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European Security & Defence

€ 8.90
D 14974 E

1/2020

International Security and Defence Journal

Armoured Vehicles

- Surviving the City Fight
- The Return of the 6x6 AFV
- Light Tactical Mobility Platforms
- UK AFV Programmes
- Australia's Armour Renaissance
- Polish Fleet Modernisation
- Turret Options
- Vehicle Protection

January 2020 • www.euro-sd.com • ISSN 1617-7983

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My New Armoured Vehicle is a Camel

A camel, remarked the British designer Alec Issigonis, is a horse designed by committee. Given that the requirements of modern armoured vehicles are driven by so many conflicting factors, perhaps they are the defence establishment's own camels. Mobility, protection and firepower as core requirements are by no means confined to Main Battle Tanks, but the emergence of uninformed, or "claimed" national industrial strategic capabilities; the tightening of budgets; the growth of "zero-casualty" politics; and the ability to destroy an enemy at drone's length all impact global demand for vehicles with the full suite of capabilities now available.

That "full suite" costs space and manoeuvrability, as crews of 4x4 vehicles in combat have, historically, sometimes found to their detriment. This, we propose, is one of the reasons for the "return" of the 6x6 vehicle, despite its being inherently a compromise. In the end, a modest dual-use 6x6 armoured vehicle will be a more acceptable presence on our own cities' streets – in due course – than an overgrown 4x4 platform. Nevertheless, as Police work becomes increasingly deadly, and as manufacturers seek new markets to amortise development costs, it is likely that we will see more "dual-use" vehicles on police fleets, rather than fewer.

The 6x6, although more easily strategically transported by air, rail or sea, can be disadvantaged by its size. This is not such a problem in terms of mission packages, as electrical components become ever smaller, more capable and less power-hungry, but in terms of self-protection and firepower there are more compromises to be reached: how large the main armament, or how big the manned / unmanned turret?

But the main concern should be for those cursed to be long-range passengers under armour. Cost and operational factors keep even the largest 8x8s within some dimensional limits, but people are getting bigger, and the loads they carry, even into the actual combat phase of an operation, continue to grow. Urban warfare, cost and the survival instinct have ensured we have mostly moved on from hanging our kit on the outside of the vehicle, but where, realistically, does it go? And this is before we start to look at exoskeletons and the like: hang them on the outside!? (For clarification: once armies accept the concept of locking exoskeletons to replace seats, with the soldier sitting in it, permanently connected to the vehicle's power until disembarking, that problem will resolve itself, but until then…) And let's not start on situational awareness in the back!

In the face of all these compromises and conflicting requirements we have seen a never-ending procession of arrivistes jumping into – or remaining in - one of the most competitive arenas in the entire defence industrial complex. Think back a few generations of IDEX: where did that glut of AFV companies come from – or indeed, where did they go? For surety we have various protocols that help to sort the men from the boys – various ISO standards, STANAGS and so on – but the sheer cost is enough to discourage anyone from dipping an optimistic, if naïve, toe in the water. Nowadays there are only a few companies (read: nations) capable of designing, developing, marketing, selling and supporting vehicles that meet the requirements. Setting aside China and Russia, there are a few in North America, probably not including Canada, where there may be two (fight over it!) plus some in Western Europe, a very few in Eastern Europe (one of which is excellent), perhaps two or three each in Africa and the Middle East and a vanishingly small number in Asia. Thank goodness 8x8 development / integration costs and final prices have thinned out the market, leaving serious, qualified suppliers and knowledgeable, well-heeled customers a relatively straightforward choice to survey. But supply and demand are growing where the compromises are even more pronounced, for 4x4 and 6x6 platforms, and education, knowledge and experience are all essential.

Ignorance may be bliss, but you get what you pay for.

Stephen Barnard

Masthead

European Security & Defence
Issue 1/2020 · January 2020
ISSN 1617-7983 · www.euro-sd.com

Published by

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Mittler Report Verlag GmbH
A company of the Tamm
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Layout:
CREATIVE.CONSULTING GmbH, Germany

Production:
Lehmann Offsetdruck GmbH
22848 Norderstedt, Germany

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PressUp GmbH, Postfach 70 13 11,
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Email: mittler-report@pressup.de

European Security & Defence

Cover Photo: Sgt. Joseph Prado, 1st Marine Divion

Annual subscription rate:
€64.90 incl. postage

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Ground Mobility – Crucial on Tomorrow's Battlefield

Tim Guest

Warfare is speeding up. For combat vehicles, tracked and wheeled, that means being agile and fast, able to cope with various terrain and extreme driving conditions, whatever the tactical circumstances. Excellent ground mobility will be a defining factor for all future conflicts.

Whether deployed to hotspots or in any of the varied terrains of an increasingly uncertain European theatre, wheeled and tracked vehicles on future battlefields need to display the best possible ground mobility that their designers, engineers, latest technology and, of course, budget, can deliver. This article looks at what is meant by ground mobility, the many factors impacting it and shares some of the thoughts from industry.

Photo: BAE Systems

While off-road, wheels are at a disadvantage to tracks.

Military vehicles on the battlefield of tomorrow will need to perform with optimum efficiency in all scenarios in which they are designed to operate and in the face of the widest possible range of both natural and man-made obstacles. They must be fast across country and on road in all weathers if they are to complete their missions and survive. Survivability on tomorrow's battlefield will have as much to do with effective ground mobility, as it will with other technical aspects of a vehicle design, such as armour protection and weaponry. Optimum mobility is now one of the highest priorities militaries demand from their vehicles, and one of the chief attributes manufacturers must confer on their latest designs.

RBSL Managing Director, Peter Hardisty, commenting on the importance of mobility for the future battlefield, underlined the aforementioned sentiments to ESD, saying, "Our Armed Forces are in constant evolution. They need to be flexible, adaptable and capable, and we seek to facilitate that by providing armoured vehicles with superior levels of mobility." In the context of a latest defence industry development he added, "The British Army is preparing for the future battlefield, especially its ability to reorganise for a range of operations at increased readiness. Its recent procurement of the BOXER 8x8, wheeled vehicle is just one example of how this is being realised and how advanced mobility remains, and will remain, a top priority."

Author

Tim Guest is a freelance journalist, UK Correspondent for ESD and former officer in the UK Royal Artillery.

Mobility Variously Defined

The mobility of a military vehicle, one typically transporting troops and weaponry, combines not only its ability to move, or be moved, freely and easily, but also its capability to move over any specified terrain, even when affected by adverse environmental conditions, such as the widest range of weather. The optimum mobility of a vehicle also factors in its effectiveness in being able to achieve various tactical objectives in different conditions and in varied terrains. Engine and transmission type, horsepower, suspension, resulting speed capabilities, acceleration, turning circle and vibration are just some of the factors contributing to the mobility of a military vehicle. Other technical attributes conferred on a final vehicle design will also play their part in determining the final ground mobility of a vehicle and if everything, technologically, that can be included to deliver optimum ground mobility has been incorporated within the design for the available budget, then an optimum ground mobility can be considered as having been realised. But just as beauty is in the eyes of the beholder, so, too, is optimum mobility a subjective realisation.

Assessing Mobility – Theory and Practice

Assessing the mobility of a new military vehicle is typically carried out under different environmental conditions and over a wide range of surfaces and terrains prior to any final contractual commitments and operational deployment; during vehicle development phases, mathematical modelling will be used extensively to determine the ultimate mobility of a design. Studies by the US Army's Engineer Research and Development Center (ERDC), for example, treat mobility in its mathematical modelling as a function of "trafficability", itself defined as the ability of a given vehicle to traverse a specified terrain. Other

Photo: KMW

RAND Corporation's report showed that several technologies affect the performance of both tracks and wheels, though tracks still retain their advantage over wheels in off-road scenarios. Pictured is a LEOPARD 2A6. The continuous upgrading of the LEOPARD 2 A4 to the current A7V variant retains mobility as one of the vehicle's key combat value criteria alongside firepower and protection.

complex mathematical models look at the effect of soil moisture on mobility, as well as tyre-soil interaction for wheeled vehicles and track-soil interaction for tracked vehicles. Different terrain types, deformable ground versus hard ground, adverse environmental conditions, gradients, and other parameters can all be factored into various mathematical models, although the creation of one single generic mobility model, applicable to all vehicles for all scenarios, remains a challenge for both academia and industry. This challenge is made all the more fluid as technologies, (new transmission types and latest suspension developments), employed to optimise the mobility of new tracked and wheeled military vehicles, improve and evolve. So, while the mobility of a vehicle is an extremely important attribute, all the variables mentioned above make the ultimate, optimum mobility of any vehicle both difficult to define, as well as subjective to the satisfied end-user and maker – "it's performing just as we'd hoped… for the procurement budget we had available". Even then, however, under rapidly-changing operational scenarios in different terrain, predicting absolute mobility is highly unpredictable.

On-Road/Off-Road – A Basic Distinction

That said, with the actual mobility of any military vehicle determined by the eventual terrain over which it operates, notwithstanding vehicle attributes for mobility –

Photo:. UK MoD Crown Copyright

Assessing the mobility of a new military vehicle is typically carried out under different environmental conditions and over a wide range of surfaces and terrains. Depicted is a FUCHS CBRN 6x6 in Jordan.

Photo: UK MoD Crown Copyright

Tracks confer greater mobility to a vehicle in snowy conditions due to the surface area of the track, much like a snow shoe. Depicted is a VIKING in deep snow.

Photo: BAE Systems

Engine and transmission type, horsepower, suspension, resulting speed capabilities, acceleration, turning circle and vibration are just some of the factors contributing to the mobility of a military vehicle.

wheels, tracks, transmission, horsepower, suspension, weight and so on – one general terrain-type distinction in classifying mobility can be made: that of 'on-road' and 'off-road' mobility.

On-road mobility primarily depends on the type of vehicle used, though it can be assumed in most situations that any required speed will be achieved more easily on-road using wheeled vehicles rather than tracked. On-road, wheeled vehicles do have better mobility and displayed dashboard speeds are typically a function of horsepower and weight; greater horsepower improves mobility, increased weight decreases mobility.

The friction of tyres on a road surface is another factor to consider. This will vary with tyre type and size and the surface area in contact with the road. Environmental conditions will also play their part – wet conditions decrease friction, dry conditions increase friction. That said, in some environmental conditions – wet, icy and snowy scenarios – the on-road mobility of tracked vehicles will often surpass that of wheeled vehicles. Prolonged on-road driving for tracks, however, can lead to mechanical problems due to issues such as excessive vibration and such use can impact mobility at some stage. Military operations, however, will, invariably, require intensive degrees of off-road mobility for all vehicles, thus making both good off-road and on-road mobility performance, essential.

However, when it comes to quantifying off-road mobility this is very complex to define and calculate; it depends on a number of factors, many of which are hard to measure. Vehicle weight in the off-road scenario is the key attribute impacting its ground mobility, although the resistance of the surface also plays a vital role. Complexities arise, however, when trying to make a direct correlation between weight, surface type and mobility, because surface type and ground pressures – the ratio of gross vehicle weight to the surface area of contact the vehicle tracks or wheels have with the ground – vary so widely, they make resistance extremely hard to predict.

One term frequently used when discussing ground mobility and the relationship between soil strength and vehicle ground pressure, is the Vehicle Cone Index, or VCI, which has been further defined as the minimum soil strength necessary for a self-propelled vehicle to consistently make a prescribed number of passes, in track, without becoming immobilised.

A threshold ground pressure, which varies among vehicle types, once reached will result in a vehicle becoming increasingly bogged down. This is why tracks are preferred for off-road movement over wheels,

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as tracks provide greater surface area over which to disperse the weight of the vehicle and, consequently, deliver less ground pressure. In general, the off-road mobility of a vehicle is optimised by having a higher horsepower-to-weight ratio, low VCI, low ground pressure, and an advanced suspension system for the vehicle.

In addition to mathematical modelling for determining ground mobility, simulation models are also used to understand the performance of a vehicle in different terrains and other conditions. One of the most popular simulation models for analysing mobility is the NATO Reference Mobility Model (NRMM), which comprises three modules: vehicle dynamic module, obstacle crossing performance module, and primary prediction module. NRMM can predict the mobility of a combat vehicle for both on-road and off-road operations, with mobility typically predicted as achieving an effective maximum speed balanced against differing attributes. However, NRMM has its limitations, not least of which is being unable to determine mobility in complex terrains; as a result, adaptations to this simulation model have been proposed so that it can help predict the ground mobility of wheeled vehicles under different terrain types – flat and rigid, or deformable – and when facing different obstacles.

A Manufacturer's Thoughts on Mobility

With RBSL's Peter Hardisty quoted earlier underlying the importance of ground mobility and stressing that "advanced mobility remains, and will remain, a top priority", ESD sought some further industry insights from the company in this regard.

Emphasising some of the earlier sentiments in this article, an RBSL spokesperson said that ground mobility is generally defined by a vehicle's ability to access different types of terrain and its speed in traversing that terrain. As such, "optimum mobility" is difficult to define, as a vehicle's mobility can always be improved upon. However, it was stressed that in the defence industry, with each customer requiring value for money, an optimum balance has to be achieved between cost versus performance versus weight, etc.

There have also been a number of key programmes looking at the future mobility of armoured vehicles, such as DARPA's Ground X-Vehicle Technologies and Dstl's UK Future Ground Combat Programme to name just two. At the same time, RBSL has also been performing R&D into future mobility, focusing on innovation in suspension systems, electrification of vehicles, autonomy, advanced cooling systems, as well as future fuels, all of which will have some impact on the overall ground mobility of associated vehicles.

Wheels v. Tracks

As to whether there is a trend towards the use of wheels for heavy armoured vehicles for mobility reasons as opposed

Tracks or Wheels?

A Rand Corporation report on in 2017, "Assessing Tracked and Wheeled Vehicles for Australian Mounted Close Combat Operations", commissioned by the Australian Defence Science and Technology Group, looked at lessons learned in recent conflicts, together with the impact of advanced technologies and system-level implications on mobility. This was commissioned to help the Australian Government make decisions about its future mechanised land forces, including Project LAND 400, which involves the updating the Australian military's close combat capability. RAND was asked for help to assess trade-offs between tracked and wheeled combat vehicles, with a particular focus on infantry fighting vehicles (IFVs). The report looked at the expected performance of tracks and wheels based on experience and then at how advanced technologies might affect the performance of both into the future, with several seen that could alter the mobility, protection, and firepower of future vehicles and that should be considered before any choice between one or the other is made. Key findings in the report said, unsurprisingly, that tracked vehicles have shown their advantages in off-road mobility, flexibility in weight growth, and ability to fight and survive on the battlefield, while wheeled vehicles have shown better on-road mobility, savings in maintenance, and reduced crew and squad fatigue. At the same time, RAND also concluded that the distinctions between the vehicle classes are blurring as new technologies and systems are introduced. One of the recommendations of the report was for detailed force-level modelling and simulation (M&S) to assess the force-level impact of specific IFV alternatives. Together with business case analysis, force-level M&S should provide further information and guidance on specific IFV platforms.

At this time, Hanwha and Rheinmetall have been selected to participate in the next phase of the Australian Government's US$10.3Bn IFV programme, to be delivered under Project Land 400 Phase 3.

Photo: Tim Guest

The right side track of a Soucy CRT which had been in the trials and shows clear wear, vs. the left side track which is, effectively, new and did not go through the trials.

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An important difference between military trucks and their civilian equivalents lies in mobility: logistic support must be able to stay close to its combat- ready clients.

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The Vehicle Cone Index (VCI) has been defined as the minimum soil strength necessary for a self-propelled vehicle to consistently make a prescribed number of passes, in track, without becoming immobilised.

Photo: UK MoD Crown Copyright.

Vehicle weight in the off-road scenario is the key attribute impacting its ground mobility. Depicted is a CVR(T) on desert terrain in Afghanistan.

to tracks, the spokesperson said that there have been a number of studies performed to analyse the "wheels-versus-tracks" question. The general conclusion from these studies is that a tracked vehicle provides better traction and lower ground pressure than an equivalent wheeled vehicle, which, as discussed above, can be of considerable advantage in off-road scenarios. However, the difference in performance is narrowing with improvements in the technology of wheeled vehicles. Additionally, wheeled vehicles also offer significantly lower running costs and reduced maintenance activities, so, the choice depends on the operational environment in which a vehicle will be expected to perform at optimum levels, with tracked vehicles preferred for significant cross-country operation and wheeled vehicles preferred where roads are the primary operating scenario.

Indeed, in regards to wheeled vehicles and the impact of tyre types on mobility, RBSL's spokesperson said that the company generally selects tyres on the basis of their worst-case usage. That means either mud-pattern tyres for vehicle types to be used mainly in temperate climates, with either sand or all-terrain tyres fitted to vehicles used in hot climates. In addition, most of any wheeled fleet will be fitted with run-flat inserts to remain mobile under some sort of failure condition. RBSL has worked with the majority of the biggest OEM tyre suppliers over the years, and these are selected either through a competitive procedure/tender, or as a result of a customer's specific wishes.

On the subject of the use of traditional tracks versus Composite Rubber Track, CRT, and the potential impact of CRT on overall vehicle ground mobility, RBSL said that in trials it had conducted of CRT on both WARRIOR and CVR(T), the track performed extremely well under the majority of conditions giving significant reduction in noise and vibration signatures. The trial RBSL WARRIOR was actually on display on the Soucy (CRT maker) stand at DSEi. The tracks, which weigh up to 50% less than equivalent traditional tracks, went through extensive tests with UK specialist company, NPrime, during the summer and the results showed vibration to be 40% less than with traditional tracks, as well as a 25% saving on fuel. In addition, the life of electronics and other vehicle components improved by some 70%. It was also shown that by adopting the CRT, 1.5 metric tonnes that could now be used for improving armour protection or carrying other systems and armament were freed up. Crucially, it was clearly shown that using CRT will impact the total cost

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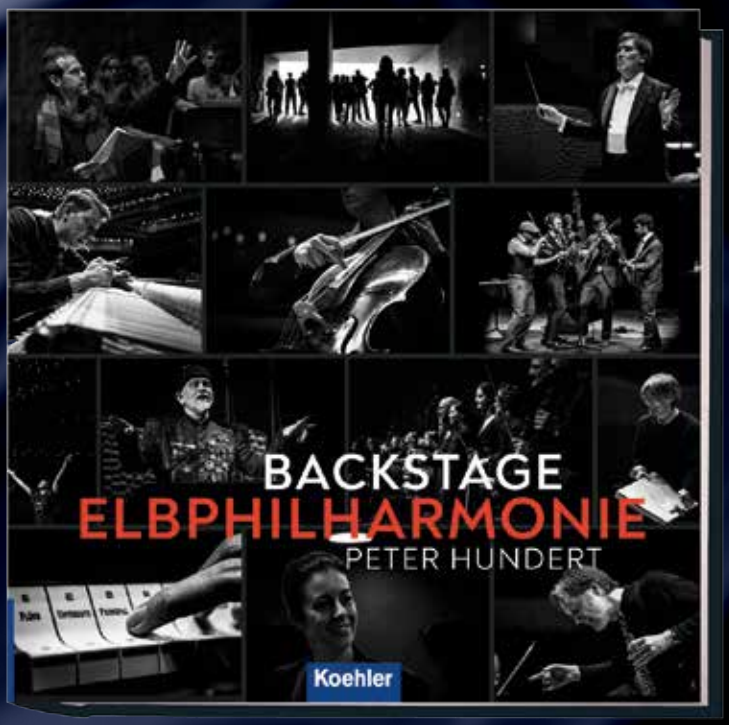

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"Mobility is vastly improved."

Interview with with John Mackey, Principal Engineer, Electric Drive & Propulsion, QinetiQ

ESD: What are the challenges of maintaining the right mobility for an armoured vehicle using an electro-mechanical transmission like the E-X-Drive?
Mackey: The E-X-Drive has been demonstrated successfully in the US Future Combat System and Ground Combat Vehicle Programs to TRL 7. Mobility is vastly improved in terms of acceleration, reliability and fuel consumption.

ESD: Using the E-X-Drive, will an armoured vehicle's mobility improve over a purely mechanical transmission?
Mackey: Yes, peak torque is available from standstill and there is no torque interruption on gear shift or steering.

ESD: How do you ensure optimum or improved mobility using new electro-mechanical drives?
Mackey: QinetiQ's advanced modelling tool (HYSIM) ensures our designs meet customer mobility and performance requirements. This has also been successfully validated in various programmes for both UK MOD and US DoD.

ESD: Mobility using such a system in wheeled and tracked – wheeled better mobility? Tracked better mobility?
Mackey: HED in wheeled platforms is not as mature as tracked, but aims to close the mobility gap between wheeled and tracked vehicles. QinetiQ is currently developing an in wheel Hub Drive for the U.S. ONR (Office of Naval Research) building on the successful work for DARPA on the GXV-T programme. Additionally, we are looking, as part of a UK MOD programme, at how the use of electric hub drives enable other advantages in terms of suspension freedoms.

ESD: Other than its electro-mechanical transmission work, what other latest work and developments and/or comment, in relation to ground mobility, does QinetiQ have vis a vis suspension, tracks, wheels?
Mackey: In 2019 QinetiQ was awarded the Mobility Risk Reduction (MRR) contract by the UK MoD (Dstl) to study advanced suspension systems making use of electric Hub Drives and select concepts for further development and test. The key area of interest is the opportunity offered by individual wheel control in conjunction with suspension freed of the normal mechanical drive limitations in order to bridge the gap between the mobility of wheeled and tracked platforms.

The interview was conducted by Tim Guest.

of ownership of a vehicle platform, which, as stated, can have implications for mobility decisions. The particular vehicle on display at DSEi and one of its tracks had been part of the UK's 10-week ATDU tests at Bovington involving various units of the UK armed forces putting the tracks through 10 x 500km battlefield missions. By the end of those, the tracks showed a degree of wear, though when compared with new track at DSEi, still appeared to have thousands more kilometres left in them. Asked if RBSL intends to adopt CRT for future armoured tracked vehicles the company said they view CRT as a developing technology that started with CVR(T) on light vehicles, though used by other armies across the globe (for example, the Norwegians on CV90). As armoured vehicles become heavier, more development is required if CRT is to be more widely used and adopted. They added that to use CRT on new RBSL platforms, a full evaluation would be conducted for each class of vehicle. An optimal track would then be selected based on customer requirements. In addition, it's also not only about the maturity of a technology, but also about the logistical support needed in the field to maintain the track's capability, whether CRT or metal tracks. Further from a mobility standpoint, it was said that CRT provides a number of pros and cons to a conventional track system depending upon the type of vehicle and the customer requirements. One example cited in suggesting that CRT doesn't currently meet all of the needs of armoured vehicles was that it is not aggressive enough in gripping on ground going up hills and when lifting/towing. It is understood Soucy CRT is currently pitched for the Warrior Automotive Improvement Programme.

On the subject of suspension and transmission developments in relation to ground mobility improvements for future vehicle platforms, the RBSL spokesperson indicated that the latest suspension developments for future armoured vehicles are aimed at providing increased articulation, so they flex more readily, delivering a smoother, better ride – and incorporating increased ride and damping control through active and semi-active systems. Of transmission types, it's understood RBSL is actively exploring various different transmission options, including hybrid electric and hydromechanical systems. The company said that electric drive systems offer the potential of enhanced silent watch, silent manoeuvre, as well as improved economy. The optimum transmission is a compromise between performance, usability and cost.

A Final Thought

A final thought from RBSL on mobility, was that its position alongside other vehicle attributes such as armour/protection on the list of priorities for a given design and customer is that its importance will vary from vehicle to vehicle and, interestingly, sometimes from country to country. Taking the Boxer programme as an example of this and looking at France, Germany and the UK, mobility has been prioritized over protection by France and Germany, who opted for firepower and mobility in their Boxer vehicles as top priorities, whereas the UK has prioritised firepower and armour over mobility. ■

Acknowledgements:
Rheinmetall BAE Systems Land (RBSL).
'A Fuzzy Simulation Model for Military Vehicle Mobility Assessment' by George, Singh, Dattathreya and Meitzler.
RAND Corporation – "Assessing Tracked and Wheeled Vehicles for Australian Mounted Close Combat Operations".

The Return of the 6x6 AFV

Christopher F. Foss

While an increasing number of countries are now deploying 8x8 armoured fighting vehicles (AFV) for an expanding range of battlefield missions, there is still a demand for 6x6 AFV's with a number of new designs already in production.

When compared with their 8x8 counterparts, 6x6 AFVs are more compact, lighter and are, therefore, easier to deploy by aircraft and can be used in confined spaces such as that encountered during urban operations. These are also more suited to more specialised roles such as reconnaissance. These 6x6 are traditionally used as armoured personnel carriers (APC) fitted with a protected weapon station (PWS) or a remote weapon station (RWS), typically armed with a .50 M2 HB machine gun (MG) or sometimes a 40 mm automatic grenade launcher (AGL). They can, however, be fitted with larger calibre weapons, with a good example being the Austrian General Dynamics European Land Systems – Steyr PANDUR (6x6) supplied to the Kuwait National Guard, with some of these fitted with a Belgian John Cockerill Defence (previously CMI Defence) two-person turret armed with a 90mm gun and 7.62mm co-axial MG.

In the past, most 6x6 APCs and variants were designed and built by European AFV contractors. However, in recent years, Brazil, China, Indonesia, South Africa, South Korea and Turkey have also developed 6x6 APCS. These are also now being offered on the export market although some key elements – such as engine, transmission, drive line and weapon system –w are often imported.

In addition to being deployed by the Austrian Army, sales of the PANDUR (6x6) were also made to Belgium, Gabon (trials), Kuwait (from Austrian and US production lines), Slovenia (made in Slovenia) and the US. Although the original Austrian Army contract was for 71 PANDUR (6x6), a contract for an additional 34 was placed with GDELS-Steyr late in 2016 with the first deliveries made in 2018 and final deliveries due in 2020.

Photo: GDELS-Steyr

The latest General Dynamics European Land Systems' Steyr PANDUR EVO (6x6) APC for the Austrian Army showing the raised roof line to the rear and the RWS armed with .50 M2 HB MG to the rear of the driver's position.

These latest Austrian Army PANDUR are referred as the PANDUR EVO and have many improvements, including a new hull design with improved protection with a raised roof line to the rear for greater internal volume, electronic architecture and a new power pack (consisting of a 455 hp diesel coupled to a fully automatic transmission). Gross vehicle weight (GVW) is being quoted as 18.50 tonnes and a RWS is fitted that is the same as that fitted to other Austrian AFV for fleet commonality.

The Brazilian Army operates a fleet of ENGESA EE-11 URUTU (6x6) APC, which were first fielded in the 1970s and these have now begun to be replaced by the GUARANI Wheeled Medium APC (6x6), which uses technology supplied by the Italian company Iveco Defence Vehicles. GUARANI has a GVW of 18.3 tonnes and is fully amphibious being propelled in the water by two waterjets. A variety of weapons can also be fitted including the UT-30BR RWS armed with a Northrop Grumman 30mm MK44 dual feed cannon and 7.62mm co-axial MG.

The Peoples Liberation Army has been moving towards a more balanced fleet of tracked and wheeled AFVs for many years, with the latter including the China North Industries Corporation WZ551 (6x6) APC called the Type 92. This is used for a wide range of battlefield missions, including deployment as an APC, ambulance, command post, air defence, repair and recovery to name but a few. The latest version is the WMZ551 (6x6) with a more powerful diesel engine and is currently being marketed in a wide range of battlefield missions, including fitted

Author

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with a turret armed with a 120mm gun/ mortar and another with a 105mm low recoil gun, which is called the WMA301 ASSAULTER.

The Finish state owned company Patria has built large numbers of their Armoured Modular Vehicle (AMV) (8x8) with the latest version called the AMV XP, which will provide extra performance, payload and protection. To expand their product range of wheeled AFVs, mid-2018, Patria launched their latest Armoured Wheeled Vehicle (AWV) (6x6), which which it has developed using internal research and development funding. This is one of the heavier 6x6 currently being marketed and has a GVW of up to 24 tonnes of (which 8.50 tonnes is payload which in armament, ammunition, amour package, crew and fuel.) It was first shown fitted with a 12.7 mm PWS but has also been shown more recently fitted with the PATRIA 120mm NEMO turret mounted mortar system.

The French Army has now phased out all of its tracked APCs and currently deploys 630 (8x8) Nexter Systems Vehicule Blinde de Combat d'Infanterie (VBCI) and a large fleet of former Renault Trucks Defence, today Arquus, Vehicule de l'Avant Blinde (VAB) (4x4) in different versions. The VAB (4x4) is to be replaced by the GRIFFON (6x6), which which has been developed by a consortium consisting of Nexter Systems, Arquus and Thales with final integration taking placed at the Nexter Systems facility in Roanne. The French Army is due to field five versions of the GRIFFON – APC, command and control, engineer and recovery, artillery observation and ambulance. However, in the long term, there will be many more variants, including a 120mm mortar carrier. The baseline GRIFFON APC has a crew of two and carries eight dismounts and is fitted with an Arquus HORNET RWS, cameras for situational awareness, and electronic architecture with provision for acoustic threat detection device. Although Arquus built some 5,000 VAB in 4x4 and 6x6 versions, the French Army only deployed the 4x4 model. To meet potential export requirements, Arquus has developed, using internal research and development funding, the VAB Mk 3 that is only marketed in a 6x6 version. When compared to the older VAB, first fielded as far back as 1976/1977, the VAB Mk 3 has greater volume, payload and protection and can be fitted with a wide range of weapons, including a now John Cockerill Defense CSE 90 LP turret armed with a 90mm gun and 7.62mm co-axial. Known sales of the VAB Mk 3 are Tunisia (from a US production line) and the Kingdom of Saudi Arabia, although the latter were originally earmarked for Lebanon.

Photo: Iveco

Brazilian GUARANI (6x6) amphibious APC can be fitted with a wide range of weapons, including an RWS armed with a stabilised .50 M2 HB MG.

Photo: Patria

The latest Patria Armoured Wheeled Vehicle (6x6) can be fitted with a wide range of weapon systems including the Patria 120mm NEMO turret mounted mortar system.

Nexter Systems, who has long record in investing in research and development and using internal research and development funding, developed the Tactical Infantry Transport and Utility System (TITUS) (6x6) APC based on a Tatra chassis, which has a high level of cross country mobility. This was launched in late 2013 and, in 2018, the Czech Republic ordered some 62 units. TITUS typically has a crew of three and carries up to 10 dismounts who can rapidly leave via the large power operated ramp at the rear. It can fitted with a wide range of roof mounted weapon systems, including the Nexter Systems ARX20 RWS that is typically armed with a .50 M2 HB MG.

Rheinmetall MAN Military Vehicles (RMMV) built large numbers of the Transportpanzer 1 FUCHS (6x6) APC and variants for the German Army with the latest version

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Photo: Christopher F Foss

The latest GRIFFON (6x6) APC of the French Army undergoing inspection at the Arquus Hub facility at Fourchambault

Photo: Christopher F Foss

The hull of the latest Arquus VAB Mk 3 (6x6) APC taking shape at the Arquus Hub facility at Fourchambault

Photo: Paramount

The South African Paramount Group has developed the MBOMBE family of wheeled AFV, which includes the Mbombe (6x6) (shown here) fitted with a remote controlled turret armed with a 30mm 2A42 dual feed cannon and 7.62mm coaxial MG.

being the A8 standard which has many improvements, especially in the area of survivability. Further development by RMMV, using internal research and development funding, resulted in the FUCHS 2, which has more volume, payload and protection and this has already been sold to Algeria (local production), Kuwait and the United Arab Emirates with the latter being built in three specialised NBC reconnaissance versions.

One of the more recent 6x6 vehicles to be developed is the Indonesian PINDAD ANOA (6x6), which is similar in overall layout to the French now Arquus VAB (6x6) APC and is already in service in Indonesia. Baseline PINDAD ANOA (6x6) is armed with a PWS armed with a .50 M2 HB MG, there are also more specialised versions such as ambulance, command post, mortar carrier and recovery. Further development by Pindad resulted in the BADAK (6x6) direct fire support platform, which which has a brand new all welded steel hull with the driver and diesel engine compartment at the front and the now John Cockerill Defence CSE 90LP two-person turret towards the rear armed with a 90mm gun and 7.62mm co-axial MG. The first contract is for 50 vehicles with deliveries already underway.

South Korea is now self-sufficient in the design, development and production of tracked and wheeled AFVs with Hanwha Defense marketing their BLACK FOX in both 8x8 and 6x6 configurations with 22 of the latter already being supplied to Indonesia and fitted with the John Cockerill Defence 90mm turret. To meet the potential requirements of Malaysia for a 6x6 APC, they have teamed up with the Malaysian company AVP Engineering to offer a new 6x6 called TIGON.

The South Korean Army held a public competition for a family of 6x6 and 8x8 APC and variants, which was won by Hyundai Rotem, with their KW1 (6x6) and KW2 (8x8) family of vehicles now in production and being offered for the export market.

The South African defence industry has developed a wide range of wheeled AFV with many of these being aimed at the export market. The Paramount Group, for example, is marketing the MBOMBE family of vehicles in 4x4, 6x6 and 8x8 configurations to enable the end user to field a complete family of vehicles, which share many automotive components and provide reduced through life cycle costs and easier training requirements. MBOMBE 6 (6x6) has a maximum GVW of up to 22.50 tonnes of which 5.20 tonnes is payload consisting of weapons, ammunition, armour package, fuel and crew. It has

been shown fitted with a wide range of weapon stations including an overhead weapon stations, that can be armed with a 20mm or 30mm dual feed cannon and a co-axial 7.62mm MG.

The Turkish company FNSS Savunma Sistemleri developed the PARS family of vehicles (FOV) to meet the potential requirements of the export market with the first customer being Malaysia who is taking delivery of 257 in the 8x8 configuration with local assembly and production completed by DefTech. These are known as the AV-8 GEMPITA and 12 variants are being supplied and latest PARS III (6x6) is being marketed for Malaysia under the local designation of the AV-6.

A second customer is Oman who is taking delivery of 172 of which 145 are in the 8x8 configuration and remaining 27 in the 6x6 configuration with these being the latest PARS III model which has a number of improvements (including a new suspension system). Following a competition in May 2019, it was announced that the Turkish Land Forces Command (TLFC) would take delivery of an initial batch of 100 PARS III FOV with 45 in the 6x6 configuration in two variants, radar and command post vehicles. The rest will be in the 8x8 configuration with reconnaissance, CBRN and AFV variants. Of the 100 units, five are designated for the Turkish Gendarmerie.

PARS III for TLFC will feature a hydro pneumatic suspension system and a locally supplied Tumosan diesel engine and automatic transmission with CTIS and run flat tyres being standard. GVW of the PARS III (6x6) is currently being quoted as 25 tonnes, with a maximum crew of nine including commander, gunner and driver.

The PARS III also features an integrated air conditioning system, which means that even in 'desert-like' conditions, the internal temperature of the vehicle can be kept to +25 degrees Celsius.

The Turkish company Otokar has established itself as one of the largest contractors of wheeled AFVs and tactical wheeled vehicles in Europe and in addition to marketing a complete range of 4x4 light armoured vehicles has also developed the ARMA. This has been developed as a private venture and is currently being marketed in both 6x6 and 8x8 versions with the former being the first one to enter production for the export market with Bahrain being the launch customer. ARMA (6x6) has a GVW of up to 18.50 tonnes of which payload is 4.50 tonnes and it shares the same power pack and drive line elements as the heavier ARMA (8x8). ■

Photo: Christopher F Foss

To meet the potential requirements of Malaysia, the South Korean company of Hanwha Defense Systems and AVP Engineering of Malaysia have teamed up to offer the TIGON (6x6) APC.

Photo: FNSS

The first customer for the FNSS Savunma Sistemleri PARS III (6x6) is Oman who will deploy this version, fitted with the SABER-25 one-person turret armed with a 25mm cannon and 7.62mm co-axial MG, for use in reconnaissance roles.

Photo: Otokar

Otokar are marketing their latest ARMA in 6x6 and 8x8 configurations that share many common parts. This is the ARMA (6x6) fitted with an Otokar designed turret armed with a medium calibre cannon and 7.62mm co-axial MG.

Light Tactical Mobility Platforms

Latest Developments

Sidney E. Dean

A new generation of purpose-built light tactical vehicles is destined to redefine what military mobility means in the near future, as armed forces are seeking new capabilities in mobility platforms for general or specialized use, air-droppable and air-transportable, with a large payload capacity and long endurance.

The worldwide largest light tactical vehicle procurement project remains the US military's Joint Light Tactical Vehicle (JLTV) programme. The JLTV is produced by Oshkosh Defense. It entered full-rate production (FRP) in June 2019, following completion of reliability qualification and performance testing as well as logistics supportability evaluations at various military installations across the United States. The first US Army unit to be fully equipped is the 1st Brigade, 3rd Infantry Division, which received its complement of more than 300 vehicles (from Low Rate Initial Production or LRIP stocks) in April 2019. The US Marine Corps (USMC) declared Initial Operational Capability of the JLTV in August 2019. US Army and USMC training commands have also received their full complements of the new vehicles.

Under current planning, the US armed forces would procure at least 64,000 of these vehicles to replace a major percentage of the current Humvee tactical vehicle fleet. The US Army is set to acquire 49,099 vehicles through the mid-2030s, although this figure is expected to drop and the speed of acquisition to slow at least temporarily in order to free up funds for higher priority procurement programmes. The US Marine Corps will purchase 15,000 vehicles by 2022. The US Air Force and Navy will procure several dozen vehicles each for special security forces.

Foto: USMC

A JLTV displays its capabilities at the School of Infantry West, Marine Corps Base Camp Pendleton, California, in February 2019.

International Procurement

In addition to the US armed forces, various allied and partner nations also plan or consider acquisition of the JLTV. Slovenia and the US signed a letter of offer and acceptance (LOA) in late 2018 for 38 JLTV, constituting the first foreign sale. According to Slovenian national armament director Zeljko Kralj, at least a portion of the vehicles will be equipped with a remote-controlled weapons station (RCWS) mounting anti-tank missiles. In June 2019, a JLTV outfitted with the Rafael Mini MLS RCWS fired a SPIKE missile during a demonstration in Slovenia. This demonstrated capability could encourage further JLTV sales in Europe, where eighteen nations already operate the SPIKE missile.

Montenegro issued an order in October 2019 for 67 JLTV, initiating a potential procurement cascade by European allies. The Lithuanian MoD and the US Defence Department signed a LOA on 25 November 2019 for the purchase of 200 JLTV. The vehicles belong to the Combat Tactical Vehicle variant of the JLTV; they will be equipped with weapons turrets and 12.7mm M2 QCB machine-guns, and assigned to two combat brigades of the Lithuanian rapid reaction forces. Deliveries are scheduled to begin in 2021. A follow-on order is likely, as the US State Department had approved a total of 500 JLTV for Lithuania in August 2019.

Mike Ivy, Senior Vice President and General Manager of International Programmes at Oshkosh, confirms that the company expects to secure a major contract for up to 1,700 vehicles with the United Kingdom. "We don't expect their first buy to amount to that. Their first buy will probably amount to 850-ish vehicles," Ivy said in November 2019. The final hurdle before contract award, the main gate review by the British MoD, is expected to be completed in spring of 2020.

Performance and Training

According to the US Army, the JLTV family of vehicles is designed to restore payload and performance that were lost when the legacy HUMVEE light tactical vehicles were up-armoured to enhance protection; the new vehicles represent an improved protected mobility solution and are the first vehicle purpose-built for modern battlefield networks, according to

Author

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an Army statement issued in June 2019. Technological advances over the HUMVEE include improved maintainability through on-board diagnostics, and facilities to fully integrate into current and future tactical data and communications networks.
In addition to hands-on training, soldiers and marines can practice operating the JLTV in the simulator developed by Doron Precision Systems. Introduced in December 2019 at a training and simulation conference in Florida, the simulator is mounted on a three degrees of freedom motion platform, and features software which incorporates the JLTV's specific vehicle handling properties.

Photo: US Marine Corps / Cpl. Carlos Lopez

US Marines with 3rd Battalion, 7th Marine Regiment, 1st Marine Division attached to Special Purpose Marine Air-Ground Task Force, Crisis Response-Central Command drive a Utility Task Vehicle around security positions at Fire Base Um Jorais July 4, 2018. Program Executive Officer Land System's Light Tactical Vehicle programme office is currently implementing several upgrades – including upgraded tyres, clutch improvement kit and floorboard protection – to UTVs across the fleet.

Infantry Squad Vehicle

The US Army is currently pursuing a second light tactical vehicle acquisition programme. According to a statement by the Army's Programme Executive Office / Combat Support and Combat Service Support (PEO CS&CSS), the Infantry Squad Vehicle (ISV) "is intended to provide enhanced tactical mobility for Infantry Brigade Combat Teams to move quickly around the battlefield. This capability provides flexibility for entry operations (permissive and non-permissive) to counter threat anti-access strategies by using multiple austere entry points to bring in combined-arms-configured units." The ISV will be smaller and lighter than the JLTV, and will be transportable inside a CH-47 Chinook helicopter and sling loaded beneath a UH-60 Black Hawk helicopter. The vehicle will transport a full nine-person infantry squad plus their gear, including heavy crew-served weapons such as anti-tank missiles and heavy machine guns. It is intended for light infantry units, especially airborne and airmobile units, and will allow forces to be dropped at greater distance to their objective; this reduces the risk of detection and allows a covert approach to targets protected by air defence systems.
The Army is conducting an open competition for the ISV award. In August 2019, the PEO CS&CSS narrowed down its selection to three competitors. Each firm or industrial team was awarded an OTA (other transaction authority) task assignment, a congressionally authorised DoD contracting mechanism enhancing flexibility in the award of prototyping, research and production contracts. Each contender received US$1M to build and deliver prototypes, which are currently being tested by personnel of the 82nd Airborne Division at Fort Bragg, North Carolina. The winner will be selected by the end of March 2020.

Photo: GM Defense

The militarised version of the Chevrolet COLORADO truck, as tested for the US Army's ISV programme.

The initial production contract is expected to cover 651 ISVs to be delivered by the end of 2024; the objective requirement is for a total of 2,065 vehicles. The contenders are:

SAIC/Polaris DAGOR: Science Applications International Corporation (SAIC) has teamed with Polaris Defense to offer a variant of the Polaris DAGOR (Deployable Advanced Ground Off-Road) tactical vehicle. Launched in 2014, the DAGOR family of vehicles is combat proven, serving – among other users – with the 82nd Airborne Division. Originally designed for special operations forces, the basic DAGOR vehicle weighs approximately 2,100 kg. In 2018, the upgraded A1 variant was introduced, with a 9-person capacity and an enhanced payload of 1,800 kilos. The turbodiesel engine can utilise a variety of fuels including JP8 aviation fuel. If this offering is selected, SAIC would perform the systems engineering and integration work.

Oshkosh/Flyer: Oshkosh Defense and Flyer Defense have submitted a prototype based on the FLYER 72. This proposal has an advantage inasmuch the FLYER is already in service with US Special Operations Command. Under a separate procurement programme, several hundred units have also already been acquired by the US Army and assigned to selected infantry units to meet an urgent operational requirement. The FLYER 72 is somewhat longer than the DAGOR, and weighs circa 2,500 kg. It, too, has a turbodiesel engine.

Photo: Plasan

The Plasan SANDCAT light armoured vehicle

Chevrolet COLORADO: General Motors Defense is proposing a militarised variant of its Chevrolet COLORADO ZR2 pickup truck. The rugged civilian variant has proven itself in off-road desert racing. The military version retains 70% commercial off the shelf parts, including the original multimatic DSSV dampers that contribute to the civilian truck's off-road capabilities. The ISV prototype displays a totally new hull, with seating in place of the cargo bay. The COLORADO is powered by a 2.8 litre diesel engine.

USMC UTV

The USMC is upgrading its ultralight Utility Task Vehicles (UTV) procured in 2017. The 144 Polaris MRZR-D vehicles have back seats which convert to a small cargo bed. They can carry four marines or 680 kg of gear. The vehicles are deployed at regimental level, primarily for rapid battlefield supply. They can also be used for casualty evacuation. In December 2019, the USMC announced that it was upgrading the UTVs based on user feedback. The upgrades will benefit both safety and performance.

According to the USMC, changes include high clearance control arms (a crucial element of the vehicle suspension), new run-flat tires, a more durable floorboard, a road march kit, a clutch improvement kit and an "environmental protection cover" (a modular roof to protect occupants from the sun). Marines were reporting frequent damage to the suspension and floorboard from rocks and other foreign objects when manoeuvring at high speed over rough terrain. The new control arms are comprised of material about twice as strong as the original control arms; they also add an extra 2.5 inches of clearance. A clutch improvement kit is also part of the upgrade package; it reconfigures the original off-the-shelf clutch system, enabling it to better engage the belt to keep it from breaking. The new flat-run tires adopt the "Tireball" technology used in off-road desert racing. "Inside each tire are 16 inflatable cells, so if any one cell pops from running over a spike or nail, you'd still have 15 other cells full of air to continue driving on," says Hason Engstrom, lead systems engineer for the UTV at PEO Land Systems. Finally, the UTV's Road March Kit – comprising turn signals, a horn, and a rearview mirror – is designed to enhance on-road safety, especially in the presence of civilian traffic. It was already introduced in March 2019.

Photo: US Army

Army soldiers test the Polaris DAGOR at Fort Bragg, North Carolina.

URO VAMTAC ST5

Spanish manufacturer URO Vehículos Especiales S.A. (UROVESA) has been producing the VAMTAC (Vehículo de Alta Movilidad Tàctico) light tactical vehicle since 1998. More than 5,500 units have been sold worldwide; currently eleven nations continue to operate the VAMTAC. It remains in production, and is available in several purpose-built modular configurations including tactical transport, weapons carrier, missile and mortar carrier, field ambulance, surveillance and control, and command and communications. The VAMTAC ST5 variant was introduced in 2013; the ST5 BN3, featuring STANAG level 3 armour, was added in 2015. In the troop carrier configuration, the ST5 can seat eight and carry a topside weapons mount.

The most recent major purchase order is the 2018 contract for delivery of 139 units to the Portuguese armed forces. The buy includes four different configurations of the ST5: troop carrier (107 units), command vehicle (7), ambulance (13), and special operations (12). All will be outfitted with ballistic and mine protection. Additional equipment will include the Rheinmetall ROSY L rapid obscuring system, the Critical Software EYECOMMAND battle management system, and the EID PRC 525 combat net radio. The command vehicles and a portion of the SOF variant will be equipped with a satellite communications suite. The twelve vehicles configured for special operations forces will be armed with the Browning M2 machine gun, the Heckler & Koch GMG automatic grenade launcher, or the MINIMI M3 minigun.

The majority of vehicles will be assigned to commando and parachute infantry battalions. The first ten units (configured as troop carriers) were delivered in October 2019, with a total of 50 units delivered by end of the year. The remaining vehicles are scheduled to be turned over to the Portuguese army in 2020. A two-year training

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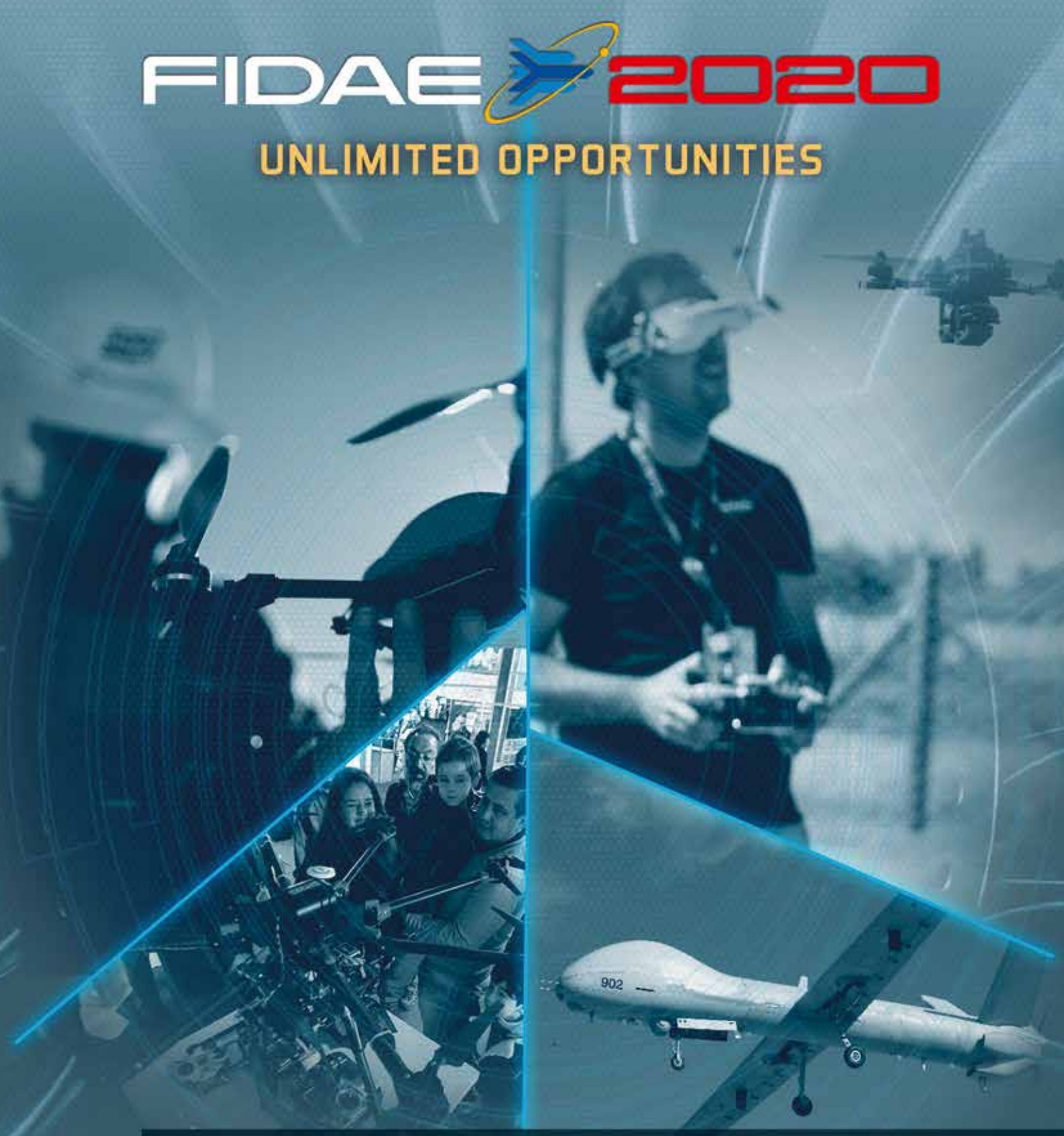

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Photo: NATO

A Spanish Army VAMTAC ST5 being offloaded in Sczcecin, Poland in 2016 as part of the NATO Spearhead force

Photo: Italian Army

Italian Army 8th Alpini Regiment VTLM LINCE vehicles during exercise Abbey Road 2019

and spare parts agreement is part of the €60.8M procurement contract. A logistics support contract is to be negotiated at a later date.

IVECO Light Multirole Vehicle

Italy's IVECO launched the Light Multirole Vehicle (LMV) in 2006. Long- and short-wheelbase variants are available, as are several configurations including troop carrier, CASEVAC, NBC unit, pick-up truck, RSTA and SOF. Various levels of armour are available. The second generation LMV2 was introduced at EUROSATORY 2016. Both the original LMV and the LMV2 are currently being produced simultaneously.

According to the manufacturer, the second generation vehicle features an increased payload (1.5 tonnes), better performance, greater reliability, and increased crew comfort. Details include a new 220 horsepower engine; an upgraded driveline capable of managing more power; a new air filtration system; enhanced suspension; a new automatic eight-speed gearbox and a new electronic stability control system. The latter three are designed to optimise performance during off-road operations. The crew cell has been redesigned to increase space and enhance passenger comfort and safety. It accommodates five combat-equipped soldiers and their associated gear. Blast protection is enhanced by the use of new materials, and by addition of a third hinge added to each door. Finally, the second generation vehicle features an enhanced digitised electronic architecture and power supply, thereby accommodating a larger suite of on-board electronics and electronic counter-measures (ECM). Weapons options include a crew served or remotely controlled weapons station.

The standard LMV is currently in use in 19 countries. LMV2s are currently being delivered to the Italian armed forces. The latest major order comes from the Netherlands. The contract signed in August 2019 calls for delivery of 1,275 LMV2s for the Royal Netherlands Army and Marine Corps between 2022-2027. The order covers five variants of the LMV2.

Plasan SANDCAT

Israeli firm Plasan introduced the the fourth generation of its SANDCAT light armoured vehicle in 2018. The all-terrain 4x4 SANDCAT is available in configurations for military (including special operations), border security and law enforcement units. The ceramic/metal composite monocoque is mounted on a modified Ford chassis, and can be armoured up to STANAG 3 level without impairing performance. Plasan reports top speeds of 120 km/h, acceleration to 96 km/h within 23 seconds and a turning radius of 12.3 metres. The SANDCAT comes in three variants: troop carrier, utility, and single-cab. Depending on variant, the six-meter long vehicle has a payload capacity of up to 2,100 kg, and can carry up to 12 combat equipped soldiers including the driver (troop carrier variant). A remote weapon station is optional.

The SANDCAT can be equipped with six different integrated system modules to enhance mission-specific performance. They include: Driver Assistant module (includes thermal cameras and a dashboard display, enabling driving and navigation under limited visibility conditions); Situational Awareness module (includes six external cameras and analytical software to provide a 360 degree situational picture of the vehicle's immediate vicinity); Mission Management module (centralised command and control over on-board sensors, navigation systems, weapons, and electronic warfare systems); Vehicle Analytics module (collects and analyses data from vehicle components and systems to monitor vehicle health); Vehicle to Vehicle module (broadband data exchange between vehicles); Autonomous Vehicle Operations module (allows unmanned vehicle operation including remote operations and leader-follower scenarios).

Since the introduction of the SANDCAT family in 2004, some 700 have been built. SANDCAT vehicles are in use in 16 countries around the world, including three NATO nations as well as Sweden and the Ukraine. ■

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In October 2019 Mercedes-Benz Special Trucks (MBS) invited ESD to the Defence Vehicles Experience (DVE) 2019 at its Ötigheim Test Range. Visitors were able to get behind the wheel of a range of military vehicles. The DVE is aimed at users and buyers from the defence sector, partner companies and defence media. ESD had the opportunity to talk to Dr. Ralf Forcher, Member of the Board of Management and Head of Marketing, Sales and Service, and Marcus Ernst, Head of Sales Defence and Industrial Customer Business, Mercedes-Benz Special Trucks

ESD: What goals are you pursuing with the Defence Vehicles Experience (DVE) event?
Forcher: With the DVE, we want to present the products of Mercedes-Benz Special Trucks and bring them closer to our customers. In addition, we want to show how our business unit is positioned and what services we provide for our customers, such as the German Armed Forces. In addition to presenting the current portfolio, this also includes a look into the future with the development of vehicles and technologies. These are our core goals and we want to achieve them by offering not only ideas and explanations but also the opportunity to put hands on the vehicles and experience them for yourself while driving or riding along.
Ernst: At this year's DVE 2019 we had visitors from 39 countries. Compared to the last event in 2017, we were able to double the number of participants. In addition to the markets and the end customers, we also had many guests from industry and partner companies. We are working closely with industry partners to be able to present an overall system that covers logistical and tactical capabilities for mobility in the field.

ESD: What services does Mercedes-Benz Special Trucks provide for the public sector?
Forcher: We are the discussion partner who talks to the clients about future directions and about the requirements which need to be met, and we explain what services are available today and in the future to meet the needs of our customers. We provide the necessary and comprehensive information. If there is a concrete need, we develop the individual vehicle hand in hand with the customer. In doing so, we use tried and true solutions and large-scale production units and assemblies that have proven their worth in the toughest of everyday situations. Of course, we are happy to deliver vehicles to the public sector but for us it is not merely about sales and procurement; we also talk about the in-service phase; we offer technical support, spare parts and training.
Ernst: With over 5,000 service centres worldwide, we are globally positioned. We have sold vehicles in over 85 countries. So, it is a good match that we are also global in our after-sales activities. This also includes the area of Integrated Logistic Support (ILS) with life cycle cost calculations, documentation, training and consistent spare parts supply. We are connected directly to the logistics systems of the armed forces via the associated technical documentation.
Forcher: We also offer training services to ensure the operation of the vehicles. You can drive with a truck driver's license – I also have a truck driver's license – but there is a big difference between driving and controlling the vehicle. For the training we can offer the whole range of vehicles so that you can push your driving performance to the limits of physics. In this way, you can get the performance features from the vehicle that our engineers have realised there.

ESD: In your opinion, what is the most important product that Daimler offers for the defence sector?
Forcher: In essence, we have two business models. One is, we offer complete vehicles, or nearly finished vehicles, which are then equipped and finished by partners. We also offer individually configurable chassis, which are the mobility platform for body and system manufacturers.
Currently, the AROCS is the focal point. But the G Wagon is also on the road worldwide as a smaller vehicle in large quantities. It is difficult to pick a vehicle. UNIMOG, AROCS and ZETROS – they are all important to us.
Ernst: Mercedes-Benz is the only manufacturer with a complete portfolio in all payload ranges – from 0.5 tonnes to over 100 tonnes. Then, of course, it depends on what other capabilities are required. When it comes to high off-road capability, the UNIMOG and the G Wagon are top performers. The AROCS is celebrating its first worldwide successes in the defence sector and, as our technology leader, is also the platform for future applications.
I would like to add an interesting number: Since the start of statistical recording, we have sold more than 210,000 Mercedes-Benz vehicles worldwide for logistical and tactical use.

ESD: What particular advantages would you assign to your truck? What distinguishes you from your competitors?
Forcher: Let me mention two topics. The first is off-road capability. Here we have special products in our range that clearly outperform our competitors and, secondly, the subject of innovative strength and a focus on drivability. Here we are bringing

Photos: Heiming

AROCS 6x6 for the German Armed Forces based on the new Mercedes-Benz standard platform for off-road vehicles

something from civil developments that flows into the powertrain, the operation of the powertrain and the safe movement of the vehicle.

Ernst: Another point is commonality, for example the equality of assemblies and parts, which has a direct impact on parts procurement, documentation, training and education. The family concept with the new AROCS family offers the advantage that we can travel with different axle formulae on the same platform. Everything that Mercedes-Benz Special Trucks currently has to offer in terms of technology has been incorporated into our truck series. The AROCS has thus also become the starting platform for the New Generation ZETROS (NGZ).

ESD: One feature of the ZETROS is the cabin behind the engine, recognisable by the unique bonnet. You mentioned as one of the reasons that a lot of space had to be saved in the standard commercial area. But there is also a significant advantage in logistical and tactical use. A mine detonation under the front axle destroys the axle and engine, but not the cabin.

Forcher: Well, that's another big advantage of the canopy concept that we realised with the UNIMOG and the ZETROS. If additional protection is applied, then we have a completely different situation. The driver does not sit above the axle, seat or engine package, but he sits a bit "offside", further away from the danger zone.

Ernst: With 110 units, the protected ZETROS is well-established in the German armed forces, and it has already proven itself very well in various missions. And that is where exactly what has been described above comes into play. The protected cab behind the front axle has also proved to be an outstanding solution in operation.

ESD: Is there another procurement order coming?

Ernst: We've heard that there's talk of a follow-up contract. But that's still in the planning phase.

ESD: What opportunities do you see for the marketing of Mercedes-Benz in the German armed forces? Has the AROCS already been delivered?

Ernst: The first AROCS vehicles will soon go to the body manufacturer. In early 2000, we will deliver of a total of 240 AROCS 6x6 units to BwFuhrparkService GmbH (BwFPS), the car pool service of the German Bundeswehr. Delivery will take about six months and it will be supplemented by so-called Mission Mobility Upgrades, with which the vehicles can be equipped for operation with inferior fuels. After the mission, the vehicles can be easily retrofitted to meet the Euro VI emissions standard. This is particularly relevant for the BwFPS business model.

ESD: And the Bundeswehr "Medium Protected Ambulance" programme with your partner KMW is also important, especially regarding the future regeneration of the DINGO fleet. In addition, there is a variant of the G Wagon that was presented at Eurosatory and DVE – isn't this an opportunity for a special forces vehicle?

Ernst: Yes, of course, such a project is currently underway and, of course, it is an opportunity for the G Wagon platform, and here too we are cooperating with partners. The "Medium Protected Ambulance" programme is a lighthouse project for us. The basis is a three-axle UNIMOG special chassis and thus the mobile platform for a DINGO 6x6. In addition to other national and international projects, we see growth potential for the regeneration of the DINGO fleet, which is due in a few years' time.

In the DINGO partnership, KMW is the general contractor and we supply the corresponding chassis. This is of great importance to us. If you talk about commonality and see the UNIMOG special chassis as a platform for the medium-protected ambulance, then the proven UNIMOG in the lighter class for unprotected transport of wounds fits in with it. The customer benefits in particular from a family concept based on the UNIMOG and special chassis in the areas of training, documentation, spare parts and repair.

This interview was conducted by Gerhard Heiming in cooperation with Jürgen Hensel and Michael Horst.

One of the first series vehicles of the ZETROS New Generation

Power Supplies for Armoured Vehicles

Tamir Eshel

In commercial vehicles, the need for extra power is small, but military vehicles are different as they provide a platform for different mission applications. Combat vehicles are often loaded with energy-hungry electronics.

A vehicle automotive powertrain is designed with adequate power to deliver the vehicle's needs. While vehicles built for the 2020s have increased power to drive the computers and electronic systems on board, and also to provide spare electrical power for other electronics, there is a limit to that power draw. Military vehicles are often loaded with energy-hungry mission electronics, such as navigation, communications and survivability systems.

Photo: TESLA

Smart batteries communicate with the user and provide information about the battery state of health, state of charge, and other functions.

Some equipment may use a special generator to provide electricity, but some systems, such as Threat Detection, Active Protection Systems and data communications are operating continuously, draining the vehicle's energy reserve. In order to meet this demand, vehicle designers integrate more powerful alternators, auxiliary power units, energy generation systems and high capacity batteries to increase the energy available on board.

Vehicles typically carry two to eight batteries, which can cost US$4,000 each when life-cycle costs are accounted for. As a result of a lack of confidence in power availability,
crews continuously idle their engines to ensure battery banks are charged, thus requiring frequent refuelling of their combat vehicles.

Author

Tamir Eshel is a security and defence commentator based in Israel.

Vehicle Modifications and Improvements

While adding more power is a trivial solution, a comprehensive power management approach is likely to deliver the optimal result. As each combat platform uses different methods of electrical power generation, distribution, conversion, and storage, BAE Systems, for example, approaches a vehicle energy management design with the specific power system architecture of the platform.

Traditional vehicle electrical systems are designed for peak events, but power management systems allow power to flow differently during acceleration, road march, attack/defend mode, and braking. When the vehicle is stationary, power can be provided from an energy storage system to operate in pure electric 'stealth mode', also known as 'silent watch', with the engine off to reduce the vehicle's noise and heat signature.

For example, mechanical accessory packages are implemented differently on each platform. Traditional mechanical auxiliary subsystems, whose unco-ordinated and continuous operations are inherently inefficient, generate waste heat that must be exhausted through already burdened cooling systems. Electrifying and managing power-hungry mechanical accessories, such as pumps and cooling fans, can contribute to heat reduction and fuel saving. Addressing the system, and finding the optimal level of integration, ensures that energy loss and inefficiency are minimised.

On-Board Power Generation

Leonardo DRS has designed a specialised power system known as TITAN On-board Vehicle Power (OBVP). As the permanent magnet generating system is integrated within the transmission, OBVP turns the power train into an efficient electricity generator delivering more energy than a standard vehicle alternator without significant load increase. OBVP is designed to support the increased demand for electricity in command vehicles and command posts, missile launchers and high-energy weapon carriers.

Optimal Battery Charging

Discharging a lead-acid battery to less than half of its capacity is not recommended because it might cause internal damage to the battery. Ideally, a 100Ah battery should not be discharged below 50Ah. Therefore, measuring the battery State of Charge (SoC) and State of Health (SoH) are key indicators for effective power management

Photo: Brentronics

Li-ion batteries provide higher capacity but require special containers to protect the vehicle and crew from fire hazard in case of battery failure or combat damage.

on board. SoC is often thought of as the equivalent of a fuel gauge for a battery bank. In this analogy, SoH would be the size of the fuel tank. Merlin Power Systems, a company offering battery monitoring systems for combat vehicles, defines 50Ah remaining as 0% SoC; thus, automatically topping up the battery when needed.

Energy Storage Upgrades

The majority of combat vehicles in the US Army and NATO use the 6T battery format, the most common of which are lead-acid batteries, such as EnerSys' 6T Hawker ARMASAFE Plus battery. At a unit weight of 40 kg, the battery's capacity is 120Ah and it is designed for a life of 120 deep recharging cycles. Multiple batteries are installed in a vehicle to achieve the voltage and energy capacity required for the specific vehicle design.

In recent years, the introduction of Lithium-based batteries has provided higher capacities and power management capabilities, enabling users to better support combat missions. Li-ion batteries suitable for powering combat vehicles were introduced in 2015. The new batteries contain hundreds of standard rechargeable lithium cells interconnected in multiple groups to deliver the required voltage and current. Designed to maintain a safe operating environment through physical isolation and using battery management systems to monitor and regulate electrical voltage, currents and temperature on charging and discharge, batteries are designed to prevent user abuse as well as meet harsh operating conditions. As the power delivered by such batteries quickly degrades in cold temperatures, built-in heaters are used to maintain an optimal operating environment under extreme temperatures. Unlike lead-acid batteries, smart battery features enable communication with the end user, which provides information about the battery SoH, SoC, and other functions.

Batteries of this type integrate into modern vehicles communicating with vehicle systems over the CAN BUS, relaying vital information, including SoC, SoH, cell voltages, temperatures and battery diagnostics. Since some Li-ion chemistries are more flammable than others, users and manufacturers opt to use 6T packs utilising Lithium Iron Phosphate (LFP) that are non-flammable. Li-ion batteries provide higher capacity but require special containers to protect the vehicle and crew from fire hazard in case of a battery failure or combat damage.

For example, Saft's XCELION 6T leverages the company's Super-Phosphate technology that supports the recharging cycle, longer life, and higher energy density over lead-acid batteries. The Saft XCELION 6T is a 28V, 60Ah Li-ion battery system that is designed within the dimensions of a traditional lead-acid battery, enabling easy installation into a vehicle. Addressing the US Army requirement for vehicle batteries to meet MIL-PRF-32565, Saft redesigned its XCELION 6T introducing the 6T Type 1-A variant of the MIL-PRF-32565 Rev B standard, withstanding extreme cold temperature

Photo: Revision

Revision's SILENT WATCH Battery Pack (SWBP) is a modular lithium-ion power platform composed of up to 10 independent 28V, 160Ah modules (SWatPacks), plus a power manager (SMS). This device was designed as a power enhancement for the STRYKER 8x8 armoured vehicle.

performance requirements without the need for pre-heating. The battery provides slightly lower energy capacity - 58 Ah with a nominal voltage of 26.4 volts. Designed to support a cold start without pre-heating, XCELION 6T Type 1-A delivers 1,100 amps at a temperature of -18 C° for 30 seconds, and 400 amps at -40 C° for 30 seconds.

Saft received several contracts to supply its XCELION 6T batteries to foreign customers, including Thales Australia, for use in the Australian Hawkei protected tactical vehicle. The Switzerland-based General Dynamics Land Systems Europe company has also placed a multi-million-dollar contract for batteries to equip 300 PIRANHA V armoured personnel carriers.

A major producer of Li-ion batteries, Bren-Tronics has embarked on a US$6M project establishing a high-volume automated manufacturing facility for military 24V 6T Li-ion batteries for the US Army. The line is expected to produce up to 2,000 6T batteries per month. The company offers two 'Brenergy' brand BT-70939 models of Li-ion vehicle batteries formed in the 6T standard, one optimised

On Board Power Generation

(sb) Power supplies for armoured vehicles must, by definition, also include on-board power generation as well as storage, and there are numerous options. These range from relatively small systems such as solar power generation – which due to the impact of weather, timing, environmental factors, space and technological limitations are broadly speaking unsuitable for powering anything more than small peripheral equipment – to on-board petrol or diesel generators, also known as Auxiliary Power Units (APUs). Over time most conceivable configurations have been assessed by the world's militaries, including petrol, diesel, JP-8, four-stroke, two-stroke, diesel two-stroke, Wankel in both petrol and diesel, normal and forced induction, and even vehicle-mounted gas turbine generators. Fuel consumption terminated that last, and now the norm is a four-stroke normally-aspirated, water-cooled diesel engine, such as the PE-150 N series by Fischer-Panda, which consumes 1-1.5 litres of diesel per hour and emits 55DdB(A) at 7 metres while charging at up to 360 Amps. Fischer-Panda's success is notable, as this is another competitive area of business: even well-established manufacturers such as Lister-Petter have tended to try a brief foray before withdrawing to less specialised arenas.

Power generated other than by the main engine is very nearly as critical for vehicle functionality and mission success as the main engine itself, and it needs equipment capable of generating reliable, "clean" power without variation, hesitation or fluctuation – as required by many high-technology systems. Power management is another fundamental requirement, as high-quality, highly reliable, zero- or limited-variance power is essential to avoid shortfalls in the performance of advanced electrically-driven systems – which may include gun stabilisation systems, communication and surveillance systems, life support (e.g. CBRN filtration systems, HVAC) and main turret positioning drives.

Companies involved in main engine-driven generators include Vincorion, a subsidiary of Jenoptik from Germany, which has recently been selected to provide custom-made power for the Main Ground Combat System, due to be operational in 2035.

In general, on-board APUs are not silent, and they are not primarily designed for stealth. Instead, they augment the main engine-driven alternators and generators, and provide power when the main engine is shut down, reducing heat and noise as well as saving fuel and mechanical wear. Some power generation systems are quieter than others: the EMILY 3000 fuel cell supplied by SFC, again from Germany, makes only 39dB(A) at 1 metre, while providing up to 300W peak power. Danish company Fack-Schmidt is currently under contract to develop an 8-10kW APU demonstrator using Solid Oxide Fuel Cell (SOFC) technology, operating on NATO diesel (F-54) / JP-8. Fuel Cell R&T is extremely competitive and offers much greater potential outside the military market: the Japanese government is pushing SOFC development hard in order to use the 2020 Olympics as a showcase for its hydrogen and fuel cell strategy.

However, for heavier armoured vehicles with any significant electro-mechanical drives, or with electrically-demanding mission modules, greater power is required, which is where conventional petrol or diesel generators, mounted on the vehicle, come into their own.

Collins Aerospace, which within the next 24 months will complete deliveries of the last of 400 of a new electrical generator for the M1A2 ABRAMS MBT under a General Dynamics 2013 contract award to UTC Aerospace Systems. This new equipment provides 50% more power than its predecessor.

Elbit Systems – Kinetics are another supplier of on-board APUs; further information is apparently available on Social Media for those inclined to look.

One of the more remarkable aspects of this topic is that while all sides appear to agree that, increasingly, some form of APU is required on-board a modern armoured vehicle – some very significant battery advances notwithstanding – in the West there is startlingly little awareness of developments just across The Pond.

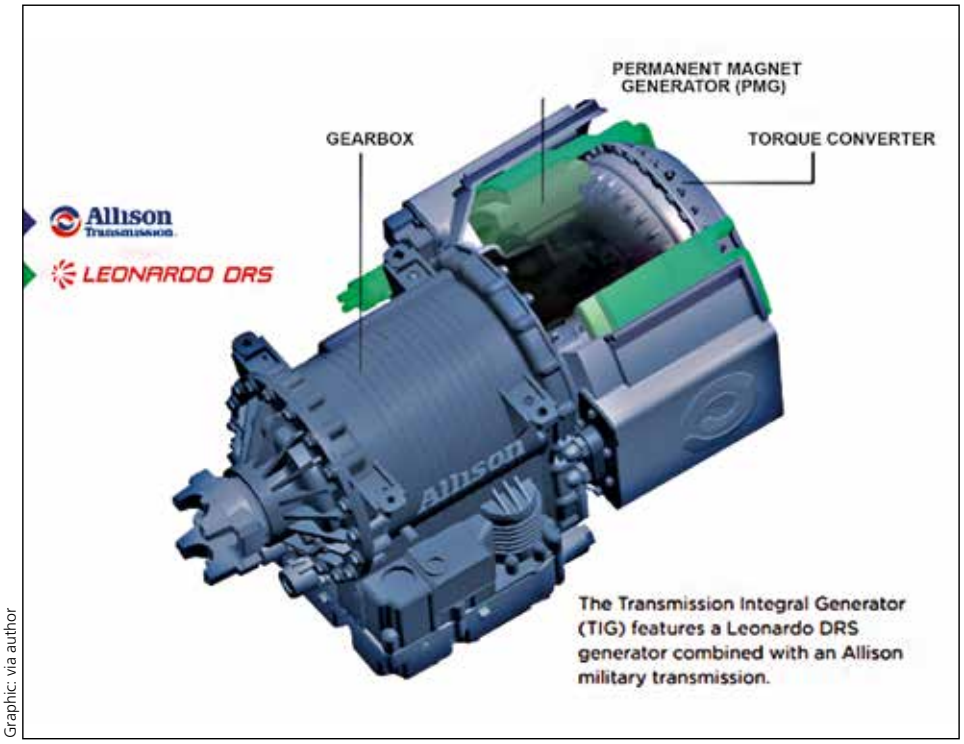
In both directions.

for high-power (AP-APH) delivering 103 Ah, and the other for high-energy (CU/CUH) delivering 126 Ah.

The 6T battery from Denchi Power weighs 25 kg and delivers 85Ah (2.142 kWh) with 900 A cold cranking Amps. The battery is designed to support 3,500 deep charging cycles at charge rates of up to 270 A. As the battery management system limits battery to 45 A, Denchi also offers higher charging rates at 'bypass mode', enabling the battery to charge directly for fast charging at rates up to 270 A. This mode enables the battery to absorb energy during turret braking, sinking energy pulses up to 500 A for five seconds.

In Search of New Cell Chemistries

The Li-ion 6T packs hundreds of rechargeable Li-ion cells to deliver the energy it is designed to provide. The type of cell chemistry determines the energy density – some provide higher energy level, others are less vulnerable to damage and fire. Obviously, increasing the energy density and preserving safety would be highly beneficial for the military user. A new cell developed by the US Army Research Laboratory (ARL) implements aqueous electrolyte could provide reliable high energy source with robust damage tolerance. The new cell employs several technologies developed by the team, including the intrinsically safe "water-in-salt electrolytes" (WiSE) and the technique to stabilise graphite anodes in WiSE, and a novel cathode chemistry that further extends available energy for aqueous batteries to a previously unachievable level. The energy output delivered by the experimental water-based battery is comparable to conventional Li-ion batteries based on flammable organic liquids other than



Graphic: via author

Leonardo DRS has designed a specialised power system known as TITAN On-board Vehicle Power (OBVP), which turns the power train into an efficient electricity generator.

Photo: Epsilor

An Epsilor ELI-52526 fire-protected battery pack

water, but is much safer. The new system is able to hold 240 milliamps per gramme for an hour of operation, delivering about 25% extra the energy density.

A different approach to vehicle power storage is reflected in Revision's SILENT WATCH Battery Pack (SWBP), a modular lithium-ion power platform composed of up to ten independent 28V, 160Ah modules (SWatPacks), as well as a power manager (SMS). Although this device was first designed as a power enhancement for the STRYKER 8x8 armoured vehicle, according to the company, it can be customised to fit different enclosures and attachment methods. The system was mounted externally in order to avoid potential hazards or flammability issues with Li-ion cells.

Individual SWatPacks are made of seven high-end lithium polymer cells rather than hundreds of smaller cells, typical of most current systems. Fewer connection points mean less potential for failure, thus greater reliability and lower lifetime maintenance costs. Each SWatPack can last up to 6,500 cycles (approximately ten years), and multiple redundant safety measures have been incorporated. SWBP systems and individual SWatPack cells are available now for global forces. Just like the XCELION 6T Type-1A, SWBP is designed to be MIL-PRF-32565 compliant.

Another new concept for vehicle battery is the dual voltage battery developed by Spear Power Systems LLC addressing a US Army requirement. The new battery that Spear is developing will support multiple voltages, avoiding the need for multiple fielded batteries to address multiple voltage requirements. The 24/48 Volt battery conforms to 6T standard offering a drop-in replacement for 12 Volt batteries. Configured in packs of multiple 48 V batteries, the new system will provide a 'building block' for higher voltage systems up to at least 300V.

While the unit cost of Li-ion batteries is higher in comparison to lead-acid batteries, a comparison of life cycle costs shows that the cost of ownership over the battery life cycle of Li-ion 6T batteries is slightly lower than similar lead-acid batteries. This LCC is expected to decrease even further, as Li-ion cell prices drop in tandem with wide penetration of electric cars. With current battery cost reduced to around US$100/kWh, it is expected that in the long-term, military vehicle batteries will further reduce in price, and reduce logistical burdens to stow, transport and distribute replacement batteries. According to estimates by Saft, this translates to over US$200M of savings in the total cost of ownership for a fleet of 20,000 vehicles over a 20-year life span. ■

Powering the Needs of Tomorrow's Armoured Vehicles

Tim Guest

New hybrid drives, energy storage and sophisticated power management systems are just some of the technologies that will be key to meeting the needs of electricity-hungry armoured vehicles operational on future battlefields.

Armoured vehicles rely on power derived from various sources to run and operate both main-vehicle electrical systems and peripheral devices and sensors, key to the overall effective operation of the vehicle. From battle management systems, internal/external communications and command and control systems, to the numerous ancillary sensors (such as low-power laser devices, night vision systems, situational awareness sensors and cameras together with the data connections that support them), all rely on an ever-ready electrical power to function. And in the future, higher powered, vehicle-mounted, directed-energy systems/weapons may have to be considered as well. So, there is no getting away from the fact that tomorrow's battlefield will be more power-hungry than any past battlespace and the armoured vehicles operating therein will necessarily be platforms of power innovation. This will not simply be in terms of the main drives that power the vehicles themselves, but also the innovative power supply systems that will ensure every critical electrical/electronic device in place on these armoured platforms has an uninterrupted and reliable power supply. From generated power to stored power, electrical supply and management architecture will need to be able to intelligently draw on any source of power and distribute it throughout the vehicle to the systems that require it when they need it, without wasting a single amp. The new demand for electricity has pushed the limit of what is available on conventional vehicle platforms – platforms never conceived with the electrical demands of today in mind and, as a result, a fundamental design rethink has been required.

Photo: US Airforce

The E-X-Drive was considered for a retrofit BRADLEY Fighting Vehicle in the US GCV programme, although the programme was cancelled in 2014.

This article, therefore, focuses on the potential move away from the restrictions of the internal combustion engine and traditional driveline components, with the emergence of Hybrid Electric Drive (HED) systems. These offer credible alternatives to conventional mechanical designs, delivering technological advantages, not least of which will be increased onboard power supplies and power availability for future armoured vehicle fleets and all the power-hungry systems they will carry.

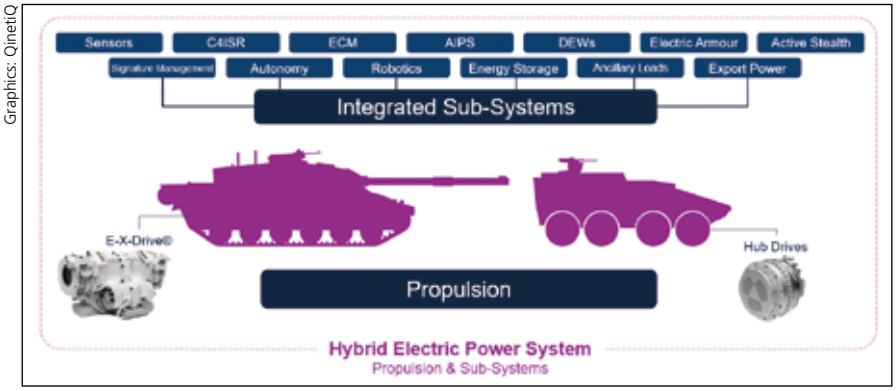
The Electrified Battlespace

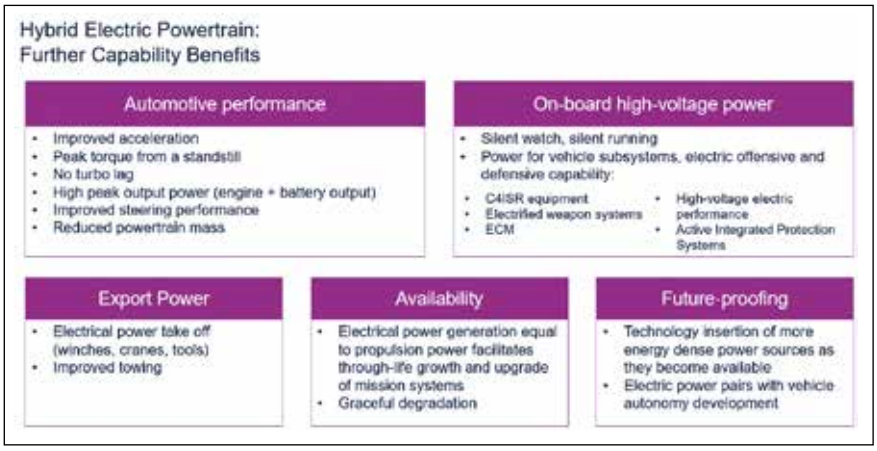
Traditional vehicle power packs combine a diesel engine with a transmission for both tracked and wheeled vehicles. Electrical power is generated via alternators driven by the engine, or a power take-off from the transmission. These generally operate at 28V and are limited in their power-generation capability, a factor, which, according to QinetiQ in conversations with ESD, limits future power availability for the new defensive systems, weapons and intelligence, surveillance, target acquisition, and reconnaissance (ISTAR) systems carried on the vehicle. Hence, traditional systems are making way for the latest innovations to meet the needs of electrified battlespace and HEDs, such as the E-X-Drive electromechanical transmission developed by QinetiQ for tracked vehicles, by operating at higher voltages, enabling a dramatic increase in the availability of electrical power in conjunction with higher capacity energy storage solutions. The E-X-Drive weight range currently addresses vehicle designs in the 10 tonne to 80 tonne range, with demonstrations having been conducted for 18t, 30t and 80t-range platforms. QinetiQ actually conducted concept and design work with BAE Systems for an E-X-Drive variant to retrofit Bradley Fighting Vehicles in the US GCV Programme, although that programme was cancelled in early 2014.

Author

Tim Guest is a freelance journalist, UK Correspondent for ESD and former officer in the UK Royal Artillery.

Graphics: QinetiQ





In a hybrid electric vehicle, electric motors housed in the transmission of tracked vehicles and in the wheels of wheeled platforms, draw power from a battery or generator. However, as vehicle design constraints are more flexible than with a conventional mechanical platform, these can be situated almost anywhere on the vehicle.

QinetiQ says that it uses its own "validated modelling tool to size the battery appropriate to the use and duty cycle of the vehicle and locate the batteries flexibly to suit the vehicle architecture". Not only does this flexibility impact and improve such things as mobility and survivability, it also improves the vehicle's lethality by enabling it to conduct extended periods of silent watch and silent running, with no main engine, (and, therefore, minimal acoustic and thermal signatures), required to power all vehicle systems. Electrical power is also available in such scenarios for high-power requirements, including rotating the turret.

When not in silent running, the energy produced by an HED's on-board generator can be stored and used when and where needed, perhaps delivered to the wheels for an added burst of acceleration, or, as mentioned, to power a future directed energy weapon enabling it to fire on and neutralize a threat. Regarding how an armoured vehicle using a HED applies brakes that can hold the vehicle on a substantial slope, QinetiQ eased ESD's curiosity in relation to its E-X-Drive. Their HED has a foundation brake able to meet European heavy-vehicle, multiple-stop requirements and maintain the hold position on a 60% slope. It also has electrical regenerative braking available, depending on the battery state of charge, and this will be sufficient for most manoeuvres, or for long downhill running.

New Demands Drive Innovation

The increasing emergence and deployment of platform-borne sensors and the subsequent growing reliance on greater amounts of readily available electrical power has led QinetiQ, for one, to recognise that the full electrification of combat vehicles is essential for both wheeled and tracked platforms in the future. The company says that current technology supports the transition from purely mechanical to hybrid electric propulsion systems and that this transition offers significant benefits in vehicle architecture, with associated improvements in survivability, performance, fuel consumption and reliability. As mentioned, the ability to flexibly package and relocate elements of the driveline – those parts of the powertrain excluding the engine – and energy storage systems, radically removes the constraints associated with traditional vehicle architecture.

Possible 'knock-on' effects resulting from the transition to HEDs will, according to QinetiQ, include to logistics supply chain, largely due to increased fuel efficiency experienced using HEDs. This will be achieved by being able to run diesel engines at their optimum operating point on the fuel map, due to required changes in torque, changes that are supported by the vehicle batteries smoothing the demand. HED systems, mechanically simpler than traditional drivetrains, also have fewer components resulting in reduced maintenance demands, in turn leading to improved reliability and through-life support costs.

As to the power management in a hybrid system, this is more efficient and effective because all electrical automotive and integrated systems can use the same energy source and a vehicle designed with a sufficient power budget from the outset will be able to accommodate new systems and technologies, as needed, or when available.

While dependent on the platform and installed battery capacity, an example of the sort of power demands QinetiQ's HED E-X-Drive could accommodate to operate sensors and onboard systems (such as SA, CCTV, NVG, communications, ISTAR etc,) is: a future 50 tonne tracked vehicle with an installed generation power of 800 kW and 200 kW battery capability, which could produce around 1 MW of available electrical power, if a vehicle is stationary.

Research and Development Initiatives

There are several initiatives that address HED as the future for both tracked and wheeled vehicles, including in the US, where the US Congress, as far back as 1992, initiated the 'Electric and Hybrid Vehicle Technologies (EHV) Programme', to serve, as it put it, "the needs of the USA's national defence". The defence community and government agencies realised then that electric and hybrid propulsion systems, cleaner and more efficient than conventional systems, had a great potential in terms of solving military issues relating to performance, stealth, fuel efficiency and logistics/resupply-of-diesel challenges. Over time, however, the HED's exceptional ability to deliver substantial electrical power throughout the vehicle for a wide range and increasing number of on-board vehicle systems and sensors, as well as its ability to export power for stationary applications, has also, as with other

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programmes looking at this tech, been recognised by the US Programme.
As for QinetiQ's work on HED's in addition to customer-funded programmes the company has invested significant IRAD funds in developing HED for E-X-Drive (for tracks) and Hub Drive (for wheels). IRAD (Independent Research and Development) funding is an 'allowable cost' so that companies can initiate and conduct Research and Development projects of potential interest to the US Department of Defence, funds, which are then reimbursed through overhead cost rates. Looking ahead, including the evolution towards platform-borne directed energy systems, the company told ESD that "Electric drive offers the precision and the control necessary to better deliver autonomous solutions and enables the powering of high power weapon and defence systems" in the future.

Hybrid Power Management Solution

Just over 12 months ago, the Greek defence company, Intracom Defense Electronics (IDE), was invited to trial its intelligent Vehicle Hybrid Power Management System – Hybrid GENAIRCON – on a UK Army Warrior FV510 TES Infantry Fighting Vehicle (IFV) during the Army Warfighting Experiment/Autonomous Warrior Exercise 2018 (AWE18). Working closely with the UK Army Armoured Trials and Development Unit (ATDU) to integrate its Hybrid Genaircon system, IDE was able to demonstrate the tactical advantages of the Hybrid GENAIRCON in field operations. The system operated successfully as an autonomous vehicle power supply and management system, providing over 20 hours of continuous silent watch with full operational capability in an automated manner. The system was also shown to contribute to mission sustainability and survivability, demonstrating its capability to enhance defensive readiness under silence and to operate under the same conditions as a field 'Energy Hub', exporting power to other vehicles and to various portable equipment during operations. The system delivers advanced

Photo: UK MoD Crown Copyright

IDE's Hybrid GENAIRCON system was tested on a British Army WARRIOR FV510 TES IFV during the AWE18.

power management and environmental control through the integration of a what the company calls 'best-in-class' APU and A/C designs together with innovative energy storage modules, which are controlled from a centralised control unit. This prioritises how the stored energy is used and where it will be delivered. During the AWE demonstration, not only did the Hybrid GENAIRCON provide continuous 24 VDC auxiliary electrical power for more than 20 hours of silent running, but it also provided more than six hours of power during full operations. This it drew from its stored supply in the Hybrid GENAIRCON's associated Energy Storage System (ESS) to power such on-board systems as the battle management system, communications, thermal imaging system, situational awareness equipment, turret elevation and traverse, weapon systems, and all auxiliary requirements (such as lights, door opening, and filtration/ventilation, etc.
The ESS is scalable and enables silent running operations and a pulse power draw capability for power-hungry, urgent applications. Using advanced-chemistry cells and integrated electronics, each continuous power module of the ESS provides the equivalent energy storage as multiple 6T NATO Standard Form Factor lead-acid batteries, while also reducing space and weight needs.

Powering Directed Energy Systems

High-powered, armoured-vehicle-mounted directed energy weapon systems will, one day, likely be a standard feature of the battlefield, though one requiring a substantial power supply drawn from any armoured platform on which they are mounted. In the context of a vehicle using an HED, such a future power requirement should not be a problem. However, at this time, directed energy weapons still require more electrical energy to function than is available on a typical, traditionally-powered armoured vehicle, which is not surprising given that to fire such a weapon will require the repeated, rapid drawing of energy either from large batteries/fuel cells, or from a generator capable of rapid re-charge and energy replenishment. Hence, such weapons being used on armoured vehicles (as opposed to naval use, for instance), is still some way off. It is, nevertheless, worth knowing a little bit about how such a system operates and how it will impact power supplies on an armoured platform.
Conducting a mission effectively using a directed energy system will require highly detailed intelligence about any target and its surroundings. This is because the laser beam can and will be attenuated by the operator to ensure an optimum level of energy is used to neutralise a target. This use of an optimum amount of energy per shot will avoid the unnecessary depletion of stored energy and will also avoid potential collateral damage. Hence, detailed intelligence on a target's structural materials and construct is essential, not only in order to identify vulnerable areas most susceptible to a strike by the weapon, but also to determine the optimum power levels needed against different enemy platforms and installation types. In time, such information and corresponding power requirements will be stored knowledge. However, the key message here is that with the other sensors, ISTAR and communications systems carried on future wheeled and tracked armoured vehicle platforms all requiring effective and reliable uninterrupted power supplies, the introduction of directed energy weapons will only become possible if it is done in tandem with the introduction of suitable novel power systems. HEDs will most certainly play a major part in delivering the power supplies aboard the armoured vehicles of the future to make all of this happen. ■

Hybrid Power for Lightweight Armoured Vehicles

Alex Horobets

Approaches to military operations are constantly changing, requiring military hardware to the adapt to the new conditions on the battlefield. Among the current trends are the need for the flexible reconfiguration of hardware under conditions of irregular warfare, the ability to withstand weapons used by rebels such as improvised explosive devices and anti-tank mines, and the ability to function in urban areas. Armies want their combat vehicles to be both mobile and fast.

As a result, many modern military operations use light and medium-weight armoured vehicles that are constantly being upgraded. Examples of such upgrades include a mine-proof V-shaped hull, a general improvement in crew survivability, a reduction in the vulnerability of wheeled vehicles through the use of a central tyre inflation system, and improved communications and situational awareness.

The use of hybrid drives in light armoured vehicles raises many questions, the most important being when will armies make massive use of them and whether they will do so at all. After all, such engines can be used to address issues of fuel consumption and mobility. The decisive advantage of hybrid and electric engines is also that they are much quieter than conventional diesel and gasoline engines, which could be crucial for covert manoeuvres in combat operations. Another important advantage is the ability to operate the energy-intensive sensors without having to start the diesel engine.

Experts appreciate several key features of electric power units. These include high efficiency and reliability, in contrast to mechanical units, as well as lower fuel consumption and increased vehicle agility. In addition, the possibility to replace an engine with electrical power sources and fixed mechanical parts – with flexible cables – opens up the scope for further modifying the vehicle's design according to its intended purpose.

Today's armored vehicles face a number of challenges that can be solved with the introduction of electric engines. First, of all, the weak point of these vehicles is the mechanical shaft that drives the wheels. It must run along the vehicle floor and limits the underbody protection. Indeed, most fatalities were caused by roadside IED explosions in Iraq and Afghanistan. Another drawback of modern technology is that it is poorly adapted to the growing number of energy-consuming sensors and systems that are creating new electrical burdens.

Author

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Photo: BAE Systems

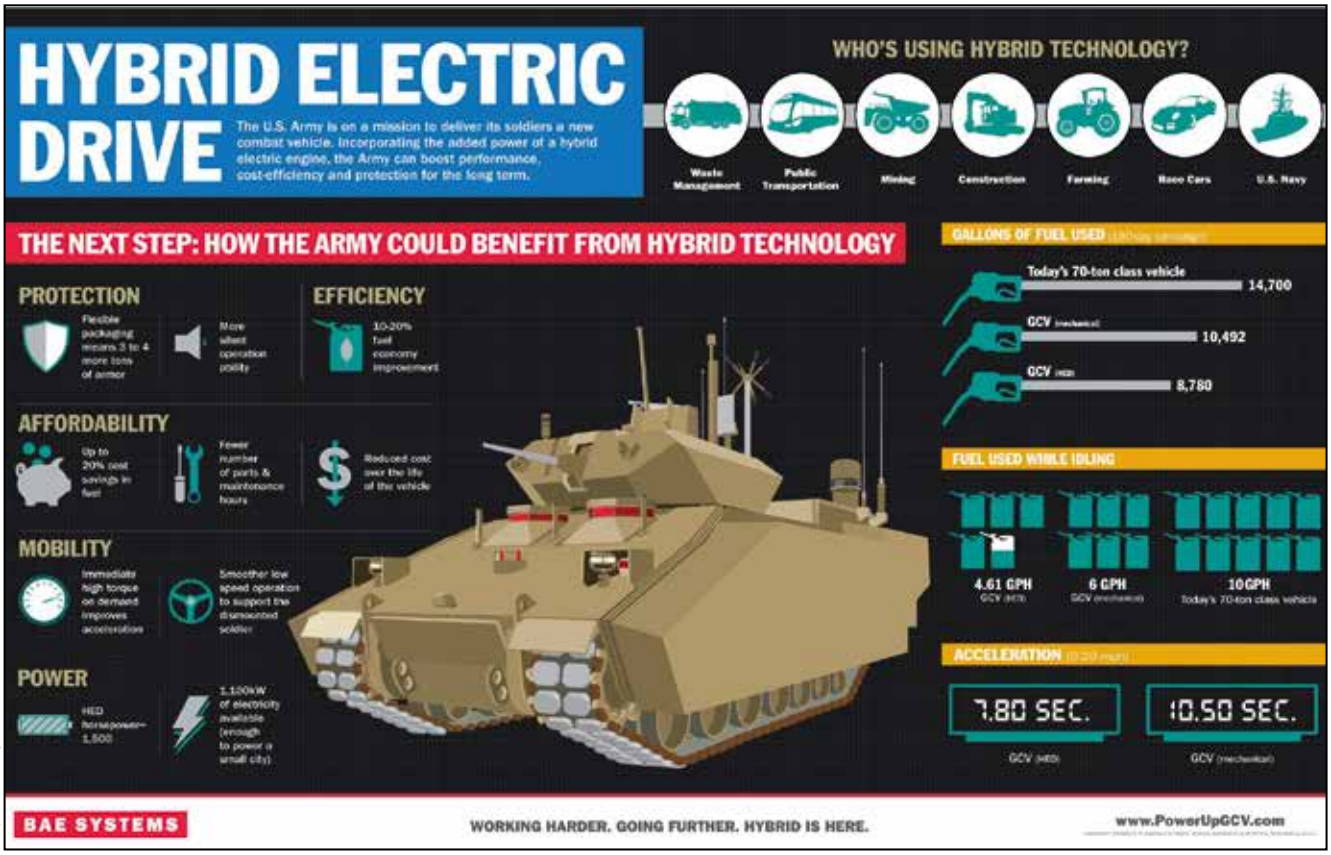
Artist`s rendition of BAE Systems' electric armoured vehicle

Hybrid or All-Electric

These problems are to be solved by means of vehicles with hybrid or electric drive. The replacement of mechanical elements by more flexible and lighter electrical systems will make vehicles more mobile and allow for the better placement of the armour. In addition, the electric drive does not require a mechanical drive shaft, which allows the design to be changed in order to provide better protection against IEDs.

The electric engine is seen as a key element for the future introduction of complex sensors and electronics in combat vehicles; it will be more organically linked to such systems than to mechanical ones and will simplify the integration of AI technology. This will allow for the creation of 'intelligent' combat vehicles, which will ensure better situational awareness and response to incoming threats.

The first public test of hybrid technologies took place in 2005 when the US Army's National Automotive Center and BAE Systems announced the development of the first armored hybrid electric tracked vehicle, a 15-ton prototype M-113 with hybrid drive. At that time, a battery was used to



Graphic: BAE Systems

meet short-term energy requirements for acceleration, steering and uphill driving. The vehicle was powered by an additional battery pack. At that time, however, the prototype had to undergo a series of tests to prove its survivability and superiority in combat.

The Pentagon has shown a great interest in hybrid vehicles, solar energy, and other clean energy sources. For the US Department of Defense, the construction of a new generation hybrid combat vehicle is a matter of saving valuable budget funds in an era of tightening budget policies.

First Developments

In 2012, there were reports in the US about the development of the first armoured infantry fighting vehicles with hybrid drive. The project, led by BAE Systems and Northrop Grumman, involved the use of the MTU883 Hybrid Electric Drive as the main diesel engine, using the 1,100 kW Hybrid Electric Drive transmission from the UK manufacturer QinetiQ. At the time, it was estimated that fuel consumption could be reduced by 10-20% depending on the type of operational terrain. At the same time, around 17.5 litres of fuel were consumed per hour when idling, which is 20 litres less than with a conventional engine.

Back then, BAE Systems and Northrop Grumman Corporation began developing IFVs under the GCV (Ground Combat Vehicle) project. In addition to the advantages of the hybrid drive - i.e. the simple design and lower weight - the project had a number of other advantages too, including better dynamics and better protection. The disadvantage, however, was the cost of the project, which was five times the cost of the M2 Bradley IFVs in service with the US Army.

Meanwhile, research continues regarding the latest electric drive systems for future armoured and robotic vehicles. To date, however, electric batteries are unable to produce the required level of energy needed to move a 60-tonne tank.

Andrew Holland, Programme Director of the American Security Project, a Washington-based think tank, believes that the latest developments in battery technology make it possible to consider electric and hybrid light armoured vehicles as feasible for the military. In recent years, he says that modern technologies have made a leap forward. Batteries are becoming cheaper, better and lighter - and this is happening much faster than previously expected. Inevitably, the charging process will also be much faster, which will eliminate the issue for military vehicles at a tactical level.

In the future, eliminating the main engine will bring a number of benefits to the military, such as the use of one electric motor per wheel to better distribute weight and maintain mobility when one of the engines fails. Electric motors also provide much higher torque than a diesel or gasoline engine when needed.

Ongoing Research

Today, programmes have been launched at different levels to develop and further introduce new types of light armoured vehicles. These are both national programmes and initiatives introduced by private defence companies. A prominent US project titled 'Next Generation Combat Vehicle' (NGCV) is designed to replace the US Army's key IFV, the M2 Bradley. Taking military requirements into account, the project implies a crew of two with space for six paratroopers on board and high mobility to be provided by a 1,000 hp engine, combined with passive and active protection and a remote weapon station with a 50mm automatic gun.

The Project places a key focus on the use of modern technologies and materials. In particular, designers are considering alternative energy for their NGCVs, including through hybrid and all-electric power units. Another necessary element is noise reduction thanks to the electric drive and a battery to control vehicle systems without having to start the engine. This will enable the vehicle to be deployed in a wider spectrum of missions.

The main focus in the modernisation of new NGCVs will, therefore, be on the further introduction of modern electrical engineering. According to the terms of the programme contract, the hardware is to be operational by the end of 2022 and tested in 2023.

In 2017, Israel began field tests with a new hybrid power source for tanks and

armoured vehicles. This involved advanced rechargeable lithium-ion batteries developed by Epsilor-Electric Fuel in cooperationn with the Israeli Ministry of Defence and operationally supported by Merkava (Israel) as well as most other major battle tanks and armoured vehicles worldwide. According to the developers, the batteries will be able to operate at high capacity for 12 hours without being recharged. This will allow operations at night without the need to switch on the main engines, i.e. to carry out the so-called 'Silent Watch' missions with power-hungry surveillance, targeting and communication systems. This significantly reduces the likelihood of being detected and attacked by the enemy.

The UK has also been working on developing electric drive systems for future tanks. The Defence Defence Science and Technology Laboratory (DSTL), the UK equivalent to the US DARPA military research agency, has launched an electric vehicle project worth US$4.1M. According of Chief of Staff, Sir Mark Carleton-Smith, the current fleet of military vehicles could be the last generation to run on fossil fuels. He believes that we may well be seeing the end of combat vehicles powered by traditional fuels.

In 2010, the USA decided that its army needed an ultra-lightweight combat vehicle (ULCV). At that time, the Office of the Department of Defense and DARPA appointed the Tank Automotive Research, Development & Engineering Center (TARDEC) as the executive body for the ultra-lightweight combat vehicle program. This led to the creation of a prototype for a hybrid drive. The vehicle is equipped with a 175 HP Subaru boxer turbo diesel engine. American Traction Systems Remy-410HVH HT traction motors turn the wheels that drive the UQM-200 phase generator and inverter.

TARDEC, together with several US defence companies, built and tested three ULV prototypes. Their hybrid power unit received wide appraisal. The system, consisting of a diesel and two electric engines, allowed for high running performance and provided the required level of sustainability. Two relatively compact electric motors left enough space for the unique mine-resistant bottom shape without vulnerable spots. Besides, the vehicle also retains mobility if one of the engines fails. The level of ULCV development, against that of heavier and armoured hybrid combat vehicles, suggests it is more likely to appear in the army earlier than other new types of military equipment.

According to the online military magazine Defence Blog, researchers with the US Army Combat Capability Development Command Ground Vehicle Systems Center (GVSC) and US Army Research Laboratory are developing combat vehicles, including MBTs and IFVs, powered by hydrogen fuel cells. The hydrogen fuel cell system produces no smoke, noise, or odour, boasting a number of acoustic and thermal advantages, as well as high torque. New fuel cells are more energy efficient than internal combustion engines.

A hybrid system is by far the most realistic one to appear in the army in the near future, since fully eliminating diesel or gasoline engines will hardly be 'at the table'anytime soon for military vehicles operating in combat. It is primarily about logistics. The key criterion is time required for pumping a full tank and fully charging a modern car battery. In any case, everyone has long since stopped regarding electro traction as a 'technology with promising future.' The main question today is when it will be used in military hardware.

Turret Options for 8x8 Combat Vehicles

Sidney E. Dean

Medium weight armoured fighting vehicles (AFV) are equipped with a broad choice of primary weapons, ranging from 20mm autocannons to full-bore 120mm guns. Overall, modern AFVs – whether light tanks, infantry fighting vehicles (IFV), or armoured reconnaissance vehicles – are trending towards more powerful weapons than previous vehicle generations.

The primary reason for this trend is that they must contend with a more diverse set of opponent vehicles and threats, as well as with improved armour on enemy vehicles. For this same reason AFVs are also mounting additional weaponry including anti-tank guided missiles (ATGM) and air defence weaponry suitable against helicopters and unmanned aerial vehicles (UAV).
A wide variety of turret systems are available as weapon and sensor platforms. Given the wide range of user requirements, flexibility has become a major consideration in the development of modern turrets. This includes the ability of a single turret to accommodate a variety of gun calibres. In addition to weapons, various cameras and sensors, including thermal imaging system and the targeting system, are integrated with the turrets. Both traditional manned turret configurations and unmanned/automated turrets which permit gun crews to remain in the main vehicle compartment are available. This article will discuss turret options for wheeled 8x8 AFVs.

Photo: Canadian DND

Installation of the new turret as part of the Canadian Army's LAV VI upgrade programme

GDLS LAV II/LAV III/LAV VI

The majority of 8x8 turrets are designed for autocannons in the 20mm to 50mm range. The General Dynamics Land Systems (GDLS) Light Armoured Vehicle III serving with the Canadian land forces and four other armies is typical in this respect. The turret employed on the LAV III and its predecessor the LAV II features a 25mm M242 Bushmaster 25mm chaingun as the primary weapon, with a coaxial 7.62mm machine gun and a second machine gun pintle-mounted atop the turret. Smoke grenade launchers are mounted on both sides of the turret. Chaingun ammunition is stored in bins inside the turret.

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Turret hydraulics were replaced with an electric turret drive system during an initial upgrade. Currently, the Canadian LAV III is being upgraded again, this time to the LAV VI standard. This will include another turret upgrade with advanced electronics, fire control systems, visual sensors and crew displays to improve target acquisition and weapon accuracy. Ergonomics and safety for the two-person turret crew are also being improved. The upgraded LAV is expected to stay in Canadian service through 2035.
The LAV-25, the immediate predecessor of the LAV III, is also utilised by the US Marine Corps (USMC) in various configurations including the LAV-AT (Anti-Tank) variant. A new turret was introduced on the LV-AT in 2017. Produced by Raytheon, this unmanned turret mounts two TOW tube-launched, optically tracked, wireless-guided ATGMs and the associated targeting and tracking sensors. Unlike its predecessor, the new turret is unmanned. The USMC cites numerous advantages, including greater crew safety; improved maintainability; and greater accuracy. The new turret deploys both wire-guided and radio frequency TOW missiles. The improved thermal sight can acquire targets while the LAV is in motion. Additionally, the new turret is equipped with a Far Target Location system, new commander/gunner video sight displays, and an electric elevation and azimuth drive system which helps rotate the weapon system onto the target.

Kongsberg MCT-30

In 2015, the US Army decided to upgrade a portion of the STRYKER Infantry Carrier Vehicle (ICV) fleet with a 30mm automatic cannon. The first STRYKER DRAGOON equipped with the Kongsberg Protector MCT-30 turret was delivered to the US Army in Europe in December 2017. The MCT (Medium Calibre Turret) as incorporated on the STRYKER carries a 30mm Mk 44 BUSHMASTER chaingun, but the Norwegian-designed turret is capable of also mounting a 40mm automatic cannon. In addition to the main gun, the turret mounts a coaxial 7.62 machine gun and a roof-mounted second machine gun. Alternately to the roof-mounted

MG, the PROTECTOR MCT can be equipped with a secondary remote weapon station (RWS) such as the Kongsberg PROTECTOR CROWS. Optional supplementary armament includes JAVELIN ATGMs mounted either on the CROWS or coaxially on the turret's side. Two banks of four smoke grenade launcher tubes each can be optionally mounted on the turret. Turret mounted sensors include daylight and infrared cameras and a laser range finder with a target identification range in excess of 3,000 metres.
The unmanned turret is fully stabilised, including point stabilisation. It is capable of 360-degree rotation in azimuth -10 to + 45 degrees, and elevation up to + 60 degrees, making the gun effective against ground and aerial targets including UAVs. Both the vehicle commander and gunner are stationed within the vehicle hull, and operate the turret from a special control panel. A commander's independent weapon station is optional. Reloading the turret's automated munitions handling system is also performed under armour from within the hull (the turret includes storage for 600 rounds of 30mm munitions, in addition to 2x 75 rounds for immediate weapons feed). Soldiers note some loss of visual field outside the vehicle, as there is no turret hatch, but crew safety is considerably increased. The 30mm gun is remotely aimed and fired from within the vehicle proper.
Vectronics are modular, permitting customers to either retain the fire control and target acquisition sensors supplied by Kongsberg, or install alternate systems of their choice. The fire control system automatically performs ballistic computation compensating for the lead angle, cant, tilt and vehicle motion, making targeting easier in the most challenging scenarios. In addition, the turret is equipped with the Kongsberg Integrated Combat Solution (ICS), which allows it to gain access to a number of enhanced lethality features like automated precision Hunter-Killer, and target sharing between vehicles.
The standard turret comes with STANAG 1 level protection, which can be increased through modular armor on the front and sides. Soft-kill and hard-kill active protection systems are available as optional upgrades, as is a threat detection system. The turret adds approximately two tons to the STRYKER ICV's weight.

BAE Hägglund E35

The MCT-30 is also utilised on the Croatian army's PATRIA AMV (armoured modular vehicle). However, most other versions of the PATRIA AMV are armed with the BAE Hägglund E35 turret which was originally designed for the Hägglund

Photo: USMC

Anti-tank weapon systems are mounted on LAV Anti-tank variants at Camp Pendleton, CA. The Marine Corps Systems Command's LAV Anti-Tank Modernisation programme team completed its first fielding of four upgraded ATWS in September 2019.

Photo: USMC

A US Marine tests the enhanced vision capability – part of an upgrade to the LAV`s Anti-Tank Weapon System – during equipment training in September 2017 at Camp Pendleton, CA.

Photo: Kongsberg

The Kongsberg MCT-30 turret demonstrated on the GDLS LAV in 2017

CV9035 tracked AFV. More than 600 of these turrets are in service with the land forces of six nations. The system was extensively proven in Afghanistan, where Danish and other forces praised the turrets responsiveness, accuracy and lethality. The E35 has demonstrated precision fire beyond 4,000 metres engagement range.

The manned E35 turret has side by side seating for the vehicle commander and gunner, with the breach of the cannon positioned between the two. This places the weapon's centre of gravity centrally inside the E35's turret ring, maximising stability for the vehicle and for the firing process. The two tonne turret is designed with a fully digital architecture, and mounts a 35mm Bushmaster III autocannon. Two 35 round belts with different ammunition options are simultaneously loaded, while an additional 140 rounds are stored on board. The advanced fire control system developed by SAAB provides the commander with an independent panoramic sight with day and night vision modes. When a target is detected the turret automatically slews into a firing position, while the gunner assumes responsibility for the final aiming and firing process. While the gunner engages the selected target, the commander is already searching for the next opponent. This hunter-killer mode is customary on latest generation MBTs, but still uncommon on IFVs.

Photo: NATO

The CENTAURO II 8x8 Mobile Gun System (MGS) produced by Iveco Fiat / Oto Melara is equipped with the HitFact turret. Designed primarily as a tank-destroyer, the CENTAURO II is armed with a 120mm smoothbore cannon.

Leonardo HitFact

Leonardo Defense Systems (formerly OTO Melara) produces two turrets suitable for different vehicle types. Both turrets are designed to support large bore weapons.

The HitFact Mk 2 medium turret provides near-MBT (Main Battle Tank) quality striking power to light tanks and to tracked or wheeled medium AFVs such as tank destroyers. It accommodates both 105mm and 120mm low recoil guns. Secondary armament include a coaxial 7.72mm NG and either a pintle-mounted second MG or the HITROLE Light RWS. The turret itself is smaller than that of an MBT, scaled to the requirements and capacity of medium-sized wheeled vehicles. It is composed of ballistic aluminium, steel plates and composite materials to reduce weight while providing protection equal to that of heavier turrets. Mounting low-recoil guns permit firing on the move without endangering vehicle stability or excessively stressing vehicle frame integrity.

The Mk 2 is the second generation of the HitFact family. The original Hitfact was the first low-recoil turret capable of providing 120mm MBT-equivalent firepower on an 8x8 wheeled AFV. The common modular gun mount enables rapid field reconfiguration between either cannon. The gun's recoil is minimised through the combined action of the hydraulic recoil/counter-recoil system and the integrated, high-efficiency muzzle brake.

More than 500 HitFact turrets are in service with the armed forces of Italy and other nations. The Mk 2 incorporates lessons learned from real-world operations with the original turret.

The electric servo-driven HitFact turret can accommodate a two- or three-person crew, and includes the option of an automated munitions loading system. Commander and gunner stations are connected to stabilised electro-optical day and night sights for targeting and for battlefield surveillance; a mechanically-linked periscope system as backup for the electro-optical systems can be accessed from within the turret. Munitions for the primary and secondary weapons are housed in a separate compartment at the rear of the turret to protect the crew from the effects of deflagration. Turret ergonomics, including blast mitigating seating, are optimised for crew survival. An automated fire-extinguishing and anti-explosion system is standard.

The HitFact Mk 2 is designed to maximise flexibility. The turret can be mounted on a variety of chassis. The open electronic architecture design allows end-users to choose from different types of electronics, sensor

suites, communications, and secondary weapons to produce a customised weapon system.

Leonardo HitFist

Leonardo's HitFist light turret is designed specifically for infantry fighting vehicles. It can accommodate either a 25mm Oerlikon KBA or 30/40mm ATK Mk 44 main gun. Additional armament includes a coaxial 7.62 MG, a second pintle mounted MG, and an optional mount for two ATGMs at the side of the turret. The armoured turret has a low silhouette and features enhanced ballistic protection.
The latest generation HitFist III is two-person power-operated turret is equipped with state-of-the-art vectronics including man-machine interface systems to maximise efficiency. The gun is electrically controlled for elevation, azimuth, and tracking. The gun elevation arc ranges from -10 to +60 degrees, with a 360-degree training arc for the turret. The fully digital servo systems ensure stabilisation and a high degree of accuracy when firing. The side-by-side commander's and gunner's stations are both equipped with LCD colour displays. The fire control system is wedded to a self-stabilised optical sight for day and night and a Commander Panoramic Sight with daylight and infrared television cameras, providing the crew with situational awareness and full hunter capability modules. When necessary, one person can operate the turret alone.
Leonardo has also introduced an unmanned variant designated the HitFist OWS (Overhead Weapon System). Leonardo describes the new turret as a remotely operated weapon station developed with the latest technologies in the field of electronics, signature and Man Machine Interface. The main armament consists of the 30mm chain gun, electrically controlled in elevation, traversing and firing operations. The new turret has the advantage of being mounted on any wheeled or tracked vehicle without special preparation and without penetration of the hull. For now, it has been mounted on the newly developed 8x8 CENTAURO Armoured Infantry Fighting Vehicle FRECCIA presented by Iveco-OtoMelara. It is armed with either a 25mm or 30mm chain gun, with a 7.62 coaxial MG and side-mounted ATGMs being optional. The turret includes optical sensors and a laser rangefinder, and provides both 360-degree situational awareness as well as full hunter capability modules. The weapon can be controlled by a single soldier from within the vehicle hull utilising a multifunction colour display and a joystick. The turret can be accessed for reloading and maintenance through adjacent hatches in the vehicle roof and the turret floor.

Photo: US DoD

A Polish ROSOMAK IFV mounting a Leonardo HitFist light turret with a 30mm chaingun

Rheinmetall LANCE

Rheinmetall produces the LANCE turret in two variants, manned and unmanned (LANCE RC – Remote Controlled). The LANCE system ranks among the most modern and modular turrets available today. The turrets and their associated weapons can be mounted on virtually any tracked or wheeled vehicle. The manned LANCE turret is mounted on Rheinmetall's BOXER AFV which is deployed with the German army and several other land forces. The two-person crew consist of the vehicle commander and the gunner. The primary weapon deployed here is Rheinmetall's Mk 30-2/ABM automatic cannon, although other guns – including those made by different manufacturers – can be installed on the turret. In addition to the actively loaded munitions, an additional 200 rounds of reserve ammunition for the main gun are carried within the turret, enabling reloading under armour. The turret enjoys a high degree of protection against blast, fragmentation and even RPG fire; modular add-on armour is available to further increase the level of protection.
Both the manned and RC versions of the LANCE turret are fully stabilised, permitting accurate fire while moving through rough terrain. Each variant is outfitted with a state-of-the-art, fully digital fire control system. External sensors include two electro-optical sights, each equipped with a high-resolution camera, a thermal imaging camera, and a laser rangefinder. One of the sights enables 360-degree visibility, irrespective of the movement of the turret. All turret systems can be operated by both the commander or the gunner, whether from inside the turret or – with the RC variant – from within the vehicle hull.
A wide range of optional equipment can be integrated onto the LANCE turret. These include a situational awareness system (SAS),

Photo: Patria

A Patria AMV35 mounting the BAE Hägglunds E35 turret

an independent weapons station mounted atop the turret, C4I systems for network-enabled operations , and an additional sight for the commanding officer. Rheinmetall stresses the modular approach to the LANCE design which aims to ease integration of future hardware to keep the turret at the cutting edge of technology and capabilities throughout the vehicle's lifetime.

Photo: Rheinmetall

The medium-calibre LANCE turret is based on Rheinmetall's Modular Turret System (MTS).

Nexter Turrets

French company Nexter offers a wide range of turret solutions mounting weapons between 25mm and 105mm. The DRAGAR, originally developed by GIAT, is armed with the 25mm Nexter Systems 25 mm Model 811 dual-feed cannon and a coaxial 7.62mm MG. The two-tonne turret is suitable for smaller and lighter wheeled IFVs, providing 50% more firepower than a 20mm-armed turret but without impacting manoeuvrability. The turret is all electric, with no hydraulic components. The turret's modular design has enabled Nexter to regularly upgrade the DRAGAR with new vectronics and auxiliary systems including defensive systems, battlefield IFF, and the FINDERS battlefield management system. The gunner's sights are also displayed on the vehicle commander's station which is located inside the hull; an override switch allows the commander to direct and fire weapons from his station if the gunner is incapacitated.

The TARASK turret, a derivative of the DRAGAR, was selected for the French Army's 8x8 VBCI ((Véhicule Blindé de Combat d'Infanterie – Armoured IFV) which entered service in 2008.The single-seat TARASK provides the gunner with day and night cameras for target acquisition as well as a series of episcopes placed around the turret to provide 360-degree situational awareness. The vehicle commander's station inside the hull controls the Panoramic Observation Device (Moyen d'Observation Panoramique, MOP), a day/night observation sight allowing the commander to hunt for new targets or threats while the gunner engages the current target. The turret is also equipped with the LIRE (Leurre Infra RougE) infrared wire-guides missile jammer. The turret itself has a 360-degree traverse arc, while the gun barrel has a vertical arc of -7 to +45 degrees. The welded steel and aluminium turret is protected against small arms fire and artillery fragmentation; modular add-on armour is available.

Nexter's two-person T40 turret was selected for the VBCI 2, which is larger and heavier than the first generation VBCI. The T40 is armed with the 40CTAS (Case Telescoped Armament System) 40mm cannon developed by CTA International; it is considerably more powerful than the TARASK's chaingun. The T40 turret is augmented by a roof-mounted remote weapon system equipped with either a 7.62mm or 12.7mm MG. Unlike the TARASK, this turret can also mount ATGMs on both sides. It is compatible with a variety of missile types. The gunner and commander receive situational awareness and targeting data through periscopes and video cameras mounted along the turret. The T40 also is outfitted with an on-board simulation capability and vectronic fire for training purposes. Overall, the open vectronic architecture ensures both scalability of the weapon systems capabilities, as well as the ability to continually upgrade with the newest components. Nexter also offers an unmanned variant of the T40.

Photo: via author

The future French VBCI mounts the TARASK turret, a derivative of the GIAT / NEXTER DRAGAR.

Cockerill 3000

The wide range of potential threats has increased interest in modular turret systems which can be optimised for various and changing threat environments, from anti-tank warfare to urban operations and peacekeeping missions. This trend toward modularity includes manufacturers designing turrets capable of supporting a range of weapons on the same basic frame. John Cockerill Defense's 3000 series turret is one of the most versatile, capable of accommodating anything from a 25mm autocannon to a 105mm high pressure direct fire gun. Up to four ATGMs can be carried on optional mounts at the sides of the turret. The 3000 series is available in manned (two-person crew) and unmanned configurations.

The basic turret provides full digital stabilisation and computerised for accurate fire when stationary or moving. The welded ballistic aluminium turret can accept modular add-on armour which can increase protection up to STANAG level 5. Additional protective systems include eight smoke grenade launchers, APS, anti-sniper detection, and distributed acoustic sensing.

Turrets for APCs

Israeli Solutions

Arie Egozi

After Israel developed the MERKAVA Main Battle Tank and NAMER APC, the accumulated operational experience pointed to the need for an advanced 8x8 APC. This task was given to the Armoured Vehicles Directorate in the Israeli MoD, and the result is the EITAN APC.

The EITAN is at the final field testing in one of the Israeli Defence Forces (IDF) infantry brigades, with series production scheduled to start in 2021.

In a special interview with ESD, Brigadier Guy Paglin, Head of the Armoured Vehicles Directorates in the Israeli Ministry of Defence (MoD) explained that the EITAN will replace the last old M-113 still in service with the IDF. IDF MERKAVA 4 tanks and NAMER Armoured Personnel Carriers, played a major role in Operation 'Protective Edge' in Gaza in 2014. While the two armoured platforms are operational, based on operational requirements, it was decided to develop a wheeled APC.

In the past, the IDF has evaluated the STRYKER, noting that "it meet the operational requirements." Brigadier Paglin told ESD. The necessity for an 8x8 APC was recognised, especially in the wake of Operation 'Protective Edge'. During this operation, the IDF used a small number of Israeli NAMERs and old M-113s. To increase the protection level of the old M-113s, they were loaded with sandbags.

Operational Advantages

It can be said that the main operational advantage of a wheeled APC is its agility, or, in other words, the capability to move from one combat zone to the other, with no use of heavy transport trucks. "The EITAN is the best protected 8x8, and its remotely operated turret is the most advanced in operation now", Brig General Paglin highlighted. The production models will be equipped with a variety of sensors that will enable the APC to be part of the Multi-Doman concept and will be armed with a 12.7mm heavy machine gun and an ATK (Northrop Grumman) 30mm automatic cannon. The turret was designed to carry anti-tank missiles, in this case, the SPIKE produced by Rafael. It will also be equipped with smoke dischargers and an integral 60mm mortar, providing indirect fire capability that includes high explosives, illumination, and smoke effects. "We will equip the EITAN with anti-tank missiles like the SPIKE produced by Rafael, which has a range of 2.5 miles", explained Brig General Paglin. The prototypes carry different sensors, which provide the three men crew with a real-time situational awareness.

The Directorate decided to develop the turret in despite of the fact that two Israeli companies manufacture very advanced turrets for APCs. Without any doubt, the turret is the most advanced system of the EITAN and is ultimate proof that the turret is and will play a major role in the effectiveness of 8x8 APCs in other countries. The basic turreted EITAN platform is likely to be used for moving infantry in the battlefield and command and scout roles, while the turretless variant will be used to support specific configurations, including weapon carriers(e.g. mortars, etc.), combat engineering, recovery and casualty evacuation. Brigadier Paglin stated that the 30mm Northrop Grumman gun placed on top of the special turret has an elevation of 70 degrees "which gives it a lot of advantages when using the EITAN in urban warfare. This elevation allows the gunner to deal with high placed targets like enemy soldiers using all types of anti-tank weapons, which are very popular among terror organisations".

Photos: via author

A SAMSON 30 remotely controlled weapons station (RWS) on a BOXER

An In-House Development

He explained that the decision to develop the turret 'in-house' stems from the need to integrate different systems made by some Israeli companies. And Israeli defence companies have realised very quickly the special role of advanced turrets and have then embarked on developing them. Elbit Systems, one of Israel's main defence industries, began developing special turrets

Author

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An Elbit turret. The turret's modular design enables customers to use manned or unmanned turrets, addressing different operational considerations.

for APCs, including the 8x8 type after realising that more and more armies wanted to deploy them. Company sources say that these high manoeuvrability APCs are designed to cope with new trends in land warfare. Equipped with different mission systems, these vehicles play as significant part of a combat team, wielding effective firepower. Such weapon systems include high rate 30mm guns.

Maimon Ifergan, Vice President, International Land Systems at Elbit Systems' Land and C4I Division, told ESD that these concepts are becoming popular with many NATO members and other countries modernising their armed forces and who need to phase out obsolete tanks and APCs. "By fielding modern vehicles, they meet current challenges and fully adapt to NATO standards. Wheeled vehicles prove to be more affordable, agile and adept to the road and transportation infrastructures in developing countries".

Mission-Optimised Weapons

According to Elbit, these armoured vehicles are based on platforms that were originally designed as troop transporters. By adding a complex range of mission-optimised weapons and systems, they are transformed into highly effective combat vehicles. These combat vehicles are equipped with 'state-of-the-art' offensive and defensive weapon systems, complemented by sensors, guidance, control, communication and networking. Most of these systems are located in the turret around the main weapon systems. Elbit Systems' UT30MK2 is a configurable unmanned or manned turret that can be supplied in any protection level, adding highly effective firepower to APCs without ever compromising troop safety. Firepower, optronics and threat detection sensors all benefit from integration into the turret. "A spacious and modular turret such as UT30MK accommodates the ballistic computers, electro-mechanical weapon and turret controls, and other systems on the turret, thus saving space in the fighting compartment, adding to integration efficiency and modularity while reducing development risks", Ifergan said.

Ifergan added that the company's latest turret design, UT30MK2, was successfully integrated in new and upgraded combat vehicles, both tracked and wheeled. "Apart from the technical functions of remotely controlled weapons, our design implements extensive experience in crew station design, human machine interface, fire control and weapon stabilisation, providing intuitive and efficient operation and support for complex functions such as 'hunter-killer' functionality," he added. This capability, he explained, is utilised by providing independently stabilised and interconnected sights for the gunner and commander, enabling the two crew members to engage separate targets simultaneously.

An Elbit turret on an ASCOD APC

APC Weaponisation Programmes

Ifergan added that based on the extensive experience gained in numerous modernisation programmes worldwide, the company provides complete solutions integrating weapons and systems. The legacy of APC weaponisation programmes includes projects undertaken throughout NATO forces, as well as with customers in Asia, Africa, North and Latin America. "Providing turrets and combat systems for NATO members, Elbit Systems co-operated with all leading vehicle manufacturers. Currently, our turrets are installed on the GDELS PANDUR and PIRANHA, Iveco LMV, PATRIA AMV, the KMW DINGO and BAE Hägglunds BVS10 and other 4x4 platforms of central European countries, the US STRIKER, Iveco GUARANI in Latin America and M113 in Asia Pacific."

Ifergan explained that this versatility is derived from the UT30MK2 modular approach, which that enables customers and manufacturers to adapt the turrets they order to meet the vehicle's characteristics and operational requirements. He explained that the turret's modular design enables customers to use manned or unmanned turrets, addressing different operational considerations.

"The designs places all systems, including electronic controllers, and ammunition loading in the turret, clearing valuable space in the hull. The unmanned turret is attached without penetrating the hull. The manned version differs from its unmanned sibling by the added turret basket, seating two crew members, commander and gunner side by side below the deck for added protection."

Designed with a low profile, the UT30MK2 encompasses a broad range of weapon systems, countermeasures and advanced electro-optics, to deliver reliable, high performance firepower on the battlefield. The turret integrates a stabilised Northrop Grumman/ATK MK44 ABM 30/40mm automatic cannon, coaxial machine gun with precision levels, providing the highest first-round and burst hit on the market. Guided missiles are also available, engaging targets

at an extended range. Defensive systems such as and soft kill capabilities are also included. The turret and vehicle retain a high level of ballistic protection, retaining the vehicle's full overhead protection. Cameras installed around the turret and vehicle provide the crew with panoramic vision/driving capabilities under closed hatches, using 360 degree systems, the see-through armour or IRON VISION helmet mounted displays.

Other systems on board include Chemical, Biological, Radiological, Nuclear, and Explosive materials (CBRNE) and air conditioning, along with communications and Battle Management Systems (BMS), which also supports the IRON VISION helmet mounted augmented-vision system, enabling crew members to operate all weapons in the most intuitive way. Such systems also offer integral simulation and training.

As customers often opt for a 'family of vehicles' to equip combined task forces, Elbit Systems says that it provides other weapon system configurations, including a light remotely operated weapon station that mounts a 40mm automatic grenade launcher, a .50 cal heavy machine gun (HMG) or a 7.62mm light MG. Other systems include a 120mm self-propelled autonomous mortar providing 'pocket artillery' for battalion commanders. The armed scout configuration benefits from an elevated mast-mounted sensor pack comprising of radar and observation systems, which provide tactical intelligence surveillance and reconnaissance (ISR) for the unit.

The company's senior official said that the UT30MK2 is the result of extensive knowhow and operational experience of company engineers, most of whom are also serving in the IDF reserve, thereby offering a fully integrated product that includes many systems developed in-house. "Elbit Systems can ensure work-share and high levels of maintenance capabilities and share technology with its customers, supporting local manufacturing, training and continued through-life support," stressed Ifergan.

Elbit Systems says that it has implemented several successful integration programmes with GDLS Europe, including the PANDUR in Portugal and Croatia, the PIRANHA 8x8 vehicle selected by Belgium and Romania, and the ASCOD tracked combat vehicle proposed to the Czech Republic. The company has joined other manufacturers, including Iveco CNI, which implemented the Elbit turret on its GUARANI 6x6 vehicle in Brazil.

Rafael's Solutions

Rafael, one of Israel's largest state-owned defence companies, has developed a series of remotely controlled weapon turrets for APCs. The company has developed the SAMSON 30mm RWS with a 7.62mm coaxial machine-gun and a dual SPIKE-LR ATGM launcher. This turret is now deployed on the Steyr-Daimler-Puch (now GDLS–E) 8×8 PANDUR for the Czech Republic.

According to the Director of Marketing and Business Development at Rafael, ongoing projects to deliver SAMSON 30mm RCS to Lithuania (on ARTEC Boxer) and to other customers will produce a better protected and more lethal turret, which integrates many complementary features. He noted that these robust weapon stations are deployed

in over 25 countries and are a dependable force multiplier and trusted partner for the most challenging missions under rigorous combat and environmental conditions. The SAMSON 30mm RWS enables ammunition reloading from within the hull.

According to Rafael, this newest member of the SAMSON family is an all-in-one system that integrates a remarkable combination of today's most effective solutions, including TROPHY – the only combat-proven APS (Active Protection System), and the SPIKE LRI/II multi-purpose guided missile. Delivering MBT (Main Battle Tank)-level protection, the system provides mission-appropriate fire power without degrading the vehicle's mobility.

Photo: wikimedia.org

Rafael´s SAMSON Mini RWS was displayed at the ADAS exhibition in Manila, the Philippines, in 2018

Rafael says that supporting mission diversity, the SAMSON 30mm RWS enables the use of the relevant firepower – 30/40mm automatic main cannon, 7.62mm coaxial machine gun, dual launcher for SPIKE LRI/II ATGMs - ensuring flexibility in urban and open terrain scenarios. The Rafael official pointed to the lethal nature of the system, based on the types of weapons it carries. These weapons are highly effective based on a two-axis stabilised, electrically driven– 'fire on the move' capability, which that uses a new fire control system with advanced image processing capabilities.

Rafael has also developed a mini version of the weapon station, which has been designed for light wheeled or tracked combat vehicles that require additional offensive capabilities. The system enables target engagement with enhanced accuracy, while maximising crew protection from enemy fire.

This single-weapon RWS accommodates a variety of armaments, including a 5.56mm, 7.62 mm, 12.7 mm HMG, 14.5 mm, 40 mm AGL and ATGM launcher. Supported by a ballistics-protected multi-sensor Sight Pod, with an optional mechanism for super elevation ballistic angle calculations, the SAMSON Mini/Mini MLS provides an 'around-the clock' response to high-manoeuvring battlefield challenges.

The company's official pointed to the fact that members of the SAMSON RWS family share many of the same sub-assemblies, which have been fully tested and qualified, utilising the same infrastructure. "By employing the same installation, operation, and maintenance concepts, the entire assimilation process becomes faster and much simpler."

Based on the vast experience of the IDF, the design of the turret was made to better protect the crew. This is why operations, including ammunition reloading, is carried out from inside the hull (in the SAMSON Dual, SAMSON 30mm and SAMSON 30mm Integrated RWS).

While the Rafael turret was designed in Israel, its export potential became clear it was made to comply with MIL-STD-810F for both ground and marine applications, including salt fog, humidity, fungus, etc. Rafael's SAMSON Mini RWS has an identical marine counterpart called the MINI-TYPHOON, which is operational in the US Navy Special Forces.

The Carmel Programme

The great success of the gun turrets has led to plans to give APC crews more capabilities. Last year, the Israeli MoD launched a competition to develop a capability to be integrated into future combat vehicles. Brigadier Yaniv Rotem, Head of the Research and Development Department in the Israeli MoD, highlighted that the three proposals of the major Israeli defence companies are currently being tested on the ground at the Israeli APCs EITAN and NAMER and at MERKAVA 4 MBT. "In the future, we may see fleets of manned and unmanned ground vehicles equipped with the systems and sensors that we are now evaluating."

The development of systems designed to turn every combat vehicle into a real 'war machine' has reached a stage where all components have been developed as well as are now being integrated into various combat vehicles. The operational integrations will include the cockpit systems that have been developed and additional weapon systems like the Rafael SPIKE anti-tank missiles and the company's automatic weapon stations.

The Carmel Programme does not produce a new vehicle, but rather a breakthrough vision for combat based on advanced technology. The Programme focuses on autonomous and automatic manoeuvring, artificial intelligence and more. It was launched three years ago as a multi-year programme for the development of advanced technology to upgrade the IDF's combat vehicles – producing an agile, effective, innovative, compact, easy-to-manoeuvre vehicle with relatively low costs. The aim of the programme was to develop the technology necessary for the 'combat field of the future,' maintaining operational superiority via technological superiority.

The proposed suites made by the three companies have been installed on M-113 APCs that are used for demonstration purposes. The advanced cockpit integrates autonomous capabilities (manoeuvring, detecting targets, defence, etc.). In addition, the combat soldier enjoys multi-sensor fusion and 360-degree surround vision, high connectivity, and situational awareness. Ultimately, the soldiers are only required to make decisions that the mechanism cannot (as yet) make by itself.

The three companies – Israel Aerospace Industries (IAI), Elbit Systems and Rafael – built demonstrators. The platforms that have reached an advanced stage in the development process are already being integrated into the APC that the Tank and APC Directorate in the Israeli MoD is developing and producing today. According to the MoD, the technological capabilities tested in the Carmel Programme have never before been integrated into combat systems. The results of the Programme are will be the technological and technical infrastructure for the manned and autonomous defence and weaponry of the future.

A possible result of the programme could also have a third back seat – as an option for a fighter who can manage unmanned tanks or unmanned APCs, which will participate in the fights next to the manned Carmel.

In the coming years, Carmel developers want to increase survivability by equipping the device with an active protection system such as Rafael's TROPHY. Brigadier Paglin states that the Carmel designs will undoubtedly serve to test new systems that will be installed in the new unmanned towers in the future. ■

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Medium Calibre Cannon and Ammunition

David Saw

There was a time when it was considered perfectly acceptable to equip a Light Armoured Vehicle (LAV) with a rifle-calibre machine gun, assuming that such a weapon was perfectly adequate to support dismounts from an APC, or for a reconnaissance vehicle that was supposed to avoid being embroiled in combat. Today such thinking is a thing of the past.

Current thinking is that the top end of the medium-calibre cannon category is the wave of the future. When it became clear to that the rifle-calibre machine gun was not really viable as a vehicle weapon, the next step was the move to the heavy machine gun. For the pro-Western camp this translated into the usage of the 12.7x99mm M2HB Browning, initially on pintle mounts and then in a host of different turret options. For the Soviet camp, the answer was the 12.7x108mm DShk and then they moved on to use the 14.5x114mm KPV, with the later weapon being used on the BRDM-2 reconnaissance vehicle and the BTR-60/-70/-80 series of wheeled armoured vehicles.

While the 12.7mm and 14.5mm where, and still remain in many applications, very useful they were not an optimum solution. The reason for this was very simple – the performance of these systems was well known and therefore providing vehicles with suitable protection was not that much of a challenge. As an example, the basic protection level for the British WARRIOR Infantry Fight Vehicle (IFV) that entered service in 1987 was that it be proof against Soviet 14.5mm. Others decided that it made more sense to go beyond the 12.7/14.5mm stage and provide light armour with a cannon armament and thus make the move to medium-calibre cannon.

Of course the move from the rifle-calibre machine gun to the heavy machine gun and then on to the medium-calibre cannon was not the straightforward logical progression that might be implied. Different philosophies led armies along different paths, added to which there were the cost factors involved in equipping light armour with higher performance and therefore more expensive weapons. For example, the US Army was prepared to deploy the M2HB heavy machine gun on the majority of its light armour, initially covering both wheeled and half-tracked vehicles. With the introduction of the tracked APC in the form of the M75, succeeded by the M59 and eventually the M113, which arrived in the early 1960s, the M2HB remained the weapon of choice although combat experience in Vietnam led to US to develop protected weapon stations for the M113.

It was only with the arrival of the M2 BRADLEY IFV equipped with the 25mm M242 cannon in 1981 that the US would move beyond the heavy machine gun towards the medium-calibre cannon. Others had already looked beyond 12.7mm HMG vehicle armament, for example Germany. The Bundeswehr adopted the Hispano-Suiza Schützenpanzer Lang HS.30; this had entered service in 1960 with the vehicle having a turret mounting an HS-820 20mm cannon. The Swedish Pansarbandvagn 301 (pbv 301) APC that entered service in 1961 was equipped with a Bofors 20mm m/45 cannon on a remote mount operated from within the vehicle.

Photo: Rheinmetall

The front face of a Rheinmetall LANCE turret mounting the Rheinmetall 30x173mm MK-30/2 ABM cannon. This cannon is in service with Germany on the PUMA and in Austria and Spain on the ULAN / PIZARRO and has been selected by Australia for the BOXER.

Reaction and Response

Conventional thinking on the issue of the IFV versus the APC and what weapon systems they should be equipped with was challenged by the arrival of the BMP-1 in the mid-1960s. This was certainly something different. Its turret was equipped with a 73mm 2A28 smoothbore low pressure gun, a 7.62x54mm PKT co-

Photo: US Army

A STRYKER DRAGOON Infantry Carrier Vehicle (ICV) with a Kongsberg MCT-30 unmanned turret and an XM813 30mm cannon.

Photo: US Army

A Swedish CV90 IFV equipped with a 40mm L/70 cannon. Export variants mount the 30mm BUSHMASTER II or 35mm BUSHMASTER III cannon.

ax machine gun and a launcher for the 9M14 MALYUTKA (AT-3 SAGGER) anti-tank missile. By the standards of the time that was a lot of firepower for a small (13 tonne) vehicle and one which was, superficially at least, rather well protected.

In many respects the BMP-1 was a false dawn as far as the IFV was concerned. The 2A28 was disappointing in terms of range and power, while the vehicle itself proved deficient in terms of protection. The end result was the arrival of the BMP-2 at the start of the 1980s. This offered better protection and the main armament was changed to a 2A42 30x165mm cannon. The 2A42 is a dual-feed system commonly utilising AP-T and HE-T rounds, though an APDS nature is also available. The rounds for the standard 2A42 are percussion primed, while variants of the system used for airborne and naval applications are electrically primed.

The 2A42 remains the standard Russian medium-calibre cannon for armoured vehicle applications, being used in the BMP-2, BMD-2, BMD-3, BTR-80A and the BMPT. It is also standard fit on the next generation of Russian armour such as the KURGANETS IFV, the BUMERANG wheeled vehicle and the T-15 heavy IFV. The 2A72 variant of the 2A42 cannon is also in service on the BMP-3 IFV and on the BTR-82 APC. As the BMP-2 was sold so widely, ammunition is available from multiple sources apart from Russia. Mecar in Belgium, a subsidiary of Nexter, produce the M929 APFSDS-T round for the 2A42 to meet the demand for better penetration characteristics than the standard AP round offered for the 2A42.

In Germany the search for a true IFV system had seen the development of the MARDER, which entered service at the start of the 1970s. The turret is equipped with a 20x139mm Rh-202 cannon, and vehicle protection levels are good as is mobility. The original MARDER was to be replaced by the MARDER 2 at the end of the 1980s; the new vehicle would have been heavier and better protected, with enhanced firepower. This was an expensive vehicle and that fact plus the end of the Cold War marked its demise.

The successor vehicle to the MARDER in the German military is the PUMA produced by PSM, a joint venture of KMW and Rheinmetall. The first PUMA vehicles were delivered to the Bundeswehr on 24 June 2015 and the last of the 342 vehicles on order will be delivered in 2021. PUMA is a major advance on the previous generation MARDER vehicle, offering increased mobility, increased protection (protection levels are scalable to match the threat environment) and firepower. The PUMA is equipped with a Rheinmetall 30x173mm MK-30/2 ABM cannon in an unmanned turret; there is a complete range of ammunition available for this cannon including APFSDS-T, KE-TF (air burst), PELE(penetrator with enhanced lateral effect) and FAPDS (frangible) natures. The MK-30 cannon is also in use with the ASCOD IFV used as the ULAN in Austria and the PIZARRO in Spain, and in the BOXER Combat Reconnaissance Vehicle (CRV) selected by the Australian Army for its Project LAND 400 Phase 2 requirement, in this application the cannon is installed in the Rheinmetall LANCE turret. Another BOXER customer is Lithuania, but they selected a different armament option for their vehicles in the form of the Rafael SAMSON Mk II Remote Weapon Station mounting the Northrop Grumman MK 44 BUSHMASTER II 30x173mm cannon.

The BUSHMASTER II is a development of the 25mm M242 cannon as used in the M2 BRADLEY, and is used in ground, air and naval applications. Ammunition types include the Mk264 MPLD-T (multi-purpose low-drag tracer), Mk266 HEI-T, Mk238 HEI-T/SD, Mk239 TPT-T, Mk258 APFSDS-T, Mk320 APDS-T and the Mk317 TPDS-T. Further growth for the MK 44 features the addition of an airburst munitions capability allowing the utilisation of the Mk310 PABM-T programmable airburst nature.

This weapon has been widely adopted internationally; it is on the CV9030 operated by Finland, Norway and Switzerland, the PANDUR II operated by Czech Republic and Portugal, Singapore's BIONIX II and HUNTER IFV, the ROSOMAK in Poland, and on the PIRANHA vehicles operated by Ireland and Romania. More recently it has been acquired by Spain for its DRAGÓN (PIRANHA V) vehicles.

The BUSHMASTER II has also entered service with the US Army in the XM813 variant that features an extended barrel to support the use of programmable airburst munitions (Mk310), the weapon in mounted on the Kongsberg PROTECH MCT-30 unmanned turret which is integrated with the STRYKER vehicle. Initially it was decided to upgrade some 83 STRYKER vehicles in service with the 2nd Cavalry Regiment based in Germany, with the upgraded vehicles being classified as the Infantry Carrier Vehicle DRAGOON (ICVD).

The MCT-30/XM813 combination is known as the Medium Calibre Weapon System (MCWS) to the US Army and after evaluating the performance of the ICVD system it was decided to embark on a STRYKER upgrade programme to fit the MCWS. However, integration of the MCWS would only be carried out with the vehicles that had undergone the Double-V-Hull (DVH) upgrade to improve protection against mines and IEDs, and these vehicles are classified as the DVHA1 ICV. The US Army plans to upgrade three STRYKER brigades equipped with the DVHA1 ICV with the MCWS.

Other Approaches

The British Army had come to the conclusion in the 1960s that its future light armour would require a medium-calibre cannon, to provide the necessary level of firepower. At that time consideration was given to having light armour equipped solely with an anti-tank missile armament, but this was rejected due to the long time-of-flight of such weapons and their cost, not to mentioned their unreliability. Another possibility was a recoilless weapon. Again, this was rejected due to operational and performance limitations. This left the medium-calibre cannon with a calibre of between 20mm and 40mm as the only plausible solution for light armour.

It was decided that 30mm was the appropriate calibre and there was a great deal of interest in adopting the Hispano-Suiza Type 831SLM cannon for the requirement. The problem was that the Type 831 did not have the characteristics that the British necessary for a turret mounting on light armour, the trunnion pull was too high and the long inboard length of the gun took up too much real estate in the turret. This resulted in the design of a new gun in the form of the 30x170mm calibre L21A1 RARDEN, the calibre was selected in order to utilise the full range of existing Type 831 ammunition, in addition the British also developed a new APDS round for the gun.

Photo: Nexter

The EBRC JAGUAR, the future reconnaissance platform of the French Army, is equipped with the 40mm Cased Telescoped Armament System (CTAS).

Requirements for the RARDEN were the destruction of light armour at any angle at a range of 1,000 metres and penetration of the side armour of a main battle tank, engagement of soft-skin vehicles of troops in the open or behind light cover and deterring aircraft or helicopters flying at low level. Vehicles fitted with the RARDEN were the FV721 FOX 4x4 reconnaissance vehicle (retired), the FV107 SCIMITAR tracked reconnaissance vehicle, still in service with the British Army in the upgraded Mk 2 version, and with Latvia, and finally with the FV510 WARRIOR.

The era of the RARDEN in the British Army is coming to an end as new vehicles and medium-calibre cannon will be introduced. The SCIMITAR is due to be replaced by 2026 by the AJAX reconnaissance vehicle, part of the acquisition of 589 SCOUT Specialist Vehicles (SV) from General Dynamics Land Systems-UK. While the WARRIOR fleet is to be upgraded under the WARRIOR Capability Sustainment Programme (WCSP). One common feature of AJAX and WCSP is that both will see the introduction of a new cannon in the form of the 40 mm Cased Telescoped Armament System (CTAS).

In 1994, BAE Systems and Nexter formed a joint venture company CTA International, based at Bourges in France, to develop the CTAS. British interest in the CTAS came from the fact that they recognised that they would need a new medium-calibre cannon that offered more hitting power, increased range and ammunition that offered a much broader target engagement profile. This would a larger calibre compared to the RARDEN, but, in comparison to conventional cannon systems, the CTAS and its ammunition would occupy far less turret real estate.

By the mid-2000s, the British had been investing in the CTAS for some time and were looking at it to equip an upgraded WARRIOR. They looked to bring competition into the upgrade via an evaluation of competing turret solutions from Italian and US suppliers both utilising the BUSHMASTER II cannon. This demonstrated that the CTAS was the way forward, although progress on the programme would be slow due to issues with vehicle programmes. Eventually, matters became clearer, there were two programmes in the form of a new vehicle, AJAX, and an upgrade, WARRIOR WCSP, and in 2015 this led to a British order for 515 CTAS weapons, 245 for each vehicle and 25 for testing, qualification and spares use.

France was also developing a new armoured vehicle, in this case to replace the AMX-10RCR, ERC-90 SAGAIE and the VAB HOT. This led to the Engin Blindé de Reconnaissance et de Combat (EBRC) JAGUAR, a 6x6 vehicle with a

combat weight of some 25 tonnes. The JAGUAR is equipped with the 40mm CTAS, which is significant due to the fact that it is replacing the AMX-10RCR that has a 105mm gun and the ERC-90 that has a 90mm gun. The fact that the JAGUAR turret has two launchers for the MBDA MMP missiles demonstrates why it is also the VAB HOT replacement. The French Army ordered 300 JAGUAR vehicles, while Belgium has ordered 60 JAGUAR as a part of their 'CaMo' programme to re-equip its mechanised brigade. The CTAS has a full range of ammunition natures available including: APFSDS-T, GPR-PD-T (general purpose point detonating - tracer), GPR-AB-T (general purpose airburst - tracer), A3B (anti-air airburst) and TPT rounds.

More Calibre Growth

While the British and French have selected the 40mm calibre as their medium-calibre future, others are already there. In the early 1990s the Swedish Army introduced the CV90 IFV and this carried a Bofors 40mm L/70 gun. Export customers for the CV90 have not followed the 40mm path opting for the 30mm BUSHMASTER II or, in the case of Denmark, Estonia (ex-Netherlands vehicles) and the Netherlands, the 35mm BUSHMASTER III. Meanwhile in Korea the Republic of Korea Army (ROKA) opted for the indigenous S&T Dynamics K40 40mm cannon for its K21 IFV that entered service in 2009.

At this point, 30mm is the minimum baseline in terms of calibre, as far as medium-calibre cannon is concerned. The trend for the future appears to be for 40mm and above. Indications of this contention come from growth versions of the BUSHMASTER II and III that are being offered. In the case of the BUSHMASTER II this can be upscaled from a 30x173mm calibre to the MK 44 STRETCH configuration in 40x180mm or 'Super 40' calibre. The new configuration retains 90% logistics commonality and 90% operator and maintenance training commonality with the standard MK 44 according to the manufacturer. The Super 40 was demonstrated at the start of the 2000s as part of the US Army's Advanced Light Armament for Combat Vehicles (ALACV) programme.

The BUSHMASTER III was originally fielded in 35x228mm calibre. This was a standard Oerlikon round and was no stranger to an IFV application. The Japanese Ground Self-Defense Force (JGSDF) had selected the Oerlikon KDE cannon in 35x228mm as calibre for the Type 89 IFV, that entered service in 1989. As a standard calibre there were plenty of different ammunition natures available from multiple manufacturers.

In the 1980s, as a part of developing a new externally-driven cannon, known as the Rh 503 to equip the proposed MARDER 2, Rheinmetall used the 35x228mm round as the base from which they developed a 50x330mm round. The Rh 503 was designed to be dual-calibre from the start, sizing up to utilise the 50mm calibre was a matter of replacing the barrel, with the feed system and breech capable of accommodating the larger round which is of a cylindrical design. With the end of MARDER 2 the Rh 503 programme was put on hold.

Meanwhile in the US there was a resurgence of interest into increasing the hitting power of medium-calibre systems; the MK 44 Stretch had proven what was possible and the BUSHMASTER III had the capacity to move up from 35mm to the 50mm SUPERSHOT. The SUPERSHOT is a 50x319mm round and appears to be a necked-up version of the 35x228mm round. The BUSHMASTER III provided the basis for the US Army to develop a variant known as the XM913 and this is what they envisaged as equipping the BRADLEY replacement, the Next-Generation Combat Vehicle - Optionally Manned Fighting Vehicle (NGCV - OMFV).

US Army interest in a 50mm cannon for NGCV and the fact that the General Dynamics proposal for that requirement was fitted with the XM913, led Rheinmetall to resurrect their 50mm Rh 503 cannon, which could be fitted in the turret of the KF41 LYNX IFV that they were proposing for the US programme. The NGCV programme now appears to have stalled, that being said the future of medium-calibre in the US now appears to be at a calibre of 50mm.

Of course, there is nothing new in wanting a larger calibre weapon for an IFV application. At the end of the 1970s, the Bofors 57x438mmR cannon was tested on the MARDER, while OTOBreda and IMI jointly developed a 60x410mmR cannon. The idea was that a larger round would offer more penetration on armour targets and that still holds true. These days, though, a larger round also offers the possibility for a larger payload to increase the combat utility of the round, for example as an airburst munition.

To conclude, while Europe and the US are feeling their way towards the 50mm calibre, Russia is already there. They used the old S-60 57mm anti-aircraft gun as the starting point for the development of a new 57x347mm SR gun known as the BM-57. This gun is utilised by the Baikal AU-220M unmanned turret which will be fitted to the T-15 heavy IFV as an alternative to the current 30mm turret. The next stage in the evolution of the BM-57 will be the development of advanced ammunition types including airburst rounds, with the cannon being fitted to other Russian light armour. ■

Situational Awareness in Fighting Vehicles

Doug Richardson

Situational Awareness (SA) involves a multi-stage process – perception of all the elements that make up the combat situation, understanding how these combine to make a whole, then anticipating how the situation can evolve in the immediate future.

At first, the concept was applied particularly to fighter-versus-fighter air combat. It has long been an axiom that most pilots who survive the experience of being shot down report that they had never seen the enemy aircraft that had attacked them.

Today, SA is seen as a vital factor in ground combat operations. US DoD manual FM 17-96 defines SA as "The ability to maintain a constant, clear mental picture of relevant information and the tactical situation including friendly and threat situations as well as terrain." SA is important not only to individual combat elements such as an AFV, but also to friendly assets such as other AFVs that combine to make up the combat team.

The task of obtaining SA has traditionally been one for the vehicle's commander. In the past, the commander of an AFV could either observe the external scene via whatever vision aids such as periscopes or direct-vision devices that were incorporated into his cupola, or lift his head out of the cupola hatch and use his eyes, supplemented if necessary by binoculars. In some armoured corps such as those of Israel's Tzahal, operating "head out" became the accepted practice for decades, but this left the commander vulnerable to snipers or to fragments from artillery rounds bursting nearby. Operating with all vehicle hatches closed maximises crew survivability, but significantly reduces the crew's SA. But technology offers a potential solution, as the selection of systems and vehicles described in this article will illustrate.

Photo: Elbit

Operating head-out gives a vehicle commander the good all-round visibility needed for situational awareness, but leaves him vulnerable to attack by snipers.

Author

Following an earlier career in engineering, **Doug Richardson** is a defence journalist specialising in topics such as aircraft, missiles, and military electronics.

Vision devices built into the commander's cupola must serve multiple roles – the observation of the surrounding terrain, the location and identification of friendly assets and enemy forces, and the detection then identification of potential targets. Unfortunately, these roles require different levels of optical capability. While surveillance and target detection require a low magnification and a wide field of view, the identification of targets require a higher magnification.

The classic solution for providing all-round vision proved to be a circular array of unit power periscopes or even direct-vision blocks of laminated glass. Vision blocks are simpler than periscopes, but require the commander's head to be located within the cupola, where it has less protection than a location under the turret armour.

In some cases, the commander is being given a specialised sensor intended to help him scan surrounding urban terrain. For example, in 2006 Nexter Systems announced the AZUR [Action en Zone URban] version of the LECLERC, a private-venture variant optimised for urban operations. In addition to a remotely controlled 7.62mm machine gun, and additional passive protection intended to counter threats such as rocket-propelled grenades (RPGs) and petrol bombs, the vehicle has also received a new panoramic sensor that allows the commander to make a swift visual scan through a full 360 degrees.

Inevitably, the commander of an AFV requires higher-magnification optics in order to examine specific areas of interest, to identify potential targets, and to assign these to the gunner. A night-vision capability is also essential for modern combat operations. However, these capabilities are largely provided by dedicated sighting systems that form part of an AFV's fire-control system, a specialised topic in its own right.

Ideally, the commander's higher-magnification sight must be free to scan in any direction with respect to the turret, but this is not always the case. The commander of the M1A1 version of the ABRAMS MBT has an all-round view via an array of six periscopes. Although he also has a feed from the gunner's sight, the latter does not rotate, so the commander must slew the turret in order to survey the terrain – a feature that limits his SA.

Infantry fighting vehicles (IFVs), armoured personnel carriers (APCs), and the lighter vehicles that feature in modern combat operations, all pose potential SA problems. This is particularly the case with many traditional APCs, which served as 'battle taxis' intended to carry a team of soldiers close to the point of action. In many cases, the latter had no vision aids, so could not fully understand the combat situation until they had left the vehicle. In the classic M113 APC, the commander has an array of five M17 day periscopes to provide all-round surveillance and SA, but no vision systems are provided the soldiers that the vehicle carries into action.

While this lack of vision aids for the soldiers is not uncommon for APCs of this vintage, many of the more modern troop-carrying vehicles allow their 'dismounts' a view of the outside world. For example, while Nexter Systems' VCI wheeled IFV gives the commander four unitary vision periscopes located around his hatch, plus the ability to see imagery from the vehicle's turret-mounted Moyen d'Observation Panoramique observation sight, the soldiers can use six periscopes that provide a combined 215 degrees of visual coverage.

For lighter vehicles such as the M114 up-armoured version of the AM General High Mobility Multipurpose Wheeled Vehicle (HMMWV), the windows provide a good external view, and offer the same level of basic protection as the rest of the vehicle's structure. However, combat experience in Iraq and Afghanistan have shown that these relatively light vehicles are vulnerable to the effects of land mines, IEDs, and small arms fire, even when fitted with additional armour.

An array of cameras can improve the SA of combat vehicles when these are operating with the hatches closed. A video data-bus can distribute the imagery of all crew members of an AFV, and to the soldiers being transported in an IFV or APC. In the MERKAVA Mk 4, SA is increased by Vectop's Tank Sight System (TST), which uses four cameras in hardened housings to provide 360-degree coverage. An additional camera mounted at the rear of the vehicle gives the driver a good view when reversing

Photo: Elbit

The helmet being worn by this AFV commander is fitted with Elbit's IRONVISION system, which uses an array of external cameras to provide all-round visibility.

the vehicle. A fully digital Maanak system links the vehicle's sensors, computers, and other electronic systems, and can present data on each crew member's flat panel displays. The vehicle is also fitted with a Vectop VDS-60 digital data recorder, which stores the imagery collected by the sights and sensors during a mission.

The new AJAX series of tracked AFVs due to replace the British Army's ageing CVR(T) series offers a Thales ORION periscope able to give the vehicle's commander a wide-area search capability, automatic target tracking, and a built-in laser designator intended to mark targets for attack using air or surface-launched semi-active laser guided missiles. Each crew member will have a flat-screen monitor, and an array of cameras will provide additional SA.

A situational awareness suite based on cameras mounted around the vehicle is also a feature of the BOXER series of 35 tonne-class 8x8 wheeled vehicles being developed by ARTEC GmbH, a teaming of KMW and RMMV. These should allow the driver to manoeuvre the vehicle in a cluttered or complex environment without having to open the hatches.

Commercial-off-the-shelf virtual reality glasses and augmented reality technology have allowed the creation of systems that effectively make the hull of an AFV transparent, providing the crew with enhanced visibility. Several systems of this type were described in our recent article on AFV EO sensors. Given imagery of sufficiently high resolution, these could provide a high degree of SA. According to the Australian company Tectonica, the situational awareness technology it is developing under a 2016 contract under Round 20 of the Australian Department of Defence, Capability Technology Demonstrator (CTD) Programme project is intended to create a solution based on its ALTERA vehicle camera system that will provide a vehicle's crew operating with

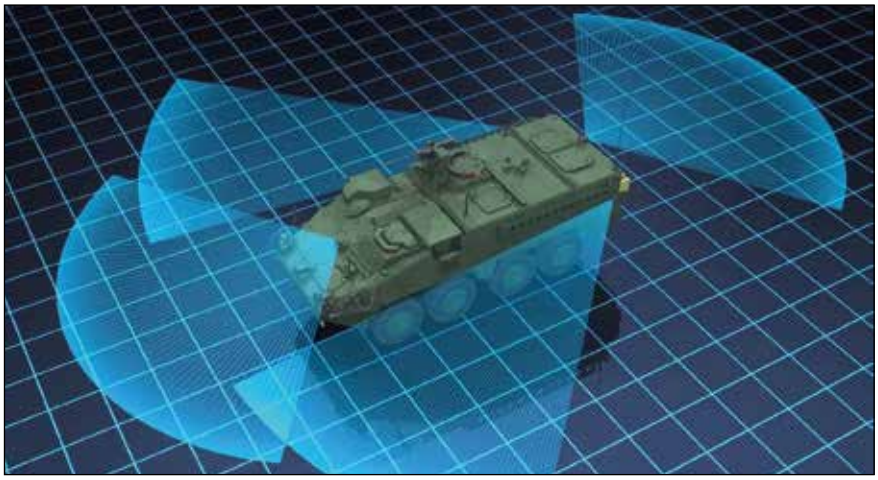

Photo: LeonardoDRS

This configuration of the LeonardoDRS (ESA) system uses an array of four cameras to provide improved situational awareness.

Photo: via author

The sides of the Véhicule de l'Avant Blindé (VAB) wheeled APC are fitted with windows that will give the soldiers within the cabin a degree of situational awareness. These windows can be partially or completely covered by armoured panels.

closed hatches with the level of SA traditionally associated with operating with hatches open.

An important part of SA is knowing that the vehicle is either under attack, or about to be attacked. In the case of AFVs, is information can often be obtained from a laser-warning receiver (LWR), a sensor able to detect incoming laser energy from rangefinders, target designators, and the guidance beams on which beam-riding antitank or air-to-surface missiles must rely.

Several countries are known to have adopted the UTC Aerospace Systems AN/VVR-3 LWR. This consists of a roof-mounted laser detector and a display unit normally located at the commander's position.

The THIRD EYE laser warning system developed by Moked Engineering (1969) was designed to meet an Israel Defense Force (IDF) requirement, and is known to have been used on some of that service's MBTs. The mast-mounted component of the system includes sensors able to detect laser and IR radiation, so can warn the crew if their vehicle has been illuminated by the IR searchlight. Even if the threat ceases to emit, the system will continue to indicate the threat type and bearing.

Although LWRs were originally fielded in AFVs as a stand-alone aid to SA, their usefulness in such a basic role is becoming more limited as more sophisticated anti-tank threats continue to proliferate. Their use as a method of initiating the release of countermeasures proved to be the start of a trend to make them part of an integrated defensive suite that include passive countermeasures and active jammers.

Photo: US Army

The most externally obvious feature of the Tank Urban Survivability Kit (TUSK) developed for ABRAMS main battle tanks committed to operations in Iraq was the addition of reactive armour on the sides of the hull, but situational awareness was not neglected. A thermal sight was provided for the top-mounted M240B 7.62mm machine gun, and an exterior telephone that allowed nearby infantry to communicate with the tank commander was installed on the rear of the vehicle.

The development and deployment of weapons that use radar seekers or datalinks that operate at millimetric-wave frequencies raises the prospect that specialised radar-warning receivers might be needed in order to alert the crew of an AFV to this relatively new form of attack. Romania's Military Equipment and Technologies Research Agency has combined laser-warning and radar-warning sensors into a single system, whose RF coverage is from 33-37 GHz. This system seems to have been a bit ahead of its time – no orders have been reported, and it is not currently in production.

For lighter and soft-skinned vehicles, acoustic-based sensors can warn of attack. The AAI Projectile Detection and Cueing System has been deployed operationally by US forces operating in Afghanistan and Iraq. Acoustic sensor units are installed at all four corners of the vehicles being protected in order to provide all-round coverage. Alerts for detected threats are provided to the vehicle's crew in the form on audio warnings, or data shown on a display. By comparing the acoustic signature of a bullet with that created by the weapon's muzzle blast, the system can estimate how far away the threat is located.

The French company 01dB-Metravib currently offers its PILAR MK-2w acoustic system in three versions, one of which uses a personal digital assistant, and is specifically intended as an interim solution for vehicles that require temporary protection, either to meet a short-term need or as a stopgap pending the installation of an integrated system. According to the manufacturer, the system can detect small arms fire, 20mm cannon fire, rocket propelled grenades (RPG), mortar rounds, and even anti-tank guided weapons (ATGW). It has a response time of two seconds.

In US Army service, the system is designated the M2, and known platforms include the General Dynamics Land Systems-Canada STRYKER (8x8) infantry carrier vehicle and the AM General HMMWV. In mid-2006, Belgium had selected the system for installation on some of its General Dynamics European Land Systems - MOWAG PIRANHA III (8 x 8) armoured personnel carriers, and in the following year Poland ordered systems for PATNA armoured

modular vehicles and other applications. In 2011 France adopted the PILAR MK-2w for use on VAB 4x4 wheeled APCs. Other known users include Italy and the UK. PILAR MK-2w has seen action in Afghanistan and Iraq.

Rafael Advanced Systems' Small Arms Detection system are known to have been installed on some IDF High Mobility Multipurpose Wheeled Vehicles (HMMWVs) in order to meet an urgent operational requirement. This is an acoustic-based system able to indicate the bearing and elevation of small-arms threats. The output information is handled by a ruggedised PC running dedicated software.

Thales' Vehicle-Mounted Acoustic Sensor System (VMASS) uses a low-profile microphone array mounted in a circular housing, and a processor unit that includes a flat-panel display. According to the manufacturer, it can detect small arms fire out to the maximum range of this class of weapon, mortars out to 5 km, and gun-launched projectiles at up to 10 km. Threat bearing is determined to within 3 degrees in azimuth, and 6 degrees in elevation, and this data can be used to automatically slew the vehicle's weapon towards the threat.

Some hostile-fire detection systems can combine several types of sensor. When the AN/VVR-3 LWR described earlier is teamed with a MacDonald Detwiller & Associates Ferret acoustic threat-warning system, the combination is designated as the Acoustic Optical Warning System, which is known to have been fitted to some Canadian vehicles deployed to Afghanistan.

Saab Sensis took a non-acoustic route to solving the hostile-fire detection problem when it began development of its Small Scale Radar as a private venture about a decade ago. The system is a C-band active radar that uses a total of four antennas (each covering 120 degrees in azimuth and 60 degrees in elevation) to provide all-round detection of threats ranging from small-arms fire to rocket-propelled grenades. The system has been tested by the US Army, but no orders have been reported.

A modern communications and command (C2) system or battlefield management system (BMS) can improve SA by providing all the vehicles participating in a combat action with a knowledge of their own location, the location of other friendly forces, and the location of the enemy. This data can significantly speed the Observe-Orient-Decide-Act (OODA) cycle of friendly forces, and provide a combat advantage, particularly against an opponent that does not have effective C2.

Photo: Doug Richardson

Elta's ELO-5220 OTHELLO uses uncooled short-wave infrared technology to locate the source of enemy fire. Each sensor has a coverage of 96° in azimuth and 60° in elevation, so an array of four can provide all-round coverage. The company's ELM-2133 WINDGUARD is a phased-array pulse doppler radar designed to detect and automatically track anti-tank guided missiles, unguided anti-tank rockets, and gun-launched projectiles.

Improved SA was one of the goals of the Abrams M1A1SA/ED upgrade developed for use in Iraq from 2010 onwards. Some vehicles were fitted with the Force XXI Battle Command Brigade and Below (FBCB2) blue-force tracking system. Operating at brigade level, and interoperable with the Bradley M2A3 IFV, this improved SA by keeping automatic track of friendly and hostile force locations, and helping the user to plan manoeuvres. The M1A1SA also has a rear-mounted infantry phone that allows soldiers to talk to the tank crew.

One of the improvements introduced by the follow-on M1A2 was the addition of a Commander's Independent Thermal Viewer on the left side of the turret. This allowed the commander to independently scan for targets in all weather conditions and in the presence of battlefield obscurants.

A programme that updated M1A2 tanks to the M1A2 SEP v1 standard included installing the FBCB2 system to these vehicles. The follow-on M1A2 SEP v2 upgrade completed the process of replacing older analogue electronics with new digital hardware, while an M1A2 SEP v3 programme begun in 2017 installed third generation FLIR technology in order to improve target detection and recognition.

General Dynamics Land Systems' STRYKER eight-wheeled APC – the US version of the company's LAV III – entered service in 2002, and is likely to remain in service until beyond 2035. The commander has a total of seven M45 periscopes to provide all-round surveillance, but also has a display linked to the FBCB2 digital battle-management system. An omnidirectional antenna can be fitted to allow the vehicle to access video data from UAVs or Video Unmanned aerial system Intelligence Teaming (VUIT-2) equipped AH-64 APACHE helicopters. The M1126 Infantry Combat Vehicle variant of STRYKER can also be fitted with the WARFIGHTER Information Network Tactical (WIN-T) increment 2 system, which is intended to provide the mobile broadband networking capability needed to give commanders battlefield SA. But for the moment, there is a penalty to be paid for installing what is still fairly bulky hardware – two of the seats within the vehicle must be removed to make room for electronic hardware.

Ideally, the commander of an AFV should in the future have the ability to extend the reach of his SA by launching a small UAV, but most current examples of the latter need to be hand-launched, so would require a crew member to open his hatch and expose himself to the risk of hostile fire. In 2003, GIAT (now Nexter Systems) proposed a modernisation scheme for the LECLERC that would have included the installation of two pop-up launchers for mini-UAVs. Promoted as the 'LECLERC 2015', this ambitious scheme also included a commander's sight with an automatic target-detection capability. To date, no subsystems of these types have entered service, but they remain an intriguing possibility for the future. ■

CBRN Decontamination of Vehicles

Dan Kaszeta

It has long been assumed that chemical, biological or radiological/nuclear (CBRN) threats pose a major problem for the military and civilian response forces. The main reason for this assumption is that vehicles can be contaminated with liquid or solid CBRN materials.

Some threat materials, such as persistent nerve agents, sulphur mustard, anthrax spores, and many radioactive isotopes, can remain potent threats for days or weeks after an attack or incident.

Vehicle Contamination

Vehicle contamination becomes a key concern in military operations. When chemical weapons first made their military debut in 1915, warfare was largely an affair dominated by infantry foot soldiers, and artillery was towed by horses. Warfare in the modern era relies heavily on armoured and unarmoured vehicles. Artillery systems are towed by vehicles or are self-propelled. Vast logistical trains of trucks support modern armies in the field. Aircraft have numerous military uses. All of these are vulnerable to contamination.

Various surfaces and materials on vehicles could absorb liquids and actually make them more persistent than they would normally be in the ambient environment. Persistent contamination could cause injuries long after an attack, as substances desorb out of vehicle exteriors or interiors. Vehicle crews and passengers could be forced to wear cumbersome protective clothing, thus degrading their operational capability. Loss in operational capacity due to the operational necessity of wearing CBRN protection is a strong motivator in military decontamination planning. No artillery crew wants to spend hours or days in full kit while conducting fire missions.

Military commanders must make critical decisions when vehicles get contaminated. Do they take vehicles and their crews out of combat operations for decontamination? Or do they continue to fight, and assume the risks of diminished capability, injuries to crew and passengers, and spread of contamination? The cold hard logic of military operations is clear and well-founded on studies of the history of chemical warfare. Usually, the best course of action is to continue the conventional fight and worry about decontamination later. Any serious study of modern warfare shows that small arms and artillery are, statistically, far more lethal than chemical weapons, even against troops with little protection. Moreover, in some of the few battles in history where chemical weapons played a decisive role showed that it was conventional follow-up to chemical attacks that made the important difference. Therefore, decontamination, as an operational imperative, needs to take second billing to conventional warfighting.

Deferring decontamination does pose its own risks. Contaminated vehicles could spread contamination from the site of an attack, thus contaminating roads, airfields or supply routes. Vehicle crew or passengers could inadvertently transfer contamination when they leave a vehicle. Driving to a designated decontamination site is likely to spread contamination. The decision as to where and when to conduct decontamination needs to account for the operational imperatives of ongoing combat operations, while also understanding that decontamination is best done quickly and nearby, rather than much later and far away.

CBRN vehicle contamination was long relegated to the military as a defence issue. However, civil emergency services may be vulnerable to vehicle contamination as well. Fire services and ambulance services rely heavily on specialist vehicles. Terrorist incidents could cause contamination of emergency vehicles. Police vehicles, fire engines, and ambulances could be taken out of service at precisely the time they are needed most. Only in recent years has the reality of CBRN contamination of vehicles been realised among civil responders. Small amounts of residual contamination were found or suspected in a number of vehicles involved in response in Salisbury in 2018 after the Novichok incidents.

Photo: Kärcher

Kärcher Futuretech is a market leader in sprayers of all sizes for every major CBRN vehicle decontamination requirement.

Author

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How Clean is Clean Enough?

Every discussion of decontamination needs to ask the question – when do you stop decontaminating? As discussed in previous articles in this journal, there are not really many useful standards as to how clean is clean enough. A standard of zero threat is not realistic as there is no way of proving a negative. Every conceivable detection and identification method has a minimum threshold of detection, so even the most thorough decontamination methods may leave some residue of hazards. As a practical matter, until detection methods improve and standards of cleanliness get agreed upon, the only reasonable course of action is to decontaminate to levels set by the available detection methods. However, improvements in the sensitivity of detection will likely provoke requirements to decontaminate to a higher standard. Efforts to provide rational standards for vehicle decontamination are necessary, but are proceeding at a glacial pace. It is a bit unsatisfactory that there is an ISO standard for a cargo container, but not for the decontamination system inside the container.

Patterns of Contamination

Contamination can be caused by liquids or solids. However, the various types of substances that can cause contamination are too many to list and too diverse to attempt to describe in this article. More importantly, the geometry and distribution of contamination on vehicles is a useful concept. Gross contamination all over a vehicle is clearly a major problem, but spot contamination of one or two particular patches is a lesser problem. In theory, it is much faster to decontaminate just one bit of a vehicle that decontaminating the entire vehicle. However, knowing the distribution of decontamination requires detection equipment and a lot of time and labour. Surveying a tank at 1 cm per second (the current state of the art) will take a lot longer than decontaminating the entire vehicle. Improvements in detection would greatly help in improving the efficiency of decontamination.

Exterior contamination of vehicle surfaces is one type of contamination, and it can be addressed in particular ways. Interior contamination, with softer and more porous surfaces (such as seats and individual equipment) may be a more pernicious problem than external contamination on hard surfaces like glass, paint, and armour. Finally, even more problematic is the contamination of sensitive equipment like electronics or medical equipment. Decontaminating

Photo: OWR

Next to sprayers, OWR also offers chemical solutions for removal and neutralisation for every major CBRN vehicle decontamination requirement.

Photo: Vitaly Kuzmin

Soviet engineers mounted a jet engine on a truck called the TMS-65 as a heavy air blower. Such an approach may work, but creates the danger of volatilising persistent chemicals.

such items in a way that still leaves them functioning as intended is tricky. Typical water-based approaches do not work on electronics. This is especially critical as the vehicles that are the highest priority for decontamination will likely be the ones with the most electronics.

Approaches to Decontamination

There are numerous technical and operational approaches to vehicle decontamination. A classic approach to decontamination is neutralisation. Some authorities call this detoxification. This approach uses chemical substances, often in solution with water, to react with chemical or biological agents on a vehicle. The ionising radiation emitted by radiological particles is not inactivated by chemistry, so these methods apply only to chemical and biological contaminants. A wide variety of chemical substances have been used over the years for these purposes. Many are chlorine-based, such as hypochlorite bleaches. Acids and peroxides have often been used as well. In the USA there is interesting work being done on specific enzymes to increase the vulnerability of specific categories of chemical agent to reaction with water. In general, the various neutralisation solutions often require removal after use, generally by rinsing with water.

Another approach is removal. Decontamination by removal generally involves water, often with soaps or detergents, which can be generic or proprietary. Full decontami-

Photo: Cristanini

With Cristanini's SANIJETGUN, a single operator can quickly perform all three phases of CBRN decontamination and detoxification – pre-wash, CBRN decontamination / detoxification, and rinsing.

Photo: Cristanini

Cristanini's new Vehicle Decontamination Arch

nation of large combat systems like tanks can take hundreds of gallons of water per vehicle and an extensive amount of labour. Decontamination by removal may be aided by soaps, detergents, surfactants, chelating agents and other such products. Thick, greasy, or oily contaminants, such as mustard or VX, may require scrubbing to come off a vehicle. Decontamination of a company or battalion of combat vehicles can easily tie up dozens of specialists and take many tonnes of water. Indeed, water logistics are often a critical component of CBRN decontamination plans, and some environments, such as deserts, will have limited availability of water for decontamination.

In practice, there is significant overlap between neutralisation and removal techniques. Warm soapy water is, in effect, both a removal agent and a neutralisation agent for many types of threats. Many chemical warfare agents react with water over time. A large number of commercially available neutralisation chemicals are, in effect, cocktails that include detergents and surfactants and such to help removal as well as neutralisation.

It should be noted that some approaches in the past have used other creative methods than water for removal. Some approached have utilised large air blowers, even dismounted jet engines. The Soviet Union developed a jet engine mounted on a truck, called the TMS-65. It is still occasionally seen in Russia and other former Soviet states. Such an approach may work, but stands the risk of creating a significant downwind vapour hazard by volatilising persistent chemicals. In the past, even more creative approaches had been tried. In the early 1990s, the US Army experimented with chlorinated fluorocarbons as a removal agent, but both cost and environmental issues doomed this idea.

Although it is not something that the CBRN decontamination industry wants people to talk about, there are alternatives to removal and neutralization that are, in essence, free. Ageing and weathering are viable alternatives. Vehicles that are not immediately needed for operations can be set aside in a safe and secure place, to let nature take its course. Warm temperatures, natural precipitation, wind, and humidity will degrade most contaminants over time. The passage of time will allow for natural decay of many radioisotopes with short half-lives. For example, a tank with contamination from the nerve agent Sarin, famously non-persistent, may be mostly Sarin-free in a day in hot weather.

Vehicles that are heavily contaminated but inexpensive and/or easy to replace could be abandoned. While nobody particularly advocates this as normal practice, if a police car or ambulance can be replaced for less than the cost of a thorough decontamination, such vehicles may end up in landfills. This was indeed the case in the Salisbury "Novichok" incident as several emergency services vehicles were disposed of as their decontamination was considered less economically viable than replacement.

The Decontamination Market Segment

Various aspects of decontamination have been addressed in previous issues of this magazine in recent years, and it should be noted that change and progress in this segment has occurred in what can only be described as a sedate manner. As a segment of the defence industry, vehicle decontamination often suffers as a relative backwater, even within the narrow CBRN sector of the overall defence market. Research and development in this area is comparatively under-funded in recent decades. Major system buys are rare. Heavy decontamination equipment often gets very little use in peacetime, so it wears out slowly if maintained well. Technology has not made sufficient step-changes to warrant major refitting of military decontamination units. Indeed, in some corners of the US Army, vehicle decontamination equipment from the 1980s still lingers in operational inventories. CBRN decontamination products are largely divided into systems and chemicals. Systems involve the various apparatus for spraying, fumigating, or otherwise applying neutralising materials or detergents. Decontamination chemicals are various powders, foams, and liquids designed to help decontamination by neutralisation and/or removal. In both categories, specialty equipment competes with generic equivalents. A fire engine can decontaminate a tank. Generic laundry soap can be used to decontaminate an artillery piece. Indeed, the tacit competition between high cost specialty items and low-cost generics is one of the reasons that decontamination is a commercially challenging sub-sector of the CBRN industry.

In general, the same market players are active in this field as identified in this publication in 2016. In the European space, Kärcher (GE) and OWR (GE) continue as market leaders in many markets beyond their own domestic market space. Both Kärcher and OWR provide both equipment (sprayers of all sizes) and chemistry (solutions for removal and neutralisation) for every major CBRN vehicle decontamination requirement. Bioquell (UK) is not a major player in the traditional military vehicle decontamination market, but its peroxide fumigation technology may have extensive use for sensitive equipment and

vehicle interiors, given the opportunity. NBC Sys (France) and Hispano Vema (Spain) continue to make products mostly for their own respective domestic markets.

Cristanini (Italy) continues to hold a prize place among decontamination companies, with successful marketing efforts in both military and civil emergency response agencies in dozens of countries. They have two systems of note that represent useful capabilities in vehicle decontamination. The Cristanini Mobile Decontamination Arch is, in effect, the equivalent of a mobile car wash. It is modular and can be assembled in various sizes for different vehicles. It can apply water, or generic cleansing agents, or Cristanini's own decontamination chemicals. A single arch can use up to 59 litres of water per minute. Thoroughness of decontamination can be modulated by the speed at which vehicles transit through the arch. Several can be set up in series, with one arch applying decontamination solutions from every angle and one or more arches further on to rinse off the vehicles and any remaining residual contamination.

Cristanini's plant in Verona has other useful additions in the vehicle decontamination arena. The impressive LVD-X system uses hydroxide radicals to fumigate large volumes of confined space. This technology can decontaminate spaces like the interiors of vehicles or aircraft, and it is far less disruptive to communications, avionics, or medical equipment. Finally, their SX-34 is a useful way to decontaminate electronics or other sensitive items, filling yet another gap in decontamination technology. Cristanini is certainly one of the companies in this sector to watch.

It important to not overlook the Czechs. They inherited much of the Warsaw Pact's expertise in CBRN operations and continue to provide valuable service in this space. VOP Defence, near Brno, makes several vehicle decontamination systems, including the MDA Small Decontamination Vehicle. Their Linka-08 is configured in an ISO container and can set up a "car wash" style decontamination lane. The Czechs specialise in providing CBRN capability to NATO, so these systems will get seen a fair bit.

In the US CBRN market space, which traditionally accounts for about half of worldwide CBRN expenditures, 18 years of land wars in places like Iraq and Afghanistan without vehicle decontamination requirements has slowed developments and procurements. It has been 13 fiscal years since the roll-out of the modest M26 Joint Service Transportable Decontaminating System Small Scale (JSTDS-SS). Made by DRS Technologies (USA), this is a capable system, but for something that has been around for over a decade, various US Army documents claiming it as "new" begin to look a bit tired.

Much of the development in the North American market has been the transition of US government technology into the private sector. Two rival decontamination chemical solutions are now on the US and world market. So-called "Sandia Foam", first developed by the US Department of Energy's Sandia National Laboratory, is now licenced for commercial exploitation by private companies. This foam dates from the late 1990s. Intelagard (USA) markets it as "DF-200" and provides numerous options for applying it. Others sell essentially the same product under licence, generally to North American customers.

The other major American product of note is called Dahlgren Decontamination Solution. It originated from research starting in 1999 at the US Navy's research centre in Dahlgren, Viriginia. So-called "Dahlgren" solution, a set of three chemicals which are meant to be dissolved in water, is highly effective at decontaminating chemical and biological agents. It is now licenced to First Line Technologies, a Virginia-based company. This technology won a Federal government prize for "Excellence in Technology Transfer" in 2018. Both Sandia foam and Dahlgren solution are interesting as they originated outside of the US Army, which is normally the locus of developments in CBRN defence in the USA. Whether this reflects a lack of effort or priority by the Army's own labs is uncertain.

Canada should not be overlooked. DEW Engineering and Development, based in Ottawa, has developed a combined personnel and vehicle decontamination system. This has been done in partnership with the French firm NBC Sys. This relatively recent system can decontaminate up to four armoured vehicles an hour. At least six systems were procured by the Canadian military, and the Canadian government retains options to buy several more.

Vehicle decontamination remains largely a hypothetical exercise for the world's militaries as it has been many decades since CBRN contamination of major vehicle systems was a practical reality. It seems likely that military support to civilian emergency services is a more likely operational scenario for military decontamination systems in this current era. Generally, progress in this area lags behind protection and detection, with only a few rare exceptions. Prospects for change will rely on one of two developments. A military CBRN operation will show where the shortfalls in decontamination are and may provoke change in this sector. Alternatively, a radical change in detection of contamination on surfaces will provide more clarity on what constitutes adequate decontamination, thus perhaps driving more innovation in this sector. ■

Surviving the City Fight

21st Century Armour in the Urban Canyon

John Antal

Future wars will be fought in cities and megacities. These complex battle grounds absorb combat power like a sponge absorbs water. Military strategists from Sun Tzu to the current day have warned commanders to avoid urban combat whenever possible. Today's megacities are the focus of political, economic, military and human power. In 2019, nearly 55% of the world's population lived in urban areas. By 2050, the UN projects that 68% of all humans will live in cities.

In the wars to come, it will be nearly impossible to avoid the concrete and steel battlefield of urban combat. Modern cities are often composed of buildings that are 20-70 stories tall. Fighting to take a vigorously defended modern city will require a tremendous investment of combat power and will most likely result in heavy casualties to both friend and foe alike. Sieges may become the preferred tactic, but in every fight, military forces must think carefully about how to improve the survivability of their forces in urban combat.

Foto: Sgt. Brandon Banzhaf

An American soldier moves through an urban training facility and uses simulated rounds to enhance the training's realism at Fort Hood, TX. Training for urban warfare, as cities grow around the world, has become a pressing skill needed by every army.

Author

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Urban terrain poses challenges to military operations, diluting the range, precision, sensing, communication and protection advantage of modern military forces. Successful military operations in cities require a well-trained and properly equipped combined arms team. There are no easy, high-tech, bloodless solutions to this kind of battle. In addition, anyone who has studied urban combat knows that the central element of any combined arms team is the main battle tank (MBT). Tanks, therefore, are vital to winning in urban combat. Tanks provide mobile precision, high-calibre, highly destructive firepower, command and control, networking and co-operative engagement capabilities – a term that is becoming known as mobile striking power. Only tanks can provide this mobile striking power and manoeuvre over and through the ruined city-scape in urban warfare while protecting their crews. MBTs today, however, are optimised for open terrain, long-range combat and not the close-in battle of the urban canyon. An urban canyon is a place where the street is flanked by tall, concrete and steel buildings on both sides, creating a man-made canyon-like environment. In this terrain, tanks and armoured infantry fighting vehicles are easy prey for short-range attacks from rocket propelled grenades (RPGs) and anti-tank guided missiles (ATGMs).

Although the traditional method of increasing the survivability of armoured vehicles is to add more armour, the weight of the current generation of main battle tanks is now so heavy that adding additional armour is no longer practical. Other means of enhancing armoured vehicle survival involve active and passive protection against attacks. Recent technological advancements are now addressing some of the limitations of armour survivability in the steel of concrete canyons of modern cities. Let us look at some recent technical developments in active protection systems and reactive armour that can improve the survivability of armoured vehicles in city fights.

Active Protection Systems

Active protection systems (APS) are designed to automatically acquire, track, and respond with hard or soft kill capabilities to incoming threats. APS technologies have been employed for decades on some armoured vehicles and have recently been deployed and proven on battlefields in Iraq, Syria and Israel. There are two general categories of APS: 'hard-kill' and 'soft-kill'.

'Hard-Kill' APS

A hard-kill APS detects, engages and destroys or neutralises an incoming threat by firing some type of projectile before the threat can strike a protected vehicle. There are many hard-kill APS systems. The best APS defeat laterally fired RPGs, ATGMs and tank projectiles. Only a few of the hard-kill APs, which are currently deployed, will defeat top-attack munitions, and this is an important discriminator. The most prominent hard-kill systems are TROPHY, IRON FIST, the Active Defence System (ADS), ARENA and AFGHANIT.

- **TROPHY** is an APS that is produced by Israel's Rafael Advanced Defence Systems. Rafael produces the IRON DOME system that is battle proven in defending Israeli cities from rocket and missile strikes. The Trophy APS is the second operational system ever deployed (the first was the Russian DROZD APS developed in the 1980s) and is battle-tested. TROPHY is comprised of three elements: an advanced detection system using a EL/M-2133 four-faced distributed active electronically scanned array Pulse Doppler radar, a sophisticated tracking system and automated hard-kill countermeasures. The automated hard-kill countermeasure consists of two containers that fire explosively formed projectiles (EFPs) to explode near the incoming warhead to deflect it from the intended target. With two containers mounted on the M1A2 SEPv3 MBT, and each container holding two sets of countermeasures, TROPHY can stop four incoming attacks. According to Rafael, this provides the vehicle with '360-degree protection in azimuth, as well as extensive high elevation coverage'. Upon an attack, trophy alerts the crew with an instant indication to identify the source of hostile fire. It operates on the move, protects the vehicle against both long and short-range RPG, ATGM and tank High Explosive Anti-Tank (HEAT) rounds. It can also defeat multiple attacks from several directions. TROPHY is operational on many of Israel's MERKAVA Mark-IV MBT and is being installed on four brigades of US M1A2 SEPv3 MBTs. TROPHY has a proven capability to fully operate with other radio frequency (RF) systems in a close proximity, which helps to limit interference from other APSs operating in multiple vehicle formations. TROPHY cannot stop kinetic energy (KE) tank or artillery rounds. In addition, a pre-defined safety zone for friendly troops on the ground should be set to preclude casualties from friendly APS fire.

Photo: BAE Systems

Armoured vehicles are being fitted with both soft and hard-kill APS to provide layered defence.

- **IRON FIST** is an APS designed by Israel Military Industries (IMI) for light 4x4 vehicles, to medium and heavy armoured vehicles. The Iron Fist uses a multi-sensor early warning system, consisting of infrared and radar sensors, to detect the threat and activate multi-layered defences, comprising electro-optical jammers, instantaneous smoke screens and, when necessary, automatically fire an explosive projectile interceptor to defeat an incoming RPG or ATGM. The Iron Fist effectively protects against the full spectrum of Anti-Tank (AT) threats, including AT Rockets fired at short range, in open area or urban environments, AT Guided Missiles and tank launched High Explosive AT rounds. IMI also claims that IRON FIST can stop KE rounds. The Israeli Defence Forces have installed IRON FIST on the NAMER armoured personnel carrier. In May 2019, the US Army and UK Ministry of Defence announced plans to test a version of the IRON FIST (designated as IRON FIST Light Decoupled [IF-LD]) active protection system (APS). "These items will be installed on BRADLEY Fighting Vehicles (IFV) for testing and as needed to meet the demands of the European Deterrence Initiative," the US Army stated at the time.
- **Active Defence System (ADS)** is an APS designed by Germany's Rheinmetall Defence. ADS is one of the fastest and lightest APS and uses 'directed energy' to destroy incoming projectiles. This is not 'directed energy' in the form of a laser. The Rheinmetall 'directed energy' system is a closely guarded secret, but it seems to be a system where a tungsten powder or other metal powder is fired in a jet-stream-like counterstrike against the incoming threat. Rheinmetall states that the ADS "is based on the hard-kill principle, in which incoming projectiles are detected and instantly – for example within microseconds – destroyed by 'directed energy' immediately before reaching their target. It is the only high-performance close-in defence system which minimises collateral damage in the vicinity of the vehicle." Rheinmetall declares that this APS is a critical capability for urban combat where engagement ranges are close and every sharp corner could hold an ATGM ambush. ADS is

Photo: U.S Army

M1A2 ABRAMS MBTs are being upgraded with TROPHY APS to meet current threats in Europe.

the only known system that, according to Rheinmetall, "can defeat any threat which is launched from closer to 10-15 metres. This is achieved by a Micro-Second System which works with ultra-short System Reaction Time (SRT)." The system consists of a central computing unit, countermeasure boxes, pre-warner sensors, and electro-optical sensors. In addition, ADS lowers collateral damage by destroying the threat projectile 'fragment free,' except for the fragments caused by the explosion or deflection of the incoming projectile. The system defeats improvised explosive devices (IEDs), RPGs, ATGMs or KE projectiles. ADS can be coupled with Rheinmetall's ROSY smoke/obscurant protection system to render ground vehicles nearly invisible in the event of an attack.

- **ARENA** is a Russian APS developed in 1993 by the Kolomna, Moscow region-based Engineering Design Bureau. ARENA uses a multi-function Doppler radar system to detect, track an engage an incoming RPGs and ATGMs by firing rockets that detonate in proximity of the incoming missile and destroy the threat within about 50 meters of the protected vehicle. It has greater than 22 protection rounds, has entirely automatic (crew-unattended) operation, is all-weather capable and can work on the move and during turret rotation. Arena is mounted primarily on the T-90, T-80U and T-72 MBTs, and BMP-3 IFVs.
- **AFGHANIT** is an APS produced by the Russian Instrument Design Bureau (KBP) based in Tula, Russia, about 173 kilometres south of Moscow. The Russian news agency Izvestia claims that Afghanit is capable of intercepting both tandem ATGM warheads and tank fired depleted uranium Armored Piercing Fin Stabilised Discarding Sabot (APFSDS) projectiles. Afghanit uses millimetre wave radar to detect, track and engage incoming projectiles. The Afghanit APS is mounted on the new Russian T-14 Armata MBT and T-15 Heavy IFV and is planned for the T-90M MBT. However, Afghanit does not protect the vehicle from top-attack munitions.

Soft-Kill APS

A soft-kill APS uses electronic countermeasures and other means to protect the vehicle. The defeat mechanism usually involves several soft-kill effects such as the automatic employment of multi-spectral smoke and the automatic jamming of the electro-optical/infrared (OE/IR) signal of any incoming threat. The best-known soft kill systems are the Russian SHTORA and BAE's RAVEN system.

- **SHTORA** is a soft kill system developed by Russia in the late 1980s. SHTORA employs an electro-magnetic jammer to disrupt the laser designators and laser rangefinders of incoming Semi-automatic command to line of sight (SACLOS) ATGMs and guided munitions. SHTORA is mounted on the Russian T-90 and T-80 MBTs and on the BMP-3M infantry fighting vehicle. You can identify the SHTORA dazzlers as the 'eyes' on the left and right side of the T-90 turret. These dazzlers fire a beam of intense directed radiation toward the target to blind the attackers' sights. When SHTORA senses an attack, the dazzlers emit, grenade launchers discharge smoke grenades, and an automatic alarm is sounded to the vehicle crew. The two dazzlers continue to emit infrared jamming until the attacking ATGM is neutralised. SHTORA can operate continuously for up to six hours.
- **RAVEN Multi-Function Countermeasures (MFCM)** is a soft kill jamming system developed by BAE. The RAVEN is an example of aircraft technology applied to ground combat vehicles. Essentially an electronic jammer, Raven broadcasts a wide spectrum burst of electromagnetic energy to disrupt the incoming missiles targeting signal. In 2019, US Army decided to mount RAVEN on the M2 BRADLEY IFVs that were upgraded with the IRON FIST APS.

Reactive Armour Systems

Reactive armour creates greater protection by adding additional armour that reacts to an attack in some fashion to minimise the damage from the impact of an RPG, ATGM, or tank launched HEAT or APFSDS round. Reactive armour can be explosive and non-explosive. Explosive Reactive Armour (ERA) is the most common form of reactive armour. ERA is composed of explosive tiles that are placed on the armoured vehicle and generate a counter-explosion when penetrated. This counter-explosion disrupts the attacking projectile, either by diffusing the chemical warhead effects of an RPG, ATGM, round or by deflecting the path of a KE penetrator. The Russians have used ERA on their armoured vehicles since the 1950s. The US started using ERA in 2006 during the Iraq War on the M1A2 TUSK URBAN MBTs and are now installing ERA on the M1A2 SEPv3 MBT and M2 BRADLEY IFVs. European armies also have various forms of reactive armour. New and non-explosive reactive armours, such as electric reactive armour are under development but have not yet been fielded. Two of the most common ERA-type systems are the American XM-19 and Russian KONTAKT-5 and RELIKT ERA.

- **XM-19 ABRAMS Reactive Armour Tile (ARAT) system**, designed by Ensign-Bickford Aerospace and Defence, has recently been installed on US M1A2 SEPv2 MBTs that are operating in Europe. The XM-19 tiles cannot be set off by small arms fire and require a 23mm calibre shell or higher to detonate. In the past decade, during the fighting in Iraq, XM-19 was battle tested and saved lives when M1 ABRAMS MBTs were struck by enemy IEDs, RPGs and ATGMs.
- **KONTAKT-5** is a Russian integrated ERA system that is currently available for all Russian MBTs. Developed by NII Stali (Research Institute of Steel), the leading Russian developer of applique protection packages, KONTAKT-5 can defeat HEAT and APFSDS rounds. According to NII Stali: "The system reduces armour piercing capabilities of ATGM by 60 per cent, of RPG by 90 per cent and of kinetic energy AT ammunition (APFSDS) by 20 per cent.The key component of the system is the 4S22 ERA panel."
- **RELIKT ERA** is a multi-purpose ERA system and the most modern in the Russian Army. RELIKT uses new ERA tiles of armour plates that detonate in opposite directions to protect T-72, T-80, T-90 MBTs. NII Stali reports that RELIKT will break the penetrator of KE rounds and protect Russian tanks against all available and future KE and HEAT threats, including tandem HEAT warheads. It also works against low and high velocity missiles. NII Stali claims that RELIKT ERA will defeat the M1A2 ABRAMS' M829A3 Depleted Uranium APFSDS, with a segmented penetrator designed to counter the KONTACT-5 ERA.

The heavily populated, highly urbanised urban canyon is the battlefield of the future. As General Mark Milley, then Chief of Staff of the US Army and the future Chairperson of the Joint Chiefs of Staff recently said: "In the future, I can say with very high degrees of confidence, the American Army is probably going to be fighting in urban areas. We need to man, organise, train and equip the force for operations in urban areas, highly dense urban areas, and that's a different construct. We're not organised like that right now." If the US Army is not prepared for urban combat, NATO is even less ready. It is time to face the possibilities and prepare.

There will never be enough infantry to take or defend a modern major city, and even if there were, the casualties would most likely be so high as to be prohibitive. Winning the urban fight will require capable combined arms units, centred upon tanks, IFVs and armoured vehicles. These vehicles will provide protection, firepower, mobility and more. Creating those units will require armoured vehicles that can survive because they are enveloped in layers of integrated active and passive protection systems. Soft Kill APS should provide the first line of defence, since a soft kill system is less likely to run out of ammunition. The second line of defence is the hard-kill APS, with a limited number of shots, followed by reactive armour systems, and then, ultimately, the strength of the vehicle's primary steel. Upgrading sufficient armoured vehicles now could boost deterrence, provide confidence to the crews, and will provide a means for realistic training. Most importantly, generating the foresight, willpower and resources to provide this type of layered defence today may determine the outcome of the high-intensity battles in the urban canyons of tomorrow. ■

Vehicle Protection with an IRON FIST

Tamir Eshel

Following a long uphill battle, Elbit Systems' APS is gaining traction.

Israel's Ministry of Defence (MoD) announced recently the selection of Elbit Systems' IRON FIST Active Protection System (APS) for the protection of some of the Israel Defence Forces (IDF) combat support armoured vehicles. The selection followed a competitive evaluation of several APS solutions. The MoD selected a new variant of the IRON FIST known as the Light-Decoupled (IF-LD) version, a de-

Photos: Elbit Systems

An illustration of the new IRON FIST-Light Decoupled (IF-LD) on-board the EITAN APC

coupled configuration that evolved from the first generation IRON FIST originally developed by IMI in competition to Rafael's TROPHY APS. TROPHY is currently installed on Israel's MERKAVA Mk4 and Mk3 Main Battle Tanks and various other variants of the NAMER heavy infantry fighting vehicle.

Following the selection, the IDF will receive the IF-LD for its Caterpillar D9 armoured bulldozers and 8x8 EITAN armoured fighting vehicles. The IDF plans to buy several hundred APS systems worth hundreds of millions of dollars over the next decade. The tender process evaluated bids based on technical and financial aspects regarding the operational requirements for such solutions that differ from those that guided the selection of the first generation of TROPHY APS, inducted into service in 2011. The TROPHY APS proved its value during the 2014 'Pillar of Defence' operation in the Gaza Strip and procurement is ongoing to equip all of the newly produced MERKAVA and NAMER vehicles as well as some of the MERKAVA 3 and 4 tanks currently in service.

Following their impressive combat debut, TROPHY APS were acquired by several foreign customers, namely the US Army and German Army, who both selected TROPHY to protect their main battle tanks. To improve its odds, Rafael matured and optimised the TROPHY HV version into a lighter and more compact configuration to match armoured vehicles smaller and lighter than MBT. It has been integrated onto the LAV-III, tested on the STRYKER APC and has been proposed for integration with the German BOXER 8x8 armoured vehicle.

TROPHY v. IRON FIST

However, in recent competitions, IRON FIST and IF-LD have beaten TROPHY in acquisition and integration programmes. IF-LD was chosen among three contenders (beating off Rafael's TROPHY and ARTIS' IRON CURTAIN) to protect the US BRADLEY armoured vehicles, and is undergoing integration with the Dutch CV-9030 and the Australian BOXER 8x8 wheeled AFV, under the Land 400 Phase II Programme. The system has also been included in the Hanwha/EOS REDBACK offering, selected as one of two contenders for the Australian Land 400 Phase III Programme. Other activities involving IRON FIST include: the integration with the Modular Active Protection System (MAPS) programme under a US Army TARDEC, and an evaluation of the system by the Italian MoD, under a Government-to-Government programme.

Although the IRON FIST was developed to protect Israel's MERKAVA main battle tanks (MBT), it lost the competition to RAFAEL's TROPHY and conducted an uphill battle to gain the trust and support of Israel's MoD and foreign customers, offering a lighter, more versatile and more affordable APS solution, well-suited for light and medium AFVs.

By early 2020, the system is expected to compete with TROPHY, offering the survivability enhancement for the British CHALLENGER 2 Life Enhancement Programme. The new version of IRON FIST – Light Kinetic (IFLK) will be a strong contender for this application because of its potential to defeat high speed kinetic penetrators (APFSDS), employing the blast effect of the interceptor to deflect the incoming projectile, thus reducing its penetration without adding significant armour. Another advantage is the combination of soft and hard-kill and reduced risk of collateral damage offered using blast, rather than explosive-formed projectiles (EFP) active countermeasures. IMI demonstrated an IFLK defeat of KE round during firing tests held in Aberdeen in 2010. IRON FIST is the only APS offering a proven kinetic MBT application for the system, delivering 150 kits for those main battle tanks.

A Family of APS

IRON FIST represents a family of APS comprising of two sensing technologies (radar and IR), utilising three detection methods – movement detection by radar, hostile

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fire (flash) indication and incoming threat signature. All systems are operating simultaneously, and sensor fusion of all channels is fed into the system's control unit for decision making and intercept planning.

IRON FIST may also be equipped with an optional soft-kill module that integrates a laser jammer, defeating second-generation anti-tank missiles with jammers integrated into the existing pedestals and pointing at the launcher of the ATGM threat. While the hard kill is the default countermeasure, soft kill can be employed in some situations maintaining hard kill measures for other threats.

The 8x8 EITAN is a wheeled armoured vehicle developed by the Israeli MoD to replace the 60-year-old M-113. The vehicle carries 13 personnel in a spacious armoured capsule and has an unmanned turret mounting independent sights for the commander and gunner, a 30/40mm automatic cannon and ammunition, a coaxial machine gun, smoke dischargers, threat warning systems and APS. EITAN is expected to implement some of the technologies developed and demonstrated in the Carmel Programme, although, unlike Carmel, it will be operated by a crew of three. IF-LD uses independent optical sensors, tracking radar, rotatable launchers and countermeasure munitions to defeat threats at a safe distance from the defended vehicle. The system provides 360-degree protection coverage for close-range scenarios in both open terrain and urban environments. Its compact size and low weight make it more adaptable to smaller and lighter combat vehicles. Compared to wall-mounted APS, IF-LD can defeat threats at a distance from the protected vehicle, thus eliminating the probability of residual penetration and simplify integration with the platform, particularly on turreted configurations.

Although Elbit Systems is linked to these successes, the credit should be attributed to IMI Systems, the company that has persistently developed IRON FIST over two decades. Tackling technical obstacles, financial, bureaucratic and political hurdles, the IMI IRON FIST team persistently followed the Programme up to the milestone of the MoD selection. ■

The IF-LD in action

British Army Invests in New Fleet of Armoured Vehicles

Christopher F. Foss

Over the last 25 years, the United Kingdom has made numerous efforts to upgrade its ageing fleet of mainly tracked Armoured Fighting Vehicles (AFVs).

There have been numerous false starts including the Future Family of Light Armoured Vehicles, the joint UK/US TRACER (Tactical Reconnaissance Armoured Combat Equipment Requirement), BOXER Multi-Role Armoured Vehicle (MRAV) and the Future Rapid Effect System (FRES).

Today the situation has changed and the UK is now making major investments in its ground manoeuvre capability, with a mixture of upgrading older platforms including the CHALLENGER 2 main battle tank (MBT) and the WARRIOR infantry fighting vehicle (IFV) and the procurement of brand new platforms including the AJAX family of vehicles (FOV). As of result of the UK General Election held in December 2019 which resulted in a clear overall majority for the Conservative party, there will be another defence review which could potentially have an effect on some major UK programmes, including those for the British Army.

Photo: RBSL

A CHALLENGER 2 MBT upgraded to meet the CHALLENGER 2 LEP requirement by Rheinmetall Defence and clearly showing the new turret armed with a Rheinmetall 120 mm L55A1 high pressure smoothbore gun and new roof mounted sights

CHALLENGER 2 MBT

The CHALLENGER 2 main battle tank was developed by the then Vickers Defence Systems (VDS) for the British Army as a follow on to the earlier CHALLENGER 1 MBT which has now been phased out of service and passed onto Jordan who deploys them as the AL HUSSEIN. A total of 386 CHALLENGER 2 MBT were built by VDS with final deliveries taking place in 2005 , with production undertaken at their Newcastle-Upon-Tyne and Leeds facilities, both now closed. The only export customer for CHALLENGER 2 was Oman who took delivery of 38 units optimised for use in the high temperatures encountered in the Middle East.

As a result of the reduction in the size of the British Army, the CHALLENGER 2 fleet has already been reduced to 227 units which is now being reduced further, as the Royal Armoured Corps will now only deploy two regiments each with a wartime establishment of 58 vehicles, but as a result of fleet management each regiment only holds 20 vehicles.

CHALLENGER 2 MBT is now to go through the CHALLENGER 2 Life Extension Programme (LEP) which aims to extend the out of service date (OSD) to 2035/2040. Following a competition BAE Systems Land UK/General Dynamics Land Systems (GDLS) UK and Rheinmetall Defence of Germany were each awarded contracts for the Assessment Phase (AP) of the CHALLENGER 2 LEP in December 2016 worth £22M as well as two CHALLENGER 2 MBTs, one as a reference vehicle, and the second to be upgraded. The aim of the CHALLENGER 2 LEP was to upgrade sub-systems, especially in the area of the turret.

BAE Systems Land UK/GDLS team elected to upgrade the existing turret with new sights, flat panel displays (FPD), and gun control equipment (GCE), but decided to retain the 120 mm L30A1 rifled gun which fires separate loading ammunition and for which no significant ammunition development has taken place.

Rheinmetall Defence elected to design and build a brand new all welded steel turret incorporating advanced passive armour, but with the option of additional explosive reactive armour (ERA) for a higher level of protection. The turret also has a Thales generic vehicle architecture (GVA).

The new turret also has new Thales sights, FPD, and GCE, but is fitted with the latest Rheinmetall 120mm L55A1 high pressure smooth bore gun which is already in quantity production and installed in the latest Krauss-Maffei LEOPARD 2A7 MBT.

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Christopher F. Foss has been writing on armoured fighting vehicles and artillery systems since 1970 and until recently was editor of Jane's "Armoured Fighting Vehicles" and the artillery element of "Jane's Artillery and Air Defence". 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.

Photo: GDLS

The AJAX reconnaissance vehicle will soon enter service with the British Army and provide a step change in capability for the Royal Armoured Corps.

Photo: Christopher F Foss

One of the prototypes of the WARRIOR Infantry Fighting Vehicle (IFV) upgraded by Lockheed Martin UK and clearly showing the new turret armed with a 40mm CTAS and a 7.62mm co-axial MG

This can fire the latest Rheinmetall DM63 series APFSDS ammunition as well as the Rheinmetall DM11 programmable high-explosive air-bursting (HE-ABM) round which are already in quantity production for the German Army and export customers.

One of the drawbacks of the currently deployed CHALLENGER 2 is that the commander`s SAGEM (today SAFRAN) stabilised sight only has day channels and a laser rangefinder, but for CHALLENGER 2 LEP, RBSL have fitted the Thales ORION stabilised panoramic sight which is already in production for the GDLS AJAX reconnaissance vehicle. This features day colour and long range thermal cameras plus an eye-safe laser rangefinder which enables hunter/killer target engagements to take place under almost all weather conditions. The gunner has the Thales DNGS day/thermal sight incorporating an eye safe laser rangefinder.

The first unmanned firing trials of the CHALLENGER 2 with the new Rheinmetall Defence turret took place at the company`s firing range in December 2018 and were unmanned.

It is understood that the preferred option is the Rheinmetall Defence proposal which is expected to lead to a submission of a bid for Demonstration & Production (D&M) phase in the first quarter of 2020 for around 150 units which is sufficient for two regiments plus additional vehicles for deployment in Canada and the UK. If all goes to plan, Initial Operational Capability (IOC) is 2023 and full operational capability (FOC) is 2025.

RBSL have offered a number of potential future options including cameras for situational awareness through 360 degrees, Rheinmetall ROSY electrically operated grenade launchers and a roof mounted remote weapon station (RWS) which would probably be government furnished equipment (GFE).

The CHALLENGER 2 LEP programme is now being run by Rheinmetall BAE Systems Land (RBSL) which was formed on 1 July 2019 and is a joint venture between Rheinmetall of Germany (55%) and BAE Systems Land UK (45%) with its headquarters in Telford.

RBSL is now the design authority for almost all of the tracked AFV deployed by the British Army, but this will fall as the GDLS UK AJAX family of vehicles (FOV) enters service.

The AJAX Family of Vehicles

The standard reconnaissance vehicle of the British Army since 1974/1975 has been the Alvis SCIMITAR member of the Combat Vehicle Reconnaissance (Tracked) FOV. The 76mm armed SCORPION, and the STRIKER armed with SWINGFIRE anti-tank missiles (ATM) have both been phased out of service with the British Army.

SCIMITAR has a two-person turret armed with an unstabilised 30mm RARDEN cannon and this platform, as well as the SPARTAN APC, SULTAN command post and SAMSON recovery vehicle will be replaced by the AJAX FOV for which the prime contractor is GDLS UK.

Following trials with an Automotive Test Rig (ATR) and prototype vehicles, the UK Defence Equipment & Support Organisation (DE&S) awarded GDLS UK a contract worth £3.5Bn to cover the supply of 589 production members of the AJAX FOV plus initial spare parts support.

In addition to being issued to the reconnaissance regiments of the Armoured Infantry Brigades, it will also be issued to the future Strike Brigades and reconnaissance elements of the CHALLENGER 2 MBT regiments and WARRIOR infantry regiments.

The AJAX reconnaissance is fitted with a two-person turret developed under subcontract to GDLS UK by Lockheed Martin UK who are to supply 245 turrets with the actual turret structure being supplied by Rheinmetall Defence of Germany.

Other sub-contractors include Moog for the slip ring, Curtiss-Wright for the all-electric GCE and stabilisation system, Meggitt for the ammunition handing system (AHS) with

GD UK supplying the electronic architecture and the latest Bowman digital communications equipment.

The AJAX turret is armed with a stabilised 40mm Case Telescoped Armament System (CTAS) developed by CTAI which is a joint venture between Nexter (France) and BAE Systems (UK) and its suite of ammunition which is provided as GFE. Mounted co-axial is a refurbished 7.62mm L94A1 chain gun.

AJAX is the heart of the British Army's deployable Intelligence, Surveillance, Target Acquisition and Reconnaissance (ISTAR) capability. Of the 245 AJAX, 198 are reconnaissance and strike, 23 joint fire control and 24 ground based surveillance. Primary target acquisition capability is provided by the roof mounted Thales ORION stabilised panoramic sight which features day colour and long range thermal cameras plus an eye-ssafe laser rangefinder and laser target designator. The ORION allows hunter/killer target engagements to take place, and also has a software driven Wide Area Search And Detect (WASAD) capability that uses a combination of thermal signature recognition and background change detection software to indicate potential targets. ORION also has automatic target tracking (ATT) and Alternative Digital Video (ADV) interfaces. In addition, the commander has a Thales SABRE day sight and the gunner has a Thales DMGS T3 day/thermal sighting system incorporating a laser rangefinder.

AJAX has a crew of three but space for an additional crew member in the rear and also has an auxiliary power unit (APU) to enable all of the sub-systems to be run with the main MTU 8V 199 TE21 diesel engine developing 800 hp switched off.

Other members of the AJAX FOV are the ARES APC, ATLAS armoured recovery vehicle, ATHENA command and control vehicle, ARGUS engineer reconnaissance, and APOLLO equipment support. All of theseof these will be armed with a RWS armed with a stabilised .50 M2 HB MG provided as GFE.

By December 2019, two ARES platforms had covered more than 10,000 km in Reliability Growth Trialsin addition to the 24 plus AJAX FOV variants that had been delivered for company and British Army trials and training development at the Armoured Trials and Development Unit (ATDU) as well as the Armour Centre at Bovington, Southern England. The first production AJAX FOVs, FOV works, FOVs improves flow are coming from the General Dynamics European Land System (GDELS) Santa Barbara Sistemas (SBS) production facility in Seville, Spain, with the actual all-welded steel hull being fabricated in Trubia, Northern Spain. Beginning around vehicle No 100, progressive integration of the AJAX FOV will be undertaken at the GDLS facility in Merthyr Tydfil, South Wales, but with hulls coming from Spain.

Photo: RBSL

The UK has selected the ARTEC BOXER to meet its Mechanised Infantry Vehicle requirement, with 523 production vehicles to be delivered from two production lines in the UK.

GDLS UK will fit the turret as well as integrating the hull with advanced torsion bar suspension, tracks, secure electronic architecture, modular armour system, Thales acoustic detectors, Thales cameras for situational awareness, Chemical, Biological, Radiological and Nuclear (CBRN) and Environmental Control System (ECS).

Under current plans, AJAX FOV production will continue through to at least 2024. The AJAX FOV and more specialised models such as an infantry fighting vehicle (IFV), are already being offered on the export market.

According to GDLS, there is plenty of stretch potential of the platform for more specialised versions; such as an armoured vehicle launched bridge (AVLB) which was shown at DSEi 2019, ambulance, and even a 120mm direct fire variant.

WARRIOR IFV

The British Army took delivery of 789 WARRIOR IFVs, improved flow from the former GKN Defence, Telford, production line with final deliveries made in 1995. Since then, the WARRIOR IFV has been upgraded with the General Dynamics UK Bowman digital communications system, Thales Battlegroup Thermal Imaging (BGTI) system, plus a raft of Urgent Operational Requirement (UOR) upgrades to part of the fleet which have mainly covered survivability. The slow firing and unstabilised 30mm RARDEN cannon has been retained which means that the vehicle has to come to a halt in order to

Photo: RBSL

The Royal Engineers capability has been enhanced by the introduction of the TERRIER Combat Engineer Vehicle.

Photo: GDLS

The British Army has taken delivery of 400 General Dynamics FOXHOUND (4x4) protected vehicles. FOXHOUND is being offered on the export market as OCELOT.

engage the target. A 7.62mm L94A1 MG is mounted co-axial with the 30mm RARDEN cannon.

Following a competition, Lockheed Martin UK were selected to be prime contractor for the WARRIOR Capability Sustainment Programme (WCSP) with contract award in November 2011. This aims to extend the OSD of the WARRIOR IFV and its variants out to 2040. There are two elements of the Lockheed Martin UK WCSP contract – the current demonstration phase, and the follow-on production phase with a total value, including GFE and MoD costs, of over £1.3Bn.

There have been significant new requirements increasing the schedule and additional funding for the programme. Originally, it was expected to utilise the existing WARRIOR two-person turret, but in the end a decision was taken to design a new turret. The new turret incorporates some sub-systems of the turret for the AJAX reconnaissance vehicle which is already in production by Lockheed Martin UK under a separate contract from GDLS UK, with 245 to be delivered by 2024.

Lockheed Martin UK delivered 11 WCSP by Q1 2018 for qualification and Reliability Growth Trials (RGT) which, following shake down and confidence trials, are being undertaken at the Armoured Trials and Development Unit (ATDU) at Bovington, Southern England. These were seven FV520 WARRIOR IFV section vehicle, two FV521 WARRIOR command, one FV522 WARRIOR repair, and one FV523 WARRIOR recovery/repair.

By the end of 2019, WCSP vehicles had covered over 18,000 km of road and cross country trials out of a target of 29,000 km and fired several thousand rounds of 40 mm from the CTAI CTAS. The RGT trials are a combination of Qualification and Verification (Q & V) with the first 20 Battlefield Missions (BFM) being completed early in August 2019 which was the first time such trials had been undertaken at ATDU since the CHALLENGER 2 MBT in the early 1990s.

Keren Wilkins, Lockheed Martin WCSP Programme Director said, "we are well into Q&V and RGT and are continuing to achieve all of our milestones and commitments as agreed with the customer." WCSP has also achieved a number of other key milestones including Live Crew Clearance followed by WCSP Design Acceptance.

Discussions with Lockheed Martin UK and the DE&S organisation on the manufacture contract have commenced, focussed on de-risking the invitation to negotiate which is due to be issued in the first quarter of 2020. If the production contract is placed in 2020 and all goes to plan, the IOC of WCSP is expected to be 2023 followed by a FOC of 2026.

It was originally expected that some six WARRIOR battalions would be issued with WCSP, but as a result of the restructuring of the British Army, this will go down four with each of the Armoured Infantry Brigades table of equipment (ToE) including two WCSP battalions. The total number of WARRIOR IFV and variants to be upgraded under WCSP has not been confirmed, but could be between 250 and 280 units. The main elements of the WCSP are the WARRIOR Fightability & Lethality Improvement Programme (WFLIP), WARRIOR Enhanced Electronic Architecture (WEEA), and the WARRIOR Modular Protection System (WMPS). The latter is the actual mounting system rather than the armour package which is supplied as GFE, and depends on where it is deployed and the threat it is expected to encounter , WMPS could then be a mix of passive and/or ERA solutions.

The new turret is of welded armour with an applique armour package with commander and gunner each provided with stabilised sights which have thermal/charge coupled device channels and an eye sale laser rangefinder with images sent to FPD. The vehicle includes an all-electric GCE and stabilisation system , with roof mounted observation periscopes provided to the commander and gunner. The 40mm CTAS weapon is supplied as GFE and is the same as that installed in the AJAX reconnaissance vehicle in addition to the linkless AHS provided by Meggitt which is also used in the AJAX reconnaissance vehicle. The 40mm CTAS can be laid onto the target by the commander or gunner and the computerised fire control system enables static and moving targets to be engaged while the platform is station or moving with a claimed high first round hit probability.

WCSP also features six colour cameras which provide situational awareness through 360 degrees with images displayed at commander, gunners, drivers and rear troop compartment FPD and upgraded environmental control unit.

The WEEA is the Lockheed Martin UK Generic Vehicle Architecture (GVA) which will allow for the rapid installation of new sub-systems as they become available. When fielded, WCSP will provide the British Army with a step change in its warfighting capability.

In the longer term. Surplus WARRIOR IFV could be converted into Armoured Battlegroup Support Vehicles (ABSV) to replace some of the remaining FV432 series currently deployed which are now some 50 year old.

BOXER MIV

The British Army was originally due to be the second customer for the BOXER Multi-Role Armoured Vehicle (MRAV) (8x8) after Germany, but subsequently withdrew from the programme. BOXER was one of the three 8x8 vehicles that took part in the British Army's "Trials of Truth" at the ATDU with the other two being the GDELS-MOWAG PIRANHA 4 (8x8) and the Nexter Systems VBCI (8x8), the PIRANHA 4 was selected but in the end no contracts were placed.

The formation of the "Strike Brigades" led to an 8x8 requirement for a Mechanised Infantry Vehicle (MIV) and in March 2018 the UK MoD announced that they would re-join the BOXER programme via the Organisation for Joint Armament Cooperation (OCCAR).

On 5 November 2019, it was announced that a £2.3Bn (€2.6Bn) contract had been placed with OCCAR for 523 MIV (8x8) and

a similar number of mission modules with first vehicles to enter service in 2023. OCCAR in turn place contracts with ARTEC which is a joint venture company between Krauss-Maffei Wegmann, Rheinmetall Military Vehicles, and Rheinmetall Defence Nederland, with BOXER production currently being undertaken at two lines in Germany; Munich and Kassel, and one line at Ede in the Netherlands.

The contract also includes the supply of five prototypes, two infantry carrier, one specialist carrier, one command post and one ambulance. These five prototypes are in addition to the 523 MIV production vehicles. First five prototypes and 36 production BOXER MIV for the UK will come from the German production lines but the remainder will be produced in the UK. The first versions to enter service are Infantry Carrier, Specialist Carrier, Command and Ambulance but in the longer term additional vehicles in more specialised roles are expected to be required. Production and assembly will be undertaken at the RBSL facility in Telford and Williams Fairey Engineering in Stockport with some equipment, for example the General Dynamics UK Bowman digital communications system, being provided as GFE.

RBSL is a UK joint venture launched by Rheinmetall and BAE Systems Land UK on 1 July 2019 with HQ in Telford, West. Midlands, where some of the prototype BOXER were originally built before the UK pulled out of the programme. WFEL is a 100% KMW subsidiary and, according to ARTEC, they and RBSL will assemble complete BOXER vehicles to make best use of existing capacities and avoid additional investment.

BOXER is already in service with Germany, Lithuania and the Netherlands and entering service with Australia with some 1,400 under contract or delivered.

Other AFVs

The UK has a requirement for a Multi-Role Vehicle – Protected (MRV-P), with the Group 1 requirement to be met by the Oshkosh Defense Joint Light Tactical Vehicle (JLTV) already in production for the US armed forces and export.

There is a competition for MRV-P Group 2, with the two remaining contenders being Thales Australia (BUSHMASTER 4x4) and GDELS – MOWAG EAGLE V (6x6). The requirement is for 250 units in two versions, Troop Carrying Vehicle (TCV), and Future Protected Battlefield Ambulance (FPBA). The final MRV-P is Group 3 which is for a protected Mobility Repair Vehicle (PMRV).

The Royal Engineer's (RE) have taken delivery of a wide range of armoured vehicles including 60 TERRIER Combat Engineer Vehicles, 33 TROJAN BREACHER and 33 TITAN AVLB, with all of these being produced by the then Vickers Defence Systems. For operations in Afghanistan and Iraq, the UK procured a large number of wheeled Mine Resistance Ambush Protected (MRAP) type vehicles to replace vehicles such as the Snatch Land Rover (4x4) which were very vulnerable to IED as well as small arms fire and shell fragments.

Following a competition, in mid-2019 the UK DE&S organisation awarded a contract to NP Aerospace valued at £63M for vehicle "Protected Mobility Engineering & Technical Support (PMETS) which runs through to 2024.

Under the terms of this contract, NP Aerospace and its partners will ensure that the British Army fleet of some 2,200 Protected Mobility Vehicles (PMV) are upgraded to the highest standards and ready for combat and ensures the vehicles are repaired, upgraded, and returned to the front line as soon as possible. The wheeled vehicles covered under this contract include the FOXHOUND, MASTIFF, WOLFHOUND, RIDGEBACK, BUFFALO, CHOKER, RODET, JACKAL, COYOTE, and HUSKY.

For PMET, NP Aerospace is the lead vehicle integration and engineering authority and will work closely with all of the vehicle OEM and three key partners. The latter are Atkins who are the systems safety partner, HORIBA MIA the vehicle engineering and test partner and Interactive Technical Solutions who are the integrated logistics support partner.

Under UOR funding, the UK also purchased from STK Land Systems 115 BRONCO all terrain tracked carriers (ATTC) which were delivered between 2009 and 2010. These were modified to meet UK requirements and called the WARTHOG. The UK procured four versions of the WARTHOG, ambulance, command vehicle, repair and recovery, and troop carrier. Modifications included mine protection, installation of bar armour, smoke grenade launchers, air conditioning system, cameras for situational awareness, and roof mounted PWS.

It was expected that these would be taken into the core British Army AFV programme, but a decision was subsequently taken that they would no longer be deployed. They are now up for sale by the Defence Equipment Sales Authority. ■

Spain to Invite New Bids for the 8x8 VCR DRAGÓN Programme

Esteban Villarejo

The Spanish MoD shocked the industry last Christmas by rejecting the offer of GDELS-SBS. A new public tender is to be announced in the course of this 2020.

Waiting and waiting could still be the headline of the story about the future 8x8 armoured fighting vehicle for the Spanish Army, the so-called DRAGÓN project.

The last, surprising news came unexpectedly on 23 December 2019, when the Spanish Ministry of Defence refused to accept the offer of General Dynamics European Land Systems-Santa Bárbara Sistemas (GDELS-SBS) to produce a first batch of 348 vehicles in the scope of a €2,083M contract, covering the 2019 to 2030 fiscal periods.

The MoD stated that "the offer does not prove the unconditional acceptance of the requirements of the technical specification". In addition, "the offer presented by GDELS-SBS does not include any economic item associated with risks so that the programme could require more budget".

It has been made public that the budget rise by another 25% if so required. But the Government invests efforts to avoid an increased budget requirement.

After this decision, the acting Minister of Defence, Margarita Robles, announced that the Government would make the contract subject to competition. "It will be an open public international tender", the minister said. Previously, the contract was awarded to Santa Bárbara under the terms of a procedure excluding other contenders, which is based on a legal exception for matters related to national security.

According to some industrial sources, "the decision to cancel the contract is interpreted as a step towards obtaining a new and better offer from GDELS-SBS or redefining the capabilities of the vehicle rather than the end of the project".

The BOXER - an Option?

Therefore, other companies like the French Nexter (VBCI vehicle), the Italian Iveco (FRECCIA) or the German-Dutch ARTEC consortium (BOXER) could become contenders for the new contract that the Spanish Government has announced, to send RfPs for this year.

Photos: Esteban Villarejo

The forward artillery observer version may be equipped with the GUARDIAN RCWS from Escribano, believed to be the favoured solution in this category. The PIRANHA V vehicle has been proposed by GDELS / SBS, but despite funding limitations it is unclear whether the vehicle and particularly the turrets and RCWS options shown, will in fact be the MOD´s final selection.

The ARTEC option could be interesting for Spain since it is an OCCAR programme. In December 2006, OCCAR awarded the contract for the series production of 272 vehicles for Germany and 200 vehicles for the Netherlands to ARTEC, a consortium of Krauss-Maffei Wegmann, Rheinmetall Landsysteme and Rheinmetall Nederland, the former Stork PWV. The BOXER for Germany currently comes in four different vehicle versions. The Netherlands have ordered five different versions. Lithuania joined the BOXER programme in August 2016 to procure 89 IFVs. On 4 November 2019, the OCCAR-EA Director and the ARTEC Chief Executive Officers signed a contract for the procurement of more than 500 BOXER vehicles on behalf of the United Kingdom of Great Britain and Northern Ireland (UK).

As was to be expected, GDELS-SBS has been justifying its bid by stating that "It responds both to the technical demands outlined in the specifications and to the economic requirements. We understand that the problem is insufficient budget to cover the scope and solutions defined in the specifications. Santa Bárbara Sistemas will continue to look for alternatives to obtain the 8x8 VCR contract and is prepared to guarantee the most competitive bid possible in any tender."

"The proposal is backed by the company's extensive experience in the design and manufacture of wheeled and tracked armoured vehicles, with more than 11,000 PIRANHAs in different variants contracted in many countries", the company said in an official statement.

The background to this project is very complicated. After some delays, the

Left: Section Command Post version shown with Oto Melara's HITFIST manned turret.
Right: Company command post variant showing Rafael's SAMSON unmanned turret

Spanish Government authorised the contract signature for the manufacture of the DRAGÓN with General Dynamics European Land Systems (GDELS) as the prime contractor and technical integration authority in July 2019.

The Spanish companies Indra (systems integration) and Sapa (transmission) were selected as main partners. However, there will be no contract signature in January 2020, as originally scheduled.

"This contract will include a schedule of vehicle deliveries that will meet the objectives set by the defence administration according to the deadlines planned so far, which means that the first pre-series DRAGÓNs are to be delivered towards the end of 2021".

13 Different Configurations

According to official documents, Spain plans to acquire a first batch of 348 DRAGÓN vehicles in 13 different configurations under the terms of a €2,083M contract, covering the 2019 to 2030 fiscal years. This includes the components of the mission system (armament, protection level, sensors, communication, and command and control systems) as well as the logistic support elements derived from logistic support analysis.

In the other acquisition phases, the total number of units for the Spanish Army may be around 1,000 within a total budget of €3,800M - €1,600M for the acquisition itself and €2,200M for the maintenance and modernisation services during the 30 year life of the project.

However, this was the theory. After the delays, the Spanish Army may reconsider the total number of vehicles given that the operational conditions for military deployments abroad might change.

Cockerill Integrates in the Spanish Market

In 2019, John Cockerill Defense successfully expanded into Spain; in January 2019 John Cockerill Defense España opened its offices in Madrid. On several occasions throughout the year, at the CESEDEN seminar, at FEINDEF, and at the Industry Forum of the Spanish Army, for example, John Cockerill Defense España presented its 3000 Series Cockerill modular turret system.

The company emphasises the considerable advantages that its commonalities can provide for the Spanish armed forces, more precisely for the current 8x8 VCR programme of the Army and the Marine Corps, as well as other forthcoming programmes that require maximum versatility and readiness of materiel for operations.

The turret system's inherent modularity provides two essential characteristics. First, a single turret can accommodate 30mm, 90mm or even 105mm guns. Second, it can accommodate a two-man crew or it can be used in the unmanned mode – all this with a conversion time of no more than 48 hours. The turret owes these advantages to the up to 75% commonality of its subsystems and spare parts. The benchmarks that can be set in this way extend to training, too: in a single system, both turret crew (commander/gunner) and maintenance technicians can be trained.

In 2019, Cockerill signed MoUs with several Spanish partners, including Abengoa Innovación, SDLE and Itainnova, with all of whom the company is already working on specific projects to optimise its defence systems. Cockerill has already identified the location where it will install its first Spanish production line, and recently organised visits and firepower demonstrations for representatives of the Spanish armed forces to its facilities in Belgium and France.

John Cockerill's recent expansion in Spain is a first step towards integrating the company as a fundamental part of the Spanish defence industrial base.

Photo: John Cockerill Defense

John Cockerill's 3000 Series, the modular turret in its different configurations, to answer the needs of the Spanish Armed Forces

Background: The Attack in Lebanon

After an attack in Lebanon - in which six soldiers died - the contract that is now authorised had its antecedent in a Council of Ministers decision (dated 2 November 2007), which approved the 'Plan for the Renewal of Armed Forces Materiel'. This agreement included the need to purchase an armoured vehicle on wheels, replacing the obsolete BMR 6x6 wheeled armoured personnel carrier. The programme was interrupted due to lack of funding for the crisis. "Its objective is to replace, in a progressive way, the historical BMR, TOA and VEC, and the vehicles used for the protection against mines and improvised explosive devices, such as the LINCE and the RG-31", an Army official explained.

What about the Demonstrators?

Another problem faced by the project is the fact that the Army was unable to provide the technical requirements for the five demonstrators - a demand of the Chief of the Army General Staff, General Francisco Javier Varela and a clear condition for the Spanish Army, that wanted to conclude the operational evaluation this year, which is now scheduled to begin on 2 July 2020 and will last for some five months. "This date could still undergo further modifications", official sources told ESD. The Legion, located in Almería (south-east Spain), is the military unit designated for the experimental tests.

For these demonstrators, an initial budget of €92M was allocated for GDELS, Indra and Sapa as a joint venture. That contract was awarded separately from the production order.

Capabilities to be provided by the five prototypes have been identified by the Spanish Army as follows:

- D1: Basic vehicle: remote control weapon station with a 30mm gun;
- D2: Section command post with manned turret with 30 mm gun;
- D3: Company command post as an armoured platform with remote-controlled turret integrating a 30mm gun;
- D4: Engineer vehicle with a remote-controlled weapon station with a 12.7 mm machine gun;
- D5: Forward artillery observer with a remote-controlled weapon station with a 12.7 mm machine gun.
- From a technology point of view, the demonstrators should also consider:
- An increase in safety: a laser lighting alert system, acoustic fire detection, a protection kit against RPG, add-on armour for ballistic protection against mines and IEDs; bulldozer IED clearing device.
- 360° situational awareness using panoramic cameras, driving support with two infrared cameras (at the front and at the back).
- Integrated communication and information services (CIS) with systems at squad/section/company level, vehicle electronics;
- Propulsion system: DC13 engine from Scania; SAPA SW624 transmission;
- Forward observer: stabilised sensor platform on a flying mast; portable sensor system.

Made in Spain

For the Spanish MoD, it is essential that the DRAGÓN is a "made in Spain" vehicle with future export potential. "It will have an impact on the Spanish industrial base obtaining a national product, integrated in, and with the design authority in Spain", an official MoD source told ESD. This is a lesson learnt

Engineer vehicle configuration shown here with Rafael's MINI SAMSON RCWS and a 12.7mm machine gun

Foto: John Cockerill Defense

The Cockerill 3030 variant of the 3000 Series turret. This series offers virtual immersive cockpits and embedded simulation systems for training: for operational purposes turrets can be equipped with 25-105mm calibre main armament, smoke grenade launchers, Defensive Aid Suites, sniper detection systems, anti-tank weapons and more.

from the LEOPARD 2 main battle tank programme, which could not be sold to Saudi Arabia due to the German Government's export restrictions.

In total, it is estimated that the production of the new armoured vehicle will generate some 650 jobs, and a further 1,000 indirect jobs should GDELS-SBS be chosen as the prime contractor in response to the new RfP. The name DRAGÓN evokes the military virtues of the former Dragoon units, a mixture of Infantry and Cavalry, predecessors of the current units.

The Battle for the Turrets

As the kind of armament the vehicles will be equipped with which is yet to be decided, a battle is going on between the bidders of the turret systems for the ATK MK44-ABM BUSHMASTER II chain gun. The two main Israeli land defence companies, Elbit Systems and Rafael, displayed their turrets during the first edition of the Spanish International Defence and Security Fair (FEINDEF) held in May 2019 in Madrid.

The reasonis the lucrative contract to arm the DRAGÓN, whose programme includes an initial phase of 348 vehicles: 190 units will be armed with an unmanned turret of 30 mm. This second-level contract is valued at €350M. This competition between the two Israeli companies has generated a number of synergies and alliances with Spanish companies. "There is an unwritten rule there must be a technological and employment return in the country that is bidding the contract.", retired Brigadier General and Vice President of Rafael, Michael Lurie, told ESD. For this 'Spanishisation', Rafael is presenting its turret through its subsidiary company in Madrid, Pap Tecnos, which has no production factory in Spain. However, Rafael has also established communications with another Spanish company, Tecnobit, that could be added to the business as it does have a production plant.

The SAMSON MK-II unmanned turret is the Rafael option for the DRAGÓN: "It is lighter than manned turrets and does not require penetration into the vehicle hull, saving significant interior space. The in-hull reloading system boosts crew survivability, and the low silhouette enables the platform's surfaces to easily accommodate protective armour. An anti-tank guided missile launcher and smoke grenade launcher are also optional".

Rafael is a state-owned company from Israel that was established as a military technology "laboratory". "If we win the contract, Tecnobit will also be a production partner for future exports," Lurie said.

On the other hand, Elbit Systems has entered into an alliance with Navantia (100% Spanish state-owned company). Both companies presented the TIZONA unmanned 30 mm turret at FEINDEF (TIZONA is the name of a sword of "El Cid", the Spanish medieval national hero). The Spanish company Expal is also part of the team. The objective of Navantia is to "diversify" its business, beyond shipbuilding, and enter the subsector of systems integration of land platforms.

The Italian company Leonardo has been the third foreign contender, bidding in a partnership with the Spanish Escribano and Indra. Another contender is the Belgian company John Cockerill Defense, recently re-branded from CMI Defense. The company has an established footprint in Madrid and is already delivering projects with Spanish partners, including Albengoa Inovació, SDLE and Itainnova. The company offers its 3000 Series modular turret system, and is in the process of establishing a production facility in southern Spain with another major Spanish defence company. In addition to both manned and unmanned alternatives, through careful design the 3000 series offers significant cost benefits in terms of price, production, training and maintenance. (See box-out, page 68.)

In addition, the technology demonstrator used to study systems integration considers three weapon stations: the 12.7 mm GUARDIAN remote-controlled weapon station (RCWS) from Escribano and Rafael's 12.7 mm MINI SAMSON RCWS (believed to be the favoured solution in this category). Last but not least, the 30 mm HITFIST manned turret from Oto Melara may have already been chosen. ■

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Australia's Armour Renaissance

The Land 400 Programme

David Saw

The Australian Army found itself in a situation where it was necessary to replace two major elements of its existing armoured vehicle fleet and this led to the development of Project LAND 400. The objective of LAND 400 is to acquire a Combat Reconnaissance Vehicle (CRV), an Infantry Fighting Vehicle (IFV), a Manoeuvre Support Vehicle (MSV) and an Integrated Training System (ITS).

Thus far, progress on meeting these requirements for new armoured vehicles has been more than satisfactory. The first CRV acquired under LAND 400 Phase 2 was handed over to the Australian Army in September 2019, while the IFV requirement of LAND 400 Phase 3 has seen the selection of two competitors on the road to a final acquisition decision.

According to the Australian Army, "LAND 400 aims to enhance the mounted close combat capability of the Land Force by providing armoured fighting vehicles with improved firepower, protection, mobility and communication characteristics to enable tactical success in the contemporary and future operational environment." In detail, this will require the "staged retirement of the in-service Australian Light Armoured Vehicle (ASLAV) and the M113AS4 Armoured Personnel Carrier (APC) fleets in line with their technical Life of Type and reducing tactical utility in the contemporary operational environment that involves increasing levels of lethality and complexity." To provide context, LAND 400 Phase 2 covers the ASLAV replacement, while Phase 3 will see the replacement of the M113AS4.

Photo: Commonwealth of Australia

A Rheinmetall BOXER Combat Reconnaissance Vehicle (CRV) taking part in a live fire training exercise at the Puckapunyal training area in northern Victoria, Australia, in 2018. Under Project LAND 400 Phase 2 Australia will acquire 211 BOXER vehicles to replace the existing ASLAV fleet.

Armour Overture

In the early 1960s, the Australian Army looked to acquire an effective mounted close combat capability. This saw the acquisition of a small number of wheeled armoured vehicles from Britain and, subsequently, a major tracked APC purchase from the US. From Britain they acquired 18 FV601 SALADIN armoured cars, equipped with a 76mm L5A1 gun and a 7.62mm coax (delivered in 1960) and more than 20 FV603 SARACEN (delivered in 1959/1960). Neither the SALADIN or the SARACEN made much of an impression with the Australian Army and both vehicles were taken out service somewhat rapidly. However, the turrets and 76mm guns of the SALADIN would go on to find a new home on a different Australian vehicle.

Unlike their wheeled vehicle selection, their tracked vehicle programme can certainly be considered as a success. They identified the British FV432 and the US M113A1 as potential candidates for their requirement and trialled both vehicles in Australia between November 1962 and April 1963. The M113A1 proved superior to the FV432, with orders for the M113A1 being placed in 1963, deliveries commencing in 1964, with the vehicle entering service in March 1965 and replacing the SARACEN.

In total, the Australian Army would acquire some 800 M113A1 vehicles in numerous variants with deliveries continuing through to the late 1970s. These included the standard M113A1, M125A1 81mm mortar carrier, M577A1 command vehicle, M113A1 Fire Support Vehicle (FSV) mounting the SALADIN turret (15 converted), M806A1 ARV, M113A1 fitters' vehicle, M548 logistic load carrier and the FSV replacement in the form of the M113A1 fitted with the turret

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of the British SCORPION light tank mounting a 76mm L23A1 gun. Later known as the Medium Reconnaissance Vehicle (MRV), some 48 M113A1s were converted to this configuration.

By the 1980s, Australia was looking to acquire a successor system to the M113A1, believing that the M113 would reach the end of its service life by 1995. The replacement programme was known as Project Waler and both wheeled and tracked options were to be considered, with between 800 and 1,000 vehicles to be acquired. The winning Project Waler vehicle was to be produced in Australia and vehicle submissions had been received from FMC (now BAE Systems), Krauss-Maffei (now KMW) and Vickers (now BAE Systems) amongst others. The scope and therefore the cost of Project Waler was such that the Australian government decided to postpone the programme, instead opting to look into a life extension and upgrade programme for the M113 fleet.

This resulted in Project LAND 106, the ultimate objective of which was to extend the service life of the M113 out to 2010 and enhance the operational capabilities of the vehicle. Initially, there was a demonstration phase and this was to be followed by the actual upgrade programme for a total of 537 vehicles to be conducted in two phases. Then the programme, as originally envisaged was halted, discussions on M113 upgrades continued through the 1990s and finally in 2002 a contract was signed with the local company Tenix to upgrade 350 M113s and extend their service life to beyond 2020.

Eventually 431 M113A1s were included in the upgrade programme and seven different variants were produced. The rest of the M113 fleet was either sent for scrap, with some 30 vehicles being preserved for display purposes. Delivery of the first 16 upgraded M113AS4 was in November 2007 and final deliveries were made in late 2012. The upgrade was more complicated and costly than expected, originally it was due to be complete December 2010. On the other hand, the Australian Army did eventually end up with a vehicle that could be viable out to 2030.

While it was investigating its options as regards tracked armour in the 1980s, the Australian Army also looked into acquiring a new wheeled armoured system. This led it to acquire 15 General Dynamics Land Systems (GDLS) LAV-25 vehicles for evaluation and trials in Australia under what would become Project LAND 112. This initial buy proved the concept of wheeled armour and it was decided to proceed with the acquisition of a modified LAV-25 vehicle known as the ASLAV. In total Australia would acquire 257 ASLAV vehicles in seven different variants, with first orders placed in 1992. According to the Australian Army they needed to replace the ASLAV "due to obsolescence factors that constrain tactical employment and increase the cost of ownership. These obsolescence factors cannot be mitigated through upgrade and without replacement starting in 2020, a capability gap will result."

Armour Renaissance

Clearly the need to replace the Australian Army ASLAV and M113AS4 fleets would be an extremely ambitious and inevitably expensive undertaking. The resulting Project LAND 400 was officially described as the largest and most expensive procurement programme in the history of the Australian Army. According to the Australian government, total programme value is between AU$14Bn (€8.64Bn) and AU$20Bn (€12.345Bn), covering the acquisition of 611 armoured vehicles over 15 years. Additionally, maintenance and support contracts will cover the sustainment of these vehicles over 30 years.

Project LAND 400 was divided into four distinct phases. LAND 400 Phase 1 was the

Land 400 Phase 2 Weapon Station Contract Signed

The Defence Systems activity of Australian company Electro Optic Systems (EOS) has been awarded a AU$45M (€28M) contract to supply Remote Weapon Systems (RWS) for Project LAND 400 Phase 2. While EOS had been notified that they had been selected for the award in August 2019, the contract signature on 16 December 2019 means that work on the programme can now officially get underway.

The contract covers the development, integration and test of an RWS solution for the Rheinmetall BOXER Combat Reconnaissance Vehicle (CRV) that was selected as the winner of Project LAND 400 Phase 2. Once the development, integration and test phase is complete, EOS will supply 82 R400S-MK2-D-HD RWS starting in 2022. EOS note that their RWS systems can support a variety of weapon payloads from light machine guns up to cannon and missiles. Bearing in mind the importance of local industrial involvement in defence contracts to the Australian government, EOS states that 88% of their supply chain is sourced locally, consisting of 70 Australian companies. This is the latest order to be received by EOS from the Australian military, the Australian Army has over 230 EOS RWS systems in service at the present time. Beyond their involvement in LAND 400 Phase 2, EOS are looking to have a far more significant role in LAND 400 Phase 3. EOS is a primary subcontractor in the Hanwha Defence Australia bid for LAND 400 PHASE 3 with the AS21 REDBACK vehicle. The REDBACK will mount the EOS T2000 turret and if successfully this will be a major boost to the fortunes of the Australian company.

Photo: EOS

The Defence Systems subsidiary of Australian company Electro Optic Systems (EOS) will be supplying their T2000 turret system for the AS21 REDBACK vehicle being offered for LAND 400 Phase 3 by Hanwha Defense Australia. According to EOS, victory in LAND 400 Phase 3 would be worth more than AU$1Bnn.

project definition study defining the scope of the requirements and the roles and missions that would need to be fulfilled. As previously noted, Phase 2 covers the acquisition of a Combat Reconnaissance Vehicle (CRV) to replace the ASLAV, Phase 3 covers the acquisition of an Infantry Fighting Vehicle (IFV) and a Manoeuvre Support Vehicle (MSV) replacing the M113AS4, while Phase 4 covers the acquisition of an Integrated Training System.

The first element of LAND 400 to be awarded was Phase 2 covering the acquisition of a wheeled CRV. Candidates for the programme had included: BAE Systems with the AMV 35, a variant of the Patria AMV with the E35 turret of the CV9035 IFV. Elbit offered the SENTINEL 2, the Singapore Technologies Kinetics TERREX 3 vehicle fitted with the Elbit MT30 turret. Rheinmetall offered the BOXER vehicle, while Thales and the Australian subsidiary of General Dynamics Land Systems (GDLS-A) offered the LAV 6.0 vehicle. Others companies had looked into the programme but decided not to participate.

In July 2016, Australia identified the BAE Systems and Rheinmetall proposals as offering the best basis for selecting a Phase 2 solution and started a further evaluation effort. Then on 14 March 2018, the Australian Department of Defence announced that it had selected Rheinmetall and the BOXER vehicles as the winner of LAND 400 Phase 2. It noted that, "The decision to select Rheinmetall is the result of a comprehensive three-year tender and rigorous testing process, which assessed its BOXER CRV as the most capable vehicle for the Australian Defence Force." It was also stated that, "The Government will spend AU$5.2Bn (current value €3.226Bn) to acquire the 211 vehicles, which will replace the Army's current ageing Australian Light Armoured Vehicle (ASLAV) fleet."

An important aspect of these LAND 400 acquisitions is that the Australian government intends that they support both the enhancement and sustainment of the Australian defence industrial capability. The Australian government stated that, "Over the 30-year life of the vehicles, Australian industry will secure AU$10.2Bn (current value €6.328Bn) of the total investment in acquiring and maintaining the fleet."

Fleet sustainment is only part of the LAND 400 Phase 2 industrial story. The first 25 BOXER vehicles will come from Germany; the rest will be sourced from the Military Vehicle Centre of Excellence (MILVEHCOE) established by Rheinmetall near Brisbane in partnership with the Queensland State Government. According to Rheinmetall, "The MILVEHCOE will serve as the focal point for the execution of the programme and a base for the establishment of an export orientated military vehicle industrial complex in Australia." This new industrial facility is described as "state-of-the-art" by Rheinmetall, and Rheinmetall will be transferring technologies in such areas as "military vehicle design, production, turret systems, sensors, survivability" to MILVEHCOE.

On 24 September 2019, Rheinmetall handed over the first BOXER CRV to the Australian Army at Enoggera Barracks in Brisbane, Queensland. September 2019 also saw substantial progress as regards LAND 400 Phase 3, in that it was announced that Rheinmetall and Hanwha Defence had been shortlisted for further evaluation. This will see the two candidates subject to rigorous testing and evaluation, as well as working with Australian industry to maximise the local content in their proposals. This process will commence in the third quarter of 2020 and be completed in the third quarter of 2021, with a decision on the winning candidate due in 2022.

Photo: Commonwealth of Australia

An M113AS4 on exercise in July 2014 at Shoalwater Bay Training Area. The M113 entered Australian service in the early 1960s. It is due to be replaced from 2025 onwards by a new Infantry Fighting Vehicle (IFV) to be acquired under Project LAND 400 Phase 3.

Tracked Investment

Originally, four contenders had responded to the Request for Tenders (RfT) for LAND 400 Phase 3. These were BAE Systems with the CV90 Mk 4, GDLS with the AJAX, Hanwha Defence Australia with the AS21 REDBACK and Rheinmetall with the KF41 LYNX. The original requirement was framed around the acquisition of 383 IFVs and 17 Manoeuvre Support Vehicles (MSV). The IFV element would consist of eight separate variants, of which 232 would feature a manned turret. As regards the MSV this was originally envisaged as a dedicated combat engineer platform whose role would be to "overcome enemy constructed obstacles and to aid the construction of defensive fortifications." The MSV will now be more closely related to the standard IFV, most likely a developed and more capable version of the combat engineer variant of the IFV.

Added to the numbers of IFVs and MSVs, there was a Request for Information (RFI) on the supply of 27 IFV logistics vehicles, 15 mortar carriers with 120mm calibre mortar, and 25 mortar ammunition carriers. An additional RFI covers the provision of 50 vehicles for amphibious operations, though these do not have to be a variant of the IFV. Without doubt the number of vehicles to be acquired under the umbrella of LAND 400 Phase 3 make this a highly desirable programme by any international standard.

As with the Phase 2 programme indigenous industrial involvement and capability development will be critical issues in selecting the vehicle to meet the Phase 3 requirement. With Rheinmetall already having an armoured vehicle manufacturing infrastructure in Australia, the MILVEHCOE in Queensland, thanks to their victory in the Phase 2 programme, this would appear to strengthen their KF41 LYNX offer for Phase 3. However, the Hanwha proposal should not be underestimated; their REDBACK vehicle is based on the K21 IFV that is already in service in large numbers with the Republic of Korea Army (ROKA) and this Korean company has a strong defence pedigree.

In the context of their offer for the Phase 3 programme Hanwha has established Hanwha Defence Australia to prime their efforts, with team members Electro Optic Systems (EOS), an Australian company

whose T2000 turret will be used on the REDBACK vehicle, as a primary subcontractor, and Elbit. Hanwha is also working with the government of the Australian state of Victoria and intend to establish a manufacturing facility at Geelong near Melbourne.
Another possibility has emerged that could allow Hanwha to further sweeten its offer to Australia. A new requirement has emerged in the form of Project LAND 8116 Protected Mobile Fires. In essence, this is a self-propelled artillery requirement covering much of the same ground as the LAND 17 Artillery Replacement Programme that was cancelled in 2012. The Hanwha K9 155/52mm self-propelled gun system had been offered for LAND 17 and was apparently highly thought of.
Now it appears that a new variant K9 optimised for LAND 8116, along with the K10 Ammunition Resupply Vehicle (ARSV), based on the same chassis, are being offered for the new artillery requirement. The Hanwha proposal is said to cover over 30 K9 guns and more than 10 K10 ARSV. As the K9 and K10 share the same automotive elements as the K21/AS21 there are commonality advantages between the vehicles, and Hanwha would look to manufacture the K9 and K10 at their Geelong facility.

Photo: Commonwealth of Australia

An Australian Light Armoured Vehicle (ASLAV). Australia acquired some 257 ASLAV vehicles under Project LAND 112. The ASLAV fleet will need to be replaced from 2020 onwards, hence Project LAND 400 Phase 2 for which the BOXER vehicle was selected.

There is still a long way to go before the fate of LAND 400 Phase 3 is settled, thus far though the LAND 400 programme appears to be progressing extremely well. With BOXER being selected for the Phase 2 programme and an industrial infrastructure to build the vehicle being established in Australia, that is a win for the Australian military and for the Australian defence industry. With Phase 3 being a much bigger programme in terms of cost and number of vehicles, the impact of this programme in Australia will be much greater. Also of interest will be the evolution of a competition between European and Korean defence companies for a major international programme which will be worthy of much analysis. ■

Striking Power for STRYKERs

The US Army Up-Guns its Mobile Striking Power in Europe

John Antal

To cope with the numerous new weapon systems that the Russian Army has fielded in recent years, the US Army has modernised its STRYKER vehicles.

On 9 May 2019, over 130 weapon systems rolled through Red Square in Moscow. NATO nations were warily watching as Russia showed off its latest military hardware. As T-14 ARMATA Tanks, BMPT-72 TERMINATOR Multipurpose tank support combat vehicles, T-15 Heavy Infantry Fighting Vehicles, and BTR-82A armoured personnel carriers drove by the reviewing stand they proved that Russia has been hard at work upgrading its mobile striking power. In a few short years, the Russians have developed and deployed a new generation of ground combat vehicles. Since the Russian annexation of Crimea in 2014, the threat of conflict in Eastern Europe has spurred NATO to upgrade and up-gun its own armoured forces. For the US Army, this means the fielding of the M1A2 SEPv3 main battle tank, the development of a new infantry fighting vehicle, and major improvements and new variants of the M1126 STRYKER.

The US Army's M1126 STRYKER is produced by General Dynamics and provides the US Army with a number of rapidly deployed fire-brigades that can move by air or sea to deter opponents in Eastern Europe. The STRYKER is a versatile eight-wheeled, light-armoured infantry carrier that was first fielded in 2002. It is air transportable by C-130, C-117, and C5A aircraft. The C-5 can carry seven STRYKERs and the C-17 aircraft can carry four. A single US Navy SPEARHEAD class expeditionary fast transport (EPF) can carry a company of STRYKERs at 43 knots across moderate seas. The STRYKER cannot swim or ford rivers without expensive preparation. Depending on the configuration, the average cost of a new Stryker is about US$5M.

Photo: US Army

US soldiers firing a 30mm cannon on a STRYKER Infantry Carrier Vehicle – DRAGOON (ICVD). The ICVD features a remote weapon station (RWS) mounting a linkless, 30mm chaingun. The upgraded armament offers more firepower with the same capacity to carry cavalry and infantry personnel.

The STRYKER was highly successful in past combat operations in the urban centres of Iraq. In the less-urbanised terrain of Afghanistan, the STRYKER encountered more difficulties, but eventually proved itself again. The first STRYKER Brigade Combat Team (SBCT) sent to Afghanistan during the 2009 surge was the US Army's 5th SBCT from Fort Lewis, Washington. The 5th SBCT deployed 350 STRYKERs and approximately 4,000 troops into combat in the densely vegetated valley of the Arghandab River northwest of the strategic Afghan city of Kandahar. This terrain was not ideal for STRYKERs and consisted of narrow trails, stone walls, and a patchwork of densely-planted orchards that made close-in ambushes the favourite tactic of the enemy. The Afghan insurgents successfully employed IEDs in this restricted terrain and in the first few months of combat operations, the 5th SBCT lost 21 STRYKERs to Improvised Explosive Devices (IEDS) with 21 Soldiers killed and as many wounded. According to the official US Army report on the fighting, "The worst incident occurred in October 2009 near the town of Jeleran where a massive 18,000-pound IED detonated under a STRYKER from Charlie Company killing 7 Soldiers." These losses caused the Army to reassess the "V" shaped hull of the STRYKER and led to the development of an improved double-v hull (DVH) design to channel the blast force away from the vehicle and its occupants. In spite of the difficult opposition in the Arghandab fighting, the STRYKER proved an excellent combat vehicle in direct fire fights and the Remote Weapons Systems (RWS) was praised by the soldiers of the 5th SBCT. First Lieutenant Daniel Boirum, who fought in the Arghandab, noted: "The amount of firepower and infantry that [the carriers] can put on the table and the air-

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guard hatches and RWS make the STRYKER an unstoppable vehicle in a shootout."

The STRYKER Family

The STRYKER currently has twelve configurations, with more variants soon to be added:

- **M1126 Infantry Carrier Vehicle (ICV)** acts as an infantry squad carrier, equipped with a PROTECTOR M151 RWS with .50-cal M2 machine gun, 7.62mm M240 machine gun, or Mk-19 automatic grenade launcher.
- **M1127 Reconnaissance Vehicle (RV)** is armed with the same PROTECTOR RWS and weapons options as the ICV.
- **M1128 Mobile Gun System (MGS)** is configured with a 105mm M68A2 rifled cannon. The MGS variant uses an automatic loader, can store eight rounds in the autoloader carousel, and can carry an additional 10 in a replenisher located at the rear of the vehicle. The gun has a firing rate of six rounds per minute and fires four different types of ammunition: the M900 kinetic energy penetrator to destroy armoured vehicles; the M456A2 high explosive anti-tank round to destroy thin-skinned vehicles and provide anti-personnel fragmentation; the M393A3 high explosive plastic round to destroy bunkers and emplacements; and M1040 canister shot for use against dismounted infantry.
- **M1129 Mortar Carrier (MC-B)** carries the Soltam Cardom RMS6L 120mm mortar which has a maximum effective range of 6.8 km. In addition, depending on the echelon (battalion or company mortars) the M1129 carries either an 81mm M252 mortar, or a 60mm M224 mortar, that must be displaced from the vehicle and used dismounted. The M1129 lacks the RWS and the commander's station is instead ringed by a skate mount for an M240B machine gun.
- **M1130 Command Vehicle (CV)** integrates the C4ISR equipment required for unit commanders and is armed like the ICV.
- **M1131 Fire Support Vehicle (FSV)** provides artillery Fire Support Teams (FIST) with the systems that enhance surveillance, target acquisition, target identification, target designation, target tracking, and communications to deliver a "first round" fire-for-effect capability. The FSV is armed with the same RWS as the ICV.
- **M1132 Engineering Squad Vehicle (ESV)** has a mine-clearance blade, carries an engineer squad, and has the same RWS as the ICV.
- **M1133 Medical Evacuation Vehicle (EV)** does not have an RWS or mount weapons. The M1113 carries a medical aid team and can transport four litter patients or six ambulatory patients.
- **M1134 Anti-Tank Guided Missile Carrier (ATGM)** armed with two tube launchers for Tube-Launched, Optically Guided, Wire Controlled (TOW 2) anti-tank missiles.
- **M1135 Nuclear Biological Chemical Reconnaissance Vehicle (NBCRV)** has a chemical, biological, radiological and nuclear defence (CBRN) sensor suite that provides NBC situation awareness to STRYKER units and is armed with the same RWS as the ICV.
- **M1296 Infantry Carrier Vehicle DRAGOON (ICVD)** is fitted with the Kongsberg designed unmanned 30mm cannon turret. The Dragoon is operated by two crewmen, a commander and driver, and carries a squad of 9 infantrymen.
- **STRYKER A1 Interim Manoeuvre Short-Range Air Defence (IM-SHORAD)** is a prototype STRYKER anti-aircraft variant, armed with 4 STINGER missiles on one side of the RWS, two HELLFIRE Missiles on the other, and a 30mm auto-cannon, coupled with a .50 calibre machine gun, in the middle. The first prototypes will be delivered in 2020, with up to 144, deployed in four battalions, by 2022.

Photo: US Army

The Common Remotely Operated Weapon Station (CROWS) is for the M240 machine gun. Other CROWS weapons include .50 calibre machine guns, grenade launchers, and JAVELIN anti-tank missiles.

Photo: US Army

A M1296 STRYKER ICVD at Grafenwoehr Training Area, Germany, 2018. This STRYKER variant increases the lethality of the 2CR.

The RWS platform used for STRYKER vehicles is the PROTECTOR RWS manufactured by Kongsberg of Norway. According to Kongsberg, the PROTECTOR is the most fielded RWS in the world with more than 20,000 units delivered and in use by militaries around the globe. The US Army's version of the PROTECTOR is termed the Common Remotely Operated Weapon Station (CROWS). In an open competition, Kongsberg was awarded five-year contracts for the delivery of the PROTECTOR RWS CROWS II program in 2007 and again in 2012. CROWS II is a joint acquisition programme for weapon stations for all US Army vehicle programmes. A third five-year contract, signed in September 2018, will enable Kongsberg to continue providing CROWS to the US Army. CROWS have been placed on over 8,000 US Army vehicles and including the HMMWV, STRYKERs, and the M1A2 ABRAMS.

The CROWS provides for greater protection and increased weapon's accuracy. It allows soldiers to operate from inside the protection of the vehicle without exposing the gunner to enemy fire. The gunner observes the target through a display screen that provides daylight and thermal options and controls the weapons by means of switches and a joystick. The sensors include stabilized precision options with a daylight video camera, thermal imager, and an eye-safe laser rangefinder. The key capability of the CROWS` aim and fire function, the Detached Line of Sight (DLOS) system, enables the gunner to keep his sights on a target, independent of the ballistic solution for the weapon and ammunition in use. The system's camera can identify targets nearly 1.6 km away, track targets moving as fast as 56 kph, and has a 95% accuracy rate. The CROWS on STRYKER vehicles also include integrated smoke grenade launchers that can provide obscuration in directions independent of the vehicle's orientation.

Photo: US Army Photo

An M1296 STRYKER ICVD mounting a JAVELIN missile launcher (CROWS-J)

The Unmanned MCT-30 Turret

The US Army has worked with Kongsberg and other defence companies for the past several years to rapidly field a new 30mm cannon and unmanned turret to the 2nd Cavalry Regiment (2CR) stationed in Vilseck, Germany. The 2CR, also known as the 2nd Dragoons, is an active STRYKER equipped cavalry regiment of the US Army. The new STRYKER configuration fielded to the 2CR is designated as the M1296 STRYKER ICV DRAGOON. The DRAGOON has an unmanned MCT-30 turret that is produced by Kongsberg and an MK44 Bushmaster II 30mm autocannon designed by Alliant Techsystems of Northrop Grumman. The 30mm chain gun auto-cannon, can range out to 3,000 metres, holds 156 ready rounds in the turret (78/side) and has the capability to fire single shot or burst fire up to 200 rounds per minute. The 30mm cannon can fire either direct fire high-explosive, or airburst rounds. The MK310 Programmable Air Burst Munition rounds are programmed to detonate above the targets to defeat troops in trenches or in defilade, and can destroy trucks, drones and helicopters. The turret has a coaxially mounted M240 machine gun with 400 ready rounds of 7.62mm. While the addition of the turret added two tonnes to the vehicle's weight, there has been no significant loss of performance.

There is little doubt that adapting the MCT-30 unmanned turret to the STRYKER has improved its lethality and effectiveness. "With this (referring to the 30mm auto-cannon), we're seeing a shot group about the size of a basketball," the senior NCO of the Army's STRYKER programme, Sergeant First Class Nicholas Young, reported in a 2017 Army Public Affairs article. He praised the remotely operated cannon as it hit a target 1,800 metres away. "If I aim at something, I know I'm going to hit it and I'm going to do damage to it." Soldiers of the 2CR noted that the only significant drawback of the new turret is the lack of a top hatch which prevents the crew from seeing outside. As more RWS are fielded to armoured vehicles, the need to mitigate this visibility issue may be solved with "transparent armour" technologies that add external cameras to the sides of the STRYKER coupled with an Augmented Reality (AR) capability for the crew to "see through" the armour and view outside the vehicle without opening a hatch. Another issue is finding an active protection system that will work for the STRYKER. Two systems were tested, IRON CURTAIN and TROPHY VPS (Vehicle Protection System), but both failed to work for the STRYKER.

The DRAGOON programme was rapidly executed to produce 81 vehicles for the 2nd CR in Europe due to an Urgent Operational Needs Statement issued in 2015. The DRAGOON is a flat-bottomed STRYKER and will not be fielded to the other SBCTs. In May 2019, the US Army picked five companies to compete to provide upgraded STRYKERs with improved lethality for the US Army's STRYKER fleet. These five companies are Fabrication Inc., General Dynamics Land Systems, Kollsman Inc., Leonardo DRS, and Raytheon and Pratt & Miller Engineering. This upgraded STRYKER system will incorporate the improved STRYKER A1 DVH hull, im-

proved RWS, and better situation awareness for the crew. The plan is to field a full SBCT improved STRYKERs by 2022.
Another CROWS addition to the STRYKER that is part of the rapid fielding process to the 2CR in Europe is the CROWS-J configuration. This RWS is an M153 CROWS II, manufactured by Kongsberg, which has been modified to launch fire-and-forget, infra-red homing, top-attack, FGM-148 JAVELIN ATGMs. The STRYKER crew can engage targets with the JAVELIN missile while under armour. The US Army has deployed 81 STRYKER CROWS-J to the 2CR thus equipping 50% of the vehicles in the rifle and scout platoons with an ATGM capability. Combined with the fielding of the 30mm cannon, the additional upgrades to the STRYKERs of the 2CR provide NATO with an enhanced force for reconnaissance and defensive operations. The US Army plans to equip three more STRYKER Brigade Combat Teams (SBCT) with both MCT-30 turret and CROWS-J capabilities in 2022.

Meeting NATO Obligations

NATO is facing a significant military threat that requires all NATO nations meet their treaty obligations. Some members, however, are years behind their pledge to fund, upgrade, and field adequate forces as part of the Alliance. With a few exceptions, NATO nations have not developed and deployed new tanks, infantry fighting vehicles, or light armoured vehicles, since the 1980s. The US has responded to the threat and is enhancing NATO's ability to respond by up-gunning the STRYKERs of the 2d Dragoons with 30mm cannons and JAVELIN CROWS and plans to upgrade more SBCTs in the next two years. Eventually, all nine US Army SBCTs (seven Regular Army/two Army National Guard) will be upgraded. The US Army even plans to mount 50 kW-class Multi-Mission High Energy Laser (MMHEL) in the next four years to protect against unmanned aerial systems (UAS), helicopters, and incoming rocket, artillery, and mortar rounds. In addition, the US Army has recently added a company equipped with the Light Armoured Vehicle (LAV) 25A2s, armed with a 25mm cannon in a manned turret and borrowed from the US Marine Corps, to the 82d Airborne Division based at Fort Bragg, North Carolina. The LAV is lighter and smaller than the STRYKER but it is of the same general design and has a commonality of parts. While these lightly armoured LAVs are the 82d Airborne's only organic armoured vehicles, they are better than no armoured vehicles at all.
Upgrading existing equipment and adding a dozen LAVs to the 82d Airborne Division, however, is merely a stopgap measure. STRYKERs and LAVs are no match for tanks and the combined arms threat posed by Russian forces in Eastern Europe. In a stab and grab operation by Russia into any of the Baltic nations that NATO has pledged to protect, how would NATO forces respond in time? As of December 2019, only nine of the 28 NATO countries spend at least 2% of their GDP on defence (US 3.42%, Bulgaria 3.25%, Greece 2.28%, the United Kingdom 2.14%, Estonia 2.14%, Romania 2.04%, Lithuania 2.03%, Latvia 2.01%, and Poland 2%). All agreed to spend at least 2%. To provide a convincing deterrent force that will prevent war, every NATO partner must not only meet its financial commitments but should also step up the effort to provide a rapid, heavily armoured, combined arms response to the Russian challenge. The US efforts to upgrade the STRYKER are an example to follow. Unless the threat is taken seriously, and all NATO nations act accordingly, the addition of the 30mm cannon and JAVELIN ATGM RWS to American STRYKER units may only be a forlorn hope.

Poland's Indefinite Procurement of New Multirole Vehicles

Michał Jarocki

The Polish Army and other branches of the country's armed forces have an urgent requirement to modernise the fleet of multirole, high mobility, all-terrain vehicles.

Due to their obsolescence, most platforms of the Polish Army, such as HONKER, UAZ469 and some Mercedes-Benz vehicles, no longer meet the requirements of the modern battlefield and no longer guarantee the safety of crews. Despite several attempts over the last 5 years to procure new multi-purpose vehicles with high mobility, Poland has so far failed to complete the long-awaited acquisition necessary for the country's armed forces to improve their core capabilities, such as mobility, troop protection and manoeuvrability.

Picture: Polish MoD

The Polish Army operates approximately 2,500 HONKER vehicles in several configurations, including the TARPAN HONKER, HONKER 2324, HONKER 2000 and HONKER 2000 2N, as well as special purpose variants, such as HONKER SKORPION-3, ZWD-3, WD-2001 or ZWD-99bat.

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Michał Jarocki is is an independent, Warsaw-based defence expert who has reported on security issues and developments from a qualified "insider" position for many years.

The first steps towards the modernisation of the Polish fleet of high mobility multipurpose vehicles were taken in June 2013, when the Armaments Inspectorate, on behalf of the Ministry of Defence (MoD), invited a number of Polish and European manufacturers to participate in a technical dialogue. Twenty companies decided to participate in the project and presented a wide range of multipurpose wheeled vehicles, ranging from light off-road vehicles to armoured MRAPs (Mine-Resistant Ambush Protected).

The technical dialogue enabled the Armaments Inspectorate to identify the desired quantity of new multipurpose vehicles to be procured and the number of variants in which they will be procured and put into service. In addition, the dialogue helped the Inspectorate to complete the list of technical specifications that were included in subsequent procurement procedures and presented to future bidders.

Procuring New Multirole Vehicles

A first attempt to modernise the fleet of multiple, highly mobile vehicles of the Polish Armed Forces was made in July 2015, when the Armaments Inspectorate published the first open tender under the "Mustang" programme. It called for the procurement of 882 vehicles, including 841 in the soft skin variant and 41 armoured vehicles. Deliveries were to begin in 2016 and run until 2022.

The long list of technical requirements associated with the first MUSTANG Programme included such features as a 4x4 drivetrain, up to 3,5 t gross vehicle weight (GVW) in the soft-skin variant, loading capacity of no less than 1 t (soft-skin) or 600 kg (armoured variant) and accommodation for 9 people (soft-skin) or 5 people (armoured variant), including a driver. Furthermore, the Armament Inspectorate required that both variants of the new multirole vehicle will have an unified design in reference to the power transmission system, onboard equipment, displacement of the steering gears and most of electric systems.

In May 2017, nearly two years after the tender was launched, it turned out that eventually only one bid was submitted in the MUSTANG Programme. A consortium of Polish Armaments Group (Polska Grupa Zbrojeniowa, PGZ) and Military Automotive Works (Wojskowe Zaklady Motoryzacyjne, WZM) in Poznan offered a Multipurpose Terrain Vehicle (Wielozadaniowy Samochod Terenowy, WST) based on the Ford RANGER Pickup 4x4 platform.

A month later, the tender procedure was eventually cancelled. The Armament Inspectorate informed that the sole bidding consortium valued its offer at over PLN2Bn, while the programme's budget was set by the Inspectorate at PLN232M.

Poland Does not Abandon its Procurement Plans

A second tender under the MUSTANG programme was launched in July 2017; it called for the procurement of 872 soft-skin and

41 armoured multipurpose high mobility vehicles, with deliveries starting in 2019 and running through to October 2022 (soft-skin) and October 2021 (armoured variant). The Armament Inspectorate included an option for additional 2787 soft-skin vehicle, which were to be delivered by October 2026.

As in the case of the first tender, the Armament Inspectorate drafted a number of technical requirements for potential bidders, which included all-wheel drive capability, a maximum GVW of 3,500 kg (soft skin), a carrying capacity of at least 1 t (600 kg for the protected variant), as well as a fording capability of at least 50 cm without previous preparation or no less than 65 cm (with preparation). The new MUSTANG vehicles were to accommodate nine people (a driver and eight passengers) in the soft-skin variant or five people in the armoured variant. Furthermore, all vehicles were to be equipped with run-flat tyres and should have a STANAG 4569 protection level 1 for kinetic energy and blast resistance.

In May 2018, the Armament Inspectorate informed that only one bidder decided to present its offer in the repeated tender. A consortium of Polish Defence Holding (Polski Holding Obronny, PHO acting as the lead company) and Concept offered the DINO 319 4x4 Light Tactical Multipurpose Vehicle (LTMPV) and the DINO 519 4x4 Light Tactical Multipurpose Armoured Vehicle (LTMPAV). Both platforms were designed in association with the Austrian company Oberaigner and presented as light duty, high mobility off-road vehicles, based on the Mercedes-Benz SPRINTER 319/519 CDI models.

Following an in-depth evaluation of the bid submitted by the PHO-Concept consortium, the Armaments Inspectorate decided to terminate the tender. Once again, the main reason was the cost of the bid, which amounted to PLN524M and exceeded the programme budget by almost 120%, as the Inspectorate planned to allocate no more than PLN239M for procurement.

Picture: Polish MoD

The HONKER vehicles as well as the post-Soviet UAZ469 and some of the Mercedes-Benz vehicles are still widely used in the Polish armed forces. Due to their obsolescence, these platforms no longer meet the requirements of the modern battlefield, especially in terms of ballistic / IED protection, and need to be replaced.

Other Procurement Attempts

On 14 August 2018, the Armaments Inspectorate launched its third MUSTANG tender. This time, the project called for the procurement of 900 multirole, high mobility all-terrain vehicles, including 859 in soft-skin and 41 in armoured variant, with deliveries starting in 2019 and running through to 2022. The tender included an option for additional 812 soft-skin vehicles, bringing the total number of platforms to be acquired to 1712. The Armaments Inspectorate made only symbolic changes to the list of technical requirements and underlined its intention that both variants of the future multi-purpose platform should have as much commonality as possible in their design in order to reduce operating, maintenance and repair costs.

A few months later, in March 2019, the Armaments Inspectorate announced that the invitation to tender had to be terminated because none of the manufacturers could submit a bid that fully met the technical and procedural requirements of the procuring institution.

Picture: Polish MoD

The Polish Army needs to procure a fleet of new, multifunctional and highly mobile vehicles to meet its requirements. If the new vehicles are also to be used in future expeditionary missions, it seems sensible to acquire at least two different configurations of the platform – one for use in peacetime and one for use in combat.

Changes in Procurement Policy

Two more attempts to acquire a fleet of new multi-purpose off-road vehicles with high mobility were made by the 2nd Regional Logistics Base in Warsaw. The first tender was launched in June 2019 and provided for the procurement of up to 610 vehicles in the soft-skin configuration, 485 of them under the basic contract and another 125 as an option. Deliveries were to start in 2019 and run until 2022. Although three manufacturers were able to submit their bids, the supervisory authority had to terminate the tendering process as none of the bids were in line with the programme budget.

The most recent procurement attempt was launched in October 2019 when the 2nd Regional Logistics Base in Warsaw invited tenders for the procurement of 635 commercial vehicles, of which 485

Picture: Michal Jarocki

The LTMPAV DINO 519 4x4 was offered as a possible replacement for the multipurpose vehicles HONKER, UAZ and Mercedes-Benz. The vehicle was designed by Concept in cooperation with the Austrian company Oberaigner. It is based on the Mercedes-Benz SPRINTER 519 CDI model.

were to be awarded as part of the basic contract and the remaining 150 as an option. Deliveries were to start in 2020 and last until 2022, including the delivery of 160 basic vehicles (plus 50 as an option) per year in the period 2020-2021 and 165 basic vehicles (plus 50 as an option) in 2022. The value of the programme was estimated at approximately PLN121M.

Shortly after, on 6th November, the 2nd Regional Logistics Base informed that three companies decided to submit bids. The list of bidders included a consortium of Auto Podlasie (leader) and STEELER Marcin Piasecki as well as a Demarko company, both of which offered the Nissan NAVARA 4x4 platform, and a consortium of Glomex MS Polska (leader) and Glomex MS offering Fiat Chrysler Furgon WRANGLER IV 4x4.

One month later, the 2nd Regional Logistics Base cancelled the tender, arguing that none of the bidders could meet the budget of the programme.

Outlook

It is very likely that after five failed attempts to procure a fleet of new high mobility all-terrain multi-purpose vehicles, the Polish MoD will eventually decide to change the procurement procedure from an open tender to direct negotiations with selected industrial partners. This will give the MoD more freedom in deciding on the number of platforms and in determining the technical specifications or the delivery time frame. However, in order to secure the successful acquisition of new multipurpose vehicles the MoD will have to conduct an in depth market analysis, evaluating the availability of particular of-the-shelf platforms and providing adequate procurement funds. ■

WiSENT 2: When Armoured Vehicles Require Assistance

Bjørn D. Josefsen

Modern combat vehicles have a formidable capability to keep going, even in impossibly difficult terrain. Still, they sometimes just grind to a halt, perhaps being stuck in snow or mud, or because of a breakdown or technical fault with the vehicles.

Photo: Anette Ask/Defence

Two NM217 armoured recovery vehicles based on the LEOPARD 1 chassis provide recovery for a LEOPARD 2 MBT which threw its tracks after going off the road during exercise Cold Response 2016.

Situations such as these call for material with the ability to extract a stranded vehicle or get a broken-down vehicle towed or carried to a workshop facility for repairs. And, with the modern combat vehicles putting on ever more weight, the recovery vehicles need correspondingly more muscle as well.

The Norwegian Army operates 40 LEOPARD 2 A4NO main battle tanks, and with a weight of some 55 tonnes, some seriously powerful material is needed to extract such a vehicle when it is bedded down. The Army is also relying on the recovery material working well even in combat situations, through the recovery vehicles being armoured and protected on a par with the vehicles they are assisting. This is why the Norwegian Army has recently procured six WiSENT 2 ARV (Armoured Recovery Vehicle) with the primary task of being a kind of rescue vehicle for embedded or broken-down armoured vehicles.

What is more, the Norwegian MoD contracted six units of the WiSENT 2 AEV (Armoured Engineer Vehicle), with the main task of supporting and serving the Army's armoured vehicles, as well as the Army's other vehicles and personnel.

The WiSENT 2 is built on the LEOPARD 2 chassis and will partially replace the Norwegian Army`s current recovery vehicles – of the type NM217 built on the LEOPARD 1 chassis.

WiSENT 2 ARV

The WiSENT 2 ARV (Armoured Recovery Vehicle) weighs 63.5 tonnes. It is the heaviest land vehicle in the Norwegian Army and about 20 tonnes heavier than the old NM217 recovery vehicles. The WiSENT 2 ARV vehicle has a crane with a lifting capacity of 32 tonnes, and a winch with a pulling force of 40 tonnes. This means that the vehicle can lift the turret or the engine off a LEOPARD 2 main battle tank or pull the whole thing along. For lighter rescue missions, the WiSENT 2 sports an auxiliary winch with a lifting/pulling power of 2.7 tonnes, working through 260 metres of wire.

These vehicles also have a Combat Recovery System enabling them to hitch on to an incapacitated vehicle under battened hatches, which means that the crew can rescue the troubled vehicle without even leaving the comfort of the WiSENT 2. This is realised, among other things, with a rear-facing camera making it possible to back up to a vehicle to attach a hook remotely. On the NM217 vehicles, the crew needs to leave the vehicle to execute this task, while the newer vehicle lets them do this while still protected by being inside their own vehicle. For the crew, this naturally means a new level of safety when the WiSENT 2 ARV is tasked with recovering a stranded battle vehicle from a position far out on the battlefield. The cameras also have a thermal capacity, enabling the vehicles to operate with battened hatches both in daylight and darkness.

"To date, Norway has taken delivery of five of the total of six WiSENT 2 ARV vehicles, and our experiences with them has so far been nothing but positive", says Major Cato Berg, the Project Manager for Norwegian WiSENT 2. "In addition to training and practice, we have also used the vehicles in summer and winter exercises, at home as well as abroad, including together with other NATO Member States. Our new WiSENT 2 ARV's have functioned in a very satisfactory manner. We have also conducted mobility testing, and even in most demanding terrain, the WiSENT 2 has demonstrated the same mobility and agility as the Leopard 2 main battle tanks", Berg further highlighted.

Author

Bjørn Domaas Josefsen is Editor-in-Chief of the Scandinavian military magazine militærTeknikk.

Photo: Fredrik Ringnes/Defence

The crane on the new Norwegian WiSENT 2 ARV has a capacity of 32 tonnes.

Photo: Fredrik Ringnes/Defence

With its combat recovery system, the WiSENT 2 can hitch on to an incapacitated vehicle under battened hatches, which means that the crew can rescue the troubled vehicle without leaving the WiSENT 2.

WiSENT 2 AEV

While the Norwegian Army now has taken delivery of five of the total of six ARV's, the first of the six WiSENT 2 AEVs are expected to arrive by Christmas this year.

Like the ARV, WiSENT 2 AEV is based on a LEOPARD 2 chassis and has a full armour to allow the vehicles operate in a combat zone.

The main task for the armoured engineering vehicles is to remove obstacles and establish negotiability for Army battle tanks and other vehicles. In addition, the vehicles may be tasked with various other field jobs such as digging trenches, levelling terrain in a base camp area, performing extractions and establishing battle positions. AEVs can also be used to deploy obstacles to hinder enemy vehicles' progress.

Facts and Figures: The Norwegian WiSENT 2 Project

WiSENT 2 is a part of two projects in Norway – the P5430 Armoured Recovery Vehicle and the P5049 Armoured Engineering Vehicle.

Both projects will be delivering six vehicles each, and both the engineering and the recovery vehicle are built on the modular WiSENT 2 platform. This platform ranks among the world's most advanced support vehicles that are available on the market today. The vehicles' design and modular solutions ensure the capability of rapid changeovers from retrieval to engineering vehicle, and from engineering to breaching vehicle.

As of today, five of the six armoured recovery vehicles have been delivered to the Army. The final vehicle will be delivered in November 2020. Within the armoured engineering vehicle project, the first vehicle has been delivered in November 2019, and the remaining vehicles will arrive in 2021 and 2022. The vehicles are made and delivered by FFG Flensburger Fahrzeugbau Gesellschaft mbH in Flensburg in North Germany, where the WiSENT 2 platform has been developed.

The procurement of the armoured recovery vehicle is the first of four projects with the LEOPARD 2 portfolio, which further consists of an engineering vehicle, bridge laying vehicle and main battle tank. A few years back, the upgrade project for the wheeled recovery vehicles NM 154 F4 from Scania was completed.

The AEV vehicles are equipped for digging, dozing and ripping of different types land masses/soils to let tanks and vehicles negotiate or circumvent obstacles.

The armoured engineering vehicle has an excavator arm mounted instead of an crane arm and a more advanced dozing blade where you can adjust the angle of attack (pitch) and the sideways cut angle on the horizontal plane. The armoured engineering vehicle can be used as a penetrating armoured vehicle using a mine breaching plough to replace the dozer blade, as well as a tagging system for marking mine field pathways.

A Modular Platform

The Norwegian Army will, at the outset, be operating the WiSENT 2 in its ARV and AEV configurations. However, the vehicles' design and modular solutions offer the capability of rapid changeovers from retrieval to engineering roles, and from engineering to breaching, according to the changing operational needs.

Furthermore, the crane arm on the ARV may be exchanged for an excavating arm, for example, or a mine plough or other equipment may be attached.

Quick couplings enable automatic tool change on the digging arm, even while in the field.

Both the WiSENT 2 ARV and the AEV have a crew of three: a commander, driver and operator/gunner.

Having the WiSENT 2 built on the LEOPARD 2 battle tank chassis contributes to simpler technical and economical logistics. The armoured vehicle, like the LEOPARD itself, is constructed along a modular principle, whereby the main components are replaceable in a short time. For example, both the engine and the hydraulics package can be replaced as individual parts.

Military Capacities

The WiSENT 2 vehicles come with a command and control system (Integrated Combat Solution) from Kongsberg. The system offers the vehicle crew enhanced situational awareness, as well as the possibility of co-operating with the army's new CV90 armoured combat vehicles.

For their own protection, the new vehicles will be armed with Kongsberg Nordic + Remote controlled weapons stations with a 12.7mm machine gun. In comparison, the old NM217 vehicles use a mounted 7.62mm machine gun, which needs to be operated manually. The crew can also use the sensors of the weapons station to get a better image of the surrounding situation. This is then

Photo: FFG

The Norwegian Army received its first WiSENT 2 AEV in November 2019. This picture shows an AEV with an excavator arm.

information that the crew can share with other units and other vehicles. In a similar manner, the WiSENT 2 is, of course, able to receive such information from other units.
The vehicles also have a camera system from Kappa, enabling the vehicles to operate with battened hatches both in daylight, smoke and darkness. The cameras also reduce the danger of road accidents.
The WiSENT 2 platform has integrated ballistic armour to Level 5, and mine protection to level 4, according to the NATO STANAG 4569. Additional protection can also be attached where needed.
For the purpose of reducing noise, engine wear and fuel consumption, the WiSENT 2 is supplied with an 'Auxiliary Power Booster'. This is a system based on lithium battery technology, which provides the vehicles with a so-called 'silent watch' capability with an operating time of up to eight hours without running the main engines.

Technical Data – WISENT 2 ARV NOR	
Manufacturer:	FFG Flensburger Fahrzeugbau Gesellschaft mbH (FFG)
Engine:	Standard LEOPARD 2, V12, 48 litre MTU, 1103 kW (1500 HP)
Gear:	Standard LEOPARD 2, 4 forward gears, 2 reverse gears, electro-hydraulic gearshift, strengthened brakes
Max speed:	Ahead: 60 kph Reverse: 31 kph
Towing:	40 kph
Towing in terrain:	15 kph
Weight:	63.5 tonnes
Length/width/height, metres:	9.30/3.54/2.74 (w/o RWS)
Crane capacity:	32 tonnes
Main winch:	40 tonnes pull, 160 m wire
Aux. winch:	2.7 tonnes pull, 250 m wire

Israel's Carmel Programme

Charting Future Concepts for Mounted Combat

Tamir Eshel

Israel's military assesses new approaches to future mounted combat, addressing the need to do 'more with less' – lighter and smaller combat vehicles that will be able to undertake more missions and capabilities, with smaller crews.

In its pursuit of protection, lethality and battlefield agility, Israel has been a forerunner of innovation in armoured combat vehicle technology. Israel's priorities have not been centred on the classic AFV's iron triangle, as its priorities moved between protection and versatility, over lethality and mobility, as reflected by the MERKAVA tank design. While the MERKAVA lived through 40 years of technological and combat operational evolution, from the Mk-1 to the latest version, MERKAVA Mk-4 BARAK, the Israeli Defence Force (IDF) assesses new approaches to future mounted combat. In August 2019, Israel's Ministry of Defence (MoD) Research and Development Directorate (DRDD) completed an operational assessment of future combat vehicle technologies to be introduced on combat vehicles in late 2020 and beyond.
Some of those technologies were shown to IDF, MoD and foreign delegations invited to experience the different technologies and demonstrators first-hand. Indeed, ESD was also among the guests invited to explore the CARMEL.

Photos: Tamir Eshel

The platform presented by IAI for the Carmel programme. All solutions presented were based on the M113.

Technology Demonstrators

DRDD invited three industry groups to provide technology demonstrators for the programme – Rafael, Elbit Systems and IAI. The demonstrators were all based on the M-113 used as a platform surrogate for the combat vehicle. The future platform will use a new chassis powered by a diesel generator, with a rechargeable battery bank to provide the electricity for propulsion and all systems.
During the first phase of the Carmel Programme, a significant challenge was presented to the three major Israeli defence companies: to prove the feasibility of an AFV that is operated by only two combat soldiers with closed hatches. The two persons employ different sensors on-board and off-board, including radars, thermal imaging sensors, video cameras, acoustic and lasers and drones. All inputs are fused and displayed to the crew for situational assessment and response.
Each company was asked to develop its own technological concept that would transform and upgrade the interior part of the IDF's combat vehicles to an advanced cockpit – like a fighter jet's cockpit. The challenge was in proving the feasibility of two soldiers conducting closed-hatch operations and integrating technological capabilities that enhance mission efficiency for the IDF's manoeuvre forces. To achieve this, each group took a different approach, utilising high-level integration, sensor fusion, vehicle autonomy, and artificial intelligence. These approaches enabled effective situational awareness and understanding, decision making and weapon employment, provided by different, advanced cockpit integrations capabilities.

Closed-Hatch Operations

Each team tested its solution over a period of one-week within a series of complex operational scenarios, where crews composed of DRDD teams used the vehicles in a variety of challenging scenarios, some facing 35 threats on a mission.
Each group took a different approach to meet their objectives – a light (35 tonne) combat vehicle armed with a medium calibre autocannon and missiles, and operated by a crew of two, with an additional seat for a third crew member operating specialist systems. Designed for manned operation, Carmel is equipped with sensors, artificial intelligence, and advanced automation and system autonomy to reduce operator workload. This approach enables human operators to take decisions and actions in a timely and effective manner.

Author

Tamir Eshel is a security and defence commentator based in Israel.

Elbit's Approach

Elbit Systems' approach applied autonomous capabilities and Artificial Intelligence (AI) to accelerate decision making and facilitate target engagement with dramatically increased rapidity and accuracy. The AFV successfully demonstrated its capacity to function as an independent high fire-power strike cell, as a networked station for multi-spectral sensing and information fusion, as well as a base platform for operating additional unmanned systems.

Inside IAI's Carmel platform

Artificial Intelligence

The company's Future Combat Vehicle Technology Demonstrator can perform all the key combat tasks with high level of autonomy – off road driving, rapid target acquisition and prioritisation, as well as fast high precision fire missions, day and night. The AFV is networked, allowing it to carry out missions ordered by Headquarters and other fighting platforms as well as to transmit intelligence to other forces. Additionally, the AFV is capable of operating other unmanned platforms, such as Virtual Take-off and Landing (VTOL) to feed intelligence into the crew's operational picture or a fighting UGV to perform high-risk missions.
Elbit Systems presented a technological concept, one that integrates two forms of User Interfaces (UI) – large screens for planning and IRON VISION augmented reality helmet displays in a combat phase of the mission. IRON VISION provides a 'See-Through Armour' function, enabling the crew-members to view their surroundings in an intuitive and detailed way.
The different UIs are optimised for different operational phases – the planning phase and the contact phase. The planning phase relates situations where crew members use information and communications to gain situational understanding and planning. In this phase, the vehicle is not engaged in direct combat and the crew can be more effective with conventional user interface, using large flat video screens.
When moving into contact or sensing a direct threat, the crew-members use their IRON VISION Helmet Mounted Display (HMD) to gain a more intuitive and panoramic situational awareness. Using the IRON VISION 'See-Through' HMD, the two crew-members were capable of operating the AFV entirely under closed hatches. The system transmits real-time, provides a high resolution video onto the crew's helmet mounted display, providing them with a 360° view of the surroundings, together with relevant symbology and C4I data. In addition, IRON VISION enables the crew to acquire targets, conduct line-of-sight (LOS) driving and navigation and enslave the AFV's weapons systems to their LOS.
Elbit Systems' Carmel successfully demonstrated its capacity to function as an independent high fire-power strike cell, as a networked station for multi-spectral sensing and information fusion, as well as a base platform for operating additional unmanned systems.
The capabilities were exhibited by a technology demonstrator integrating a range of the company's systems, such as: the UT30 unmanned turret, the IRON VISION HMD, a land robotic suite, the TORCH Command & Control (C2) system, E-LynX software defined radios, the SupervisIR terrain dominance system, the MAY acoustic situational awareness system, AI applications, the THOR VTOL and the PIONEER fighting Unmanned Ground Vehicle (UGV).

Rafael's Carmel platform

IAI's Platform

IAI ELTA Land Systems presented a platform based on the company's family of autonomous systems and robotic vehicles. It's Carmel platform combines a panoramic display made of several large screens, individual control screens, and a control unit – similar to a gaming console joystick. The vehicle delivered by IAI offered enhanced functions of autonomous mobility, particularly in route planning and in response to the evolving situation. This enables crew members to focus on situational awareness and combat, leaving movement control to the machine. Altogether, the platform demonstrated its ability to provide high survivability, lethality, threat detection, target acquisition and prioritisation in battlefield environments while also distributing real-time situational information to the relevant decision-makers. As such, a high level of autonomy is involved in threat detection, classification, and identification, using Artificial Intelligence and Machine Learning processes. Autonomous vehicle systems require a soldier-in-the-loop only to monitor and act for handling complex scenarios. At the centre of ELTA's CARMEL solution is ATHENA, an autonomous C6I and com-

bat management system, which operates all the sub-systems on the platform using Deep Learning and Artificial Intelligence (AI) techniques. Apart from the obvious autonomous navigation, manoeuvring and decision-making capabilities, sub-systems coupled with ATHENA in the technology demonstrator included several sensors, countermeasures and weapon systems. These included the ELI-3312 compact target acquisition systems, which detects, classifies and tracks ground targets and fire sources while providing a real-time situational awareness. Another sensor coupled with Carmel's situational awareness system is Elta's ELM-2135 STORMGUARD, a radar system providing force protection and target acquisition. Hostile fire detection was delivered by OTHELLO ELO-5220, employing a passive multi-spectral sensor system, while the vehicle's active protection (APS) WiND-GUARD ELM-2133 radar provides an instant warning and targeting of incoming threats. Other systems controlled by ATHENA included the Remote Control Weapon Station (RCWS), VTOL loitering munition, missile interceptors, and electronic countermeasures.

IAI's CARMEL system was designed as a platform-agnostic solution that can be integrated onto a multitude of current and future Ground Combat Vehicles. As such, ATHENA and autonomous navigation and manoeuvring systems are kits that can be adapted and integrated onto different vehicles, and the radars and other sensors can be adapted to conform to the vehicle type and particular mission requirement.

Rafael's Solution

Rafael's solution for future combat fighting vehicles utilises a large video wall display enabling the two crew-members to focus on the mission while intuitively sharing tasks among themselves and with virtual assistants. This transparent cockpit design provides constant 360-degree situational awareness, stacking two-layers, each covering 180 degrees. Augmented reality is used for real-time battlefield information and data. Video annotations highlight the objects of interest, friendly forces, suspected and confirmed targets, or messages alerting crew-members to act.

This includes targets, Blue Forces, and other Points of Interest, as well as an autonomous mission support system for autonomous mission planning, driving, and simultaneous operation of all vehicle weapon systems, all based on combat artificial intelligence capabilities.

Elbit's Carmel technology demonstrator can perform all key combat tasks with a high level of autonomy.

These technologies are also combined with RAFAEL's breakthrough FIREWEAVER Networked Targeting and Control System, providing real-time pixel-based target designation and fire co-ordination, allowing simultaneous precise strikes on multiple targets within seconds.

Other Capabilities

The Carmel Programme also includes the development of other capabilities that were not presented during the demonstration day. Such capacities include: a platform with hybrid-electric propulsion, energy storage with high capacity to support the electronic systems on board, signature reduction (including active camouflage), multi-task radar providing self-defence (active protection) from anti-tank threats as well as detection and tracking of drones, vehicles and humans, blue force tracking and various types of weapon systems (including direct and indirect fires, self-protection and high-energy lasers).Another aspect to be pursued at a later stage is teamwork – the synergy between several Carmel vehicles, sharing information and tasks using broadband connectivity. Manned-Unmanned Teaming will evaluate the advantages of augmenting the small crew with the capabilities of associated robotic team members.

Lessons Learned

The lessons learned from the recent evaluation will be assessed and presented to the DRDD for further action. DRDD is expected to either recommend a technology mix for further development and integration in a future platform or to select a single provider or a team to act as a prime contractor. Among the technologies already selected for integration into future platforms is the IRON VISION helmet display from Elbit Systems, which will be integrated in the next phase of the MERKAVA Main Battle Tank – the MERKAVA Mk4 BARAK. Other systems could be included in the EITAN APC and NAMER heavy armoured infantry combat vehicle.

While Carmel is undergoing evaluation and technology demonstrations, the IDF plans to introduce two new armoured vehicles to modernise and enhance the capabilities of armoured and mechanised infantry. The MERKAVA Mk4 BARAK (lightning in Hebrew) is the latest version of MERKAVA, soon to be entering service. This will implement some of the capabilities developed for the Carmel, including AI and the IRON VISION augmented vision system, enabling the crew to view the outside world on their helmet display, with information embedded in the world view. AI enables the crew to improve target recognition and tracking under difficult visibility.

EITAN, the new 8×8 armoured vehicle designed and built by the MoD Tank Authority, will replace the M-113s, which is being withdrawn from active and reserve service. EITAN employs a new remotely operated turret mounting a 30mm auto-cannon that is likely be used in the Carmel, either in the original 30mm or 40mm SUPERSHOT version. The turret will also integrate advanced sensors and active protection capability, enhancing the vehicle's combat effectiveness in the complex battlespace. ■

Estonia, Finland and Latvia Jointly to Develop Armoured Vehicles

(ck) Estonia, Latvia and Finland intend to cooperate in the procurement of armoured vehicles in the future. To this end, the three countries have signed a Letter of Intent on defence cooperation. The Letter of Intent was signed by the Estonian Defence Minister Jüri Luik, the Latvian Defence Minister Artis Pabriks and the State Secretary of the Finnish Defence Ministry Jukka Juusti, the Estonian Defence Ministry announced. "The LOI signed today is a most welcome start for the Joint Undertaking between Estonia, Latvia and Finland for the procurement of new armoured vehicles. We have agreed to conduct defence-related technical research and I believe that our cooperation will lead to a positive outcome" Luik said in a statement. The aim of the LOI is to find

Photo: MoD Estonia

an optimal solution for all three countries to increase infantry mobility, with procurement initially planned for 2024. Estonia, Latvia and Finland will focus, initially, on the cooperation programme to find common ground for future procurement. "We have a very positive long-term relationship with Finland in terms of procurement policy, we have jointly purchased self-propelled artillery and radar systems. Now we want to extend this cooperation to Latvia, as all three countries have a common interest in armoured vehicles" Luik added.

GRIFFON Delivery on Time

(ck) EBMR, a consortium consisting of Nexter, Arquus and Thales, have delivered the 92nd VBMR-GRIFFON to the French armed forces. In doing so, the consortium has met its objectives for 2019, in accordance with the initial purchase notified in 2017 and as defined in military programming law. In July 2019, the DGA submitted a first batch of vehicles to the French army, at a ceremony attended by the French Army minister, Florence Parly. Since then, the production of the full 92 GRIFFON has been achieved in less than six months which has represented a real industrial

Photo: Arquus

challenge. Since 2015, Nexter, Arquus and Thales' parties have been fully involved, in partnership with the DGA, to achieve the development, qualification and production of the GRIFFON. They have worked together to conceive a vehicle with a high level of protection, ergonomics, great mobility, an effective weapon system, and a sophisticated communication system with new functions such as sensors, electronics and algorithms for collaborative combat. Nexter has been in charge of the development and production of the vehicle structure, including the armoured hull, NRBC and ballistic solutions, and the interior layout. Arquus has designed and produced the full driveline for the GRIFFON, including all parts that ensure the vehicle's mobility. Thales has brought on board all the technologies enabling the use of data and information for the collaborative engagement of the platforms. This has included on-board vetronics, which are computer-based and link all navigation, protection, observation and communication services. Under the SCORPION programme, the EBMR consortium is to deliver 1,872 GRIFFON vehicles to the French army; 936 vehicles are to be delivered by 2025 with all maintenance and logistic support.

Limpid Armor's See-through Armour Tested in Ukraine

(ck) In December 2019, trials of the Land Platform Modernisation Kit (LPMK) integrated with the BTR-4E IFV took place at the proving ground of the Ukrainian Armed Forces near Lviv. During the test, the driver operated the BTR-4E IFV with hatches closed, navigating purely with the help of Limpid Armor's LPMK enhanced situational awareness system. In 2020, additional trials will take place with five LPMK kits that will be transferred to the Armed Forces of Ukraine to test the system on multiple vehicles simultaneously. "It was a huge success for us to get to this stage of trials. It is, indeed, an important step that highlights an increased interest to our technology from the Armed Forces of Ukraine. We expect the initial feedback after these trials and we will be transferring a few more units for further testing on BTR-4E IFVs", said Mykhailo Grechukhin, Limpid Armor's CEO. The Land Platform Modernisation Kit aims to improve the survivability of armoured units; it is an enhanced situation awareness system that consists of several cameras, sensors, a server and a military-grade helmet with Microsoft Hololens integrated into it. The cameras installed on the perimeter of an armoured vehicle provide the video feed that is "stitched" on the gointo a "see-through armour" 360-degree panoramic view, with different important information being overlaid on the glasses, such as position on a map, speed, other telemetry data as well as friend or foe identification.

Photo: Limpid Armor

CAESAR for Denmark

(ck) The Danish procurement authority DALO has contracted Nexter, a KNDS company, to deliver four additional CAESAR 8x8 self-propelled artillery systems. In 2017, Denmark purchased 15 CAESAR

Photo: Nexter

8x8 systems for delivery in mid-2020. The CAESAR 8x8 is the heavy, protected and high payload capacity variant of the CAESAR family. It is equipped with a 155mm artillery gun, combat-proven in the French armed forces on CAESAR 6x6. The modular CAESAR 8x8 can carry up to 36 projectiles and charges as well as a wide range of equipment according to operational needs (secondary weapons, electronic countermeasures, smoke, etc.). Its shielding offers a high level of ballistic and anti-mine protection (level 2A and 2B STANAG 4569) and anti-IED protection. Finally, it has an automatic shell reloading system, whose speed can be configured according to the user's operating modes (semi-automatic to automatic).

New President of Patria's Land Business Unit

Photo: Patria

(ck) Jussi Järvinen, 40, Master of Science (Economics and Business Administration), has been appointed as President of Patria's Land business unit. He is now a member of the Board of Management and reports to Esa Rautalinko, President and CEO of Patria Group. His predecessor Teemu Raitis will start in a new position outside Patria. Jussi Järvinen has been working for five years at Patria in various management positions, most recently as Vice President, Operations. The key areas in the Land business unit include armoured wheeled vehicles, mortar systems and related life cycle support services. The business unit employs 230 people in Hämeenlinna and Tampere.

500 BOXERs for UK

(ck) Under the UK's Mechanised Infantry Vehicle (MIV) procurement programme, theUK MoD will buy more than 500 BOXER 8x8-wheeled armoured vehicles for the British Army. The corresponding contract with the Artec consortium, led by Rheinmetall and Krauss-Maffei Wegmann (KMW), has a total value of approximately €2.6Bn. The contract has been awarded to Artec via the European procurement agency Organisation for Joint Armament Cooperation (OCCAR). Artec will sub-contract 50% of the order volume to Rheinmetall and Krauss-Maffei Wegmann. The total number of BOXER vehicles already delivered by Artec, or currently on order, now exceeds 1,400 vehicles. The BOXER

Photo: Rheinmetall

vehicles ordered by the British Army will be supplied in several different configurations, including an armoured personnel carrier, command vehicle, specialist carrier and field ambulance. Delivery of the vehicles is expected to start from 2023. Most of the production will take place in the UK, safeguarding and creating a substantial number of British jobs. Full-scale production will begin in Germany, but 90% of the BOXER vehicles destined for the British Army will be produced in the UK, principally at plants operated by Rheinmetall BAE Systems Land (RBSL) and KMW's subsidiary WFEL. This order marks the return of the UK to a European defence programme, having taken part in the BOXER project when it was still in its infancy. BOXER is now on its way to becoming one of NATO's standard vehicles. At present, some 700 vehicles in twelve different versions are on order from three different NATO nations: Germany, the Netherlands and Lithuania. Australia has also ordered 211 BOXER Combat Reconnaissance Vehicles (CRV) in seven variants, the first of which was recently delivered.

SPIKE Guided Missile for the German Infantry

(ck) Rheinmetall and its joint venture partners Diehl Defence and Rafael have won an order to supply the German armed forces with the advanced SPIKE antitank guided missile which the Bundeswehr calls MELLS (Mehrrollenfähiges, leichtes Lenkflugkörpersystem). Rheinmetall is tasked with

Photo: Rheinmetall

supplying key components to Eurospike, the company that manufactures the MELLS multirole lightweight guided missile system. The order has a value of over €30M. Delivery begins in 2020 and will continue through to 2023. A framework agreement contains an option for the fabrication and delivery of around 100 additional weapon systems and a five-figure number of component sets for the MELLS guided missile during the 2024-2031 timeframe. This would mean incoming orders for Rheinmetall in the three-digit million-euro range. The MELLS missiles now ordered by the Bundeswehr are intended for infantry operations. Rheinmetall will be supplying over a hundred integrated command and launch units, including transport and storage containers, as well as 1,500 sets with components for the long-range SPIKE LR missile produced by Rafael. Produced by Eurospike – a joint venture of Rheinmetall, Diehl Defence and Rafael – the MELLS is a state-of-the-art effector capable of engaging armoured targets at ranges of up to 4,000 metres. Rheinmetall has already integrated the MELLS missile into the MARDER infantry fighting vehicle, and is doing so again in the PUMA IFV. In addition, another contractor is currently integrating the system into Rheinmetall's air-portable WIESEL weapons carrier.

Telerob Robots for US Air National Guard

(ck) The US Air National Guard has awarded a contract to Telerob under which 19 TELEMAX HYBRIDs will be delivered to 17 locations in the USA in 2020. The EOD robots will be delivered to 17 US states, bringing the number of US states where TELEMAX robots are in use to 25. Up until now only police units have used Telerob EOD robots in the United States of America, and this is the first time a military customer has chosen TELEMAX. Telerob has a subsidiary in Pennsylvania and Managing Director Thomas Biehne has stated that "The US subsidiary was founded to explore the North American market and to guarantee our customers optimal service on site". The TELEMAX HYBRID EOD robot offers a strong, high-performance arm with minimal dimensions. With a payload capacity of up to 37 kg, the TELEMAX HYBRID is therefore ideally suited for use in built-up areas and in confined spaces. The 4-track undercarriage reaches a maximum speed of 10 km/h. Telerob mainly manufactures products for the homeland security sector. The product range includes remote-controlled robots for defusing dangerous explosive devices and detecting NBC hazards, as well as fully equipped emergency vehicles and mobile system solutions to ensure the safety of critical infrastructures and people.

Photo: Telerob

LEOPARD 2 A7 to Enter Service

(gh) The latest version of the LEOPARD 2 main battle tank was handed over to the German and Danish armed forces by general contractor Krauss-Maffei Wegmann on 29 October 2019. 40 years after its first introduction to the forces, NATO's


Photo: KMW

standard tank has once again been thoroughly overhauled to meet the threat posed byoperations. Protection, mobility, firepower and controllability have been significantly increased. Key features include an even higher level of protection, a powerful power supply, new NBC and air conditioning systems and the integration of C4 I systems to meet the requirements of a modern networked operation. The modernisation of the powertrain and further optimisation of weapon stabilisation during travel enhance the agility and combat strength of the vehicles. Both nations will receive comparable variants of the seventh generation of the LEOPARD 2 main battle tank. The Danish army will receive a total of 44 LEOPARD 2 A7s by 2022. The Bundeswehr will be equipped with a total of 104 LEOPARD 2 A7V by 2023. The German Army will then have a total of 328 LEOPARD 2 main battle tanks. It is planned that in the medium term all tanks of the army will be brought up to the same technical standard.

Amphibious Combat Vehicles for the US Marine Corps

(df) The US Marine Corps has contracted BAE Systems and Iveco Defence Vehicles to deliver additional Amphibious Combat Vehicles (ACV) under a third order for Low Rate Initial Production (LRIP). The award


Photo: Iveco

is for the ACV Personnel Carrier variant (ACV-P) and represents an important next step on the path to full rate production.
The ACV is an advanced 8x8 ocean-capable vehicle with a new six-cylinder, 700hp engine, which provides a significant power increase over the legacy fleet currently in service. The vehicle delivers mobility in all terrain and has a suspended interior seat structure for 13 embarked Marines, blast-mitigating positions for a crew of three, and improved survivability and force protection over currently fielded systems.
Current low-rate production is focused on the ACV-P variant. Further special variants will be added under full rate production within the ACV Family of Vehicles programme. Iveco Defence Vehicles and BAE Systems previously received the Lot 1 and Lot 2 awards.

Mobile Bridge Systems

(mj) At the Military Institute of Armoured and Automotive Technology in Sulejowek, near Warsaw, General Dynamics European Land Systems and Griffin Group Defence presented a number of mobile bridge systems offered for the armed forces of Poland and several other countries


Photo: Michał Jarocki

in the Central and Eastern Europe (CEE) region. According to Rolf Wenning, Senior Manager, International Business & Services Bridge Systems Europe, GDELS, the company is aware of the broad requirement for mobile bridge systems across the CEE region. GDELS is particularly focused on countries such as Poland, Slovakia, the Czech Republic and Romania, which lack modern and proven mobile bridge systems, capable of providing a sustained transport capability for heavy armoured vehicles across water and land obstacles.
The marketing campaign for GDELS bridge systems seems to come at the right time, as NATO has already identified the need to improve troops manoeuvrability throughout the CEE region as part of its enhanced forward presence initiative on the Alliance's Eastern flank. Over the last few years NATO has organised a series of exercises during which a number of troops and various military equipment, mostly from the US Army contingent in Germany, were transported via Poland and other CEE countries to the Baltic States as part of a show of force against the background of the deterioration of relations between the West and Russia. During these exercises a number of deficiencies regarding road and bridge infrastructure were identified, which complicated and delayed troop movements or even led to a series of accidents. Among the systems presented during the seminar at WITPIS was the VIPER modular, lightweight folding bridge integrated with the Jelcz 442 two-axis truck manufactured by the local Jelcz company, a member of the Polish Armaments Group (Polska Grupa Zbrojeniowa, PGZ) holding. VIPER is made of aluminium modules and is available in lengths of 4, 6 and 8 metres. It provides river/gap crossing capability for land platforms of different wheelbases, and is designed for maximum loads of up to MLC 40. The system is equipped with an adaptable launcher, which can be integrated with a wide range of land platforms, such as transport, tactical and specialised vehicles or trailers. Another system presented was the MAMBA lightweight infantry bridge. It is designed to support operations of infantry and airborne troops during crossing of dry and wet gaps with a maximum width of 30 m. The system can be extended by attaching additional bridge modules. MAMBA can be used for movement of troops, evacuation of injured soldiers as well as transport of supplies and other auxiliary equipment across harsh terrain.

Portable Chemical Laboratory for the Spanish Army

(df) Indra will supply the Spanish Army with an advanced portable chemical laboratory which can be deployed rapidly in any theatre of operation, in order to identify the chemical warfare agents and toxic industrial chemicals that the enemy may be using. It is composed of two 6 m containers, one of which houses the work area and a backup equipped with HVAC, CBRN air and water tank filtration, non-interruptible power supply, a diesel generator and storage for collected materials. To take delivery of samples and prepare them, operators have a handling booth isolated from the rest of the lab. It also has a commu-


Photo: Indra

nication system that sends the results immediately to the command centre. The laboratory will enter the first CBRN Defence Regiment "Valencia" of the Spanish Army. Until now, this regiment had VAMTAC (high mobility tactical vehicle), BMR 6x6 (armoured carrier) Reconnaissance Vehicles and the Sampling and Identification of Biological, Chemical and Radiological Agents (SIBCRA) team that collects samples in a contaminated area and sends them to a lab for subsequent analysis. All of the analysis equipment is completely compatible with that currently used by the Institute of Technology located in La Marañosa.

Tender for Tactical Airborne Utility Terrain Vehicle

(gwh) On the European tender platform TED the German procurement agency BAAINBw has published the start of the competition for a "Tactical Airborne Utility Terrain Vehicle" (LL-UTV). The procurement project includes a framework agreement with a term of seven years for the manufacture and delivery of a maximum of 148 high terrain and airborne unprotected four-seater LL-UTV emergency vehicles, including an installation kit for the installation of an auxiliary device launcher and other onboard equipment, special tool kits, initial spare parts requirements and documentation for each vehicle. The minmum purchase in the 1st lot is 65 vehicles with the remainder being an option. The active agent launcher is the Rheinmetall Defence ROSY system.

Three IFV Competing in the Czech Republic

(gwh) Of the four bidders invited to the competition, three – BAE Systems with CV90, GDELS with ASCOD and Rheinmetall with LYNX KF41 – submitted their first bids to replace the outdated Soviet BVP-2 in the Czech army. PSM Projekt System & Management has decided not to offer the PUMA infantry fighting vehicle (IFV) because, from the company's point of view, the PUMA could only be adapted to the requirements with a costly conversion. This explanation was published by the Czech Ministry of Defence. After evaluation of the submitted bids, competitors are to be invited to submit a final bid in the foreseeable future. The Czech Republic intends to acquire around 210 infantry fighting vehicles and has budgeted almost €2Bn for them. The vehicles are to be produced – at least partially – in the Czech Republic. While BAE Systems and GDELS are looking for partner companies in the country, Rheinmetall has started to recruit personnel for its own production company.

ZETROS Next Generation Introduced

(gwh) At its in-house Defence Vehicle Experience event, Mercedes-Benz unveiled the second generation of the ZETROS heavy-duty truck to users and procurers from the defence sector as well as system houses and body

Photo: Gerhard Heiming

manufacturers. A good ten years after its market launch, the workhorse has been significantly overhauled and modernised for heavy off-road tasks and its performance has been improved. The new generation ZETROS is characterised by a drive train adapted to the increasing requirements for total weights and total train weights with more powerful engines up to a maximum of 375 kW and powerful torques of up to 2,400 Nm. On the outside, the new ZETROS can be recognised by the newly designed distinctive radiator grille, which enables even more effective cooling thanks to optimised air flow. Powerful engines, optional permanent all-wheel drive and planetary axles with dif-ferential locks, together with high ground clearance, guarantee exceptional mobility and durability. The new ZETROS uses assemblies from a comprehensive modular unit system, especially the AROCS. As a result, the AROCS is increasingly becoming the standard vehicle for (military) heavy-duty applications. The customer is spared technical risks because reliable and high-performance assemblies are used from the start of production.
The ZETROS is one of the few hood vehicles on the military market. This design offers numerous advantages. The vehicle is approximately 50 cm lower than trucks with a comparable load capacity. The driver's position behind the front axle reduces the vibration load for the driver, especially when driving off-road. The hood concept allows access to the engine compartment without tilting the cab. Equipment and personnel can remain in the cab when working on the engine. In 2012, the German Armed Forces ordered a total of 110 ZETROS with two axles and a protected cab – designed for a military payload of five tons – as part of the armament programme for Protected Transport Vehicles (GTF). The first vehicles have been in service in Afghanistan since 2013. Initial discussions for a second batch of 185 have taken place. As yet there is no concrete timetable and nor are there any planned financial resources. The ZETROS is deployed internationally in Algeria, Bulgaria and Jordan. Algeria has a four-digit number in use and assembles some of the vehicles on site in its own production facilities.

Iveco Trucks for the Romanian Army

(ck) The Romanian Ministry of Defence has commissioned Iveco Defence Vehicles to supply more than 2,900 high-mobility trucks. A first batch of 942 vehicles

Photo: Iveco Defence Vehicles

will be delivered within four years, starting in 2020. The framework contract covers four types of military logistics platforms from Iveco Defence Vehicles' range of high-mobility trucks: 4x4, 6x6, 8x8 and 8x8 PRIME MOVER, ordered in 16 different variants, of which about one third have an armoured cabin. Equipped with Central Tyre Inflation System (CTIS), black-out lights, dual-fuel engines, self-recovery winches and tactical axles, they can provide outstanding mobility, fording capability and air transportability by C-130 to support tactically any military operation. The current contract is a follow-up to two previous contracts for 57 high-mobility trucks in 2015 and 173 in 2017.

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