

International Security and Defence Journal



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- Vehicle Situational Awareness
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Guest Editorial

European Defence Agency Annual Report: Much Water in the Wine

The European Defence Agency (EDA) published its annual report on defence spending of the 26 EDA Member States for the period 2019-2020 on 6 December 2021. Despite the economic impact of COVID-19, with an increase of five per cent compared with 2019, they amount to €198Bn. This is the highest level since record-keeping began in 2005, and represents 1.5% of the gross domestic product (GDP) of the 26 EDA Member States. At €44Bn, defence investment measures are the highest ever recorded by the EDA, which at the same time represents an increase of 5% compared with 2019.

Of the €44Bn defence investment spending, 83% or €36Bn was used for equipment procurement and 17% or €8Bn for research and development.

Despite the continued increase in overall defence spending, the agency elaborates, collaborative defence spending has continued to trend downwards. In 2020, Member States spent a total of €4.1Bn on the procurement of new equipment in collaboration with others, a 13% decrease compared with 2019. European collaborative defence procurement has been declining since 2016. Participating Member States made only 11% of their total defence procurements in cooperation with other EU Member States in 2020. This is well below the benchmark of 35% to which they have also committed themselves within the framework of Permanent Structured Cooperation (PESCO). The trend of launching defence projects nationally rather than in cooperation also applies to defence R&D. In 2020, Member States spent €143M on defence R&T projects in cooperation with other EU countries. At six per cent, this represents the lowest ever figure for total defence R&T spending by Member States. It is far below the benchmark of 20%. Again, the imbalance in R&T investment is evident. Six Member States - Croatia, Estonia, Italy, Poland, Portugal and Spain - meet the 20% benchmark, with three of them sharing more than 50% of their defence R&T expenditure with other countries.

In this context, defence R&T spending amounts to €2.5Bn, a massive 46% increase compared with 2019, and a new high. France and Germany are largely responsible for this increase. Together, the two Member States account for the lion's share of the increase in research and technology. For the first time since 2014, research and technology reaches a share of

1.2% of total defence spending.

At €198Bn, EU defence spending is higher than the share of the US defence budget that can be assumed for Europe, which observers in Brussels put at €147 - 156Bn. Despite the positive baseline, the results fall short of expectations and self-set targets. Within the framework of PESCO, the bar for research and technology has been set at two percent. The United States, noted High Representative Josep Borrell during the European Defence Agency conference in Brussels on 7 December 2021, spends US\$14Bn, or two per cent of its defence budget, on research and technology. He also cited Israel, which devotes 5% of its gross national product to civilian and military research and development. And finally, he pointed to Google. The company spends almost ten times more on research and development than the defence ministries of the European Union put together. Against the backdrop of strategic competition, the quest for economic autonomy and the growing economic impact of innovations, "but also the greater strategic importance of technologies and innovations, it seems obvious that we can no longer afford to just watch what is happening and what others are doing," he says. And sums up in his keynote: "The choice is simple: either we invest properly in innovation in the field of defence or we become irrelevant in terms of defence". Borrell continued: "Yes, we will continue to have armies and parades, but from the point of view of practical impact on the power-political game, we will become irrelevant."

Well, we have already pointed out elsewhere that the EU is not a monolithic bloc and not a federal state like the United States of America. Defence is first and foremost a competence of the Member States and is organised intergovernmentally at the European level. Despite the many tasks arising from the Lisbon Treaty in the field of defence, there are no central powers in Brussels for defence matters. In its industrial dimension, a competence lies with the Commission with its Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs (GROW). Defence industries play a role as a part of the respective industrial sectors. However, according to Josep Borrell, "the hard core of defence remains the responsibility of the Member States."

Hans Uwe Mergener

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Nexter, land defense architect and system integrator in France, is a major reference in armored combat systems, artillery, and in the ammunition field. Nexter designs innovative solutions for land, air, sea and security forces, in order to bring French and foreign armed forces a decisive operational advantage.













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Firms & Faces

Renk Group Appoints **Niklas Beyes as New CFO**

(jh) On 07 December 2021, the Supervisory Board of Renk Group announced the appointment of Mr Niklas Beyes as the new CFO of the Group effective 01 January 2022. He succeeds Mr Winfried Vogl, who has held key positions at Renk for almost 14 years and retired at the end of 2021.





Mr. Beyes is an operational CFO who has spent the last 15 years in the automotive supply industry and who has led various transformations and strategy programmes for global companies like Brose, FTE automotive, SKF and Schaeffler. With over 20 years of management experience in all commercial functions, IT, purchasing and operations, he brings relevant industry and capital market experience as well as business leadership to Renk, the company writes in a press release.

New CEO at German Naval

Photo: German Naval Yards

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(jh) German Naval Yards Kiel has announced Mr Rino Brugge as its new CEO in succession to Jörg Herwig. Mr Brugge has already been part of GNYK's management since

the middle of 2021. The graduate mechanical engineer and industrial engineer, who comes from a shipbuilding family, previously held leading positions in the international shipyard industry in Europe, Asia and the Middle East. Among others, he was CEO of the large state shipyard in Qatar and CEO of DAMEN Shipyards in Romania, the largest shipyard within the DAMEN Group.

Type 31 Frigate Assembly Hall Completed

(jh) Babcock has unveiled plans to recruit 500 workers for the Type 31 frigate programme as the build of its new assembly hall, The Venturer Building, is completed at the company's Rosyth site.



The announcement was made as Douglas Chapman MP, employees, industry representatives, local school children and trade unions gathered to witness the commemorative 'topping out' ceremony at the new facility.

The event included a demonstration of two 125 tonne gantry cranes, which will be used to assemble the frigates. Local schoolchildren added the final touches to the facility by helping to plant bulbs and shrubs around its perimeter.

Measuring 147m x 62m x 42m, The Venturer Building will initially be used for the assembly of the Royal Navy's Type 31 frigates, providing a facility that can support UK and international shipbuilding activity for decades to come, according to Babcock. As the Type 31 programme continues, the fully covered hall will house two frigates for uninterrupted parallel assembly to support productivity gains through improved access to the platforms and digital connectivity.

The initial recruitment drive to support the programme will include a variety of trades including welders, fabricators and mechanical and electrical fitters as well as production support operatives, the company has announced. The announcement sees the 500 new roles contribute towards the direct workforce which is expected to reach around 1,250 people at the height of the programme across the UK, supporting a similar number in the extended supply chain.

Central European Office for Milrem

(jh) Milrem Robotics has opened an office in The Netherlands, making the first step towards creating a Central European robotics centre, the company writes in a press release.

One of the reasons the city of Best near Eindhoven was chosen as the location for Milrem Robotics' Dutch office is to be closer to one of the company's key customers - the Royal Dutch Army - and other relevant markets, according to the press release

At the opening ceremony, Milrem Robotics also introduced their upgraded THeMIS UGV that was specifically designed to accommodate all hardware, software and the flawless operation of the Milrem Intelligent Functions Integration Kit. This features wired and wireless follow-me, waypoint navigation and obstacle detection and avoidance. Upgrades were also done to THeMIS' camera system. Milrem Robotics Netherlands is the company's fifth office in Europe. The other offices are in Estonia (two), Sweden and Finland.



At present, Milrem Robotics is the leader of a consortium that was awarded €30.6M from the European Commission's European Defence Industrial Development Programme to develop a European standardised Unmanned Ground System. In the scope of the iMUGS designated project, a modular and scaleable architecture for hybrid mannedunmanned systems is to be developed to standardise a Europe-wide ecosystem.

NBC-Sys Opens Automated **Integration Line for Filter** Cartridges

(jh) In November 2021, NBC-Sys, a subsidiary of the Nexter Group, received several representatives from the French Armament Delegation (DGA) and French Army officers at its Saint-Chamond site, Nexter writes in a press release. During a tour of the facilities, NBC-Sys inaugurated a new fully automated line dedicated to the production of its entire range of Nuclear, Biological and Chemical filter cartridges. This production line is considered a strategic industrial asset that guarantees the supply of current filter cartridges for the



French Armed Forces and will be compatible with the new cartridges of the EPIA programme to provide individual protection kits for the armed forces by 2025. NBC-Sys is based in Saint-Chamond (Loire) and specialises in protection against Chemical, Biological, Radiological and Nuclear (CBRN) threats. Among others, the company is a supplier of the gas masks for the French Armed Forces. According to the press release, NBC-Sys offers a complete catalogue of solutions for conducting military or civil protection operations under the CBRN threat, including decontamination systems for personnel, vehicles, aircraft and sensitive equipment (such as weapons, helmets, radios), some of which were heavily used in the scope of the COVID 19 pandemic.

MCM Lab Launched by Naval Group

(jh) On 25 November 2021, Naval Group announced the creation of the MCM R&D Centre of Excellence at its subsidiary Naval Group Belgium. It is the third Centre of Excellence created by Naval Group outside France, the company says, which will work jointly with Belgian partners.



The MCM Lab is one of the key components of the industrial cooperation plan associated with the Belgian-Dutch Remote Mine Countermeasure replacement programme awarded in 2019 to Belgium Naval & Robotics, the consortium made up of Naval Group and ECA Group. This consortium was chosen by the Belgian and Royal Netherlands navies to supply 12 MCMVs and a toolbox composed of around 100 drones.

Rheinmetall Acquires UAV Company EMT

(jh) As part of its digitisation strategy, Rheinmetall is taking over the activities of EMT, an established German UAV manufacturer. An agreement to this effect has been signed by both parties, Rheinmetall writes in a press release. Headquartered in Penzberg in Bavaria, EMT Ingenieurgesellschaft Dipl.-Ing. Hartmut Euer mbH develops, produces and maintains unmanned tactical aviation systems for reconnaissance missions. EMT's most important customer is the German Bundeswehr,



which is currently introducing the company's newly developed LUNA NG reconnaissance system. LUNA NG is reported to be a key element in networked C4ISTAR communications and reconnaissance and is destined to play a vital role in tactical data transmission. With effect from the end of December 2021, the takeover is an asset deal. In addition to the normal board decisions, the transaction still requires final approval from the competition authorities. The parties to the transaction have agreed not to disclose the purchase price.

Diehl Takes Over Eagle-Picher

(gwh) The Diehl & Eagle-Picher joint venture, founded in 1971, has become a whollyowned subsidiary of Diehl Defence by acquisition of all company shares retroactively as of 1 January 2021. Since 16 Novemer 2021, the company has been operating under the name Diehl Energy Products GmbH (DEP). Diehl describes DEP as a leading manufacturer of special batteries. The product portfolio includes the product line of ther-



mal batteries, which are mainly used in missiles and torpedo defence systems. The product line of activateable lithium thionyl chloride reserve batteries is also used in the defence sector, here for use in proximity, time and multi-function fuses for mortar, artillery and naval gun ammunition. In the product area of battery packs, customer-specific batteries in lithium, nickel-metal hydride and nickel-cadmium technology are developed and produced for defence customers and increasingly for industrial customers.

For Diehl Defence's product portfolio, DEP's components are of significant importance due to the special requirements of military applications.

Acoustic gunshot detection: A key feature to move into the era of collaborative combat

Metravib Defence is more than ever one of the key partners of the French Armed Forces since its PILAR V gunshot detection system became "common equipment" for the new SCORPION vehicles and that the acoustic threat detection is a selected innovative feature to the current/future dismounted Soldier within the CENTURION programme.



It is vital for troops to locate the enemy in case of ambush on the battlefield. By processing the acoustic signature of a shot, Metravib Defence products accurately report the enemy's GPS coordinates with details of azimuth, elevation, range of the shot(s), calibre identification and firing mode. This information is essential to better protect the troops and enable accurate fire response.

To meet these operational needs, Metravib Defence has developed the PEARL (mounted on the soldier's rifle) and the PILAR V (to equip any vehicle) that will be able to share the localisation data to the BMS¹ or the RCWS² for quick rotation towards the identified threat.

SCORPION & CENTURION programmes aim to liaise platforms/equipment/combatants; in order to improve collaborative combat by integrating the latest innovations such as more distributed and integrated sensors, the passive detection of a wide spectrum of threats (small, medium and large calibre, drones) and processing of multimodal battlefield data. The PEARL and PILAR V can be easily interfaced with:

- Optical equipment: IR binoculars, riflescopes, helmets equipped with enhanced vision,
- Softwares: BMS and other monitoring systems. tactical communication, ballistic calculators,

• Remote controlled devices: UAVs, UGVs, weapons systems or pyrotechnic solutions. In the era of collaborative combat, the Metravib Defence systems are a major operational asset that significantly increases the right perception of the battlefield and its dangers for an advanced Situational Awareness and a greater Force Protection.

Please visit us at booth B9 at IAV London

2 Remote Controlled Weapon System

¹ Battlefield Management System

First M88A3 to be Delivered in 2022

(gwh) For the M88 heavy armoured recovery vehicle modernisation programme, BAE Systems will deliver the first M88A3 prototype to the US Army in 2022, following a contract amendment, the company announced on 21 December 2021. According to the statement, the 2019 development contract for eight prototypes has been expanded by US\$79M (€70M) to US\$329M (€290M).



The modernisation is intended to make the M88 armoured recovery vehicle capable of towing the new versions of the M1A2 main battle tank, the weight of which has increased to nearly 80 tonnes. As part of the modernisation, the M88 will receive a Caterpillar diesel engine with a power output of 990 kW and hydropneumatic suspension. The seventh roller, which became necessary due to the increased weight, is one external modification. At the same time, protection against bullets and blast is improved.

The weak point of M88A3 remains the A-mast for moving heavy loads (up to 36 tonnes).

After completion of the tests, a decision will be made on conversion of the entire fleet. The US Army currently operates 835 M88A2s and 360 M88A1s.

Start of DRAGÓN Series Production

(gwh) With the cutting of the first steel in front of a high-ranking audience, series production of the 8x8 DRAGÓN wheeled vehicle for the Spanish Army has begun at GDELS-Santa Bárbara Sistemas' Trubia plant



(Asturias), GDELS has announced. General Dynamics European Landsystems (GDELS) is part of the TESS Defense consortium, which also includes Indra Sistemas, Escribano Mechanical & Engineering and Sapa Placencia. TESS was contracted in 2020 to produce 348 DRAGÓN vehicles for €1.7Bn. (euro-sd. com reported https://euro-sd.com/2020/08/ news/18750/spanish-army-8x8-contractawarded/)

The 8x8 DRAGÓN is derived from the highly protected GDELS PIRANHA V and offers a spacious crew compartment and significant payload capacity, as the company underlines. Technical features include all-wheel steering and hydropneumatic suspension. Indra supplies electronics and software, Sapa the propulsion and Escribano the turret. Depending on the equipment, the vehicle weighs over 33 tonnes. At 8.00 m length, 2.99 m width and 2.34 m height, up to eight soldiers can be accommodated in the protected cabin, in addition to the regular crew of three.

In the first batch, 348 PIRANHA Vs in 13 different configurations will be procured, including the respective mission system components (armament, protection elements, sensors, communication and command systems) as well as logistic support elements. The first vehicles are to be delivered in 2022. The DRAGÓN programme covers the production and delivery of 1,000 vehicles. After the first batch of 348, a second batch of 365 and a third batch of 287 vehicles are to follow. While the second batch is to be ordered in the foreseeable future, the third batch has not yet been scheduled.

Keel Laying Ceremony for First French FDI

(jh) On 16 December, Naval Group laid the keel of the first Defence and Intervention



Frigate (FDI) ordered by the DGA. The ship will be delivered in 2024 and is the first of five to be delivered between 2024 and 2030.

On the same day, the Panoramic Sensors and Intelligence Module, the integrated mast of the FDI, was also powered up. This marks the start of the testing of the frigate's complete combat system, several months before its final integration on the ship. The first FDI frigate will be named AMIRAL RONARC'H, Chief of Staff of the French Navy between 1919 and 1920.

Dutch BUSHMASTERs Modernised

(gwh) Dutch Defence Minister Henk Kamp has presented details of the modernisation programme for protected BUSHMASTER vehicles to the Chamber of MPs. According to current plans, the fleet of more than 100 vehicles will be modernised by Thales Australia by 2027. The first modernised BUSH-



MASTERs are to enter service in 2024. The Netherlands procured the BUSHMAS-TERs in several lots starting in 2006. The vehicles have been laid out for tasks such as:

- Command and control
- Patrol
- IED defence
- Ambulance
- Electronic combat

The vehicles were heavily used in missions in Afghanistan and Mali, Kamp said. Now they have to be equipped with new technology to meet the changed threat environment. Measures include: new remote-controlled weapon stations, strengthening protection with new armour elements, improving command and observation equipment and communication systems, as well as a rear-view camera. In order to supply power for the increased electrical demand, an auxiliary power unit will be installed, which is also expected to reduce fuel consumption and CO2 emissions.

The BUSHMASTER, which weighs about 15 tonnes, is powered by a 224-kW diesel engine via a ZF transmission to all four wheels. Depending on the mission equipment, up to nine soldiers can be accommodated in addition to the driver. Ballistic and mine protection are up to Level 3 according to STANAG 4569. Thales has delivered about 1,200 BUSHMASTERs worldwide since 1997, the vast majority for the Australian Army.

■ NATO Budget Drops to €1.8Bn

(gwh) At the recent North Atlantic Council meeting, the Allies decided on the NATO budget for 2022. According to an official announcement, the budget will be reduced by ≤ 25 M to $\leq 1,849$ M.



The civilian budget, with funding for civilian personnel, operating costs and civilian programme spending, has been raised to \in 289.1M, an increase of 8.9% compared with 2021. The military budget, for operating costs of headquarters, the NATO command structure and programmes, missions and operations around the world, decreases by three per cent to \in 1.56Bn. The third funding pillar is the NATO Se-

curity Investment Programme (NSIP) for which a ceiling of €790M has been set. The funds are to be used for major investments in construction projects and command and control systems.

All member states contribute to the budgets and the NSIP according to an agreed cost-sharing key based on gross national income.

Final GRIFFON for 2021 Delivered

(jh) On 6 December 2021 the 119th and last GRIFFON planned for 2021 was delivered to the French Army. The 119 GRIF-FONs were first submitted to the verification operations of the DGA at the Nexter site in Roanne before being sent to the regiments. Thus, the GME team, composed of Nexter, Arquus and Thales, has met its delivery target for 2021, in accordance with the initial order of April 2017 and the 2019-2025 military programming law, according to a press release from the companies.



For the record, 128 GRIFFONs had been submitted for verification in 2020, and 92 in 2019, making a total of 339 since the notification of the TC2 conditional tranche of the EBMR contract. In addition, all variants of the troop transport version are now qualified, namely:

- The FELIN
- Sniper section
- 81mm mortar
- Refuelling
- Light intervention element
- Engineer
- Medium range missile
- Command post vehicle version

Test Firings of New Missiles for the Russian Navy

(yl) The Russian Pacific Fleet frigate MAR-SHAL SHAPOSHNIKOV has conducted missile firings in the Sea of Japan. A video of the exercises was posted on the Russian Ministry of Defence's YouTube channel.

According to the information from the ministry's press service, the frigate launched a brand-new OTVET (REPULSE) anti-submarine missile to engage an underwater target. Reportedly, the weapon hit the target. The firings were carried out at a naval range in the Peter the Great Bay.



The missile was launched from a 3S-14 universal launcher designed for CALIBER cruise missiles and ONYX anti-ship missiles. Earlier in April the Russian Ministry of Defence reported a CALIBER missile successfully engaging a coastal target at a distance of more than 1,000 km during firings in the Sea of Japan.

TheOTVETsystemconsistsofananti-submarine guided missile which is launched from 3S-14 universal launchers. At the front, the missile carries a small anti-submarine torpedo with a homing head. When approaching the target, the missile parachutes a torpedo into the water, which independently continues to search for the submerged target using a sonar. The maximum range of the surface-launched missile version is 40 km. The system can be installed on frigates, corvettes, destroyers and cruisers. The large former Soviet ASW ship MARSHAL SHAPOSHNIKOV had been subject to major overhaul and modernisation measures at the Dalzavod («Far East plant») ship-repair facility and was re-qualified as a frigate. In the scope of the the modernisation programme, the ship received new weapons, including universal launchers for the CALIBER and ONYX missiles, as well as, in the future, ZIR-CON, the URAN anti-ship system with Kh-35 missiles, a new artillery mount, and a new electronics fit.

The Vladivostok-based Dalzavod Ship Repair Center is also involved in major overhaul of the Project 1155 sister ship ADMIRAL VINO-GRADOV which entered service with the Soviet Pacific Fleet in 1989.

The day after the MARSHAL SHAPOSH-NIKOV exercise the Project 22350 frigate ADMIRAL GORSHKOV caried out a successful firing of the ZIRCON supersonic missile against a shore target. Reportedly, ZIRCON reached a top speed of Mach 8 to destroy the target at the testing range based in the Arkhangelsk region. The missile is to come into service with the Russian surface combatants in 2022. According to the Russian MoD, the related facilities are under construction.

International Flight of a REAPER UAV in Controlled Air Space

(gwh) To investigate the operational framework and regulatory regime for unmanned drones in controlled air space, French and Spanish authorities have conducted an international flight of a French drone over numerous air traffic controller checkpoints.

As the Spanish air navigation service provider Enaire reports, the French Air Force's MQ-9 REAPER, with call sign FAF7802, took off near Bordeaux and flew under civilian ATC to the Spanish border. There it was handed over to Spanish civilian air traffic controllers and guided by civilian and military controllers to the Barcelona area. From there, it returned to Frenchcontrolled air space over Marseilles to the departure airfield in Cognac.





Unlike normal flights, in which drones must operate exclusively in closed areas separated from civilian traffic, this test flight was conducted without a special air space structure and operated alongside commercial aircraft. The drone was subject to the same air traffic control services as a manned aircraft, Enaire said. This allowed it to be separated from other aircraft, ensuring the coexistence and integration of this type of aircraft with conventional air traffic.

The drone followed its flight plan during the nearly four-hour flight and successfully passed the requirements from the safety and feasibility studies conducted by the EDA. Enaire and the French DSNA aviation administrations, as well as the military authorities in Spain and France, aim to promote the drone sector and develop a European regulation that meets the needs of future civil and military users of remotely piloted air systems (RPAS).

Sweden to Join Finnish-Latvian CAVS Programme

(gwh) Patria has announced that Sweden has officially expressed the wish to join the CAVS programme for the procurement of a jointly developed Common Armoured Vehicle System (CAVS) 6x6 vehicle, which is currently in series production for Finland and Latvia.





In 2019 Finland and Latvia agreed to jointly develop the CAVS and, starting in autumn 2020, under Finland's leadership, the vehicle was developed based on the Patria 6x6 wheeled armoured vehicle. Deliveries began in early November 2021 with the handover of the first of 200 vehicles to Latvia. Reportedly, Finland intends to procure 160 vehicles. The quantity of the Swedish requirement has not been made public.

CAVS is to be based on Patria's protected 6×6 vehicle, which was presented as a novelty at Eurosatory in 2018, combining the features of Patria's XA and AMV types. A diesel engine with 294 kW of power and a torque of 1,870 Nm, as well as the independent suspension known from the

AMV provide the basis of the 24-tonne vehicle's off-road capability. Protection against ballistic and blast threats can be implemented between STANAG Level 2 and Level 4, depending on requirements.

Industrial Offer for the Modular and Multirole Patrol Corvette Submitted

(jh) On 9 December 2021, a consortium led by Fincantieri, Naval Group and Navantia, coordinated by Naviris, submitted an industrial proposal related to the MMPC call of the European Defence Fund (EDF), Naval Group writes in a press re-



lease. With this proposal, the consortium is a contender for the development of the joint project.

According to the companies, the clear objective of the proposal is to maximise synergies and collaboration among European shipbuilding companies. By developing together a new ship, the EPC, they aim to ensure a European sovereignty in the second rank warship. The EPC PESCO project is supported by four countries, namely Italy, France, Spain and Greece.

■ iXblue to Equip Finnish Corvettes

(jh) iXblue has been selected by the Finnish Navy to provide PHINS series Inertial Navigation Systems and NETANS Data Distribution Units as part of the service's SQUADRON 2020 project, according to a press release by the company.

This project involves the development of four POHJANMAA class multi-role corvettes by the Finnish shipyard Rauma Marine Constructions. Together with existing HAMINA-class missile boats, they will



form the backbone of the Finnish Navy. Furuno is in charge of providing a fully integrated navigation system for those future vessels.

HUNTSMAN Artillery Systems for Australia

(jh) Hanwha Defense Australia has signed a contract with the country to supply its HUNTSMAN AS9 self-propelled artillery system to the Australian Army, the company writes in a press release. This is reportedly the first major defence acquisition by Australia from an Asian defence prime contractor. The procurement is part of LAND 8116 Phase 1, which will see the acquisition of 30 AS9 HUNTSMAN self-propelled howitzers and 15 AS10 armoured resupply vehicles.

The vehicles will be manufactured in Australia at a new Hanwha facility to be constructed in the Greater Geelong area of Victoria. Australian companies involved with Hanwha on local manufacture and support of the new Howitzers include:

- Kongsberg Defence Australia
- ElmTek
- Penske Australia
- HIFraser
- CBG Systems
- TAE Aerospace
- Bisalloy Steels
- Thales Australia
- Sigma Bravo
- Elphinstone Pty Ltd



With the AS9 HUNTSMAN, Hanwha is offering a proven 52-calibre 155mm gun system that is in-service with multiple nations around the world including the NATO Alliance, according to Hanwha. The AS10 Armoured Ammunition Resupply Vehicle is a highly protected ammunition resupply vehicle with a loading system that reduces risk to soldiers from enemy fire.

The Republic of Korea Army has offered to work with the Australian Army to share their experience to help expedite development and growth of local expertise in the self-propelled howitzer capability. Construction of the new Hanwha manufacturing facility is scheduled to commence in the second quarter of 2022 and take 24 months to complete. Production of the AS9 HUNTSMAN self-propelled howitzers is scheduled to start in the fourth quarter of 2024.

Rheinmetall Presents ACW WIESEL

(gwh) Rheinmetall has unveiled the Autonomous Combat Warrior (ACW) WIESEL and demonstrated various capabilities on an offroad course in Australia. Russell Gallagher, Chief Engineer – Research & Technology, Rheinmetall Australia, explained, the ACW WIESEL is Rheinmetall's first platform-independent autonomous vehicle. He said the autonomous system could be integrated with any wheeled or tracked vehicle such as:

- HX series trucks
- GTK BOXER
- The LYNX family of vehicles

The top priority was to improve the safety of soldiers, he said.

According to Rheinmetall, the ACW WIE-SEL was developed over two years in cooperation with research services of the Australian Departments of Defence and Economic Affairs and two Australian universities. The vehicle is based on the WIE-SEL 2 with an 81-kW VW diesel, which drives the tracked running gear with four track rollers on both sides via a hydromechanical torque converter.

The autonomous system allows operation in several modes. It allows manual control on site and enables remote-controlled operation. In autonomous mode, the vehicle travels along pre-programmed waypoints and can avoid obstacles. There is also a follow-on mode, in which the vehicle follows a lead vehicle in convoy mode or preceding soldiers.

Gallagher describes the autonomous system as the brain for mapping waypoints and managing the flow of data from the sensors. To translate this into vehicle functions, he says, a system is used to control the engine and transmission, which controls throttle response, brakes and steering via Rheinmetall's proprietary drive-bywire system.

To complement the autonomous capabilities, systems for recognising the behaviour of soldiers ahead, for terrain recognition us-



ing computer vision and advanced LIDAR technology, and to make tactical decisions based on environmental conditions, can be retrofitted to the ACW WIESEL.

CARL-GUSTAV M4 Delivered to Estonia

(gwh) The Estonian Ministry of Defence's Riigi Kaitseinvesteeringute Keskus State Defence Investment Centre has announced that the first 300 plus CARL-



GUSTAV M4 shoulder-launched anti-tank weapons have been handed over to the Estonian Armed Forces.

In 2020, Estonia, together with Latvia, ordered an unknown number of these weapons, also known as anti-tank rifles, from Saab. In the medium term, the M4 will replace the M2 and M3 variants currently in service. At 6.6 kg, the new M4 weighs considerably less than its predecessors and is 13 cm shorter. Three types of ammunition are available:

• Multi-role ammunition to engage targets in buildings or vehicles

Rounds to engage unarmoured targetsPyrotechnics (smoke/light).

The M4 is equipped with an attachable telescopic sight. It can also accommodate thermal imaging devices, image intensifiers or a red dot sight. The weapon can engage stationary and moving targets at ranges of up to 2 km.

Jankel Starts LTTV Production

(gwh) British vehicle manufacturer Jankel has started serial production of the 199 Light Tactical Transport Vehicles (LTTV) ordered for the Belgian Armed Forces in 2018. The Belgian MoD had previously given the green light for this after passing the preliminary technical acceptance test, Jankel writes. Within nine months (by the third quarter of 2022), the vehicles are to be delivered from a production facility set up specifically for this purpose.

Jankel has built the LTTV on the 4×4 chassis of a UNIMOG U5000 from Daimler, which is equipped with a 163 kW multifuel engine (Euro 3). A semi-automatic transmission drives the wheels on the two coil-sprung portal axles. The driver's cab and (mission) body were designed by Jankel. Series-production components from Daimler were used as much as possible. The open cabin is based on an armoured hull, the protection of which can be supplemented by armoured doors and a folding, split windscreen with armoured glass.

Among the features of the LLTV are interchangeable mission modules. These are attached to the chassis with four standard ISO twist locks. There are 167 modules for the transport of troops and special forces, eight ambulance modules and 24 logistics modules for cargo transport. Configured as a troop carrier with armoured floor plate, up to six persons can be transported. A central ring mount for light and heavy machine guns in addition to foldable roll-over protection also feature. This makes it possible to transport the vehicles in C-130s and A400Ms as well as an external load for the CH-47. The ambulance module is designed for two stretchers and two attendants with access via two rear doors. The modules in which people are



transported can be adapted to the threat by means of protective modules. The logistic module offers an open cargo area.

The basic vehicle has a net weight of 6.5 tonnes. The module-dependent payload can reach up to three tonnes, including protection.

Jankel also wants to market the LTTV in other countries, so the company has developed further options together with Daimler. These include a self-recovery winch, camouflage lighting, cold and heat package and emergency running features. These can be integrated into the modular chassis.

Moscow and Delhi Strengthen Military Ties

(yl) At the recent bilateral summit Russia and India agreed on a schedule for military-technical cooperation between 2021 and 2031. The agreement was signed by the Head of the Russian Federal Service for Military-Technical Cooperation (FSVTS), Dmitry Shugaev, and Deputy Minister of

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Photo: HPW



Defence of India for military procurement, Kant Rag. According to the Kremlin, the agreement covers military and personnel training, as well as technology transfer and the joint development and production of weapon systems, including those for the third parties.

It looks like the countries have reached a new stage of strategic partnership. According to the Indian Ambassador to Moscow, Bala Venkatesh Varma, the total amount of bilateral defence procurement contracts was around US\$2-3Bn in 2018. At present, the volume of contracts awarded amounts to US\$14Bn. The figure was disclosed by Dmitry Shugaev who also announced the total volume of Indian defence contracts awarded to Moscow since 1991 has been around US\$70Bn.

According to Alexander Mikheev, CEO of the Russian export organisation Rosoboronexport, hundreds of Sukhoi multi-role fighters and over 2,500 main battle tanks were produced in India under licence from Moscow. He stressed that India has always been and remains one of the key buyers of Russian equipment for decades and reported that consultations were underway regarding the T-90 upgrade programme. Preliminary tests of several modernised systems and subsystems produced in India have been carried out and are expected to form the basis for respective upgrade measures. Over 100 R&D efforts are reportedly on the way, "creating a huge reserve for the high-tech industries development in both countries in the future", Mikheev emphasised.

He also announced that Rosoboronexport intended to take part in the Indian light tank tender with the SPRUT-SDM1 (OC-TOPUS) amphibious tank from the High Precision Weapons Holding.

Russia "will even offer the transfer of technology and, most likely, local production of several units and parts production", Mikheev said.

HX 8x8 Recovery Vehicles Delivered to NZDF

(jh) Rheinmetall MAN Military Vehicles has announced the official handover of

three HX 8×8 Heavy Recovery Vehicles to the New Zealand Defence Force (NZDF) at an official ceremony on 25 November 2021 at the Trentham Military Camp in Wellington, New Zealand. The delivery of the vehicles to the NZDF provides the New Zealand Army with important new capabilities, with the HX 8×8 Heavy Recovery Vehicles having enhanced recovery and mobility specifically developed to meet the current and future operational needs of the NZDF, Rheinmetall writes.

The HX 8×8 Heavy Recovery Vehicles delivered to the NZDF are the first in the world to use the Integrated Armoured Swap Cabin which allows configuration of the vehicles in accordance with opera-



tional needs. Rheinmetall will also provide a dedicated team to conduct initial training on the vehicle with the NZDF. At just 2.55 metres wide, the HX 8×8 Heavy Recovery Vehicle features the ability to cross ditches of 1.4 metres wide and cross flooded areas of 1.5 metres in depth, as well as scale gradients of up to 60% and side slopes of 30%. The vehicles are able to operate in a range of different environments, in cold conditions as low as -32°C and in hot conditions all the way up to 49°C.

Polish Navy Acquires iXblue's DriX USV

(jh) The Hydrographic Office of the Polish Navy has purchased iXblue's DriX Unmanned Surface Vehicle (USV) through the company's local partner Thesta, the company reports. The USV is to support



the Polish Navy's hydrographic capabilities. As an 8m USV developed to conduct various missions, DriX is particularly well suited for hydrographic surveys, the company points out. Equipped with advanced sensors (radar, lidar, cameras) and its own artificial intelligence, the USV analyses the environment, avoids obstacles and carries out missions autonomously. Equipped with a launch and recovery system, DriX can be launched from a vessel or sail from a harbour to autonomously map large areas of the ocean.

Open Tender for Danish Patrol Vessels

(jh) According to a press release from Terma, the Danish Navy plans to embark on a procurement effort for new patrol vessels to address additional tasks and act as a replacement for the current oil-recovery vessels. As a result, the Danish MoD has initiated a development project of the new vessels type. Reportedly, it is the political intention to ensure involvement of Danish companies for the development of the vessels.

On 6 December 2021, three Danish companies OMT, PensionDanmark, and Terma hosted a dialogue meeting in Nyborg, Denmark, about business opportunities related to the requirement. The meeting was coordinated in collaboration with the Confederation of Danish Industry's



Defence and Security Association and Danish Maritime – a business association for Danish manufacturers of maritime equipment and ships. The three companies decided to submit a proposal for the project.

At the meeting, preliminary thoughts and ideas were discussed, and afterwards, both Terma and OMT conducted individual meetings with each company present. During these sessions, the participants had the opportunity to present their own unique competencies and technologies relevant to the project, both technical aspects of shipbuilding and of military operation.

First User Test of India's AGNI-5 ICBM

(ss) In what could be called an arms race on the subcontinent, India conducted its eighth test as the first "user-launch" of its indigenous strategic Intercontinental Ballistic Missile (ICBM) after service introduction of the weapon system. This was also the first night test of the AGNI-5 missile – believed to have a range of 5,000 km. The three-stage solid fuel, 50-ton sur-



face-to-surface ballistic AGNI-5 with a 1.5-tonne warhead and travelling at 24 times the speed of sound, was launched from the APJ Abdul Kalam Island, off the

Odisha coast. The successful test of the missile's trajectory and flight parameters were constantly monitored by radars, electro-optical tracking systems, telemetry stations and ships before it splashed down in the Bay of Bengal.

AGNI-5 is said to be capable of striking targets at distances up to 5,000 kilometres with a very high degree of accuracy and is part of India's tri-services Strategic Forces Command inventory. The AGNI series of missiles form the bedrock of India's nuclear deterrence programme. The test is significant as it comes during the ongoing 19-month long border stand-off with China in the eastern Ladakh region.

Meanwhile, China has gone ahead and conducted the second test of its longrange hypersonic missile, with a speed of mach eight. China's first test in August this year was termed a failure as the missile could not hit the target. Viewed as a cause of concern by Washington, the Chinese weapon has been called a 'destabilising weapon' by the American Space Force Command, which has called the test 'Sputnik moment' – a wakeup call for the US administration.

GALILEO Satellites No. 27 and 28 in Orbit

(gwh) A Soyuz VS-6 from Arianespace launched the two satellites No. 27 and 28 for the European navigatio system, GALILEO, into space on 5 December 2021 from the European spaceport in French Guiana. According to the European Space Agency (ESA), the two satellites have been parked in an intermediate orbit where, in the so-called launch and early operations phase, the on-board systems will be gradually tested for operational use and the descent into the final working orbit at an altitude of 23,222 km above Earth will be initiated. It will take several weeks before the new satellites can contribute to the robust operation of GALILEO.

Following an upgrade of the global ground segment, the Launch and Early Orbit Phase (LEOP) will be controlled for the first time by GALILEO operator SpaceOpal



Multi-mission Intelligent SWARM A2/AD Breaching Unmanned Aerial System



European Security Spotlight



at GALILEO's own control centre in Oberpfaffenhofen, Germany, ESA writes.

The new satellites are the first two of the final batch 3 of twelve first-generation satellites that will complete GALILEO's full operational capability concept. The satellites are being manufactured and tested by OHB in Germany with navigation payloads from Surrey Satellite Technology Ltd. This final batch of first-generation satellites is due to be launched into orbit over the next three years.

According to ESA, the "GALILEO Second Generation" (G2G) satellites are currently being developed by Airbus Defence and Space and Thales Alenia Space. Twelve satellites were commissioned. According to ESA, they are the most advanced, powerful and fully reconfigurable navigation satellites ever built. The G2G satellites are larger than previous ones and for the first time feature electric propulsion. The first start of G2G is planned for 2024.

The steady expansion of the GALILEO system is intended to improve the accuracy and resilience of the European navigation system.

CAVION Brand Launched by Hensoldt

(jh) Under the CAVION brand Hensold is launching a family of avionics computers that significantly expands the performance of existing computers for mission control on board flying platforms of all kinds, the company writes in a press release.



CAVION is based on a Hensoldt proprietary development of electronic modules that enables the use of multi-core processors even in safety-critical areas while securing their aeronautical certification on board any platform:

- Helicopters
- Mission aircraft
- Fighter jets
- UAVs

Until now, the certification of multi-core processors in aerospace applications has been a major challenge. The reason is that the process flows within these multi-core processors are unpredictable. By using the new and specially developed multicore processor boards, the computers of the CAVION family are significantly more powerful than previously used generation of avionics computers, according to Hensoldt. The products of the CAVION family are available in various modular configurations for flight control of the respective aircraft, for special military applications and as mission computers for police and rescue operations.

Keel Laid on First rMCM

(jh) Naval Group has laid the the keel for the first of the 12 Mine Countermeasure Vessels (MCMV) of the Belgian-Dutch rMCM programme. The ceremony took place in Concarneau, in the presence of



the Belgian and Dutch Chiefs of Defence, respectively Admiral Michel Hofman and General Onno Eichelsheim. In 2019 the programme was awarded to Belgium Naval & Robotics, the consortium formed by Naval Group and ECA Group, following an international competition. The contract covers the delivery of 12 MCMVs (six for each Navy) and around a hundred drones integrated inside a "toolbox" that will equip the vessels. Kership, a joint venture between Naval Group and Piriou, is in charge of the production of the vessels which are assembled in Concarneau. As the prime contractor, Naval Group is responsible for the design of the ships, system integration, the testing and commissioning of the mission system (combat system and mine countermeasure system). ECA Group, as co-contractor, is in charge of the unmanned system. These will be produced by the ECA Group workshop in Ostend, Belgium. The first delivery is scheduled for the end of 2024 in Zeebrugge, Belgium and completion is scheduled by 2030.

15th JLTV Order for Oshkosh

(gwh) Oshkosh Defense has received its 15th production order for the Joint Light



Tactical Vehicle (JLTV) since series production started in 2015. The JLTV is procured centrally by the US Army for all branches of the armed forces in the US as well as for partners. The new contract is for the delivery of 1,669 JLTVs, and 868 associated trailers and related package and installation kits. It is worth US\$591.6M (approximately €523M) with 20,000 vehicles worth US\$6Bn now under contract. About half of the demand is registered by the US Armed Forces.

Oshkosh says that it has already built over 14,000 JLTVs. The 15th order includes 125 vehicles for the armed forces in Brazil, Lithuania, Montenegro and Slovenia. Some of these are being supplied from previous orders. Marketing, especially in Europe, is to be pushed further as Portugal and the UK have expressed interest. One of the largest users in Europe will be Belgium, when deliveries of 322 JLTVs on order begin from 2023.

AGDUS Training Systems for the Bundeswehr

(jh) Rheinmetall is supplying new simulation technology for the German Army's Combat Training Centre. Earlier this year, the BAAInBw awarded Rheinmetall a procurement contract for 440 "Training



Device, Duel Simulator (AGDUS), Passive Vehicle" systems. The contract is worth a figure in the upper single-digit million-Euro range. Delivery began in 2021 and is scheduled to be complete by December 2023.

The laser-supported AGDUS consists of laser sensors on the vehicle, the central electronics, and a display and control unit. The systems enable realistic combat training through precise determination of the simulated hit location and a detailed damage simulation based on vehicle-specific damage models. All data and facts concerning the laser-based engagement are relayed in near-real time to the exercise control cell, where the results of hits are displayed.

The AGDUS passive version currently in service is a cable-based system. In the new version, the "AGDUS passiv" vehicle target system features a wireless connection to the central electronics. The connection to the sensor modules necessary for detection relies on radio transmission. Furthermore, the equipment now includes a roof sensor that enables detection of hits above.

Combat Sights for the Bundeswehr

(jh) Raytheon ELCAN, a Raytheon Technologies subsidiary, and Leonardo Germany, a Leonardo SpA subsidiary, have been awarded a contract for 107,929 sights to provide the main combat sight (HKV) for the German Armed Forces. Leonardo Germany is the prime contractor to the BAAInBw and will provide in-country



support, the companies write in a press release.

According to Raytheon ELCAN, the SPECTER DR 1-4x is a combined reflex and telescopic sight allowing soldiers to see close up or far away with a single sight. Those chosen by the Bundeswehr will have a bullet-drop compensator (BDC) etched reticle and a PICATINNY/ STANAG rail integrated into the housing with an ambidextrous, easy-to-use, throw lever to switch instantly between magnifications. The sights have an integrated laser filter to help keep soldiers safer on the battlefield. Deliveries started in the third quarter of 2021.



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SECURITY POLICY

Global Instability and the Challenge for Europe

David Saw

As 2021 came to an end, all the signs pointed towards 2022 being another year that would offer a range of complex global security and economic challenges for Europe. The hopes that COVID-19 was finally on the verge of being conquered were dashed with the emergence of what the World Health Organization classifies as the Omicron (B.1.1.529): SARS-CoV-2 variant. The purpose of this article is to discuss some of these political, economic and strategic challenges and the potential consequences if these challenges are not met effectively.

ur starting point comes with the end of an era. On 8 December 2021 came the end of the 16-years of Angela Merkel as the chancellor of Germany. History will judge the Merkel era and its consequences for Germany but there can be no doubt that Angela Merkel was a major world leader and the pre-eminent European leader as German chancellor. Now attention focuses on the new chancellor Olaf Scholz who heads a coalition government of his own Social Democratic Party (SDP), the Greens and the Free Democratic Party (FDP). This is a peculiar coalition due to the obvious contradictions between the policy positions of the three coalition members. Contradictions of this nature generally tend to not lead to good governance.

Two days after taking power in Germany, Scholz was in Paris to meet French President Emmanuel Macron. There were common positions from both leaders on further European integration; both are committed to this. However, there are distinct differences on the subject of energy. While both subscribe to fight against man-made climate change, how they intend to achieve this is where the problem arises. European nations want to decarbonise their economies, but this cannot be achieved at the cost of energy insecurity and the strategic vulnerability that would entail.

Energy

France does use renewables, but in November Macron stated that they will decarbonise and achieve energy security by building new nuclear power plants, an area where France is already the European leader. In contrast, Germany will continue with its 'Energiewende' or energy transition programme. Here, the aim is to shut down



US President Joe Biden is 79 years old. He is increasingly seen as being out of touch and of presiding over a dysfunctional administration. These are not exactly comforting thoughts at a time when the West is beset with a multitude of crises.

nuclear power stations and eventually coal-fired stations, with the bulk of energy requirements being met by renewables. This energy transition has added to German energy costs and with energy price rising, this puts further pressure on the German economy - all of which is bad news for Europe, because Germany, as Europe's strongest economy, has to be the motor that drags Europe out of the economic recession caused by COVID.

Of course, even though it might like to, Germany cannot meet all of its energy needs through renewables. It needs natural gas and it gets this via the NORD STREAM pipeline, the first two lines of which were openend in 2011, and which transports Russian gas to Germany and other parts of Europe. The next development was NORD STREAM 2, an additional pipeline to increase Russian gas supply. The previous US Government had sought to block NORD STREAM 2 but the current Biden administration has removed its objection to the pipeline project. However, France believes NORD STREAM 2 will compromise European energy independence, while both Poland and the Ukraine have attempted to persuade the German Government not to sanction operation of NORD STREAM 2. Thus far, the German energy regulator Bundesnetzagentur (BNetzA) has not given clearance for NORD STREAM 2 to begin operations, and it would appear the line will not become operational until much later in 2022. In the meantime, it is going to be a cold winter in Europe and natural gas prices are at a high level. Russia has the gas to supply and will no doubt be perfectly happy to have more leverage over Europe's energy needs.

Leadership Questions

Dealing with the continuing COVID crisis, ongoing economic problems, energy security, climate change, and strategic threats all pose major challenges to national leaders. Obviously, there will be different priorities in different countries. What is key, though, is having national leaders who have the ability to lead. Unfortunately, this is where the West appears to have a problem. It has an ever expanding political class, sadly when you look for real political leaders the choices are somewhat underwhelming.

Whether Europe or the West in general likes it or not, the key strategic actor is and will remain the US. For the moment, the US sits at the summit of a rules-based international system and it is still a superpower in a multipolar world. Ideally, US allies would



With Angela Merkel stepping down as German chancellor, French President Emmanuel Macron sees himself as the preeminent European leader. This is not necessarily a bad thing as Macron and France do have a comprehensive strategic vision for both France and Europe.

like to have some ability to participate in the US decision-making process, or at least have the ability to influence the process. This is particularly important at a time when the US is facing a serious challenge to its strategic and economic superiority from China, and a host of other strategic challenges around the world that confront its idea of how the international system should work.

What the West needs from the US is leadership and, unfortunately, the current US administration is proving sadly deficient in this regard. European elites disliked Trump and in Joe Biden they thought that they were getting a US president who was far more palatable and who shared many of their views. The problem is that Joe Biden is 79 years old. Age need not be an obstacle to a leader but clearly for Mr Biden it is an issue and it is plain that his performance is impaired through age and/or other related factors.

Having a US president who is not on top of his game needs not be a major problem. After all, Washington, D.C. is full of advisors, staffers and bureaucrats who keep the machinery of government running. What we are seeing out of Washington at present is a government apparatus that appears to have lots of competing power centres, but no unified strategy, with the exception of being highly responsive to domestic political considerations and the concerns of the more ideological wing of the Democratic party. All in all, this is not a recipe for a thoughtful and reasoned foreign and strategic policy that US allies can buy into.

The US withdrawal from Afghanistan and the fall of Kabul to the Taliban in August 2021 can only be seen as a strategic defeat. What was most disconcerting about the whole episode for US allies was that the US decided to cut and run from Afghanistan unilaterally with no consultation. Episodes of this nature put doubt into the minds of US allies and create a perception of uncertainty over US reliability. That, added to a US inability to understand the needs of foreign partners, contributes to situation like the United Arab Emirates (UAE) deciding to purchase 80 Dassault RAFALE F4, rather than the 50 Lockheed Martin F-35A Joint Strike Fighter (JSF) that were cleared for sale in November 2020. The UAE was not prepared to accept US-imposed operational limitations on the aircraft and had come to believe that the US Government was increasingly exhibiting bad faith as regards the JSF sale.

Fundamentally, a leadership deficit in the US is bad news for

everybody else, especially since weak leaders generally make bad strategic decisions. To make matters worse, the arrival of a new German chancellor on the scene, replacing an acknowledged world leader, is also a concern. It is to be hoped that Olaf Scholz can get to grip with the international aspects of being the German chancellor in the midst of a plethora of strategic challenges. More uncertainty is to come: On 10 April, there is the first round of the French presidential election, followed by a second round between the top two remaining candidates on 24 April. Emmanuel Macron, the current president, might be irritating but he does have a strategic vision for France and for Europe as a whole. In contrast, the other potential candidates

for president hardly seem calculated to fill anybody with enthusiasm. That being said, a continuing COVID crisis in France and poor economic performance makes Macron's road to winning a second term as president more difficult.

Unconventional Threats

A strategic appreciation of the threats confronting Europe now would cover both conventional and unconventional threats both within the direct European strategic space and beyond in the Middle East, Africa and further afield. Obviously, terrorism is at the top of the list of unconventional threats. This threat continues to evolve though and there is an increasing nexus between terrorism and organised crime, particularly in terms of drug trafficking. Groups such as Hezbollah fund their activities through illegal narcotics in Latin America, the Middle East and beyond.

Drug Trafficking

The case of fentanyl can provide us with some answers. Fentanyl is an opioid and





A French Air Force Dassault RAFALE fighter seen in tandem with a Dassault MIRAGE 2000-9 of the UAE Air Force. In December 2021 the UAE ordered 80 RAFALE F4 aircraft from France. Arguably, the inability of the Biden administration to deliver on a deal for the JSF for the UAE opened the door to RAFALE.

primarily used as a high strength pain medication. Illegal fentanyl in the US originates in China or Mexico. It is far stronger than heroin and is either used on its own or mixed with cocaine, heroin, ecstasy, Xanax, Oxycontin or marijuana. According to the US Center for Disease Control (CDC) in figures issued in December 2021, fentanyl is the leading cause of death for Americans between the ages of 18 and 45!

CDC figures released in November 2021 list annual drug overdose deaths in the

US as amounting to 100,306 people; of these 64% were linked to fentanyl. By late 2021, US law enforcement had seized 6,804 kg of fentanyl since January according to official figures but far more had illegally entered the country. Fentanyl is increasingly becoming a factor in the European illegal drugs scene. If it causes the same level of overdose deaths in the 18-45 age group as it does in the US it will become a major strategic threat. Furthermore, trafficking such drugs to

Photo: Ukroboronprom



As the Russian troops mass on the borders of Ukraine, the Ukrainian Ground Forces are seeking to add to their capabilities. In early December, they received a number of BMP-1 Infantry Fighting Vehicles (IFV) that had been overhauled and modernised by the Lviv Armoured Plant.

Europe will become even more lucrative for terrorist organisations.

Illegal Migration

Another area that is becoming of great concern to Europe is illegal migration. Increasingly, this is becoming used as a political/strategic threat as in the case of Belarus using the threat of uncontrolled migration into Poland and the EU as a tool to obtain political goals. Beyond state actors facilitating illegal migration, you also have criminal groups involved in illegal migration for profit and combining that with human trafficking. Terrorist groups also utilise the service of trafficking gangs to move their own people into Europe.

For many in the developing world, the lure of Europe is irresistible and if they have to pay criminal enterprises to get them to Europe they will. Countering illegal migration will require concerted action at EU and national government level, most probably requiring a logical EU migration path with strong enforcement action against illegal migration. Until this is achieved, criminal organisations will get richer and stronger via trafficking people and drugs, and will become far more dangerous and difficult to control and a growing threat to national security.

Choices

It would appear that the only thing there is these days in surplus is a crisis; whether it be a climate crisis, a crisis on the borders of the Ukraine, a crisis in the Middle East, a crisis in Africa, an economic crisis, rising energy costs, an illegal drugs crisis and, inevitably, the COVID crisis. More than that, it must be noted that there is an increasing crisis of legitimacy surrounding EU and national political elites. You can describe that as populism and condemn it, but it is a real factor. If the rulers become increasingly divorced from significant numbers of those that they claim to rule, that will do nothing for social stability, something that is already under threat from myriad causes.

There are no easy answers to the strategic and increasingly the social challenges confronting Europe. In the end it comes down to whether you wish to confront these challenges and try to resolve them, or whether you look to compromise and appease in an effort to defuse, or most likely delay the threat. Which brings us to the conclusion that the real crisis facing Europe is a crisis of leadership, and resolving that crisis is the real challenge.

"The Ultimate Weapon"

Proliferation of Weapons of Mass Destruction: Developments and Trends

Christian Herrmann

The production of weapons of mass destruction and their proliferation pose a serious threat to international peace and security. They can also destabilise entire regions.

The proliferation of nuclear, biological or chemical weapons of mass destruction (NBC weapons), or the goods and technologies used to manufacture them, as well as corresponding weapon delivery systems (for example missiles and drones), including the know-how required for this purpose, is referred to as proliferation.

Risks

Despite some considerable technological progress of their own, states striving for weapons of mass destruction (countries from which it is to be feared that NBC weapons will be used in an armed conflict or their use is threatened to enforce political goals) remain dependent on the global market for the development and production of such weapons and delivery systems. Among other things, they try to procure necessary goods in Germany by circumventing licensing requirements and export bans. The direct procurement of such goods is now rather the exception. The existing strict German and European export control regulations to prevent such purchases have led to a change in the purchasing and procurement behaviour of proliferation-relevant states.

Circumvention Attempts

In order to circumvent an export ban by the licensing authorities, those states procure these products via third countries (known as circumventing exports), use front companies or submit false information about their intended use by making "dual-use"

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UAE Armed Forces perform a vehicle checkpoint as part of Exercise LEADING EDGE 13 at the AI Wathba training facility. The exercise aimed at training to prevent WMD related materials proliferation.

goods (products that can be used for both civilian and military purposes which are also subject to export controls). Direct financing of such transactions and products from the relevant states is also the exception. Instead, this takes place via company and bank networks in order to disguise the origin of the buyer as well.

For students and scientists from proliferation-relevant countries, German universities, universities of applied sciences, scientific institutes and research societies, as well as research departments in industry, are also possible sources for the acquisition of proliferation-related knowledge.

Pakistan

The Islamic Republic of Pakistan is one of the four countries in the world that have not signed the Nuclear Non-Proliferation Treaty and its related security agreements; the country operates an extensive military nuclear and missile technology programme in addition to a civilian one.

Ever since its founding, Pakistan has been in an almost constant state of tension with India. The reason for this is the still unresolved conflict over the Kashmir region. The expansion of its own nuclear weapons potential through the development and deployment of new nuclear-capable missiles and the increase in the production of fissile materials continues to be of great importance to Pakistan.

In 2020, there were also indications in Germany and numerous other Western countries of proliferation-relevant Pakistani procurement attempts. Indications do not only arise if the goods to be procured can obviously be used in a weapons of mass destruction programme. The methodical procedure for procuring the goods (for example, by means of covert procurement networks consisting of front companies and intermediaries) or existing knowledge about the recipient and end user can also indicate a proliferation-relevant procurement background. The focus was particularly on goods with a possible use in the field of nuclear technology.

Correspondingly, intensive and covert efforts are also to be expected in the future. The reconnaissance and prevention of proliferation-relevant Pakistani procurement attempts thus continues to be one of the focal points of the counter-proliferation activities of the Federal Office for the Protection of the Constitution (BfV).

Iran

Iranian procurement efforts continue to be the focus of proliferation defence. In this context, the clarification of possible Iranian proliferation efforts is a high priority for both the nuclear programme there and for the ambitious and internationally sanctioned missile and launcher technology programme.

Since the US withdrew from the Joint Comprehensive Plan of Action (JCPoA) on 8 May 2018, the reinstatement or expansion of sanctions against facilities and individuals in Iran, and Iran's gradual suspension of JCPoA agreements since 2019, the nuclear deal is in a precarious state. The reports of the International Atomic Energy Agency (IAEA) state a consistent removal of Iran from essential JCPoA restrictions. At the end of 2020, the stockpile of low-enriched uranium is fourteen times above the permitted upper limit. In addition, Iran has ex-



WMDs are generally understood to encompass chemical, biological, radiological/nuclear, and explosive elements.

panded its diverse research and development work with advanced centrifuges and is using these machines for uranium enrichment in contravention of the agreement. Furthermore, Iran is pursuing one of the most extensive missile programmes in the Middle East. Among other things, Iran is accused of supplying missile and drone technology to various state and non-state actors in the Middle Eastern region, in contravention of applicable UN Security Council resolutions.

Convictions for Violation of the Foreign Trade and Payments Act (AWG in German)

On 15 May 2020, the Regional Court of Frankfurt am Main (Hesse) sentenced a businessman to five years in prison for



Several institutions have organised trade control awareness seminars. The event depicted was organised by the US Department of State to help countries around the world to meet their commitments under UN Security Council Resolution 1540 to regulate strategic trade. The US State Department brought in experts from Malaysia, Singapore, and China to share how their countries have protected their borders by streamlining regulations on dual-use goods that could become weapons or WMD components.

violating the Foreign Trade and Payments Act (AWG). The sentence is final. The convicted man had illegally delivered printing machines and accessories to Iran. The machines would have enabled the Revolutionary Guards to produce banknotes. The Federal Court of Justice had partially overturned the initial verdict from 2018. The court considered the confession, which had been made in the meantime, as mitigating the punishment, but by way of aggravating the punishment, the court considered the "high criminal energy" of the convicted man, who had known what he was getting into with the multi-million dollar deal.

Against the backdrop of the ongoing poor economic situation, the indications of proliferation-relevant procurement attempts by Iran for its nuclear programme increased in 2020. However, a violation of the JCPoA could not be established in these cases so far. The procedure established by UN Security Council Resolution 2231, which allows Iran to obtain NSG-listed goods and dualuse goods after prior approval by the Security Council (via the so-called "procurement channel"), remains in place.

The ambitious Iranian launcher technology/missile programme is not covered by the provisions of the JCPoA. Procurement activities in Germany are persistently high in this regard. With an upward trend, they roughly corresponded to the level of the previous year.

In September 2020, the Regional Court of Würzburg (Bavaria) convicted a Chinese managing director and one of his employees with German citizenship for violating the Foreign Trade Act. The managing director had commercially exported dual-use goods to Iran without authorisation. The employee of the company assisted him in doing so. In two cases, both had exported proliferation-relevant machines to Iran with the involvement of Iranian procurement companies, deceiving the responsible export control authorities. Actual use of the machines in Iran's missile technology programme cannot be ruled out. The two defendants made a full confession and the Chinese businessman was sentenced to a total term of imprisonment of two years and nine months, while the German national was sentenced to a total term of imprisonment of one year and six months suspended. The verdict is legally binding. The BfV assisted the investigating authorities.

North Korea

North Korea has an advanced nuclear weapons and missile programme and repeatedly tests short-range ballistic missiles. On the occasion of the military parade celebrating the 75th birthday of the North Korean Workers' Party on 10 October 2020, the regime also presented a new long-range missile.

The threat of the corona pandemic led to the closure of the borders and the complete isolation of North Korea at the beginning of 2020. Since any import of goods from abroad is also considered a potential source of danger for the import of the virus, the danger of proliferation-relevant procurement of goods from Germany is currently considered low. However, since North Korea had expressed interest in dual-use goods in Germany until the beginning of the restrictive corona protection measures, the current infection protection measures are only temporarily delaying North Korea's procurement efforts.

North Korea continues to strive to increase its nuclear power. Therefore, activities to procure proliferation-relevant goods can also be expected in the future. Since the regime attaches absolute priority to the further development of the nuclear weapons programme, the state-controlled national economy is linked in every respect to its financing. Thus, any procurement of foreign currency by North Korea will continue to be accompanied by indirect proliferation financing.

Syria

Following Syria's accession to the Chemical Weapons Convention (CWC) and admission as a State Party to the Organisation for the Prohibition of Chemical Weapons (OP-CW), large quantities of chemical weapons and warfare agents were destroyed under international supervision in 2014. However, it can now be assumed that Syria's initial declaration of chemical weapons stockpiles was incomplete and that not all stockpiles have been destroyed.

For example, in a report dated 8 April 2020, the OPCW's Investigation and Identification Team (IIT) identified the Syrian Air Force as the perpetrator of three chemical weapons attacks in March 2017 near the Syrian village of Ltamenah (see OPCW homepage of 22 December 2020). Despite the comprehensive restrictive measures against the Syrian regime, which were again extended by one year by the Council of the European Union in October 2020, continued proliferationrelevant procurement efforts by Syria can also be assumed in Germany. The Scientific Studies and Research Center (SSRC), which is considered the main sponsor of Syria's weapons of mass destruction programmes, plays a significant role in this and continues to use a network of various front companies and intermediaries. The progressive stabilisation of the Syrian regime and the associated reconstruction of the country also give rise to expectations that the research, development and production of military programmes in Syria will be expanded, which is likely to include proliferation-relevant goods. The focus remains on laboratory-specific equipment, which suggests the establishment and expansion of chemical and bio-

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logical laboratories. For 2020, the procurement activities identified in Germany are at a low level overall.

New Intelligence Focus: Russia

In response to Russia's actions that contributed to destabilising the situation in Ukraine, in particular failing to take steps to prevent the flow of arms, equipment and combatants across the Russian-Ukrainian border, the EU imposed an arms embargo and trade restrictions on "dual-use" goods and equipment for the energy sector on 31 July 2014 (Decision 2014/512/ CFSP, as well as EU Regulation 833/2014 of 31 July 2014). In addition, restrictions were imposed on capital market access for listed Russian state banks and companies in the defence and oil sectors Further EU sanctions against Russia are regulated in EU Regulation No. 269/2014 of 17 March 2014 and No. 692/2014 of 23 June 2014. For some time now, the BfV has had indications of Russian proliferation-related

activities using state and semi-state actors and circumventing sanctions and concealment of actual end users. In the meantime, the BfV has been able to verify an increasing number of actual indications of proliferation-relevant procurement attempts involving Russian intelligence services with a concrete connection to Germany. The products procured are predominantly dual-use goods that are to be put to a military or proliferationrelevant end use. Despite unclear information on the intended use and end use, the BfV's counter-proliferation unit was able in some cases to make a concrete assignment to a specific area of the Russian weapons programme. Intensive Russian procurement efforts are also to be expected in the future.

Indictment for Violation of AWG

On 8 October 2020, the Office of the Federal Public Prosecutor brought charges against two German nationals before the State Protection Senate of the Hanseatic Higher Regional Court in Hamburg. One of the defendants is accused of violations of the AWG. In seven cases, he is alleged to have sold machine tools worth around €8M to a state-owned arms company on a commercial basis and for the secret service of a foreign power with the support of the second accused. The equipment is used to manufacture missile systems, some of which are nuclear-capable, for the Russian Armed Forces.

Illegal Procurement Efforts for Foreign Military Space Programmes

The possible use of space-based technology and systems in the context of and in the run-up to conflicts is gaining massive importance for many states. Therefore, it cannot be ruled out that Germany and its allies could also be victims of such a deployment.

The following scenarios, for example, could arise in connection with such conflicts:

- Obtaining a strategic advantage through targeted disruption or destruction of communication satellites;
- Using/re-purposing satellites as weapons;
- Cyberattacks through and against satellites; or
- Use of military/intelligence observation and surveillance satellites.

The German space industry bundles new high-tech fields such as electronics, robotics, measurement and control technology and new materials. As one of the world's leading producers of such technologies, it is a target of illegal procurement activities by states that could also use their own space programmes for military and intelligence purposes to the detriment of German or European interests.

Russia and China in particular use procurement channels and methods as in the context of "classical" proliferation. Using state, semi-state and intelligence actors, as well as circumventing sanctions and concealing the end use, they try to obtain satellite or space weapons technology that can be used for military and intelligence purposes.

Both states need advanced technology in addition to the knowledge of German companies to modernise and expand their position and presence in space. The BfV's counter-proliferation unit therefore monitors corresponding illegal and clandestine procurement attempts with the aim of clarifying and preventing them.

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MITTLER REPORT



Viewpoint from New Delhi

The Second Quad



A imed at economic cooperation, the new Middle East (ME) Quad comprising India, Israel, the US and the UAE has created quite a flutter in stra-

Suman Sharma

tegic circles. Christened as the second Quad by foreign policy watchers, it held its first hybrid foreign ministers' meeting in October during India's External Affairs Minister S. Jaishankar's visit to Israel. Minister Jaishankar and his Israeli counterpart, Yair Lapid, were physically present while US Secretary of State Antony Blinken and UAE Foreign Minister Sheikh Abdullah bin Zayed Al Nahyan, joined them virtually. Minister Lapid, expressing his satisfaction, said, "I don't want to conclude with fear, but with hope. We are writing a new chapter in our history. There is an alliance of moderates. Focussed on life, focussed on hope, focussed on optimism, focussed on looking forward."

Though the ME Quad hailed the economic focus, Israel's Ambassador to India, Naor Gilon, explained the format as stemming from concerns about Iran causing instability in the region.

Iran

Ambassador Gilon noted that Iran was perceived as a 'real threat' with its extremist ideology and nuclear capability, adding that there was considerable synergy between the four countries which could be used for economic and infrastructural development.

Regarding the non-military aspect of the grouping, Ambassador Gilon added optimistically, "We do not exclude any cooperation with India and the UAE."

The New Delhi based Iranian embassy hit back at the Israeli Ambassador, calling him 'adventurous' and slamming his remarks as 'childish'.

Spats between Tehran and Tel Aviv are common, but India has steered clear in becoming the hosting ground for them both. There is speculation that Tehran's non-inclusion of India in its own foreign ministerial meeting is a snub over the new Quad.

IP Quad versus ME Quad

Comparisons are typical between the two Quads – Indo-Pacific (IP) and ME, as both are groupings comprising four countries with the US and India being common members in both, implying strategic proximity.

While the IP Quad, with the US, Japan, Australia and India as its members, is viewed as a counter to China, the ME Quad is seen as leaning towards countering Iran. Though India is the only country in the ME Quad which enjoys a comfortable relationship with Iran, it remains to be seen how New Delhi performs this balancing act. In the IP Quad, India is the only country sharing a border with China and is against its militarisation. Minister Jaishankar said at the recent India-US Forum, "The Quad partnership is one of the ways in which we could address strategic competition and

geopolitical challenges in the Indo-Pacific region." Neither of the two groupings is a formal alliance and both stick to their charter of soft diplomacy such as COVID vaccines, climate change, resilient supply chains, and disaster management. Dr. Md. Muddassir Quamar, Associate Fellow, Manohar Parrikar Institute for Defence Studies & Analyses, says, "The ME Quad meeting has to be seen from a geo-economic perspective, especially as it comes after the devastating impact of COVID-19 on the global economies."

As far as military drills are concerned, navies of the IP Quad have been jointly exercising in the Malabar maritime exercise, whereas India participated in Israel's largest ever air force exercise, Blue Flag, this year, alongside seven other nations.

However, there are divergences in these groupings. The IP Quad was born with a definite strategic aim of keeping the Indo-Pacific free and open along with ASEAN centrality. It has grown into a summit-level engagement, while the ME Quad is chiefly focussed on economic cooperation between private companies.

Adding to the intricacies of these alignments are India's comfortable relationship with Iran and West Asia, China's substantive economic relations with Israel, the UAE and Iran, security stakes in Afghanistan, oil supplies, Chabahar port and INSTC, making the complex regional scenario extremely strategic, which rules out any group becoming averse to any one nation in the near future. Moreover, the Middle Eastern countries would not want to become a theatre for playing out the ongoing US-China or US-Iran rivalries.

Overall, the new ME Quad is an amorphous alliance. It lacks a clarity of purpose and with India part of so many regional groupings, which include China, Russia and Iran, it might make it difficult for New Delhi to enhance a new grouping without annoying others, in which case avoiding overlap with any of the existing arrangements with anything new, is probably the best approach. "If at all, it should be seen within the context of the Abraham Accord, signed between Israel and the UAE, in a way the quadrilateral meeting among the FMs of these three and India expands the accord into an Indo-Abrahamic Accord with a focus on leveraging the good political and economic relations between the four countries to develop a sustainable economic cooperation", adds Dr. Quamar.

All-Seeing Situational Awareness

Tim Guest

Vehicle commanders and crews face an increasing number of threats from all directions on the modern battlefield. Optimising a vehicle's tactical situational awareness capabilities is one way of optimising the crew's chance of survival.

rmoured vehicle sensor capabilities continue to evolve to provide increased situational awareness (SA) for vehicle commanders. Whether electro-optical, acoustic or otherwise, such SA sensors and local SA systems (LSAS) are improving the abilities of onboard crew to make informed, tactical battlefield decisions as they face modern, asymmetric threats, often in intense, highanxiety urban scenarios. Having eyes -- and ears -- in the back of your head, as well as on top of it, will be crucial if armoured vehicles and crew are to survive on tomorrow's battlefield. But lots of sensors means lots of real-time data, so armoured vehiclemounted sensors must not only be able to gather tactical SA information, but onboard systems must also be able to process and use that information in the blink of an eye so the crew can respond appropriately.

Not only will optimal SA aboard each vehicle in, say, a mechanised battalion, enable future armoured vehicle operations to be better informed to handle the tactical situation, but it will also help the whole battalion and wider battlegroup to achieve and maintain strategic advantage on the battlefield. This article outlines what SA is and takes a look at some latest SA developments and systems from a handful of leading manufacturers.

Understanding SA

SA can be explained as the perception, understanding and anticipation of all the various factors within an operational environment required for operatives/vehicle crew to act effectively within that particular environment. It is an absolute prerequisite in order for a commander or operative to execute timely and accurate decision-making in a fast and highly stressful scenario, such as that of an Infantry Fighting Vehicle (IFV) operating and disembarking its occupants into an active operational situation. With the introduction of ever more sophisticated electronic sensor and optronic technologies onto the battlefield, this is expected to improve vehicular - and dismounted -



SA can be explained as the perception, understanding and anticipation of all the various factors within an operational environment required for a vehicle crew to act effectively within that particular environment.

SA by providing the right information, at the right time and in the right format for all concerned to make the best possible decisions, not only for a mission to succeed, but also for a vehicle and its crew, (together with other friendlies in the tactical locale), to survive.

Throwing a whole load of information and visual data from a myriad of sensors at any soldier, whether commander or otherwise, about local threats, terrain, uncertainties and more, must not overwhelm, confuse or create sensory overload in the minds of recipients. It must help them perceive immediate threats, make accurate time and space appreciations of a developing tactical situation, and comprehend how a particular action by them will turn out: If I do this, so what? If I do that, so what? Effectively, the system must conduct a digital combat appreciation that can be easily understood, it must be able to prioritise and highlight the more critical aspects and threats in the immediate tactical environment.

The sophistication of the SA sensors and core processing elements coming out of in-

dustry is, thankfully, taking all these issues into account. So, let us now take a look at just a few of those systems.

Companies and Solutions

Enabling commanders at the tactical edge of operations to receive optimum levels of SA needed to do their job is the Move Out/Jump Off (MOJO) terminal from Viasat's Government Systems division; it is a reduced-form-factor terminal that allows it to be integrated onboard a variety of platforms, including ground vehicles and small maritime vessels. The terminal - based on Viasat's KOR-24A Small Tactical Terminal (STT) – can be operated on-the-move to ensure Line-of-Sight (LoS) and Beyond-LoS communication over air, land and maritime environments and is a gateway that gives a 360 degree view of the battlespace by blending air and ground situation pictures, and provides at least three-channel, simultaneous access to disparate and incompatible communications networks, including Link 16, TADIL-J, VHF/UHF (SINCGARS, SRW, ANW2C, SATCOM, IW and DAMA) and

another embedded radio such as EPLRS/ SADL networking. MOJO also features an integrated computer capable of hosting and controlling gateway applications, which allow soldiers to select their own mission-specific applications and external displays that best suit their information and SA needs. It is designed to provide access to a Common Operating Picture (COP) across disparate networks and in remote and austere locations, so that such things as targeting cycles can be shortened and any collateral damage can be reduced during fire missions, by providing a much greater SA picture to the commander. Importantly, Viasat's MOJO also enhances interoperability between US and coalition partners, providing access to the COP through Link 16 or SADL-enabled platforms, among others. The system can be set up by a single end user within about 15 minutes with little or no training, making it a rapidly deployable communications solution capable of being operated anywhere in the world for largescale combat operations. MOJO is expected to be networked to Viasat's planned XVI Link 16 Low Earth Orbit satellite to extend its ability to communicate with BLoS assets in the immediate battlespace.

360 Views

Some five years ago, BAE Systems drew on advanced fighter jet technology to come up with its BattleView 360 SA system, which effectively allows armoured vehicle crews to 'see through' their vehicles, in real time, providing commanders with, as the name



Battleview 360 includes a helmet-mounted monocle, which synchronises with vehicle cameras to provide its 'see-through' capability in both visible and infrared modes.

implies, a complete 360-degree view of the battlespace surrounding the vehicle. The system seamlessly integrates with multiple existing vehicle types, (such as CV90s, BRADLEY IFVs, as well as UAVs), and their onboard electronics and communications systems. It has, at its core, a digital mapping system that collates, displays, and tracks the positions of all surrounding features of interest in either two- or three-dimensional modes, allowing vehicle commanders to make rapid and informed decisions and communicate plans and instructions to their crew, as well as other friendly vehicles. Displayed imagery can, for example, enable a commander to distinguish between friend or foe in order to either engage the enemy, or for friendly forces to find a safe route out of enemy sight and range.

According to the company, the headworn part of the system including the





SETAS uses high-resolution cameras in ruggedised, integrated modules that can be positioned around the hull of a wide variety of tracked and wheeled armoured vehicles.

helmet-mounted monocle, synchronises with vehicle cameras to provide its 'seethrough' capability in both visible and infrared modes. And once disembarked from their mother vehicle, dismounts can also relay further SA information back to the vehicle for processing and, if necessary, wider dissemination to friendly forces. BattleView 360 has a headdown, touch-screen display that allows commanders to assess incoming information, including from the displays of other crew members, such as a gunner, or driver, thereby optimising his own decision-making capabilities. Key features displayed and enabled by BattleView 360 include: blue force positions, route planning, UAV route planning, route progress monitoring, dead-ground display, red-ground display – namely, ground that can be seen by hostile forces – and areas of uncertainty.

Another 360-degree view of the battlefield is provided by the see-through-armour system - SETAS - from Hensoldt, which uses an array of high-resolution cameras, including 12-megapixel CMOS day cameras and uncooled thermal imagers, in ruggedised, integrated modules that can be situated around the hull of a wide variety of latest tracked and wheeled armoured vehicles types, as well as legacy platforms, to give commanders and crew an all-round view of their external environment, in real time, 24 hours a day, while remaining closed down. Hensoldt's sensors offer a range a capabilities to protect and improve survivability, with sensor data fusion, artificial intelligence, augmented reality and other technologies playing a role in their function. But it is SETAS that specifically represents the company's latest and most advanced SA sensor system. Its CMOS camera, for example, enables it to recognise the human form, such as a sniper, out to 300m, providing crew sufficient time for appropriate decisionmaking actions. The system has a powerful Central Image Processing Unit (CIPU) that can handle huge amounts of imagery data generated by the sensors, running complex algorithms so camera feeds from each SETAS module can be 'stitched' together to give a seamless, 360-degree view of what's going on outside the vehicle. The CIPU features up to eight outputs, allowing eight crew members to view the low-latency, video feed via a human-machine interface (HMI). Crews can use standard display screens as well as helmet-mounted displays that give instant orientation, as SETAS has an open HMI architecture. The system also allows each user to have graphical overlays that assist further with SA and decision making. For instance, a crew member could choose to have vehicle information overlaid on his SETAS view, giving them up-to-date information on how the vehicle is performing using the NATO Generic Vehicle Architecture (NGVA) to receive vehicle data, or a soldier could have military symbols from the battlefield management system (BMS) overlaid on their view, giving them indications of enemy and friendly forces before they dismount.



Crews using SETAS can use standard display screens as well as helmet-mounted displays that give instant orientation.

A number of new software-enabled features for SETAS are currently in development, including a picture-in-picture mode and digital image enhancement, the latter includes digital image stabilisation enhancement to allow crew members or remote users to focus on specific objects while the vehicle is moving. By using machine-learning algorithms, SETAS can identify targets, thereby reducing crew workload. In the future, the company intends to network SETAS with other vehicle sensors, including Hensoldt's Multifunctional Self-Protection System (MUSS) and shot detection systems, both of which alert the crew to potential missile and ballistic threats. In so doing, SETAS will evolve from a standalone SA solution to become a powerful sensor-management system, incorporating advanced AI algorithms and connecting a host of sensors to provide optimum SA and survival capabilities for vehicle commanders and crew.

Product Feature: EVPÚ Defence

EVPŪ DEFENCE

Create Your Own Perfect View with the GATRIA Modular Awareness System

Last year, EVPÚ Defence a.s. attracted a lot of attention in the defence sector following a successful supply of its remote-controlled weapon stations to the Army of the Czech Republic and winning the Golden IDET 2021 for RCWS MANTIS. While certainly well-deserved, this focus slightly overshadowed the fact that EVPÚ Defence a.s. also produces a number of other interesting and versatile electro-optical systems for armoured vehicles. Let's take, for example, the GATRIA modular awareness system. As its name suggests, it has been developed to monitor vehicle perimeter, detect and identify threats and targets and equip vehicle commanders with complete and continuous situational awareness. GATRIA consists of a number of modules which include a pan device and a variety of day and thermal imaging camera combinations. Together, the modules offer 360° view of the battlefield but customers



do not need to order a complete set. Depending on the needs of their project, they can choose any combination of the modules on offer to cover the required angle, which could lead to significant saving in the total cost. The whole system is operated from the vehicle interior via a touch screen terminal which displays the images from individual sensors.

Besides the flexibility and variety of options it offers, GATRIA can also be relied upon to operate in harsh conditions. The cameras and other electronic parts of each module are safely encased in a ruggedized aluminium housing for use on combat vehicles. Since 2016, the system has been used on five different types of vehicle in service with the Czech Army.

All in all, GATRIA offers one of the most reliable, flexible and cost-effective solutions to vehicle perimeter security that are currently available on the market.



In use with the French Army is the Thales ANTARES, a 360-degree optronic video system that alerts all vehicle occupants precisely what is happening around them before disembarking. Its five million pixel/360-degree view of its surroundings provides a closed-down crew with a 'see-through' view of the battlespace outside and the chance to react to threats in a timely fashion and survive. With an increasing number of 360-degree solutions now available, it's worth mentioning OCTOPUS 360 from Israel's Computech International (CTI). This is an SA system designed for combat teams in closeddown vehicles in hostile environments that provides a 360-degree, in-motion, visual solution to armoured vehicle crews; it processes data from hull-mounted cameras and advanced sensors to display a 'stitchedtogether', 360-degree, tactical view of the local environment around the vehicle. The system supports multiple monitors to create a full-view, real-world picture, and has Picture-in-Picture capabilities, which display data in real-time, telemetry streams and markers, and it also offers real-time recording and off-line playback for debriefing and simulation. Virtual Reality and Augmented Reality glasses can be connected to improve user experience, and multiple display modes are available to support users with different operational requirements. OCTOPUS 360 provides real-time object detection and marking with dynamic tracking, compression and image transmission which enable remote monitoring. The system can be installed on any platform, from light to heavy vehicles, working insync with the vehicle's existing electronic systems to provide combat squads with a complete, real-time SA picture.

A CITADEL Footnote

While not every vehicular SA system can be mentioned in such a brief article, the local SA pedigree of Copenhagen Sensor Technology, CST, deserves a mention. Yet, it, too, has an array of solutions that are too many to be covered here. Suffice to highlight CST's CITADEL LSAS, which is a complete vehicle system consisting of both SA cameras and driver-vision-enhancement cameras. CITADEL itself has several versions, including CITADEL PANORAMA, COMPACT/THERMAL, CONNEX, DUAL and QUATTUOR, to name just some. CST says that CITADEL, in its various formats, is suited to vehicle mid-life upgrades and retrofit programmes, due to its analogue core, enabling it to be integrated into existing analogue vehicle architecture. Citadel provides day and night vision using a combination of visual and thermal night vision devices and has been field proven on a variety of tracked and wheeled armoured vehicles





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Mobile Situational Awareness with HENSOLDT's SETAS-System

The future of integrated ground vehicle sensors

Ground combat has changed significantly over the last decade. Conflicts are now more likely to be fought in urban environments - where movement and visibility is difficult for armoured vehicles - and the enemy is more adept at using asymmetric tactics to neutralise the capabilities of a modern equipped army. In this environment, how can we make vehicle and crews safer?

Limited view in a changed battlefield

The design of armoured vehicles has had to adapt to an increasingly dangerous environment. As conflicts in the 21st century have shown, asymmetric tactics to destroy vehicles can include hidden improvised explosive devices, rockets, and more recently armed drones that can drop bombs from above. To address this, modern armoured vehicles



SETAS offers several camera variants for maximum flexibility depending on the field of view requirements.

- such as wheeled 8x8s and tracked vehicles - are now extremely well protected with significant blast and ballistic protection to address a range of threats.

To achieve this level of protection, potential weak points in the hull including windows or firing ports are no longer fitted – with the impact of decreasing visibility. To see the outside world, crews have to rely on the limited visibility provided by optical periscopes, or open the crew hatches, which of course can be extremely dangerous.

So, the challenge: How can we give all soldiers inside a vehicle the same outside view as if they were using their own eyes looking out of the hatch?

Solving the situational awareness challenge

A few years ago, HENSOLDT engineers thought about this very challenge and they knew they had the answer. Within the HEN-SOLDT environment, which encourages innovation and the development of product ideas, engineers could submit their ideas and they went through an innovation process that eventually led to a concept phase and finally to the main development.

That idea was the See-Through Armour System – or SETAS.

SETAS uses an array of high-resolution cameras-starting from 12 megapixel CMOS day cameras and also uncooled thermal imagers in ruggedised integrated modules situated around the hull of an armoured vehicle. This gives crew members a 360-degree view of the external environment 24 hours a day, all while remaining under cover.

Like the human eye, the target for SETAS was to be able to recognise humans within 300m, which is critical for early threat detection and ensuring that potential threats are addressed as guickly as possible. With the high-resolution 12MP CMOS cameras, you can recognise a sniper or soldier within 300m and this gives you time to make decisions and react.

SETAS also includes a powerful Central Image Processing Unit (CIPU) that can process the huge amounts of imagery data being generated by the sensors, and part of this includes running complex algorithms that allows the camera feeds from each module to be stitched together, which gives the user a seamless 360-degree view of the external environment.

The CIPU features up to eight outputs, allowing eight crew members to view the low-latency video feed via a human-machine interface (HMI).

HMI is just as important as all the other elements, it's how you get the information from the sensors to the user and how to control the displayed information, noting that SETAS has an open architecture for HMI that allows crews to use standard display screens as well as helmet-mounted displays that give instant orientation.

The system also allows each user to have graphical overlays that assist further with situational awareness and decision making.

For instance, a crew member could choose to have vehicle information overlayed on his SETAS view, giving them up-to-date information on how the vehicle is performing using the NATO Generic Vehicle Architecture (NGVA) to receive the vehicle data. Meanwhile, other soldiers could use military symbols from the battlefield management system (BMS) overlaid on their view, giving them indications of enemy and friendly forces before they dismount.

Adding additional capabilities – becoming a sensor management system

HENSOLDT is continually adding features to SETAS, which will benefit vehicle crews and soldiers on the frontline. The team is working on a number of new softwareenabled features, including a picture-inpicture mode and digital image enhancement. On the latter, the enhancement includes digital image stabilisation that allows crew members or a remote user to concentrate on specific objects whilst the vehicle is moving.

Using machine learning algorithms, SETAS is also capable of object identification, which reduces the workload for crew members that have to scan a wide area for potential threats. It is also possible to host their own customer owned algorithms if required, owing to the flexibility of the system.

SETAS enables the securing of open terrain sections that are unusual for infantry operations and can serve as a threat warning system by sharing information across platforms, for example in combination with the HENSOLDT Multifunctional Self-Protection System (MUSS).

Future developments such as networking SETAS with Unmanned Ground Vehicles (UGVs) or Unmanned Air Vehicles (UAVs) can increase direct support to dismounted forces, as SETAS can enable joint reconnaissance. SETAS is the first step to a sensor management system, it is so powerful and with AI you get far more information than you would from the sensors alone.

See the capabilities of SETAS yourself by watching our video:



Propulsion Systems for AFVs – Embracing the Future

David Saw

f you want to look at a transformative technology then the Internal Combustion Engine (ICE) certainly fits that description. The petrol engine started to become a viable proposition in the 1870s, while in 1886 Karl Benz began commercial production of a motor vehicle equipped with an ICE. In the 1890s, Rudolf Diesel developed a reliable diesel engine and the basis for a technological revolution was established.

At that time, the world had entered the oil age and this would have immense strategic implications. In the early years of the twentieth century, Britain's Royal Navy, then the largest and most important navy in the world, took a critical decision when it decided that its major units would use oil rather than coal as fuel. Winston Churchill, as First Lord of the Admiralty, and effectively the civilian head of the Royal Navy, was convinced that oil offered much more energy efficiency than coal and that this would translate into major operational gains. This was a courageous move as Britain had immense coal reserves, but no oil access at home. However, across its empire and area of control, oil strikes were starting to be made. The British were not the only navy to turn to oil, with the US Navy and Italy, inter alia, soon following suit.

The ICE essentially made aviation a reality, and as performance increased and cost decreased, a mass market for the motor car started to become feasible, especially with Henry Ford leading the trend with the manufacture of the 'Model T' in 1908. In parallel came trucks and buses, heralding the dawn of a whole new era of mobility. The ICE would transform warfare just as it would transform society.

Industrial age economies were built upon oil and other fossil fuels; they provide the power both for manufacturing and for the heat and light central to a modern society. Oil was critical to the global economic recovery post-1945, and in many respects, economic growth was due to the fact that oil was plentiful and cheap. It might seem strange today, but at that time there appeared to be a commonly shared assumption, from politicians to government officials, to oil company officials, and shared the general public, that there would always be oil and plenty of



The Véhicule Blindé Multi-Rôles (VBMR) GRIFFON was developed as part of the SCORPION EBMR armoured vehicle programme and will replace the VAB in French Army service. Arquus and the Direction Générale de l'Armement (DGA) are investigating a new hybrid propulsion package for the GRIFFON.

it. There were just so many applications for oil, such as nylon and plastics, that it became part of everyday life.

In the wake of the 1973 Arab-Israeli War came the Arab oil embargo, and all of a sudden, the age of cheap and plentiful oil was over; this would have a devastating effect on western economies. Perceptive people would start thinking about how to confront the threat of energy insecurity, while others would take concrete steps to make sure that they had power to keep the lights on and the country running. France would embark on a programme to provide secure electric power via the construction of nuclear power stations, and eventually 70% of French electricity would be generated by nuclear power. France would also find itself able to earn substantial sums via exporting electricity through connectors to other European countries thanks to its nuclear capability.

Moving to the Modern Era

Nuclear power stations offered carbon-free electricity and yet they did not become the dominant source of power in Europe. The reasons for this were the Three Mile Island nuclear accidents in 1979 and Chernobyl in 1986, both of which acted as a catalyst to the anti-nuclear and broader environmental movement which would grow exponentially in the coming years. As an aside, the Fukushima nuclear disaster in March 2011 can be said to have led to the end of nuclear power in Germany and other European countries. That being said, France has stated that it intends to proceed with a new generation of nuclear plants to ensure energy independence.

While there are more references to energy security and energy independence these days, it is clear that energy policy is influenced more by political commitments to



The Volvo FH truck on cold weather trials; the vehicle has two or three electric motors providing up to 330-490 kW (450-666 hp) of continuous power and a range of 300 km. Volvo has invested heavily in ICE replacement technology and all of its trucks will be electric by 2040 or earlier. Volvo technology is being used by Arquus for military ICE replacement applications.

fight climate change and to decarbonise national economies. Whether climate-driven energy policies will achieve the results loudly proclaimed by the sponsors of such policies is open to question. Politicians, bureaucrats and so-called elite opinion are all deeply invested in the climate crisis narrative and policy recommendations that follow that narrative are those that will be followed. The result of this is that nations have set themselves the ambitious goal to decarbonise their economies, hence the emphasis on renewables in their energy mix. More changes will be needed though and one area where this change will be felt is with cars and trucks. According to the EU and other European governments, the age of the ICE-powered vehicle is over. According to the British Government, new cars with petrol or diesel-fuelled ICEs will be banned from sale in the UK from 2030, small diesel-fuelled trucks from 2035, and

diesel-fuelled trucks with a weight of over 26 tonnes from 2040 or earlier if possible. France has already stated that ICE-powered cars would be banned from 2040 onwards, while on the other hand, it is keeping a flexible position on bans regarding other vehicle types. The situation could be changing in Europe though. In July 2021, the European Commission issued proposals that called for a complete ban on the sale of conventional ICE cars within the EU from 2035 onwards. This was not that much of a shock as Volkswagen, among others, was reported to have stated that it would stop selling ICE cars in Europe by 2035.

What the EU appears to envisage is that from 2035 onwards, Battery Electric Vehicles (BEV) will dominate the marketplace, but for that to become a reality, it will be necessary to have a massive Europe-wide investment in charging stations. Neither is it clear how these charging systems will be paid for, nor how the electricity grids in many European countries - many already operating at near full capacity will be able to cope with the increased demands for power. Another negative factor in the shift to BEV, according to the French automotive trade association, is that electric or fuel cell powered cars are less labour intensive to build than conventional ICE vehicles and that many car workers will lose their jobs as a result. As things stand, then post-2035, in the EU it will only be possible to purchase BEV, Hybrid Electric Vehicles (HEV) and Fuel Cell Electric Vehicles (FCEV). From 2035, the EU will also ban the sale of



LEOPARD 2 tanks of the Austrian Bundesheer on exercise. According to Arquus, the technology path to equip armoured vehicles such as tanks with hybrid propulsion systems to replace existing ICE is clear. What remains is to develop a hybrid system architecture that can be accommodated within different armoured vehicle types.

Plug-in Hybrid Electric Vehicles (PHEV), such as the Toyota Prius for example. It is expected that busses, trucks and other large commercial vehicles will be included in the ban on ICE vehicles in Europe. Despite this, existing ICE powered personal and commercial vehicles will continue to exist in Europe, meaning that the infrastructure to fuel and support these vehicles will continue to exist, although for how long is impossible to predict.

Military Options

With Europe going down the road to decarbonisation and seeking to bring an end to the age of the ICE in Europe, serious challenges will be imposed on European militaries. These challenges come at the same time as many European militaries are starting to subscribe to the ideology of the 'climate crisis,' therefore they are on board with the need to decarbonise. However much work has been done on BEV, HEV and FCEV in personal transport applications and in commercial applications, the challenges that military vehicles face are of a different magnitude and it will require considerable thought and investment to develop a post-ICE strategy.

Fortunately, there has been work done on non-ICE solutions for military applications. Some ten years ago in France, a study was conducted by Arguus on the possibilities offered by a VAB armoured vehicle with its ICE replaced by an electric system. It became clear that a BEV armoured vehicle was not the answer. Indeed, an outline objective of an electric vehicle capable of undertaking a three-day mission led to a vehicle in the 25-tonne weight class; of its overall weight, the batteries alone would account for 11 tonnes and such a vehicle would not be able to conduct the desired mission. In the future, perhaps within the next five to ten years, battery performance could have improved to the point where a BEV might be a viable solution for certain military applications.

Arquus continued its studies into new vehicle engine solutions, helped in this regard by being part of the Volvo Group. Volvo is a major force in the truck business and it was quick to realise that the era of trucks powered by ICE was coming to an end. This was largely due to the fact that seven per cent of global emissions are caused by freight on roads. They now believe that there will be a "historical shift" from ICE to new propulsion types, and Volvo has stated that by 2030, 50%

of their trucks will be electric and that by 2040, or perhaps even earlier, 100% of their truck range will be electric.

Arquus benefits immensely from large investments made by Volvo in sustainable engine technologies, as the power requirements of commercial trucks are such that they cover the majority of power requirements in military logistic and armoured vehicles. This allows Arquus to choose from a range of viable mobility solutions and then optimise them to meet the challenges of military applications. The company already has its first hybrid-powered vehicle in the form of the SCARABEE, a 4x4 reconnaissance vehicle developed to meet evolving French Army requirements in this category.

In France, there is interest in exploring how they can replace the ICE in armoured vehicles with hybrid options. In September 2020, Florence Parly, French Minister of Defence, announced an effort to look into hybrid options for the GRIFFON and VBCI armoured vehicles in service with the French Army. Arguus are currently working with the Direction Générale de l'Armement (DGA) regarding a study on a hybrid propulsion package for the GRIF-FON moving towards the integration of a hybrid engine demonstrator with the vehicle. Other French military vehicles could also benefit from hybrid installations, and suggestions in this regard include the JAGUAR reconnaissance vehicle and, as France is looking to acquire a new generation of tactical trucks, these could comprise a hybrid or other non-ICE propulsion solution.

One key future programme that will need to embrace a non-ICE propulsion solution is the Main Ground Combat System (MGCS), the next generation tank set to replace the current LEOPARD 2 and LECLERC in Germany and France respectively. Arguus sees MGCS as offering an ideal platform for hybrid propulsion, and they believe they can offer a 60% reduction in fuel consumption and increase operational autonomy by three times in comparison with current generation main battle tanks. Hybrid solutions could also be applied to existing tanks as part of an upgrade programme, as France is already committed to upgrading significant numbers of LECLERC tanks to cover the gap until the arrival of the MGCS. Having analysed the possibilities, Arquus believes that a hybrid installation would significantly enhance the LECLERC's performance.

Non-ICE mobility solutions for military vehicles will eventually dominate. As we have seen, there are numerous non-ICE solutions that could be utilised, but in so many respects this is still an emerging technology. Batteries have evolved enormously in recent years, yet more work is still needed in order to reduce fire risks,



An Arquus graphic showing the likely format of a powerpack designed for tank applications. Depending on customer preference, the existing transmission could be retained or a new system integrated, after which comes the decision on battery types and location, plus the fitting of associated systems such as cooling.

weight, increase power potential and reduce charging times. There has been considerable discussion on hydrogen as a basis for non-ICE power, though there are limitations here, as the equivalent of 400 litres of diesel in hydrogen would be three times the volume and weight, according to one vehicle manufacturer. As for fuel cells, this is still a complicated technology and there are concerns regarding safety of using these cells in tanks, for example.

The last question regarding non-ICE solutions is infrastructure and logistics; supporting military vehicles in non-combat day-to-day operations in Europe, made more complicated during combat operations. Will these new technologies deliver guaranteed performance in a hostile environment? If you deploy to Central Africa for example, will you be able to support your non-ICE vehicles and will they be more of a burden to support than ICE vehicles? Once non-ICE powered vehicles can conclusively demonstrate they have the same or better operational capabilities than ICE powered vehicles, then everybody will be happy. Until that point, considerable doubts will remain over a non-ICE future.

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European 6x6 Options

Christopher F. Foss

While an increasing number of European countries are moving to a more balanced fleet of tracked and wheeled (8x8) medium armoured fighting vehicles (AFV) for use in the infantry fighting vehicle (IFV) and armoured personnel carrier (APC) roles, there is still a place for more compact platforms including 6x6.

n some cases, these have been developed to meet the specific requirements of the home market but in some cases, original equipment manufacturers (OEM) have developed 6x6 platforms specifically for the export market.

Austria, Belgium, Finland, Estonia, France, Latvia and Sweden either operate new fleets of 6x6 APC, or are moving in that direction.

The main advantages of these 6x6 APC is that they are more compact and well suited to operations in confined spaces as well as being easier to transport by air.

PANDUR

In addition to a fleet of 112 General Dynamics European Land Systems-Steyr (GDELS) ULAN tracked IFVs, the Austrian Army took delivery of 71 PANDUR (6x6) APC of which three were in the ambulance configuration. Since then, these have been upgraded with an enhanced passive armour package developed by RUAG of Switzerland which has also been fitted to Belgian PANDUR vehicles. Export sales of the PANDUR (6x6) were made to Belgium, Kuwait (first batch from a US production line and second batch from Austrian production line), Slovenia (local production as the VALUK) and the US Amy for the Special Operations Command to meet their requirement for an Armored Ground Mobility System (AGMS). Austrian Army PANDUR (6x6) have a protected weapon station (PWS) normally armed with a 12.7 mm M2 HB machine gun (MG).

<u>Author</u>

Christopher F. Foss has been writing on armoured fighting vehicles and artillery systems since 1970. He has also lectured on these subjects in many countries as well as chairing conferences all over the world. He has also driven over 50 tracked and wheeled AFVs.



Latest Austrian Army PANDUR Evo (6x6) APC clearly showing appliqué armour package and remote weapon station (RWS) armed with 12.7 mm MG

PANDUR (6x6) platform can be fitted with much heavier weapons with the ones for Kuwait including a 81 mm mortar carrier, fitted with a two person turret armed with a Northrop Grumman 25 mm M242 dual feed cannon and 7.62 mm co-axial MG with another fitted with a now John Cockerill Defense turret armed with a 90 mm gun and 7.62 mm co-axial MG.

The Austrian Army subsequently took delivery of 34 PANDUR (6x6) Evolution (Evo) and in late 2020 the Austrian MoD ordered



Latest Patria 6x6 APC fitted with John Cockerill Defense COCKERILL LIGHTWEIGHT WEAPON STATION (CLWS) and showing wire cutter at front of hull roof



For the export market, Arquus has developed the VAB Mk 3 (6x6) APC which has more volume, payload and protection and is shown here fitted with remote weapon station armed with a medium calibre cannon.

another 30 PANDUR (6x6) Evo with deliveries to run from 2022 through to 2024. The latter are in APC configuration but their modular design enables them to be rapidly rerolled for other battlefield missions including casualty evacuation, for example. When compared to the original PANDUR, PANDUR Evo has improved mobility and protection and when being used as an APC has a crew of three plus eight dismounts. GDELS - Steyr also developed the PANDUR II (8x8) for the export market with sales to Czech Republic and Portugal and more recently to the Philippines, although the latter contract through Elbit of Israel with the vehicles coming from the Czech Republic. According to GDLES, "more than 800 PAN-DUR platforms are in operation worldwide of which more than 500 are in NATO ". The Canadian Army operated 491 now General Dynamics Land Systems - Canada Armoured Vehicle General Purpose (AVGP)



The French Army is taking delivery of increasing numbers of the GRIF-FON (6x6) APC armed with a HOR-NET remote weapon station shown here without the machine gun.

but these have been phased out of service as Canada has concentrated on 8x8 platforms as they have more volume and payload.

Patria developed the XA series of 6x6 APC and variants which were built in large numbers for the home and export market with the latter including Lithuania, Netherlands, Norway and Sweden.

Estonia has taken delivery of surplus vehicles from Finland and the Netherlands and at least part of the Finnish Defense Force (FDF) are being upgraded to extend their operational lives.

AMV and CAVS

Patria then developed its best-selling Armoured Modular Vehicle (AMV) (8x8) and more recently the AMV XP (8x8) which features extra performance, payload and protection and can have a gross vehicle weight of up to 32 tonnes.

Patria saw that there was still a requirement for a new generation 6x6 and in mid-2018 launched their new vehicle which was originally simply called the Patria 6x6 and early in 2020 it was announced that this had been chosen as part of a joint Finnish-Latvian vehicle development programme which is also called the Common Armoured Vehicle System (CAVS). Latvia has already started taking delivery of more than 200 CAVS and Finland has signed a letter of intent to order 160 in 2023. In December 2021 it was announced that Sweden wanted to join CAVS.

Early in 2021, Patria and SIA Unitruck established a joint venture in Latvia called SIA Defence Partnership Latvia which is owned 70% by Patria and 30% by Unitruck. This has a maximum GVW of up to 24 tonnes of which 8.5 tonnes is the payload which comprises the crew, weapons, ammunition and the modular armour package which is to STANAG 4569 Level 2 baseline but upgradeable to Level 4. For improved mobility it has a fully independent suspension system with powered steering on 1st and 2nd axles with option rear axle steering. Options include an amphibious capability and a central tyre inflation system (CTIS).

The Finnish company Protolab Oy has developed a Protected Multi-Purpose Vehicle (PMPV) and under a contract signed in 2018 four have been delivered to the FDF. The latest versions are the PMPV 2 and PMPV 3 with the latter having more powerful engine options.

VBCI and VAB

Apart from its Nexter LECLERC main battle tanks (MBT) and some remaining AMX-30 series specialised support vehicles, the French Army has moved to a total wheeled fleet of AFVs which offer greater strategic mobility over their tracked counterparts, this is of particular value to France with its remaining interests in Africa.

The French Army has replaced its tracked AMX-10P IFV with 630 Vehicule Blindé de Combat d'Infanterie (VBCI) (8x8) in IFV and command post versions.

Arquus (previously Renault Trucks Defense) built over 5,000 of its Vehicule de Avant Blindé (VAB) APC plus a huge number of more specialised versions for the home and export market. The French Army only took delivery of 3,975 of the 4x4 model from 1976 but export sales were made of the 6x6 model with its greater mobility.

For operations overseas part of the French Army VAB fleet has been upgraded which included increased protection, electronic devices to counter improvised explosive devices (IED), Kongsberg RWS and acoustic detection devices to name but a few.

GRIFFON

The VAB has now started to be replaced by the GRIFFON (6x6) APC which is manufactured at the Nexter facility in Roanne with Arquus supplying the complete drive line and Thales the electronics and optronics. Late in December 2021 it was announced by the industrial consortium that a total of 339 GRIFFON (6x6) had been delivered to the French Army. All variants of the APC version have now been qualified with the ambulance and artillery observation



The Nexter TITUS (6x6) APC has been developed as a private venture and is based on a TATRA chassis for a high level of cross-country mobility, and is shown here in internal security role.

versions due to be qualified in 2022. The French Army is expected to take delivery of 1,722 GRIFFON while Belgium will take delivery of 417 GRIFFON.

While the VAB (6x6) had a typical GVW of only 12.7 tonnes when it was first deployed the GRIFFON (6x6) has a GVW up to 24.50 tonnes due to its greater volume, payload and protection. The baseline GRIFFON (6x6) APC has a crew of three and carries eight dismounts but a number of more specialised versions have already been developed including a command post and a version with a Thales 120 mm 2R2M mortar in the rear firing through open roof hatches.

The GRIFFON (6x6) is one part of a complete series of new wheeled vehicles being deployed by the French Army with the other two being the JAGUAR (6x6) reconnaissance vehicle (also ordered by Belgium) and the SERVAL (4x4) APC plus many variants. While Arguus Defense is involved in the GRIFFON (6x6) using internal research and development funding it has developed the VAB Mk 3 for the export which is marketed only in a 6x6 configurations with a typical GVW of up 20 tonnes of which 7.5 tonnes is payload. This can be fitted with a wide range of weapon stations up to a John Cockerill Defense two person turret armed with a 90 mm gun and 7.62 mm co-

Photo: RMMV



The Rheinmetall MAN Military Vehicles FUCHS (6x6) APC upgraded in many areas including installation of a FLW series RWS armed with a 12.7 mm MG installed on a plinth for greater area coverage

axial MG. This has been sold to Tunisia from the Mack production line in the USA and called LAKOTA) and the Kingdom of Saudi Arabia (fitted with a Nexter ARX25 RCT armed with 25 mm cannon and 7.62 mm coaxial MG) plus at least one other country.

TITUS

Nexter has a long tradition of investing its own research and development funding in new products for both the home and export markets. A good example is their Tactical Infantry Transport & Utility Sysyem (TITUS) (6x6) which was first unveiled in late 2013 with the first export customer being the Czech Republic who have ordered 62 units for specialised battlefield missions (command, signals, artillery fire coordination) rather than being used in the APC mission.

TITAS is based on a TATRA (6x6) chassis which gives a high level of cross country mobility with the all welded steel hull with applique armour giving a high level of ballistic, mine and IED protection.

FUCHS

The German Army took delivery from the now Rheinmetall MAN Military Vehicles (RMMV) of 996 FUCHS (6x6) APC and variants with final deliveries taking place in 1986, but production continued for the export market. A FUCHS (8x8) was built and tested by this never entered production.

The German Army still has a significant fleet of FUCHS (6x6) with the latest upgraded version being the FUCHS 1A8 which has a higher level of mine and ballistic protection as well as de-coupled seating, reinforced wheel housings, doors and window mountings to name but a few. Further development has resulted in the FUCHS 1A8 Plus which has a new power pack, transfer case, improved steering and cameras for situational awareness. For the export market, RMMV developed the FUCHS 2 (6x6) which has more volume and payload and has a typical GVW of at least 23 tonnes of which payload is 6 tonnes. Over 1,000 have been sold including Algeria (local production), Kuwait and the United Arab Emirates (UAE) who took delivery of a fleet of 32 in the highly specialised NBC reconnaissance role.

PIRANHA and DRAGÓN

The Spanish Army operates a large fleet of now BMR-600 (6x6) APC and variants but these will be replaced by a new vehicle
called DRAGÓN based on the Swiss PIRA-NHA V (8x8) with final assembly and integration being undertaken by GDELS-Santa Barbara Sistemas. First contract is for 348 but up to 1,000 is the long term aim.

Turkish Platforms

Turkey has traditionally relied on medium tracked IFVs and APCs but the Turkish defence industry has been very successful in exporting 4x4, 6x6 and 8x8 wheeled AFVs. A typical example is the FNSS Savunma Sistemleri PARS FOV which was originally marketing in 4x4, 6x6 an 8x8 models but sales are now concentred on the latter two. Whilst Malaysia opted for the PARS (8x8) and took delivery of a total of 257 in 12 configurations Oman opted for a mixed fleet consisting of 145 8x8 and 27 in 6x6 configuration under the designation of PARS II with some 80 fitted with the latest SABER 25 mm turret.

In 2019, Turkey ordered 100 PARS III of which 55 are in 8x8 configuration and 45 in 6x6 configuration, with deliveries underway including some 6x6 for the Special Forces. Otokar are the largest manufacturer of wheeled AFVs in Turkey with their COBRA (4x4) being built in large numbers for the home and export markets.

To meet user requirements for wheeled vehicles with more volume, payload and protection Otokar developed the ARMA FOV which are available in 8x8 and 6x6 versions and share many common components. The ARMA (8x8) has a typical GVW of up to 25 tonnes of which 19 tonnes in payload and can be fitted with a wide range of weapons up to a turret armed with a 105 mm gun and 7.62 mm MG. Otokar have confirmed that the ARMA 6x6 is in service with Turkey who has also ordered the ARMA 8x8. The ARMA 6X6 is in service with Bahrain while an African country has ordered ARMA 8x8 and further development of this resulted in the deployed by the United Arab Emirates as the RABDAN. The third company to design a 6x6 APC was Nurol Makina who developed the EJDER (6x6) APC with 70 being delivered to Georgia from 2007. All marketing of this has now ceased as the company is concentrating on its 4x4 series of APCs and variants.

Kazakhstan Paramount Engineering has been building the South African Paramount MATADOR (4x4) MARAUDER (4x4) mine protected vehicles (MPV) and late in 2021 it was announced that production of the BARYS (6x6) has started in Kazakhstan. The BARYS is a further development of the MBOMBE (6x6) optimised to meet specific local requirements. Iveco Defence Systems has developed a 6x6 APC which is now in quantity production in Brazil.

Turkish company Otokar has developed the ARMA family of 8x6 and

Turkish company Otokar has developed the ARMA family of 8x6 and 6x6 APC with the latter already having been sold on the export market. This example is fitted with Roketsan anti-tank missiles.



Latest Turkish FNSS Suvunma Sistemleri PARS III (6x6) APC fitted with SABER one-person turret armed with 25 mm dual feed cannon and 7.62 mm co-axial MG



Iveco Defence Vehicles developed the VBTP (6x6) to meet the requirements of the Brazilian Army. The vehicle is shown fitted with a protected weapon station but without armament fitted.

More Punch for Medium Armoured Vehicles

Christopher F. Foss

This article concentrates mainly on European medium calibre developments and shows that unlike main battle tanks, where the 120 mm smooth bore gun is now almost the NATO standard tank gun, a wide range of medium calibre weapons are deployed in NATO IFVs and this shows no signs of changing.

n addition to requiring their future infantry fighting vehicles (IFV) to have more volume, payload and protection, more end users are now demanding an increase in fire power which has led to the development and production of larger calibre cannon firing more advanced natures of ammunition.

If one excludes the older Russian BMP-1 IFV and BMP-3 IFV (which was not deployed in large numbers), the former Warsaw Pact standardised on the 30 mm 2A42 cannon, with the platform also having an anti-tank guided weapon (ATGW) to engage threat targets beyond the range of the 30 mm cannon.



The 40 mm Case Telescoped Armament System (CTAS) has been developed by CTAI, a joint venture company between BAE Systems of the UK and Nexter Systems of France.

Author

Christopher F. Foss has been writing on armoured fighting vehicles and artillery systems since 1970. He has also lectured on these subjects in many countries as well as chairing conferences all over the world. He has also driven over 50 tracked and wheeled AFVs.



The JAGUAR (6x6) reconnaissance vehicle has a two person turret armed with a 40 mm CTAS, a pod of two MMP ATGW shown here in the raised position and a HORNET RWS armed with a 7.62 mm MG.

In NATO, there are few contractors that can supply the actual medium calibre weapons and ammunition, with the largest being CTAI (joint venture between Nexter and BAE Systems), Nexter (France), Rheinmetall (Germany and Switzerland) and Northrop Grumman (previously ATK Armament Systems) of the US.

The costs of the design, development, production and qualification of a medium calibre weapon and its associated suite of ammunition is significant as is the cost of integrating the weapon and its ammunition feed system into a turret.

The type of medium calibre weapon and its application, for example manned turret or unmanned, is normally selected by the end user when the contract for the vehicle is placed. In addition, there is often a separate contract for the ammunition.

Today, stabilised medium calibre weapons are installed in manned or remote controlled turrets (RCT) that are normally fitted with a computerised fire control system (FCS) and stabilised day/thermal sights incorporating a laser rangefinder.

As well as new medium calibre weapons being developed and placed in production, there is always the development and fielding of new natures of medium calibre ammunition to take into account changing operational requirements driven by the threat expected to be encountered on the battlefield.

Ammunition Types

The traditional armour piercing discarding sabot (APDS) round is giving way to the armour piercing fin stabilised discarding sabot (APFSDS) round, with both of these having an optional tracer element so the gunner can see the flight of the round to the target.

Air Bursting Munitions (ABM) are being fielded for medium calibre weapons in in-

creasing numbers, with the payload of submunitions being optimised for the target set to be encountered. They are, however, more expensive that traditional natures of medium calibre ammunition.

As with larger calibre tank ammunition, many medium calibre natures of ammunition are now being manufactured that are Insensitive Munition (IM) compliant for added safety.

While some armies have a common medium calibre cannon throughout their light and medium armoured fighting vehicle (AFV) fleet, with the obvious logistical and training advantages, some countries have two calibres, especially as a new IFV enters service while the older vehicles remain in service.

The French Army Nexter Vehicule Blind de Combat d'Infanterie (VBCI) (8x8) is armed with a Nexter 25 mm M811 dual feed cannon and a 7.62 mm co-axial machine gun (MG). The two war shot 25 x 137 mm rounds fired are high explosive incendiary - tracer (HEI-T) and APFSDS-T which both meet STANAG 4173 requirements. Nexter Munitions has also been working on a HEI-AB round with a dual mode (Point Detonating and AB) fuze which will be IM compliant.

The 25 mm M811 cannon has also been manufactured in Turkey by MKEK and is installed in the Turkish FNSS Savunma Sistemleri SHARPSHOOTER one person turret installed on the the Turkish AIFV which has also been exported to Malaysia as the AR-MORED COMBAT VEHICLE – 15 (ACV-15).

40 mm Ammunition

The two main reconnaissance vehicles currently deployed by the French Army are the



two MBDA Missile Moyenne Portee (MMP) ATGW on the right side which are raised prior to being launched. In addition to France, which is to take de-

AMX-10RCR (6x6) armed with a 105 mm

gun and the Sagaie (6x6) armed with a 90

mm gun. These are to be replaced by the

livery of 286 JAGUAR, it has also been ordered by Belgium which will take 60 units while the French Navy has selected the 40 mm CTAS for installation on its surface craft with this version called RAPIDFire-



The first customer for the Rheinmetal LYNX IFV is Hungary who has ordered 214 vehicles armed with the latest Mauser 30 mm MK30-2 Air Bursting Munition cannon and 7.62 mm co-axial MG.

German Army PUMA IFV is fitted with a remote controlled turret armed with a Rheinmetall 30 mm MK30-2 Air Bursting Munition cannon and co-axial MG. This PUMA has a pod of two Eurospike ATGW mounted externally on left side of turret.

Naval. By late 2021 over 600 40 mm CTAS had been delivered according to a company statement. The 40 mm CTAS has also been demonstrated in the Nexter T40 turret and is also marketed as part of the next generation BIHO II air defence system from Hanwha Defense of South Korea as well as being installed in the TURRA 40 turret designed by EVPU of Slovakia. As mentioned later in this article, the 40 mm CTAS has also been adopted by the UK with one programme cancelled and the other in doubt. CTAI have already gualified the 40 mm APFSDS-T, general purpose round - point detonating - tracer (GPR-PD-T), general purpose round round - airburst tracer (GPR-AB-T) and target practice - tracer (TP-T). For the RAPIDFireNaval, a new round called anti-aerial airburst (A3B) or kinetic energy air burst (KE-AB) with a payload of 200 tungsten pellets for use against air threats such as unmanned aerial vehicles is being developed.

There has been concern about the cost of 40 mm ammunition for the CTAI weapon but in a statement by Jeremy Quin, UK Minister of State for Defence Procurement on 15 September 2021 to the House of Commons Defence Committee "While the 40 mm is more expensive compared to a 30 mm on a round by round basis, considering the step change in capability, higher lethality, and the greater effectiveness and survivability of our platforms, this round represents value for money. "

30 mm Ammunition

The Rheinmetall MARDER 1 IFV entered service with the German Army as far back as



General Dynamics Land Systems UK's AJAX reconnaissance vehicle is fitted with a two person turret armed with a 40 mm CTAS and a 7.62 mm co-axial MG with this version also having a roof mounted RWS.



LAV-25 (8x8), fitted with a two-person turret armed with a Northrop Grumman 25 mm M242 dual feed cannon and 7.62 mm co-axial MG. This is also fitted with the RAFAEL TROPHY active defence system.

1971 and since then has been continuously updated while still retaining its Rheinmetall 20 mm Rh 202 dual feed cannon and 7.62 mm co-axial MG. MARDER 1 has already started to be replaced by the PSM PUMA IFV fitted with a RCT armed with a Rheinmetall (previously Mauser) 30 mm MK30-2 ABM dual feed cannon with a 5.56 mm co-axial MG. The latter will be replaced by a 7.62mm MG. A pod of two EUROSPIKE ATGW is being mounted externally on the left side of the turret. The two main rounds for this are a 30 mm APFSDS-T and an ABM round which is programmed as it leaves the muzzle of the cannon. In addition to being installed in the PUMA (360 + 220 units), the 30 mm MK30-2 ABM has been sold for the BOXER (8x8) being deployed for the reconnaissance role by Australia.

Hungary is the launch customer for the new generation LYNX IFV and 218 30 mm MK30-2 ABM will be supplied for this platform. The LYNX is also a contender for an element of the Australian Land 400 Phase III requirement which could cover a further 350 30 mm MK30-2 ABM.

The earlier 30 mm MK30-2 dual feed cannon is installed in a number of IFVs including the ULAN (Austria) and PIZARRO (Spain) with both of these based on the ASCOD (Austrian Spanish Co-operative Development) but do not have the ABM capability.

Larger Calibre Cannons

Rheinmetall is also investing in larger calibre cannons, both of which are externally pow-

ered and these are the WOTAN 35 which uses the 35 x 228 mm ammunition already in quantity production for air defence applications such as the Rheinmetall Air Defence upgraded GDF series of twin 35 mm weapons. Further in the future is the WOTAN 50 which will fire a new family of 50 x 358 mm ammunition.

The Swedish Army deploy the BAE Systems CV9040 IFV which is fitted with a two person turret armed with the BAE Systems Bofors 40 mm L/70 cannon which is loaded with clips of ammunition from below and with the empty cartridge cases being ejected forwards and outside of the turret with the main round being an APFSDS-T.

While the Swedish Army opted for the BAE Systems Bofors 40 mm L/70 cannon all export customers have opted for medium calibre cannon from Northrop Grumman. The first was Norway with the original 30 mm Bushmaster II (which is no longer marketed) but these have now been replaced by the latest 30 mm MK44 with other CV90 countries being Denmark (35 mm Bushmaster III), Estonia (35 mm Bushmaster III), Finland (30 mm MK44), Netherlands (35 mm Bushmaster III) and Switzerland (30 mm MK44). The 35 mm Bushmaster III can be upgraded to 50 mm but no customer has yet selected this option.

For many years, the standard medium calibre weapon of the British Army has been the 30 mm RARDEN cannon which was developed by the now closed Royal Small Arms Factory (Enfield) and the Royal Armament Research and Development Establishment (RARDE) at Fort Halstead.

The unstabilised and slow-firing 30 mm RARDEN is fitted in a two-person turret installed on the now RBSL WARRIOR IFV and the now RBSL SCIMITAR reconnaissance vehicle. It was also installed in a two person turret installed in the FOX (4x4) armoured car which has been phased out of service with the British Army.

The UK mandated the CTAI 40 mm CTAS for two British Army programmes, the Lockheed Martin UK WARRIOR Capability Sustainment Programme (WCSP) and the General Dynamics Land Systems UK AJAX family of vehicles (FOV) which is due to replace the SCIMITAR (FOV). The last of 515 40 mm CTAS were delivered to the UK late in November 2021, seven months ahead of schedule, but the WCSP was cancelled in mid-2021 and as of early December 2021 there was some doubt that the AJAX FOV programme will still go ahead, despite the expenditure of over GB£3Bn.

In December 2021, Northrop Grumman confirmed that they had "delivered more than 16,000 of the Chain Gun world-wide with orders for more that 1,400 on hand



The largest member of the expanding range of Northrop Grumman medium calibre cannon is the 50 mm XM913 shown at the front.



The new Northrop Grumman 50 mm XM913 will fire a new suite of 50 x 228 mm ammunition, from left to right these are the HEAB-T XM1204, APFSDS-T XM1203 and TP-T XM1202.

for delivery in next three years." The BAE Systems BRADLEY IFV deployed by the US Army and the Kingdom Saudi Arabia (KO-SA) is fitted with a two person turret armed with a Northrop Grumman M242 25 mm dual feed cannon 7.62 mm co-axial MG and a pod of two Raytheon TOW ATGW mounted externally on the left side. The 25 mm M242 is also installed in the two-person turret fitted to the LAV-25 used by the Marine Corps for the reconnaissance mission.The original 25 mm APDS was replaced by a 25 mm APFSDS-T round with a

depleted uranium (DU) penetrator. Currently under development is the Northrop Grumman/US Armament Research, Development and Engineering Center (AR-DEC) is the 50 x 318 mm mm dual fed cannon designated the XM913 which is expected to be installed in the BRADLEY replacement, currently called the Optionally Manned Fighting Vehicle (OMFV).

This fires a new suite of 50 mm ammunition including an APFSDS-T round designated XM1203 which will have a conventional penetrator rather than a DU penetrator with the other two rounds being the XM1204 HEAB-T and X1202 TP-T.

The General Dynamics Land Systems M1126 STRYKER (8x8) infantry carrier vehicle (ICV) was originally fitted with a Kongsberg RWS armed with a 12.7 mm MG. More recently, the US Army has taken delivery of a batch of 81 up gunned with a Kongsberg RCT armed with a 30 mm XM813 dual feed cannon and 7.62 mm coaxial MG. This is part of the STRYKER Lethality Upgrade Programme with the vehicle designated the XM1296.

As previously mentioned, the Northrop Grumman 30 mm MK44 is used by some CV90 operators and by December 2021 over 20 customers had adopted this weapon for a variety of applications with over 3,000 weapons delivered.

30 mm MK44 Stretch can be upgraded to 40 x 180 mm and the company has produced kits to allow this to be carried out.

Typical examples of the 30 mm MK44 are Poland for their locally produced AMV (8x8), Singapore for their tracked BIONIX IFV and Ireland for its PIRANHA III (8x8). The latest 30 mm MK44 Stretch has recently been ordered to support Poland and their latest BORSUK with their new HSW turret.



While the main emphasis in the article is the weapon, the ammunition is the key to an effective weapon system. This is the latest Northrop Grumman qualified 30 x 173 mm proximity fuzed ammunition for maximum target effect.

Tactical Trucks: Cargo Vehicles for Front-Line Replenishment

Sidney E. Dean

Steady replenishment of consumables – including food, munitions and spare parts – is essential to maintaining combat capability. This vital mission is accomplished by tactical trucks, also known as tactical logistics vehicles or simply as supply trucks.

These wheeled, off-road capable cargo carriers form the long-range link between strategic ports and regional supply depots, as well as the medium- to short-range link between supply depots and dumps for the frontline forces. This resupply mission can extend all the way onto the extended battlefield, typically to within one to four kilometres of the fighting units. Land forces worldwide – including in North America and Europe – are modernising their tactical logistics fleets to improve efficiency and enhance the ability to sustain operational forces in the field.

North America

The United States Army's Common Tactical Truck (CTT) programme aims to replace the various medium- and heavy-lift truck models currently in service with a single modular vehicle system. According to Army planning statements, the vehicles are to supply combat and combat support units across all tactical mobility levels as far forward as mission, enemy, troops, terrain, time and civil considerations allow. Operations must be conducted on road and cross-country, around the clock and in all climate zones. Five CTT variants are planned: Load Handling System, Off Road Tractor, Line Haul Tractor, Fuel Carrier and Cargo Carrier. These variants will perform all supply mission categories including - but not limited to - containerised cargo, bridging equipment, and breakbulk cargo. They will replace the current Palletized Load System (PLS), M1088 Medium Tactical Vehicle Tractor, M915 Line Haul Tractor and the Heavy Expanded Mobility Tactical Truck (HEMTT).

The US Army Common Tactical Truck

The Load Handling System (LHS) will be required to load, transport and offload a wide variety of flatrack types as well as ISO containers, engineering mission modules,



RMMV has signalled its intent to compete for the CTT award, and is likely to present a prototype based on the HX3 truck line. The HX3 is available in 4x4, 6x6, 8x8 and 10x10 models.



Canadian Army SMP trucks have a carrying capacity of 9.5 tons and come in five variants: Cargo; Cargo with Material Handling Crane (shown here); Load Handling System; Mobile Repair Team; and Gun Tractor.



Pictured from left to right are MSVS (SMP) trucks in Cargo, Load Handling System (LHS), Material Handling Crane (MHC), and Material Repair Truck (MRT) variants.



General Dynamics Land Systems and Mercedes Benz have teamed for the Canadian LVM programme, and are offering the Mercedes Benz ZETROS.



The German Army's new UTF trucks will support NATO's Very High Readiness Joint Task Force (VJTF) in 2023.

and fuel tanks and pump modules. Minimum payload capacity is 16,477 kg, in addition to towing a palletised load trailer. The Off Road Tractor will tow a variety of flatbed and lowbed semitrailers with up to 40 tons capacity, including trailer-mounted vans and fuel tanks.

The Line Haul Tractor will be restricted to on-road operations. It will tow flatbed semitrailers and tanker trailers at highway speeds. The Tanker truck will carry and dispense a minimum of 9,464 litres of fuel, and can tow a trailer with an additional fuel tank. The tanker will dispense a variety of fuels directly to aircraft and vehicles, or transfer fuel to other tankers or to fuel dispensing stations.

The Cargo variant will primarily carry munitions and have a minimum capacity of 10,000 kg. Additionally the truck can tow a trailer with additional cargo. Loads can include either eight standard transport pallets or four MLRS rocket pods. An on-board crane will load and unload cargo.

The CTT family of vehicles will be based on modified commercial, off-the-shelf (COTS) vehicles and will incorporate modern and emerging technologies and capabilities not found in legacy military trucks. This will permit more efficient integration with other state-of-the-art and developmental tactical vehicles and communication, command and control systems. Modularity will enable frequent exchange or upgrade of vehicle components and systems to ensure the trucks remain state-of-the-art over their service life.

The Army aspires to retain as much commonality as possible with the civilian variants of the new trucks, to ensure access to market-priced replacement and upgrade components, thereby reducing lifecycle costs. Choosing a common core vehicle using the same chassis, powertrain and transmission will also simplify maintenance. Regarding maintenance, CTT will also be equipped with AI vehicle health monitoring and diagnostics to enable targeted proactive repairs before components fail.

An abbreviated draft version of the CTT Specifications document presented to industry on 6 October 2021 was also released publicly. Among the requirements are: airmobility (C-5, C-17) and seamobility (Roll-On, Roll-Off vessels); off-road capability; the ability to operate in degraded or denied environments; a minimum unrefuelled range of 500 km off-road and 640 km on-road; AI (Artificial Intelligence) aided operation; optionally unmanned operation including fully automated loading/offloading of cargo; digital drive-by-wire controls; and the potential for converting the vehicles to hybrid or electric drive in the future. In November 2021, the Army clarified that it has not yet decided whether the CTT design needs to support a conversion to full electric drive.

Commercially available Advanced Driver Assist Systems (ADAS) should be incorporated in CTT to enhance safety. This includes lane departure warning, lane keeping, adaptive cruise control, blind spot monitoring, collision warning, collision avoidance, stability control, advanced driving behaviour analytics, and 360 degree surround view. The draft specifications also require that "ADAS and safety systems incorporating Vehicle Control Intervention Technology that may interfere with the mission must provide manual shut off, automatic shut off, or driver override for wartime operations."

Specifically military aspects of the CTT will provide force protection. These include a fully armoured replaceable cab (plus under-



The 8x8 variant of the German Army's new UTF truck family



The German Army is procuring 1,048 GTF protected transport vehicles with 15 tons payload capacity.

Photo: British Army



The British Army's EPLS MK3 Load Handling System with an ISO container.

wheel, underbody and fuel tank protection) and/or the ability to accept modular armour up to MRAP level; a common remotely operated weapon station (CROWS); and an Objective Gunner Protection Kit. Furthermore, the vehicle should be designed to withstand Chemical, Biological, Radiological and Nuclear (CBRN) contamination and decontamination, as well as the effects of High Altitude Electromagnetic Pulse (HEMP).

The Army intends to pursue a rapid acquisition strategy. The request for proposals (RfP) for prototype development is expected during the third quarter of Fiscal Year 2022 (FY2022). The prototyping contract award is expected during the fourth guarter of FY2022 or early in FY2023. The Army is expected to issue prototyping contracts to three firms. The competition is open to foreign manufacturers. Foreign built prototypes may be submitted for the assessment phase. However, serial production of the CTT would have to take place in the United States if a foreign manufacturer wins the competition. Prototype delivery and assessment could take place during FY2024, with a likely production contract award in FY2025. CTT fielding is projected to begin in Fiscal Year 2028. The US Army's current medium and heavy lift fleet comprises approximately 30,000 vehicles. It is currently unclear whether CTT will replace these trucks on a one-to-one basis. The new truck is required to have a minimum useful economic life of 30 years, with an objective life of 40 years.

Canadian Armed Forces Logistics Vehicle Modernisation

The Canadian armed forces effectively completed their Medium Support Vehicle System (MSVS) modernisation programme in Spring 2021. The programme began in 2009 with a contract award to Navistar International for 1,300 Military Commercial Off-The-Shelf (MILCOTS) trucks which were delivered through 2011. The vehicles were derived from the firm's International WorkStar 7400 civilian truck, and were provided in six different configurations. Three of these were cargo transport versions totalling 360 vehicles. All MILCOTS trucks were assigned to the reserve forces for domestic operations only.

An additional order for 1,500 Standard Military Pattern (SMP) trucks (plus 300 trailers and 150 armoured protection systems) was awarded to Mack Defense in 2015. Final deliveries in 2020 brought the procurement total to 1,587 SMP trucks and 322 trailers, all assigned to the Regular Army. The SMP, which is based on the Renault KERAX 8x8 truck, achieved Full Operational Capability (FOC) in February 2021.

A new Logistics Vehicle Modernisation (LVM) Project was approved by Parliament in 2019. The LVM project will procure both light (4 to 5 ton) and heavy (16.5+ ton) logistics vehicles to replace the current fleet, which is reaching the end of its service life. In addition to vehicles the project will also acquire trailers, special-purpose containers and modules, material handling systems,



The Fench PPLOG can mount 16 tons of flatrack cargo, 6 metre ISO containers, and fuel containers.

and bulk fuel and water containers. An RfP for the first two truck types (both classified as "Medium" in the document) was released in October 2021. Both require a conventional cab and chassis, a heavy duty box van for cargo, a 4x2 drivetrain and dual rear wheels. Medium Truck 001 requires a minimum payload capacity of 2,727 kg. Minimum van dimensions are 492 cm long by 244 cm wide by 234 cm high. Medium Truck 002 requires a 5,455 kg cargo capacity and van dimensions of 369 x 259 x 264 cm.

Seven supplier teams had qualified in 2019 to compete for the contract: Daimler AG (withdrew in September 2020); General Dynamics Land Systems – Canada Corporation and General Dynamics Land Systems, Inc.); Iveco Defence Vehicles S.p.A.; Mack Defence LLC; Navistar Defence LLC; Oshkosh Defence Canada Incorporated and Oshkosh Defence, LLC; Rheinmetall Canada Inc. and Rheinmetall MAN Military Vehicles (RMMV) GmbH.

Under current planning, project approval and contract award are expected in the 2023/2024 timeframe. First delivery is expected as early as 2026/2027, with final delivery in 2030/2031. The vehicles will have an expected service life of 20-30 years. As it is based on COTS systems, the LMV project is classified as low risk, although the state of the current fleet does exert some pressure to remain within the target timeline.

European Programmes

Several reset programmes are also underway in Europe.

Germany – UTF/GTF

The German armed forces are investing in new unprotected transport vehicles (Ungeschützte Transportfahrzeuge – UTF) to meet the increased demands of domestic and out-of-area operations. The UTF family includes 6x6 vehicles with 5-7 ton payload capacity, and 8x8 vehicles with up to 14,200 kg capacity. Cargo can be transported on flatracks or in containers; the trucks can also be equipped to transport fuel. Built by RMMV, the HX2 series trucks can traverse unimproved and damaged roads, but - thanks in part to the low-torsion ladder frame and robust leaf spring suspension - are also capable of heavy-duty off-road operations. According to the German Army, the trucks can even keep pace with main battle tanks in the field. Off-road performance includes the ability to climb a 60% gradient and ford 1.6 metres of water. A remotely operated weapon station can be mounted atop the cab. When operationally necessary the unarmoured cab can be swapped with an armoured cab. The first of 3,271 planned vehicles were delivered in 2018; the final tranche is expected to be completed by the end of 2022. Army leaders have indicated a future demand

for at least 3,000 more UTF-type logistics vehicles. Additionally, the German MoD awarded RMMV a separate contract in 2020 for delivery of 4,000 Load Handling System trucks based on the HX2 8x8 variant. The contract is to be fulfilled through 2025.

In January 2021, the German military's procurement office awarded Iveco Defence a contract for 1,048 protected trucks (GFT – Geschütztes Fahrzeug) with a delivery window of 2021-2028. The first tranche consists of 224 units based on Iveco's militarised 8x8 TRAKKER truck, to be supplied in five variants. The vehicles feature armoured cabs offering best-in-class ballistic, mine, IED and NBC protection. Some will be equipped with hydraulic cranes and winches. Payload capacity is 15 tons.

Britain – EPLS MK3

The British Army acquired approximately 7,500 Logistic Support Vehicles (LSV) from RMMV in the 2008-2013 timeframe. Some 90% of these trucks belong to the HX family. The five variants include cargo trucks with 6, 9 and 15 ton capacity as well as unit support tankers and recovery vehicles. According to the British MoD, the new LSV provide far greater mobility than previous generation cargo vehicles and can be fitted with armour, communications and ECM equipment, and a 7.62 mm machine gun. In the Spring of 2021 the Army completed acquisition of the Enhanced Pallet Load System (EPLS) MK3 which is based on the 15-ton LSV variant. Equipped with a HIAB hook lift, the EPLS can accommodate a 16-ton flatrack payload or comparable cargo loads, and enable rapid loading and unloading in the field. Alternately it can lift and carry a six metre



The French PPLOG is equipped with the Ampliroll hooklift manufactured by Marrell, a Fassi Group subsidiary.



The Fench Army PPLOG with trailer



The Scania GRYPHUS truck in the 8x8 configuration, equipped with a Marshall Aerospace maintenance workshop mission module.

Photo: NL MoD



Driver's station of the Scania GRYPHUS truck

ISO container without loading it onto a flatrack. As described by the MoD, this procurement satisfies the requirement for a versatile medium lift capability to provide the next generation of materiel distribution across the battlefield, and in multiple operating environments. In total, 382 EPLS MK3 are being created through conversion of 15-ton LSV trucks already in service. The work is performed by RMMV's subsidiary MAN Truck and Bus UK Ltd.

France – PPLOG

The Porteur Polyvalent LOGistique ("Multipurpose Logistics Carrier") or PPLOG is the supply "workhorse" of the French Army. More than half of the ordered units feature armoured cabs with ballistic and mine blast protection. A manned ring-mount weapon station is situated atop the cab. The climate-controlled cab can accommodate a range of military communication and command systems as well as an electronic countermeasures system. The 8x8 truck has an autonomous articulated hook-lift loading system mounted behind the cabin, and up to 16,000 kg carrying capacity. The vehicle is all-terrain capable (including snow covered mountain roads), and is suited to all climate zones.

The PPLOG is part of the French Army's PPT (Porteur Polyvalent Terristrière – Multipurpose Land Carrier) programme conceived in 2010. In addition to the PPLOG (which forms the majority of the planned acquisition), the PPT programme also includes a recovery vehicle and an engineering vehicle. All three are based on the Iveco Defence M320.45 truck chassis, and assembled in France by Soframe. The French Army took possession of the first units in 2013. A total of 2,400 PPT units is planned. The state of the art transport system has also been exported to several countries.

Netherlands – DVOW

The Netherlands is conducting the Defensiebrede Vervanging Operationele Wielvoertuigen (DVOW) or "Joint Replacement Programme - Wheeled Vehicles." This broad programme includes replacement of the DAF logistics vehicles with 2,800 Scania GRYPHUS trucks, which are derived from the civilian Scania XT which was launched in 2017. The new vehicles feature significantly improved off-road capability and modern vetronics. The modular trucks can be configured for a broad spectrum of missions, from cargo to personnel transport. Some will be equipped with a crane located behind the cab. Depending on mission reguirements, the unarmoured cab can be replaced with a fully armoured one. Other improvements over the previous vehicles include a driver assist package and a 360-degree situational awareness system. To reduce damage to the environment, the GRYPHUS is equipped with AdBlue, which is released into the vehicle exhaust to break down harmful nitrogen oxide into its harmless components.

The land forces will receive 2,400 vehicles, with the remainder supporting the other services. A total of 2,500 trucks will come in the standard 8x8 configuration with a 10 ton cargo capacity, with the remain-



RMMV's HX family of trucks serves with the land forces of many nations including Australia (shown here), the UK, and several Scandinavian armies.

der being 6x6 and 4x4 vehicles. The vehicles are modular, and can be mission configured, including optional mounting of cranes, generators, and/or containers. The larger trucks feature weapons mounts, electronic countermeasures, military-grade communications suites, infrared lighting, camera mounts for 360 degree situational awareness, and camouflage patterns. The unarmoured truck cabs can be exchanged for armoured cabs when required; 185 armoured cabs are being procured from Centigon for this purpose. The procurement programme also provides for 1,600 general and mission-specific containers or modules to be provided by Marshall Aerospace & Defence Group (Canada). Many of these modules will be permanently mounted on the 8x8 GRYPHUS variants.

The 6x6 trucks come in two variants. The light version have a 10-ton capacity, but are not militarised; they will be used for ground

transport at military airfields. The heavy 6x6 trucks have a 15-ton capacity. The 4x4 trucks have a five-ton capacity; they will primarily be assigned to the Marine Corps. Initial deliveries began in early 2021. Final deliveries under the DVOW programme are slated for 2026.

Future Trend Toward Automation

A major feature likely to become standard, at least among leading armed forces, is vehicle autonomy. When RMMV's newest vehicle generation, the HX3 series, rolled out in May 2021 RMMV's CEO Ludwig Ostler quickly dubbed it "the future tactical truck." Among its attributes: advanced driver assistance systems (ADAS) as well as optionally semi-autonomous and fully autonomous operation. The ADAS include Emergency Brake Assist (EBA), Adaptive Cruise Control (ACC) and Lane Departure Warning (LDW), all of which contribute to safety by mitigating driver fatigue and compensating for difficult driving conditions.

With the proper interface, ADAS can be enhanced further to enable vehicle autonomy. Recent experiments conducted by the US Army have proven the viability of leader-follower operations, with manned trucks at the head of a convoy guiding up to nine unmanned vehicles. Successful US Army experiments were conducted in both urban and open country settings in the 2018-2020 timeframe. Building on this experience, the Army Futures Command has established a multi-year capabilities development programme as part of the autonomous ground resupply science and technology objective. In September 2020, a yearlong operational technical demonstration (OTD) was launched by supplying LF/TWV (Leader-Follower Tactical Wheeled Vehicle) technology kits to every truck in the 41st Transportation Company at Fort Polk, Louisiana. The demonstration will test the technology as well as determine future training and doctrine requirements for semi-autonomous operations. Beginning in 2023, an additional five companies will receive the LF/TWV conversion kits. Initially the units will train to operate Leader-Follower convoys with four autonomous vehicles, advancing to the full 1:9 manned-unmanned vehicle ratio by the 2030s.

Fully autonomous supply missions are considered the logical next step, especially in support of highly dispersed units. Such missions would permit deployment of single vehicles (perhaps escorted by armed unmanned security vehicles) without exposing human crews to enemy fire or capture. Implementing such a capability will require further advances in artificial intelligence.



The Mercedes Benz family of trucks has a solid track record operating in desert conditions.

CBRN Recce Vehicles: New Frontier or Fighting Old Wars?

Dan Kaszeta

Some commenters have predicted the demise of the chemical, biological, radiological, and nuclear (CBRN) reconnaissance vehicle for about 15 years. Reports of the end of the CBRN recce vehicle are premature, but an astute observer can see why its lifespan may be short.

Conceptually, the entire existence of CBRN reconnaissance vehicles is under challenge on several fronts. The first of these is based on economics and logistics. Even the largest army will only have scope for so many CBRN recce vehicles. Overall, European armies are much smaller in size than in previous decades and have far fewer combat vehicles. CBRN vehicles will only ever be a small percentage of an overall inventory. Having a vehicle platform that is different from the rest of your fleet of combat vehicles makes training and main-

general use. FUCHS made a lot less sense, logistically, in the US Army, where it was a standalone end item (called the "FOX" to protect sensibilities) that baffled much of the rest of the Army. For these reasons, many CBRN recce vehicles these days tend to be extensions of existing product lines.

Technological Challenges

Technology also challenges the concept of the CBRN recce vehicle. The very concept of CBRN recce vehicles dates from of this publication). An infantryman can literally carry more C and R detection than the best CBRN recce vehicle of 1985, for a small fraction of the size and expense - and power it with AA batteries.

The advances in detection technology raise certain questions. Why make a speciality CBRN vehicle when soldiers with handheld equipment can operate out of any vehicle? If you can mount high quality detection equipment on every combat vehicle, isn't every tank and APC now a CBRN recce vehicle? Both the proponents of and



The M1135 NBCRV by General Dynamics Land Systems is the US Army's current CBRN recce vehicle.

tenance more complex. The Rheinmetall FUCHS wheeled APC as a CBRN recce vehicle made sense in the 1980s Bundeswehr, where the FUCHS was commonplace for

<u>Author</u>

Dan Kaszeta is Managing Director at Strongpoint Security Ltd. and a regular contributor to ESD. 1960s and 1970s Cold War era doctrine. At the beginning of this author's military career in the late 1980s, chemical detection equipment was in its relative infancy. It was expensive, difficult to use, and rare. Biological detection was non-existent. A number of technical advances have made radiation detection equipment somewhat cheaper and better, but there has been a series of revolutions in chemical detection equipment (as discussed in previous issues manufacturers of CBRN recce vehicles are sometimes hard-pressed to come up with a reasonable answer to either question.

CBRN Recce Doctrine

The third challenge that conceptually confronts the CBRN recce vehicle is doctrinal. What is it that you expect a CBRN recce vehicle to do? CBRN recce doctrine varies somewhat from country to country, but for the most part, CBRN recce vehicles and teams are expected to perform a fairly basic set of missions. These missions usually include area surveys to confirm and map out the extent of contamination after a suspected CBRN attack, sampling of materials to identify unknown hazards, surveillance to provide warning to the main body of forces, and route reconnaissance to see if an axis of advance or a transportation route is free of contamination. Technology has spent much of the last 50 years actually catching up to the doctrine to do these missions. Further, it is a well-known axiom in professional CBRN defence circles that none of these missions is actually easy. Many notional CBRN recce scenarios involve either placing CBRN recce vehicles and soldiers in highly vulnerable positions and/or sacrificing their recce capability quite early in an operational scenario due to the vehicles becoming quickly contaminated. The latter is easily demonstrated by route reconnaissance – a clean route is easily cleared but the minute a CBRN recce vehicle drives over persistent contamination the vehicle usually becomes contaminated itself as tracks or tyres become covered in hazardous materials and it cannot do any more recce missions until it gets decontaminated. Some of the doctrine this author never thought made any sense when he was a Chemical Corps lieutenant still does not make any sense thirty years later. Sitting in a command post and looking at divisional and corps level operations, many "traditional"

CBRN recce missions are nearly suicidal for lightly armed and armoured troops. The actual utility of specialty recce vehicles for such missions is unknown. Since the advent of specialty CBRN recce vehicles, the armies which have them have not had to defend against widespread chemical weapons threats, so the overall concept remains untested in practice.

The Market

All of these conceptual problems aside, there clearly is a market for CBRN recce vehicles. If there was no market, there would be little need for this article. Military doctrine still calls for CBRN surveys. However, the market has moved relatively little since the most recent market overview in this magazine in issue 02/2021 of this publication. The same programmes and manufacturers dominate the space.

By far the most robust and interesting programme in this field is the M1135 STRYKER Nuclear, Biological, and Chemical Reconnaissance Vehicle (NBCRV). This is a CBRN recce version of the STRYKER now widely fielded in the US Army. If one were to develop a notional archetype of a CBRN recce vehicle, this is the example to follow. The M1135 is made by General Dynamics Land Systems as part of the large fleet of STRYKER variants that are now commonplace as armoured vehicles in the US Army, thus addressing many of the logistical and maintenance concerns posed by a specialty vehicle. The M1135 (pictured) replaces the M93 FOX, which had been bought as an emergency fill-in during the first Gulf War. A significant amount of technology resides in an M1135. It includes a mass spectrometer, current generation radiation detection, chemical vapour/gas detection, the JS-LSCAD standoff detector (see issue 01/2018 for a discussion of standoff detection), and one of the first practical field biological sensors. About 300 of these vehicles are in service.

The aforementioned Reinmetall Man (DE) FUCHS CBRN vehicle (originally Daimler Benz), continues in service in many countries. The British Army brought them out of retirement in 2014. Germany, Norway, The Netherlands, Israel, Saudi Arabia, Kuwait, and the UAE have used the FUCHS CBRN recce vehicle and many still remain active or in reserve units. Over 100 units served in the US Army as the M93 FOX until supplanted by the M1135. The FUCHS holds a special place in CBRN recce history, having brought a mobile mass spectrometer, a serious bit of electronic instrumentation, onto the battlefield. As with other categories of detection instrument, mass spectrometers no longer need a vehicle to carry them. Man-portable instruments with better capability than the 1990s-vintage mass spectrometer originally installed in the FUCHS are now widely available. Reinmetall Man continues to market more up to date versions, though.





Many CBRN reconnaissance missions involve dismounted soldiers.

Other systems continue to appear at defence shows and in marketing literature, with quite variable uptake. Saab's mobile CBRN recce system, based on their Automated Warning and Reporting mobile system prototype has been around since about 2010. Kuwait has bought Saab systems, possibly to supplement or replace their now ageing FUCHS systems. Finland continues to punch above its weight in this space, with Finnish firms Patria and Environics both touting CBRN recce vehicles. Turkey's defence industry offers an FNSS "PARS" CBRN recce vehicle on 6x6 and 8x8 APC platforms. Switzerland has a dozen MOWAG (CH) PIRANHA III CBRN vehicles. General Dynamics European Land Systems continues to market a CBRN PIRANHA. The French Véhicule de l'avant blindé (VAB) continues on in a 4x4 CBRN recce version in the French Army's 2nd Regiment of Dragoons. Developments in this space in Czechia and Slovakia were discussed in the 10/21 issue of this magazine. India and Russia have home-grown CBRN recce vehicles based on Soviet-era APCs. The Italian firm Cristanini produces a "Light Multirole Vehicle" based on IVECO 4x4 vehicles.

Mobile CBRN Laboratories

There is also a market segment for "Mobile CBRN Laboratories." These are not true recce vehicles in the same way as the systems mentioned above. These systems are not hardened nor are they meant to operate in a live combat environment. Most are not meant to operate on the move. However, they do provide a lot of capability to analyse hazards and some are clearly designed to support the work of dismounted CBRN recce and survey teams. In some countries, with appropriate doctrine, these could serve in CBRN recce-type roles. As a few examples of many, Indra (Spain) and Cristanini (Italy) produce mobile laboratories that are intended to perform detailed analysis of samples collected by specialists.

What is not always readily apparent is how many countries are integrating chemical and radiological detection on their normal (i.e. not specially dedicated to CBRN) reconnaissance assets. The armoured, mechanised, and armoured cavalry space is full of tanks, AFVs, APCs, and various related vehicle platforms. Coverage of systems in this conventional space rarely if ever devotes much time to CBRN sensors integrated onto "normal" combat vehicles. But it is clearly happening, as sales of vehicle mounts and adapter kits by the major sensor vendors will attest. Such efforts will supplant some of the traditional requirement for CBRN recce vehicles, if this dispersed detection capability is properly leveraged.

Capabilities

The capabilities of such vehicles are far more based upon the detection hardware than the vehicle platform itself. Usefully incorporating sensors into a vehicle requires a fair bit of integration, and rarely is the vehicle manufacturer itself the most qualified to do it. But often the sensor manufacturer is not the most qualified either, as multiple different sensors from different manufacturers are specified by the customer. Bruhn-Newtech (Denmark) fills a valuable market niche in this regard as a specialty system integrator that works with sensors of all types and vehicles (and other applications) of all types. Others are in this business as well. CACI (USA) is the integrator for the US M1135 vehicle.

Upgrade Programmes

With advances in detection technology progressing at a speed faster than military armoured vehicle development programmes, it is inevitable that upgrade programmes are as significant as procurement of new CBRN recce vehicles. Having gradually fielded hundreds of M1135s, for example, the sensor upgrade programme for the CBRN STRYKER is likely to be one of the larger expenditures in the CBRN market space. For example, the US "Surface Chemical Detector" is likely to be integrated into the M1135. FLIR (USA) is the lead contractor for the NBRCV Sensor Suite Upgrade programme. There is about USD 21M in the current fiscal year budget for this upgrade, on top of nearly 100M in previous fiscal years. It rates as one of the bigger spending efforts in the CBRN space. In the UK, a GBP 16M contract was let in late 2020, to Rheinmetall BAE Land Systems to upgrade the UK's small FUCHS fleet.

Rheinmetall also won a contract to upgrade the Bundeswehr's CBRN FUCHS vehicles in an effort that runs through July 2024, with a reputed value in the tens of millions of Euros.

Looking at the size of these contracts relative to the vehicle fleet size, upgrades are where the commercial opportunities lie.

As a final note, the future in CBRN recce may not be in specialty manned reconnaissance vehicles. The area to watch for interesting developments is in unmanned systems, both ground and aerial. Miniaturisation of sensor equipment means that one does not necessarily need a large mobile platform to conduct high quality detection of hazards. UGV and UAV systems could conduct a lot of the traditional CBRN recce survey missions and do so in ways that do not place soldiers in dangerous environments. Given the trends in sensor equipment and overall situational awareness on the battlefield, this author guesses that the new frontier in CBRN recce will be in unmanned systems. The next M1135 or FUCHS may be an unmanned system.

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CBRN Reconnaissance Vehicles – Czech Army Solutions

Martin Smisek

The increasing budget of the Ministry of Defence of the Czech Republic in recent years has enabled the Czech Armed Forces to finally modernise some of its CBRN (chemical, biological, radiological and nuclear) reconnaissance vehicles and, most importantly, to purchase a new combat CBRN reconnaissance system consisting of S-LOV-CBRN and LOV-CBRN II vehicles.

he Czech chemical troops entered the new millennium with obsolete BRDM-2rch and UAZ-469CH radiological-chemical reconnaissance vehicles which were deployed to Kuwait and Irag as part of the Czech participation in Operation Enduring Freedom in 2002 and 2003. Both vehicles retained their original Soviet and Czechoslovak detection systems, although the former was later equipped with new technology such as the RAID-1 chemical threat detector and the RDS-200 portable multipurpose radiation metre. Despite their considerable age, both types are still operated by the Army of the Czech Republic (Armáda České republiky, AČR).

The situation improved in the first decade of the 21st century with the introduction of new mobile systems based on the Land Rover DEFENDER 130 chassis with a box body superstructure and a trailer. The first of them was the Land Rover RCH designed by the Vojenský technický ústav ochrany (in 2013, reorganised into Vojenský výzkumný ústav – VVÚ) for mobile semi-automated radiological and chemical reconnaissance, delineation of the contaminated area, radiological, chemical and meteorological observations, as well as determination of nuclear explosion parameters. A prototype was produced in 2001 and subsequently deployed to Kuwait and Iraq as part of Operation Enduring Freedom. Only eight vehicles from serial production were ordered in 2003 and 2005 and later introduced into the inventory of the 31st Radiological, Chemical and Biological Defence Regiment in Liberec.

<u>Author</u>

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The Czech Army uses a single Land Rover RCHM prototype that has been operated by the 31st Radiological, Chemical and Biological Defence Regiment in Liberec since 2017.



The upgraded BIOROVER B2M biological reconnaissance vehicle was introduced into the Czech Army's inventory in 2020; two serve with the Military Medical Institute in Prague.

The second vehicle, also developed by the Vojenský technický ústav ochrany, was the BIOROVER B2 capable of mobile survey, detection and identification of biological agents, transportation of biohazardous samples in special packaging, laboratory activities and decontamination of persons in field conditions. Some eight vehicles were manufactured between 2001 and 2004, with most of them currently operated by the Military Medical Institute in Prague.

Land Rover RCHM

Although the Land Rover RCH proved its worth during deployments to the Middle East and in the protection of the Athens 2004 Summer Olympics, as time went on it became apparent that the vehicle was in need of at least a partial upgrade. The main disadvantage was that the vehicle's information system was not compatible with the current automated command and control system of the AČR. Another significant drawback was that the vehicle was equipped with an unsupported model of the fast chemical ion mobility spectrometry detector (RAID-1).

Therefore, the main aim of the modernisation was to ensure connectivity and compatibility with the field command and control system of the Czech Army (IS VŘ PozS AČR) and improve the onboard chemical detection system. The modernisation project started in 2014. During the following year, a contract for the development and conversion of one Land Rover RCH was concluded with the state enterprise VVÚ. Upon its completion, the Land Rover RCHM prototype underwent a series of tests, including operational evaluation, which resulted in minor modifications to the vehicle and the writing of a definitive user manual. Subsequently, the prototype was introduced into the ORBAT of the 31st Radiological, Chemical and Biological Defence Regiment in 2017.

The Land Rover RCHM is designed to perform radiological, chemical and non-specific biological surveys and observations with automatic data collection, evaluation and information transfer. In an emergency, these tasks can also be performed in manual mode. The vehicle has a brand new communication and information system based on an all-in-one computer. Original communication equipment was replaced with the VICM 200 COMBAT intercom and the RF-13250E radiostation produced by MESIT.

The chemical detection system is based on the RAID-M100 chemical agent detector with an ammonia sensor. Other detection systems remained mostly without changes.



The interior of the BIOROVER B2M with the IZO 85 biological isolator produced by the Czech company Labox.



The single S-LOV-CBRN prototype has been operated by the Czech Army since 2014. Forty serial production systems and an additional 40 LOV-CBRN II vehicles were ordered in 2018.



The LOV-CBRN vehicle of the S-LOV-CBRN reconnaissance system is based on the chassis of the Italian Iveco M65E19WM LMV light armoured vehicle.

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The serial production S-LOV-CBRN and LOV-CBRN II during evaluation. The first two of each type were manufactured in 2020.

Navigation capabilities were enhanced with the installation of the AN/PSN-13 Defense Advanced GPS Receiver (DAGR) and civilian Garmin ZUMO 590LM navigator. The AČR currently has no plans to upgrade

the remaining RCHs, which will instead be replaced by the S-LOV-CBRN and LOV-CBRN II vehicles by 2023.

BIOROVER B2M

A similar modernisation effort was also carried out on selected BIOROVER B2 biological vehicles. The aim of the upgrade was to replace obsolete instrumentation for detection and identification of biological agents, computer technology, decontamination equipment, personnel protection gear and other special equipment installed in the superstructure and trailer. The contract for the upgrade of two BIOROVER B2 vehicles and four BIOROVER 110 vehicles (rudimentary variant based on the regular Land Rover DE-FENDER 110 SW with a trailer) was signed with state-owned company Vojenský technický ústav on 22 May 2020. The modernised vehicles were handed over to the AČR representatives by the end of the same year. The upgraded BIOROVER B2M (also designed as the BIOROVER 130-M) is used to conduct biological reconnaissance, collect samples, detect and identify biological agents in field conditions and safely package and transport biological samples in special containers. The BIOROVER B2M has clean and wastewater tanks in the trailer for the decontamination shower, an inflatable tent and a sampling kit. The vehicle body is equipped with a biological isolator and other equipment for the safe processing and preparation of samples for laboratory analysis by molecular genetic methods directly in the field.

Within the frame of the modernisation, the box-body superstructure was equipped with a next-generation sequencing system based on the iSeq 100 device and the Min-ION analyser for small molecule DNA analysis. The obsolete R.A.P.I.D. instrument for rapid identification of dangerous biological agents was replaced by the MIC qPCR cycler. The original BK-56 communication and information block, as well as two old laptops, were replaced by new portable workstations. Another change is the use of the DC100 decontamination shower instead of the original EDK-04 type.

S-LOV-CBRN and LOV-CBRN II

The recent acquisition of the S-LOV-CBRN and the LOV-CBRN II armoured chemical, biological, radiological and nuclear reconnaissance vehicles is undoubtedly the most important rearmament project for the Czech chemical troops in recent years.

The development of the S-LOV-CBRN and the production of one prototype took place between 2009 and 2012 and cost the Ministry of Defence CZK 98M (EUR 3.9M). The first S-LOV-CBRN was officially introduced into the ORBAT of the AČR (311th Radiological, Chemical and Biological Defence Battalion at Liberec) in 2014. However, due



In 2020, company and inspection trials of the first pair of S-LOV-CBRN and LOV-CBRN II vehicles were conducted. Both vehicles are equipped with the ZSRD 07 remote controlled weapon station, from EVPU and VTU.

to a lack of funds, the purchase of production vehicles had to be postponed. Therefore, the Ministry of Defence concluded the related contract with VVÚ for the delivery of 40 S-LOV-CBRNs and 40 LOV-CBRN IIs on 30 August 2018. The value of the deal was CZK 5,111Bn (EUR 199M). Due to the acquisition delay, some of the equipment used originally in the prototype had to be replaced with new technology.

The S-LOV-CBRN and LOV-CBRN II are designed for conducting CBRN reconnaissance and observation, including sampling and transport of samples, through automated superstructure with integrated CBRN detection systems. The crew of each vehicle comprises two soldiers.

The S-LOV-CBRN consists of the LOV-CBRN reconnaissance vehicle and the P-LOV-CBRN off-road trailer. The LOV-CBRN is based on the lveco M65E19WM LMV light armoured vehicle. It is equipped with detection instruments for CBRN reconnaissance and situation monitoring with the automated operation, integrated chemical agent detection subsystem, radiation monitoring subsystem and biological aerosol detector. The vehicle is capable of automatic collection and processing of CBRN information from on-board equipment for monitoring of chemical (e.g. GID-3, RAID-M100, AP2C, CHP-5), radioactive (DPV-1, RDS-200) and biological contamination (SmartBio Sensor). There is a demarcation device on the starboard side of the superstructure with the control unit and heads for delineation of the contaminated area by signal flags. The onboard IRDAM 5056B meteorological station enables the measurement of basic meteorological parameters of the ground layer of the atmosphere without the need for the crew to leave the vehicle.

The cab has ballistic protection of Level 3 and mine protection of Level 2a according to STANAG 4569. The superstructure is not ballistically protected as a whole, and only its key elements are armoured. Protection of the crew against the effects of chemical and biological agents, as well as radioactive dust, is provided by a combined overpressure protection subsystem enabling operation in the vehicle without wearing protective masks. Also incorporated is a system of emergency clean air supply in case of internal contamination of the crew cabin. For self-defence, the LOV-CBRN is equipped with the ZSRD 07 remote controlled weapon station mounted on the superstructure. The weapon station is manufactured by Vojenský technický ústav and is fitted with the FN MAG machine gun, as well as the CRANE-SR1G sensor sight unit produced by EVPÚ Defence.



The port side of the LOV-CBRN II superstructure with transport boxes and the FVZ-98M (KP) filtration and ventilation unit produced by Vojenský technický ústav.

Day vision is provided by a combination of a fixed-focus day camera and a zoom camera with colour and black-and-white mode. An uncooled thermal camera provides vision at night and in conditions of restricted visibility. Range measurements are performed by an eye-safe laser range finder. The vehicle carries a total of 2,000 rounds of 7.62 mm ammunition. The communication equipment is comprised of the AN/PRC-152A V4C and the AN/PRC-117G(V)1 radiostations. The integrated communication and information technology ensure full connectivity and compatibility with the IS VŘ PozS AČR command and control system.

The unmanned subsystem is composed of the ORPHEUS-AC2 unmanned ground vehicle (UGV) which is carried in the rear part of the LOV-CBRN. The ORPHEUS- AC2 is designed for remote CBRN, visual and acoustic reconnaissance. It carries a beta probe, a gamma-ray detector, an automatic chemical detector, an oxygen sensor and a sampling device for atmospheric sampling. The UGV is also equipped with three cameras, a thermal imaging camera, a GPS unit and a system for acoustic monitoring.

The P-LOV-CBRN trailer on the PRAGA 35 (CL ARM 35 LMV) chassis carries the AMZ-CRN portable autonomous monitoring module, a portable weather station, a portable demarcation device and supporting equipment. The trailer provides electric energy to the vehicle at the static observation post through an internal power generating set or by connecting to a 230 V public electricity distribution network. Both LOV-CBRN and P-LOV-CBRN are fitted with the multispectral camouflage system made by B.O.I.S. - FILTRY for camouflaging in the visible, infrared (near, medium, far), and microwave spectra.

The LOV-CBRN II vehicle complements the capabilities of the S-LOV-CBRN and is directly based on the LOV-CBRN. Its equipment enables mobile and on-foot CBRN reconnaissance via a combined detection subsystem with automated operation and message transmission to the vehicle's information system. The LOV-CBRN II carries a decontamination set and a kit for collection, short-term storage and transport of liquid and solid samples containing radioactive substances or military chemical and biological agents. The vehicle allows the integration of the

STAR LIGHT SFP radio controlled improvised explosive devices jammer (within the parameters of the contract, only ten jammers were ordered). The S-LOV-CBRN

and the LOV-CBRN Il are due to replace all BRDM-2rch, UAZ-469CH and Land Rover RCH vehicles within the ranks of the regular AČR units. The 311th and 312th Radiological, Chemical and Biological Defence Battalion of the 31st Radiological, Chemical and Biological Defence Regiment will become the primary users. The remaining S-LOV-**CBRNs and LOV-CBRN** Ils will be operated by the radiological and chemical reconnaissance squads of the combat battalions within the 4th Rapid Deployment Brigade and the 7th Mechanised Brigade, as well as some other combat support units.



The rear section of the LOV-CBRN superstructure is intended for the transport of one ORPHEUS-AC2 CBRN reconnaissance unmanned ground vehicle developed by the Brno University of Technology.

The first 13 production vehicles of each type were delivered during 2021. The original schedule envisaged that shipments would be completed during 2022. However, due to the COVID-19 pandemic, this date has had to be postponed, so that the last vehicle is currently expected to be delivered by the end of July 2023.



Ammunition Handling for Armoured Fighting Vehicles

David Saw

Once an operational requirement for an armoured vehicle is formulated, one moves on to the design phase which is generally said to involve a compromise between three key factors; those factors being firepower, mobility and protection. To three broad categories one needs to add in sensors, electronics, including command, control, communications and computing, plus networks amongst other elements. The modern armoured vehicle truly is a system of systems these days, and consequently is a highly complex and sophisticated environment.

Armoured vehicle design used to be a much more straightforward process, with a main battle tank, for example, it was how big does the gun have to be in calibre terms to being necessary to accommodate ammunition in ready racks around the turret/fighting compartment for immediate use and to store ammunition elsewhere that can be accessed without too much difficulty to replenish ready racks as necessary.

There is more to come though: you have to accommodate the co-axial machine gun, a sight and its ready use ammunition, as well as extra ammunition boxes. If a Heavy Machine Gun (HMG) mount on the turret roof is specified, you then have to find space within the vehicle for substantially larger ammunition, normally 12.7x99 mm NATO (0.50 BMG) or 12.7x108 mm, the standard former Soviet round used by Russia and many others. There are those whose HMG enthusiasm requires an even



A French Army LECLERC fires its main gun as part of a training exercise in Estonia in December 2021. France made some unique choices with the LECLERC. It has a 120 mm CN-120-26 52 calibre smoothbore gun fed by an autoloader system with a capacity for 22 rounds.

defeat current and projected threats, then it was how much space will the gun and its optical sights require in the armoured envelope of the tank, and then space has to be allocated for those who serve the gun (gunner and loader). This then brings us to much space is available on the tank for ammunition, obviously the larger the calibre of the main gun, generally its ammunition will require significant space, it larger calibre leading to the installation of a 14.5x114 mm KPV on the turret roof, certainly a powerful weapon, but storing its ammunition will take up even more space. The armoured envelope of our notional tank is starting to fill up, but remember, you have to add the space for the commander and the appropriate vision systems for all of the crew. Then comes the communication equipment and intercom, plus all of the other bits of equipment that the tank crew will need. On a British tank there has to be space for a boiling vessel to provide the hot water for tea, amongst other things, while the Israeli MERKAVA tank has a chilled water dispenser in the turret. Of course, one cannot forget the driver, plus the propulsion and mobility systems that have to be accommodated on the tank.

Evolution

Thus far we have described a 'generic' tank, and, as you can see, there are so many factors that need to be taken into account in the design process. One of obvious solution to finding the space that you need to fit everything in is to have a larger vehicle, but bigger is not necessarily better! A bigger vehicle means more weight, it also means that more protection is needed to cover critical areas which also equals more weight. More weight means that you need a more powerful engine to move your vehicle, plus suspension modifications and other changes, that in turn equal more weight. You might have added to firepower and protection with a bigger vehicle, but that has come at the cost of mobility. Unbalanced armoured vehicle designs are rarely successful.

The somewhat basic tank design that we have sought to describe thus far, has evolved immensely in the modern era, current generation vehicles with their complex arrays of sights and sensors, plus immense computing power can engage targets at extended ranges in day/night conditions offering high first-round kill probabilities. Of course, that means that there are even more things to fit within the armoured envelope and new issues emerge which armoured vehicle designers have to take into account.

Clearly the endgame with any tank design is to have most effective possible system within the constraints that are being operated under, these constraints could be diverse, ranging from cost to size and weight, operational considerations and even cultural factors. As a result, what passes as a good tank design in country A could be totally unacceptable in country B. Despite this, most tank designs have followed a pretty similar formula, yet there have been incidences of innovation.

In the early 1960s the then Soviet Army had developed a requirement for a new tank design that would supplement and then replace the T-62 and earlier model tanks. This led to the state-of-the-art T-64, the first true variant of which was equipped with a 125 mm smoothbore cannon fed by a 6ETS11 autoloader carrying 28 rounds of ammunition in APFSDS, HEAT and HE/ HEF variants. These are two-piece rounds comprising of the projectile and a propellant charge which are loaded separately by the autoloader.

For political and economic reasons it was decided to sanction another tank programme in the shape of the T-72. Again, this had a 125 mm smoothbore cannon fed by an autoloader of a different design to that used in the T-64, with space for only 22 rounds of ammunition. Both the T-64 and the T-72 autoloaders were subsequently modified to load cannonlaunched guided munitions, initially the 9K-112 and later the 9K-119/9K-130 systems and their evolutions. The later T-80 tank would also use an automatic loading system the 6ETS-15 KORZINA, while the T-72 autoloader would evolve to provide the system for the T-90. The future Russian T-14 ARMATA tank features an autoloader with a 32 round capacity for its 2A82-1M 125 mm gun.

From the perspective of the designers of the T-64 and the T-72, the use of an autoloader made a great deal of sense, an autoloader meant that the loader could be dispensed with, meaning that the internal volume of the tank could be reduced. Add that to the fact that nobody was really interested in ergonomics in this design process, and the



In a contract signed in May 2021 the British Army will upgrade 148 tanks to the new CHALLENGER 3 configuration. Replacing the 120 mm L30A1 L/55 rifled gun with its two-piece ammunition, with the Rheinmetall L55A1 120 mm smoothbore gun and its associated ammunition required the development of a new turret as the existing turret could not cope.

end result was a tank with a reduced visual signature, but not necessarily one that was easier to fight in.

The fact that Soviet designers and their successors in Russia and the Ukraine have kept faith with autoloaders demonstrates that they have many positive operational characteristics. The vulnerability of T-72s to catastrophic damage in combat in the Middle East does not negate the Soviet preference for autoloader systems. There is no getting away from the fact that a tank is a steel box full of flammables, whether it be fuel, hydraulics, lubricants or ammunition, if the vehicle is penetrated the end

result is generally not pretty. Soviet export tanks had significantly reduced armour arrays compared to the protection afforded to domestic tanks, the end result being that penetrations usually led to unpleasant consequences.

Other Options

One characteristic of modern tanks is that their service lives can be greatly extended. These days a minimum life of 30 years is expected and most often exceeded. This creates a requirement to upgrade vehicles to increase their capabilities and to deal with



India has a large fleet of T-72M AJEYA tanks in service, many of which were built under licence in India at Avadi. The T-72M features a 2A46 125 mm smoothbore gun fed by a carousel autoloader with a capacity of 22 rounds. The autoloader means a human loader is not required and the tank has a crew of three.

current and projected future threats. Upgrades could be very straightforward, for example the ability to use a higher performance ammunition nature. However, an upgrade of this type would be complicated if you had T-series tanks with a carousel autoloader. An APFSDS variant with an extended penetrator would require significant alterations to the autoloader to be accommodated.

As previously discussed, within the armoured envelope of a tank, space is at a premium. That being said, the replacement of 1980s era components with modern systems can win a surprising amount of space in the turret, taking into (CLIP), an effort that saw the installation of the Rheinmetall 120 mm smoothbore gun into the CHALLENGER 2. As a programme, CLIP obtained no traction and then came the CHALLENGER 2 Capability Sustainment Programme (C2 CSP), another upgrade effort that led nowhere. Eventually the British Army decided that it really wanted a CHALLENGER 2 upgrade programme and this led to the CHAL-LENGER 2 Life Extension Programme (CR 2 LEP), which grew in scope and cost as the programme evolved. Remarkably for a British armour programme managed to get to the contract award stage, with Rheinmetall BAE Systems Land (RBSL) re-



The contenders for the LAND 400 Phase 3 programme under evaluation by the Australian Army in August 2021. On the left is the Hanwha Defense Australia REDBACK, and on the right the Rheinmetall Defence Australia LYNX KF-41. Both vehicles have 30 mm cannons as main armament. In this type of application increasing the cannon calibre would require further compromises in vehicle design.

account human factors and ergonomics can also allow the available space to be used much more efficiently. Sometimes though, you have to accept the fact that the required serious upgrades for tank are going to be more complicated and more expensive than anticipated. This certainly was the case in the British Army CHALLENGER 2 upgrade programme. The CHALLENGER 2 entered service with the British Army in 1998, with 386 tanks being delivered by 1992. The main gun was the 120 mm L30A1 L/55 rifled system that used two-piece ammunition, but it became apparent that the rifled gun was not the way forward as everybody else in NATO had opted for 120 mm smoothbore. This led to the CHALLENG-ER Lethality Improvement Programme

ceiving an £800 million contract in May 2021 to upgrade 148 tanks to the CHAL-LENGER 3 configuration.

The CHALLENGER 3 programme upgrades the firepower, mobility and protection aspects of the tank. In terms of firepower, the installation of the Rheinmetall L55A1 120 mm smoothbore gun and its associated ammunition could not be accommodated in the existing CHALLENGER 2 turret, consequently a new turret developed by Rheinmetall was selected and installed in place of the original turret.

French Perceptions

France saw the advantage of automatic loading systems many years ago, indeed they started working on a system in this category for the AMX-13 light tank all the way back in 1946! The AMX-13 had a 75 mm main gun which was fed via an automatic loader from two six-round magazines in the bustle of the FL-10 turret of the tank. However, it was to be many years later before there was a resurgence of interest in autoloaders for French tanks.

In the 1980s the French Army was looking for a successor to its AMX-30 tank. Initially this need was to be met by a joint venture tank developed with Germany. The collaborative programme failed and a national programme was instituted instead, the new tank would be far better protected than its predecessor and it would also have far more in the way of firepower.

The resulting LECLERC tank was equipped with a 52-calibre 120 mm CN120-26 smoothbore gun, capable of utilising a complete family of French APFSDS, HEAT and HE variants. In addition, the French gun can utilise all standard NATO 120 mm smoothbore natures. Where the LECLERC was unique for western tanks of that era is that the decision was taken to opt for a three-man crew and an autoloader. The autoloader has space for 22 rounds, with there being an additional 18 rounds onboard to restock the autoloader.

With a 120 mm main gun there are reasons both for and against manual loading and for and against autoloading. In the next generation of western tanks, such as the Franco-German Main Ground Combat System (MGCS), this will be equipped with a successor to the 120 mm smoothbore, for example Rheinmetall in Germany have 130 mm smoothbore in development, while France developed a 140 mm smoothbore in the 1990s. Once you move up to 130 or 140 mm calibre, the attractions of an autoloader system are obvious. As a result, French operational experience with autoloader systems will be key to MGCS.

The need to confront increasing threat capabilities with larger calibre weapons is not only confined to tanks. Increasingly thought is being given to enhancing the firepower available to Infantry Fighting Vehicles (IFV), these days the minimum cannon calibre is 30 mm, but increasingly interest is being shown in larger calibres such as 40 mm, 50 mm or even larger. The risk with all of this is that in the constrained space of an IFV, accommodating a larger calibre gun and its ammunition will mean compromises will have to be made, this could be less ammunition carried, fewer dismounts or reduced capability in other areas. Both for IFVs and tanks, you can add more firepower but you will have to make difficult choices in the process.

Vehicle Active Protection Systems from Israel

Tamir Eshel

srael has been a forerunner of armoured Vehicle Protection Systems (VPS) and Active Protection Systems (APS) for more than 20 years. The demand for such capabilities evolved during the 19-year occupation of South Lebanon (1982-2000), where Israeli tanks and other heavy armoured vehicles were exposed to attacks on road patrols and in static positions. Israel's Defence Forces (IDF) have developed and tested several such countermeasures, used primarily against guided missiles fired by Hezbollah. Some of those systems relied on activating IR jammers to defeat Anti-Tank Guided Missiles (ATGM) using Semi-Active Command to Line-Of-Sight (SACLOS) - such as the BGM-71 TOW and 9K115-2 ME-TIS. Toward the end of that war, the IDF conducted an operational test of PURPLE THUNDER, an experimental APS that combined radar to detect the approaching missile that automatically triggered jammers and smoke screens to protect MERKAVA Mk2 tanks.

Unfortunately, PURPLE THUNDER has not reached operational use, and, at the break of the Second Lebanon War in 2006, Israeli armour was ill-prepared to deal with the ATGM threat. Of particular concern was the laser-beam-riding 9M133 KORNET, which could be fired from long range, with minimal signature, and was impossible to jam by soft kill countermeasures.

Pioneering APS Technology

Lessons learned during that war brought the IDF to revive APS developments that included two different concepts. The TROPHY system, developed by Rafael Advanced Defense Systems, was designed to defeat RPGs, ATGM, and tank rounds. Relying on a radar sensor to detect the threat at a long range, TROPHY activates explosively formed projectiles (EFP) countermeasures to defeat a threat at a long-range. These charges are well-aimed to meet the incoming threat at a relatively long distance from the protected vehicle, destroying it by a direct impact. The intercept distance is long enough to avoid damage even if the intercept activates the shaped charge in the missile's warhead. A guick reloading process follows the EFP firing. The reloader quickly

positions another EFP charge, enabling the tank to maintain its protection even under a ripple attack by RPGs and ATGMs.

IRON FIST was another system was developed by Israel Military Industries (IMI - now a division of the Elbit Systems company). This system used a combination of passive (EO) and radar sensors to launch an explosive charge that creates a powerful blast wave that crushes the incoming projectile at a safe distance from the protected vehicle. This method disrupts the initiation of the shaped charge. By design, IRON FIST Light Decoupled (IFLD) is optimised to fit to the platform constraints to provide multilayered protection. When SACLOS threats are detected, the system engages the AT-GM with soft kill while hard kill would be used against beam riders like the KORNET, RPGs, or HEAT projectiles fired by tanks and recoilless rifles. The IRON FIST Light Kinetic (IFLK) system has some capability to defeat kinetic energy (KE) rounds, as the blast wave deflects the long-rod penetrator on its path, thus degrading its effectiveness in penetrating heavy armour.

The Eyes of the APS

Both systems rely on the radar for threat detection, classification, and target acquisition. TROPHY uses the IAI Elta Systems' WindGuard radar to enable its long-range hit-to-kill effect. Rada developed the Compact Hemispheric Radar (CHR) to meet the parameters of IRON FIST. The latest versions of these systems are enhanced with multi-mission capabilities to perform Hostile Fire Detection (HFD), close-range area, and aerial surveillance.

Elta's ELM-2133 WindGuard radar is a four-facet distributed phased-array pulse-Doppler radar designed to detect and automatically track Anti-Tank Rockets (ATRs), Anti-Tank Guided Missiles (ATGMs), and tank rounds. Upon detection and identification of a potential threat, the radar delivers early warning to the crew, indicating the accurate 3D direction of the threat, calculating the Time-To-Impact (TTI), and - when deemed an imminent threat to the vehicle - automatically activates TROPHY'S hardkill protection system for optimal reaction. The radar warning and APS response only



WindGuard: A model of the ELM 2133 WindGuard installed on the CHALLENGER 3.



Elta Systems' ELM 2133 Wind-Guard has been integrated with the company's ENA5220 OTHELLO to enhance hostile fire detection capabilities.



IRON FIST and its eCHR radar are shown here on the modernised CV9035 on display at DSEI 2021.



The German Army will soon receive TROPHY APS for its LEOPARD 2A7 tanks, following the expected successful completion of a test series.



Rafael also developed a light version for the TROPHY, utilising different hard kill mechanism for close-in defence.

to direct threats, but with the ability to calculate the location of the threat launching point, it facilitates rapid weapon aiming at the threat. IAI also offers a multimission radar of this type - the ELM 2135 StormGuard multi-mission radar for similar purposes, enabling armoured vehicles to extend their situational awareness of low signature threats including crawling and slow-moving persons, vehicles of all types and moving patterns, and aerial threats, including drones and UAVs, in addition to anti-armour threats.

WindGuard can also be integrated with EO sensors to provide Hostile Fire Detection (HFD). Elta Systems' OTHELLO (ENA5220) provides this capability. It comprises an array of EO sensors designed to detect gunfire, mortar, RPG, and ATGM. The system consists of two sensors. The arc-shaped OTHELLO-P with a field of view of 190x40 degrees provides a rough indication of a gunshot, RPG, or ATGM launch, enabling

the vehicle to manoeuvre and activate soft kill measures or an instant smoke screen. The box-shaped OTHELLO system uses more sensors to cover 90x60 degrees with an accuracy level sufficient for slew-to-cue of weapons and APS to engage the target with counter-fire or hard kill.

Multi-Layered Defence

Rada has recently introduced the second generation of multi-mission CHR that improves the situational awareness of landbased and aerial threats, including UAVs and loitering weapons. eCHR utilises the latest technology of Active Electronic Scanning Arrays (AESA) and Gallium Nitride (GaN) amplifiers that deliver high agility. Two systems are available - the aCHR tailored for VPS, APS, and HFD and the eCHR, optimised for Counter-Unmanned Aircraft System (C-UAS) and Very Short-Range Air Defence (VSHORAD) missions. These software-defined radars provide automatic and complete dynamic Air Situational Picture (ASP) with four units mounted on each tactical vehicle using advanced signal processing and algorithms. Together they handle hundreds of targets simultaneously through Track While Search (TWS) and revisit modes, analysing target in-depth in a 4D analysis of Doppler and other target features. Since its early day's, IRON FIST was de-

signed as a multi-layered vehicle protection system protecting from ATGM, RPG, and tank round – both HEAT and long-rod penetrators (KE). The system was designed to counter each threat with the least costly method – SACLOS (2nd Generation) ATGMs would be engaged with infrared countermeasures (IR jammers), while RPGs, KE, and HE would require hard kill in different schemes. ARIEL Photonics cloud soft-kill systems initially provided Iron FIST's soft-kill layer. Such a system included a missile warning sensor (radar or optical), a tracker, and a laser jammer.

Elbit Systems also offers a soft kill layer for its VPS with the EO SHIELD, Vehicle Infra-Red Countermeasure System (VIRCM) that protects armoured fighting vehicles against SACLOS guided anti-tank guided missiles. Other methods employ a laser jammer mounted in line with the IRON FIST launcher. The jammer is linked to the threat warning sensors in this configuration to obtain early warning and target classification. Unlike a hard-kill APS with a limited magazine against multiple attacks, VIRCM can be used continuously and in all directions to engage multiple incoming threats until the attacking missile veers off its course. If the missile is not affected, other layers of defence are used.



TROPHY being fitted on the modified and modernised turret designed by RBSL for the CHALLENGER 3 (CR3) displayed at DSEI 2021.

Combat-Proven Systems

TROPHY was first to reach operational use, with the first operational deployment on the Gaza strip in 2011. The system demonstrated its effectiveness against real threats in battle numerous times. These threats included 9M113 KORNET, advanced (tandem) RPGs and 9M113 KONKURS. According to Rafael, TROPHY systems have accumulated over 1,000,000 operational hours. TROPHY systems have been mounted on MERKAVA Mk 4 and 3 and NAMER AIFVs. For lighter vehicles, such as the EITAN 8x8 APC, the IDF opted the use the IRON FIST for its lighter weight and ability to operate with open hatches without the TROPHY's shield deflectors. IRON FIST that has been selected to provide the APS for the 8x8 EITAN wheeled armoured personnel carrier is expected to mature toward the initial operational deployment of EITAN with the Nahal infantry brigade, scheduled soon.

Although it took over 20 years to mature, today, TROPHY remains the world's first and only combat-proven APS. Wars in Ukraine, Caucasus, North Africa, and throughout the Middle East, where modern battle tanks and heavy armour were defeated by unguided rocket-propelled and guided weapons, brought many armies to the understanding that the time for APS has come. The US Army was first to recognise its role, adding TROPHY as another layer of protection for its M-1A2 main battle tanks based in Europe. Germany has followed Exporting the US with the integration and fielding of the first platoon of LEOPARD 2A7 equipped with the system. TROPHY is also integrated and is likely to become part of the planned modernisation of the British CHALLENGER 3 main battle tank

Rafael pursues new opportunities through collaboration with international partners. In the USA, Rafael cooperates with Leonardo. In Europe, they established a JV with KMW and General Dynamics European Land Systems (GDELS) to market and support TROPHY integration in the scope of existing and new European armoured vehicles programmes, including the LEOPARD MBT community. TROPHY also supports wheeled APCs - it has been integrated on the Canadian LAV III APC and installed for a demonstration on the GDLS STRYKER for the tests by the US Army. The system has been integrated into Rafael's SAMSON MKII turret currently offered to several NATO countries for AFV modernisation programmes.

Although Rafael has expanded the TRO-PHY family with a reduced weight version for medium armoured vehicles and a light version for light wheeled vehicles, TROPHY HV continues to be the system of choice



Al next-generation combat vehicle concepts explored in the CARMEL programme utilise the WindGuard and StromGuard radars as part of the system's hemispherical situational awareness capability, feeding the system's battle management system.



The TROPHY APS is also integrated with the SAMSON 30 mm turret, designed as an 'all in one' system.

for customers as it is the most mature and proven APS.

IRON FIRST received a boost following the acquisition of IMI by Elbit Systems. Leveraging Elbit's strong marketing position and IMI's expertise, the IRON FIST programme was streamlined and integrated with other product lines and cooperation programmes. Two examples are the Dutch CV9035/NL modernisation, underway with BAE Systems, and integration with the BOXER APC and LYNX for the Australian LAND 400 programmes. The integration with the remotely operated turret used on the Hanwha REDBACK AIFV, a competitor to the LYNX in the Australian LAND 400 Phase 3 programme, also represents the system's ability to integrate with new unmanned turrets, such as Elbit Systems' UT30MK2.

The Way Forward

Both systems are being offered as part of complete integrated turrets. Having the APS as part of the turret mechanical and electronic design help reduce integration cost and reduce weight. Being a part of a comprehensive battle management system (BMS) allows the APS sensors to become part of the vehicle's situational awareness, providing early warning, weapon laying information, and target acquisition for onboard and remotely operated weapons.

Turret Options for 8x8 Armoured Vehicles

Christopher F. Foss

An increasing number of countries around the world are now deploying fleets of 8x8 armoured fighting vehicles (AFV) with the baseline version normally being an infantry fighting vehicle (IFV) or an armoured personnel carrier (APC) with both of these being fitted with a manned turret or remote weapon station (RWS).

hile some Original Equipment Manufacturers (OEM) have the capability to design and manufacture the complete system, e.g. running 8x8 hull and turret, some contractors just concentrate on supplying the baseline running hull. This leaves the end user greater flexibility in the selection of not only the armour and survivability package, seating arrangements, hatches and doors, but also the weapon system. The main value in many platforms is in supplying the turret and for this reason some OEM, for example General Dynamics Land Systems - Canada (GDLS-Canada) and Nexter, can supply the complete vehicle (hull and turret) as well as a training package and integrated logistic support (ILS). Initially, one or two person turrets were armed with a 20 or 25 mm cannon coupled to day/image intensification sights. There is today a clear trend to fit two person turrets with a larger calibre weapon such as a 30 mm dual feed cannon and fit stabilised day/thermal sights incorporating a laser rangefinder allowing hunter killer target engagements to take place. Gun control equipment (GCE) is now all all electric rather than hydraulic.

Finland deploys the Patria Armoured Modular Vehicle (AMV) fitted with a Norwegian Kongsberg RWS normally armed with a 12.7 mm machine gun (MG). The Swedish AMV has the same RWS. The Finnish Army also deploys the AMV fitted with the Patria AMOS twin barrelled 120 mm mortar system.

<u>Author</u>

Christopher F. Foss has been writing on armoured fighting vehicles and artillery systems since 1970. He has also lectured on these subjects in many countries as well as chairing conferences all over the world. He has also driven over 50 tracked and wheeled AFVs.



Latest Patria Armoured Modular Vehicle XP (8x8) fitted with Kongsberg remote controlled turret armed with 30 mm MK44 dual feed cannon and 7.62 mm coaxial MG. On the roof is a Kongsberg RWS armed with a 12.7 mm MG with a JAVELIN ATGW mounted to the right.



Nexter VBCI (8x8) fitted with a Nexter T40 turret armed with a 40 mm CTAS, roof mounted RWS armed with a 7.62 MG and mock-up of an ATGW on either side of the turret.

TIOLO: KREINTIEL

Other AMV export customers fit their specific weapon systems as well as usually developing specialised versions to meet their own requirements.

The Polish Army has a version of the AMV called the ROSOMAK with the IFV version fitted with the locally manufactured version of the Italian Leonardo (previously Oto Melara) HITFIST 30 two person turret armed with a stabilised 30 mm Northrop Grumman (previously SATK) MK44 dual feed cannon and 7.62 mm co-axial MG. The turret also features locally developed laser warning system. The Polish Army deploys many specialised versions of the ROSOMAK including one fitted with a locally developed HSW RAK turret mounted 120 mm breech loaded mortar system.

To replace its currently deployed RATEL (6x6) family of vehicles (FOV), South Africa will deploy a version of the AMV called the BADGER in five versions which will have a two person Modular Combat Turret (MCT) developed by Denel Land Systems. The IFV version is armed with a locally developed 30 mm GI-30 dual feed cannon and a 7.62 mm co-axial MG while the anti-tank version has pods of Denel Dynamics INGWE laser guided anti-tank guided missiles (ATGM) either side which have a maximum range of up to 5,000 m.



BOXER (8x8) with Rheinmetall LANCE turret armed with 30 mm MK30-2 ABM cannon, roof mounted RWS armed with 12.7 mm MG and pod of ATGW. It is also fitted with an active protection system.

VBCI

The French Army has taken delivery from Nexter of 630 Vehicule Blinde de Combat de Infanterie (VBCI) of which 520 are in the IFV configuration and the remaining 110 in the command post vehicle (CPV) configuration. The IFV is fitted with a Nexter one-person turret armed with a Nexter M811 25 mm dual feed cannon and 7.62 mm co-axial MG while the CPV has a FN RWS armed with a 12.7 mm MG. While the 25 mm weapon would normally be laid onto the target by the gunner, the commander is provided with a panoramic sight mounted on top of the turret allowing for hunter/killer target engagements.

Product Feature: Racal Acoustics Ltd.

Protecting Crew Against Military Vehicle Noise

Noise exposure in military vehicles is a growing concern as ambient vehicle noise is likely to decrease crew performance and cause long-term hearing problems.

Many retired personnel suffer permanent hearing damage and effective hearing protection is needed for troops on the front line, without compromising their communication, situational awareness or comfort. Racal Acoustics Ltd., part of the INVISIO Group, specialises in advanced head-



sets for high noise environments – across land, sea and air and for use in tracked or wheeled vehicles, dismounted tactical applications and aviation environments.

The RA4000 MAGNA hearing protection headset is designed specifically for vehicle crews in infantry fighting vehicles, armoured personnel carriers and main battle tanks. This means it provides unprecedented performance in hearing protection (36 dB SNR), communications intelligibility and situational awareness at safe levels (<85 dBA).

The addition of digital Active Noise Reduction (ANR) is advantageous for mitigating low frequencies that tend to dominate the noise profile when mounted in military vehicles. Digital ANR, in particular, can be modified through software to improve the overall performance of hearing protection. A digital headset improves ANR performance with added capabilities for technology upgrades, reducing whole-life costs.

As a complete solution, the RA4000 headset also offers modular, customisable, and



upgradeable benefits and accessories to match specific mission requirements and extend product life.

Facts on RA4000

- ANR of 36 dB SNR
- Software upgradeable
- Comms intelligibility in high noise
- Talk-through and situational awareness at safe levels (<85dBA)
- Internal AA battery powered
- IP68 immersible



Turkish Otokar ARMA (8x8) in IFV configuration and fitted with Otokar MIZRAK-30 remote controlled turret armed with 30 mm dual feed cannon and 7.62 mm co-axial MG.

Photo: Krauss-Maffei Wegmann



BOXER (8x8) MRAV with rear mission module fitted with John Cockerill Defense C3105 two person turret armed with 105 mm high pressure rifled gun fed by a bustle mounted automatic loader and 7.62 mm co-axial MG.

For the export market Nexter has marketed the VBCI fitted with their private venture two person T40 turret armed with a CTAI 40 mm Case Telescoped Armament System (CTAS), roof mounted 7.62 mm MG and optional an ATGM mounted either side. The installation of the latter allows high value targets such as main battle tanks (MBTs) to be engaged beyond the range of the 40 mm CTAS. As well as being marketed in the manned configuration, the T40 turret is also being marketed in the unmanned configuration.

BOXER

The German Army deploys the Artec BOXER (8x8) Multi-Role Armoured Vehicle (MRAV) as an APC fitted with a Krauss-Maffei Wegmann FLW 200 RWS typically armed with a 12.7 mm MG or a 40 mm automatic grenade launcher (AGL).

Lithuania deploys BOXER (8x8) as an IFV under the local name of the VILKAS (WOLF) and fitted with am Rafael SAMSON II RCT armed with a 30 mm MK44 cannon and 7.62 mm MG with these weapons being reloaded under armour. Following a competition the Australian Army selected BOXER (8x8) to replace its currently deployed Australian Light Armoured Vehicle (ASLAV-25) (8x8) armed with a 25 mm M242 cannon and 7.62 mm deployed in the reconnaissance role.

The Australian BOXER reconnaissance version is fitted with the latest Rheinmetall LANCE two person turret armed with a stabilised Rheinmetall (previously Mauser) 30 mm MK30-2 dual feed cannon which in addition to firing conventional natures of ammunition can also fire Air Bursting Munition (ABM) rounds.

UK has also selected the BOXER (8x8) with the baseline vehicle equipped with the Norwegian Kongsberg RWS armed with a 12.7 mm MG supplied via Thales UK. The Royal Netherlands Army BOXER also have a Norwegian Kongsberg RWS armed with a 12.7 mm RWS. Detachable rear mission module of the BOXER (8x8) MRAV offers mission flexibility for the end user and the vehicle has recently been demonstrated with the rear mission module fitted with the John Cockerill Defense C3015 turret armed with a 105 mm high pressure gun and 7.62 mm co-axial MG.

CENTAURO

The first Italian Army deployed 8x8 was the CENTAURO mobile gun system (MGS) fitted with a Leonardo 105 mm turret. This is being followed by the CENTAURO II (8x8) with a 120 mm turret and these turrets have been fitted to other 8x8 platforms for trials. To operate with the CENTAURO MGS the Italian Army deploys an expanding fleet of Freccia (8x8) IFV fitted with a two person Leonardo turret armed with a 25 mm cannon and 7.62 mm co-axial MG.

Serbia has developed and placed in production the Yugoimport LAZAR (8x8) which can be fitted with a variety of RWS and turret options including a Russian turret armed with a 30 mm 2A42 dual feed cannon and 7.62 mm co-axial MG.

The Swiss General Dynamics European Land Systems – Mowag PIRANHA is the most widely used 8x8 in the West and is also manufactured in Canada and the USA to meet local requirements. Latest PIRANHA 5 (8x8) is being selected by an increasing number of countries including Denmark (309), Romania (227) and Spain (348) for local production/assembly with the end user selecting the weapon fit.

PARS

PARS (8x8) was developed by the Turkish company FNSS Savunma Sistemleri as a private venture for the home and export markets. The first PARS customer was Malaysia who took delivery of 257 PARS I (8x8) under the local designation of the AV8 with final assembly of most of these being undertaken in Malaysia at the facilities of Deftech. Of these, the IFV is fitted with the FNSS SHARPSHOOTER one-person turret armed with a stabilised Northrop Grumman 25 mm M242 dual feed cannon and 7.62 mm MG.

The armoured IFV is fitted with a version of the South African Denel Land Systems LCT-30 turret armed with a stabilised 30 mm GI-30 cannon and 7.62 mm co-axial MG. The increased weight of this turret means it is not fully amphibious as are most other members of this FOV.

The second customer for PARS is Oman who has taken delivery of the 172 in both the 8x8 (145) and 6x6 (27) versions with some of the former fitted with the latest generation FNSS Savunma Sistemleri SABER one person turret a 25 mm cannon and 7.62 mm co-axial MG.

Turkey has selected the latest PARS III (8x8) and will take delivery of 100 units in both 8x8 and 6x6 versions with these having a much higher local content in the areas of turrets, power pack and driveline.



Patria 120 mm NEMO mortar turret installed on an AMV (8x8). The first customer for NEMO was the Kingdom of Saudi Arabia for their LAV (8x8) vehicles.

ARMA

Using internal research and development funding the Turkish company of OTOKAR developed the ARMA FOV in 8x8 and 6x6 configurations with share 90% of common components. The first version to enter production was ARMA (6x6) for Bahrain fitted with a PWS followed by Azerbaijan. ARMA (8x8) can be fitted with a wide range of turrets including the Otokar MIZRAK RCT armed with a stabilised 30 mm cannon and 7.62 mm co-axial MG and fitted with two stabilised day/thermal sights for hunter/ killer target engagements. ARMA (8x8) has also been shown fitted with a John Cockerill Defense turret armed with a 105 mm gun fed by an automatic loader and 7.62 mm co-axial MG.

The Kingdom of Saudi Arabia (KOSA) is one of the larger users of the GDLS – Canada Light LAV (8x8) and is now taking delivery

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Malaysian Army AV8 (8x8) in IFV configuration fitted with FNSS SHARPSHOOTER one person turret armed with stabilised Northrop Grumman 25 mm M242 dual feed cannon and 7.62 mm co-axial MG.



The Serbian LAZAR (8x8) marketed by Yugoimport can be fitted with a wide range of weapon systems including a Russian turret armed with a 30 mm cannon and 7.62 co-axial MG.

of the latest generation fitted with John Cockerill Defense C3000 series two person turrets in two configurations.

The C3030 turret is armed with a Northrop Grumman 30 mm MK44 dual feed cannon and 7.62 mm co-axial MG while the C3105 is armed with a 105 mm rifled gun fed by a bustle mounted automatic loader.

This turret is also in production for installation on the Tiger light/medium tank developed by FNSS Savunma Sistemleri now in production for Indonesia.

KOSA also deploys an earlier LAV fitted with other turrets including the former Royal Ordnance 120 mm Armoured Mortar System (AMS) with MECAR supplying a complete family of ammunition.

All marketing of the AMS has ceased and Patria have supplied 36 of their 120 mm NEMO turret mounted mortar systems for installation of KOSA LAV (8x8) as well as supplying a batch for installation of coastal craft deployed by the United Arab Emirates (USA).

STRYKER

The US Marine Corps took delivery of 758 LAV (8x8) from the now GDLS - Canada in six configurations with the LAV-25, used for the reconnaissance mission, fitted with a two person turret armed with a 25 mm M242 cannon and 7.62 mm MG coupled to day/image intensification sights, although in recent years thermal sights have been added.

The US Army has adopted a version of the LAV called STRYKER (8x8) with the baseline version being designated the M1126 Infantry Carrier Vehicle (ICV) and fitted with a Kongsberg RWS typically armed with a 12.7 mm MG. The most powerfully armed version was the STRYKER 105 mm Mobile Gun System (M1128) fitted with a low profile turret armed with a 105 mm gun and 7.62 mm co-axial MG, but these have been phased out of service.

To meet an urgent requirement, the US Army took delivery of 81 STRYKER fitted with the Norwegian Kongsberg RCT (now called the RT40) armed with a 30 mm XM813 cannon and 7.62 mm coaxial MG with these being deployed to Europe and called the DRAGOON. A key feature of the RT40 is that the weapons can be reloaded under armour protection.

Following a competition, in June 2021 the US Army awarded Oshkosh Defense a contract worth US\$942.9M to integrate a 30 mm Medium Caliber Weapon System (MCWS) onto the STRYKER Double V-hull ICV for deployment with three of the the US Army's STRYKER Brigade Combat Teams (SBCT).

For this contract, Oshkosh Defense is teamed with Pratt Miller and Rafael Advanced Defence Systems with the MCWS based on the Rafael SAMPSON RCT. The first contract is for 91 vehicles with the second for 83 units

Canada operates a large fleet of 8x8 including the latest LAV-25 which is fitted with a GDLS turret armed with a 25 mm M242 cannon and 7.62 mm co-axial MG. Canada has also exported LAVs to Australia, Colombia and New Zealand.

PANDUR

The Austrian Army, and some export customers, deploy the now General Dynamics European Land Systems – Steyr PANDUR (6x6) APC and variants and further development as a private venture resulted in the Pandur II which is marketed in both 8x8 and 6x6 versions.

The PANDUR (8x8) has been sold the the Czech Republic and Portugal and more recently the Philippines with these coming from the Czech Republic with the prime contractor being Elbit of Israel with the deal also including a light/medium tank based on the latest GDELS ASCOD tracked platform with both of these having a 105 mm turret. Indonesia has also ordered the PANDUR II (8x8) with a weapon system.

While European contractors have been the main developers of 8x8 wheeled AFV, other countries have developed and placed these in production including STK of Singapore (TERREX), Hyundai Rotem of South Korea (KW2) and Taiwan (CLOUD LEOPARD).

THE BATTLEFIELD IS NOT HE HIGHWAY.

AND THE JLTV IS NOT JUST A TRUCK.

Oshkosh Defense is the premier manufacturer of armored vehicles for the US military. There are a lot of uncertainties in this world, but Oshkosh isn't one of them.



Optionally Manned Fighting Vehicle: Five Way Competition Underway

Sidney E. Dean

The United States Army's Optionally Manned Fighting Vehicle (OMFV) programme seeks to develop and procure a successor to the M2 BRADLEY Infantry Fighting Vehicle (IFV).

The new combat vehicle is intended to have both greater lethality and survivability when compared to the BRADLEY, in order to counter future battlefield threats presented adversaries, whether in the field or in dense urban environments.

The programme is currently in Phase Two, the Concept Design Phase. In July 2021, the Army announced the selection of five firms to participate in this 15-month long segment of the OMFV development programme. The competing consortia are led, respectively, by American Rheinmetall Vehicle (ARV), BAE Systems, General Dynamics Land Systems (GDLS), Oshkosh Defense, and Point Blank Enterprises.

Concept Design Phase

Contrary to common practice, the Army's December 2020 Request for Proposals (RfP) from industry was light on details. To avoid making unrealistic demands going in, the RfP kept firm requirements to a minimum, and presented a list of nine desired "characteristics" OMFV should have. These characteristics are:

- enhanced Survivability through hardening against fires and blast and reduced risk of detection;
- sufficient Mobility to keep pace with the ABRAMS Main Battle Tank (MBT) in combat;
- Growth potential for insertion of upgraded or additional systems over the vehicle's service life (to be achieved through a Modular Open Systems Approach or MOSA architecture);
- Lethality against a broad spectrum of ground and aerial threats;
- Weight must permit crossing of 80% of routes and bridges in pacing threat countries;
- reduced Logistics burden through advanced diagnostic capabilities and more efficient maintenance capability;
- Transportability via all standard air, sea, road and rail transport modes;
- Manning requirement limited to a two-



The RV-301 by BAE Systems

person vehicle crew, plus the option for unmanned remote control operation;

 Training capabilities embedded on board, and compatible with the Army's Synthetic Training Environment.

During the ongoing Concept Design Phase, the five competitors are developing purely digital designs. Several of them are based on existing vehicles and weapon systems but optimised for future requirements. James Schirmer, deputy director of the Executive Office Ground Combat Systems Programme, said the current initiative enables the Army to evaluate designs as they evolve, and test their operational viability and performance potential through modelling and simulations. "We can run them while they're still digital, and we can use this technique to avoid costly failures over a test range," thereby reducing some technical risk during the development programme, Schirmer said.

The Army is also using this phase to formulate more specific technical and capabilities requirements which it will impose as the programme moves forward. The Army plans a minimum of two cycles of requirements and specification updates during the Concept Design Phase. These updates will be preceded by interim detailed assessments of the ongoing designs. "This process allows the Army to make future decisions on the design without overly constricting vendor efforts to innovate," said Brigadier General Glenn Dean, Programme Executive Officer for Ground Combat Systems.

In October 2021, Brigadier General Dean announced that the first of these interim concept reviews had "recently" been concluded. The information from that review will guide adjustments to the simulation programme and will provide a basis for refining the Army's set of requirements for the OMFV, He said during the AUSA 2021 exposition in Washington, DC. The first formal OMFV requirements document, known as the A-CDD, is expected to be released soon. The final and binding set of requirements will be formulated after a system functional review at the end of the ongoing 15-month concept design cycle.

Contenders and Trends

Several of the contenders showcased their initial concepts at the October 2021 Association of the United States Army (AUSA) convention. While these vehicles were not prototypes of the eventual OMFV designs, they did provide insight into the general direction the respective firms are looking. It is also becoming increasingly clear that the greatest progression from current IFVs will not manifest in the vehicle chassis or even the weapon systems. The true dynamic will be presented by the onboard sensors and the advanced networking and mission control systems which will turn individual IFV platforms into nodes in a situational awareness network and kill chain. This compound structure will integrate the OMFV with main battle tanks and other manned and unmanned vehicles, and will project significantly more combat power than the sum of its component parts.

LYNX by Rheinmetall

American Rheinmetall Vehicle has definitively chosen the LYNX KF41 (Kampf-Fahrzeug or Combat Vehicle 41) as the point of departure for its OMFV design. A scale model incorporating modifications to customise the LYNX for American requirements was displayed at AUSA 2021. ARV plans to utilise a new, US-designed remotely operated turret mounting a 50mm gun and a variety of anti-tank missiles or COYOTE loitering munition UAVs. New 3rd Generation L3 sights promise to significantly enhance accuracy and engagement range.

When unmanned, the vehicle can be controlled from the ground or another vehicle, or from further back as long as the line of communications is maintained, said Mike Milner, ARV director of business development and strategy. Alternately the vehicle can be outfitted with a third crew station from which several robotic vehicles can be simultaneously controlled.

Milner stressed the LYNX's significant power generation capability, an aspect which will be vital for future upgrades with new sensors, vectronics and energy weapons. He also pointed out that the LYNX, unlike some other baseline contenders, was designed from the very beginning with a MOSA architecture. ARV has assembled a diverse industry team for the OMFV competition, including Raytheon, L3 Harris, Textron Systems and Allison Transmissions.

RV-301 by BAE Systems

BAE Systems presented the RV-301, which the company described as a "prototype rolling lab" to study various concepts the firm is considering for the OMFV design. Jim Miller, BAE's senior director of business development for combat mission systems, emphasised that the vehicle on display did not represent BAE's ultimate OMFV concept. Miller told reporters that BAE has instructed its engineers to "think outside the



The LYNX KF-41



The REDBACK



The LIBERTY by PBE

box" because the firm doubts any existing platform could be sufficiently modified to meet the Army's expectations.

The RV-301 presented at AUSA resembles a larger version of the Armored Multi-Purpose Vehicle (AMPV) which BAE Systems designed for the US Army. As displayed, the vehicle was equipped with the MT30 turret produced by Elbit (one of BAE's major partners for the OMFV programme). A 360 degree situational awareness system, an active protection system (APS) and vehicle automation solutions were also installed on the demonstrator. BAE has partnered with Curtiss-Wright Defense Solutions to develop the vehicle's MOSA suite.

KATALYST by GDLS

General Dynamics Land Systems has still not revealed details of its actual OMFV concept, but presented its KATALYST NGEA (Next Generation Electronic Architecture) on an unmanned demonstrator armoured vehicle. GDLS classifies the KATALYST MOFA as a 5th Generation electronic architecture which will form the core of the OMFV's operating system. It is designed to integrate a large number of mission systems including communications, sensors/situational awareness, fire control, electronic warfare, and APS. It is also designed to act as an interface with off-board robotic systems to enable effective manned-unmanned teaming, said GDLS' OMFV programme director, Ray Kiernan. He stressed the high level of artificial intelligence (AI) being designed into the firm's OMFV concept in order to reduce crew workload; features include autonomous driving and targeting capabilities. GDLS has so far limited the number of external partners, and has tasked General Dynamics' own Mission Systems division with providing vectronics and networking/communications/cyber systems. The display vehicle at AUSA did feature the AeroVironment SWITCHBLADE loitering munition.



The Army has chosen the Northrop Grumman/Bushmaster XM913 50mm chain gun as the OMFV's primary weapon.

Oshkosh

Oshkosh Defense, which has teamed with Hanwha Defense and Rafael, presented a large graphic of its OMFV concept for the first time at AUSA. The chassis is based on Hanwha's REDBACK IFV, but incorporates a Rafael SAMSON turret. Other partner firms include Plasan, Pratt Miller and QinetiQ. Being new to the development of large combat vehicles, Oshkosh Defense is relying heavily on its partners for specialised expertise.

LIBERTY by PBE

Point Blank Enterprises (PBE) is maintaining secrecy over its concept, which has been dubbed the LIBERTY platform. PBE's primary partner is Keshik Mobile Power Systems. Company talking points emphasise the benefits of the vehicle's distributed redundant hybrid electric drivetrain, exportable electric power and system-wide MOSA. Paul Palmer, PBE's senior vice president for advanced technology programmes, referred to LIBERTY as a "non-traditional platform" designed



Rheinmetall plans to utilise COYOTE loitering munition UAVs.

to facilitate the insertion of future technologies.

Major Third-Party Components

Some major components have already been determined, regardless of which firm builds the combat vehicle. The Army has chosen the Northrop Grumman/Bushmaster XM913 50mm chain gun as the OMFV's primary weapon. Utilising interferometric radar for target tracking, the XM913 promises precision accuracy against stationary or moving targets at stand-off range. In addition to ground targets, the weapon has been demonstrated in both the counter rocket, artillery and mortar (C-RAM) and counter-unmanned aerial vehicle (C-UAV) roles. Munitions options include coursecorrecting XM1203 Armor Piercing Fin Stabilized Discarding Sabot with Trace (APF-SDS-T) as well as XM1204 High Explosive Airburst with Trace (HEAB-T) projectiles. Northrop Grumman cites an effective range of four km, or roughly double the range of the Bradley's 25mm gun. The more powerful gun will significantly enhance the ability to engage peer-level adversaries. Another third-party subsystem is the Wireless Ethernet Backbone Security Network developed by Thales. The firm is currently working on an integration concept for fielding the network on the final OMFV.

Going Forward

The ongoing Concept Design Phase (Programme Phase 2) will continue through the end of fiscal year 2022 (FY22), that is through the end of September 2022. It will be followed by a four-months long interval during which the Army will conduct a full and open competition leading up to



The KATALYST NGEA by GDLS

Programme Phase 3, the Detailed Design Phase. Firms other than the five companies which are currently developing digital concepts will be eligible to compete for Phase 3 contracts. Army leaders have stressed that firms not participating in the current digital design competition are being kept abreast of developments. "The rest of industry will begin to see the direction that we're shaping that competition, and they'll see the performance specifications," Brigadier General Dean stated in October 2021. "They don't quite have the inside track [as the five current contractors], but if they are following along, they will be ready to pick up and compete."

The Request for Proposals for Phase 3 (and for the subsequent Phase 4, Prototype Construction and Testing) of the OMFV programme will be issued as early as May 2022. Up to three firms will receive Phase 3 contracts in the second quarter of fiscal year 2023 (FY23). This Detailed Design Phase will run through the end of FY24, and will also rely on digital engineering and testing to optimise designs before investing in physical prototype evaluation. "[We want to] look at the designs as they evolve in real time, and then take those designs and the data that comes with them and plug them into models and simulations so that we can run them while they're still digital, and we can use that technique to avoid costly failures on a test range," said James Schirmer in October 2021.

The subsequent Prototyping Phase (Phase 4) will begin in FY25. During Phase 4, each of the three selected contractors will build 12 prototype vehicles, which will be tested by the Army beginning in FY26; Phase 4 will culminate in downselect to a single competitor and award of a low-rate initial production (LRIP) contract. This Milestone C event initiating Programme Phase 5 (LRIP) is expected in the 4th quarter of FY27. The first operational battalion is expected to receive OMFVs beginning in 2028. The full-rate production decision is expected in FY29.

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Innovations in Transparent Armour

Tamir Eshel

Military operations have changed in the 21st century, from linear, massive battles between peers, to asymmetric engagements involving unequal forces. Military against insurgents, law enforcement against terror, and air power against elusive combatant elements hidden underground



and immersed within the civilian population. This new type of warfare has changed the perspective of military planners. The linear battlespace of the past required combat vehicles protected by massive frontal armour, supported by unprotected logistic formations that operated away from the danger at the front line. Today's warfare exposes all elements to threats, and requires all-around vehicle protection for the heavy forces and support elements alike; frequent increases in threat level requires constant improvements in protection.

Situational awareness, and quick response are mandatory, as forces are exposed to risks of attack from ambushes, remotely operated roadside IEDs or drone attacks from above while moving on public roads, immersed with the civilian population in the urban environment. In these environments, 360 degrees of vision and situational awareness become mandatory, as the unit and individual soldier's survival are dependent on their ability to identify the threat, react to the attack, and quickly defeat the enemy, thus denying him the element of surprise. This is easier said than done, since heavily armoured vehicles, raised high above the ground, such as today's Armoured Fighting Vehicles (AFV)s, even the Mine Resistant Ambush Protected (MRAP) vehicles rarely provide soldiers good coverage and situational awareness in these environments.

The ongoing conflicts in the Middle East and Africa, in Syria, Iraq, Yemen, Afghanistan, Central Africa, Ethiopia, Egypt, and Libya create an exponential demand for such MRAP-type armoured vehicles better designed for operations on roads in urban areas. For such missions, vehicles are designed with a monocoque formed with opaque armour, a large windshield, and side windows made of Transparent Armor (TA). This combination offers good situational awareness for the soldiers riding inside the vehicles and contributes to rapid orientation upon disembarking and egress. Traditionally, opaque armour is produced of steel or aluminium that offers a thinner but heavier solution for a given level of protection; ceramic or composite materials often augment metal armour to add protection and reduce weight. Lacking a transparent metal solution, TA facilitates ballistic protection by combining layered hard transparent materials and transparent composites bonded with resins and adhesives to provide a level of protection similar to opague armour. The most common design combines many layers of glass, polycarbonate, and polyurethane. In this combination, the glass provides the strength to resist a projectile's impact: as it shatters on the outer layer, the polycarbonate layer absorbs the energy of the fragments resulting from this impact. The level of protection increases by repeating the process through multiple layers of glass and polycarbonate, enabling such transparent blocks to contain the damage of 12.7 mm or even 14.5 mm projectiles inside the block, thus avoiding risk inside the protected space.

The Short Life of Transparent Armour

However, increasing the number of layers to improve the protection level also multiplies the block's weight, which becomes thicker and heavier. Another issue is that transparent armour laminates suffer unpredictable delamination in ambient-condition service, interfering with their transparency and reducing operational lifespan. The mechanisms leading to delamination are unknown and believed to be driven by exposure to moisture, thermal cycling, and stresses induced by differing thermal expansion of the



Transparent armour elements of the JLTV make the significant part of the protection package of the vehicle.
layers. These layered glass blocks may also become sensitive to chemicals used during routine operation and maintenance. Therefore, unlike opaque armour, vehicle operators should consider the recurring cost of transparent armour even for the combat vehicles kept in storage.

According to a Rand research study, TA has a relatively short lifespan of four to six years; other sources stated lamination longevity between six months and three years, resulting in high cost and reduced vehicle readiness. For some platforms, TA is the most unreliable vehicle component, and highend products provided with better sealing and framing ensure better transparency over time. Unfortunately, ATPD-2352T, the current purchase description for TA that sets the requirements for developing TA falls short in identifying a test to address long-term durability or service life.

As part of the effort to improve TA production guality, new inspection measures specify that TA meets certain delamination specifications during the manufacturing phase. For this purpose, the US Army Research Laboratory contracted Lumetrics, a manufacturer of precision noncontact thickness measurement and noncontact optical inspection systems, to produce a quality measurement method for TA products. Inspections using advanced integrated solid-state multiwavelength sources will increase the sensitivity and robustness of the MS-LCI technology. Real-time simulations of TA materials will also shed light on root causes and possible remediation methods.

While complete window and windshield replacement are costly, services turn to repairs. The Hardwire Company has developed a "Relamination" repair process that can reverse this process. Accelerated ageing testing shows repaired TA samples lasting over four years without delamination. Therefore, repaired TA could last much longer than currently available TA, making relamination of even smaller windows more economically attractive.

Relamination services done by the manufacturer or other TA glass OEMs often include the removal of the glass from the frame, replacement of the original polycarbonate layer which causes most of the hazing, re-bonding the layers in an autoclave, and repairing the frame as needed. Although this is a manual intensive process, it eliminates the need to replace the complete TA window.

Improving manufacturing processes is another way forward. New developments pursued under Small Business Innovation Research (SBIR) funding encourage companies to improve the service life of TA by



Relamination: Relamination provided by Hardwire demonstrates how delaminated TA can be repaired and returned to effective use.



Ballistic protected windows on the HIMARS rocket launchers use synthetic sapphire layers enabling the window to withstand the heat and blast produced by the rocket launch.

exploring the use of alternative materials, design, maintainability, and manufacturing techniques applicable to tactical wheeled vehicles, aircraft, and vision blocks. The objective is to develop and test an innovative lightweight, transparent armour system with equivalent performance to the current solution but that is 25% lighter at less than half the price. The new armour system should be a direct drop-in replacement for existing parts and is to be demonstrated and tested in a curved 33 in x 17 in window format.

Another issue with TA is that each impact reduces the protection level of the armour block. At the Naval Research Laboratory (NRL), scientists have developed a transparent thermoplastic elastomer that enables damaged armour surfaces to be repaired 'on the fly' in the field. Ther-

moplastic elastomers are soft, rubbery polymers converted by physical means, rather than a chemical process, to a solid. This process is reversible, thus enabling the repair. Up to now, NRL scientists have tested the use of polymeric materials as a coating to achieve improved impact resistance of the rigid substrates. Applying polyurea and polyisobutylene layers enhances armour and helmets' ballistic performance and achieves greater ballistic effectiveness and mitigation of blast waves. By using a variation of employing thermoplastic elastomers, NRL scientists can recreate superior ballistic properties of polyurea and polyisobutylene coatings, with the added benefit of the material being transparent, lighter than conventional bullet-resistant glass, and repairable.



The US Air Force Research Laboratory has developed transparent armour for helicopters using the AION ceramic material, offering dramatic reduction in weight and thickness while maintaining a high level of protection for the aircrew.

Harder Materials for Lighter Protection

When weight and performance are paramount, armour designers turn to unique products that can offer thinner solutions to reduce the weight of an armour kit and increase the available volume inside the protected capsule. While these methods also use layered glass to create the transparent block, using materials significantly harder than glass offers better ballistic performance that results in higher protection levels or fewer layers to meet a given level of protection. Sapphire (Al_2O_3) , the hardest transparent material, second only to diamond, provides an extremely hard and abrasion-resistant strike face that 'breaks' the projectile upon impact. It has a high transmission level in both the visual and infrared spectra, thus offering good visibility in daylight and for night vision devices. It is chemically inert to withstand harsh chemical environments better. For transparent armour applications, Saint-Gobain provides the Synthetic SAFirE line of products that includes transparent protection solutions, offering performance at half the weight and thickness compared with conventional layered glass products of the same capability.

Frequently, the combination of two or more properties makes Sapphire the only material available to solve complex engineering design problems. For example, ballistic protected windows on the HIMARS rocket launchers, enabling the window to withstand the heat and blast produced by the rocket launch.

Traditionally, transparent armour was associated with land warfare, where heavy, flat windows made of heavy glass-polymer blocks are used in armoured vehicles. But the need to protect low-flying aircraft and helicopters calls for the use of more advanced, curved, lightweight structures that can protect aircrews and passengers from ground-based small arms, machine guns and sniper fire.

Over the past several decades, the US Army has been interested in transparent (visible and infrared wavelengths) armour ceramics that offer lightweight protection with minimal optical distortion. Aluminium





Transparent armour plate installed in the cockpit of an Airbus H145M. This application uses OSG's CERALITE product that offers a high level of protection, low weight and good transparency following an impact.



TA windows made of a matrix of rectangular or hexagonal ceramic pieces offer high levels of protection and residual visibility even after multi-hit events (below).

oxynitride (AlON) and Spinel (MgAl $_{2}O_{4}$) are two leading materials for such applications. Initially, the producibility of such materials was limited to small panels, leading to armour applications of vision blocks for armoured vehicles to face shields for individual soldiers. Production methods have improved significantly in recent years, yielding sheet sizes up to 26x9 inches.

The cost and slow manufacturing of Sapphire have limited the use of this material in mass-produced, price-sensitive programmes, driving developers to seek other solutions that would offer similar characteristics at a lower cost and production scale. AION and Spinel are two solutions based on transparent Alumina ceramics. AION is a transparent ceramic material composed of aluminium, oxygen, and nitrogen (aluminium oxynitride). It offers higher performance than glass, although lower than Sapphire. Currently, AION is used only on flat surfaces; the next step in the manufacturing process will be to produce curved windows, which may require different materials.

Aerospace applications were the driver of this development. In 2019 the US Air Force Research Laboratory demonstrated the use of AION for transparent armour used on the BLACKHAWK and CHINOOK helicopters of the US Army. Unlike Sapphire that must be manufactured from a large block, AION begins as a powder formed into unique shapes and made transparent through the application of high temperature and pressure. The NRL has worked on a method of making spinel sheets out of powders sintered in a hot press. It is a low-temperature process, allowing to produce large sizes. Spinel comes in different flavours; some, like CeraNova Spinel are x6 stronger and x3 harder than glass, so they provide an excellent strike face for transparent armour, offer scratch resistance, and very high heat resistance - Spinel maintains 75% of its strength at temperatures of up to 1,000°C. Another advantage of Spinel is that it is not limited to flat surfaces - curved parts, such as sensor covers and conformal windows, can be produced at near net shapes, significantly reducing machining requirements.

Since the most vulnerable area in the helicopter is the lower section of the fuselage, lightweight composites and ceramics can provide reasonable protection against such threats. However, chin and side windows that are critical for the pilot situational awareness, particularly during the landing approach, require transparent protection to function. Since using layered glass-polymer products for this purpose is impossible for this application, due to the high specific weight of these products and low transparency in the infrared waveband, OEMs turn to other modern materials such as curved ALON, Spinel, or Matrix Armoured Glass for these applications.

Using a matrix of high-hardness transparent parts as the strike faces of an armoured glass window offers the benefits of both worlds - producibility at a lower cost and flexible curving that can meet any existing or new design, regardless of the shape of the outer envelope. In 2021 OSG introduced the first Ceralite-based products of this type, offering transparent chin inserts for Airbus H145 helicopters and lower side windows for Lockheed Martin Sikorsky UH-60. The insert is mounted on an A-kit installed in the cockpit; thus, it can be removed when the helicopter operates in routine missions outside the danger zones. Ceralite offers a weight reduction of 40-60%, compared with glass-polymer layered products. Another advantage of the matrix formation is improved multi-hit protection and visibility, as these structures performed 50 to 100% more efficiently against multiple strikes and impacts.

Window Alternatives

While TA is heavier than opaque armour, it is also limited in the protection capability it can offer. A window would become a vulnerable point on medium and heavy armoured vehicles. Therefore, on such vehicles, designers turn to other solutions to improve visibility while reducing the window



GuS produces panoramic periscopes up to one-metre wide. By replacing a large and heavy windshield made of laminated glass this periscope reduces up to 90% of the weight and offers multi-hit capability.



An e-glass concept used in the side doors of the NXT 360 'next-generation HUMVEE' from AM General was shown by the company at DSEI 2021.

area as much as possible. Two technologies being explored are panoramic periscopes and electronic windows.

A panoramic periscope can replace a STAN-AG level 4 glass with a width up to one meter while offering more protection and approximately 90% less weight than a conventional armoured glass window. Such a periscope is designed for the driver and the commander to see through one object. This vision system is built with acrylic prisms for better ballistic performance, offering good multi-hit capability and residual visibility after impact. It can be optimised to cover a specific field of view adapted using flap mirrors.

'Electronic windows' are another method used to improve protection and reduce weight. Such an e-glass concept is used in the NXT 360 'next-generation HUMVEE' from AM General. Digital video cameras deliver a 60°-120° field of view live feed of the outside environment to ruggedised low-latency high-definition LED displays on the inside of the vehicle, at the passenger's position, and to the commander's display. This eliminates the need for heavy transparent armour on the rear passenger doors. TA expert OSG also offers the ScreeneX display system embedded into the window, enabling the presentation of emergency signage, tactical maps, or outside camera views directly on the glass window.

Summary

Carving its place as an essential element in the protection suite of modern combat systems, TA has become increasingly important. Beyond the traditional ballistic protection of warfighters in combat vehicles, transparent armour also protects aircrews, sensors, and effectors, in numerous combat systems applications. Improved optical transmission, better abrasion resistance, and higher tolerance to temperature and the elements improve tolerance and extend life span, enabling designers to offer users more reliable and useful materials.

Diesel vs. Electric Propulsion: Hybrid Power for Heavyweights

Launching the process of military equipment electrification

Alex Horobets

Decrease in fuel requirements for military equipment on the battlefield is one of the arguments in favour of using electric motors or hybrid power plants in the near future. In addition, electric motors are quieter than internal combustion engines, which reduces the audibility of approaching vehicles and their detection in the infrared range.

n a military environment, the delivery of fuel under enemy fire can often lead to casualties among the soldiers involved. A high number of US and other NATO soldiers were attacked while delivering fuel in Iraq and Afghanistan. However, any confrontation with an opponent such as Russia, which operates long-range missiles, poses an even greater threat to the security of convoys.

Development Programmes

Today, no one knows for sure when the leading armies of the world will be implementing electric traction in their armoured vehicles. The development of electric transmissions began in the 1980s, and the interest in this development continued into the 1990s. However, projects of this nature failed to make any progress due to the lack of technological development.

The Armored Systems Modernization (ASM) programme of the US Army lasted from the mid-1980s into the 1990s. Under this programme, Kaman Electromagnetics, in collaboration with Allison Transmission (a General Motors department), together with Teledyne Vehicle Systems, developed an electric transmission for a 50-tonne tracked vehicle. At that time, the Army planned to modernise its armoured family of vehicles with a common chassis and modular components. This principle was supposed to reduce the costs of maintenance but since that time, costs of development and production were deemed too high. The Teledyne design made it possible to create a prototype for further testing of new elements in heavy armoured vehicles. The General Electric LV-100 gas-turbine engine with 1,235 hp was developed under the Advanced Integrated Propulsion



A HMMV convoy deployment in the Afghanistan mountains

System (AIPS) programme of the US Army, and the Kaman transmission generator converted mechanical energy into electrical energy.

During the tests, the advantage of the electric transmission was demonstrated, when electric energy was transmitted not only to traction motors, but also to the systems of protection against nuclear and chemical agents, and to the active protection power supply and the turret.

At that time, the electric motors and generator were quite compact, but the electric transmission control systems have remained cumbersome.

In addition to the Kaman transmission, the United Defense Company was developing an alternative solution with asynchronous traction motors. Each of the options had its disadvantages; however, the simplicity and the ability to develop high levels of torque made it possible to consider the most suitable for creating electric transmissions for tracked vehicles. Furthermore, the United Defense Company was carrying out work with a hybrid drive in the M113 Armoured Personnel Carrier. The portable battery power supply created an alternative to the engine as a source of energy. Such a hybrid drive provided the possibility of covert movement for short distances with the main engine shut off, depending on the capacity of the batteries. Research in the field of electric drives in the 1990s was also carried out in France for the French Ministry of Defence. The CS-Defense Company, along with Panhard, worked on the electric drive for a 15-tonne armoured vehicle with a 6x6 wheel arrangement.

The development of electric transmissions was also carried out in Japan by Mitsubishi.

The Electric Motor

Today, it is too early to talk about the widespread introduction of electric motors for military equipment. However, experts are



Soldiers on patrol in Afghanistan

expecting a quantum leap in these activities over the coming decade. As we can see, the whole idea of an electric motor and transmission is nothing new, and many private companies are already implementing innovations in this area. Many private defence companies have also developed armoured vehicles with an electric or hybrid power plant. The global market for electric drives is changing as their efficiency is improving. One factor to consider here is the rapid growth of electric vehicles in the civilian sector. Today, an increasing number of countries are planning to move away from using internal combustion engines within a few decades. And this trend has created a precedent when new technologies are first introduced in the civilian sector on a large scale, and are then transferred to the defence sector, and not vice versa. We should bear in mind that the introduction of an electric motor requires changes in the form of the armoured vehicles and the features of their use.

This implies the use of modern technology to improve the survivability, mobility and automation. Sensors in such a technique will be able to collect a huge amount of



The M113 armoured personnel carrier has already been tested with a hybrid drive system. The portable battery power supply provided an alternative to the engine as a power source. Such a hybrid propulsion system offered the possibility of moving covertly over short distances with the main engine switched off, depending on the capacity of the batteries.

information about the environment and to process it with the help of artificial intelligence.

As a result, combat missions can be performed more efficiently and safely. Of course, outdated equipment will no longer be able to compete in many respects.

The electric engine underlies many changes and the introduction of new technologies. The electric engine for example, works better than the internal combustion engine in terms of controllability, starting speed, acceleration, and manoeuvrability of the equipment.

In this context, many mechanical parts required for the traditional propulsion system are being replaced by flexible cables, creating a large, redesigned space.

The replacement of many mechanical elements in the engine and shaft also creates the basis for the formation of a unified electronic system, which includes the power plant itself, control elements, necessary sensors, communication systems and the on-board computers.

Equipment Autonomy

All these components allow for greater autonomy of military equipment, as an intermediate element to smarter vehicles. The source of electricity will be used both for movement and for powering the electronic devices, sensors and electronics. Computers usually interact more organically with electrical than mechanical systems.

Mobility and manoeuvrability also contribute to the advantages of electric motors. Military vehicles can achieve faster speeds as each wheel can be independently controlled in terms of both grip and direction of rotation. Replacing the mechanical elements with lighter electrical systems allows for the optimisation of the armour. This is also due to the fact that the mechanical drive shaft is removed from the base of the combat vehicle which provides for better protection from explosive devices. In addition, electrical systems are easier to replace and upgrade compared to internal combustion engines and transmissions. Of course, the electric motor also offers lower fuel costs and improved fuel efficiency. The electric propulsion system provides a dramatically improved acceleration time than the internal combustion engine.

The hybrid electric drive system responds instantly to the need for movement by generating torque. This principle can be seen in electric vehicles, and it also applies to armoured vehicles. The ability of the electric motor to control the accuracy



The M1A2 ABRAMS Main Battle Tank

and direction of movement, together with computer systems, creates the basis for further integration with intelligent systems, including the creation of unmanned systems.

It is expected that the development of electric motors will provide for the improvement of related systems, namely the necessary sensors, batteries, and improved capabilities of artificial intelligence.

Batteries

Over the past decade, the cost of batteries has already dropped significantly; while their capacity has increased, the charging time has decreased, resulting in significantly enhanced performance. So, the assertion that main battle tanks and other armoured vehicles of the future will run on electricity, or use a hybrid drive system in a transitional phase, is difficult to refute. Such a shift will not only reduce the demand for fuel in a war situation, but it will also reduce the risk to convoys transporting fuel to the front lines.

In modern conditions, the multi-tonne armoured vehicle requires a huge amount of energy to move over rough terrain, power fire control systems and sensors. Spare power for towing other tanks and armoured vehicles is also required.

According to Global Security Review, the Army's armoured division, with all its armoured vehicles and tanks, can consume up to 500,000 gallons of fuel a day when active and on the move, which is typically supplied from the continental part of the United States. Accordingly, the transition to electric drive systems will significantly reduce the amount of fuel required in the combat zone. But this will not completely remove the need for energy; it will simply be generated in a different form. And this is still under discussion.

According to the National Defense magazine, in 2004, the US Army expected their hybrid trucks to meet their stated goal of 75 per cent fuel savings by 2020.

At that time, according to the Defense Science Board, which advises the US Department of Defense, fuel accounted for about 70 per cent of the logistics tonnage in a heavy armoured division. And the cost of delivering a gallon of fuel to the battlefield was US\$600.

The Oshkosh Truck Company expected that its hybrid-electric vehicle, the Heavy Expanded Mobility Tactical Truck (HEMTT) with the ProPulse system, would burn 40 per cent less fuel than a standard HEMTT, depending on the mission.

Despite the distinct advantage and effectiveness of hybrid installations, to date, however, they are still at the experimental stage, and as yet, have not been put into operation. For example, this deals with the possibility of installing a 1,000-hp Advanced Powertrain Demonstrator on the M2 BRADLEY, or on the new models of the controlled or robotised machinery.

Advanced Powertrain Demonstrator Initiative

The Advanced Powertrain Demonstrator (APD) initiative was launched in 2015 after the Army rejected the previous Ground Combat Vehicle programme. The main objective was to develop key technologies required for the creation of revolutionary platforms of the future. The Advanced Powertrain Demonstrator consists of several components, including an advanced combat engine, a gearbox, a built-in starter generator, modular batteries, and a temperature management system. The builtin starter generator is actually an engine, which is another piece of key technology. It generates 160 kW of power, which is about ten times more than on the current medium combat vehicles. The large amount of power generated by the engine can be used to expand the capabilities of the platform, such as electrical armour and lasers, or it can be exported to power other systems.

According to the digital magazine Breaking Defense, the 1,000-hp Advanced Powertrain Demonstrator produces 48 per cent more horsepower than the most modernised BRADLEY variant and 67 per cent more than the standard 600-hp model. It is also compact enough to fit even into the BRADLEY.

The current Advanced Powertrain Demonstrator installed in the M2 BRADLEY for testing, can move military vehicles weighing up to 50 tonnes. The power created by the engine is crucially important for the modern combat vehicle. For example, during the war in Iraq, the outdated BRADLEYs were augmented with a large number of sensors, additional monitors, communications equipment, and radio jamming systems to deactivate explosive devices.

In modern conditions, the vast arsenal of the Russian RPGs and anti-tank missiles



BAE Systems integrated an HED system onto a BRADLEY Fighting Vehicle for the US Army's RCCTO.

pose a serious threat and this triggers debates concerning the installation of active protection systems on armoured vehicles. Such systems include radars to detect artillery shells and the corresponding missile launchers to counter them. This also implies high energy consumption. They will later need the additional energy for the operation of the laser and microwave weapons, as well as for countering drones. By 2022, it is planned to integrate the Advanced Powertrain Demonstrator into the unmanned BRADLEY prototype, also referred to as the Advanced Mobility Experimental Prototype.

Another logical nominee for APD technology is the Optionally Manned Fighting Vehicle, which is being developed to replace the BRADLEY.

Electric Motors in the Coming Years

In 2021, we observed some progress in terms of gradual introduction of electric motors into military armoured vehicles operated by the US Army. In all likelihood, heavy armoured vehicles will be the first to be equipped with a hybrid system. The hybrid electric drive systems use the energy accumulators of higher energy densities and capacities in order to power vehicle systems and to support the main engine during its peak performance such as during acceleration. In general, preparations for transition to electric motors in the US Army have already begun.

The Army Futures Command made a request to Fort Benning, one of the largest military bases in the United States, for information on what is required to equip tactical and combat vehicles with electric motors. According to a news release, the Manoeuvre Capabilities Development and Integration Directorate is currently drafting a document on the future requirements for the tactical and combat electrification of vehicles, the introduction of electric motors in the US Army's ground forces, and reducing dependence on fossil fuels.

According to information provided by Military.com, Lt. Gen. Eric Wesley, the deputy commander of Army Futures Command and director of the Futures and Concepts Centre, stated in April 2020 that the developers of the Tesla civilian vehicles in Palo Alto, California, have already proved that electric motor technology can be used to drive vehicles as large as the Joint Light Tactical Vehicle. It seems that the Pentagon also believes in switching to electric traction power and batteries. Since 2009, a new diesel hybrid called the Clandestine Extended Range Vehicle (CERV) has been tested in the US Army. It is designed for shortterm special operations such as reconnaissance, surveillance and targeting. It was noted that fuel economy would be a considerable advantage of this special vehicle. The vehicle was designed by the Quantum Fuel Systems Technologies Worldwide in cooperation with the US Army's Tank Automotive Research, Development and Engineering Centre (TAR-DEC) National Automotive Centre.

In 2020, the US Army's Rapid Capabilities and Critical Technologies Office (RCCTO) signed an agreement with BAE Systems for US\$32M. Under this agreement, the Hybrid Electric Drive (HED) system is expected to be installed onto the BRADLEY. A key component of the HED system for the tracked combat vehicles is the cross drive transmission (Modular E-X-Drive) developed by QinetiQ. Such an integration should significantly improve the efficiency of the vehicles and provide the energy reserves for integration with future systems and technologies. Moreover, the Hybrid Electric Drive should significantly increase the mobility of the combat vehicle on the battlefield, and also its range, which significantly exceeds the existing operational capabilities of the BRADLEY IFV.

Due to slight modifications, the Hybrid Electric Drive technology can be installed on other combat vehicles, including the BRADLEY, the M109A7 self-propelled howitzer, and the family of Multiple Launch Rocket Systems.

Conclusion

According to trends in the US Army and defence companies concerning the introduction of electric and hybrid power plants, the question is not whether this will happen, but when, and in what form new models of armoured vehicles will take.

Most likely, during this transition period, hybrid power plants will be introduced, since electric motors at this stage are not yet able to fully power the multi-tonne equipment on their own.

These days, many companies have already expressed their readiness for further electrification of their armoured vehicles. Every year, armoured combat vehicles face an increasing need to confront new challenges, such as drones.

Further development of laser technology is also expected in the nearest future. This whole set will require more and more energy from the power plant for a longer period of time.

The civil electric vehicle market will also make its own adjustments, as the production of electric motors will gradually divert the industry, moving further away from the internal combustion engine. In addition, electric motors have a number of advantages that are applicable specifically under combat conditions, such as quieter operation when moving, ease of maintenance due to fewer mechanical parts.

This technology can also increase the range of vehicles.

It should also be taken into account that if hybrid installations are already applicable today, then with fully electric equipment, the question regarding the source of recharging during combat missions, far from support bases, remains unresolved. However, according to the experts, this issue can be resolved in the upcoming decades.



Viewpoint from Tel Aviv





The Military Business Behind the Abraham Accord

Tamir Eshel

he 2021 Dubai Air Show was the first international air show happening live since the break of the COVID19 pandemic. For the Israeli exhibitors the Dubai Air Show represented a unique and important milestone. A year following the signature of the Abraham Accord, the normalisation between Israel, the UAE and Bahrain, it was the first time that Israel's defence companies could officially participate in at a defence and aerospace event in an Arab country in the Middle East.

The participation came nine months after the earlier event, IDEX 2021, that was supposed to bring many more Israeli defence companies to the UAE. However, at the time, Israel entered a full closure under COVID19 restrictions.

The event in Dubai had less exhibitors from Israel, but they were able to interest their Emirati customers. This time Israeli defence companies were prepared with local offices and subsidiaries handling their affairs. These include IAI, Elbit Systems, and Avnon Group. Such local offices would pave the way for those companies to establish closer relations with potential customers in government and defence, seek closer cooperation with the local industry and collaborate on export programmes. They also provide a more efficient way to deal with the Emirates under Israel's tough defence export laws.

IAI often establishes joint ventures with companies and organisations in strategic, and the company intends to follow this route in the UAE. This strategy has provided customers an early access to some of the world's most advanced defence capabilities, including spy satellites, cyber security, border defence network, air and missile defences, special mission aircraft, and loitering missiles. Cooperation is also undergoing with homeland security activities and cyber security. IAI also supports establishing a national cyber defence capability in the UAE, building on the proven model implemented in other countries. Early in 2021, IAI has signed a Memorandum of Understanding with UAE's Edge group to develop advanced Counter-Unmanned Aircraft Systems (C-UAS) tailored to the UAE market, with wide-ranging benefits for the region. By November 2021 IAI expanded its cooperation with Edge to develop unmanned surface vessels with applications in naval security, anti-submarine and mine warfare.

Rafael also aims high here. Until November 2021 the main effort was promoting the IRON DOME air defence system that was

thought to be an ideal solution for the UAE's short-range air defence requirement. Eventually, the Emirates favoured the Korean M-SAM system, despite their interest in the Israeli offer. Despite the disappointment and loss, for Rafael this was merely the opening shot for the marketing of its air defence capabilities in the region. Other areas of interest for Rafael are two previously classified programmes that are now can offered to the UAE – including the LITESAT mini spy satellites and the DRONE DOME laser-based counter-UAS system. Both were represented in detail at the company's air show exhibit.

C-UAS is one of the capabilities offered by the Avnon Group. The company demonstrated a wide range of counter drone capabilities, some are already operational with a number of operators in the Middle east and Africa.

The Dubai Air Show provided the venue launching Elbit Systems' local subsidiary Elbit Systems Emirates (ESE). According to Ran Kril, Executive Vice President for International Marketing & Business Development of Elbit Systems, the Abraham Accords provide a sound basis for business collaborations in the region. The UAE and other countries in the region are important new markets for Elbit Systems. The local presence seeks to foster long-term cooperation with the United Arab Emirates (UAE) armed forces, oversee customisation of solutions to operational needs of end users and lead the transfer of technologies to local partners. At the Dubai Air Show, the company displayed a surprisingly wide range of products and capabilities including the MUSIC line of DIRCM missile countermeasures for military, business and civil aircraft, and the ElynX family of software defined radio that has been successfully operationalised with several European Armies.

The UAE have gone a long way in acquiring a modern defence force. Its combat-experienced military is eager to seek the most advanced technologies available from the local defence industry and foreign suppliers. This makes the UAE an excellent match to Israeli capabilities, tapping Israel's technological advancements and research capability, with the ambitious, well-funded procurement programmes of top-quality defence systems, excellent technical skills, and acclaimed academic establishments of the UAE. Together, Israel and the UAE can give a new meaning to the Abraham Accord.

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East European Armoured Vehicle Programmes

Eugene Kogan

The fleets of armoured vehicles in the armies of Eastern Europe often date back to Soviet times. Most of the military equipment from that time is hopelessly outdated and irrelevant to the modern battlefield. Many countries in Eastern Europe are therefore renewing their armoured vehicle fleets.

t needs to be emphasised that the procurement funds were allocated in 2020 while the below mentioned countries reacted differently to the acquisition process. For instance, Bulgaria terminated its acquisition of the AFVs and is currently looking for possible domestic production. Although the Czech Republic postponed the tender in 2020 due to the pandemic in November 2021, the Ministry of Defence announced that none of the bids submitted meets all the requirements. However, Hungary purchased LYNX IFVs and BUF-FALO ARVs from Rheinmetall and appears to be satisfied with the choice that it made. Romania started the procurement process earlier and appears to be on the right track while the Slovak government first cancelled the purchase of AFVs in May 2020 and then agreed for a new tender in September 2021.

Bulgaria – Acquisition Termination

In 2020, the country's defence budget stood at BGN 1.94Bn (\in 1Bn) or about 1.93 per cent of Bulgaria's GDP according to data released by NATO in October 2020. In 2021, the defence budget remains the same, however, there is no figure yet for 2022.

The Defence Ministry Press Office issued an official statement in March 2021 that the ministry had sent letters to General Dynamics European Land System and Patria that "it is terminating the procedure for acquiring AFVs for the Land Forces." The reason for termination was that the two companies' price proposals, both of which were admitted to the second stage, significantly exceeded the framework ap-

<u>Author</u>

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The CV90 has been one of the contenders in the scope of the Czech IFV requirement.

proved by the country's National Assembly. Krassimir Karakachanov, then Minister of Defence, instructed the management of the state company Terem-Holding EAD, to study the possibilities for the joint production of vehicles in Bulgaria with the maximum participation of the country's defence industry. At the moment, for the newly elected government (on 13 December), the approval of the Terem feasibility study is not yet a top priority since the country is facing both economic and pandemic difficulties. However, much depends on Stefan Yanev, the old/new Minister of Defence. Whether or not things will change in 2022 remains to be seen.

Czech Republic – Disappointed Yet Looking Forward

According to Jakub Fajnor from the Defence Ministry's Communications Department, "in 2021, the defence budget increased to CZK85.48Bn or around 1.4 per cent of the GDP. The budget for 2022 has not yet been debated since the new government was sworn in only on 17 December. In addition, the budget must be approved by the Parliament." As a result, figures for the 2022 defence budget may be released in January or February 2022.

In April 2021, upon the invitation of the Ministry of Defence, BAE Systems sent the CV90 IFV, the General Dynamics European Land Systems' ASCOD IFV and Rheinmetall's LYNX IFV to the Czech Republic for testing. As one of the tender's requirements, potential suppliers must ensure that the Czech defence industry is involved in at least 40 per cent of the contract. This has stimulated a partnership between suppliers and Czech companies. In November, the ministry announced that none of the bids submitted met all the requirements. Jakub Fajnor clarified to the author that "the programme has not been cancelled and the participants have not been disgualified. However, the programme has been halted for now and a thorough analysis of the possibilities of what to do next is going to follow. We cannot rule out a continuation of the current process, which would mean discussing the shortcomings with the contractors and asking them to submit new offers. However, the analysis will be evaluated by a new minister and his/her team in order to decide what should be the next step. Therefore it is not possible to say [at the moment] what is most likely to be the next decision."

What is evident, however, is that similar to the procurement programme of Slovakia (discussed below), the Czech Republic faces an acute problem of obsolete Soviet-era BVP-2 vehicles and it is imperative for a new defence minister to refocus on the IFV procurement programme.

In addition to IFVs, the Czech Army plans to purchase 6x6 wheeled AFVs TITUS vehicles from Tatra Defence Vehicles - 42 pieces as command-staff and connecting configuration vehicles, and 20 pieces as wheeled vehicles for the Fire Support Coordination Centre (FSCC), including logistic support and training. The overall price, including accessories and support, is CZK6.072Bn. The delivery of the vehicles should take place between 2022 and 2023.

Hungary – Mission Accomplished

The country's defence budget was €2.2Bn in 2021 with an increase to €2.8Bn in 2022. Hungary agreed to purchase Rheinmetalldesigned and built LYNX IFVs and BUFFALO ARVs in September 2020 which opened a new chapter in the country's defence industry development. Furthermore, this was the largest ever defence contract in Hungary's modern era. According to the Innovation and Technology Minister, Laszlo Palkovics, "The joint-venture [between the Hungarian state and Rheinmetall] which is currently built in Zala, is completely in line with the goal of the Hungarian Government. From 2023, one of the most modern and cutting edge armoured combat vehicles will be manufactured in Zala and thanks to the nearby ZalaZone testing field, a complex development process can be re-



The Czech Army plans to replace its obsolete Soviet-era BVP-2 vehicles.

alised." Thus, it can be said that the procurement of armoured vehicles has been accomplished.

Poland – Increase in Defence Expenditure

The country's defence budget was amended in September 2021, with an increase of defence expenditure of PLN6.3Bn (~US\$1.6Bn) to PLN58.1Bn or 2.4 per cent of the GDP. It is expected that Poland will spend PLN57.78Bn on defence in 2022 or 2.2 per cent of its GDP, excluding the below mentioned long-term M1A2 v3 ABRAMS MBT procurement programme.

In July 2021, Jaroslaw Kaczynski, Head of the National Security and Defence Matters Committee of the Council of Ministers, said that "a total of 250 M1A2 v3 ABRAMS MBTs will be procured for the country's armed forces." The justification for acquisition of the MBTs in the budgetary bill for 2022 reads as follows: "The goal of the



In November 2021, it was reported that Poland was set to acquire 300 second-hand COUGAR mine-resistant, ambush-protected (MRAP) armoured vehicles from the United States. According to the Defence Minister, Mariusz Blaszczak, under the plan, the COUGARS are to be delivered to the armed forces in the first quarter of 2022 "owing to an accelerated procedure. The contract also covers a logistics and training package." The value of the deal is US\$27.5M.

Romania – Better Than Expected

According to a press release of the Ministry of National Defence (MoND) issued in February 2021, the budget of the ministry proposed for 2021 includes funds of US\$5.6Bn or 2.04 per cent of the country's GDP. The Romanian Government allotted a little more than 2 per cent of its GDP for the defence budget or about €4.5Bn.

In 2018, the MoND ordered 227 PIRANHA V wheeled armoured personnel carriers in six different configurations. The contract, valued at €850M, provides for the vehicles



Hungary has just procured LYNX IFVs designed and built by Rheinmetall.



In dynamic firing tests, GDELS verified the performance of the PIRANHA 5 overall system with the Elbit UTR30 Mk 2 turret and exceeded the set requirements in the presence of Romanian procurement authority representatives.

to be manufactured within a scope of strategic cooperation and technology transfer between General Dynamics European Land Systems-Mowag (GDELS-Mowag) and the Bucharest Mechanical Plant (Uzina Mecanica Bucuresti, UMB). In November 2019, the production of the remaining 191 vehicles started at UMB, with its employees having been at GDELS during the production of the first vehicles.

The ministry acquired the first 36 PIRA-NHA V wheeled armoured personnel carriers manufactured in Switzerland by GDELS-Mowag in October 2020. The vehicles were handed over to the Infantry Battalion "Red Scorpions" of Craiova, following a successful test at the UMB. The ministry stated that the second batch of 32 PIRANHA V carriers was handed over to the Infantry Battalion "Dolj" in Craiova on 26 October.

In July 2021, it was reported that the Romanian Special Operations Forces will be equipped with 130 Oshkosh Defense Joint Light Tactical Wheeled Vehicles (JLTV). The JLTV will replace the old HUMVEE. The deal is worth about \leq 47M. The MoND did not provide information regarding the date of arrival for the first JLTVs in the country. It is known, however, that it was a G2G contract.

In late 2020, Oshkosh Defense sent an official offer to the MoND for JLTV vehicles in the armoured and unarmoured 4x4 programme for the Army. In September 2021, it was reported that the French company Arquus will present the range of SHERPA JLTV and their industrial strategy. Arquus also intends to participate in the tender organised by the MoND for the purchase of new armoured vehicles.

In November 2021, it was reported that Oshkosh Defense was moving faster than Arquus regarding the tender. It requested an audit and initiated talks with officials of the Uzina Automecanica Moreni Plant.

Slovakia – Better Late Than Never

According to MoD Spokesperson, Martina Koval-Kakascikova, "the country's defence budget was about 2 per cent of GDP, which dropped to 1.75 per cent in 2021 and will be \in 1.838Bn. However, the overall expenditure is expected to reach over \in 1.899Bn or 1.8 per cent of the GDP in 2022."

The country's procurement programme is currently at the preliminary stage. Nevertheless, it is important to emphasise that this programme is crucially important for the Slovak Army since the current fleet of armoured vehicles is obsolete. Therefore, the ministry initiated a procurement programme with a very tight schedule in October 2021: 33 countries were invited to submit their bids. Submissions of final offers for the AFV and IFV programmes are 31 December and 31 January 2022, respectively. The three best bidders will be selected in each programme and their vehicles will undergo trials in-country. Subsequently, the ministry is to present the country's government with a recommendation for the procurement of the AFVs by the end of March 2022 and the IFVs by the end of June 2022. The first vehicles are planned to be delivered at the beginning of 2024. The total value for the 152 IFVs is about €1.739Bn and €332M for the 76 AFVs. Slovak Deputy Defence Minister Marian Majer has said that the potential suppliers must ensure that "the Slovak defence industry is involved in at least 40 per cent of the contracts. For this reason, the Ministry of Economy will also take part in the tender evaluation process. Ultimately, our aim is to deliver realistic and long-term assistance to Slovak industry and companies."

It remains to be seen whether or not the procurement programme will be successful and whether or not the Slovak Government has learned from the unsuccessful procurement programme of IFVs in the Czech Republic.

Conclusion

There is a clear realisation in these countries that procurement of IFVs and AFVs is of the utmost importance to the countries' defence and security. The respective governments understand that their defence budgets should be 2 per cent of their GDPs in 2024 and that their militaries should have all equipment interoperable within NATO in the coming two to three years. Despite the fact that there are new governments in Romania, Bulgaria and the Czech Republic, efforts are being made to pursue the ongoing procurement programmes against all odds.

The author would like to thank Jakub Fajnor, Press Section, Communications Department, Czech MoD and Martina Koval-Kakascikova, Spokesperson of the Slovak MoD for their assistance in the preparation of this article.



The SHERPA JLTV by Arquus

New Daimler G-Class Type Vehicles Unveiled

Gerhard Heiming

Mercedes-Benz recently presented the new generation G-Class vehicles for military and security applications to potential customers and the press at the G-Class Experience Center in Graz, Austria.

The new vehicles are based on the 464 series, which went into series production two years ago for civilian applications.

According to the company, the new vehicles will be factory-designed for military applications resulting in enhanced mobility, improved reliability, and easy operation. As a sign of its robustness, a forty-year-old G-Class, with a mileage of 80,000 km, was presented among the new G-Class vehicles. It was ready to drive without any restrictions, as was stressed by representatives of the company.

The variants presented were equipped with a 163-kW in-line diesel engine (Euro 3) that produces 600 Nm of torque. Despite the increase in power, the combined consumption has been reduced to less than nine litres per 100 km. Moreover, Mercedes-Benz specifies 120 km/h as the top speed. Thanks to its automatic transmission, engageable differential locks (longitudinal and transverse) and electronic assistants, the new G-model is said to be easy to handle even under difficult environmental conditions.

Severe Gradient

Participants at the presentation were given the chance to experience the vehicles themselves. The driving programme included steep stretches with severe gradients on unpaved, paved and concrete roads, in mud and deep water, as well as driving manoeuvres with extreme curves involved.

The increased demand for electrical energy is met by a 24-V network, which is set up in parallel to the 12-V network for the vehicle's technology. Two generators provide the energy, with the 24-V generator alone producing 3.8 kW. The equipment's elements that consume electrical energy are protected against electromagnetic radiation in accordance with applicable standards.



Demonstrator vehicle of the protected variant with Plasan cabin

During its operation, the subsystems are controlled by monitoring software in order to avoid failures or damage (e.g. due to overheating or lack of lubricant). In order to avoid operating restrictions in emergencies – such as escaping from a hazardous situation - the monitoring function can be switched off with an emergency override switch (EOS) and continued operation can be enabled, albeit with the risk of serious engine damage.

The company underlines that the new design and production methods have considerably increased the freely available payload - a significant customer request from previous user conferences. The Station Wagon (design BA 06) with an enclosed cabin and four seats - primarily for performing command and liaison tasks - offers a payload of 1.1 tonnes at a gross vehicle weight of 3.5 tonnes. The chassis with two-seater cab (BA 09) is equipped with a three-point mounting to accommodate dedicated superstructures and is designed for a payload of 2.4 tonnes at 4.8 tonnes gross vehicle weight.

The Armoured G-Class

A third variant presented was a protected G-Class (BA 06) equipped with an armoured cabin and four mine protection seats from Plasan. The vehicle involved in the feasibility study is equipped with reinforced axles and reaches a total weight of over six tonnes. The design and equipment of the protected vehicle meet known military requirements.

The new G-Class vehicles are due to be produced in the three main versions presented. The Station Wagon (BA 06) is in top position in terms of the number of units. A smaller production volume is expected for the chassis with a two-seater

ARMAMENT & TECHNOLOGY

Photo: authoi



The Station Wagon version is expected to become the most popular variant of the new G-Class.

cab (BA09). Finally, there is the protected version, probably with the lowest production figures.

As of yet, there are no production orders for the new vehicles though a doubledigit number of prototypes have already been produced. It is expected that series production could start in 2022. According to Daimler's sales team, there is interest in the new vehicles among the armed forces in northern and southern Europe, as well as in North America. The Station Wagon in particular also meets the requirements of the German Armed Forces, which, following a recent major procurement effort of so-called G-Class GREENLINERS, wants to further expand its stocks in this vehicle class.

The performance capacity of the new generation G-Class often reaches physical limits. In order to be able to use the potential, especially in borderline or dangerous situations, thorough driver training is necessary, which Mercedes-Benz also offers as an option.

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ESD: Where next for JLTV?

Lazar: First, continued growth. To date, Oshkosh has built and delivered over 14,600 JLTVs which have been fielded to over 40 locations around the globe.

Then, international expansion: We continue to see international interest in the Oshkosh JLTV, with orders or commitments from eight NATO, allied and coalition partners including Belgium, Montenegro, Slovenia, Lithuania, Brazil, Romania, North Macedonia and the United Kingdom.

Third, lethality and mobility demonstarions: The past 12 months were filled with dynamic demonstrations and live fires across Europe. 2022 will be just as exciting with several more live fire and dynamic events planned. Our teams have a robust pipeline of new opportunities and are preparing to participate in procurement programmes in Greece, Romania, the Netherlands and more. Integrated lethality on an agile and protected vehicle like the JLTV is quickly filling capability gaps that exist in many international militaries.

The recent Rafael SPIKE NLOS live fire demonstration in Estonia provided an example of vehicle-based coastal defence applications which compliment some of the earlier live firings of SPIKE LR on both the Kongsberg Protech RWS and the Samson RCWS. Additionally, the United States Marine Corps (USMC) has integrated the MADIS system onto the JLTV. The MADIS system Oshkosh Defense is a global company designing and producing military vehicles and mobility platforms. For over 100 years, Oshkosh has designed, tested and manufactured a robust portfolio of heavy, medium, light and highly protected military vehicles and technologies. ESD had the opportunity to talk to John Lazar, Vice President and General Manager, International Programs, Oshkosh Defense.

uses two JLTVs per section that work together to attack and destroy enemy fixedwing aircraft, helicopters, and unmanned aerial vehicles (UAVs).

It was also recently reported that the USMC will use HERO-120 loitering munitions for the USMC Organic Precision Fire Mounted (OPF-M) System on the JLTV. The HERO-120 is a mid-range, anti-armour weapon system that carries out pinpoint strikes against its targets. Finally, Oshkosh has been working with Elbit Systems Land Division to qualify a low recoil 120mm mortar on the JLTV platform. The results from manned firings are quite impressive. There are more than 10 other projects with US and International system manufacturers that our teams are engaged in daily that will be announced later in 2022.

Last but not least, ROGUE Fires: Oshkosh Defense's work on ROGUE Fires is another example of how we're evolving the JLTV's capabilities to meet the demands of our customers. ROGUE Fires is an unmanned

ground vehicle (UGV) that leverages the JLTV's extreme mobility and payload capacity and Oshkosh's advanced autonomous vehicle technologies to support Ground Based Anti-Ship Missile (GBASM) operations. In August 2021 Oshkosh Defense demonstrated the JLTV-based Remotely Operated Ground Unit for Expeditionary (ROGUE) Fires as part of the U.S. Navy's Large-Scale Exercise 2021, Sink at Sea Live Fire Training Exercises (SINKEX). As part of the demonstration, a Navy Marine Expeditionary Ship Interdiction System (NMESIS) launcher, based on a ROGUE Fires chassis, successfully launched a Naval Strike Missile (NSM) and scored a direct hit on a target at sea. The successful demonstration validates the maturity of ROGUE Fires as a weapons platform and highlights its ability to add significant firepower and capability into the light tactical wheeled vehicle fleet.

ESD: What comes after JLTV? What else do you have on offer besides JLTV?



A JLTV firing a SPIKE NLOS missile

Masthead

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Cover: ASCOD has been designed as a family of vehicles to cover different roles. Photo: General Dynamics European Land Systems

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The US Army selected the Oshkosh JLTV to become the successor to the HUMVEE.

Lazar: We are committed to providing the best possible solutions to the US military and its allies for their evolving modernisation priorities. As a leading innovator of defence technologies, Oshkosh Defense has won several recent contract awards that highlight the company's expansion into adjacencies. This includes contracts with the US Army for the STRYKER Medium Caliber Weapon System (MCWS) and Optionally Manned Fighting Vehicle (OMFV). While MCWS and OMFV may not seem like typical Oshkosh programmes, they are perfect examples of our ongoing commitment to provide solutions for the US military's ongoing needs —and proof that Oshkosh Defense is more than a TWV manufacturer.

As we grow our portfolio, our top priority is to listen to our customers and deliver against their requirements for purpose-built solutions designed for current and future missions.

ESD: What about UGV developments?

Lazar: Oshkosh Defense has over a decade of experience developing autonomous technology and is currently supporting several important US military modernisation efforts.

Since 2015, the Ground Vehicle Systems Center (GVSC) (formerly Tanks and Automotive Research Development Center [TARDEC]) has been working with an industry team including Oshkosh Defense, Robotic Research, and DCS Corporation, for the Autonomous Ground Resupply (AGR) project and the Expedient Leader-follower (ExLF) projects with focus on validating leader-follower (ExLF) projects with focus on validating leader-follower concepts for autonomous convoy implementation. Leader-follower technology serves to remove personnel from at-risk vehicles in often-targeted convoy routes. This increases the threat standoff and enhances crew protection while providing force multiplication by reducing the number of personnel performing logistics convoy missions in contested areas of operation.

Also, Pratt Miller, a wholly owned subsidiary of Oshkosh Defense, developed the Expeditionary Modular Autonomous Vehicle (EMAV) platform in conjunction with the Marine Corps Warfighting Lab (MCWL). Pratt Miller leverages the EMAV platform for the current phase of the US. Army's Robotic Combat Vehicle-Light (RCV-L) programme. EMAV and RCV-L are both undergoing end user experimentations with their respective services.

The interview was conducted by Stephen Barnard.

"Carriers are for Power Projection"

Suman Sharma

In its biggest ever overseas naval deployment post-Cold War, a UK Carrier Strike Group led by aircraft carrier HMS QUEEN ELIZABETH conducted its first ever tri-service exercise with the Indian Armed Forces.

soroku Yamamoto, a Japanese Marshal Admiral of the Imperial Japanese Navy and the Commander-in-Chief of the Combined Fleet during World War II, once said, "Japan has always regarded the aircraft carrier as one of the most offensive of armaments." In this spirit, aircraft carriers are the hallmark of global maritime power and diplomatic influence and are often used for power projection globally, as was recently witnessed when the UK Carrier Strike Group-21 (CSG21), spearheaded by the 65,000-tonne HMS QUEEN ELIZABETH (QE), undertook its biggest and most ambitious overseas post-Cold War deployment, spanning 28 weeks. In six phases, from May to December 2021, the CSG21 transited over 26,000 nautical miles, from the Mediterranean to the Red Sea, from the Gulf of Aden to the Arabian Sea, and from the Indian Ocean to the Philippine Sea, crossing 40 countries in over 70 bi- and multi-lateral war-gaming engagements using detached land, air and maritime elements of its armed forces. With India the last leg, the CSG21 crossed countries, including Australia, Canada, New Zealand, France, the UAE, Greece, Italy, Turkey, Oman and the Republic of Korea, with four carrier port visits made to Singapore, the Republic of Korea, Japan and India.

Former Indian Naval Chief, Adm (retd) Sureesh Mehta, himself an aviator, says, "Carriers are for power projection and with the increasing Chinese maritime aggression, such deployments are important. The first ever Indo-UK tri-service exercise will only get bigger with time." Being a quintessential maritime trading nation, the UK has a network of commercial, military and diplomatic alliances spread across the globe. Moreover, it has

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The UK's Carrier Strike Group, led by the aircraft carrier HMS QUEEN ELIZABETH sails with ships from the Indian Navy as part of a three-day maritime exercise in the Bay of Bengal. The ships conducted a range of multi-ship, air, sea and sub-surface maritime exercises, as well as close quarter manoeuvring.

a commitment to an open and resilient international order in which open societies and economies continue to flourish and the benefits of prosperity are shared through free trade and global growth. The deployment was aimed at solidarity with international allies and partners, reinforcing old friendships and forging new ones, as the UK, a valued NATO member, has its own security inextricably bound to that of her transatlantic allies.

Exercise Konkan Shakti

Exercise Konkan Shakti was the maiden tri-service exercise conducted between India and UK. The exercise was touted as the largest and most demanding military engagement between both militaries so far, with Strike Group elements of ships, submarines and aircraft participating in balanced offensive and defensive military manoeuvres. Both militaries practised scenarios tackling shared threats and honing interoperability, during the last leg of CSG21's deployment in October 2021, in the Arabian Sea. These joint military drills form the bedrock of the shared interest of the two countries to ensure a free and open Indo-Pacific.

The UK is the third country with which India has conducted a tri-service exercise, after the USA and Russia. The Strike Group can move, act and fight as a single force, even when spread out across hundreds of miles. Individual ships can also detach from the group to conduct independent, simultaneous activity across an entire region.

The Carrier Strike Group comprised six Royal Navy ships, a Royal Navy submarine, a US Navy destroyer and a frigate from the Netherlands. It is the largest concentration of maritime and air power to leave the UK in a generation. It was equipped with fifth generation F-35B LIGHTNING II multi-role fighters, crewed jointly by the Royal Air Force, Royal Navy and the US Marine Corps.

Exercise Konkan Shakti followed the CSG's two-day engagement with the Indian Navy in July 2021, followed by Exercise

Konkan along the UK's coast in August 2021 and Exercise Ajeya Warrior between the two armies earlier.

First Sea Lord Admiral and Chief of Naval Staff, Admiral Tony Radakin says, "Both the Indian and the Royal Navy are bluewater, multi-carrier navies, which places us in a very exclusive club. Our growing interactions are a testimony to the shared commitment to a rules-based international system, a belief in the values of open trade, and in the importance of the freedom of the high seas."

UK's Defence Adviser in India, Brigadier Gavin Thompson was optimistic, "A strengthened partnership with India is a key pillar of the UK's tilt to the Indo-Pacific. Konkan Shakti will not only boost the cooperation of our armed forces but also strengthen the living bridge connecting the people of our two great nations."

CSG21 also held exercises with Japan, Israel and Italy, to showcase military interoperability and understand how to best operate together.

There is talk about Britain increasing its presence in the western Indian Ocean by deploying a littoral defence group comprising amphibious vessels in 2023 and two offshore patrol vessels in 2022. The UK plans to carry out these deployments from Oman. Aimed at evacuation missions, counter-terrorism, disaster relief and humanitarian assistance, the proposed littoral defence group will comprise Royal Marines in addition to amphibious warships. There might even be joint patrols according to sources.

Rolls Royce and HAL

Rolls Royce has signed a Memorandum of Understanding with (MoU) Hindustan Aeronautics Limited (HAL) for propulsion collaboration for Indian warships, under the collaboration on defence and security which is a key pillar of the 2030 Roadmap agreed by the British and Indian Prime Ministers. Under this roadmap, the establishment of a portfolio of collaborative projects to support the development of new technologies and capabilities is envisaged.

The working group's first meeting was held in Mumbai, during the CSG21 visit, for discussions on integrated full electric propulsion systems for warships. The UK's offer to supply advanced electrical propulsion systems for warships was considered. The UK uses these advanced propulsion systems in its Type 45 destroyers and Type 23 frigates, both part of CSG21. India is reportedly taking a keen interest in these systems.



HMS QUEEN ELIZABETH passes through the Suez Canal to participate in Exercise Konkan Shakti

Kishore Jayaraman, President, Rolls Royce, India and South Asia, said, "As India plans the fleet of the future, our commitment to support the country's self-reliance goals and defence modernisation remains as strong as ever."

Rolls Royce is not just responsible for the electrification of the Royal Navy's warships, but also the design and deployment of a new hybrid-electric naval system. Jayaraman adds, "We believe that Rolls Royce can bring great value and learning to any future programme being planned by the Indian Navy for developing electric warships."

Richard Partridge, Chief of Naval Systems, Rolls-Royce, has noted that Rolls Royce could offer technologically superior expertise in developing integrated hybridelectric and full-electric propulsion for naval vessels.

Rolls Royce is said to be the sole provider of marine gas turbines to aircraft carriers and integrated full-electric propulsion (IFEP) powered destroyers.

HMS QUEEN ELIZABETH

HMS QUEEN ELIZABETH (QE) is the largest surface vessel ever constructed in the UK. The 280-metre-long fifth generation HMS QUEEN ELIZABETH aircraft carrier is taller than the Niagara Falls. With a beam of 70 metres, speed of more than 25 knots, and a range of 10,000 nautical miles, HMS QUEEN ELIZABETH has propellers with the capacity to generate the power of 50 high-speed trains. The carrier can house 800 personnel (rising to 1,700, air group embarked), has a capacity of 40 aircraft, and is equipped with force protection machine guns, PHALANX close-in weapons, long and medium range radars, and electro-optical systems and sensors. The carrier is powered by two MT30 ma-

rine gas turbines and four Wärtsila diesel generator sets. Through its power density and design, the MT30 benefits in terms of increased thrust and assures power throughout the 50-year service life expectancy of the ship.

The QUEEN ELIZABETH class is also capable of embarking CHINOOK and APACHE helicopters, along with the MV-22 OS-PREY tilt rotor aircraft operated by the US Marine Corps.

Symbolic of its international standing, CSG21 demonstrates UK leadership in NATO and European security and is the embodiment of NATO's 2030 global vision. CSG21 demonstrates the critical capability that the UK's 5th generation Carrier Strike capability offers NATO in the North Atlantic and Mediterranean and places the British Government on the global stage politically.

Carriers have played a significant, often decisive, role in almost all the UK's major military campaigns since the Second World War, from Korea and the Falklands, to more recent operations in Bosnia, Kosovo, Sierra Leone, Iraq and Libya. A British Ministry of Defence statement states: "An aircraft carrier represents 4.5 acres of 'Global Britain'. Capable of moving 500 miles a day, its very presence has the power to reassure allies and deter wouldbe aggressors; but, if required, it offers a sovereign, flexible and secure operating base for the delivery of airpower, with all the logistical and engineering support needed to remain on station for as long as necessary."



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