed, together with internal parts on the final drives, and changes to the track tension system," he explains. "It will need to be driven and maintained differently than vehicles with steel tracks."

The addition of the Iron Fist Active Protection System (APS) to the Dutch CV90 dates back to a 2003 requirement to up armour the vehicle against RPGs. At that point, the Army was considering reactive armour, but it would have required the vehicle to be widened, which made it unsuitable for operations in urban terrain, as well as losing the current high level of kinetic energy protection.

Also, the explosives used in the reactive armour need to be safely stored somewhere. Tarkan says the Defensive Aid Suite on board the CV90, coupled with the Iron Fist APS, will provide protection against anti-tank guided missiles and rockets. "The Dutch threat situation changed and they needed something else," says Lindell. "The beauty is that if Finland, for example, wants an APS system, they don't have to start with a clean sheet of paper. They can benefit from the experiences of the Dutch. There's a lot of development going on among the CV90 user nations that can be shared."

MOBILITY IS OUR DNA

In 2015, BAE Hägglunds also fitted an active damping suspension system

to the CV90, which was derived from Formula One racing cars. Lindell says this system, together with the rubber tracks the Dutch are fitting to the vehicle, will make a world-class system even better. "Our users appreciate the CV90's mobility, which is designed for the soft soil and deep snow in the north of Sweden," he says. "If you can negotiate that, you can negotiate any terrain in the world."

Lindell says mobility is BAE Systems Hägglunds' DNA. But he is critical of what he calls the "new kids on the block" — the UK's AJAX, the Lynx KF41 and Hanwha Defense's Redback IFV. The KF41 (34 to 50 tonnes) and the Redback (42 tonnes) were both shortlisted for the Australian Army's Project Land 400 Phase 3 programme. Hanwha's and Rheinmetall's vehicles defeated proposals from BAE Systems Hägglunds, which put forward its CV90, and General Dynamics Land Systems' AJAX.

But the vehicles shortlisted for the Australian programme are not any faster, says Lindell, have any higher survivability, or can carry any more troops than the CV90, which weighs just 24 to 38 tonnes. "We've always had the perception that being big is really bad in terms of being a war machine," he says. "Bigger vehicles are easier to target, have problems with mobility, transportability and suffer from higher costs, but it seems some companies have forgotten what is important."

Lindell is also critical of the unrealistic timelines being communicated. "Designing, qualifying and producing a modern combat vehicle is a very complex venture," he says. "A blank sheet development takes between 10 years (original CV90 Mk0) to 20 years (Puma). The Czech Army requires its vehicles to be operational by 2027."

To get a new generation of the CV90 designed and qualified, typically takes four-to-five years, says Lindell, and that's starting with a 90% solution. "The AJAX development has so far taken 10-plus years and still counting." ■



BURN UP THE TRACK

As legacy platforms undergo major mid-life upgrades, and concepts for optionally manned and unmanned vehicles emerge, are Composite Rubber Tracks about to have their moment in the sun?

By Anita Hawser

A Warrior IFV fitted with Composite Rubber Tracks from Soucy Defense
(Photo by Soucy Defense Photography)



Steel versus rubber tracks is a debate that has raged in the armoured vehicle community for many years. Despite having a higher maintenance requirement, and other disadvantages, such as high levels of noise and vibration inside the vehicle, most armoured vehicles today still run on steel tracks. When it comes to swapping steel for rubber tracks on legacy armoured vehicle platforms, affordability is an issue.

So, while users may be sold on the benefits of rubber — lower noise and vibration levels, and a reduced maintenance burden — declining defence budgets have precluded them from being a must-have on armies' wish lists. Furthermore, it is not simply a case of swapping steel for rubber. Sprockets, road wheels and idler wheels on the vehicle need to be changed, together with internal parts on the final drives, and changes made to the track tension system.

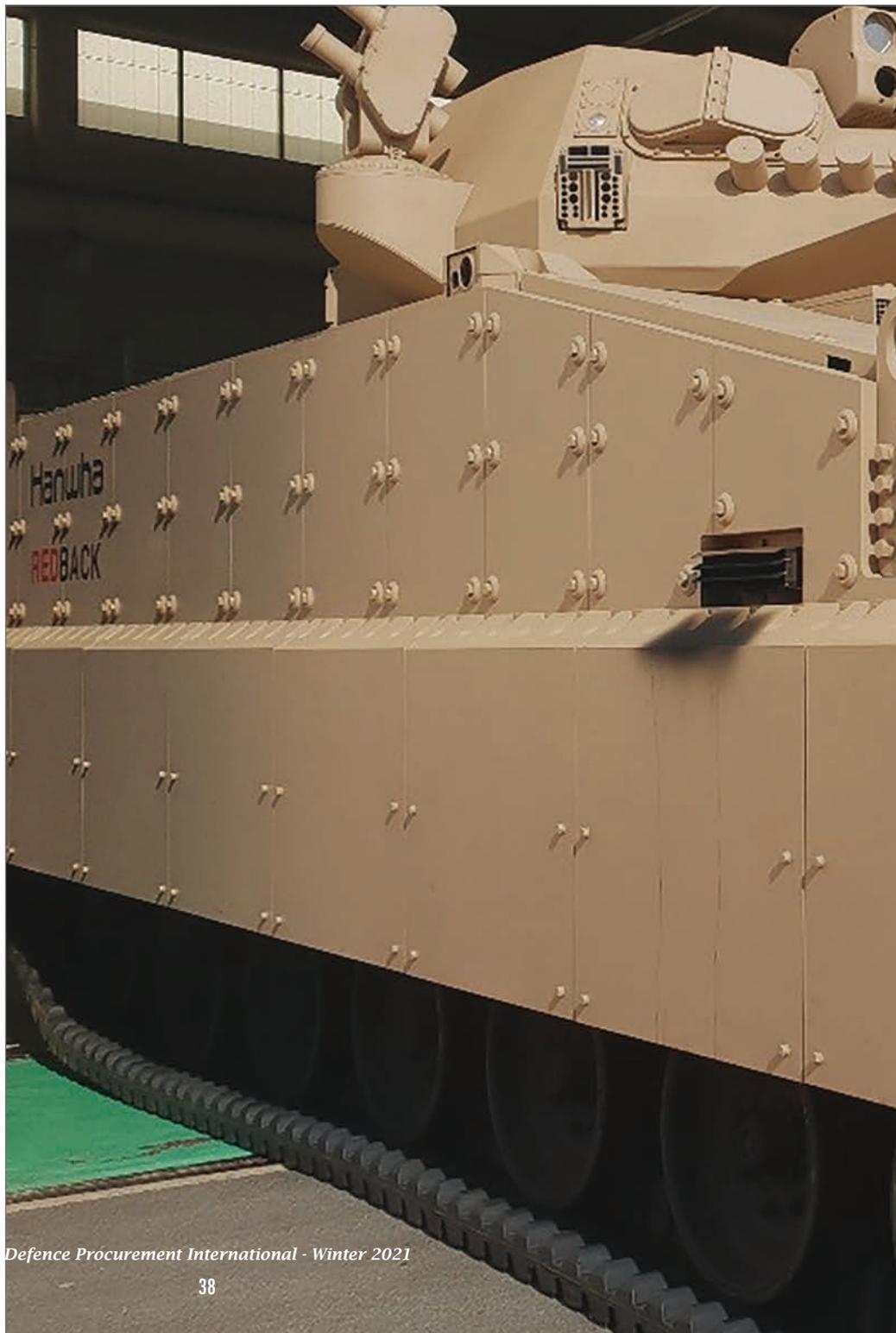
But Kevin Sloan, retired from the British Army and now director of business development at Soucy Defense, a Canadian company, which has supplied Composite Rubber Tracks (CRTs) for vehicles like the British Army's Warthog and BAE Systems' BVS10 and CV90, says a number of factors are converging to swing the pendulum in CRT's favour. "Many armoured vehicle platforms are reaching mid- or end-of-life upgrades," he explains. "Beyond armour, firepower and mobility [what the armoured vehicle community refer to as the 'iron triangle'], the biggest disruptor in mobility is rubber tracks."

Sloan says Soucy has offered its rubber tracks across the British Army's fleet of armoured vehicles — from the Warrior, to the AS90 self-propelled howitzer, and everything below. Many of these platforms are undergoing major upgrades. At DSEI in 2019, Soucy showcased the Warrior Infantry Fighting Vehicle (IFV) fitted with its Composite Rubber Tracks. Having spent 10 years in the medium-armour space — vehicles with a gross

vehicle weight of 30 to 50 metric ton — Sloan says any gains or increases in firepower, mobility, or increased protection on the vehicle, often means gains in the vehicle's weight.

This was certainly a consideration for the Dutch Army as they approached the Mid-Life Upgrade of their CV9035NL IFV. Tarkan (last name withheld), user representative/2nd IC qualification and production manager for the Dutch CV90

Mid-Life Upgrade project team, says the Dutch wanted to add additional sub-systems to the CV90. But with steel tracks that would have meant increased weight, which would have degraded the vehicle's mobility. So the Dutch opted for Soucy's rubber tracks. "The biggest gain with rubber tracks is weight," Tarkan explains, "which means we can add more sub-systems to the vehicle. There's also a huge difference in vibration and noise,



which is bad for the electronics and personnel.” Noise and vibration inside armoured vehicles on steel tracks can cause significant discomfort, fatigue and nausea for the crew inside. Some soldiers have compared it to the feeling of being inside a “washing machine.”

Historically, armoured vehicles only needed to reduce the harmful effects of vehicle noise and vibration to a level As Low as Reasonably Practicable. But that

changed in 2005, says Sloan, which hugely impacted armoured vehicle manufacturers and legacy platforms that found it difficult to comply with steel tracks' frequencies. “Seventy-percent of the vibration from steel tracks comes from the sprocket hitting the track,” Sloan explains. “If you can reduce that, then the system and the human benefit enormously.”

Soucy says its Composite Rubber Tracks can reduce a vehicle's track system weight

by up to 50%. It reports 70% less vibration and up to 13dB in noise reduction. Having recently completed rubber track durability trials on the CV90 in Sweden, Tarkan says it almost felt like driving a wheeled vehicle. “There is a big difference, especially on concrete roads,” he says. “The electronics are not rattling around and with rubber tracks you have more contact with the road surface.” Rubber tracks are also said to increase mobility on snow and ice. “You



Hanwha's AS21 Redback IFV has Composite Rubber Tracks fitted for improved mobility
(Copyright: Hanwha Defense)



(Soucy Defense Photography)

can add snow clips if you lose traction or solve it by adding other things to the rubber band track,” says Tarkan. “Driving through mud, the vehicle slides a lot more on slopes, so you have to change your way of driving. We have to unteach certain things.”

“
Composite Rubber Tracks are more efficient, reliable, and easier to maintain, reducing the effort needed to sustain formations in the field.”

Norway was the first CV90 user to fit rubber tracks to a 28-tonne CV9030 in Afghanistan in 2010. It was the heaviest vehicle at the time to have used them on operations. Today, thanks to advances in composite materials, Soucy's tracks can be fitted to armoured vehicles with a gross vehicle weight of up to 50 metric tonnes. Major Per Rune Hansen, the CV90 fleet manager for the Norwegian Defence Logistics Organisation at the time remarked: “Our vehicle crews were a little sceptical of the rubber tracks at first, but once they used them, they became big fans and really appreciate the reduced vibration and quieter operation.”

Ryan Black, Integrated Logistics Support Manager at Soucy Defense, says the rubber tracks meant Norway could better navigate different terrain and out-maneuvre opponents. When the Norwegians came back from Afghanistan they changed their entire fleet of CV90s to CRT. “In mountainous terrain, rubber versus steel tracks is like chalk and

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A CV90 with rubber tracks (Soucy Defense Photography)

cheese,” says Black. “The tension on the track is higher, the vehicle is much more responsive and rubber tracks give you better traction, braking and acceleration.” In Afghanistan, he says British Army vehicles like the Warthog (ST Engineering's Bronco 2) travelled more than 300,000 km on rubber tracks, which withstood multiple IED blasts without any fatalities. “Rubber tracks are able to withstand mine blasts up to STANAG 3, whereas with steel tracks it is only up to STANAG 1,” says Black.

DIFFERENT TYPE OF MAINTENANCE

With steel tracks, maintenance is ongoing. “The tracks need to be changed, on average, every 600 km,” says Sloan. “Taking four or five links out of the side of a track is classed as normal. With CRTs, you can travel up to 5,000 km before you need to change the track and it can be done in the field.” But unlike steel tracks, which can be easily repaired by replacing

the links, if a rubber track breaks, the entire system has to be replaced.

“Vehicles with rubber tracks need to be maintained differently than vehicles with steel tracks,” says Tarkan. “With steel tracks, nine times out of 10 a member of the crew will fix it. With a rubber track, you need help from a higher maintenance level.” In the case of the Dutch Army, any repairs to rubber tracks would need to be carried out by the Company Maintenance Group, or higher, not the vehicle's crew.

With many armies now looking at Strike or Expeditionary capabilities, Sloan says 5,000 km is the rule of thumb being set by requirements, which advantages rubber tracks over steel. “A vehicle must have the ability to travel up to 2,000 km and still have mileage to take to the fight,” he says. “Composite Rubber Tracks provide the agility and autonomy to self-deploy as independently as possible, enabling a force to project power at distance,” he says.

In vehicle competitions such as Australia's Land 400 Phase 3 programme, one of the two shortlisted contenders, Hanwha Defense's Redback IFV, features Composite Rubber Tracks from Soucy. The other vehicle shortlisted for the competition, Rheinmetall's Lynx, is on steel tracks.

But the biggest market opportunity for CRT right now is in the unmanned or optionally manned domain. “With optionally manned or completely unmanned vehicles, you don't have the manpower to do the maintenance,” says Sloan. The low vibration of rubber tracks also protects any sensitive electronics on board. “CRT reduces the maintenance burden to almost zero,” continues Sloan. “Imagine trying to do track maintenance on 12 unmanned platforms in a robot swarm. That becomes untenable.” Sloan says CRT is also likely to appeal to those armies developing armoured vehicle concepts like the Carmel programme in Israel and the US's Optionally Manned Fighting Vehicle (OMFV), which feature options for a much reduced crew (two to three people) inside the vehicle.

“The US Army's Next Generation Combat Vehicle portfolio is keeping us busy right now,” says Sloan, adding that a number of initial contenders — from the Remote Combat Vehicle Light to OMFV — offer Composite Rubber Tracks from Soucy. Moving forward, Sloan says: “Our focus is on meeting the requirements being asked by the customer and anticipating those that haven't been asked yet. Composite Rubber Tracks are more efficient, reliable, and easier to maintain, reducing the effort needed to sustain formations in the field.”

Soucy Defense has a robust R&D pipeline, which is set to broaden its offer to capture platforms from RCV/UGV, through to Light Tank concepts, says Sloan. “Our technology is advancing all the time, and we are working with our industry partners and defence, to keep pace with the evolution of vehicle designs.” ■



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Turrets system and how they will continue to provide unmatched lethality, many years into the future.

THE WORLD-CLASS LEGACY

KONGSBERG started working with remotely operated turrets in 2008, drawing on many years of successful operational



The KONGSBERG RT40 system mounted on the US Army Stryker vehicle



Livefire testing of the KONGSBERG RT20 system performed during fall 2020

experience of the already in-service PROTECTOR Remote Weapon Stations (RWS). Already at that time, the PROTECTOR RWS was a world-leading solution, integrated on armoured vehicles in many nations. This included the US, where two major programmes, Common Remotely Operated Weapon Station (CROWS) and Stryker, were being executed.

During those early years, a multitude of experience and know-how was accumulated on how remotely operated systems work, and how one maximises the benefits for vehicle operators. The ambition for the remote turret systems was to bring KONGSBERG's experience with the PROTECTORS RWS on to the new systems that would accommodate increased firepower and more advanced sensors.

KEY TECHNOLOGY CHOICES

Already from the beginning, a number of key technology choices were made for the remote turrets; choices that have proven to be industry leading today. First, in order to ensure a reliable feed system for the medium-calibre guns, the choice to incorporate a linkless ammunition handling system was made early on. This system, already in use on Apache helicopters and other air platforms, cycles each medium calibre round through the ammunition boxes without any links or chutes that can cause a jam for the feed system.

When you are in an aircraft, there is little chance to clear a weapon feed jam and KONGSBERG thought the same for an

unmanned turret, where the operator is strapped in a seat with all hatches to the turret safely closed. This choice has proven very successful, and as of today, KONGSBERG has live-fired more than 20,000 rounds, using the linkless system, without any feed issues at all.

Second, the philosophy of building a system with a high degree of modularity for customers was also prioritised from the beginning. The lessons learned from the early years of

delivering RWS proved that there is no "one solution fits all" and KONGSBERG believed this was very much the case for remotely operated turrets.

Modularity for the PROTECTOR remote turrets means that you can easily adapt a number of elements on the system. Using the sensor suite as an example, if a specific thermal imaging capability is desired by the user, this can be integrated into the system during its build. Other examples include customising the armour level, introducing new cannons (for example the CT40 and XM913 50mm automatic cannon) and missile systems, or adding Active Protection Systems.

Whilst the differences in PROTECTOR remote turret adaptations is vast, the fire control system that ties all these subsystems together remains the same. This means that from a training and operational perspective, the operators only need to learn one PROTECTOR user interface, which is then repeated across the configurations.

Speaking of fire control architecture, the PROTECTOR family of systems is now introducing a new key technology, which will future-proof firepower solutions —network based fire control architecture. This digital architecture is already being incorporated in a number of programmes, including the US CROWS programme, and will enable multi-user and multi-station capabilities. In practice, this means that one operator can control multiple stations, or that one station can be operated by multiple users through a user-defined hierarchy. Furthermore, the new

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digital architecture enables full wireless control of a RWS or remote turret mounted on an Unmanned Ground Vehicle (UGV).

THREE REMOTE TURRET VARIANTS

Since 2008, KONGSBERG's development of remote turret systems has led to the establishment of three, technologically advanced PROTECTOR remote turret variants, the Remote Turret 20 (RT20), the RT40 and the RT60. The three variants share common technology and opportunities for growth, but they can be defined as three baseline variants configured for different needs.

The lightest and smallest of the variants is the RT20 turret system, which has a weight starting at 1250 kg. This variant was developed as a lightweight solution to fit on armoured vehicles with requirements for very low turret weight. Examples of that are the two USMC programmes Amphibious Combat Vehicle (ACV) and Advanced Reconnaissance Vehicle (ARV), where requirements for buoyancy when swimming has led to a strong focus on low turret weight. KONGSBERG has contracts for the RT20 system for both these programmes and will deliver RT 20 turrets that are fully marinised.

The RT40 system is known by many as the "Stryker turret". In 2016, the USG issued an urgent Operational Needs Statement to equip the Second Cavalry Regiment (2CR) with 30 mm firepower, within a very short timeframe. KONGSBERG won the competition and within just a year, the company delivered 83 systems for the 2CR, which operates out of Germany. As part of this programme, thorough tests were conducted both in the US and Germany, and since 2018 the systems have been operationally deployed with 2CR. KONGSBERG is currently competing for equipping the next three Stryker brigades with RT 40 systems — the winner is expected to be announced in the spring of 2021.

Finally, we have the RT60 system, which KONGSBERG defines as an Infantry Fighting Vehicle (IFV) variant. The RT60 is currently under development, but a functional prototype has been built

OPTIMISED FIGHTABILITY

- Hunter/Killer
- Slew to cue
- Lock on target
- Automatic Lead Angle Correction
- Point stabilization
- High performance day and night sensors
- First round select
- All 30x173 ammunition types (AP, HE, ABM etc.)
- Single and dual user versions
- KONGSBERG CORTEX Integrated Combat Solution
- Simulation and training systems

PROVEN IN ACTIVE SERVICE

- Optimised for firing in static and moving scenarios
- Suitable for tracked and wheeled vehicles
- Highly reliable
- Low weight and profile
- Operated from under armour
- Reload from under armour
- Supporting various protection (armour) levels
- Flexible and designed for customer tailoring and growth
- Qualified for global operations

and live fire tested. The system includes an embedded dual missile launcher and a Commanders Independent RWS. This dual user configuration enables full hunter-killer capability and the inclusion of the KONGSBERG CORTEX Integrated Combat Solution (ICS), enables a number of combat services, including shared situational awareness between vehicles, target handover internally in the vehicle, and target handover between vehicles in the same formation. ■



The Remote Turret variants in the KONGSBERG PROTECTOR family

SMOOTH OPERATOR

The TAK-4i intelligent independent suspension system on Oshkosh Defense's Joint Light Tactical Vehicle has reviewers gushing over its smooth handling and ride quality. Vice President of Engineering, Dave Marek, explains how it has delivered a level of comfort to warfighters never seen before.

By Anita Hawser



Marines with Marine Wing Support Squadron 271 conduct self-recovery with a JLTV at Camp Lejeune, North Carolina (US Marine Corps photo by Lance Cpl. Elias E. Pimentel III)

Anyone who's ridden in Oshkosh Defense's Joint Light Tactical Vehicle (JLTV), which is the replacement for AM General's much-loved and iconic Humvee, will know just how well the vehicle handles off road, even on the steepest of inclines or declines. The ride is surprisingly smooth. As one BBC TopGear reviewer put it: "... nothing's allowed to disturb the serenity of the cabin capsule which floats along, and I know this is a ludicrous word here, so gracefully."

'Graceful,' is not a word that is usually uttered in the same context as armoured vehicle. Yet, despite a requirement for the JLTV to offer the crew inside a higher level of protection than the Humvee, mobility and speed have not been compromised in any way. One of the reasons for that is the JLTV's TAK-4i intelligent independent suspension system.

Many of the details regarding the JLTV are classified, but we managed to get Oshkosh Defense's Vice President of Engineering

Dave Marek to spill the beans on TAK-4i, and what inspired the company to develop it.

Marek says it all started in the 1990s, when Oshkosh Defense participated in the US Marine Corps' Medium Tactical Vehicle Replacement (MTVR) programme. "We immediately saw an opportunity to demonstrate next level mobility," he says. "Oshkosh began designing a suspension system that used a coil spring system, versus the traditional solid-axle spring system. This



Soldiers drive a JLTV at Fort McCoy (US Army photo by Scott Sturkol, PAO, Fort McCoy)

modification demonstrated a substantial improvement in mobility and ultimately helped Oshkosh win the contract.”

The TAK-4i system was purposely designed for the Oshkosh Defense JLTV. And while it may appear to be a simple evolution of the original TAK-4, Marek says it is in fact a substantial leap in technology. “The TAK-4i met, and in some instances exceeded, all mobility and ride quality requirements set forth in the US government’s JLTV Request for Proposal (RFP),” he says.

When the JLTV RFP was issued in 2008, Oshkosh had already begun testing a gas spring suspension system. Marek says the engineering team recognised alternatives like “hydropneumatic suspension systems” — gas springs, combined with the damping properties of hydraulic fluids — were limited regarding ride quality and overall vehicle performance.

Marek says some form of the TAK-4 was added to vehicles like the Medium Tactical Vehicle Replacement, Mine-Resistant Ambush Protected Vehicle, Logistics Vehicle System Replacement, Palletised Load System A1, P-19R Aircraft Rescue Fire Fighting vehicle, JLTV, and Family of Medium Tactical Vehicles (FMTV) A2.

“Through the voice of the customer, and our own work on the JLTV, we’ve come to better understand the importance and benefit of ride comfort and quality,” he adds. “We believe that the most significant benefit of the TAK-4i is its ability to overcome the world’s harshest terrains while still maintaining the high speeds needed to get to and through the fight as quickly and efficiently as possible.”

In fact, Marek says the TAK-4i allows the JLTV to travel 70% faster off-road than other benchmark vehicles. It also boasts 20 inches (50.8 cm) of usable wheel travel. “Imagine traveling over moguls at fast speeds without spilling your coffee or tea (for those in Europe) — it’s that smooth,” he says. “Furthermore, with the TAK-4i installed, warfighters experience a level of comfort that’s never been realised before

in a light tactical vehicle. This allows soldiers to arrive on the battlefield, ready to fight, compared to some light tactical vehicles, which offer a rather punishing ride, ultimately leading to early fatigue.”

In addition to ride comfort, the TAK-4i intelligent independent suspension system isolates and protects the vehicle from rocky or rough terrain, which Marek says helps it meet or exceed maintenance and reliability goals. “In fact, the JLTV more than doubled the government reliability requirement,” he says. The intelligent independent suspension system can also support larger payloads. The ability to carry a wide range of payloads while sustaining performance is a big challenge for suspension systems, says Marek, especially those based on coil or leaf springs.

“*With the TAK-4i installed, warfighters experience a level of comfort that’s never been realised before in a light tactical vehicle. This allows soldiers to arrive on the battlefield, ready to fight, compared to some light tactical vehicles, which offer a rather punishing ride.*”

A fully loaded armoured vehicle has to perform as well as a lightly loaded unarmoured vehicle. “The Oshkosh Defense JLTV is the only light tactical vehicle that can manoeuvre with combat formations on the battlefield, even with large changes in payload,” says Marek. The General Purpose variant can haul payloads up to 3,500 lbs. (1,587 kg) and the Utility variant can carry payloads up to 5,100 lbs. The TAK-4i also reduces the vehicle’s height

by up to 12 inches. “This feature allows the JLTV to be easily loaded onto airplanes or low clearance ship decks,” says Marek.

The Oshkosh Defense JLTV entered Low Rate Initial Production in 2016. Since then, Marek and his team have focused on continuous development and improvement for all aspects of the vehicle, including the TAK-4i. “We’re always monitoring the motorsport and commercial vehicle sectors for the latest innovation and technology,” he says, “not so much for the parts they use since most off-the shelf, commercial components aren’t suitable for a military vehicle, but more to get a sense of what gives them the ability to travel terrain as fast and efficiently as they do. For that same reason there isn’t a ton of suspension system-related technology in the commercial space that can be easily repurposed for the military. That said, one trend we’re evaluating for the future are computer-controlled damping systems, including both semi-active and fully active technologies.”

Oshkosh has already produced more than 8,000 JLTVs for the US Department of Defense. The vehicle has also attracted international interest with the Belgium Ministry of Defence awarding Oshkosh Defense a contract in October for 322 Command and Liaison Vehicles (CLV), which will be based on the JLTV platform and equipped with Belgian communication systems.

Lithuania has also agreed to buy 200 JLTVs, with an option to purchase an additional 300 vehicles. The vehicles are expected to be delivered from this year. Slovenia will acquire 38 JLTVs. In 2019, Montenegro said it would buy 67 JLTVs from Oshkosh Defense. The vehicle is also entering a Demonstration Phase with the UK Ministry of Defence, which will see UK equipment integrated onto the vehicle. The JLTV is the British Army’s preferred option for the initial phase of its Multi-Role Vehicle-Protected programme, which will replace a range of command, liaison and light logistics vehicles. ■

ADVANCED LIGHT ATTACK SYSTEM – ALAS

Yugoimport

The ALAS is a middle-range multi-purpose wire guided missile system. It was developed primarily for missions against tanks, armoured vehicles, fortifications, command posts, low-flying helicopters, industrial facilities and bridges.

ALAS-C (Advanced Light Attack System-Coastal) is for coastal defence and its mission is to destroy/incapacitate rigid inflatable boats, landing ships and other small vessels within the maximum range and under other conditions, in the assigned area of responsibility. It also can be used to attack lightly armed moving vehicles, missile launchers and radar systems.

The missile can be deployed by any suitable platform, including helicopters, armoured and non-armoured vehicles, ground posts, and small and big boats. The guidance system is based on video/infrared technology, with the missile connected to the launcher by a fibre-optic cable. The ALAS flies at low altitude and has small radar and infrared (heat) signatures as it uses a turbofan motor instead of a turbojet.

The fibre-optic data link provides total immunity to active jamming and electromagnetic interference and a high transmission rate for communication of complex data such as images.



Advanced Light Attack System – ALAS



ALAS-C and ALAS (ground version) on different 6x6 launchers

turbojet engine, fibre-optic cable bobbin and solid propellant booster.

The operator is able to pick up the commands at any time to control fire, select the point of impact as the missile approaches the target, and to obtain an immediate kill assessment. The ALAS system is organised in battalions. One battalion has three batteries each with four launchers. Each launcher carries eight containers with rockets.

The Battalion Command Post (BCP) is connected to the high command

Upon launching, the ALAS missile climbs to the cruise altitude and, guided by the onboard INS/GPS system supported autopilot, follows preset waypoints until it reaches the target area. The missile flight data and picture from the missile seeker are transmitted via the fibre optic data link back to the Ground Control Station (GCS) so the operator can control its flight and spot, identify and “lock on” the targets at sea or on land.

Upon target “lock on”, the missile is automatically guided by its seeker. The ALAS consists of a homing head (TV or IIR), control subsystem, payload (tandem-shaped charge or blast fragmentation warhead), fuel reservoir, wing section, propulsion subsystem,

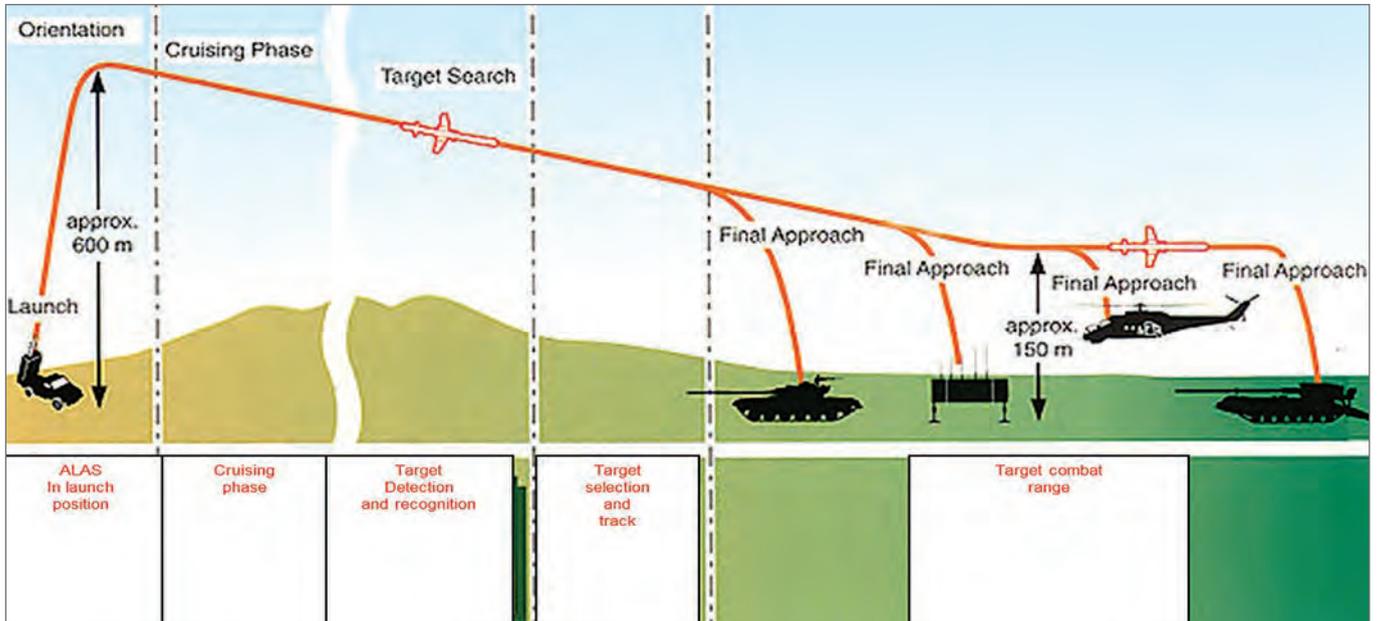
and sensors (radars) by C4I systems from which it receives target position and other necessary data. The collected data is processed and forwarded to the BCP and then to the launcher-mounted (Missiles) Ground Control Station, which directs the launcher platform, computes the missile flight path (waypoints) to the selected target and feeds it to the missile’s onboard computers.

Logistics support for the system is provided by three transloaders carrying 32 missiles in a container, equipped with hydraulic cranes for the mechanised reloading of the launchers; a mobile workshop fitted with necessary tools, spares, testing and other equipment, and the SPTA kit for the system maintenance.

MISSILE TECHNICAL CHARACTERISTICS

• Total body length [m]	2.723
• Body diameter (caliber) [m]	0.175
• Wingspan [m]	1.638
• Launching weight [kg]	73.10
• Weight in flight [kg]	59.3
• Sustainer Propulsion (type)	TMM-040/RC Turbojet engine
• Booster propulsion (type)	solid propellant engine
• Cruising speed [m/s]	120-150
• Maximum flight altitude ASL[m]	2000

- Maximum effective range [km] 25
- Minimum effective range [km] 4
- Mid-course guidance INS/GPS
- Terminal guidance TV CCD/IIR
- Payload subsystem:
 - Type 1: Blast fragmentation free rod warhead with delay, impact or proximity fuze.
 - Type 2: Tandem warhead with penetrability: > 1000 mm (RHA - Rolled Homogenous Armour) behind explosive reactive armour



Missile trajectory (max range is 25 km)

The BCP is equipped with battery surveillance radar and a panoramic sensor block, which consists of day channel – CCD camera, night channel – thermal camera, laser range finder module, GPS heading and positioning receiver and pan and tilt platform.

All of these sensors are combined into a single source of information, processed and displayed on the BCP commander's console. The launch platform carries eight missile containers (two rows with four containers each). The launcher has a sensor set, which includes position and navigation (GPS positioning, north finding system, and INS); a meteorological probe with automatic data transfer to the GCS; slope indicating sensors for the vehicle and the azimuth and elevation sensors (encoders) for the launch

platform; an electronic Ground Control station with manual trigger for missile launching from the vehicle cabin or remotely, up to 50 m from the launcher, by cable.

The GCS is located in the launcher vehicle cabin in front of the co-driver's seat. It carries out activities related to commands; target and other data received from the BCP; firing mission verifying and its distribution to the missiles onboard computers; implementation of missile prelaunch procedures; launcher platform positioning; and missile containers controlling firing and missile guiding. The operator of the GCS is also the launcher commander.

The GCS is equipped with two consoles. The first is the client of the Battle Management System (BMS) and is connected via vehicle radio set to the BCP. The second is the ALAS mission computer-console for controlling all ALAS subsystems: the missile, launcher and container mechanisms.

ALAS is a modern rocket system, which assures complete supremacy within a 25 km range because of the missile's low-profile flight (flight on low height, between hills) and total immunity to jamming. The missile is accurate up to 1.2 m and the warhead has 1,000 mm penetration behind explosive reactive armour, which is enough to destroy any modern tank. One battalion can cover a wide front with 96 precise hits in a short space of time. ■



Ground Control Station

INSIDE ISIS'S LASTING LEGACY

ISIS may be largely defeated in territories it once occupied in Iraq and Syria, but one of its legacies lives on in the form of the Armoured Suicide Vehicle-Based IED, a highly effective weapon, which still poses a threat today.

By Ed Nash

When the Islamic State of Iraq and Syria (ISIS) — also known as the Islamic State of Iraq and the Levant, or the Arabic term Daesh — erupted onto the world stage in 2014, they did so by unleashing a wave of terror.

Committing genocide and brutal murders, the group made shocking territorial gains in Iraq and Syria. At one point, the group controlled

approximately 45,377 square kilometers of territory across both countries. Its actions brought an array of military force to bear, principally advanced air power, which destroyed ISIS's ability to conduct conventional military operations. As a result of the destruction wrought by Coalition air strikes, the terrorist organisation was forced to resort to the heavy use of a weapon, which they have since become synonymous with;

the Armoured Suicide Vehicle-Based Improvised Explosive Device (ASVBIED).

With the taking of ISIS' last territorial holdings in 2019, many had written off the ASVBIED as an aberration; a weapon used by fanatical jihadists as a desperate last measure when no other viable system or counter to conventional military tactics was available. However, this assumption is incorrect. Not only did the use of these weapons predate ISIS, their simplicity of



ISIS was cunning in its deployment of ASVBIEDs. This vehicle, disguised as a civilian car, would have been difficult to recognise as an attacker until it drew close. (Photo taken from ISIS propaganda)



The rather ramshackle construction of many ASVBIEDs can be a source of derision, but belies the fact that they are lethal weapons, which are simple to make and hard to stop. (Photo taken from ISIS video)

construction, effectiveness, difficulty in countering and spectacular propaganda value means that they have already begun to proliferate around the globe.

HERE TO STAY

The reason why armoured suicide bombs don't get a lot of attention in defence circles is because no major military power has had to face them in general practice. That unfortunate experience is limited to a handful of special forces or local security. But that scenario is almost certain to change. "An advancing or a defending force cannot provide counters all the time or cover every direction from which an SVBIED attack might come," says Alaric Searle, Professor of Modern European History at the University of Salford and author of *Armoured Warfare: A Military, Political and Global History*. "At the moment, one SVBIED will always get through... armed forces need to be prepared for the reality that the threat of suicide vehicles

is not going to diminish significantly in the foreseeable future. Some creative thinking will be required."

With the benefit of hindsight, the evolution of the Vehicle-Based IED (VBIED) — the simple car bomb — through to the SVBIED and the ASVBIED, seems obvious. The use of suicide bombs has escalated rapidly since the 1980s. According to the University of Chicago's Chicago Project on Security and Terrorism (CPOST), the rate of these types of attacks globally went from an average of three a year in the 1980s to one a month by the 1990s. Between 2001 and 2003, that figure increased to about one a week. From 2003 to 2015, a suicide bombing occurred somewhere in the world on average once a day.

Going hand in hand with the increased use of suicide bombs, the use of vehicle-based attacks also increased. According to the Office of the Director of National Intelligence, between 2009 and 2015,

there were 10 attempts to use VBIEDs within the United States. ASVBIEDs are now seeing a similar escalation as non-state groups begin to appreciate the capability such weapons possess. Initially, the proliferation was with groups affiliated to ISIS, with ASVBIED attacks being undertaken by Boko Haram in Nigeria against government forces in 2018. However, by 2020, the Taliban was using captured Humvees as ASVBIEDs against the Afghan Army.

Also in 2020, footage aired on social media, which caused some amazement and amusement. A Syrian T-72 tank was confronted by a Turkish-made ACV-15 armoured personnel carrier driven by a member of Hayat Tahrir al-Sham, an Islamist group with ties to Al Qaeda. On paper no fight at all, but reality proved different as the tank retreated from the charging and lightly armed carrier, which proceeded to ram the fleeing tank before turning and exiting the scene.



“

Armed forces need to be prepared for the reality that the threat of suicide vehicles is not going to diminish significantly in the foreseeable future. Some creative thinking will be required.

”

The aftermath of an ASVBIED explosion photographed by the author

The incident led to caustic comments about the ability of Syrian tankers, but for those of us who have faced ASVBIEDs, the plight of the tank crew inspires sympathy. They almost certainly thought they were facing an ASVBIED attack, hence their panicked reaction. Certainly, the vehicle's flat out charge to its target is a classic indicator of such an attack.

STANDARD WEAPONS NOT UP TO THE TASK

There is also a belief that existing weapons and tactics can be used to counter the threat from ASVBIEDs. However, this is only partially true. The standard weapons found on a patrol or checkpoint — small arms and short-range anti-tank weapons — are not enough to stop an ASVBIED. The sheer speed with which these type of attacks occur means that an RPG-gunner would need both great skill and nerves of steel to hit such a target. Considering the explosive mass most

ASVBIEDs carry, such an action would itself likely be suicidal. Stand-off missiles are extremely effective against them when able to engage, but most ASVBIEDs have a horrible way of surprising you as they can be easily hidden in buildings and then attack suddenly. They are worryingly effective even in areas under complete air cover as reaction times may only be a matter of seconds.

As standard practice, the Syrian Democratic Forces would build large earthworks to protect themselves from ASVBIEDs. These were amazingly intricate so as to confuse an attacker as to how close they needed to get in order to be effective.

But the main lesson learned was the need to identify the threat at maximum distance. For this observation, tactical unmanned aerial vehicles (UAVs) were invaluable. They would allow defenders to bring the correct weapon to bear or, at the very least, get clear of the threat. Even before they lost most of their territory,

ISIS ASVBIED tactics had evolved. By 2016, ISIS was using two-man ASVBIEDs, with a machine gunner on the roof to provide defence suppression for the attack. They had also begun to experiment with ASVBIEDs disguised as normal vehicles.

Although the ASVBIED's most infamous user may be reduced in significance (though certainly not destroyed), the sheer simplicity and effectiveness of this weapon means that it cannot be written off. For any military engaged in security or peacekeeping operations, the possibility of future ASVBIED attacks should be taken seriously.

ABOUT THE AUTHOR:

Ed Nash is a defence author and writer. He authored *Desert Sniper*, a memoir about his experience volunteering with the Kurdish YPG in Syria against ISIS in 2017. He is also co-author of *Kurdish Armour against ISIS: YPG/SDF tanks, technicals and AFVs in the Syrian Civil War, 2014–2019*. The book will be published by Osprey in 2021. ■



An ASVBIED captured in Syria by Kurdish forces. Even in the face of overwhelming firepower, these vehicles could be highly effective at delaying attacking forces and inflicting casualties. (Photo taken by author)

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AGILE ECONOMIC DEVELOPMENT AND INDUSTRIAL PARTICIPATION PROGRAMMES FOLLOWING COVID

By Tareq Abdul Raheem Al Hosani, CEO of Tawazun Economic Council

If there's one thing that the chaos of the coronavirus (Covid-19) pandemic has shown us, it's that economies and national strategies must be agile or risk becoming obsolete in an obstinately regressive attitude.

One aspect of our diversifying economy that requires reassessment are the industrial participation programmes that were set-up through defence and military procurement and expenditure. We should look at these programmes as an opportunity to directly contribute to economic prosperity and diversification, while continuing to offer the international defence community growth opportunities and incentives.

Since the UAE's Tawazun Economic programme was born in the late 1990s as a result of the nation's armed forces modernisation drive, industrial participation has played a significant role in generating wealth opportunities as well as fostering critical new knowledge and manufacturing capabilities for the country.

Such was the level of competition and demand for cutting-edge defence technologies and assets from major Western players, the dilemma for the UAE at the time was whether, whilst establishing strategic alliances with multinational corporations, it would have to prioritise defence expenditure over domestic wealth generation and redistribution, something that would directly impact its pace of development and progression.

Today, with major defence suppliers at the coalface of shrinking defence budgets in the West, that is no longer a conundrum the UAE faces: Industrial participation programmes today are mutually beneficial for both the defence supplier and receiver. With major defence suppliers now looking outside of their traditional markets, the GCC and the UAE offer significant growth opportunities in return for training, up-skilling, infrastructure and manufacturing improvements. It is estimated that the GCC will spend in excess of \$1 trillion on defence by 2025, according to some reports¹. This offers a vast economic-development opportunity at home, and also heralds unique growth opportunities for the region's manufacturing and knowledge sectors.

Furthermore, the UAE will be a major force in this shifting geopolitical heat map of defence spend, with 14% of the total GCC spend predicted to stem from the Emirates. Considering the UAE's determined move towards a knowledge-based economy as it diversifies away from a reliance on oil, the Tawazun Economic Programme offers a fertile and long-term field of possibility to transform the economy.

Today, following a solid decade of accelerated, sophisticated and progressive defence and security programmes, established and developing areas have become intertwined and whole sections of the UAE's economy have already been transformed. And now, as Tawazun's modus operandi shifts to prioritise procurement and acquisitions, the nature and need for a future-proof programme, in the context of the geopolitical and socioeconomic shifts created by the Covid-19 crisis, will be vital in safeguarding the nation's national security and military capabilities.

BENEFITS FELT ACROSS THE COUNTRY

Around the world, industrial participation programmes have drawn criticism because of inconsistencies in generating economic value. Indeed, transferring knowledge and technology to boost manufacturing, information communications technology (ICT), or other industries in recipient countries, can be tricky. Exporters and suppliers need to be needed, or they're out of jobs.

Indeed, up-skilling foreign workforces seems counter intuitive. Contractors need to maintain control over intellectual property. And all the while, the recipient developing country wants to break through the barriers to entry and access a self-sufficient build of critical economic infrastructure, which includes a skilled workforce, smart infrastructure and fluid supply chains.

However, a well-run programme can help reconcile conflicting interests of stakeholders. By developing incentives and addressing misgivings about policies, both national strategies and private sector buy-in can come to fruition. Pragmatism and incentivisation will be crucial in continuing to bring major players to the table, who are prepared to play hands that benefit everyone with a seat.

For those still spending on military equipment, tech and assets, we must realise the desire of the asset recipient to see such expenditure advance not just national security objectives, but also address in some way their ambitions to become a knowledge-driven economy. International defence community players supplying our armed forces and our defensive capabilities must see their contribution to our economy, through Tawazun's Economic Programme, to be as important as the equipment and assets they supply.

If we look at what 30 years of partnerships and joint ventures under the Tawazun Economic Programme have yielded, we see some of the region's leading aerospace, defence and holding companies. What is clear is that the



Tareq Abdul Raheem Al Hosani



Abu Dhabi-based GAL's ambition is to become the Middle East's leading provider of aviation maintenance, repair, overhaul and specialised support services (Copyright: EDGE Group)

direction of Tawazun's Economic Programme does favour the defence and security sector, but it is also interested in other strategic priorities for the UAE. Targeted sectors include aerospace, infrastructure & transportation, communication technology, education technology, sustainability, environment & climate change, and finally, food & water security. This approach has rekindled the interest of multinational firms in the UAE and shown the plethora of viable business opportunities that exist in the local economy.

And now is the time to diversify even further. We have entered the fourth industrial revolution, and we will not be emerging from it any time soon. Our thinking and approach should reflect both this seismic technological and socioeconomic shift, while also adapting to the changes wrought to the global economy by the Covid-19 pandemic.

Our defence procurement and expenditure will continue as the UAE fortifies its position as a regional and global powerhouse amid growing regional tension and volatility — of that there is no doubt. And as we do so, now is the time to ensure that the

benefits from the deal flow, which we have opened up, is felt across the country, across every sector, through an agile and diversified approach, which can power our economic ascent. ■

ABOUT THE AUTHOR

Tareq Abdul Raheem Al Hosani is the CEO of Tawazun Economic Council. He is responsible for driving the strategic plans for the development of the UAE's defence & security sector. Prior to joining Tawazun, he served as the CEO at Yahsat before taking on the role of Deputy Director General for the National Electronic Security Authority (NESAs). He has sat on the Boards of several UAE strategic entities, such as the UAE Space Agency and Bayanat. Tareq holds a Masters in Electronics & Communication from Université Pierre et Marie Curie in France and a Bachelors in Aeronautics from Saint Louis University in the US.

1. BGCC defense offset programs: the trillion-dollar opportunity: <https://www.es.kearney.com/aerospace-defense/article/?/a/gcc-defense-offset-programs-the-trillion-dollar-opportunity>



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A close-up, profile view of a soldier wearing a digital camouflage helmet and sunglasses, aiming a rifle. The soldier's face is partially visible, and the rifle's scope and barrel are prominent. The background is a clear blue sky.

THE RISING TIDE OF CHANGE



As the US pivots away from the so-called War on Terror, to close combat against near-peer threats, the US Army and Marine Corps' small arms are getting a much-needed overhaul.

By Peter Antill

The M27 IAR during a field exercise at Marine Corps Base Camp (USMC photo by Sgt. Alicia Leaders)

Most military hardware takes years to bring into service and is expected to remain in service for at least 30 years. In the West, this situation has been exacerbated by slowly declining defence budgets as a percentage of GDP.¹

Armed forces' procurement has tended to focus on larger, more expensive capital items, such as tanks, fighter aircraft and aircraft carriers. For a long time, small arms, the armed forces' most basic weapons, have been low on the list of spending priorities, the exception being new equipment required in time of war, for example, the UK's procurement of the L129A1 semi-automatic rifle and FN Herstal Minimi LMG for troops fighting in Afghanistan.

Many forces have had the same small arms for decades. In the UK, the SA80 (L85) and Light Support Weapon (LSW, L86) have been in service since 1985, with the SA80 being on its third version (L85A3). The SA80 replaced the L1A1 Self-Loading Rifle (SLR), which entered service in 1957, taking over from the British Army's long-serving Lee Enfield family of rifles, which first entered service in 1895. In Germany, the Bundeswehr's G3 assault rifle, first issued in 1959, is still kept in reserve in large numbers, while the G36 entered service in 1997.

The same is true for the US Marine Corps (USMC). Its legacy small arms include the M16 assault rifle, which entered service in 1964, taking over from the M14 battle rifle. Unusually, the M14 was the USMC's standard rifle for only seven years, before it was replaced in 1965 by the M1 Garand. Prior to the M1 Garand, which entered service in 1936, the M1903 Springfield rifle was accepted into service 33 years earlier. In addition, there is the M4 carbine, which was introduced in 1994, the M9 pistol (a renamed M92 Baretta), which became the standard US service pistol in 1985, taking over from the M1911A1, which had been the standard sidearm for 74 years.

DIFFICULT CHOICES

However, a few years ago, the USMC began to update many of its small arms, some of these programmes being undertaken in conjunction with the US Army. These programmes are partly informed by scientific study, by experience in Iraq and Afghanistan, and partly by the recognition that close combat has to change. Added to this, the US has substantially withdrawn troops from both Iraq and Afghanistan, with the primary focus of US strategy shifting to the Indo-Pacific region and growing rivalry with China as underlined in the 2018 National Defense Strategy.

In changing its focus from fighting violent extremists in an inland counter-insurgency war to contending with a near-peer adversary in littoral/coastal areas, the USMC is having to restructure, retrain and re-equip, facing difficult choices along the way. UK Armed Forces face a similar plight. Many of these changes, and the work that occurred in the background to inform them, emerged from a series of experiments, known as Sea Dragon 2025, which started in 2016 and were conducted over several years.

The experiments looked at, among other things, infantry squad lethality.² The small arms that are currently being developed or coming into service include:

M18 Modular Handgun System³

– The USMC started procuring the M18 in September 2020. A 9 mm semi-automatic sidearm, it is based on the Sig Sauer P320, and will replace all the legacy sidearms still in USMC service, including the M9, M9A1, M45A1 and M007. The USMC is collaborating with the Army who began fielding the weapon in 2017 in two forms, the M17 (which is a full-sized pistol) and the M18 (which is more compact for ease of concealment). The USMC is only procuring the M18 version. Its main advantages when compared to the legacy sidearms is its light weight, ease of concealment, modularity (different components can be changed to fit different

hand sizes) and an accessory rail for lights or a laser sight.

M27 Infantry Automatic Rifle⁴

– Interestingly, the procurement of the M27 started in 2000, when the USMC were looking for a replacement for the M249 Squad Automatic Weapon (SAW). After the requirement was circulated to industry in 2005, the USMC eventually



selected the Heckler & Koch (H&K) 416 in 2010 and took the rifle with them to Afghanistan in 2011. It was lighter, accurate and more reliable than the SAW, had a faster rate of (aimed) fire than the M16 and a longer barrel life. While originally slated to replace the M249 SAW, instead, the USMC started to procure the M27 in 2017 to replace all M16 assault rifles. An

accurized version of the M27 with a better optic became the M38 Squad Designated Marksman Rifle.

The 6.8 mm round⁵ – The US Army is currently undertaking the Platoon Arms and Ammunition Configuration (PAAC) Study, looking at the replacement of its platoon-level machine gun, the M240. This closely follows on from the work of the

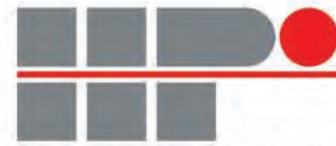
Small Arms Ammunition Configuration (SAAC) Study. The SAAC Study led the Army to abandon the 5.56 mm round it has used for more than 50 years and adopt an intermediate calibre round, the 6.8 mm, for its Next Generation Squad Weapon, which will have variants to replace both the M4 Carbine and M249 SAW. Once again, the USMC has been closely



Sig Sauer's M18 pistol (US Air Force photo by Airman 1st Class Michael Murphy)

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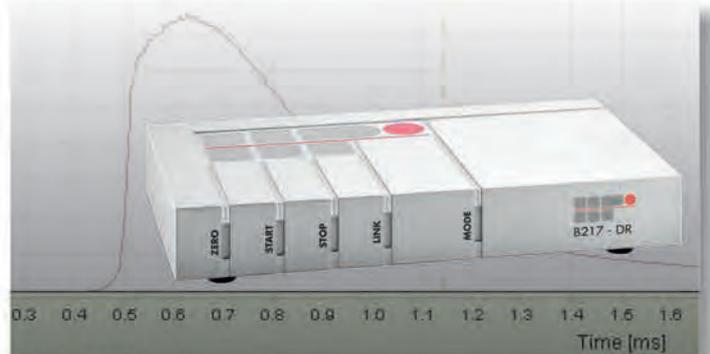
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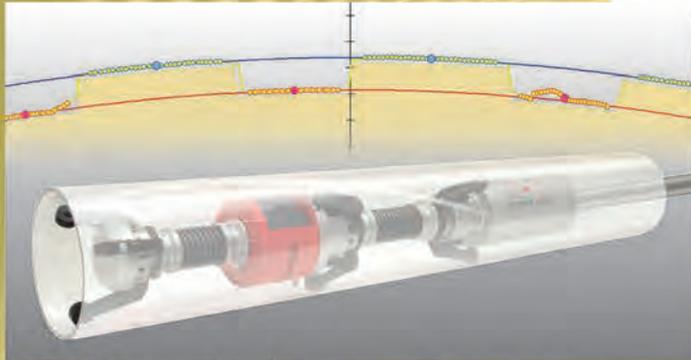
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An M18 handgun during a qualification course, at RAF Molesworth, England, July 28, 2020 (US Air Force photo by Senior Airman Eugene Oliver)

involved with the project, but is looking at the work done by Special Operations Command (SOCOM) into procuring an M240 replacement chambered for the .338 Norma Magnum cartridge.

Next Generation Squad Weapon – One of the US Army's highest profile programmes, the USMC is again participating in the platform's development, but has yet to decide which variant to procure, looking to bring it into service around 2025. In 2019, the Army awarded General Dynamics Ordnance and Tactical Systems, Textron Systems/AAI and Sig Sauer what are known as Other Transaction Authority Agreements, to develop a replacement system for the M4

and M249, cutting through the bureaucracy traditionally associated with the defence procurement process.

Mk. 13 Mod. 7 – A bolt-action sniper rifle, chambered for the .300 Winchester Magnum round. It is replacing the M40, a bolt-action sniper rifle chambered for 7.62mm NATO, which has been in service since 1966. The new rifle will have an effective range of over 1,000 metres (compared to 800 m for the M40) with new optics and accessories. Even so, the Mk. 13 Mod. 7 could prove to be merely an interim replacement as the USMC is keeping a close eye on SOCOM and its development of the Advanced Sniper Rifle.

M320 Grenade Launcher (GL)

– A US Army procurement in 2009 and a USMC procurement in 2017, the M320 GL replaces the M203 GL, which entered service in 1969, replacing the M79 "Bloop Gun" GL. The M320 is a stand-alone system, has a side-loading mechanism that accepts a longer round and so has a much wider array of munitions developed for it.

Carl Gustaf Recoilless Rifle –

Designed to replace the Mk. 153 Shoulder-Launched Multi-Purpose Assault Weapon (SMAW), the new system fires an 84 mm round that can destroy bunkers, lightly armoured vehicles and some tanks. There will be a choice of 11 different rounds, some of which almost double the range



Marines fire the Carl Gustaf Recoilless Rifle
(US Air Force photo/Alejandro Pena)

of the Carl Gustav when compared to the SMAW. The USMC is also shifting the capability downwards, from the company (which had six SMAWs to distribute as needed) to the squad level.

New Suppressors¹⁰ – The USMC is looking to procure new 5.56 mm suppressors for the M27 IAR, M4 Carbine and M4A1 Close Quarter Battle Weapon (CQBW) and is turning to a trusted supplier — the Knight's Armament Company (KAC) of Titusville, Florida—to design, develop, build and supply up to 25,853 next-generation suppressors. It is essential that the new suppressors allow the USMC to continue to use the existing bayonets, as well as the existing Small Arms Collimators, Laser Boresights and Blank Firing Adaptors. It is interesting to note that the current suppressor was designed to be used primarily with the M27 IAR and marketed with Special Operations Forces and Private Military Companies in mind, rather than conventional infantry forces.

Squad Common Optic¹¹ – To better leverage the capabilities of the M27 and M38, the USMC is looking to replace the current Rifle Combat Optic (basically a rangefinder for the whole squad) with one that has a range of between 600 and 900 metres. In February 2020, the USMC awarded an indefinite-delivery / indefinite-quantity contract to Trijicon of Wixom, Michigan with the contract

having a ceiling of \$64 million for 19,000 optics. Deployment is scheduled to begin in early 2021.

The refocusing of US geopolitical interests on the Indo-Pacific region and the movement of US strategy away from the War on Terror and its associated

counter-insurgency conflicts towards potential conflict with peer or near-peer adversaries has meant a major shift in USMC priorities.

As well as structural and doctrinal changes, the procurement of new systems has gathered pace, especially in terms of small arms and the resultant impact on infantry firepower and lethality. ■

ABOUT THE AUTHOR

Peter Antill graduated from Staffordshire University in 1993 with a BA (Hons) in International Relations and gained an MSc Strategic Studies from Aberystwyth in 1995 and a Post-Compulsory Education from Oxford Brookes in 2005. He worked at Cranfield University at Shrivenham from June 2009 to 2019, creating a defence acquisition body of knowledge. His interest lies in examining defence procurement and logistics within the realm of military history.

FOOTNOTES

1. Between 2002 and 2017, European defence budgets fell as a percentage of GDP from 1.56% to 1.35%. International Institute of Strategic Studies (IISS). (2013) 'Chapter Four: Europe' in *The Military Balance 2013* and IISS. (2018) 'Chapter Four: Europe' in *The Military Balance 2018*.
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6. Op Cit. South, 2019; Op Cit. South, 2020.
7. Lee, C. (2020) 'Marines Going After Slew of New Infantry Weapons', dated 24 August 2020, at <https://www.nationaldefensemagazine.org/articles/2020/8/24/marines-going-after-slew-of-new-infantry-weapons>.
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9. Ibid.
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11. Op Cit. Lee, 2020.

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LINCAD UPDATES ITS LITHIUM-ION POWER SYSTEM RANGE WITH THE LIPS 16

LINCAD

Lincad is an expert designer and manufacturer of bespoke batteries and chargers for a wide range of sectors, including military and defence. Every Lincad power management system contains the most suitable electrochemistry for its precise user requirements, and the most recent evolution of the company's industry-leading LIPS battery range is no exception.

Thanks to more than three decades of experience, coupled with a research and development team that is always testing new and emerging cell technologies and chemistries, Lincad can ensure that it stays ahead of the game.

The LIPS range of batteries from Lincad have become synonymous in the field with functionality, reliability and quality. The company's current manifestation of LIPS ('Lithium-Ion Power

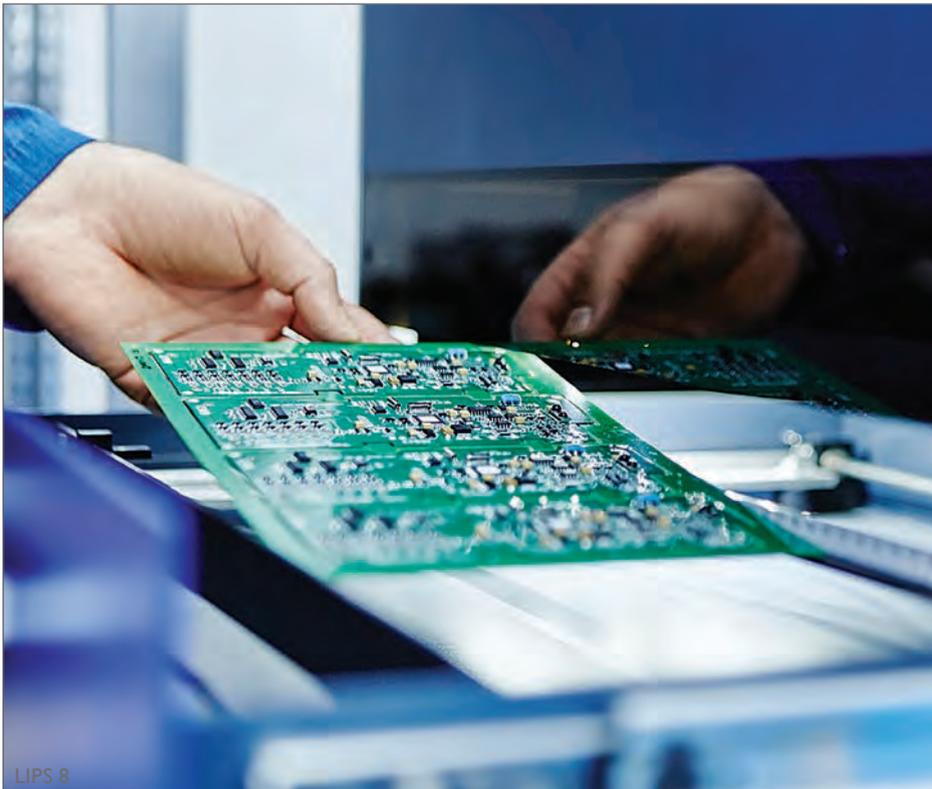
System') batteries, namely LIPS 16, is the result of an identified need to upgrade a previous model, the integration of new cell technology and an enhanced mechanical and electronic design, all designed and brought about by Lincad's team of expert engineers.

According to Mike Hendey, Senior Systems Engineer at Lincad, the evolution of the LIPS 16 is the next step in modernising its popular LIPS range. "The LIPS 16 is lighter and has more functionality than the previous model," Hendey explains. "We have updated the electronics and the internal construction to keep it current and cost-effective. We constantly research cell technology to ensure the cells we use are the best in the world."

The LIPS 16 is primarily a military battery system, as it has been specifically designed to withstand a more rugged environment and to cope with a plethora of demanding military and field-based



LIPS 16



lithium-ion batteries without the need for external equipment.

Another advantage of the LIPS 16 battery is an enhanced two-year storage life when it is in a completely discharged state. This greatly reduces the risk of over-discharge, even when the battery is left attached to the operational equipment. When the battery needs to be brought into service once more, it can be easily recharged to return many hundreds of discharge cycles. The LIPS 16 has been optimised to charge from Lincad's own in-service range of charging systems, but can be adapted to accept charge from alternative sources if required.

The LIPS 16 also features the ability to update operational software and interrogate the battery memory via a mobile device, tablet or PC. Its sophisticated internal battery management system (BMS) can also store valuable periodic operational data for use in maintenance activities during

applications across the world. It also offers users a cutting-edge upgrade to the more traditional lead acid batteries that have predominantly been used on applications such as the Hostile Artillery Locating (HALO) system. However, the LIPS 16 battery also lends itself well to a range of applications in different sectors that require that kind of performance. These include applications in the petrochemical industry and the medical profession.

Hendey continues, "We are especially excited here at Lincad right now, because after a lot of research and development work, the LIPS 16 is now available for purchase. We already have strong interest from existing customers, and we expect to see increases in global demand. Due to its in-built heating system, the LIPS 16 works well across a wide temperature range, making it suitable for use in a broad range of hot and cold environmental conditions."

The LIPS 16 also offers several operational benefits over its lead acid battery counterpart. Its fully metallic enclosure has been sealed to IP55 in order to offer superior physical protection and electromagnetic screening for the delicate internal components. The LIPS 16 is versatile, with an internal discharge feature that allows stand-alone discharge of the internal cell stack – a vital aspect for transporting lithium-ion battery equipment. This important feature allows the user to discharge the cell stack to levels optimised for long-term storage or for transport by air, thus complying with current IATA regulations for transporting

the entire useful life of the battery system.

So, what makes the LIPS 16 peculiarly suitable for military use? According to Hendey, its robust nature and long battery life are tailor-made to suit the demanding and sometimes hostile environments of the military and defence sectors. "Our new LIPS 16 battery is solidly built and has an impressive life of more than 80 ampere hours. It can be used for a large number of mission-critical applications, including powering essential military radio equipment and field hospital ventilation systems. It can even be used as a generic power supply for multiple applications at the same time, making it one of the most important pieces of kit for a military team to have in the field."

Lincad's batteries and chargers are used for a large variety of military and defence applications, from human-portable equipment to robotic vehicles and artillery pointing systems. The Surrey-based company has been supplying battery products around the world for more than 30 years, relying on its team of expert engineers and research and development specialists to create cutting-edge products that keep pace with developments in technology and provide the sectors in which it works with versatile, high-quality and resilient power management solutions. ■

For further information about the company's latest military batteries, chargers and power management solutions visit www.lincad.co.uk



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STAND ^{AND} DELIVER

Sea mines have been used to devastating effect by nation states and non-state actors, but hunting them is time consuming and painstaking. Now a new stand-off MCM concept, involving a system of robots, promises to change minehunting forever. Commander Claude Bultot, programme director “replacement MCM capacity” for the Belgian and Royal Dutch Navies, tells us what its new Stand-Off MCM Toolbox means for future mine countermeasures.

By Anita Hawser

For centuries, sea mines have given nation states and other actors, a cheap and highly effective means of defending coastal areas and ports against attack, and stopping merchant or naval shipping vessels in their tracks. They can lay hidden for long periods above or below the surface of the water, waiting for a vessel’s magnetic or acoustic signature to trigger an explosion.

Sea mines were used to great effect by both sides during the First and Second World Wars to sink merchant ships and naval vessels and to protect coastlines against German U-boats. In the First World War, the North Sea Mine Barrage, which stretched all the way from the



A graphic depicting the Stand-Off MCM Toolbox's system of robots (ECA Group)



Belgian and Dutch Tripartite-class minehunters M917 *Crocus* and M862 *Zierikzee*: The main driver for the stand-off MCM concept was the replacement of legacy MCM minehunters developed in the early 1980s and modernised around 2005 (MKFI, Public domain, via Wikimedia Commons)

Orkney Islands to Norway, was devised by the US Navy to prevent U-boats attacking trans-Atlantic shipping.

To this day, navies are still clearing the hundreds of thousands of sea mines that were laid during the First and Second World Wars. UK Royal Navy minehunters permanently stationed in the Persian Gulf continue to search for mines, which are a legacy of the Iran/Iraq War.

According to the Robert Strauss Center for International Security and Law at the University of Texas in Austin, naval mines have inflicted 77% of US ship casualties since 1950. They can also be used to

great psychological effect as the mere threat of them can bring maritime traffic to a standstill. During Operation Unified Protector in Libya, for example, NATO forces discovered mines had been laid in the Port of Misrata to prevent the flow of humanitarian aid into the country. Sea mines planted by Houthi rebel forces in the southern Red Sea and the Bab Al-Mandab Strait continue to threaten maritime traffic in the region.

For the navies that hunt mines scattered across the world's oceans, it is a painstaking task, involving sonars to detect the sea mines and remotely operated

vehicles (ROVs) or divers to identify and dispose of the mines. One of the biggest challenges for navies is operating at speed and scale. Legacy minehunters can only handle one mine at a time, which means in areas where there are large numbers of mines, it could take months, if not years, to clear.

Advances in sonar technologies and unmanned systems have made it easier to hunt mines at speed and cover larger threat areas. Mine detection and classification has also been enhanced by improvements in video compression and communication links, which means



for transporting different robots into and out of the minefield, as well as providing relay communication; as well as towed sonars, mid-sized AUVs, inspection and neutralisation vehicles. “Many drones can be in the water at the same time and will work together at different phases of the mission,” Anthony Penn, commercial and business development director at ECA Group stated during a virtual presentation at Euronaval in October.

ECA Group is developing the system of robots that will be used by the Belgian and Royal Dutch Navies in their Stand-Off MCM Toolbox. France’s Naval Group will equip both navies with 12 next-generation MCM ships (six each). A deployable C2 container, as well as an advanced MCM training simulator is also included in the contract. From 2022, the French and UK Navies will also take delivery of what Thales describes as the “world’s first fully integrated unmanned mine countermeasures system of systems,” which includes USVs, AUVs, the latest sonars, and a Portable Operational Centre (POC), which can control up to three unmanned systems in the water at any given time.

In future, most mine countermeasure (MCM) operations — except for those near critical underwater structures,

which will still require navy divers — will be conducted autonomously. But getting to this point has been a journey. For the Belgian and Royal Dutch Navies it took many war games and sea trials in the North Sea, pitting legacy minehunting systems against autonomous underwater and surface systems from a host of commercial off-the-shelf providers, including Thales, Elbit Systems, Teledyne Marine and Atlas Elektronik, before they settled on the stand-off MCM concept.

“These actions were needed to de-risk the concept and to validate our assumptions,” says Commander Claude Bultot, programme director “replacement MCM capacity” for the Belgian and Royal Dutch Navies. “Furthermore, we relied on our binational experience in this domain. Finally, we elaborated a binational BEL-NLD [Belgium-Netherlands] vision about the future MCM operations. The conclusion was to base the future of MCM operations on a stand-off concept, which was strongly supported by the Admiralty of both navies.”

The war games and trials proved what both navies had long suspected, that the performance of current autonomous systems in MCM far exceeded that of legacy minehunting vessels. In addition to keeping the crew out of the non-

data collected by underwater sensors or sonars can be more easily transmitted back to those that need to analyse it. But the thing that is likely to revolutionise the centuries-old tradition of mine hunting the most, is the concept of stand-off mine countermeasures using a system of robots.

This concept relies on a system of robots, including autonomous underwater vehicles or AUVs, unmanned surface vessels (USVs) and unmanned aerial vehicles (UAVs) to detect, identify, classify and neutralise sea mines. UAVs will be used for detecting floating mines, for relay communication or reconnaissance; USVs



New MCM vessels will transport robots into the the minefield (Image: Naval Group)



The masterpiece of the new MCM ships for the Royal Dutch and Belgian Navies is the mission bay where unmanned vehicles are stored (Image by Naval Group)

surveyed mine threat area and relatively safe, one of the biggest benefits of using multiple unmanned systems is the ability to conduct MCM operations in parallel, resulting in faster coverage and clearing of the mine threat area.

“With the stand-off concept, we are able to deploy several tools simultaneously,” explains Cdr. Bultot. “For example: one USV with a towed sonar to detect the mines and one USV with a mine identification and disposal system to identify and dispose of the mines that were localised earlier. Furthermore, we are able to deploy an UAV with a LiDAR sensor to detect drifting or moored mines on or just below the surface. This concept enables enhanced efficiency of mine-clearing operations.”

Divers will still be used for operations close to critical underwater structures. “There will be a dedicated diver’s payload for the USV in order to enable diving operations,” says Cdr. Bultot. “For shallow-water operations, we will still use the current very-shallow-water capability. So, current [minehunting] skills will still be needed in the stand-off concept.”

While the concept of stand-off MCM operations has been proven, all of the unmanned systems in the Stand-Off MCM Toolbox that the Belgian and Dutch Navies will operate in future have not

been tested simultaneously. “There is currently no platform (mothership) that integrates all the unmanned systems,” explains Cdr. Bultot. “However, each system separately, has demonstrated to be reliable and efficient through the conducted sea trials. Furthermore, the first platform will be delivered in September 2024. Until then, many tests will be performed by the contractor to validate their systems and finally, several harbour and sea acceptance tests are planned to guarantee that the delivered systems will fulfil all requirements of the contract.”

The new MCM ships being built by Naval Group, will replace the Belgian and Dutch Navies’ legacy minehunters, which were developed in the 1980s and modernised around 2005. The new ships will have a low electromagnetic, radar and acoustic signature and high shock resistance to protect the crew. Advanced automation on board the ship will allow for multiple drones to be operated simultaneously in an optimised way.

“The masterpiece of the ship is the mission bay where all the unmanned vehicles are stored,” Aymeric Moullart de Torcy, operational marketing for Drones at Naval Group stated during Euronaval 2020. “It is very compact and optimised, and devices can be easily

‘re-roled’, according to what is needed for the mission.” The ship’s mission bay is connected to the combat management system. All data collected from real-time operations can be shared outside the ship. A data centre on board the ship can also be operated independently from the shore if required.

Cdr. Bultot says the new technologies in the Stand-Off MCM Toolbox, will also help in attracting navy personnel and supporting recruitment for the new MCM platforms. Training on the new equipment will take place in phases. The first phase will entail general discovery of the ship, its characteristics, architecture, maintenance and mode of operation, through theoretical courses. In the second phase for technicians and operators, crew members will get to grips with the systems and equipment they will operate: functions, interfaces, safety conditions, start-up, stop, operating modes, maintenance first level, fault location procedures. A third training phase will take place at sea in a real-world situation with crew members.

Mission-specific training will be provided in advance using a simulator at EGUERMIN, the NATO Centre of Excellence for Mine Warfare in Ostend, Belgium. Modular teams will be trained on the systems, but also in the simulator. The simulator consists of three cubicles composed of a Combat Information Centre and a virtual reality environment. The first is to train the combat management systems as well as the mine warfare software. The latter will be used for familiarisation of the crews through a “ship explore” 3D environment and to train the operators and deck handlers in the virtual hangar of the ship. “They will be able to virtually prepare the tools and deploy them,” says Cdr. Bultot. After initial training, the crew of the MCM platform and the modular teams will continue training at the ABNL Mine Countermeasure Vessels Operational Sea Training (MOST) Centre in Zeebrugge. ■



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Building upon more than 60 years of experience in the design and manufacture of proximity fuzes, JUNGHANS Defence, a joint venture between Diehl and THALES, can now offer armed forces and munition companies a brand new family of multi-function naval fuzes, called FREMEN. These fuzes have been designed for various weapon systems, including calibres ranging from 76 mm to 100 mm and 127 mm.

In recent years, the technologies for electronic artillery fuzes, and in particular proximity fuzes, have advanced considerably. One of the most important developments concerns improved target detection, which is achieved by the use of miniaturised radar sensor technologies.

Today, new techniques of microwave electronics and signal processing allow for the realisation of proximity sensors, which offer significantly higher detection performance and precision than those provided by the previous generation of devices. In addition, these technologies are entirely compatible with the constraints of volume, energy and costs for artillery fuzes.

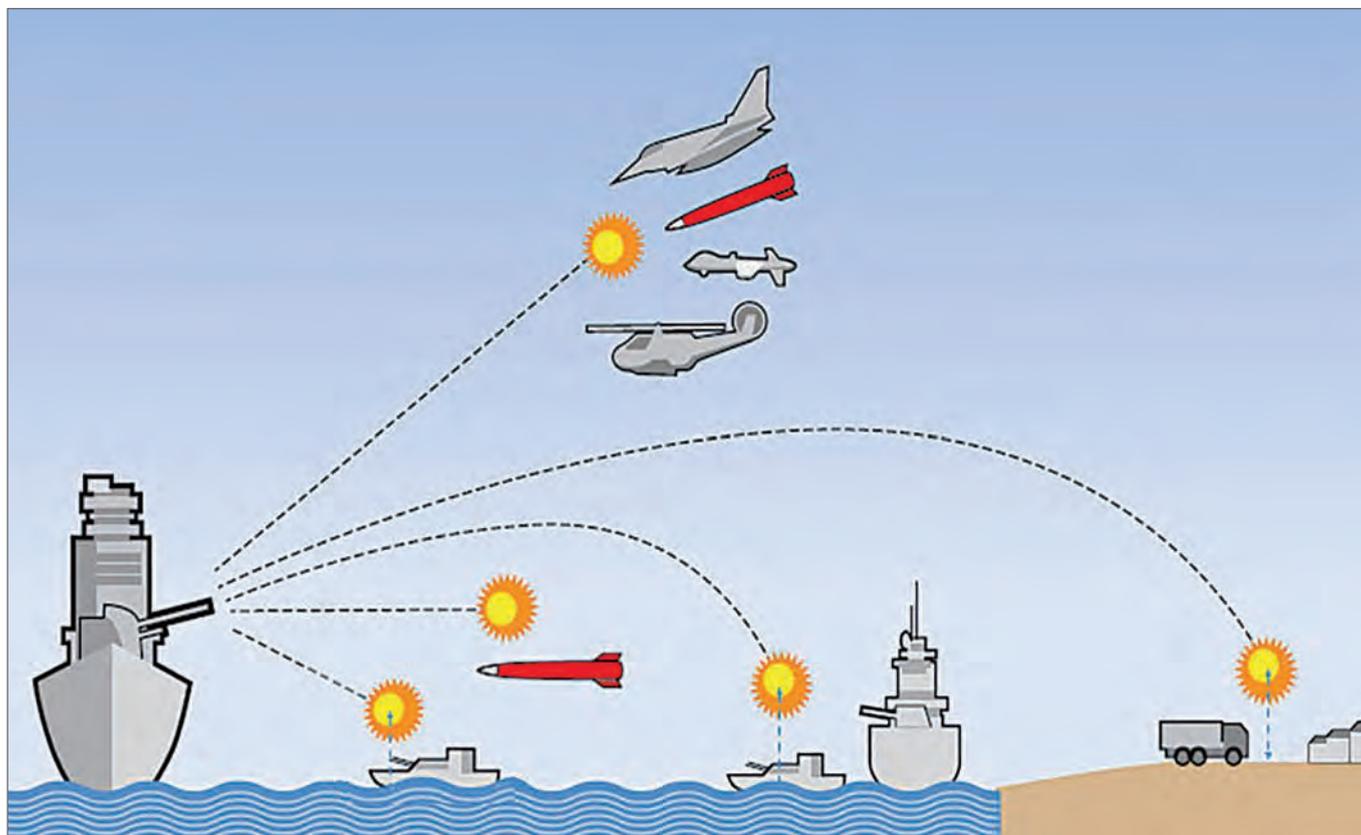
Proximity sensors now integrated into the electronic fuzes of the new FREMEN generation of products employ Frequency Modulation Continuous Wave (FMCW) with digital signal processing, realised by the use of a special processor. So far these modern solutions have been applied to proximity and multi-function fuzes for field artillery (calibres 105 mm and 155 mm) and for mortar.

Implementation in naval fuzes is significantly more challenging, as the sensor needs to detect small targets in various attack configurations. In the application of air-defence the target to be detected can be, for example, an aircraft or missile flying at high altitude, or a missile flying close to the surface of the water. In comparison to the 'ground' target, the air targets present completely different characteristics in terms of radar cross-section, sea clutter and relative speed of interception.

One of the main characteristics of the radar FMCW is the ability to measure the exact fuze target distance, in contrast to the current generation of CW (Continuous Wave) fuzes, which will only process the Doppler signal (in relation to the

speed) without giving precise information regarding distance. Conventional fuzes based on CW-Doppler sensors have notoriously limited detection capabilities for low altitude targets. They find it difficult to distinguish target signals from sea clutter, which leads to poor performance in target detection probability, as well as a high rate of 'early bursts'.





The use of FMCW technology represents a significant breakthrough in the domain of proximity fuzes used with naval artillery and air-defence. Fitted with this type of radar proximity sensor, the FREMEN fuze measures the actual distance to the target, as well as velocity. With this information the fuze is capable of discerning the target's echo signal from the signal reflected off the surface, especially from the waves (sea clutter). This can be achieved even in stormy conditions with a high level of sea clutter, without any risk of 'early burst' or target detection limitation, even against small targets.

Being able to accurately detect target distance and velocity, the FREMEN fuze detonates the munition at the correct position to the target, thus optimising the terminal effect in accordance with warhead fragment spread. Consequently, the FREMEN fuze provides naval artillery with major benefits compared to the previous generation of fuzes. It is able to improve detection and destruction of any aerial target, missile, aircraft, helicopter and UAV, even in the most difficult attack conditions, regardless of the target's size, velocity and flight altitude.

In addition to the capabilities of the fuze against aerial targets, FREMEN significantly increases the terminal effects against surface targets, on sea or land, and for fire support, as well as for littoral warfare. The FREMEN fuze features an accurate Height of

Burst (HoB) mode effective either in indirect fire configuration for shore bombardment, or in direct fire configuration against sea surface targets, for example, patrol boats.

The fuze's smart sensor also provides excellent immunity to interference, thus preventing 'early burst' caused by RF, enemy jamming or vessel radar interferences.

In terms of operational flexibility, the FREMEN fuze provides unique benefits. The extended operational modes against air, land or sea targets does not require any fuze programming prior to firing. This means that the fuze always operates with the optimum mode in a fully independent way, without the need to programme target parameters and operation mode. The fuze automatically selects either air-defence or surface-fire mode, depending on whether the sensor identifies an air or surface target.

The JUNGHANS' FREMEN naval fuze offers navies a much wider range of applications than were previously available. This new generation of multi-function fuzes provides naval artillery with unmatched capabilities to fulfil modern operational requirements and achieve a broad range of missions.

Serial production of the FREMEN fuze has now commenced to satisfy a French Navy requirement. Other naval forces have also expressed strong interest in the fuze, and an additional European navy has also placed a firm order with JUNGHANS Defence. ■



MoD Portland Bill
(Matthew Power Photography)

PORTLAND'S MAGNETISM

For 70 years, the Isle of Portland has provided important measuring and testing facilities to ensure equipment used by the Royal Navy in Mine Countermeasures (MCM) and Explosive Ordnance Disposal is "magnetically clean."

By Anita Hawser

Perched on the southernmost tip of Dorset, the tiny Isle of Portland, which forms part of the UK's World Heritage Jurassic Coast, is a major drawcard for tourists who flock to the island in summer to visit attractions such as Chesil Beach, Portland Lighthouse and the Castle.

But for the UK's Royal Navy, there is another reason to visit Portland. The navy have had a presence on the island for more than 150 years. However, since 1950 one reason for being there is less about its picturesque surroundings and more about the island's "magnetic cleanliness" due to its remote location and non-magnetic Portland limestone, which has been used in architectural landmarks such as St Paul's Cathedral.

The lack of magnetic interference on the island makes it the perfect location for measuring and testing sensitive equipment such as magnetic compasses and equipment used in Mine Countermeasures (MCM) and Explosive Ordnance Disposal (EOD). It is also an ideal location for testing the performance of electronic



“

The challenge for us is to evolve what we offer. We need to continue to provide a capability that remains relevant.

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A Royal Navy Hunt class MCM vessel: Everything on board the vessel needs to be tested at MoD Portland Bill to ensure it is "magnetically clean."
(MoD/Crown Copyright)

warfare (EW) systems fitted onto ships, submarines and helicopters.

Most of this activity takes place in a nondescript bunch of buildings known as MoD Portland Bill. To tourists visiting Portland Lighthouse next door, there is little indication of what goes on inside the buildings behind the wire fence surrounding the site, which is managed by QinetiQ under its Long Term Partnering Agreement with the UK's Ministry of Defence.

Thousands of items a year pass through MoD Portland Bill for testing and measurement. Most of it pertains to equipment used by the Royal Navy for MCM and Explosive Ordnance Disposal (EOD), although the site also does magnetic compass calibration for the Royal Air Force and other Ministry of Defence aerodromes. When it comes to MCM, all equipment used on board the Royal Navy's Hunt and Sandown-class vessels needs to be tested to ensure it is magnetically clean, says David Rollett, technical manager for MCMV and EOD at MoD Portland Bill. When Rollett says everything, he literally means everything — from cookers in the ship's galley to propulsion motors and Remote Controlled Mine Disposal Systems — all of these items must be tested using Portland Bill's Land Magnetic Range (LMR).

The range simulates the magnetic field found at any location around the world using coil systems embedded in the walls of the building, which counteracts the effect of the earth's local magnetic field. "In terms of the measurements we do, we want to measure the permanent magnetic signature of an item, and to see how it is affected by external magnetic fields anywhere on the planet," explains Rollett.

Rollett and his team also survey sites where MCM equipment is stored, to ensure that it is done in such a way that the equipment's magnetic signature is not impacted. The same is true for ships deployed overseas or at military ranges around the UK. At these locations, Rollett says sensors on the seabed are used to



Portland Bill's Land Magnetic Range simulates the magnetic field at any location around the world. (Matthew Power Photography)

test a vessel's magnetic signature.

"Other aspects that are really important is the safety of EOD divers whose equipment has to be put through the LMR at Portland," says Samantha Hill, Operations Group Lead for Maritime Ranges at QinetiQ. "For a mine disposal diver, all their equipment and clothing has to be tested so they can inspect a mine without causing it to detonate." Tests like these are conducted every three years.

The reason for doing this, says Hill, is that sea mines respond to either magnetic, acoustic or pressure influences. "More sophisticated mines use a number of different influences to make sure they are not being fooled by a minesweeping system, so you need to be as magnetically clean as possible."

The range at Portland Bill will soon enter a new phase of testing as MCM systems like the Royal Navy's unmanned minesweeping system are brought on line. The system, which features an Unmanned Surface Vessel and a system of robots, will enter the minefield instead of the traditional minehunting vessels. "These unmanned systems will be tested in the same way as manned assets on the magnetic range at Portland," says Hill.

MoD Portland Bill also provides Electronic Warfare (EW) calibration facilities for EW countermeasures on board naval vessels manoeuvring five to 10 miles out to sea from Portland. "We provide Royal Navy platforms with standard test signals to check the surveillance equipment on board," explains David Mitchell, head of site at MoD Portland Bill. "They are interested in knowing what is out there in the radio frequency environment to ensure their systems are working correctly. They are also looking for areas on board the ship where they can detect signal sensitivity."

This health check for a ship's surveillance systems is a must before they deploy on overseas operations. MoD Portland Bill is also looking to develop a mobile system so similar checks can be performed on ships overseas. "As ships are being deployed for longer and longer on operations, we want to make use of other locations worldwide to conduct these sort of tests," says Hill. "The challenge for us is to evolve what we offer. We need to continue to provide a capability that remains relevant and that offers the right level of fidelity for new systems that are entering service." ■



INDIA'S SUBMARINE FLEET GROWS FITFULLY

Last summer, a formal tender for the six long-awaited P-75 India stealth submarines was due to be announced by the Indian Ministry of Defence. Nothing was forthcoming, but then long delays are not unusual when it comes to India's indigenous submarine programme.

By Sarosh Bana



Vela, the fourth of the indigenously made under licence Project-75 submarines, at its launch in May 2019
(Copyright: Indian Ministry of Defence)

In India, the world of naval shipbuilding moves at its own unique pace. A good example of this is the country's plans to build six new generation stealth diesel-electric attack submarines (SSKs) in collaboration with foreign partners. In 2012, the then Chief of the Naval Staff, Admiral D.K. Joshi, announced that the RFP for the \$7.5 billion Project-75 India (Project-75 (I)) would be issued "soon." Eight years on and no formal RFP was forthcoming.

This summer speculation was rife that the formal tender for the six stealth submarines would finally be announced. In November, media outlets reported that the Indian Ministry of Defence was "all set to issue" the tender. When it finally arrives, it will be one of the most anticipated in naval history.

The lucrative contract has elicited wide interest among shipyards both at home and abroad, with the Ministry of Defence shortlisting two domestic contenders — state-owned Mazagon Dock Shipbuilders

(MDL) and the private sector Larsen and Toubro (L&T), either of whom will ultimately partner with one of five foreign Original Equipment Manufacturers (OEMs) bidding for the tender.

Russia's Rosoboronexport is offering India its non-nuclear Amur 1650 submarine, and France's Naval Group has put forward its next-generation SMX 3.0 concept, which features the latest digital technologies and a vertical launch system for French and Indian-designed weapon systems.

Spain's Navantia is offering India the S-80 Plus submarine, Germany's ThyssenKrupp Marine Systems has put forward the HDW Class 214 submarine, which it describes as "a cost-effective solution for future oriented navies," and Daewoo Shipbuilding & Marine Engineering is going with its diesel-electric KSS-III submarine.

Project-75 (I) will be the first so-called Strategic Partnership (SP) model ascribed to an Indian military procurement

programme. The model was promulgated in 2017 as Chapter VII of the Defence Procurement Policy (DPP) 2016. Citing the SP model as innovative and unique, Jayant Patil, L&T's whole-time director and senior executive vice president for Defence & Smart Technologies, says while Indian naval construction was previously assigned to state-owned shipyards, policy innovation now recommends that private-sector companies be simultaneously entrusted with complex programmes to comply with the "Make in India" initiative.

INDIGENOUS CONTENT

"The SP model as applied in Project-75(I) is unique in that it requires both the foreign collaborator and their Indian Strategic Partner to jointly customise the submarine design as per the Indian Navy's requirements to suit its specific operational needs," says Patil. "India is consequently expected to become self-reliant in submarine building, with an entire industrial ecosystem, comprising

equipment manufacturers, related ancillaries and R&D facilities, envisaged to be created through enhanced indigenous content."

According to Patil, the customised submarine design is expected to be clarified in the RFP, with the final configuration adapting the base design of the foreign OEM's submarine, while undertaking the modifications and enhancements required by the Indian Navy. "It is evident that these requirements are not readily available in any of the reference submarines, but can be suitably incorporated, post awarding of the contract," he says. "Also, the quantum of indigenisation will



Defence Minister Rajnath Singh and Navy chief Admiral Karambir Singh with the naval hierarchy at the commissioning of INS Khandar (Copyright: Indian Ministry of Defence)



Awaiting orders: L&T Shipbuilding's sprawling yard in Kattupalli, in north Chennai (Copyright: L&T Shipbuilding Ltd.)

necessitate design modifications suiting yard practices followed by the Indian strategic partner.”

Asked if both MDL and L&T were to be eventually contracted for the P-75(I), as two production lines could cut down on any delays, Patil says that the contract will be placed with the LI bidder (the one quoting the lowest price). However, as the project is the maiden Strategic Partnership programme, the RFP process is still evolving and Patil says it would be premature to comment on “operating models.” He points out that submarine-building nations like the US, Russia and South Korea, have built far larger numbers of next-generation submarines and awarded them to two yards separately or collaboratively, to reduce construction timeframes as well as costs.

The Indian Navy has an urgent need to surmount a slump in its undersea capabilities as it confronts a menacing Chinese presence in the Indo-Pacific, with Beijing concertedly bolstering its fleet levels and marshalling the support of India's neighbours through transfers of significant naval assets. Mindful of the Navy's operational gaps, the Cabinet Committee on Security (CCS) approved a 30-year plan back in 1999 for the induction of 24 new diesel-electric submarines by 2030, a dozen of them to be constructed with foreign collaboration by 2012, with the remaining 12 to be “built to indigenous design.”

In the Indian context, defence procurements, and their timing, are largely a political consideration rather than one premised on military and security

concerns. Thus, in the 21 years since the plan was introduced, only six submarines are being built by MDL under licence from Naval Group. Designated P-75, the programme is the precursor to P-75(I) and is itself running six years late, with its original contract cost of \$2.63 billion in 2010 spiralling to \$3.8 billion.

Project-75 was finalised in 2005, and the construction of Kalvari, the first in the series of 1,565-tonne Scorpene 2000 SSKs began in 2006. It was finally commissioned in 2017. *INS Khanderi*, the second in the series, was inducted in September 2019, while *Karanj*, the third, was launched in 2018 and was scheduled for delivery in December 2020. The fourth, *Vela*, was launched last year, and is due to enter service in intervals with the final two Scorpene by 2022.



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Asked if the Scorpene were being denied the vital Air Independent Propulsion (AIP) system on account of the Defence Research and Development Organisation's (DRDO's) protracted delay in producing one, Admiral Karambir Singh, India's Chief of Naval Staff (CNS), says the 2005 contract had not included an AIP system within the project design. "However, given the importance of AIP, the Indian Navy initiated a project for developing such a system with DRDO, and it will be progressively fitted on the Scorpene submarines," he adds, implying that this would be undertaken at the time of the submarines' medium refits.

"The AIP system that meets the Navy's requirements will be selected," says Admiral Singh. He maintains, however, that the overall aim is to achieve progressive indigenisation in a phased manner in each submarine project. L&T's Patil points out that the P-75(I) contract envisages the six indigenously constructed submarines to be furnished with an AIP system that features lithium-ion rechargeable batteries instead of lead acid batteries.

DEPLETED FLEET

Today, the Indian Navy has a depleted fleet of submarines, with 10 or less being operational at any given time. Apart from the two Scorpene in service, there are eight 3,100-tonne Sindhughosh class (Russian-origin kilo class 877EKM) submarines, and four Shalki class (HDW Type 209) submarines with a displacement of 1,850 tonnes.

While a submarine's prescribed operational life is around 25 years, seven of the eight kilos are already 29-to-34-years old and the HDWs are between 26-and-34 years old. The Navy also has a nuclear-powered 8,140-tonne Akula-II Class boat that it took a 10-year lease on from Russia in 2012.

The Indian Navy also operates the *INS Arihant*, a strategic strike nuclear submarine developed and built at home at a cost of \$2.9 billion. The *Arihant* is the



Admiral Karambir Singh (Copyright Indian MoD)

first in a series of three such 6,000-tonne nuclear-powered ballistic missile submarines conceived way back in 1998. The boat was, however, only launched in 2009 and commissioned in 2016. Its successor, *Arighat*, was launched in 2017 and will enter service by the end of 2020.

The P-75 Scorpene is being christened after the eight Soviet 1,952-tonne Type 641 Foxtrot class conventional submarines, with which India's submarine arm was established in 1967. All eight were decommissioned between 1989 and 2010.

However, even after the Strategic Partners for India's Project-75 (I) are finalised, followed by price negotiation and contract finalisation, the lead submarine is unlikely to arrive for at least another 10 years, discrediting the 30-year plan.

It looks like India will have to wait a little longer to fully realise its submarine-building ambitions. ■

ABOUT THE AUTHOR

Sarosh Bana is Executive Editor of *Business India* and Regional Editor, Asia Pacific of *Naval Forces*.

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ON A DIFFERENT TRAJECTORY

As anti-missile defences grow in sophistication, next generation anti-ship missiles are gaining in stealth, range and their ability to address multiple threats with high volume salvos.

By Atul Chandra

Increasingly complex operating environments and a rapidly evolving threat landscape present several challenges for modern anti-ship missiles. Navies globally are responding to these threats with stealthier combat vessels equipped with advanced air defence systems and electronic warfare (EW) capabilities such as active expandable decoys.

Many anti-ship missiles in use today began their development in the 1970s and 1980s, but have been constantly upgraded to detect and deter advanced threats. The US Navy has near-term capability upgrades planned for its current long-range strike weapons such as the Maritime Strike Tomahawk, new Tomahawk warhead (Joint Multiple Effects Warhead System) and SM-6/Block IB.

As part of its Offensive Missile Strategy, the US Senate Armed Services Committee was informed in April 2019 that future navy offensive strike systems would consist of a broader family of current and future weapons with a strong focus on delivering “multi-domain” capabilities; a joint warfighting concept, which involves inflicting multiple threats against a near-peer adversary.



The Kongsberg NSM's low radar cross-section and high-G capability, make it a difficult target for shipborne defences (US Navy photo by Mass Communication Specialist 2nd Class Zachary D. Bell)

Speed, range, lethality, survivability and commonality remain key parameters on which anti-ship missiles are judged. “Survivability is key,” says a spokesperson for MBDA, which predicts that a mix of various capabilities — speed, discretion, optimised trajectories and terminal manoeuvres — will be needed to penetrate enemy air defences. “In addition, operational tactics should be used based on the scenario and intelligence available, and in some cases multiple simultaneous engagement could be necessary to achieve the objective.”

SURVIVING SHIPBORNE DEFENCES

One of the most modern anti-ship missiles in service is the fifth-generation Naval Strike Missile (NSM) from Norwegian company, Kongsberg Defence & Aerospace. “Compared to competitive systems, all being radar-guided fourth generation missiles developed in the 1970s, the NSM has a much higher probability of penetrating the defences of a modern warship and its precise targeting capabilities ensure a higher success rate,” says Kyrre Lohne, vice president of Strategic Business Development at Kongsberg. The NSM does not emit any electronic signals as it uses a completely passive infrared imaging sensor. Its stealthy missile mainframe design provides an extremely low-radar cross section and the NSM’s high-G capability allows it to make unpredictable manoeuvres.

“The key challenge for any missile is to survive the defences of a modern warship, to penetrate the defence and deliver the warhead precisely at the intended hit point,” says Lohne. “The second priority is for the missile to distinguish and classify different targets to ensure they engage the correct one.”

A vital operational capability in modern battle scenarios with complicated situational awareness is the NSM’s ability to undertake positive identification of a target prior to impact, which is made



Kongsberg’s NSM has unique capabilities compared to legacy anti-ship cruise missiles (Image courtesy of Kongsberg Defence & Aerospace)

possible by the Autonomous Target Recognition (ATR) of its passive sensor. The NSM first became operational on Norwegian frigates and coastal corvettes in 2012. It has since been selected by the US Navy, US Marines Corps and received orders from countries, including Germany, Poland, Malaysia, and more recently, India.

MBDA is developing a new generation of coastal batteries under the MCDS (Missile Coastal Defence System) programme for export customers. Offered as a flexible system, MCDS allows customers to optimise their defences, according to the geography of their maritime approaches. The coastal defence system can operate Marte MK2/N (30 km class), Marte ER (100 km class) and/or Exocet MM40 Block 3 (200 km class) missiles.

There is also interest in both the maritime and land variants of MBDA’s surface-launched Brimstone concept. “The introduction of Brimstone 3 in the near future will further enhance the missile’s capability, whether being launched from the air or from the surface,” says an MBDA spokesperson. MBDA is anticipating increased activity around the Brimstone’s previously demonstrated maritime surface launch capability over the next 12–24 months.

The Brimstone 3 ultra-high precision missile system offers a “one missile, multiple platform” capability for surface launch, fast jet, Remotely Piloted Air Systems (RPAS), attack helicopter, land and maritime platforms. The new-build Brimstone missiles will benefit from several spiral upgrades over recent years, including integration of a highly capable Dual Mode Semi-Active Laser (SAL)/millimetric Wave (mmW) seeker, enhanced autopilot, a new insensitive munition compliant rocket motor and warhead. The first firing trial for Brimstone 3 occurred in March 2019 and its development stems from the Brimstone Capability Sustainment Programme (CSP) announced in March 2018.

SWARM ATTACKS

The threat to warships and smaller combat vessels comes not only from anti-ship missiles, but also torpedoes, Unmanned Aerial Vehicles (UAV) and Unmanned Surface Vessels (USV). In these scenarios, naval area swarm attack and torpedo defences are vital, if combat assets at sea are to remain unharmed. The chief challenges for ship-borne defence systems are fast threat identification and short reaction times to secure the vessel, crew

or critical assets from a variety of threats.

MBDA is proposing the VL MICA NG (Next Generation) for naval air defence needs, and is now two years into the development of the upgraded MICA NG air-to-air missile. "It is time now for MBDA to offer this new missile in combination with the very successful VL MICA air defence system, procured by 15 land and naval forces around the globe," the spokesperson says. The MICA NG will be available from 2026 onwards and retains the mechanical characteristics of its predecessor. It is also fully compatible with existing MICA launchers.

The biggest changes to the MICA NG are its new Imaging Infrared seeker (based on a focal plan array) and a new Active Electronically Scanned Antenna RF seeker, both of which are based on entirely new technologies. While the new seekers deliver a substantial increase in performance, with a comfortable margin against electronic countermeasures, the MICA NG's new dual-pulse motor allows it to conduct engagements out to a range of 40 km or more.

Israeli firm Rafael is offering various combinations of its layered defence suite, dependent upon current and future threat definition, cost-effectiveness and available reaction time. A key offering is its C-DOME naval area defence system, already operational with the Israeli Navy. C-Dome is based on the combat-proven Iron Dome air defence system, which has registered more than 2,500 combat interceptions.

"C-Dome is a highly advanced combat system, which enables hemispheric protection ship point and area defence for task force and strategic assets at sea and shore to meet the evolving threats," says Ran Tavor, vice president and head of Rafael's naval systems directorate. "It enjoys the same benefits and capabilities of the Iron Dome, which has proven to be highly effective against a wide variety of simultaneous threats, including high volume salvos."

To defend against swarm attacks by



A rendering of MBDA's MCDS with Exocet MM40 Block 3 (200 km class) missiles (Copyright: MBDA)

UAVs, Rafale also offers an Asymmetric Defence Solution (ADS) with layered defence provided by a soft and hard defence layer. The long-range guided Spike LR2 missiles can provide battle damage assessment and undertake extended surveillance missions under adverse environmental conditions. UAV detection, neutralisation and interception is handled by the Spike FireFly Vertical Take-Off and Landing (VTOL) attack munitions and/or Drone Dome laser-based systems.

By all accounts, new generation anti-ship missiles are at their most capable. However, shipborne defences, have evolved at a much faster rate than missile

technology and appear more than capable of defending against evolving missile threats. More than just the anti-ship missile alone, for a maritime missile strike to be successful, requires high quality intelligence, a clear understanding of adversary shipborne defences, impeccable mission planning and a carefully planned strike package. ■

ABOUT THE AUTHOR

Atul Chandra is an aerospace and defence journalist based in India. His articles have appeared in numerous international defence publications, including *Flight International* and *Asian Defence Technology*.

WINNING THE FIGHT

In the competitive world of multi-role combat aircraft, Sweden punches well above its weight. Some of its early aerospace achievements may be little known outside the country, but Saab's newest combat aircraft system, the JAS 39 E (Gripen E), continues a history of avionics and other features that set it apart from the competition.

By Anita Hawser



A Gripen E gets up close: An AESA radar provides a 100-degree angular look behind capability for the pilot
(Photo credit: Saab / J Hunter Aviacom)



When I first contacted Saab to do an interview about the new JAS 39 E (Gripen E) combat aircraft, I didn't count on getting a history lesson in Swedish aerospace engineering. But as I soon discovered, there was a point to this. You can't really understand how a country the size of Sweden came to produce an advanced combat aircraft like the Gripen E, without knowing what came before it.

The country's aerospace industry was borne out of necessity during the Second World War. "For years, Sweden tried to buy fighters from countries like the UK, Germany and Italy, but couldn't get the quantities it needed," says Richard Smith, Deputy Head of Marketing & Sales for Gripen at Saab in Sweden. The Wallenberg family, who still own Saab today, alongside other Swedish industry giants such as AstraZeneca, ABB, Electrolux and Ericsson, established Svenska Aero AB in 1937. Within six years of the company's formation, they'd built the world's first serial-produced aircraft with an ejection seat; the J21.

But most of Sweden's early aerospace achievements are little known outside the country. "The Swedes tend to be humble and conservative," says Smith. "I don't think many people would know Saab had the first production aircraft with an after-burner, which broke the world speed record." Despite its unusually chubby appearance, the Saab J29 "Tunnan" or "Flying Barrel," set an international speed record in 1954, averaging 977 km/h over a closed circuit of 500 km. Other countries marvelled at how a country the size of Sweden could build such an aircraft, which is said to have rivalled Russia's MiG 15 and the US's F-86A Sabre combat fighter when it came to speed.

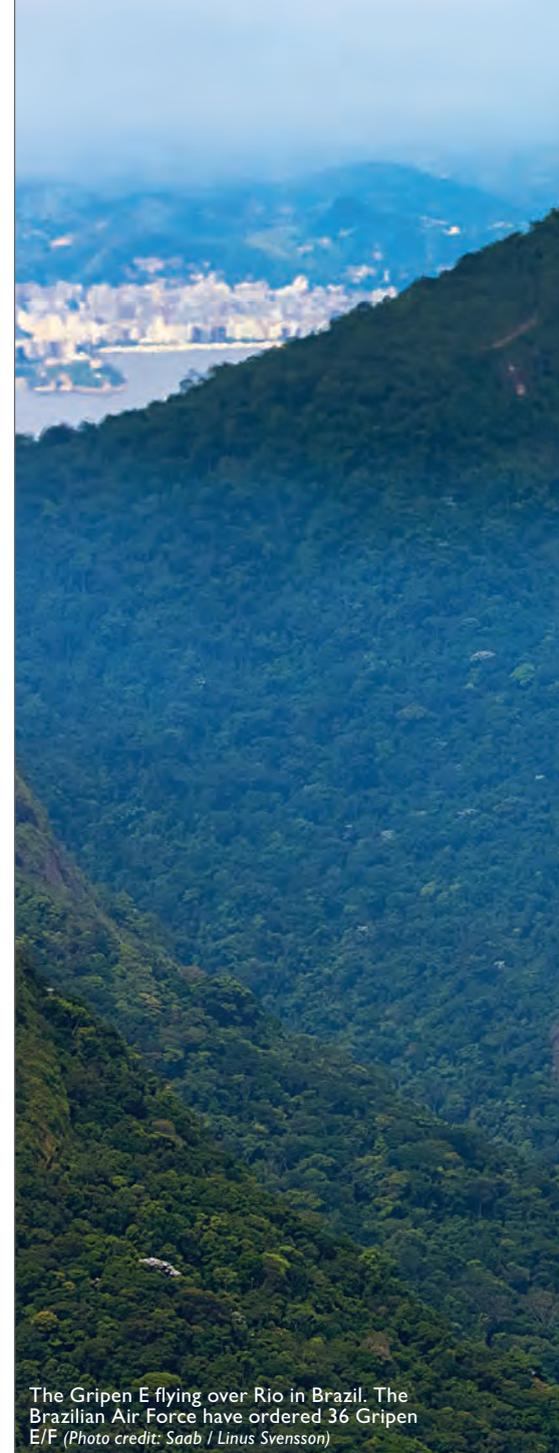
Following on from the J29, the Saab 35 Draken, was a double-delta wing designed aircraft with integrated data links, a new concept at the time. In the 1970s, the Saab 37 Viggen was the first production aircraft with a Heads-Up Display and

central computer. "We should have sold more of these aircraft," says Smith, but it was the height of the Cold War, and many countries were bankrolling new fighter jets (Tornado, Hawker, Mirage and Harrier).

By the early 1980s, Saab was already thinking about a replacement for the Draken and Viggen. They opted for a domestic solution, the JAS 39, which is the military designation for the aircraft used by the Swedish Air Force. The term Gripen, a Swedish word for a mythological creature that is half eagle and half lion, came about as a result of a public competition. The JAS 39 built on Saab's experience with the Viggen, which was one of the first aircraft to feature a delta-wing and canard configuration for enhanced aerodynamics. The Gripen is lighter and more versatile than the Viggen, and featured a single engine and fly-by-wire Flight Control System.

The first Gripen rolled off the Saab factory floor in 1987. But building a fourth-generation multirole fighter was never going to be easy. The Social Democrats, who were the dominant political party at the time within Sweden, were against building advanced military aircraft domestically, due to spiralling costs. But the then Conservative government pushed forward with the fighter, even in the face of stiff opposition. In an interview with *The New York Times* in 1992, Sweden's then Defence Minister, Anders Bjorck, stated: "No other small nation makes the same kinds of aircraft, submarines, missiles and radar we do. It is a technology and an expertise that we must keep alive, if necessary, by finding new partners in Europe."

A crash in 1993, however, could have thwarted the project. During a flight display in Stockholm, the JAS 39 stalled, eventually crashing into an island in the middle of the city and catching fire. Miraculously, no one was killed or injured. The fact that the incident occurred in the "heart of Stockholm," and followed an earlier crash, which was attributed to



The Gripen E flying over Rio in Brazil. The Brazilian Air Force have ordered 36 Gripen E/F (Photo credit: Saab / Linus Svensson)

similar problems with the aircraft's flight control software, was perceived as a threat to the JAS 39 project, according to a report into the incident. But the project survived and was sold as being positive for the country and Swedish industry.

At the Paris Air Show in 1995, Saab announced a partnership with the UK's BAE Systems. Smith says BAE helped "NATO-ise" the JAS 39, which became the Export Baseline Version of the Gripen, the JAS 39 C or Gripen C, which entered into service with the Swedish Air Force (SAF). Today, the JAS 39 C/D is the



backbone of the SAF's fighter squadrons. The new combat aircraft system JAS 39 E will be commissioned during the period 2021–2025, and will, along with the existing JAS 39 C/D, be organised in six fighter squadrons.

Despite not being a member of NATO, Smith says the Gripen C, which featured standard pylons, Link-16 radios and air-to-air-refuelling, was more NATO interoperable than most NATO operating fighters. Saab went on to export the JAS 39 to South Africa, the Czech Republic, Hungary and Thailand. Some of these

exports were dogged by allegations of bribery, but Swedish authorities closed down a criminal investigation into the suspected bribes in 2009.

The Brazilian Air Force have ordered 36 Gripen E/F, which have yet to enter service. Sweden has ordered 60 Gripen E and is the largest operator of the Gripen C, which is also operated by South Africa, Thailand, Hungary and the Czech Republic. Saab has put the Gripen E forward for Canada's Future Fighter project to replace the Royal Canadian Air Force's (RCAF) ageing fleet of CF-188 Hornets.

The Gripen is up against the F-35, which Lockheed Martin argues is the "best value fighter to replace the Royal Canadian Air Force CF-18 fleet," and Boeing's F-18E/F Super Hornet Block III, which is the next generation of the RCAF's current fighter.

The Gripen E may be the 'wild card' in the Canadian competition, but Saab hopes its "Gripen for Canada" coalition, which includes a number of Canadian manufacturers, could sway the decision in its favour. "Our total package is unrivalled in providing Canada with a defence and industrial capability that is highly

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The Saab 37 Viggen was the first production aircraft with a Heads-Up Display and central computer (Photo courtesy of Saab)

compelling and very low risk,” said Patrick Palmer, head of sales & marketing for Saab in Canada. The Gripen E/F is also taking part in Finland’s HX fighter competition to replace the Finnish Air Force’s F/A-18 C/D Hornet .

“Both Canada and Finland are big campaigns for us,” says Smith. “Both need a fighter that can handle the tough Arctic conditions and that is easy to operate. The Gripen is also able to take on current and future Russian threats (SU-30 family, S-400, SU-57).” With respect to the latter, Saab has taken an entirely different design approach to its competitors. Instead of relying on factors such as stealth, which is built into the airframe, Smith says an advanced Electronic Warfare (EW) suite

on the Gripen E “enables us to jam, defend, attack, launch and evade.”

The Gripen E features an active electronically scanned array (AESA) radar system on the nose of the aircraft. The radar moves on a swashplate, giving the pilot a 100-degree angular field of view, so they can still see threats behind them, which Smith says is advantageous in a Beyond Visual Range fight, along with the Meteor long-range missile. “But the coolest thing about the Gripen E, you can’t see,” he says. “You can have stealth, but within a year your enemies’ radar and electronic sensors will be able to pick up your signal. We’ve taken an entirely different route with the avionics system, which allows the sensors and system

to be upgraded rapidly to cope with emerging threats, and as new technologies become available.”

Smith says its avionics are quite unique among all fighters. “It allows us to learn and gather information from day one of a war, and if needed, install a software application overnight, so that in day two of combat, we have the edge of the threats and remain relevant.” A lot of companies talk about the human-machine interface, continues Smith. “But in the Gripen E, we have human-machine collaboration, which is made possible because of our avionics and sensor fusion. The pilot no longer just interfaces with the aircraft; the two work in harmony with one another.”

But one thing the Gripen lacks,

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The Gripen E's wingtip with an EW antenna (Photo credit: Saab / J Hunter Aviacom)

compared to its competitors, is real-world combat experience. That's not to say it hasn't been in conflict situations. The Gripen was used by the Swedish Air Force to conduct reconnaissance missions over Libya during 2011's Operation Unified Protector.

The Hungarian and Czech Republic Air Forces have also used the Gripen on defensive operations as part of NATO's Baltic Air Policing mission. The aircraft's short take off and landing capabilities lend themselves to these types of operations, says Smith as it is designed to be operated from dispersed airfields in Sweden's forests. The Gripen only requires a small team to turn the aircraft around quickly. "You can take off and perform a mission within 10 minutes," he explains. "It can be operated from any airfield."

From day one, Smith says the Gripen was designed to be low maintenance and to spend more time in the air than in a hangar. Pilots remark on how easy it is to fly with very little training. "You don't have to trim the aircraft, it does it automatically," says Smith. "A wide-area display system tells the pilot what to do. Our design philosophy is to make the mission as easy as possible so it has a better chance of success."

Combat aircraft manufacturers are usually reluctant to let owners tweak the avionics too much. The Israelis had to ask Lockheed Martin for special permission to access the F-35's software codes so they could integrate advanced weapon systems on board the fighter. But Smith opines about the Gripen's open architecture and flexible upgrades. "We can update the sensors and systems with new tech, and add more computing power when available. Our avionics software enables this swiftly and without the need for recertification of the flight critical software. Technology changes so quickly you can't keep pace with it. If we're developing the Gripen E, our enemies are also developing new technology, and the one who develops the fastest wins the fight." ■

CONSTANTLY INNOVATING TO STAY AHEAD OF THE COMPETITION

General Atomics Aeronautical Systems

For nearly 30 years, General Atomics Aeronautical Systems, Inc. (GA-ASI) has developed, manufactured and delivered the most successful Unmanned Aircraft Systems (UAS) in the world.

GA-ASI UAS platforms boast 6.5 million flight hours, and it is the supplier of the most utilised aircraft in the United States Air Force's current force structure, with a more than 90% mission-capable rate. In almost three decades, GA-ASI has developed 26



An MQ-9B SeaGuardian configured for surveillance operations over open water, during a set of maritime test flights in sea lanes off the coast of Southern California.

variants of the highly successful Predator series aircraft, ranging in size from 100 kg to more than 1,000 kg, to support the dynamic security needs of the United States and its allies.

Today, GA-ASI development and production is focused on: the MQ-9A Block 5; MQ-9B SkyGuardian and SeaGuardian; MQ-1C Gray Eagle ER and Avenger-series aircraft. MQ-9B is our newest version of the MQ-9-series platform, featuring truly game-changing capabilities for unmanned aircraft, which include an air-traffic collision avoidance system; a type certificate design that will enable the MQ-9B to integrate into national airspace

systems instead of being segregated into restrictive airspace; and all-weather capabilities, so the aircraft can operate in inclement weather using de-ice, anti-ice and lightning protection systems. A full SATCOM expeditionary operations capability is also available, which enables customers to operate from shorter airfields with less manning and reduced support equipment footprints, anywhere in the world.

GA-ASI provides unmanned systems that are complete end-to-end solutions of multiple sensors, along with weapons integration, sensor exploitation and ISR task-management command software. We are also investing in a family of small UAS (SUAS) that can be launched and recovered from the MQ-9 or MQ-1C Gray Eagle, as well as larger aircraft. UAS for ultra-long endurance, measured in days, are currently being developed, enabling the system to act as an aerial layer defence network for air and ground assets.

**MQ-9B SKYGUARDIAN/
SEAGUARDIAN**

The MQ-9B SkyGuardian and SeaGuardian, the maritime variants, are designed for ultimate versatility and reliability. While MQ-9B is a successor to the highly utilised MQ-9A, it is redesigned to increase mission capabilities and



A recent successful demonstration 'A' size sonobuoy carriage, release, process and control from a company-owned MQ-9A Block 5 on a US Navy Pacific test range, which is the world's first self-contained Anti-Submarine Warfare (ASW) capability for a UAS.

meet strict airworthiness type certification standards and airspace integration regulations. Additionally, the MQ-9B's open architecture allows for rapid integration of new mission capabilities and adaptation to changing mission requirements through 'bolt-on, bolt-off' mission kits. These kits enable the MQ-9B to easily transition from over-land to over-sea surveillance, using the maritime or anti-submarine warfare mission kits in combination with its high definition electro-optical/infrared and multi-mode radar, to enable true cross-domain capability.

The SeaGuardian is customised for maritime surveillance and anti-submarine warfare (ASW) operations. The maritime surveillance mission kit includes a wideband maritime surveillance radar, such as the Raytheon SeaVue or Leonardo Seaspray, installed in a centre line-mounted radar pod. In addition, an ASW mission kit can be installed with or without the maritime surveillance kit to expand missions to include subsurface search capabilities.

The ASW mission kit includes an airborne sonobuoy receiver, acoustic processor and sonobuoy dispensing pods (SDPs) that can carry 10 A-size or 20 G-size sonobuoys per pod. A total of four SDPs can be installed, providing for significant ASW capability that rivals manned ASW platforms. Finally, an integrated ESM/ SIGINT mission kit can also be installed with the maritime surveillance and ASW mission kits to expand the collection capability to the radio frequency spectrum and provide a complete maritime and ASW mission capability.

CIVIL APPLICATIONS

The growing demand for support to civilian security missions has seen several collaborative MQ-9 demonstrations in the past two years. In 2018, a range of civilian support missions were flown from Iki Island in Japan over a two-week period. In 2019, similar support missions were flown from Greece. These activities



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reinforced the multi-domain capability of the MQ-9 RPAS, particularly on a diverse array of civil support missions. The most recent civil security demonstration was sponsored by the Japanese Coast Guard (JCG) and conducted in Japan in October–November 2020.

In the JCG demonstration, GA-ASI flew a series of validation flights featuring the MQ-9B SeaGuardian. These flights validated SeaGuardian's cost-effective, real-time, wide-area maritime surveillance capabilities by conducting search and rescue, disaster response, and maritime law enforcement missions.

Mission durations ranged from six to more than 24 hours, often focusing on multiple tasks during a single sortie. The SeaGuardian operated in complex airspace, without the need for a chase plane, with separation coordinated through the Japan Civil Aviation Bureau, as well as operating in trans-oceanic airspace over 1,500 nautical miles from home base.

The SeaGuardian's leading Detect and Avoid Systems played an important role for airspace access. While detailed analysis of this recent JCG validation trial continues, it was apparent that the SeaGuardian provided unprecedented intelligence, surveillance and reconnaissance to the JCG in a very cost-effective manner, using a small footprint and workforce. The recent JCG validation trial in Japan using the MQ-9B SeaGuardian offers the most contemporary example for deployment of the system in a multi-domain, civil security context.

LOOKING TO THE FUTURE

GA-ASI is investing in new platforms, sensors, command, control and exploitation systems, as well as space-based assets. From a UAS platform perspective, the unique capabilities and expanded missions the MQ-9B offers have distinct applicability. Additionally, GA-ASI is developing an ultra-long endurance UAS capability that can provide customers with an aerial defence network for airborne and ground assets with a flight endurance of multiple days.

The family of airborne recoverable or "attritable" SUAS can provide highly specialised surveillance or attack missions to enhance capabilities. We are also investing in space-based laser communications from ground, sea and airborne assets to enable high-bandwidth secure communications. Our High Accuracy Location of Emitters (HALOE) program is a space-based Low Earth Orbit (LEO) satellite constellation designed to improve the long-range precision geolocation capability of airborne ISR platforms.



A Sparrowhawk sUAS carried on an MQ-9A and controlled exclusively using GA-ASI's Metis Software Defined Control Station hosted on a laptop computer, which drastically reduced the system's logistical footprint. This configuration supports the vision for interfaces to the aircraft from across the battlefield, without the need for a Ground Control Station shelter or vehicle.

Additionally, GA-ASI has an extensive suite of mission command, sensor exploitation and task management software. These toolsets include:

- **STARE** (System for Tasking and Real-time Exploitation) provides a toolset for exploitation, archival and retrieval and dissemination of intelligence products that can be directly integrated and are complementary with Metis. The use of open standards allows this tool to seamlessly integrate into a country's mission command or intelligence centres. Artificial intelligence is applied to improve manpower efficiencies and optimisation where the tool does most of the work and alerts analysts to anomalies
- **Metis** provides collaborative ISR task management to efficiently task ISR assets, provide updates to ISR tasks and archive intelligence products associated with each task
- **Multi-Mission Controller (MMC)** enables a single user to safely control multiple aircraft and their missions simultaneously by leveraging a combination of automation and user experience-based design. From MMC, users transit their aircraft and execute routine ISR missions.
- **Software-Defined Mission Command (SDMC)** provides UAS-agnostic command and control for multiple aircraft flown simultaneously by a single operator. Significant automation aids a single operator to operate up to six aircraft using the multi-mission controller tool within the SDMC.

GA-ASI is constantly innovating for the future and developing step-change technologies to keep our customers ahead of the competition. ■

SCHIEBEL'S CAMCOPTER® S-100 UAV: LATEST MISSIONS AND CURRENT CAPABILITIES

Schiebel

Schiebel's CAMCOPTER® S-100 Vertical Takeoff and Landing (VTOL) Unmanned Air System (UAS) is currently in use on five continents with 33 customers. More than 350 Unmanned Air Vehicles (UAV) have flown a total of 100,000 hours so far. The S-100's small footprint makes it the ideal solution for small ships. To date, it has operated from more than 30 different ships with 10,000 maritime flight hours and 2,000 deck landings.

The overall maximum payload capacity is 50 kg and the multi-role, multi-domain asset has the ability to carry multiple sensors or other payloads such as cargo. One of its capabilities includes Manned-Unmanned Teaming, which was demonstrated in co-operation with Airbus and its H145 helicopter. The S-100 achieved a Level of Interoperability (LOI) 5, which means it can be fully controlled from the operator in the helicopter, from takeoff to landing, receiving all information on board the manned aircraft.



CAMCOPTER® S-100 MUM-T LOI 5 Demonstration



CAMCOPTER® S-100 Royal Australian Navy

Most recently, the French Navy acquired four additional S-100 UAVs, which will be integrated on their Mistral-class amphibious helicopter carriers, Tonnere and Mistral. The initial two S-100s were already fully integrated on their helicopter carrier, Dixmude. This was the first time in Europe, a rotary wing UAS was fully operational and connected to the defence system of an amphibious helicopter carrier.

In August 2020, Schiebel, together with Nordic Unmanned, carried out the world's first full-scale offshore UAV delivery from shore to an active oil and gas installation for energy company Equinor. The demonstration simulated the scenario of an urgent requirement for spare parts at the gas production platform Troll A in Norway. The CAMCOPTER® S-100 successfully carried out the long-range delivery and the demonstration also included an aerial platform inspection, as well as a simulated search and rescue mission.

Meanwhile, in Australia, the Royal Australian Navy (RAN) has been operating the CAMCOPTER® S-100 since 2018. Currently, the RAN UAVs are fitted with Schiebel's proprietary heavy fuel engine, the S2. Given the single fuel policy adopted by the world's navies, the heavy fuel engine is Schiebel's alternative option to its current propulsion unit.

Another client of note is the European Maritime Safety Agency (EMSA). Schiebel was awarded a contract from EMSA back in 2018 and has flown numerous missions for them. The operations include maritime surveillance, coast guard functions, search and rescue, as well as emission monitoring. In 2020, the S-100 was operated for EMSA in France, Denmark, Croatia and Finland.

The proven system is ideally suited for land and maritime operations and its flexible and versatile capabilities allow Schiebel's customers to utilise the UAV for various operations, be it at land or sea. ■



CAMCOPTER® S-100 Cargo Delivery, Search and Rescue, Platform Inspection, Norway.



THE NEW FRONTLINE FOR ISRAELI DEFENCE FORCES

Cyber warfare is a daily reality for Israel's defence forces as "tit-for-tat" cyber attacks between Israel and Iran continue to escalate. These attacks are also taking different forms, including GPS-denial.

By Arie Egozi

Israel is buying more fighter aircraft, developing long-range ballistic missiles, smart bombs and other highly sophisticated weaponry, but it is also advancing its new long arm – cyber.

Cyber operations are mostly performed under a heavy veil of secrecy, but some events in recent months portray a clearer picture of the Israeli Defence Force's (IDF) capabilities in this new war-fighting domain.

Last July, a mysterious attack on one of Iran's main military nuclear enrichment

facilities in Natanz, caused significant damage to centrifuges. Experts say the site was damaged by a "kinetic cyber" attack performed by an unknown force. Media speculation was rife as to whether it could have been an Israeli cyber attack or air strikes by Israel or the US. In June 2020, an explosion destroyed major parts of the Parchin military facility, just outside the capital Tehran, which is associated with Iran's nuclear programme. Western analysts

claimed the explosion was the result of an Israeli cyber attack, but Israel denied any connection to the massive explosion inside the secret facility.

Israeli attacks on Iran's nuclear programme date back to 2010, when a malicious computer worm called the Stuxnet virus, believed to have been jointly developed by the US and Israel, specifically targeted equipment used only in Iranian uranium enrichment facilities. Stuxnet is considered the largest and most expensive



IDF Cyber Cadets (Copyright: IDF)

malware development effort in history, a project considered too big for anyone but a nation-state to produce.

The cyber war between Israel and its enemies (namely Iran) is a daily threat and counter operation. In Israel, two main bodies are in charge of conducting cyber warfare. The civilian Cyber Authority is in charge of detecting and preventing cyber attacks on Israeli civilian infrastructure. The IDF's elite Unit 8200, which is comparable to the UK's GCHQ, is in

charge of protecting defence assets and performing counter attacks.

UNIQUE COMBAT METHODS

Iran and Israel are exchanging cyber-attacks at a growing pace. In April 2020, Iran is said to used a cyber attack to try and increase chlorine levels in water flowing into Israeli residential areas. In retaliation, Israel launched a "tit-for-tat" attack on May 9, 2020 against computer systems at the Shahid Raja'i shipping port in Bandar Abbas in southern Iran, which caused major travel disruption for a number of days.

The attack on the Iranian port was apparently intended to act as a deterrent, senior Israeli defence officials have suggested. Former Israeli Defence Minister Naftali Bennett announced on May 18, 2020 at a ceremony marking the end of his term that "the Iranian octopus is sending its tentacles to grab onto us from all directions...We must increase political, economic, military, and technological pressure, and act in other dimensions as well. It can be done." IDF Chief of General Staff, Lt. Gen. Aviv Kochavi stated that the IDF "will continue using a variety of military tools and unique combat methods to harm the enemy."

Modern navigation, communications, intelligence collection and electronic warfare systems rely on the uninterrupted availability of satellite-based navigation for their operation. But experts say that even low-power jammers can disrupt or deny the operation of Global Navigation Satellite Systems, thus degrading a platform's ability to fulfill its mission.

In July 2019, for three weeks Israel's civilian airspace experienced interference with its GPS navigation system. Experts pointed to a possible "spill over" caused by GPS jammers used by countries like Russia in the ongoing war in Syria. GPS jammers have become an essential asset in different combat scenarios.

In 2017, Israel Aerospace Industries won an Israeli Ministry of Defense tender to integrate an anti-jamming system onto

one of the Israeli Air Force's (IAF) key platforms. According to IAI, the system allows the aircraft's avionic systems, which rely on satellite navigation, to persist in their mission, despite jamming or disruption attempts with GPS jammers or other systems designed to block satellite navigation.

But GPS denial is merely one threat in a cyber war Israel is fighting on an almost daily basis. In recent years the Israeli Air Force has increased efforts to protect its Unmanned Air Systems (UAS) from cyberattacks. The force's flight test centre is working with other departments and special units of the IDF to create a full set of regulations that protect operational UAS from cyber attacks.

This entails protecting the data link used by the UAS's Ground Control Station, as well as the payloads on board. "Everything is digital and this puts all our systems in great danger," says an IAF senior officer. "This danger can come from far away and it changes the balance of military power in the world. That is why we've built the best protection systems."

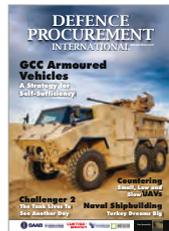
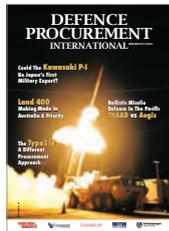
Maj. Gen. (res.) Uzi Moskowitz, former head of the IDF's Cyber Communications and Defense Division, says that the IDF's cyber challenge mainly stems from the fact that it is based on network-centric technologies. Any penetration into these networks would degrade their operational capabilities dramatically.

"Many forces in the world want to know what goes on inside the IDF," he says, "but when it comes to an intention to degrade the capabilities of the IDF, there is no doubt that Iran is considered the major threat." When it comes to protecting the IDF's assets against cyber attacks, Moskowitz described the IDF's capabilities as 'very good,' but said he could not talk in any detail about Israel's cyber offensive capabilities. ■

ABOUT THE AUTHOR

Arie Egozi is an Israeli-based journalist writing about defence and aerospace.

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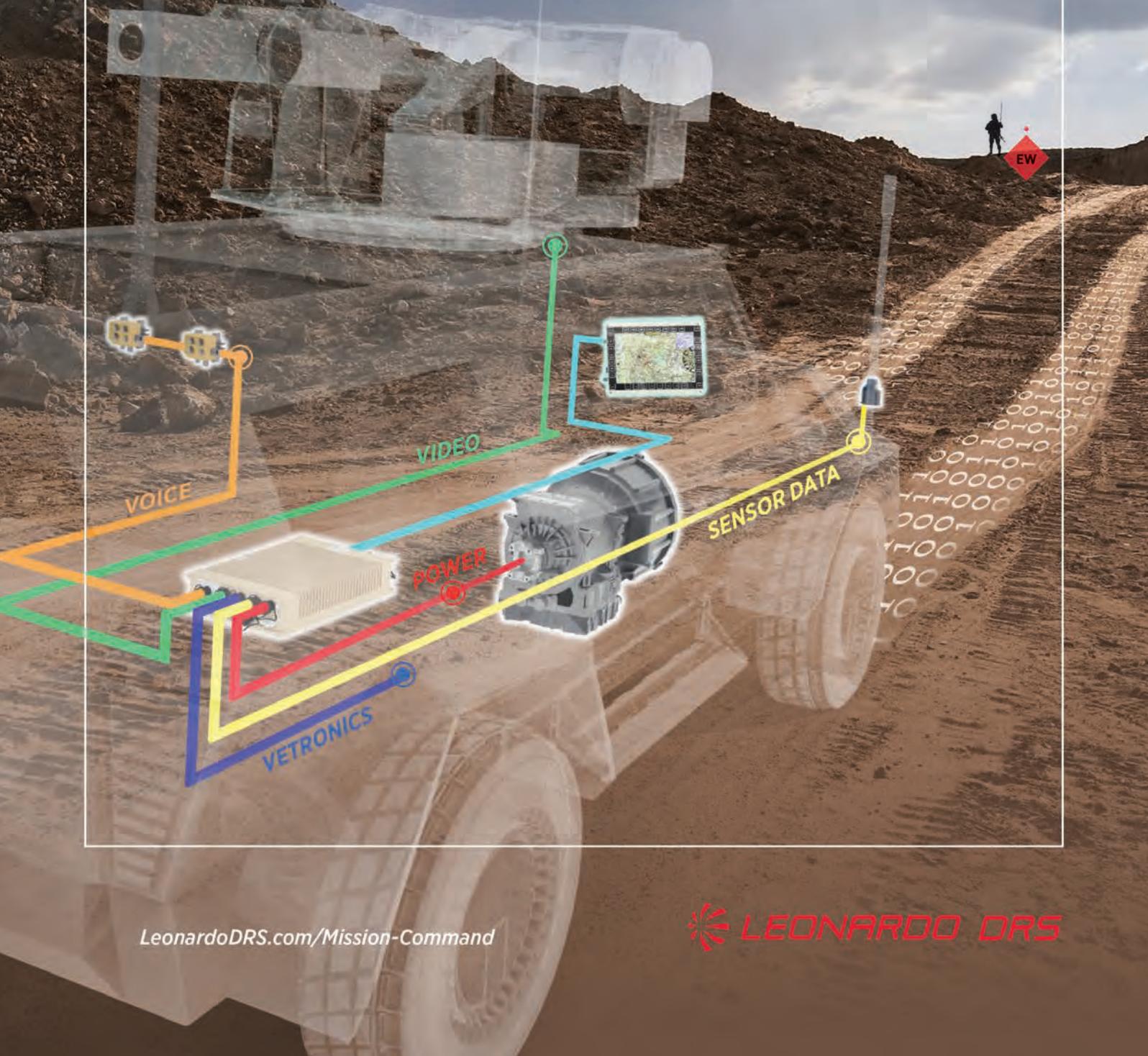
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