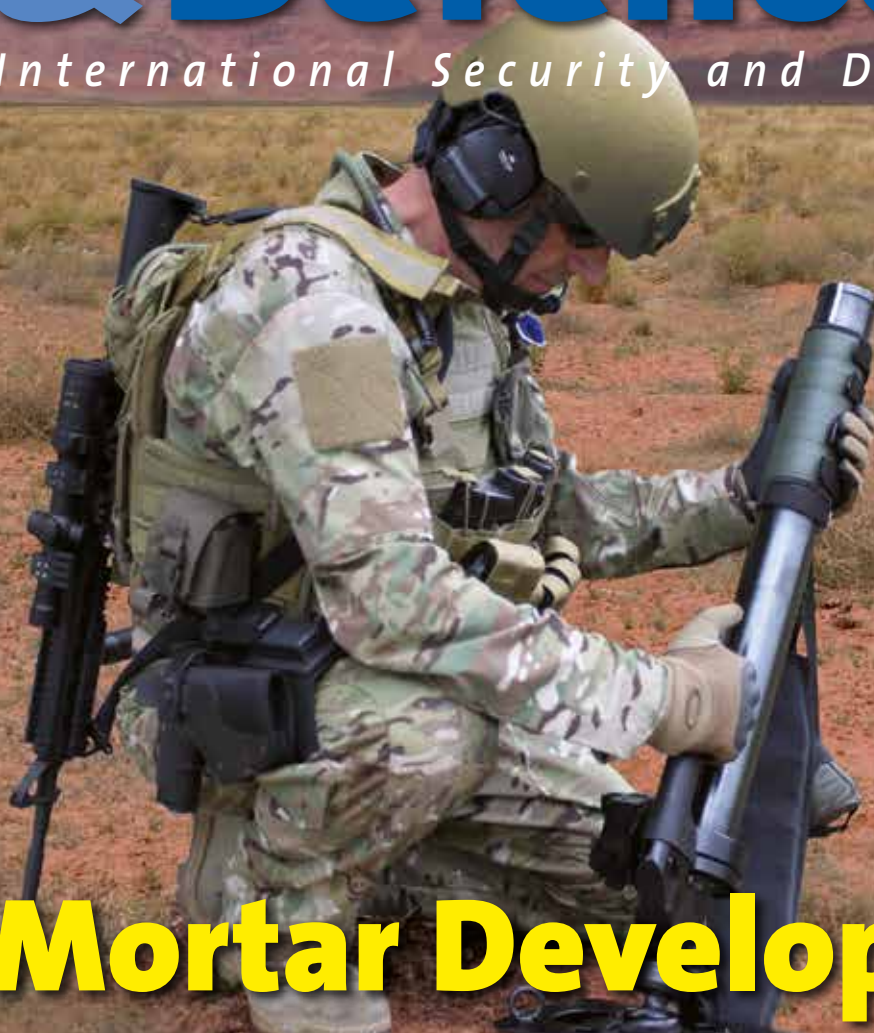


European Security & Defence

1/2017

International Security and Defence Journal



Close-Up: Armoured Vehicles



Mortar Developments



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The Focus Must Be on What Is Fundamental to the EU



Bleak forecasts about the future of the European Union are nothing new. They were there right from the very first moment. A temporary highlight came in 2005 when the citizens of France and the Netherlands – contrary to all expectations – rejected the ratification of a European constitution in a referendum, whereupon some commentators already stated the EU's demise was on the horizon. They were wrong. The EU decided – and this was not meant ironically – to take a “period of reflection”. Two years later – at the end of this phase – came the Lisbon treaty which did (almost) everything the constitution was to do in a somewhat more complicated form. The consent of the Dutch and the French to this agreement was no longer needed, and a change to the constitution was even made in Paris in order not to have to go down the referendum path again. The Irish were not given this opportunity, yet after the slip-up in the first referendum, Dublin was also able to accept the ratification with a second vote. Unquestionably, this ratification process had not been beneficial to the EU's credibility in attempting to finally put to bed the common accusation that it lacked democracy.

As the global financial crisis broke out over the continent just after Lisbon, which was followed by the Euro crisis, more Cassandra calls became louder. But once again, the EU did not break down under the weight of these new problems. On the contrary. We may not have come through the crisis even though it has taken something of a back seat in public consciousness. Nevertheless, the EU has shown (to use a new buzzword) “resilience” during this crisis.

Dark prognoses which stubbornly refuse to come true ought at some point to become obsolete. However, this is not the case. Scepticism about whether the path the EU has chosen is the right one, or is even achievable, has grown across Europe. In some countries, it has been possible to mobilise votes sufficiently to get representation in parliament or even enter government. In Great Britain, these votes, even if “Brussels” had nothing to do with some issues, led to the Brexit vote.

Great Britain's pending exit – whenever it may happen – can neither be sat out nor

talked down. As the tip of the iceberg, it is the most serious crisis the EU has had to overcome since the Treaties of Rome. Previously unquestioned certainties are shaken. Is the gradual transition from a community of states into a federal state really reasonable, feasible and are there no other alternatives? What happens if the majority of citizens in various member states no longer want it and vote accordingly in their parliamentary elections? Should their vote be simply respected or should an attempt be made to convince them that they made a mistake? Or should one look for new ways of elegantly excluding them from joint decision-making powers? – such incredible things can be heard in the democratic community of values that is Europe, as they obviously fail to grasp what the era needs.

The following question can be answered far more simply with a far larger consensus: what is really fundamental to the EU? In answering this, one encounters the achievements in earlier decades of European integration which have become so self-evident that many citizens can no longer see them – starting with a peaceful reconciliation of interests on a continent shattered by war in the first half of the last century, to the convenience of the internal market from which every individual and company benefits on a day-to-day basis. And one also comes up against policy areas, where some work is still needed (and nobody would blame “Brussels” for arbitrarily claiming competences) – from an easier way for citizens and companies to enforce their rights in other member states to a harmonisation of defence policy. The call for the EU to limit itself to that which can only be regulated on a European level and leave everything else to the member states is nothing new. The principle of subsidiarity has been invoked again and again over the past few decades. Upon taking office, Jean-Claude Juncker declared that the EU must concentrate on “big issues”. In a new “period of reflection” which would be appropriate after the Brexit vote, they would do well to follow these words with deeds.

Peter Bossdorf

In Memoriam of Professor Peter Tamm



Photo: Michael Zapf

Professor Peter Tamm, publisher and founder of the International Maritime Museum Hamburg, passed away at the age of 88 in the presence of his family on 29 December 2016. His funeral was honoured by many distinguished guests and celebrities.

Peter Tamm was a publishing house manager, a passionate collector and an "institution" of the German City and State of Hamburg. His long and successful life expired shortly before the turn of the years. In order to pay their last respect to the museum founder and patron members of his family, friends, colleagues and companions attended a memorial ceremony with the former chief reverend of Hamburg's "Michel" at the Nienstedten Church on Hamburg's Elbchaussee, among them publisher Friede Springer, Mathias Döpfner, the Chairman of the Board of the Springer Group, and the First Mayor of Hamburg, Olaf Scholz. Peter Tamm had peacefully passed away in the evening of 29 December in the presence of his family. He leaves behind his wife, five children and eight grandchildren. Peter Tamm was a descendent of one of Hamburg's oldest seafaring families, his ancestors were captains on the "Wapen von Hamburg" (Crest of Hamburg). He was cradled with his passion for seafaring and the maritime domain, and he preserved and cultivated that spirit throughout his entire life. Later, he became an unmitigated Hanseatic citizen, both in terms of his character and as a businessman. "Straightforward", "persistent" are the terms used by all who knew him. It is no coincidence that his nickname was "Admiral". But also "humane" and "generous", an example for many of his contemporaries.

Peter Tamm occupied many appointments in business associations, foundations and clubs. He was granted many honours; in 1998 he was awarded the Order of the Merit with star of the Federal Republic of Germany. To honour his work in sea-

far history the Senate of Hamburg appointed him to Honorary Professor in 2002. "Hamburg has lost an institution", Hamburg's First Mayor Olaf Scholz said in his address. "As a manager and collector he has always been someone who could stay on course, even if he had to sail close to the wind." Peter Tamm's first impressive career ended 25 years ago. Far more than two decades, from 1968 to 1991, he had been a member of the top management of the Publishing Group Axel Springer, mostly as the single Chairman of the Board. During that time he could quadruple the turnover of the publishing group, from 860 million German Mark to finally 3.5 billion German Mark, as Springer's current Chairman Mathias Döpfner recalled. "We have owed very much to him until this very day", Döpfner said. Though following a comprehensive approach he had never lost his view for detail. "But he has not only generated physical values, he has also left us intellectual values. "

Peter Tamm's career as a manager started at the age of 20 with the newly founded "Hamburger Abendblatt" newspaper in 1948. The war had just been over for three years, and Peter Tamm had had to face the dread of war; he was conscripted by the Navy when he was 17. He did his short military service aboard the "Gorch Fock" sail training ship. He started as a freelance journalist, primarily to finance his study in Economics. Instead, he became an editor for seafaring matters and met publisher Axel Springer, a fateful encounter which made him change for the publishing business.

In 1958 he was appointed as managing director of the Berlin-based publishing house Ullstein – which had just been adopted by Springer – and helped leveraging the "Berliner Morgenpost" and "BZ" newspapers. Based in Hamburg he was the Publisher of the "Bild" newspaper and Deputy Publisher of "Bild am Sonntag", the newspaper's Sunday edition, between 1962 and 1964, following which he was appointed Chairman of the Management of the publishing house Axel Springer in Berlin, and in 1968 he became the Chairman of the Board and later single Chairman of Axel Springer AG and remained in this position until 1991, even after the death of Axel Springer.

Under the aegis of Peter Tamm the company grew to become the largest European publisher of newspapers. "Opportunities are there for everybody, but everybody has to take advantage of them individually" was the life motto of the determined and assertive manager. "Peter Tamm has made something of his life, something that remains", Springer boss Döpfner honoured him. "That is how we will remember him as an example."

When his first career came to an end in 1991, Peter Tamm pursued other objectives. Ships, seafaring and trade had always fascinated him, a passion throughout his life. First, his mother had spawned his interest, when she gave the then six year-old boy a five centimetre-long cargo ship made from lead. That made a connection that had never been loosened again.

He was and became a collector, a patron and sponsor of the maritime heritage. "Although he has never been a man for the limelight or a big audience", his year-long companion and friend Wolfgang Müller said. During many decades and with significant expertise Peter Tamm extended and completed a unique private collection of items referring to seafaring and naval history. Because he believed that history was indispensable to understand the past as a basis for the generation of something new.

He founded his own „Scientific Institute for Seafaring and Naval History“ in a house on the Elbchaussee in Hamburg-Othmarschen. However, that was soon bursting at the seams. He searched for a new home for the museum for years. He found it with the help of the City of Hamburg which prepared the "Kaispeicher B" dockside magazine, Hamburg's oldest building of its kind, to accommodate the International Maritime Museum, which was solemnly inaugurated by the then Federal President Horst Köhler in 2008. "He has made history a thing to experience", Vice-Admiral Schimpf, the German Chief of Staff, Navy, between 2010 and 2014, said in honour of the museum founder.

For Peter Tamm a dream had become reality; the museum was his second lifetime achievement. "Hamburg's maritime soul", the Senator for Economics, Frank Horch, called it. There are thousands of ship models, paintings, logbooks, navigation devices, uniforms and weapons displayed on the building's nine decks, all of which had been collected by Peter Tamm in the course of his long life and donated to his home city. Even at a global scale it is the largest private collection of its kind, which has since been maintained and preserved by a non-profit endowment.

After the funeral at the Nienstedten graveyard, which was reserved to a small selected group of attendants, family members and numerous guests met for a reception at the International Maritime Museum. "The spirit and the character of our father is most present in this house", said Peter Tamm junior in his remarks.

When he felt his physical power disappear, Peter Tamm settled his succession in accordance with his straight character. His son, who had already been appointed as a member of the board the year before, will assume the position of his fa-

ther as the head of the Peter Tamm sen. Foundation and will continue to participate in all board meetings. The place of his father at the meeting table, where he used to smoke his beloved Monte Christo cigars, will remain vacant in honour. The family will carry on with the grand heritage. "He was not only a manager and publisher, father and a family person, he was also a friend and adviser – and we will miss him a lot", Peter Tamm junior said. "As a family we will take his credo into the next generation, in the museum, with the publishing house Mittler Report and its magazines "Europäische Sicherheit & Technik" and "European Security & Defence", as well as at the publishing houses Maximilian and Schiffahrts-Verlag "Hansa".

Ships and the reconstruction of the country had always been his guiding principle during the years after the war, and he had always considered the magazines as important instruments, as a "reflexion of history". Since the 1980s and already when he was the single Chairman of Springer, Peter Tamm had a share in the publishing houses Schiffahrts-Verlag "Hansa" C. Schroedter & Co. and Herforder Verlag für Verwaltung und Wirtschaft. He became the sole owner in the 1990s.

He was also engaged as a manager in the publishing houses E. S. Mittler & Sohn, Koehlers Verlagsgesellschaft (both established in 1789), Maximilian Verlag (est. 1937) and Verlag Offene Wort, with the latter tasked with the publication of the Bundeswehr's troop magazines, among others. In 2008 his son Peter Tamm junior acquired the publishing houses and merged them under the roof of Tamm Media. Since then, the portfolio has been subject to dedicated enhancements, among them the acquisition of the publishing house Report Verlag in 2011. As a result of the concentration of all publications in the area of security and defence in what is today Mittler Report Verlag, this publishing house became Germany's leading specialist publisher in this segment.

Professor Tamm's particular affinity for the German Navy is also exposed by the year-long publishing of the "MarineForum" specialist magazine on order to the German Maritime Institute and the Naval Officers Association. The salute of the German Navy at his funeral has to be interpreted as appreciation of his lifetime achievement.

In his preachment Reverend Adolphsen found the right words for a day in honour of the farewell to Peter Tamm: "Let us not grieve for having lost him; instead, let us be thankful for his having been with us."

We, too, commemorate Professor Peter Tamm with great gratitude and with respect for his lifetime achievement.

**Publishing House and Editorial Department Mittler Report Verlag GmbH
with the magazines "Europäische Sicherheit & Technik" and "European Security & Defence"**



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Photo: NIMR

- Security Policy
- Armed Forces
- Defence Industry

Pages 17-28

2 In Memoriam of Professor Peter Tamm

■ SECURITY POLICY

- 10 **NATO on its Way from the Warsaw to the Brussels Summit – A Polish Perspective**
Tomasz Szatkowski
- 15 **Russian-Turkish Convergence and the Black Sea**
Eugene Kogan

■ REGIONAL FOCUS: UNITED ARAB EMIRATES

- 17 **United Arab Emirates – Good Times at the Crossroads?**
Thomas Bauer
- 21 **The United Arab Emirates Defence Environment**
David Saw
- 25 **Sharpening the Falcon's Claws**
United Arab Emirates Strengthens Its Defence
Heiko Borchert and Shehab al Makahleh

■ ARMED FORCES

- 29 **Operation "Alpenglow...?" – Austrian Federal Army 2017**
Georg Mader
- 34 **ASW Capabilities of the Italian Armed Forces**
Giulia Tilenni
- 36 **Indian Air Force: Grand Ambition**
Jay C. Menon

■ ARMAMENT & TECHNOLOGY

- 42 **Filling The Firepower Gap: Mortar Developments**
David Saw
- 49 **Satnav and Inertial Sensors Team to Guide the Soldier**
Doug Richardson
- 53 **Clear the Battlefield and Let Me See**
Doug Richardson

Austrian Federal Army



Photo: Bundesheer

After decades of steadily declining military expenditures a respective annual budget will be provided until 2020. **Page 29**

59 Shootout in Virtual Reality

Tamir Eshel

64 The Whys and Wherefores of Precision Guided Munitions

Tim Guest

■ INDUSTRY & MARKETS

68 Future Markets and Trends for the Defence Business

Interview with Giovanni Soccodato, EVP Strategy, Markets and Business Development, Leonardo

71 International Demonstration Day at EXPAL

Waldemar Geiger

73 Shared Burden to Gain the Most Modern Air Defence System

Interview with Joe DeAntona, Vice President and Business Development Executive, Raytheon Integrated Defense Systems

77 Collaboration, Organisation, Communication – We Are Learning

Interview with Kelly Ortberg, CEO, Rockwell Collins

■ VIEWPOINT FROM ...

14 Kiev

Denys Kolesnyk

41 Islamabad

Zafar Khan

■ COLUMNS

- 3 Editorial
- 6 Periscope
- 47 Masthead
- 75 Firms & Faces
- 80 Preview

Index of Advertisers

AIM INFRAROT MODULE GmbH	57
ASDA 2017	33
boger electronics GmbH	53
EW Europe 2017	70
FMV	63
GEROH GmbH & Co. KG	58
Hirtenberger Defence Systems	43
IDEF 2017	19
InfraTec GmbH	55
ISDEF 2017	37
ITEC 2017	62
LAAD 2017	48
Leonardo	4th cover
Mercedes-Benz	2nd cover
NAVDEX 2017	7
NITEC17	23
Sensor AS	51
TTS Theissen Training Systems GmbH	61
UDT 2017	5
U.T. Sec	54
Underwater Defence & Security	75

Index of Advertisers IAV Special

ARTEC	3
ATM	27
BIDEC	3rd cover
Bren-Tronics, Inc.	13
FNSS	4th cover
Future Indirect Fires Conference	31
General Dynamics European Land Systems	5
GuS Glass + Safety	25
HOMSEC	17
Renk AG	11
Rheinmetall Defence	15
Tyron Runflat Ltd	23
YUGOIMPORT-SDPR J.P.	2nd cover



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■ Air-To-Ground Capability of IRIS-T

(df) Diehl Defence announced the extension of its proven state-of-the-art short-range air-to-air missile IRIS-T (Infra Red Imaging System Tail/Thrust Vector-Controlled), that has already been selected for the combat jets Eurofighter TYPHOON, F-16, EF-18, TORNADO and GRIPEN. Now the missile is also usable in air-to-ground engagements, a capability that has been tested successfully by the Norwegian Air Force. After its initial optimization for air-to-air use, it has already been procured for short-range (IRIS-T SLS) ground-based air defence. Now the functionality has been enhanced with an air-to-surface engage-

Photo: Diehl Defence



ment capability. This basic air-to-ground capability provides the ability to acquire, track and engage individual ground targets like boats/ships, small buildings and vehicles and has been successfully verified in a test firing from a Norwegian F-16. As part of full aircraft integration, IRIS-T supports a configuration with various sensor systems including radar and Helmet Mounted Cueing Systems (HMCS) ready to use in existing aircraft systems.

■ Modernisation of German Mine Hunters

(df) ATLAS ELEKTRONIK received an order from the Federal Office of Bundeswehr Equipment, Information Technology and In-Service Support (BAAINBw) to modernise three FRANKENTHAL class (class 332) mine hunters of the German Navy. The contract is worth €78.5M. The project, under the designation MJ 332 CL, aims to equip the ships with the new IMCMS (Integrated Mine Counter Measure System) and the unmanned underwater system SEAFOX of ATLAS ELEKTRONIK. In addition, the mine hunters receive the steering capability for the unmanned surface system SEEHUND,

Photo: ATLAS ELEKTRONIK



which has so far been integrated into the ENSDORF class (class 352). The project will be completed by 2020.

■ Vehicle Mounted Mortar for the Swedish CV90

(df) BAE Systems has received a €60.5M contract for the installation of vehicle mounted mortar systems on Swedish Army CV90 Infantry Fighting Vehicles. "The installation of the company's mortar system, known as MJÖLNER, on 40 CV90s will considerably increase the indirect fire capability of the vehicles to support mechanised battalions," the company stated. CV90 is a

Photo: BAE Systems Hägglunds



family of Swedish tracked combat vehicles designed for the Swedish Defence Materiel Administration (FMV) by BAE Systems Hägglunds and BAE Systems Bofors, which provides the vehicle's turrets with over 500 in use with the Swedish Army. "The delivery of the Mjölner solution to the Swedish Army allows it to field a capability well adapted for the CV90 while enhancing the fleet's firepower," said Tommy Gustafsson-Rask, managing director of BAE Systems Hägglunds. First deliveries are scheduled to take place in the first quarter of 2019.

■ INVISTA Introduces New CORDURA Products

(ck) INVISTA is producing a range of versatile fabric technologies, including CORDURA Dyed Nylon technologies with built-in NIR/SWIR reflectance capabilities, lightweight comfort NYCO Tactical uniform fabrics and FR (flame retardant)-coated brand polyamides for protective vests. "We are constantly evolving our technologies to address the unmet needs of future soldier programs around the world," said Anthony Green, global CORDURA brand business director. "Ultimately, our goal is to develop reliable, innovative fabric solutions that help equip soldiers to meet the battlefield challenges of today and tomorrow." For 50 years, CORDURA has been driving textile innovation with fabrics used in combat gear, such as CORDURA SDN yarn technology. These fabrics are used in carriage equipment, boots, body armour covers, knee/elbow pads and other similar gear. Available in a palette of six military colors that meet both lot-to-lot shade

and IR requirements, these textiles have built-in NIR/SWIR reflectance capability as well as resistance to sunlight UV fade and strength degradation. Focusing on lightweight comfort, NYCO Tactical fabric is the latest innovation: This optimized fabric is a comfort blend of INVISTA T420 fiber and cotton. It is engineered to provide protection for warfighters and their equipment through US Mil-Spec performance at a lighter weight and exceptional durability. The newest FR-coated CORDURA nylon 6,6 fabrics are premium protective/ballistic vests for soldiers. These fabrics are tested to meet DIN EN ISO standards for protection against heat, flame and thermal propagation in protective apparel and footwear.

■ Reliable Non-Detectable Off-Grid Power for Armoured Vehicles

(ck) SFC Energy, a producer of silent, non-detectable, lightweight off-grid power supplies for portable and stationary defense applications, has been cooperating closely with the German Bundeswehr and the US Army for over 10 years. SFC developed the new fuel cell EMILY. Electronic systems on board of armoured vehicles, e.g. audio and video surveillance, communication, optronic and weapon equipment, are becoming ever more power-hungry. They must be reliably powered at any time, also in a standing vehicle. This calls for lightweight, reliable, portable off-grid power sources. As conventional solutions are limited, SFC fuel cells are a silent, lightweight, non-detectable alternative. Fuel cells are connected to batteries, which they automatically recharge on demand. Thanks to the high energy density of their fuel (30 times higher than that of lead acid batteries and 7 times higher than that of Li-ion batteries), they enable much power at minimum weight and volume. This ensures long power autonomy and makes them the ideal power source in vehicle-based and stationary defense missions. SFC Energy's EMILY fuel cell provides reliable mobile or fielded power in multi-day missions. It recharges batteries automatically on demand, 24/7, with minimum user attention and almost zero thermal or noise emissions. The EMILY fuel cell is also ideal for fielded surveillance missions. It can be either used as standalone power source or in hybrid operation with other power generators, i.e. solar modules. Intelligent power management ensures the fuel cell will only start operation, when the other power generators do not produce enough power any more. An additional benefit of fuel cells is their small size.

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UAE Armed Forces

■ Enhanced Control and Display System for NATO Missile Firing

(df) IDE (INTRACOM Defense Electronics) has completed the delivery of the Enhanced Control and Display System (ECDS) to the NATO Missile Firing Installation

Photo: IDE



(NAMFI). ECDS supports exercises with real ammunition of ground-to-air and ground-to-ground weapon defence systems by using state-of-the-art technologies for data processing and the display of geographical information. The system interfaces with a large number of peripheral systems and unmanned flying targets. It provides in real time a consolidated and reliable tactical image of the field of operations to the NAMFI operators. The new system has already been tested with excellent results during the joint air defence exercise conducted by the Armed Forces of Germany and the Netherlands on October 5 and 6, 2016. The users have expressed full satisfaction with the high quality of the work delivered, both in technology and in time frame level and also for the organisation and effectiveness of IDE in the various stages of the ECDS project implementation.

■ Kongsberg Wins Contract for the FRIDTJOF NANSEN Frigates

(df) Kongsberg has won the order of the Norwegian Defence Material Agency (NDMA) to update the combat management system and the active sonar system of the FRIDTJOF NANSEN class frigates. The value is €2.8Bn and will be delivered over the next four years. "Kongsberg is pleased to be part of the upgrade programme extending the lifetime of the systems on board the FRIDTJOF NANSEN class," said Eirik Lie, Acting President of Kongsberg Defence Systems. "Kongsberg is a leading combat system supplier for ships and submarines delivered to eleven nations around the world, and this contract confirms our

Photo: Kongsberg



strong position." Kongsberg has supplied the anti-surface and anti-submarine warfare systems based on the company's combat management system architecture and integrated with the Aegis combat system. Kongsberg has also conducted update and maintenance activities regularly since the class was introduced.

■ Weaponised UGV

(gwh) Milrem, the Estonian defence solutions provider, and ST Kinetics, the Asian land systems company, jointly developed the first weaponised fully modular unmanned ground vehicle (UGV), the THeMIS ADDER (Tracked Hybrid Modular Infantry System). In November they performed



Photo: Milrem

successfully first live fire test with the co-operation and supervision of the Estonian Defence Forces. The UGV was equipped with a CIS 50MG but can be outfitted with smaller and larger calibre weapons as well. The THeMIS has a payload of 750-1,000 kg, speed of 24 km/h and up to ten hours operation time.

■ IEE Upgrading Passive Attack Display (PAD) for F-15C/D

(ck) Industrial Electronic Engineers (IEE) is a provider of enhanced displays for military, industrial and retail applications and currently under contract with Boeing Defense, Space & Security to develop an upgrade to the F-15 Passive Attack Display (PAD) for compatibility with the Advance Display Core Processor (ADCP) II. The PAD uses an ARINC 818 fiber optic interface to receive video from, and exchange messages with the ADCP II. The ADCP II facilitates the centralization of a number of critical display functions, such as the consolidation of multi-window configurations into one complete screen image for distribution to display units. This addresses the need for the ever-increasing amount of information available to operators to improve situational awareness. The F15-PAD upgrade features twelve programmable discreet interfaces, each of which can be provisioned by the ADCP II to three different types of inputs and outputs. These discreets can be used for other aircraft functions, giving the PAD a built-in service life extension.

■ L-3 Warrior Systems to Deliver Precision Targeting System to US Army

(ck) L-3 Warrior Systems – Insight Technology (L-3 Insight Technology) has won a €18,6M production contract from the US Army for its Small Tactical Optical Rifle-Mounted (STORM) SLX system, a smaller and lighter version of its current STORM precision targeting system. The STORM system is a battery-operated laser range-finder (LRF) with integrated multifunction



Photo: L-3

lasers and a digital magnetic compass (DMC). The LRF and DMC can be used in combination to obtain accurate location details for precision aiming, target acquisition, target/area illumination and other tactical applications. The STORM SLX has seen a size and weight reduction of more than 30% which allows the system to be applied to numerous weapon platforms. For customers the three most important factors are performance, weight and size: "We continuously improve our products to ensure we are pushing the limits of technology with their priorities in mind," said Todd Stirtzinger, President of L-3 Insight Technology.

■ Situational Awareness Even of Small Drones

(df) During the latest Unmanned Aircraft System (UAS) Traffic Management (UTM) flight tests, which were conducted by the NASA, the Location Information Service of Frequentis provided situational awareness for ground control stations. The Frequentis' Location Information Service (LIS) is at the core of the company's UTM client software and provided accurate geo-location and telemetry data received from Drone Co-Habitation Services LLC (DCS) drones and other UAS detected by the LIS service. The LIS service read the data, transformed it into structured messages, and submitted it for processing to the central UTM service operated by NASA's Ames Research Center. Multiple teams flew their drones beyond the line of sight of their operators in order to test the planning, tracking and alerting capabilities of NASA's UTM platform. NASA's "out of sight" tests, conducted in coordination with the Federal Aviation Administration and several partners, were the



Photo: NASA

latest waypoint in solving the challenge of drones flying beyond the visual line of sight of their human operators without endangering other aircraft. Frequentis is actively participating in research activities and cooperates with Air Navigation Service Providers (ANSP) around the globe to integrate small UAS into the airspace as the number of drones is expected to exceed the number of aircraft in approximately five years. At the moment, small UAS flight operations are only permitted in uncontrolled airspace up to 400 feet, and respectively 500 feet depending on national regulations, within visual line of sight of the pilot. This exempts them from classic air traffic management, which raises major safety concerns.

■ Cyber Defence Contracts Awarded to Raytheon

(df) The Defense Advanced Research Projects Agency (DARPA) has awarded Raytheon multiple contracts to research and develop technologies that will detect and respond to cyber attacks on the US power grid infrastructure. The contracts, which total €8.4 million, were awarded under DARPA's Rapid Attack Detection, Isolation and Characterization Systems programme. "During the last two decades, industrial control systems have evolved so that most are now connected to the Internet, mak-



Photo: US Army

ing them vulnerable to cyber attack," said Jason Redi, Vice President Raytheon BBN Technologies Networking and Communications unit. "A significant power disruption would have profound economic and human costs in the U.S, so our goals are to prevent attacks and to reduce the time required to restore power after an attack." Under the terms of the contract Raytheon will create technologies to provide early warning of an impending attack and de-

tecting adversary spoofing of power grid data collection and communication. This will also maintain situational awareness in the immediate aftermath of an attack. The company will also examine methods to maintain secure emergency communication networks in the aftermath of an attack. Raytheon's approach seeks to isolate affected organisations from the Internet and establish a secure emergency network.

■ New FN SmartCore Provides Enhanced Shot Counter Technology

(ck) Belgium-based FN Herstal has launched its new, self-powered FN SmartCore shot counter for the FN SCAR family of rifles based on breakthrough technology. With this device for the first time electronics is integrated into a product and generates its own power. The new FN SmartCore

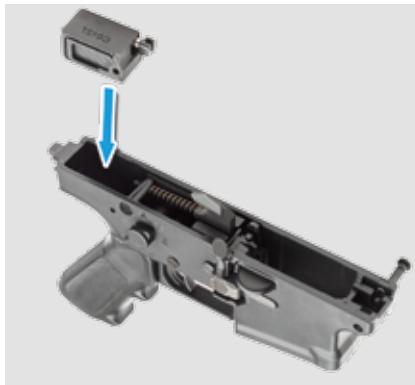


Photo: FN

is a no-battery device located inside the lower receiver of the weapon and detects firing of the weapon by using the rearward movement of the moving parts – hence, requiring no battery and no maintenance. The FN SmartCore shot counter uses fully automated software to provide precise information about a firearm. It acts as a firearm's life memory or electronic logbook of the maintenance history of the firearm and other user-defined information. This

includes the number of shots, its base location, whom it is issued to and its operational condition. The FN SmartCore can collect information automatically or upon request with no impact on the user's mission. Any data is transmitted wirelessly at short-range only and upon request, ensuring it is undetectable and there is no unintentional emission. The FN SmartCore can be housed in any rifle in the FN SCAR family.

■ Tatra Trucks for Czech Armed Forces

(gwh) The Czech Ministry of Defence received a delivery of 26 Tatra T-810 flatbed trucks. They will be followed by 40 T-815 heavy and medium trucks with container loaders and 41 T-815 transporters for PRAM 120-mm-mortars by May 2017. Since 2008 the Czech military has been replacing older logistical Tatra vehicles modified according to the requirements of the Czech Armed Forces. The Czech inventory contains about three thousand T-810 and T-815 trucks in various configurations, including vehicles with protected cabins that are generally earmarked for international operations. Tatra trucks are equipped with the time-tested chassis platform which allows for the attachment of a variety of superstructures. Between 2008 and 2009, the military procured 588 Tatra trucks with eight design modifications which comply with specifications agreed upon two years earlier.



Photo: CTK

■ CHALLENGER 2 Contracts Awarded to BAE Systems and Rheinmetall

(df) The United Kingdom Ministry of Defence has awarded the contracts for the CHALLENGER 2 Life Extension Programme (CR2 LEP). The agreements with BAE Systems and Rheinmetall Landsysteme GmbH are worth €26.6M each and signal the start of the competitive Assessment Phase. "We are building the most adaptive force to meet the threats of the future and this phase will enable the companies to develop innovative upgrades which will keep the formidable CHALLENGER 2 Main Battle Tank, crucial for the delivery of a modern ground manoeuvre warfighting capability as part of Joint Force 2025, in service with the British Army until 2035," the British MoD stated and continues: "The MOD's investment will allow BAE Systems and Rheinmetall to undertake technical studies, produce detailed digital models and consider how upgrades will be integrated onto the current platform." At the end of the two year assessment phase the companies will present their solutions to the MoD for consideration. The Demonstration and Manufacture Phases of the project will then follow.

NATO on its Way from the Warsaw to the Brussels Summit

A Polish Perspective

Tomasz Szatkowski

The developments that have taken place in Europe over the past decade have significantly lowered the threshold of using force. This development became visible to all in Georgia in August 2008 – when Russian armed forces invaded deep into Georgian sovereign territory – and since then has continued in multiple places in Europe.

Several Central and Eastern European (CEE) states – with Poland playing a key role – discerned this development already in 2007 and 2008 and were alarmed by its grim consequences. But the threat perception was not imminent to the Alliance as a whole. The “quiet days” between the Alliance and Russia lasted only a few months, although Moscow has never fully delivered on its commitments from the ceasefire agreement struck in 2008.

Essentially, one significant actor of the European security architecture has returned to a philosophy based on spheres of influence and a zero sum game, rather than cooperative security and a win-win approach. Its tactics based on intimidation, use of force, and blatant violation of international law, both overt and covert, have re-awakened the ghosts of the past. Times of heightened uncertainty have arrived. When closely analysing the developments, the following years between 2008 and 2014 only exemplified the Russian path to a revanchist state, and finally in the run up to the Wales Summit it became obvious to the entire Alliance that the European security landscape has changed significantly. As a result, NATO has started to adapt to those challenges with some decisions at the Wales Summit, after all.

The assurance and adaptation measures approved at the Summit in Wales, in conjunction with EU and global sanctions, have shown resolve and determination.



(Photo: MoD Poland)

The transatlantic community has understood that a continuation of permissive policy may lead to a pan-European disaster not unlike that of 1939–1945.

Concrete Steps Taken by NATO

A few concrete steps taken by NATO are of particular importance. Firstly, the enhancement of the NATO Response Forces (NRF) both by a larger size and increased readiness level. Within this element, a Very High Readiness Joint Task Force (VJTF) has been created.

Secondly, the Multinational Corps North-East (MNC NE) in Szczecin has been upgraded to high readiness level with significantly strengthened personnel in order to

ensure its ability to provide command and control functions for the reformed NRF, if deployed to the region. It is worth noting that since 2014 the number of MNC NE flags has grown from 13 to 24. This is a significant signal of Alliance solidarity.

Thirdly, a network of small command and control cells, known as NATO Force Integration Units, has been set up across the territories of eight allies on the Eastern flank. Increased situational awareness has also been ensured by NATO’s intelligence and surveillance assets. All the above-mentioned measures have considerably increased the ability of NATO to react to any potential threat and, if required, to deploy reinforcements to allies in need.

But the Wales decisions, although a step in the right direction, still lacked some necessary elements that would ensure a proper deterrent posture of the Alliance. It has become clear that even the fastest

(Photo: Staff Sgt. Elizabeth Tarr/US Army)



A US soldier jumps from an armoured vehicle during suppressive fire training with Ukrainian counterparts in Yavoriv, Ukraine, in November 2016.

Author

Tomasz Szatkowski, Undersecretary of State and responsible for defence policy in the Ministry of National Defence of the Republic of Poland.



The Ministers of Defence at the NATO summit in Warsaw 2016

reinforcement may not be sufficient if the adversary's attack is rapid and concealed in form of a hybrid action, making it difficult to assess the real origin and magnitude of danger. Moreover, Russia has continued its aggressive policy towards Ukraine and began an irresponsible and potentially dangerous campaign of military demonstrations in the Baltic region, both at sea and in the air.

Finally, Moscow has further developed its anti-access/area denial (A2/AD) capabilities which, when activated, would also cover significant parts of Alliance territories, decreasing NATO's ability to provide effective reinforcements. The most recent concealed deployments of its ISKANDER missiles to the Kaliningrad Oblast on civilian ferries are not helpful, either, for the creation of a conducive and predictable international security environment.

In light of these developments, the NATO Summit in Warsaw has been crucial for the future security in Europe. Decisions taken by the heads of states and governments were to significantly strengthen the NATO deterrence and defence posture in order to send a decisive signal to Russia: first, that the Alliance is coherent; second, that its freedom of action across the Eastern Allies is not undermined; and third, that it has an adequate set of necessary capabilities and procedures to ensure that any Russian incursion on Alliance territory, both conventional and hybrid, would be costly for the adversary and would be met with a proper response.

These decisions alone would already be a significant agenda for the Summit. In addition, however, NATO needed to adapt to challenges emanating from the southern strategic direction. The overall instability in the Middle East and North Africa caused by civil wars and terrorist activities has re-

sulted in an unprecedented wave of migration flowing into Europe. Unfortunately, contrary to Russia's announcements, its engagement in that region has only exacerbated the situation in Syria.

Warsaw Summit Outcomes

The main goal of the Summit was to address this deteriorating security situation in NATO's eastern and southern neighbourhoods. In order to effectively accomplish that goal, we needed to ensure that the decisions that were about to be taken were concrete, timely and universal. In other words, they were to offer specific, well-tailored solutions for current and foreseeable challenges and they were to address concerns of all allies, regardless of their geographic location. We managed to accomplish that, and simultaneously we manifested strong allied coherence and solidarity.

From Poland's point of view, the key result of the Summit was the decision to strengthen the security of NATO's eastern flank. The Alliance agreed to establish an enhanced Forward Presence (eFP) of multinational NATO forces in Poland and the Baltic States. Four battle groups will be deployed with Canada, Germany, Great Britain and the United States as framework nations. The US declared to be a framework nation for the battle group to be positioned in Poland. We welcome the British, Romanian and potentially other nations' declarations to additionally strengthen our security by deploying their troops to Poland as well.

Likewise, from our side, we have made a decision to support Canada in the battle group in Latvia with an armoured company. In addition, we have also offered, on a reciprocal basis, to deploy a company-sized element to Romania as part of the

allied forward presence for the southern part of the eastern flank. Here the Polish-Romanian mutual commitment made at the Summit serves as a key symbol of the consolidated and mutually supporting eastern flank against any threat emanating from the East.

Support of and by its Eastern Members

The creation of battle groups constitutes a fundamental correction to the philosophy of how the Alliance would support its Eastern members in a time of need. Since the NATO enlargement of 1999, it was to fulfil Article 5 commitments for its new members by sending reinforcements rather than establishing a long-term presence there. The eventual result was an imbalance in the distribution of NATO commands and forces between old allies and those that have since joined NATO. The battle groups will complement the reinforcement strategy which, as mentioned above, has been strengthened since the Wales Summit in 2014. Although the battle groups may be perceived as a modest force, they will play a multitude of functions, as they will send a strong political message (practical example of allied commitment), possess robust combat capabilities reinforcing the host-nations' forces, deter possible hybrid threats by decreasing the deniability factor and, last but not least, be ready to engage in a potential crisis situation from its very outset.

We also stand ready to provide a Multinational Division North-East headquarters, which would exercise command and control over the eFP elements and some other forces in the region, and act as an intermediary command & control (C2) structure between the eFP and the MNC NE HQ in

Polish F-16



(Photo: AJFCB)

Szczecin. Such a multinational HQ at a tactical level is militarily required for effective C2 in the region, being a linchpin between the corps and the battle groups. Although the security challenges on the Eastern flank are of vital importance to us, Poland perceives its security interests in a wider perspective. We value the decisions concerning strengthening NATO's posture on its southern flank and we are determined to contribute to the current and future allied activities in that strategic direction. Hence, in the spirit of solidarity with other allies, we took a decision to participate in the allied operation in the Aegean Sea. By conducting reconnaissance, monitoring and surveillance, the mission is set to support efforts to tackle the refugee and migrant crisis. Simultaneously, we have strengthened our efforts in the Counter-ISIL (C-ISIL) coalition by deploying for the first time in Poland's history our F-16 aircraft and providing Special Operation Forces (SOF) training and advice in theatre. We also made significant efforts to support Jordan in its C-ISIL endeavours.

Special Role of Polish-US Relations

The new, reinforced allied presence will be larger and more deterrent in nature. In this respect, we particularly welcome the US decision to deploy to Central and Eastern Europe (CEE) an Armoured Brigade Combat Team (ABCT), starting from January 2017. The ABCT elements and headquarters will be deployed to Poland, which will serve as a hub for the ABCT, from where it is to move to other places in CEE. Together with our American ally we aim to fully use the potential created by the US European Reassurance Initiative, including, but not limited to, the ABCT. We continue our cooperation in missile defence via the construction of the Ballistic Missile Defence (BMD) site in Redzikowo which commenced in May 2016, but also advance our air force training through the Aviation Detachment and deepen the cooperation of our special operations forces. All these endeavours are a visible proof of constantly growing Polish-US defence cooperation which, in light of

the current security challenges in Europe, gains even more meaning. Steadily, while Poland is becoming a centre of gravity for US reinforcements in CEE, we are bringing the mil-to-mil cooperation to a higher and mutually beneficial level.

Other Formats of Allied Presence in Poland

Concurrently, a number of Allies will commence or strengthen their support to our region conducted on a bilateral basis but maintaining coherence and unity of effort with the deployments under the NATO flag. Up to now, this presence has focused on joint exercises and training. Two allies have already been continuously present since 2014 under the assurance measures: most notably US forces in the form of consecutive company-size detachments (armoured, mechanised, and airborne) and the Canadian forces (Maple Detachment). Others were being deployed to Poland for shorter periods, just to mention forces from Great Britain, Germany, France, The Netherlands, and Belgium. Their troops were provided with many opportunities to train with Polish forces and other allies during numerous exercises on our territory. The most significant of them was this year's multinational ANAKONDA-16 exercise with the overall participation of over 30,000 troops at sev-

eral training areas and firing ranges across Poland.

In sum, the allied presence on Polish territory, together with our engagement in the enhanced Forward Presence (eFP), creates additional opportunities for further bilateral cooperation with our partners from Great Britain, Romania, Canada and Latvia.

Polish Engagement in Assurance Measures

Apart from our readiness to actively participate in eFP, Poland has been engaged in activities aimed at increasing the security of the region as a part of assurance measures. We already deployed (from May till August 2016) a motorised company to the Baltic States. We decided to continue this cooperation throughout the next year within the Visegrad Group format. We have also been engaged with six deployments in the past years in the Baltic Air Policing and we will continue such activities in the years to come. We are also ready to deploy our fighters to conduct air policing missions in the southern part of the eastern flank.

Partnerships on the Eastern Flank

The defence and deterrence of the Alliance is a key NATO task. We cannot, however,



(Photo: Ministry of National Defence of the Republic of Poland)

30,000 soldiers from 23 countries participated in ANAKONDA-16, the biggest exercise conducted on Polish territory since the end of the Cold War.

weaken our support towards eastern partners: Ukraine, Georgia and Moldova. The Warsaw Summit sent a strong message, confirming NATO's solidarity with these countries. Now we need to carry on with this policy. Poland will continue her support for Ukraine, Georgia and Moldova, both on the bilateral and the multilateral levels. We will also aim at sustaining good neighbourhood relations with Belarus.

The Future of the Alliance

Given the Warsaw decisions, we now expect nothing less than solid engagement from the allies in order to properly implement the decisions taken at the Summit. We actively take part in the political process and await decisions to be transferred into concrete military mechanisms as soon as possible. The NATO Brussels Summit in 2017 should constitute a milestone in this regard. In short, following the announcements, the Alliance now needs to walk the walk.

There are, however, other issues to be addressed in the foreseeable future. The three essential core tasks of NATO: collective defence, crisis management and cooperative security, should be properly redefined, according to the new security environment. The discussion will help to better identify our priority defence policy goals, including the direction of the dialogue with Russia.

Another important process that needs to be managed is the assessment of the effectiveness of the NATO Command Structure (NCS). Similarly to the Strategic Concept, the NCS was laid out to operate in the former security environment. However, since 2014 the NCS has been given a multitude of new tasks. This altogether creates significant challenges for its effectiveness. A bottom-up analysis viewing both the NATO Force Structure (NFS) with its Corps HQs and the NCS is needed in order to determine a suitable fit for purpose NCS meeting the military requirements in the new realities.

The evolving security environment has also shown a need for an organised and coherent regional situational awareness centre. Poland is in favour and capable of establishing an entity in order to provide robust intelligence, surveillance, and reconnaissance for the eastern flank. We also strive to strengthen maritime cooperation in the Baltic Sea by establishing a Baltic Maritime Force HQ. In this respect we envision that these two projects will be developed in a multinational format. Hence, in the latter two cases we count especially on close cooperation with our neighbours.

Defence Spending and Armed Forces Modernisation

Poland, along with the United States, Great Britain, Greece and Estonia, is currently among a group of five NATO members fulfilling the allied Defence Investment Pledge (DIP) of 2% GDP expenditures on defence. If international circumstances require, we are ready to consider even further increases in defence spending. It is worth noting that, along with six other allies, we devote the recommended 20% of our budget on modernisation. Luckily, there are already some harbingers announcing an upward trend and soon the list of NATO allies meeting the DIP is to grow. Naturally, we are



155 mm howitzer KRAB

cognizant of the essence of the NATO Treaties' self-help clause (Article 3) requiring Allies to develop their own defensive capabilities. Therefore, Poland systematically develops its own defence forces and capacity to resist armed attack. Additionally, we are looking at bilateral ties and mechanisms to further enhance the security and defensive fabric of our country and region.

Currently, we are reviewing the armed forces modernisation plan with the aim of its subsequent publication. Our priorities include air and missile defence, navy, cyber defence, armoured and mechanised forces as well as territorial defence. The final decisions will be mainly based on the assessment of operational capabilities, the scope of the Polish defence industry's participation in the development and production, transfer of technology and naturally the price. Additionally, we have started another – the third – iteration of the Strategic Defence Review (SDR), to be concluded

in the first quarter of 2017, which will draw new guidelines for the Polish Armed Forces' development. This SDR, conducted with a new methodological approach, is to take into account the current, new security environment in Europe, particularly with a sober view of the potential threats.

Territorial Defence Force

In retrospect, the deteriorating security situation has an obvious impact on the structure and posture of the armed forces. We are in the process of forming a robust Territorial Defence (TD) force, which is becoming an entirely new service. It will complement the already existing regular

armed forces. The first three of a number of planned TD brigades are to be established and positioned in North-Eastern and Central Poland by the end of 2016. A more detailed layout and posture of those brigades will follow after the publication of the SDR. Overall, we have an ambitious plan to raise the number of troops from the current level of around 100,000 to a number well above that in the near future. Again, a thorough analysis ensuing from the SDR should specify the scope of this enlargement – predominantly of the TD Forces – of our force layout.

In sum, the adaptation of NATO is a work in progress. In order to make the 2017 Brussels Summit another realistic step forward, Allies need to show continuous political, financial and military commitment. In this respect, Poland's ambition is to be an example to be looked up to. Also, while stepping up to the plate, we are ready to actively contribute to the shaping of NATO's future. ■

(Photo: MoD Poland)



Viewpoint from Kiev



Ukraine: Reforming the Security Sector

Denys Kolesnyk
Political Analyst and Senior Partner at Defence Blog

For the first time since 1991 Ukraine faced real security challenges related to Russian military aggression and the annexation of the Ukrainian peninsula of Crimea in 2014. Before that, Kiev had been gradually decreasing its military personnel, and the standing army figure had dropped from roughly 800,000 in the early 1990s to 192,000 in 2012. That figure should have dropped even further, down to 70,000, in 2017, but everything changed. Taking into account that Ukraine is not a NATO member state, the Ukrainian government cannot count on foreign powers in terms of boots on the ground to fight the Russians. That is why Kiev quickly abandoned its neutrality and proclaimed once again its course towards NATO membership. Nonetheless, it is clear that despite the official declarations that the “doors are opened”, they, actually, remain “closed”.

Ukraine has drastically increased the numbers of its armed forces and their capabilities. In the recent years the Ukrainian defence budget saw an increase from 0.96% of GDP in 2013 to 5% in 2016, with even more foreseen for 2017. This allowed the Ukrainian Armed Forces to increase their personnel to 250,000 and to repair huge quantities of military equipment: even the monstrous 2S7 PION self-propelled howitzer has been restored and brought back into service.

The USA, the UK and Canada have launched Operation UNIFIER to bring some assistance to the Ukrainian security sector. Even though the operation does not transfer lethal armaments to the Ukrainian army, it still helps to increase capacity and improve training. Over the course of last year some 2,600 Ukrainian soldiers received training. This year may bring positive news to Ukrainians, since the US Congress has unanimously approved the supply of lethal armaments to Ukraine and military assistance for 2017 at the level of some US\$600M.

It is also worth noting that not only the Ukrainian army benefitted from the increased budgets and training, but also the national police and the National Guard as well. The US helped

to set up new SWAT units in Ukraine and just recently a new SWAT unit (KORD in Ukrainian) has been set up in the war-torn Donetsk region. Kiev focusses on small, rapid reaction forces, which is why in the framework of defence reform the Special Operations Forces have been created; something that the old post-Soviet Ukrainian army did not have. The new SOF units were established in May 2016 and are currently fully operational, dealing with the most difficult missions.

It is true that the defence sector reform is considered to be the most successful among other sectors' undergoing reforms, but we cannot overestimate the remaining requirements: a lot more remains to be done.

Ukraine's military industry is an important asset both in terms of national security capabilities and as a source of foreign currency. However, quite some people are unhappy that Ukraine sells new armaments such as OPLOT-M main battle tanks and modern BTR-4 armoured personnel carriers to foreign countries, instead of massively procuring them for the needs of national defence.

According to a recent poll, 67% of Ukrainians believe that their country is not moving in a good direction, in other words the government is not very popular. On the other hand, the citizens of Ukraine show strong support and trust in defence institutions, such as the Armed Forces and the National Guard.

In terms of international cooperation, it seems that Ukraine's defence industry will see an increase in cooperation with Poland, as was announced in 2016, and with the UK, especially in the aerospace industry. This assumption was reinforced by the visit of British Defence Minister Sir Michael Fallon to Ukraine's aviation manufacturer “Antonov”, which took place on 20 January 2017.

In 2017 there are many events and challenges ahead: there is a clear understanding in Kiev that the fate of the country remains solely in its own hands.

Russian-Turkish Convergence and the Black Sea

Eugene Kogan

It needs to be remembered that the Russian-Turkish rapprochement exposed weakness in President Recep Tayyip Erdogan, who backed down from his uncompromising stand versus President Vladimir Putin's clearly orchestrated policy of stick-and-carrot, namely severe economic sanctions imposed by Putin on Turkey that hurt the Turkish economy. And the end result was clear: the chill in bilateral relations demonstrated that Turkey was more dependent on Russia than vice versa.

The economic carrots were offered to Turkey after Erdogan asked Russia to “excuse us”, thus bringing to an end the seven months of being on hold. In other words, the precedent in bilateral relations was set and can then be repeated. Thus, the same policy of stick-and-carrot can be imposed on Turkey again, if and when Erdogan tries to support NATO's policy of strengthening Alliance involvement in the Black Sea region that Russia considers its sphere of influence. In the case of NATO strengthening its position in the Black Sea region, Erdogan's Turkey is likely to remain neutral even though verbally Erdogan will reiterate Turkey's commitment to the Alliance. In other words, two other NATO member states in the region, Bulgaria and Romania, need to redouble both financial and military efforts in order to substitute Turkey's implicit neutral position. It appears that NATO realised this point and is ready to come to their assistance. The details pertaining to that assistance will be revealed in late January or early February 2017.

Russian Economy Embracing Turkey

We also need to remember that the failed military coup of 15 July 2016 in Turkey has weakened the Turkish military in general and the Turkish Air Force in particular and, as a result, its willingness to participate in actions in the Black Sea region. It also needs to be emphasised that a large part of the Turkish Navy's bases are located away from the waters of the Black Sea region. In addition, Turkish military engagements in Syria, the fight against the PKK and the fight at home against the Gulenists – those follow-



(Photo: Kremlin)

Turkey's President Recep Tayyip Erdogan and Russia's President Vladimir Putin, a new partnership and cooperation?

ing the Islamic cleric Fethullah Gulen – distract the Turkish government from the Black Sea region.

What is more, the Black Sea region was not and it is not a top priority for the Turkish government foreign and security policy. Finally, the Turkish focus primarily on the economic agenda with Russia underscores the short-sightedness of the Turkish government and thus further puts Turkey under the control of Putin's Russia. The ever mentioned Turkish analysts and commentators claim that Russian-Turkish relations constituting a strategic partnership is based on sand and not on a realistic assessment. It can be said without exaggeration that the Russian economic noose has brought Turkey into a Russian embrace and it would be very difficult for Turkey to extricate itself from this.

On the other hand, Russia is free to pursue its policy of strengthening its position in the Crimean Peninsula with its significantly upgraded naval presence in the Black Sea and thus directly put pressure on Bulgaria and Romania. Michael Fallon, UK Minister of Defence, said in September 2016 that

London was concerned about military build-up in Crimea “and indeed the militarisation of the Black Sea region generally”. “Both Bulgaria and Romania feel very threatened” and vulnerable to the Russian economic and military intimidation. The latter point is likely to be dismissed out of hand by the Russian officials.

Lacking Interest in the Black Sea Region

We also need to remember and emphasise that Romania alone has been pushing for a formal NATO presence on the Black Sea since early 2016, while Bulgaria and Turkey remained unenthusiastic in their support. Mihnea Motoc, Romanian Minister of National Defence, said on 27 October 2016 that: “the political decision is to task the allied forces to come up by the end of January 2017 with proposals on two basic elements for the maritime component – a strengthened training framework and a coordination body for the Black Sea that reports to the specialised NATO command.

Author

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[Unidentified] countries for the first time expressed a willingness to financially participate to supporting security arrangements on the north-east flank [of NATO] as well as the Black Sea region.”

Jens Stoltenberg, NATO Secretary General, said after the 27 October meeting of the ministers of defence that six NATO members – Canada, Germany, The Netherlands, Poland, Turkey and the US – have “indicated their willingness to contribute to our presence in the Black Sea region, on land, at sea and in the air. Other Allies are also looking into how they can contribute.” It remains to be seen what exactly “willingness to contribute” is likely to entail.

Furthermore, any Turkish military contribution should be carefully scrutinised since Erdogan’s words are not likely to be matched by deeds as a result of the aforementioned Russian constraints.

No Serious Naval Capabilities in Georgia

Two other countries in the region, Georgia and Ukraine, that aspire to become NATO members in the foreseeable future are different in terms of naval capabilities and their potential contribution. For instance, the Ukrainian Navy commissioned two GURZA-M missile-capable patrol boats on 6 December 2016. Furthermore, Oleksandr Turchynov, Secretary of the Ukrainian National Security and Defence Council (NSDC), said on 30 November 2016: even though “we do not have many ships we are ready to participate in joint projects, such as joint patrols.”

Mikheil Janelidze, Georgian Minister of Foreign Affairs, was rather diplomatic by saying on 27 October: “Georgia participates in the NATO discussions regarding the Black Sea security in all relevant formats.” It should be stressed that Georgia lacks serious naval capabilities aside from the small number of the Coast Guard ships. Besides the Crimean Peninsula, Russia also holds a naval base in Ochamchira, Abkhazia (part of Georgia) from where it dominates the Black Sea all the way to the Turkish border.

As expected, Russia has strenuously objected to NATO’s already heightened activity in the Black Sea. Sergei Lavrov, Russian Minister of Foreign Affairs, said in mid-December 2016 that “the proposed Ukrainian and Romanian idea to create a permanent active NATO Group in the Black Sea we perceive as provocation.”

The fact that Russia has responded to NATO’s late decision by strengthening its position in the Black Sea with Russia’s rearmament and the expanded range of exercises and naval patrols is not considered



(Photo: picture alliance/abaca)

Turkey has quite some concerns aside from the Black Sea region or the Ukraine conflict: Turkish army commanders, ministers and family members attend funeral prayers for eight of the 28 victims of the explosion in Ankara on 19 February 2016.

provocation by Lavrov but rather business as usual. Well, we cannot expect Lavrov to admit that Russia is indeed strengthening its position even if General Valery Gerasimov, Russia’s Chief of the General Staff, acknowledges that point. General Gerasimov highlighted on 24 August 2016 several of the Russian fleet’s new acquisitions, including submarines capable of firing KALIBR LACM, new aircraft and the BASTION coastal defence missiles. Gerasimov said that: “There are three submarines in the Black Sea. One more will join soon. Another two will arrive in 2017.” In other words, render unto Caesar the things that are Caesar’s and do not dare to incur the Caesar’s wrath, to say the least.

Thus, it can be said that Russia is indeed interested in reducing NATO’s influence in the region by all available means including military. The latter point can no longer be disregarded. As presented above, the balance of power in the region has shifted in favour of Russia, something that the Russian officials would consistently deny since they live in their own created world, while NATO actions in the region are as usual coming late but fortunately not too late for the countries in the region.

Limited Actions by NATO

Still, NATO involvement comes with rather limited actions such as the creation of a multinational naval brigade of about 5,000 soldiers. Nikolai Nenchev, Bulgarian Minister of Defence, said on 26 October 2016 that “Sofia and Bucharest would work together and define their takes on the increased NATO deployment in the Black Sea by December.” December is over and no joint definition of the two countries was reached since in early January 2017 a new government in Romania was inaugurated, while the current government in Bulgaria remains an interim government with elections due in spring. Nevertheless, Bulgaria has agreed to participate with 400 soldiers in the multinational brigade in Romania.

Klaus Iohannis, President of Romania, said on 27 September 2016: “We believe that during 2017 we will be in the situation to declare the initial capacity of the multinational brigade and in the most optimistic option in 2018 this brigade will be functional.”

Whether or not NATO’s limited actions in the Black Sea region will deter Russian hostile actions against NATO member states as well as NATO partners, such as Georgia and Ukraine, remains to be seen. At least, after initial hesitance NATO, prodded by Romania, decided to step in. The end result of NATO stepping in remains to be seen.

On the other hand, Russian-Turkish rapprochement limits the Turkish place of manoeuvre in the Black Sea region and puts Bulgaria and Romania in a tight spot. The enhanced military co-operation between Bulgaria and Romania is required, but leaders of the two countries have slightly different views and opinions about the nature of the enhanced military co-operation.

In conclusion, Russian-Turkish rapprochement put extra constraints on any potential Turkish involvement in the Black Sea region security agenda. Whether or not the author’s assertion is dismissed out of hand by the Turkish officials is irrelevant since the analysis presented above supports the author’s assertion.

On the other hand, NATO officials need to understand that NATO’s strengthening in the region is indeed perceived as provocation by Russia. However, NATO has to stand its ground and not to give an inch to what Putin and his officials say loud and clear, namely ‘this region is ours and you, NATO, have nothing to do and/or perhaps seek here. Leave the region to the six littoral states’. This basically gives Russia a free hand to dominate the region.

It should be emphasised that Putin’s Russia respects strength and NATO has ultimately to speak to Russia from the position of strength. Therefore, what this author suggests that NATO do is no longer a tall order but a sober-minded and realistic approach. ■



United Arab Emirates – Good Times at the Crossroads?

Thomas Bauer

The Arab region has been at the focus of international security policy for many years. The conflicts motivated by religion and power-focused politics in the region as well as the expansion of terrorist forces associated with this instability to the rest of the world constitute a real threat to international stability and security.

This is topped by the endless stream of refugees seeking to flee a life without much future in the states of the Near and Middle East and trying to get a foothold in the societies of the western world, with their perceived standards of safety and security. The increasingly reticent commitment by the USA is creating a growing sense of uncertainty.

The Initial Situation

The United Arab Emirates (UAE), in the south-east of the Arabian peninsula, are composed of seven autonomous Emirates, which, after the Second World War, intensified their co-operation in the light of the increasing significance of the region due to the rising demand for mineral oil. In 1971, with the introduction of a provisional constitution, the UAE were established. Prior to this, Great Britain had withdrawn from its military bases in the region as part of a general de-colonialisation policy in the Arab world. 1996 saw the unification of the Supreme Dynasty with Abu Dhabi as the capital city and the implementation of the provisional constitution in its final form. The form of the state corresponds to that of a constitutional monarchy.

The main sources of income are the proceeds from mineral oil exports. About one

third of the gross national product attained in 2012, amounting to just on US\$380Bn, derived from dealings with this natural resource. The UAE are among the most oil-rich states in the world, but only three of the seven Emirates actually produce the black gold. The inequality in gross national product associated with this is equalised by a solidarity income compensation arrangement between the seven Emirates. The dependency on income from mineral oil demand makes the UAE, like many other countries in the Gulf region, dependent in turn on stable political conditions in the neighbourhood. This also applies to the strategically important seaway through the Strait of Hormus. There is the direct tension with Iran regarding the island of Abu Musa and the Tunb Islands, from which the Strait of Hormus and maritime trade in the Persian Gulf can be controlled.

At the same time, the potential ending of the resources of oil and gas in the region means that the country needs to create an additional basis for economic development in the future. For this purpose, the Abu Dhabi Economic Vision 2030 was developed, which aims to reach a greater diversification of the economic base and therefore less dependency on imports from abroad. To date, components of machines and transport vehicles account for 30 per-

cent of the imported goods. This also affects high-level technologies in the armaments sector. This is the dilemma of the UAE, because the income from mineral oil business cannot be invested simultaneously in a modernisation of the armed forces to strengthen the country's position in terms of security policy, and at the same time be invested in the building up of its own industrial and technological capacities in the armaments sector.

Demands for Defence Still on the Rise

Despite the efforts of the world's eighth largest mineral oil exporter to develop other sources of income, the sharp fall in crude oil prices has put a substantial damper on the attempts by the UAE to achieve a stronger competitive position. While a barrel of crude Brent oil in 2011 exceeded the 100 US Dollar mark for the first time in 2011, and by February 2014 had risen to a new peak of more than 110 US Dollars, thereafter it was downhill all the way. In February 2016 the price had fallen to 30 US Dollars. At year end 2016/2017, a barrel was fluctuating at around 55 US Dollars.

The state income of the UAE is stagnating, and economic growth can no longer attain the high targets set from the years 2011 to 2014. At the same time, the needs for defence are constantly increasing as a reaction to the growing tensions in the region, from US\$2Bn in 2001, US\$6.3Bn in 2008, to a present US\$15.7Bn, corresponding to a share of 7.3 percent of GNP. The entire budget is made up of payments from the individual Emirates, with Abu Dhabi and Dubai providing the main share. This means they also play a key role in the decisions on procurement. The joint involvement of the individual Emirates in the command structure is represented by division among regional commanders, despite the establishment of a central Ministry of Defence and headquarters in Abu Dhabi.

United Arab Emirates	
Emirates	Abu Dhabi, Ajman, Dubai, Fujairah, Ras al-Khaimah, Sharjah, Umm al-Quwain
Capital	Abu Dhabi
Total population	About 6 million
Total armed forces of the UAE	65,000
Land forces	59,000
Naval forces	2,500
Air forces	4,000
Annual budget	US\$15.7Bn (2015)
Share of budget in GNP	7.3 percent



The country is based on a purely professional army. Some 30 percent of the total of 65,000 military personnel come from other countries of the Middle East or from the area of southern Asia. Maintaining these forces, however, is becoming increasingly difficult for the UAE. On the one hand, the efforts by the Emirates to achieve greater diversification in employment have opened up new, and for the most part better paid, opportunities in the civilian sector. On the other, the increasing threat posed by ideological and religious radicalisation of the local population is incurring increased reservations towards foreigners in the armed forces, who, due to their originating from areas of unrest in the Arab region, are seen as a potential means of Islamic fundamentalists penetrating the ranks.

In terms of modern APVs, the UAE have opted for the AMV 8x8 from the Finnish manufacturer Patria. In a first lot, 40

In the air force sector, the UAE are pursuing a modernisation model oriented towards involvement in international coalitions. In

Photo: MBDA



MBDA has proposed BRIMSTONE for the GHANNATHA Class fast patrol boat.

Armed Forces in a State of Change

The origins of the United Arab Emirates Army (UAEA) go back to the 1950s, with the "Trucial Oman Scouts", a unit of some 2,500 men responsible for internal security tasks and patrols in the hinterland, commanded by a British officer. Following independence in 1971, these well-trained forces represented the foundation in terms of personnel for the individual armed forces of the Emirates, before they were integrated into the joint armed forces of the UAE.

The majority of the equipment of the present land forces is made up of French systems. The backbone is represented by some 370 MBTs of the LECLERC type. Added to these are large numbers of armoured personnel and transport vehicles, such as the AMX-10 or PANHARD. There are also other older systems of Russian origin in use, such as the BMP-3.

vehicles of this type are scheduled for procurement.

In the sector of reconnaissance and command vehicles, the UAE have decided on the NIMR type, a 4x4 off-road. These were originally developed and produced by the Jordanian branch of Advanced Industries of Arabia (AIA). With the arrival of Tawazun Holding in 2010, the former main owners, the Bin Jabr Group Ltd (BJGL), agreed on a relocation of production in 2011 to a newly established plant in Abu Dhabi. Order books are well filled. The corporation, renamed NIMR Automotive LLC, is in the meantime developing a whole family of 4x4 and 6x6 vehicles for the military sector. In 2012, based on a co-operation agreement with Algeria, additional production capacities were established in North Africa.

February 2009, Boeing succeeded in concluding a contract for the supply of four C-17 III GLOBEMASTERS to the UAE. At the same time, Lockheed Martin received orders for the delivery of 12 tactical transport aircraft of the C-130J-30 HERCULES type. By taking these steps, the UAE are seeking to develop their capacities in the air transport sector in order to take part worldwide in rescue missions and humanitarian operations.

The M-346 Alenia deal is also intended to bring the entire training programme for local combat pilots up to the level of operations in fourth-generation combat aircraft. At the same time, the country on the Persian Gulf is going to be the first customer in the Arab world for the new C-7 version of the Advanced Medium-Range Air-to-Air Missile (AMRAAM). The United Arab Emirates Air Force (UAEAF) operates 80 F-16 E/F Block 60 and some 70 MIRAGE 2000 units from Dassault in different versions. The F-16 of the UAE is superior to the FALCON in use with the American air forces, in the Block 50 version, which makes the UAEAF one of the most potentially powerful air forces around, even in comparison with European countries. The UAEAF has been able to demonstrate its effectiveness in sorties flown together with the USA and European partners against Islamist groups in Libya and engagements against ISIS in Syria and Iraq.

In the combat helicopter sector, the country is based on 30 units of the AH-64 APACHE LONGBOW. On transport helicopters the UAEAF operates different types, several from Airbus Helicopters, such as the AS-332 SUPER PUMA or the AS-565 PAN-

Photo: David Pin



The wealth of the UAE is built almost exclusively on oil.



THER, but also from other manufacturers like some 40 UH-60 BLACK HAWK.

Development of the Naval Forces

The country's naval forces, with a relatively modest number of personnel, have been based since 2003 primarily on 12 GHANNATHA high-speed patrol boats, developed in Sweden, and a number of torpedo boats. The first three GHANNATHA units were still produced in Sweden, but the other nine came from a shipyard of Abu Dhabi Ship Building (ADSB). The small number of vessels have undergone an extensive modernisation programme since 2009, while at the same time an order has been placed with ADSB for the construction of a further nine high-speed craft. Together with three further units produced in Sweden, the UAE can now deploy a total of 24 GHANNATHA high-speed units, equipped with more powerful diesel engines and a modern weapons guidance system, as well as with a 27 mm cannon from Rheinmetall, 120 mm mortars from Patria, and MARTE Mk 2/N guided missiles from Oto Melara. In addition to the high-speed vessels, the naval forces also operate patrol boats of the FALAJ-2 class, which are based on the Italian DICIOTTI class, in use with the Italian navy for coast-guard services.

The BAYNUNAH project is the biggest modernisation project of the naval forces. Abu Dhabi Ship Building (ADSB) are building six corvettes of the BAYNUNAH class for the United Arab Emirates Navy (UAEN), which are based on an updated concept from French manufacturers Constructions Mécaniques de Normandie (CMN). The ships are equipped with modern guided missile systems, among them EXOCET and RAM Block 1A. This project also aims to enhance the UAE's future effectiveness in the sectors of monitoring sea space, mine warfare, and the conducting of surface naval operations. By 2015 four of the six vessels planned had already been handed over to the UAEN. One problem of the vessels is the shortfall in submarine hunting capacity, leading to the solution that in addition to the two corvettes of the ABU-DHABI class ordered from

Fincantieri (similar to the Italian CIGALA-FULGOSI class), two further corvettes have been ordered from Etihad Ship Building to make up this deficit, especially in the light of the Iranian submarine programmes.

Industrial Capacities

The Stockholm International Peace Research Institute (SIPRI), in its latest annual edition, lists the UAE, with a share of 4.6 percent, at fourth place in worldwide armaments importers, behind India (14%), Saudi Arabia (7%), and China (4.7%). With regard to the widespread efforts in mod-

ernisation, however, the country's own industrial policy goals also have an important role to play. To name an example, there have been local capacities for maintenance in the aviation sector available for many years, in the form of the Gulf Aircraft Maintenance Company (GAMCO), a subsidiary of the state-run Mubadala Corporation. The company, now renamed ADAT, is de facto responsible for all the types of aircraft in use with the UAEAF. Based on an investment programme costing US\$500M, ADAT is seeking to secure international customers too in the ever more important business sector of Maintenance, Repair

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Photo: US Coast Guard



United Arab Emirates soldiers in US Coast Guard training

and Overhaul (MRO). With Al Talif Technical Services, in 2006 Mubadala planted the ADAT pendant in the land system sector as well. Al Talif is responsible for more than 20,000 of the UAE's vehicles.

Abu Dhabi Ship Building (ADAB) is trying to establish itself in the Naval Support Services sector with the hope to be the main contractor for all the naval forces in the Gulf Region in the future. Added to this are numerous agencies in the Research and Development sector, as well as an arrangement with Caracal International LLC, the only manufacturer of hand-held firearms in the region. The main owner of Caracal, Tawazun Holding, recently entered into a joint venture with Rheinmetall and the Saudi Al Jabr Group for the construction of a local production plant for munitions up to artillery shell level.

In December 2014 the Emirates Defence Industries Company (EDIC) was established, a State-owned corporate group in the armaments sector. This group unites a considerable number of armament-specific organisations of the Mubadala Development Company, Tawazun Holdings, and the Emirates Advanced Investments Group (EAIG). EDIC has taken over, among other things, control of NIMR Automotive Holding, managed by Tawazun.

International Commitment

Since the provision of airfields, ports, and other military installations to the USA and

other western allies in the Afghanistan campaign in 2001, as well as in the course of the preparations for the invasion of Iraq in early 2003, the UAE were clearly positioned in the pro-western camp. Indeed, as early as 1991 the country had participated within the framework of the Gulf Co-operation Council in the campaign to liberate Kuwait from the Iraqi invaders.

With the deployment and provision of helicopters and small forces following the NATO engagement in Kosovo in 1999, a period began of increasing involvement in humanitarian and peace-keeping operations by the United Nations.

The country provided aid to the population of Lebanon after the intervention by Israeli troops in summer 2006 with a number of transport resources. There were two major reasons for this commitment. On the one hand, the country wished to show itself as a reliable partner, both in respect of western allies such as the USA as well as towards the members of the Arab League, in which the UAE play an important role. The second reason was that involvement in foreign engagements are the best opportunities for the country's armed forces to gain practical experience. The issue here is to develop co-operation with other armed forces during the engagement. The intention was to be introduced to the technical potential and strike capabilities of the western forces. For this purpose, as

early as during the period from 1995 to 2005, a comprehensive programme was launched, costing US\$15Bn.

The Outcome

The armed forces of the UAE are regarded as a dynamic army in a time of change. Equipment and weaponry are almost on a par with those of western forces. In comparison with many European armed forces, they are in fact even better equipped. The main deficits, however, are shortfalls in the training of military personnel, in handling the modern systems, resulting in the current priority of procuring simulation systems and new training programmes. In 2010 and 2011 the first two satellites produced for the UAE by EADS Astrium and Thales Alenia Space were sent into space, catapulting the country into the age of Network Centric Warfare (NCW). The UAE is set on a path which aims to guarantee its safety and security in an environment becoming increasingly difficult. To reach this goal the country is prepared to show a higher degree of international participation and involvement. However, whether quality and sustainability in the areas of training and MRO can keep pace with the improvements in armaments technology will also depend on the financial resources given to the armed forces in the years to come. The further development of oil prices could therefore play a decisive part in the success of the comprehensive modernisation efforts in the Persian Gulf. The same applies to the efforts made in the industrial armaments sector.

The greatest risk for the country must be seen in the networks and derivatives arising from the power struggles in the neighbour countries. In particular, the entanglements of Saudi Arabia in the conflicts in Yemen and Syria, together with Russia's intervention in the Syrian conflict, have brought a partially contradictory mixture of security policy interests to the states of the Near and Middle East. The hopes of the USA that Iran, too, might assist in bringing stabilisation in Syria and in the region would scarcely simplify this confused situation, in view of the selective support by religious splinter groups during the respective individual conflicts in the Arab world. While the UAE are likewise compelled to ally themselves with a regional stabilisation offensive, there is no desire to be dependent on the goodwill of outside forces such as the USA or Russia, for the restoration and maintenance of security and prosperity in the Persian Gulf, in the long term. ■



The United Arab Emirates Defence Environment

David Saw

The United Arab Emirates (UAE) finds itself at the nexus of an extremely complicated foreign policy and security situation. The issues it faces include dealing with threat from state actors and diverse groups of non-state actors. Furthermore it has to do this while prices from its primary export commodity, hydrocarbons, are at a low level and are not delivering the necessary revenue. In addition the government also has to confront internal challenges in terms of developing more equitable social outcomes and providing a stable long-term future for the country.

It is important to briefly discuss the history of the seven Emirates that make up the UAE, as this helps to provide context for the foreign policy and security decisions being made today. From the 1500s onwards the Ottomans were the major power in the Gulf area, there was also a Persian presence due to geographic proximity and as time went on the Europeans, in particular the Portuguese, became a regional factor. No one major external power became dominant for any extended period of time though, but as British control in India grew and their naval presence increased they became concerned about securing the maritime trade routes to India.

In 1820 the Emirates signed their first treaty with the British, with subsequent treaties signed in 1843 and 1853. By this point the Emirates started to be referred to as the Trucial States, reflecting their treaty relationship with the British. The treaties recognised British influence over the Trucial States. By the 1890s other colonial powers were starting

to take an interest in the emirates and this led Abu Dhabi, Dubai, Sharjah, Ajman, Ras Al Khaimah and Umm Al Quwain to sign an 1892 treaty under which they became a British protectorate. The British would guarantee their borders and protect them from external aggression. The last of the seven emirates that would eventually become the UAE, Fujairah, would only become part of the British-led security structure after signing a treaty in 1952.

For many years the main source of revenue for the emirates was pearl fishing, but as pearl fishing lost its utility, a potentially new source of revenue appeared. Oil strikes in Iraq, Kuwait and elsewhere indicated that there might be oil in the Emirates. Initially efforts to find oil had little success. Then at the end of the 1950s that changed, with oil being discovered off Abu Dhabi under a pearl bed. It is worth noting that one of the companies involved in the exploration and successful discovery of this oil was Total of France, this marked the start of the re-

lationship between Abu Dhabi and France that expanded to become a critical security relationship for the UAE. In 1962 the first oil from Abu Dhabi was exported. Dubai also struck oil in 1960, though its finds were far less extensive than those of Abu Dhabi.

The arrival of oil revenues allowed both Abu Dhabi and Dubai to invest in development, unfortunately elsewhere less positive things were happening. By the mid-1960s the British government had determined that they should no longer have any security responsibilities east of Suez and in 1968 the Trucial States, plus Bahrain and Qatar with whom Britain also had a security relationship were informed that Britain would be withdrawing from these relationships and that the British military presence in the Gulf would end on 1 December 1971. Sheikh Zayed bin Sultan al Nahyan, the then ruler of Abu Dhabi (later the first president of the UAE), offered to pay the costs of keeping British Forces based in the region but this offer was rejected. In the face of the British withdrawal, Abu

Photo: US Army



A United Arab Emirates BMP-3 IFV participating in a joint exercise with US forces on the Udairi range in Kuwait. The exercise took place in November 2016 and was designed to test armoured vehicle manoeuvre and reaction capabilities. The UAE acquired nearly 600 BMP-3 from the early 1990s onwards and now intends to modernise some of the vehicles.



Photo: US DVIDS



United Arab Emirates (UAE) troops took part in a humanitarian assistance mission near Bagram, Afghanistan, in 2010. The UAE was the only Arab nation to take an active role in Afghanistan.

Dhabi and Dubai had decided to join together and invited the five other emirates, plus Bahrain and Qatar to join them. Both Bahrain and Qatar refused the invitation, leaving Abu Dhabi, Dubai, Sharjah, Ajman, Fujairah, and Umm al-Quwain to form the UAE and achieve independence on 2 December 1971. Ras al-Khaimah would join the UAE in 1972. However, the vulnerability of the new state was made plain on the eve of independence as Iran invaded and captured Abu Musa Island and the Tunb Islands in the Gulf on 29 and 30 November 1971. The UAE still regards these islands as occupied and this occupation is one of the many factors that complicate relations with Iran. The UAE was a founder member of the Gulf Cooperation Council (GCC), along with Bahrain, Kuwait, Oman, Qatar and Saudi Arabia. It also contributes to the GCC Peninsula Shield joint military force that was established in 1984. Apart from regional security structures the UAE has looked to build security relationships with powers external to the region. The UAE has allowed the US to operate out of its territory, for example using the Al Dhafra Airbase, with France also operating out of Al Dhafra and having a separate naval base in Abu Dhabi. While investing in its own defences, the UAE has always seen value in external security guarantees that is why they wanted the British to stay in 1971 and that is why they are content to provide facilities for the French and the US today.

Economics and Influence

Population size and economic resources are critical factors in developing the military po-

tential of a country. There is no doubt that the UAE is a wealthy country, although reduced income due to the decline in oil prices is a concern. An Emirate like Abu Dhabi has vast economic possibilities; on the other hand, the majority of the other Emirates do not have the ability to call on that level of financial strength creating the potential for unequal economic development.



Photo: Arne Hückelheim

The economy of the UAE could cope with €65 a barrel, but not less. Actually the price is around €53, therefore concerns are quite high.

Our first task will be to take a brief look at the economic structure of the UAE and then provide an analysis of the key indicators, as well as related factors. We will then go on to look at the population of the UAE and the impact that the size of the population has in particular on the military possibilities open to the UAE. The key point to remember is that the UAE like the other Gulf sheikhdoms has a small population of citizens; the majority of the residents of the country are expatriates which means that the potential military personnel pool is not that deep.

According to the "BP Statistical Review of World Energy 2016" proven oil reserves in the UAE were 97.8Bn barrels, equivalent to 13Bn tons, which in turn is equivalent to 5.8% of proven world oil reserves. In 2015 oil production in the UAE was 4% of the world total. In terms of natural gas, total proven reserves at the end of 2015 amounted to 6.1 million cubic metres or 3.3% of proven world reserves. Natural gas production in 2015 was 1.6% of the world total. In previous years hydrocarbon exports would provide the UAE, primarily Abu Dhabi in this case, with enormous financial returns. In 2011 the spot price per barrel of oil in Dubai was US\$106.18, in 2012 it was US\$109.08, in 2013 it fell to US\$105.47, it fell again in 2014 to US\$97.07, followed by a massive fall in 2015 to US\$51.20. At the end of December 2016 the price per barrel was US\$51.76. As far as the UAE is concerned the minimum oil price that they can cope with is US\$70 a barrel, but unless circumstances in the oil marketplace change dramatically achieving an oil price of over US\$70 a barrel looks highly unlikely in the near term. To an extent the UAE is also cushioned by the fact that it has enough financial reserves to cover the next 30 years.

Mention should be made of the sovereign wealth funds established by Abu Dhabi. These were funded by budget surpluses and transfers of profits from the Abu Dhabi National Oil Company (ADNOC). In

total 70% of this funding was transferred to the Abu Dhabi Investment Authority (ADIA) and 30% to the Abu Dhabi Investment Council (ADIC). ADIA is the largest sovereign wealth fund in the Middle East and is thought to have some US\$800Bn under management. The ADIA mission statement is to sustain the long-term prosperity of Abu Dhabi by prudently growing capital. The smaller fund, ADIC, is believed to have US\$111.8Bn under management. Abu Dhabi has looked to diversify its economy away from dependence on oil and this



has made a significant contribution to allowing it to deal with the decline in oil prices. Dubai on the other hand started off with much smaller oil reserves and has been planning for a post-oil economy, primarily based on service industries, for many years. Dubai suffered greatly in 2008/2009 due to the international financial crisis and a property price collapse, but took the necessary steps to recover and was also helped by investment from Abu Dhabi.

The fact that Abu Dhabi has such significant financial resources is in itself an important contributor to supporting the foreign and defence policies of the UAE, as well as being important in terms of dealing with internal security threats in the UAE. The UAE is a major supporter of the current Egyptian government and had provided a €4.6Bn aid package in October 2013 to stop Egypt from falling into chaos. The UAE has, along with Saudi Arabia and Kuwait, continued to support Egypt since that point. Elsewhere UAE funding has helped Somalia in terms of improving its security forces and through economic development.

Domestically there has been significant investment in infrastructure outside of Abu Dhabi and Dubai, in an effort to promote

development and extend economic opportunity in the other Emirates. The UAE government was obviously very concerned about the Arab Spring that started in Tunisia in December 2010 and the resulting anti-government protests that spread across the Arab World from 2011 onwards. Although the UAE did not face the wave of anti-government sentiment that was experienced in other countries, these events demonstrated the need to systematically focus on social cohesion within the UAE. The financial resources of the UAE buy it a lot of influence, but sometimes influence is not enough and more concrete steps need to be taken. In recent years the UAE has taken a more assertive stance internationally, often in concert with its fellow Gulf Cooperation Council (GCC) partner states. For example in 2011 the UAE participated in the GCC-led force that was requested by Bahrain to aid against local anti-government protests. As we shall discuss the UAE is also part of the GCC force that first intervened in the Yemen in March 2015.

The UAE is also following its own foreign policy interests in Libya. Here it is supporting the Tobruk-based government of the House of Representatives (HoR) and its mili-

tary forces the Libyan Nation Army (LNA) led by Field Marshal Khalifa Haftar. Apart from financial support to the Tobruk government, the UAE is taking a more hands-on approach to assisting its clients in Libya: UAE Air Force (UAEAF) IOMAX AT-802U AIR TRACTOR COIN aircraft have been deployed to Libya. Amongst other locations they have operated out of Al Khadim air base. They are flown by contract pilots on combat missions, not by UAEAF pilots. In support of this force other UAEAF assets are also deployed to Libya in the shape of UH-60 BLACK HAWK helicopters and UAVs. As such the UAE is using hard power as well as soft power tools to advance its foreign policy interests.

People and Advisors

According to the World Factbook published by the US Central Intelligence Agency (CIA) the UAE has an estimated population of 5,927,482 as of mid-2016. Of this total only 19% are Emirati, 23% are other Arab and Iranian, 50% South Asian and 8% Westerners, East Asian and others. According to a United Nations (UN) estimate, the population of the UAE in July 2016 came to 9,267,000 people. The UN noted in 2015



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that immigrants make up 85% of the UAE population. Although the Emiratis control the levers of political, economic and coercive (police and military) power, they are a minority in their own country. This represents a security issue; however the UAE has successfully found a suitable methodology to manage a multi-ethnic state.

Where the limited number of Emiratis becomes problematic is when one is looking to create security forces for the state. Small population size acts as a ceiling on the size of the military; it also makes it extremely difficult to meet requirements in terms of highly specialised positions such as fast jet pilots for example. In addition the military can find itself in competition for high quality candidates with the government, local institutions and companies as well. Emirati commanders in the field must also be sensitive as regards this small population size, consequently they will be casualty adverse, which might limit their operational flexibility.

The senior political and military leadership are aware of these constraints and have taken steps to reduce their impact. In 2014 the UAE government introduced a mandatory national service law under which all Emirati men aged between 18-30 who have finished secondary school will serve for a year, those who did not finish secondary school will serve two years, there is also a reserve liability. Emirati women can volunteer for a nine-month national service commitment. The national service obligation covers service with the UAE Armed Forces, the Ministry of Defence, the Ministry of Interior, the State Security Service and other officially identified government institutions. National service will help to alleviate some of the personnel issues faced



Photo: US Air Force

BLACK HAWKS taking off.

by the military; in the main the real benefit of national service will be to encourage a sense of national identity and social cohesion.

The UAE is also employing the services of foreign at advisors to boost the performance of their military forces. In 2010 Major General Mike Hindmarsh, who had retired from the Australian Army in 2009, was appointed Special Advisor-National Security in the UAE, as well as commander of the Presidential Guard. According to the US State Department, "in early 2010, the Presidential Guard (PG) was formed. The PG is comprised of Marines, Reconnaissance, Aviation, Special Forces/Amiri Guard and Mechanised Brigades." Apart from the recruitment of military advisors/trainers from Australian and British sources, amongst others, the PG also benefits from a training agreement with the US Marine Corps under which US personnel under Marine Corps Training Mission – United Arab Emirates (MCTM-UAE) are on site to provide training assistance.

The PG aviation group operates Boeing CHINOOK and Sikorsky BLACK HAWK

helicopters, as well as the FENNEC in the scouting role. Mechanised units operate the LECLERC tank and BMP-3 IFV, with access to the full range of UAE Army equipment. Well trained, well equipped and motivated, the PG provides the UAE with a military force that can be rapidly deployed to meet strategic objectives. PG units have been deployed to the Yemen as a part of the GCC force sent to support the government of Abdrabuh Mansur Hadi in the Civil War against the Houthi.

More recently the UAE has looked to reduce active involvement by its military personnel in military operations in the Yemen. It has taken casualties most notably after the Houthi launched a TOCHKA TBM strike that hit a logistics base at Maarib, east of the Yemeni capital Sanaa, in September 2015, where 45 UAE soldiers were killed. As previously noted they are very sensitive to casualties. However, the UAE has employed other tools to participate in combat operations.

In November 2015 the New York Times noted that the UAE had deployed a unit of 450 contractors, primary of Colombian origin, although there were also contractors from Chile, El Salvador and Panama, to the Yemen. The article alleges that the UAE has raised a force of 1,800 troops from Colombia and other Latin American countries, these have been under training in the UAE for a number of years, with the Yemen as their first combat deployment. Commanders in this unit appear to be drawn from Australia and Europe, though increasingly UAE officers are involved. Recruiting and deploying such a unit makes eminent good sense as far as the UAE is concerned. As regards its conventional ground forces, the UAEAF and the navy, the objective remains to equip and train these units to the highest standard possible and to deploy them for missions focused on the defence of UAE territory. Recognising that it needs other tools in support of its strategic goals, the UAE will also emphasise the use of the PG and where necessary units based on contractors. ■



Photo: US DVIDS

A United Arab Emirates Air Force (UAEAF) Lockheed Martin F-16 Block 60 DESERT FALCON refuels from a US Air Force KC-135 tanker aircraft as part of mission to engage targets in Iraq in December 2016. Increasingly the United Arab Emirates (UAE) has become involved in regional security missions.



Sharpening the Falcon's Claws

United Arab Emirates Strengthens Its Defence

Heiko Borchert and Shehab al Makahleh

Events matter as they shape national security policy. From the perspective of the United Arab Emirates (UAE) three events perfectly capture the country's evolving security and defence role. Since 2007, when the UAE first deployed troops to support the international stabilisation mission in Afghanistan, the country's leadership has been steadily working on strengthening its defence capabilities.

This ambition culminated in combat operations of the UAE Air Force against targets in Iraq and Libya in 2014. But the growing international footprint of the UAE also took its toll. In September 2015 the UAE lost 45 soldiers in an attack against a military base of the Saudi and

tion of the UAE's security and defence policy. Past clichés such as the belief that "glitter" matters more than real capabilities no longer hold true. The UAE has emerged as a serious regional power that is gradually projecting power beyond the Arabian Gulf into the Eastern Mediter-

the world's ten most important container terminals. In 2015 Dubai airport handled the world's 3rd largest passenger turnover and 6th largest cargo turnover. Etihad and Emirates are world-leading airlines and strategic customers of Airbus and Boeing. DP World is one of the world's leading port operators managing ports in over 60 countries around the world. By mid-2016 the Abu Dhabi Investment Authority was the world's 5th largest sovereign wealth fund by assets under management.

The success of the UAE is most impressive given the country's vulnerable geostrategic setting. Four strategic vectors are important in understanding the current trajectory of the Emirates' security and defence policy:

First, the ongoing pan-regional power struggle sets the scene. The power struggle results from a plethora of different trends such as the overall reshuffling of political loyalties across the region in light of a perceived US retreat, Russia's re-emergence as a key strategic player in the region, ideological differences between the members of the Gulf Cooperation Council (GCC) and neighbouring Iran, and the growing economic footprint of Asia-Pacific countries in the region.

Second, because of the pan-regional power struggle, ideological radicalisation and terrorism flourish. The UAE and Saudi Arabia have stepped up efforts to fight terrorism, but diverging policy preferences among the GCC nations render coherent action very difficult.

Third, as a global transportation hub, the UAE depends on the safety and security of global air and sea corridors that integrate the country into global trade flows. As a consequence, cyber security and maritime security have risen in importance and led the UAE to set up relevant authorities and launch national programmes to deal with these challenges. Finally, food security is an emerging top security challenge. Harsh climatic condi-



(Photo: izfumbles)

The UAE is heading toward a modern army, in equipment, training and structure, with female soldiers also serving in the army.

UAE-led forces fighting Houthi rebels in Yemen. One year later, in October 2016, the same conflict caused another blow for the UAE. This time Houthi rebels fired missiles at the HSV-2 naval vessel operating off the coast of Yemen and severely damaged the platform.

These events and the underlying developments have accelerated the maturation

as well as Northern and Eastern Africa. The country's growing economic ties with trade partners in the Asia-Pacific region drive its strategic interests eastwards, thus outlining the future geostrategic trajectory of the UAE.

Geostrategic Setting

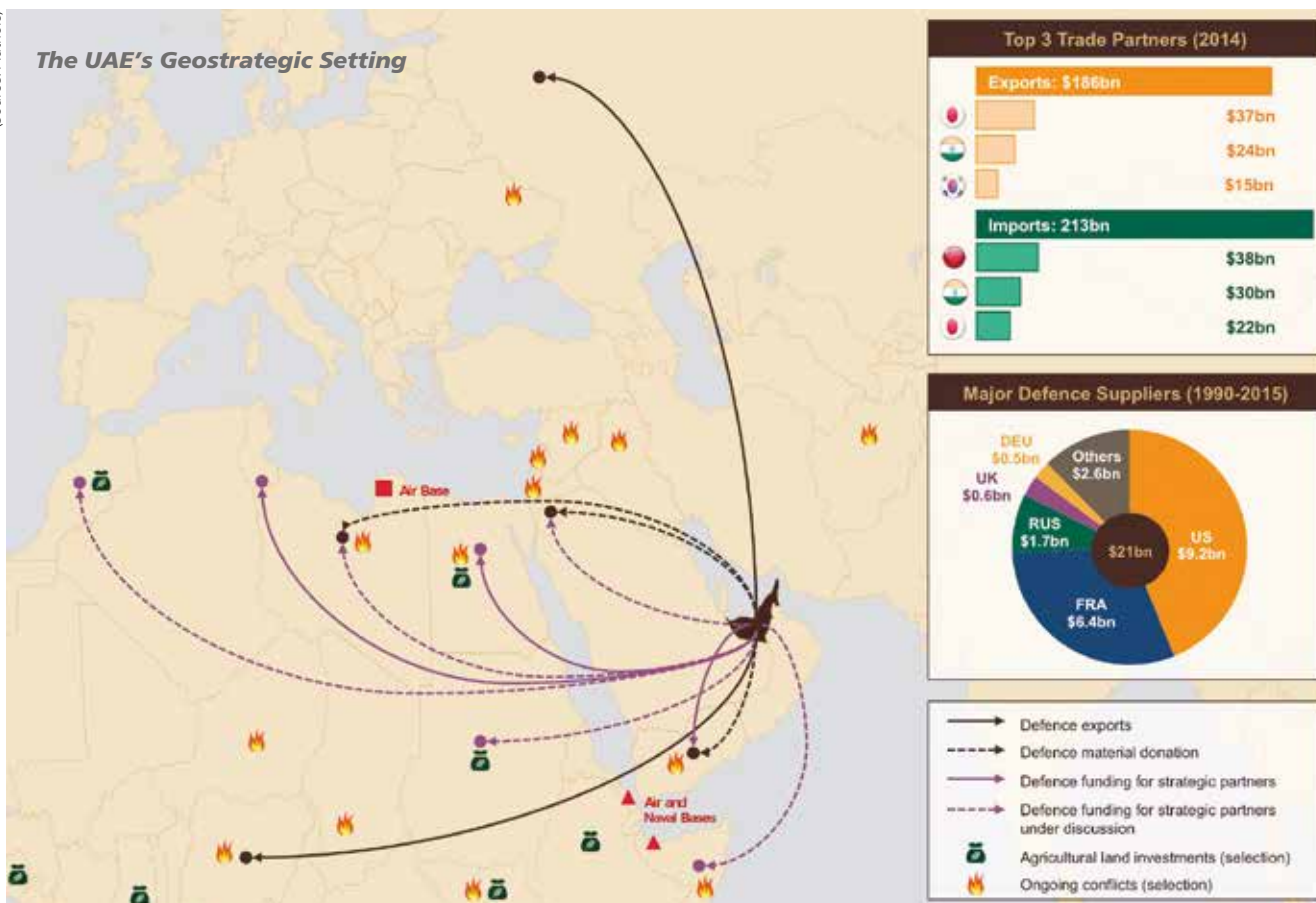
The development of the UAE since 1971 is remarkable. Today, the country ranks 16th in the 2016 World Economic Forum Global Competitiveness Index ahead of all Gulf neighbours and international heavyweights such as China, France, India or South Korea. The UAE is a key oil and gas producer and has positioned itself as a global transportation hub. Dubai is the only non-Asian port among

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(Source: Authors)



tions are detrimental to local agriculture. That is why the UAE is importing almost all agro products. In 2014 the food import bill stood at around €94Bn and is likely to grow to €375Bn over the next ten years. Food import dependence has led to UAE land investments in Egypt, Ethiopia, Ghana, Mozambique, Sudan and South Sudan as well as Zimbabwe. As the strategic relevance of these countries increases, it is hardly surprising that the UAE is taking a closer look at their geostrategic environment in order to ensure its own food supply security.

National Defence Priorities

The UAE has used strategic partnerships to offset regional risks. In 1991 it signed a security and defence cooperation agreement with the United States followed by a similar agreement signed with France in 2008. More recently, the UAE has ramped up cooperation with Russia, China, Japan, and South Korea. In addition, the UAE leverages the GCC to advance its own military ambition and stabilise the region. With regard to the UAE's defence and military ambition three shifts are noteworthy as they drive the country's procurement and defence industrial priorities:

The first shift results from ongoing operations in Yemen. The increasing operational tempo absorbs the leadership's attention and puts the military equipment under stress. As Abu Dhabi is fast-tracking material urgently needed at the frontline, logistics support and life cycle issues come to the fore. Second, the operation in Yemen is not only land-based but also involves air force and navy assets. The Air Force has been at the core of Emirati force development for the past decades. The Navy clearly emerges as a new priority, because the UAE have come to acknowledge that naval support from strategic partners can no longer be taken for granted. As a consequence, the Emirates are stepping up significant naval procurement projects. The third shift refers to the UAE's growing strategic footprint outside the Arabian Peninsula. In late 2016 news reports revealed that the UAE had been building an air force base in Libya as well as air force and navy bases in Eritrea and Somaliland. These bases play a role in the GCC's efforts to forge diplomatic alliances with these regions. In addition, the UAE donates defence material and funds defence procurement to strengthen strategic partners in these regions (see Figure). Overseas bases also reinforce the need for logistics support to sustain

troops. This explains the growing interest in supplementing existing strategic airlift capacities (e.g., C-17, tanker aircraft) with additional naval transport assets.

Established Defence Industrial Capacities

Under the leadership of Sheikh Mohamed bin Zayed Al Nahyan, Crown Prince of Abu Dhabi and Deputy Supreme Commander of the UAE Armed Forces, the UAE has established a local defence industry as a means to diversify the national economy. During the first phase, joint ventures with international defence companies were crucial to provide access to knowledge and technology. For example the Advanced Military Maintenance, Repair and Overhaul Center emerged from cooperation between Abu Dhabi Aircraft Technologies, Sikorsky and Lockheed Martin; Burkan Munition Systems resulted from the teaming of Mubadala, Bin Jabr Grup and Rheinmetall; Tawazun Dynamics is a joint venture by Tawazun and Denel; and Abu Dhabi Shipbuilding (ADSB) and former Selex-SI established Abu Dhabi Systems Integration. Joint ventures were the preferred way to fulfil offset obligations, which led to a very large and diversified portfolio of companies that started to become inefficient.

The time was ripe for consolidation. The second phase was launched in 2014 by reorganising most of the subsidiaries of Tawazun Holding, Mubadala, and Emirates Advanced Investments Group under the newly established Emirates Defence Industries Company (EDIC). The International Golden Group serves as an additional defence technology holding company. In addition, Mubadala and Tawazun cooperate on knowledge transfer and potential offset projects. So far, results are mixed. The reorganisation seems to have accelerated the development of technology capabilities. But infighting between EDIC and Tawazun has emerged. This is detrimental to setting up and implementing strategic guidance for the national companies as well as processing offset projects worth several billions. So far, a proper defence industrial strategy is missing. Against this background the current UAE defence industrial base looks as follows:

Naval Systems

The Emirati defence industry is highly advanced in the naval sector, with ADSB as the key player. ADSB sees itself as the prime contractor that also engages in through-life support, whereas subcontractors are mainly in charge of designing, manufacturing, and testing naval platforms. Among other projects, ADSB has built five of the six BAYNUNAH Class



(Photo: Imre Solt)

Under the leadership of Sheikh Mohammed bin Zayed Al Nahyan, Crown Prince of Abu Dhabi and Deputy Supreme Commander of the UAE Armed Forces, the UAE has established a competitive local defence industry.

corvettes. French partner Constructions Mécaniques de Normandie built the first vessel.

Land Systems

The UAE land systems industry develops, manufactures, and maintains armoured vehicles mainly through NIMR Automotive and Emirates Defense Technology. Finland's Patria and Renault Trucks Defense of France, a division of Volvo Group Governmental Sales, are important international partners. Rosomak of Poland, working together with Patria, has

recently also made inroads into the UAE. Keen to broaden the expertise in this segment, the Emirates are using locally built armoured vehicles in ongoing operations in Yemen to assess their performance. The UAE Armed Forces are also looking into the possibility of buying 4x4 and 8x8 vehicles for the new overseas bases.

Air Systems

The Emirates strive to establish the most potent air power in the region. As a consequence the country has set up military aerospace companies focusing on maintenance, repair and overhaul (MRO) to complement the vibrant commercial aerospace sector. In addition, the UAE has ambitious plans to establish the first truly national defence industrial base in the field of UAV/UCAV with companies like Abu Dhabi Autonomous Systems Investments (ADASI) and ADCOM Systems. ADASI has teamed with Schiebel to locally manufacture the CAMCOPTER S-100. ADCOM has been working on its UNITED-40 platform, which can also be armed. Among the different international partners involved in setting up ADCOM, Ukraine was pivotal to transfer technology. Reportedly ADCOM is also in the process of exporting UAVs, in particular to Russia and Nigeria.

Missiles and Electronics

In the missiles and electronics business Emirati ambitions have faced more obstacles. In October 2016, Tawazun Dynamics completed the delivery of 600 AL TARIQ guided weapons for the UAE's MIRAGE 2000 fighter jets. This programme suffered significant delays due to technical challenges to develop the new weapon systems. In the electronics segment, Abu



(Photo: US Air Force)

An Emirati MIRAGE 2000 aircraft during an international training exercise



Dhabi Advanced Radar Systems, a joint venture formed in 2013 between Saab and Tawazun, was meant to establish the first radar maker in the region. The company failed, leaving a gap hard to close for local actors like Emirates Technology and Innovation Center.

Defence Procurement Priorities

The shifts in the UAE's defence priorities become most visible in current and future procurement priorities. Today's focus on supplying ongoing missions does not mean that the UAE should cut back on its long-term priorities. But reshuffling funds and rescheduling projects is needed to stabilise the procurement portfolio. In addition, defence contractors interested in cooperating with the UAE must be aware of existing and envisioned defence industrial capacities as the Emirates design future procurement projects with an eye on expanding the local defence industry.

forms are being envisaged. Whereas fast patrol craft, frigates, and rescue vessels seem within reach of the local naval ship-building industry, helicopter carriers and specific types of logistics ships likely go beyond currently available capacities. International partners will thus be needed in all of these programmes. The UAE is interested in talking to different partners like Italy for helicopter carriers, the UK for frigates, and Turkey for fast patrol craft. In addition, maturing undersea threats have prompted the UAE leadership to establish a need for different types of undersea assets such as submarines and autonomous underwater vehicles. Of great interest to industry is the emerging C4ISR priority of the UAE Armed Forces. This clearly reflects an urgent need from ongoing operations, but this is also an area where the UAE significantly relies on foreign partners and suppliers. The same can be said for Saudi Arabia. Thus it is not surprising that both countries seem to have a common interest in joining forces

capacities and relies on partners. Suppliers from the United States and Germany are said to be of interest in these segments. Finally, there are long-held plans to further strengthen the country's air power. Here, too, new priorities emerge. Additional fighter jets would complement the portfolio, with the F-35 Joint Strike Fighter being a particular priority. Maritime patrol aircraft, by contrast, are a new priority, in particular as they are to be used to patrol coastal areas, notably along the coasts of Aden, the Horn of Africa and the Arabian Gulf, and for anti-submarine operations.

Outlook

The UAE's military capabilities are a force to be reckoned with. In order to balance operational requirements and long-term strategic ambitions, the UAE will need to strengthen defence industrial capacities that have hitherto not been prioritised: First of all, increased investments in MRO and supply chain management for all military services will be needed as a consequence of current operations. Professional service contractors are important, but the UAE Armed Forces would be well advised to beef up indigenous capabilities in order to improve agility and sustainability to uphold the operational tempo and sustain overseas bases. Second, the Emirates' new emphasis on C4ISR is testimony of the fact that warfighting assets need to be seamlessly integrated in order to provide maximum effect. Systems integration, however, is still in its infancy in the UAE. Therefore future procurement projects should help close this gap. In addition, tailored programmes for national capacity building in this domain are needed. Finally, state of the art defence technology is only as good as the concepts of operations driving them. Because the Emirates are tech savvy, military concepts development must be strengthened in order to fully leverage the options provided by modern defence equipment. This requires dedicated attention to doctrine development. In addition, the Emirates would benefit from creating an environment where concept developers, operators as well as national and international defence suppliers interact to analyse the country's lessons learned from ongoing operations. This would help address existing capability gaps while at the same time producing defence equipment that truly reflects the needs of the UAE's Armed Forces.

		Procurement priority is...	
		...well established	...emerging
Local defence industrial capacity...	...has been established, but needs to grow	<ul style="list-style-type: none"> UAV and UCAV Armoured vehicles (4x4, 8x8) 	
	...is emerging	<ul style="list-style-type: none"> Fast patrol craft Frigates Rescue vessels for humanitarian assistance and disaster relief 	<ul style="list-style-type: none"> Cyber security C4ISR Supply and logistic ships
	...is missing	<ul style="list-style-type: none"> CBRN vehicles Fighter jets 	<ul style="list-style-type: none"> Active protection systems for armoured vehicles Optronic systems for armoured vehicles GCC coastal air surveillance network Maritime patrol aircraft Helicopter carriers Autonomous underwater vehicles Submarines

Against this background, Table 1 provides an overview of selected Emirati defence procurement projects: Unmanned systems continue to reign high on the UAE's priority list. Most recently, Northrop Grumman has emerged as a key partner to further develop local capacities. The UAE also wants to embark on developing unmanned systems for the land and sea domain. Thus the expansion of the unmanned systems segment at the 2017 IDEX defence exhibition can be seen as an indicator of future developments. Given the country's growing naval ambitions, several different naval surface plat-

es to establish the respective capacities in the region. Along similar lines, the UAE considers setting up a GCC coastal air surveillance network. This would partly play into the hands of the national UAV industry, but segments like sensor development, sensor data management, and communication and data links to set up a federated solution would most likely require support from international partners. Operation-driven demands clearly emerge in fields like CBRN protection, active protection systems and optronic systems for armoured vehicles. In all three segments the UAE lacks local industrial

Austrian Federal Army 2017

Operation "Alpenglow...?"

Georg Mader

Still, it is not clear whether an obvious trend-reversal in Austria's security policy, accompanied by a visible revaluation of the Federal Army, is no more than an alpenglow. Like that splendid alpine natural phenomenon, which rapidly disappears after dawn or dusk, the significant budgetary upsurge and subsequent military procurement projects could still fade away after the next elections. Because, as far as the sustainability of this turnaround is concerned, it remains to be seen whether this is just due to the survival will of the ever military-sceptic chancellor party SPOE, which – reluctantly – got wind of a changing security climate also around the neutral Alps and Danube. Nevertheless, what is happening right now can only be described as a stunning upheaval for the positive.

Until 2015, Germany's southern neighbour's constitutional commitment to comprehensive national defence had manifested itself in a steady decline of military-expenditures since the fall of the wall in 1989. Measured by the economic output, the funds for the Austrian Army in this period had fallen from 0.99% to 0.55% or clearly below €2 billion in 2015, the lowest figure of all comparable nations. While a cautious approach to the NATO Alliance – obviously without achieving the self-imposed 2% of GDP in defence expenditure – by the centre-right government in 2006 has since ideologically been pushed back into a distant corner, the defence-budgets were further reduced and between 2007 and 2014, under the SPOE ministers Norbert Darabos and Gerald Klug, in fact an annual budget was deleted as a whole.

Imposed Turnaround...

Now, a respective annual budget will be added until 2020. Measured against the previous status of 'bleeding-to-death' that accompanied the nation's pacifist approach, a true 'revolution' has occurred. Officers who were disillusioned to the extent that they already calculated the months before slipping into retirement are now highly motivated to assume newly created functions and want to remain in

service until their last possible day. But even these men admit that this climate-change did not originate from wisdom out of the country itself, but that the trend reversal has been imposed upon politics

ness has lately also changed the Alpine republic. Suddenly the soldiers are the focus of an internal policy, where even in the SPOE (a party historically sceptical of militant pacifism) a right wing in favour



Hans Peter Doskozil, the Minister of Defence and Sport, in a C-130

(and media) so far sceptical of or disinterested in military matters and security policy by the international stage. Beginning with the change of state borders by military force in Ukraine, through the various forms of terrorism from the Middle East to even Central Europe (to the extent that many Austrians perceived a massive loss of control by the authorities during the meanwhile tempered migration-crisis), the mood towards more security aware-

of the Bundesheer has established itself. This led to the unprecedented process of parliamentarians from all six Viennese parties deciding to re-open the last austerity-package of Gerald Klug, the ex-defence minister of the ruling coalition.

Phenomenon Doskozil

Hans Peter Doskozil is the visible face of the change and was appointed Minister

Author

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A PINZGAUER 716 1.5-ton personnel carrier, for which a replacement is required

of Defence a year ago; formerly he was police-commander of the Burgenland-province bordering Hungary. Suddenly used by his Party SPOE as the 'shadow minister of interior', for the taste of many he meanwhile pushes too much 'military' into the 'civil' areas of internal security and migration. Within the defence arena as well as most of the boulevard press he has been pictured as a lightning-rod with unexpectedly positive decisions. With the support of Chancellor Kern he has become the first political executive to implement the first net increase in budgeting since the fall of the Berlin wall in 1989, despite heavy objections from the conservative Minister of Finance. As a result of the additional €1.7bn, entire military units will be set up again, 3,800 professional soldiers will be hired and 1,400 service posts affected by retirement will be re-assigned and not left vacant. With about 300 soldiers signing-in for longer periods after compulsory service, almost 10,000 new functions are created as a whole. Just two years ago, such ideas would have been answered with the offer of psychiatric treatment for 'acute militarism'...

Visible Shift in Responsibilities

Like in most European constitutional states, the police has been responsible for the internal security for decades while military forces were assigned to counter external threats (or at least attempted to do so by order). Nevertheless, there have always been so-called 'overlapping' areas, justified by available

technical means or simply by available manpower strengths. In light of the new threat perception, these legal and constitutional 'grey areas' have also become subject to legal consideration and



The Austrian armed forces operate a fleet of 22 LMV HUSARs which is to be increased to 200 vehicles.

clarification – reluctantly, as could be expected. In parliament the majority of the parties are signalling their approval of a so-called 'security package', which was 'laced-up' by the constitutional service in the federal chancellery including the following 'adjusted competences' of a so-called security cabinet consisting of six ministers:

Longer or permanent internal assistance missions: This is regulated for the first time, since it has become commonly

understood that the 22-year long assistance-mission to the police to monitor the border with Hungary and Slovakia after the opening of Eastern Europe was not legally covered. The Ministry of the Interior was only allowed to call the Bundesheer to help when it did not have the necessary capacities available. Over such a long period, however, it would have been quite possible to develop respective capabilities. In the future a capability will have to be provided to seal off and guard some 190 defined elements of so-called 'critical infrastructure' (transport, electricity, water, hospitals, communication) over an undefined period of time. This can only be provided by the Army with its militia forces – and for this reason such an order should also be legally correct. As a first step, there is the recent decision to guard 24 foreign embassies in Vienna with soldiers, to relieve policemen for counter-crime or street-presence.

Anti-terrorism operations: In the event of a terrorist attack or even in case of longer-lasting power-failures, the police might quickly reach their personal limits

and need to call the Army to preserve 'classical' internal security. In some cases, the Bundesheer has already been called to support in the scope of the so-called migration/asylum-crisis in 2015/16. A General Staff paper tabled to the parliament now defines internal threats by large-scale demonstrations directed against Austria, violent acts between hostile groups of immigrants and clashes of extremist formations. This was used to push for more modern protective equipment and squad vehicles for so-

called crowd and riot control operations. Forces deployed to such missions should include rapidly available infantry companies, but also heavier materiel resources for assisting both in internal and/or in explicitly corresponding solidarity-missions abroad.

Air space control: In theory, the air force is responsible for countering air-space violations by military aircraft, while the Ministry of the Interior is in charge of countering threats or violations caused by civil aircraft. In reality however, the Bundesheer and its QRA aircraft have always been deployed in the past, since the MoI has no active air defence means. Respective re-assignment of responsibilities has now formally been executed. According to Minister Doskozil, the change now includes the so-called 'hot pursuit' into the air spaces of neighbouring countries (Switzerland, above all), as well as exclusive decisions at military levels down to the worst case of a potential shoot-down. This is accompanied by an increased air force budget to raise the previous limit of 1,070 annual flying hours for the 15 EUROFIGHTER Tranche-1 / Block 5 to 1,500, as well as the growth from so far 12 to 15 or 16 supersonic pilots.

Faster emergency and disaster aid: The objectives include more independence of the Bundesheer in disaster relief and emergency operations. If, for example, emergency-aid reaches its limits at the local fire brigades, the majority of which is composed of voluntary servicemen, the military should be able to prepare faster and to stay in theatre for a longer period. For this, separate agreements with the Austrian provinces are pursued. But the Army will also be formally empowered to assist other (European) states in the protection of the EU's external borders (as is currently the case with 60 troops along the Hungarian-Serbian border). To this end, the Austrian Government aims to help relevant third countries to build appropriate facilities, such as asylum- and migration-centres. For this purpose a number of laws needed to be clarified, such as the Military Posting Act. If necessary, the Army also stands ready to carry out deportation-flights with its three (ex-British) C-130Ks, which are also to be equipped with NVG and EW-self-protection.

Things so far Unheard of...

In the past, the union of all military personnel often assumed a critical position

vis-à-vis the employer, for obvious reasons of union alignment. The more interesting was the statement last August by its president (an opposition MP of the right-wing Strache FPOE) Manfred Haidinger: "Even tanks have to be considered, and even in the Vienna area again. As an ultima ratio, tanks are also to be deployed in urban combat. Therefore the armoured battalion in the area of Vienna (Zwölfaxing) has to be activated again. New helicopters are to be procured quickly, in order to make our initial forces airborne and to support the police. Federal Minister Doskozil is absolutely right when he says that the Army constitutes the ultimate defensive element!" Haidinger signalled to the minister "full support, if it continues in this direction. For the first time in a long period, we are no longer moving towards the abyss..."

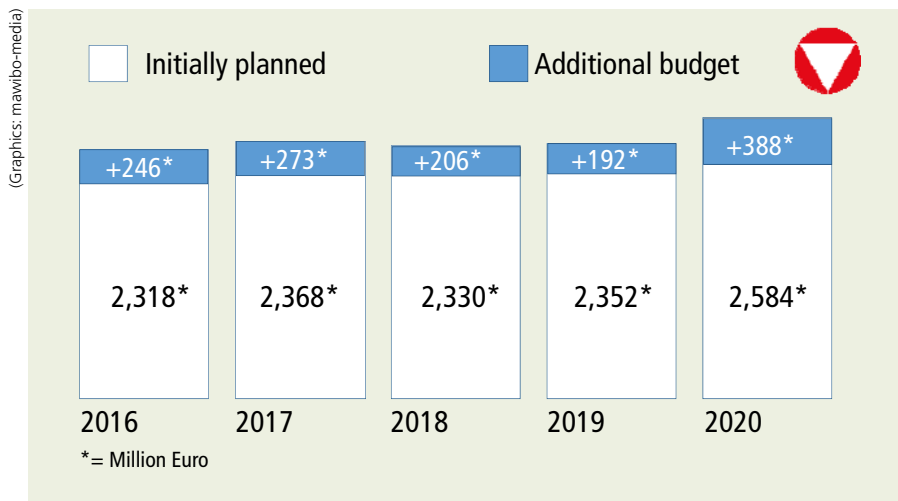
Structure 2018

Inevitably with all those changes, a reform of the army structure comes along

(Question: What has prevented the leading politicians from doing that on a permanent basis? Answer: A Europe-wide 'peace-dividend' since 1989, mixed with national 'protection' considered to be ensured just by neutrality alone – if it is only spoken out loud enough...!)

In the new structure, four brigades are assigned dedicated tasks:

- The 3rd Panzergrenadierbrigade in Mautern (Lower Austria) becomes the 'Command of Rapid Reaction forces'. The troops are specialising in "missions at home and abroad and operations in urban environments."
- The 4th Panzergrenadierbrigade in Hörsching (Upper Austria) becomes the 'Heavy Brigade'. It inherits and centralises all the former tank battalions of the Bundesheer, which are used for "robust missions at home and abroad".
- The 7th Jägerbrigade in Klagenfurt (Carinthia) forms the so-called 'Light Brigade'. These forces are "responsible for stabilisation missions abroad and are also capable of airborne landings".



Development of the budget for the Austrian Bundesheer in the years 2016 to 2020

again, hopefully one which will not be eaten up by the next one before becoming established, as could be experienced previously. On 01 October 2016 the Austrian Army began to apply the new large-scale order of battle. All brigades are specialising and are also strengthened with regard to crisis reaction operations. "With the new structure, the Army should be able to respond faster and more effectively to modern threats in the future. Austria needs a strong Army to be prepared for the security challenges" Minister Doskozil said and stressed that "we must continue to constantly develop the Army in the face of ever changing security threats..."

- The 6th Jägerbrigade in Innsbruck (Tyrol) will become the 'Mountain Warfare Command'. The troops "are globally recognised and will be dedicated to the fight in medium and high mountains."
 - The nine provincial military commands (in the nine Austrian provinces) are "gaining in importance by the new structure, each will have its own battalion and is responsible for the militia in the province and training the local conscripts."
- The Joint Forces Command (JFC), which had been set up in Graz 10 years ago to lead all troops, was dissolved. Instead...
- A 'Land Forces Command' leads the aforementioned brigades and provincial Commands. This is complemented by the

■ ARMED FORCES

sole Army Troops School and the base in charge of preparation and operation of all foreign deployments.

- So far subordinate to JFC-Graz, the Austrian air forces are gaining back their dedicated Air Force Command, leading the Air Support Command (Hörsching) and the Air Space Surveillance Command (Salzburg), as well as the Air- and Air Defence School at Langelebarb (Lower Austria, near Vienna).

- A Logistics Command is superior to all departments responsible for logistics and supplies.

- The Leading Support and Cyber Defence Command is responsible for all areas of information and communication technology and the protection of networks. Hackers in uniform have already won awards, and there are still vacancies...

- The newly established Military College conducts the training of all officers and NCOs, it assumes the agendas of the Military Academy (Wr. Neustadt), of the Army's NCO School (Enns) and of the National Defence Academy (Vienna).

- Related to all these new organisational elements is a cross-sectional element of the Federal Chancellor's office which exercises the general authority over all public servants at the federal level. The latter is to be staffed with as many civilian personnel as possible. Against the background of the purely military nature of these institutions, this is expected to provoke resistance.

Largest Procurement-Share for the Air Sector...

Until 2020 the Bundesheer will invest approx. €1.2Bn in new equipment and vehicles as well as around €500M in infrastructure. While the procurement package covers all areas from personal-equipment and vehicles through to the required IT-infrastructure for cyber defence, the focus is on the immediate protective equipment for the soldier and hardened/armoured vehicles. Beginning in 2018, a replacement programme for hundreds of previously auctioned 4x4 Steyr PINZGAUERs is to commence. The beginning of 2017 saw the service introduction of 35 new PANDUR APCs (without these the traditional GDELS plant in Vienna would reportedly have been without any order backlog) and IVECO's LMV HUSAR IFVs (initially 22, later up to 200) as well as 18 new DINGOs. Units of the new Mountain Warfare Command (Battalions 23, 24, 25, 26 and Engineer Battalion 2 are equipped with 72 fast quads as well as 32 BvS10 universal terrain vehicles from Hägglunds. In addition, 440 regular road-vehicles and



The transition from the Saab DRACON to Eurofighter TYPHOON was achieved without any problems.

-trucks and special-purpose vehicles for the counter-NBC and medical troops as well as for the military police are planned. Due to the technology implemented, the financial lion's share of future procurement efforts might go to the air sector. For the whole year of 2016 the RfPs for an armed multi-purpose helicopter was awaited, now anticipated for 2017 to replace the obsolete OH-58Bs and ALOUETTE IIIs. Also affecting the rotary share is the fact that reportedly only five of the nine S-70A42 BLACK HAWKS are ready for use at any time, as after 13 years the cockpit MFD screens are defunct. An ongoing discussion waged between (late) attaching oneself to the large UH-60L cockpit-upgrade of the US Army by Honeywell versus ideas by the MoD to use

components similar to those in the €70M avionics/NVG and self-defence upgrade of 23 AB-212s completed just recently by Agusta. Also expecting a solution in 2017 is the long-awaited successor to the SAAB-105 jet trainers (introduced in 1970!) that in the past were even assigned to a Fighter Bomber Wing (JaBoG) at Linz-Hörsching. Meanwhile 12 (out of originally 40) are being or will be modernised with NAVAID/GPS equipment, because until 2020 they still have to alternate in QRA every fortnight with the 15 'never enough' EUROFIGHTERS. Among the alternatives the Italian T-346 seems to be a favourite, also because Austrian flight students and a flight instructor are already embedded in the Italian training-model at Lecce on the MB-339. There are T-346s there, but no Austrian instructors. While not much has been heard of BAE Systems as the manufacturer of the HAWK, some 'low-cost' ideas around the Czech-built AERO L-39NG might circulate in the MoD. This has to be considered against the background that this latest version of the globally distributed ALBATROSS is currently only a single prototype and its expectable climb is possibly below that of the twin-engined SAAB 105.

A note on the Austrian interceptors in Zeltweg: Many professional observers mocked the Austrian attempt to skip the whole third jet generation to jump from the 1950s SAAB-35 DRACON to the EF-2000 EUROFIGHTER. But it was mastered superbly. The new type was, however, 'mutilated' of its DASS self-protection (including even the radar warning receivers) as well as the PIRATE IR sensor, when during the so-called 'collation' of 2007 between SPOE minister Darabos and the manufacturers in Hallbergmoos savings

Defence Budget

According to the federal budget release for 2017, funding for the Austrian Federal Ministry of Defence and Sport (BMLVS) amounts to around €2.3Bn. It thus increases by €246.4M or 11.9%, compared to the Federal Budget for 2016. In addition, a special investment programme was agreed back in 2015 with 'ÖBH 2018', which comprises a total of €350M as special financing for the years 2016 to 2019. Of this a total of €96M is to be invested in 2017, with a similar distribution of the remaining funds (€254M) planned for the years after. From 2020 onwards – though there are elections in-between – a second tranche of €266M is earmarked to be invested. This amounts to additional investments for the Bundesheer to the tune of €616M.

had to be achieved. But these were only political ones, because it will cost more than formerly saved to bring back the lost abilities to the Tranche-1/Block-5 airframes. According to the manufacturer, this can definitely be done. But this could only be imaginable in the light of today's ever closer European cooperation and integration, especially when there are ideas ventilated of 'hot pursuits' over borders or participation in exercises like TLP (Tactical Leadership Programme). Most pressing on the list would be the so-called 'all-weather radar-weapon', which normally should complement the exceptional CAPTOR radar. Today approximately 60 'Alpha'-QRA-sorties are flown annually with just one analogue IRIS-T IR-missile. In the changing or challenging security climate, any deletion of software lines for abilities the Austrians are 'not allowed to have' – like EW/DASS – is likewise nonsense, and has absolutely nothing to do with Austria's (remaining) neutrality in the event of a war or a NATO negatively connoted by the Kronen-Zeitung. According to the author's opinion, there should or could well be some 'help' or political 'persuasion' around the EUROFIGHTER by or from the official German partner. Here, too, a historical window remains open...

Conclusion: "Grab it!"

At the moment, security and sub-ordinately the military are 'fashionable' along the Danube and Alps. That even applies to the tabloids and boulevard papers, which were previously notorious for reporting the scandals of any large procurement. Like the cited alpenglow, however, this moment also can get out of vision again, given that the further fate of all those plans and decisions is closely connected with public perception and impressions conveyed to the electors by the media. In this respect, the whole question of Ukraine – closer to Vienna than Switzerland – remains particularly exciting with the new US President Donald Trump, as well as the ongoing European demographic alteration as a result of the migration crisis – which actually triggered the turnaround in public opinion on security in 2015. Compared to 2015, it is now held under the perception threshold

by the media, but it was again Austrian 'shadow-minister' Dokožil who in late 2016 pointed to still hundreds of migrants per week attempting to get to Austria and Germany supported by structures of criminal human-smugglers. The so-called Balkan Route might not be as tight as pictured, but such matters should normally not condition military procurement. Well,

maybe elsewhere. For the Austrian Army, there now is the necessity to 'grab it with both hands'. In 2017 or 2018, this window could close quickly and plans could fall apart if a Red-Black-Green triple coalition – at present the two traditional parties are 5 to 10% behind the right-wing FPOE in every poll – suddenly sets totally different priorities. ■



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ASW Capabilities of the Italian Armed Forces

Current Status and Perspectives

Giulia Tilenni

Maritime surveillance is a relevant task for the Italian defence. After decades of service, the BREGUET ATLANTIC fleet faced the end of its operational life. Italy has chosen to replace them with the ATR72 MP. Yet, today's geopolitical scenarios and the difference between past and present tasks could lead to the conclusion that this choice might not be the most appropriate.

Italy considers the Mediterranean a top strategic priority theatre. First, it is a major source of income due to fishery, trade, and energy security. Furthermore, it represents a source of instability right at the gates. Because of its geographic position, Italy has traditionally been at the forefront of anti-submarine operations thanks to specific assets. Moreover, during the Cold War, submarines were a major threat to NATO countries and

domino effects relatively far from home can hamper seriously the country's core interests. In effect, a crisis involving Babel-Mandeb or Hormuz Straits, or the Suez Canal, would have a heavy impact on the strategic interests of Mediterranean countries. As a consequence, the Italian White Book (*Libro bianco della Difesa*) released in 2015 broadens the geopolitical space of Italian interest that has to be secured.

missions by performing long range ASW missions with a joint crew of 13 specialists from the navy and the air force.

Maritime patrol missions have been carried out since the 1970s from Sigonella AB, Sicily (41° Stormo/Wing) and, until 2002, from Elmas, Sardinia (30° Stormo/Wing). After the end of the Cold War and the subsequent reduction of submarine activities in the Mediterranean, Italian Br.1150s have been performing mainly maritime surveillance operations and a few ASW NATO exercises only. During the last decade, given the imminent phase-out of the Br.1150 (expected in 2012, but begun two years later), the Italian government was forced to ensure at least some maritime patrol capabilities. Due to widespread disagreement amongst the relevant stakeholders about the future Maritime Patrol Aircraft (MPA), the government decided to purchase a "gap filler" to be used until 2020. In 2008 Italy signed a €360M deal with Alenia Aermacchi (now Leonardo's Aircraft Division) for four ATR72 MP (Maritime Patrol) aircraft to be delivered by 2017. The first two, renamed P-72A, were delivered to the 41° Stormo in December 2016, the others will follow. The aircraft feature the latest version of the Leonardo ATOS (Airborne Tactical Observation and Surveillance) system, which is able to transmit/receive information in real time from C2 centres. The P-72A operates three main sensors: the Leonardo Airborne & Space System Division's SEASPRAY 7300 AESA surveillance radar; the FLIR Systems' Star SAFIRE HD electro-optical turret; the ESM Elettronica ELT 800 V2 system. P-72A can fly 6 to 8 hour-long missions with a 200 nm maximum range from the base, and it is suited for several kinds of missions – e.g. green water surveillance, search and rescue, monitoring, transport – yet not for ASW operations. In fact, the ATR72 MP version is, somehow, a "downgrade" of the ATR72 ASW purchased by Turkey.



(Photo: Marina Militare Italiana)

The Italian White Book (*Libro bianco della Difesa*) defines an "extended Mediterranean" area that broadens the geopolitical space of Italian interest.

Italy was in charge of leading Anti Submarine Warfare (ASW) efforts in the Mediterranean. After the fall of the Berlin Wall, the threats shrank, thus performing anti-submarine warfare missions became increasingly less relevant. More recently, instead, irregular flows of immigrants, as well as political instability in several Mediterranean countries, have been representing major challenges for Europe in general and for Italy in particular. Therefore the Italian attitude towards the Mediterranean has been changing. The Ministry of Defence is today aware that

Namely, it introduces the concept of "extended Mediterranean", an area including Northern African countries, the Mashreq, the Sahel, the Horn of Africa and the Persian Gulf. On paper, future military capabilities would shape up accordingly.

Atlantic and ATR, Who Does What?

The air component to safeguard Italian interest in the Mediterranean is delivered by the air force and the navy. In order to accomplish the related tasks, the armed forces have been using maritime patrol aircraft featuring dedicated ASW, Anti Surface Warfare (ASuW), and Maritime Patrol (MP) suites and weapons. In particular, 18 BREGUET Br.1150 ATLANTICs have been accomplishing these

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(Photo: MARCOM)



NATO's most recent anti-submarine exercise showed the importance of these assets to the Alliance.

Although it is possible to install an ASW suite on the aircraft, it will be difficult to do it promptly in case of need. If this suite will not be mounted/used, Italy will likely lose its ASW capabilities, and this will negatively affect Italian capabilities in general. The country would not be fully able to protect its national interest in operational scenarios requiring ASW aircrafts – namely malicious submarine activities in the Mediterranean, especially in the proximity of strategic choke points. Moreover, Italian Armed Forces would be unable to provide ASW assets when participating in joint international operations. Finally, the number of aircraft is risible, as the maintenance and training circles will further constrain the number of available airframes for operations. Thus, to some extent, this decision will further reduce the military support Italy could offer to its allies. In addition, without ASW capabilities in service, there will be no specific training any longer, thus worsening today's gaps. The shortfall of capabilities will therefore be severe, as ASW expertise cannot be rebuilt easily in case of need. Conversely, in the near future the Mediterranean might be populated with foreign submarines – and today some 40 countries own 500+ submarines.

Are ASW Capabilities Still Important?

The Br.1150 has served the Italian Armed Forces for forty years. When the phase-out began, it was clear they would need to be replaced. When the contract for the new MPA was awarded, ASW capabilities were considered of secondary importance. The temporary absence of credible submarine threats led to the setting that the Br.1150 has not been replaced by other ASW assets, and programs like the ATLANTIC 3 were not taken into proper account. But this decision is already proving its short-sightedness. In fact, potential submarine threats are arising both in the Central and the Eastern Mediterranean, and NATO is emphasising again the importance of ASW capabilities. The boost of submarine fleets and the related traffic across the Central Mediterranean represent crucial regional security

issues (see ESD, issue 6/2016). A 2016 study by the Joint Air Power Competence Centre shows that NATO capabilities in this domain will further decrease by 2025, as a number of assets from different countries (i.e. Germany, France, Spain) will reach the end of their service life. If the current trend will not be reversed, MP/ASW Alliance's capabilities will likely lose credibility. Keeping these facts in mind, tracking submarine activities in the Mediterranean will represent a relevant capability in the near future: maintaining the capability to track submarines in peacetime provides the opportunity of detecting potentially malicious activities around the choke points, next to high value targets and sea-based strike capabilities. Furthermore, the strategic concept of the "extended Mediterranean" as the Italian White Book defines it requires a broader assessment of future submarine scenarios that Italy might have to deal with. In fact, the Persian Gulf provides several future developments on this issue. A number of countries are developing their military underwater capabilities in the Middle East, and it is well known that the region lacks political stability. Strategic competition amongst Saudi Arabia, Iran, and Turkey adds further concern. Hence, current geopolitical trends in the areas the Italian MoD has indicated as strategic for the country clash with the decisions on ASW capabilities. Following the nuclear deal, Iran (which is already deploying its belligerency – but the loosening of economic sanctions could lead to an increase in military spending.

In the meantime, Saudi Arabian intervention in Yemen demonstrates growing assertiveness. This is further confirmed by the ongoing debate about the purchase of a submarine fleet, which should be deployed in the area of Bab-el-Mandeb and Hormuz in order to oppose Iran.

Future Perspectives

Italy has preferred the purchase of a small P-72A fleet in MP configuration to reduce costs. However, this is a false cost-opportunity choice. The ongoing instability in the Mediterranean region and the Italian ambitions expressed in the White Book suggest Italy will be forced to fill the ASW gap already in the mid-term. The country would therefore need to invest in new assets and in training, even though it could have maintained the ASW capability by purchasing a less complex and more economic platform. The acquisition of the P-72A proves the Italian government is often slow and short-sighted when deciding on defence issues. Probably, two main issues have been underestimated during the procurement phase. First, the likely loss of ASW capabilities, which have on the contrary been recognised as essential in the Mediterranean. The rising number of submarines in the Mediterranean has probably been underestimated: several European countries have not been working to keep credible MPA/ASW capabilities, and this will worsen the capability shortfall that already exists. Second, the gap between ambition and real capabilities: Italy affirms the will to operate in the extended Mediterranean, but acquires MPAs developed for sub-regional uses. The P-72A has been developed starting from the regional carrier ATR 72-600, so its range is limited, as well as its overall performance. For example, to protect its interest in Bab-el-Mandeb or Hormuz Straits, Italy would have to redeploy its assets closer to the operational area. But the limited number of aircraft (4) would seriously affect real operational capabilities and rotations. ■

(Photo: Leonardo)



Leonardo delivered the first two P-72As to the Italian Air Force in December 2016.

Indian Air Force: Grand Ambition

Jay C. Menon

Handicapped by diminishing numerical strength and a troubled force structure, the Indian Air Force (IAF) is in a crisis. As the fourth largest air force in the world marked its 84th anniversary last October the only noises booming between the ears of the authorities were the frantic calls for augmentation and rejuvenation of force levels. At nominally 33 squadrons, the IAF is well short of its sanctioned strength, and many of its frontline aircraft are obsolete.

The IAF has projected a requirement of at least 45-47 fighter squadrons by 2027 to face a two front threat. At present, the strength is down to 33 Squadrons. From 2017 to 2022, there will be a drawdown of 11 squadrons of MiG-21s and MiG-27s on completion of their Total Technical Life. This would amount

2000s, six squadrons of MiG-21 BISONs, five squadrons of JAGUARS, and five squadrons of MiG-27s.

The Road Ahead

The Indian Ministry of Defence (MoD) has created a comprehensive roadmap for but-

combat capabilities to transform itself into a leading modern networked airforce. A decade-long modernisation plan is being prepared by the IAF to identify services and technologies that it would also share with the private sector.

The MoD has prepared an ambitious plan to spend some €217Bn over the next 11 years on buying or producing new equipment, including fighter jets, aircraft carriers and some 500 helicopters.

The sum of Euro 217 Billion is projected as part of the financial requirements for the Long-Term Integrated Perspective Plan (LTIPP) for the period 2012-2027. Under this ambitious plan the MoD has set a target, including the induction of an additional 200 fighter jets for the IAF, 500 various types of helicopters and another indigenous sea-borne aircraft carrier.

Fight for Fighters

According to the former Chief of the Air Staff Air Chief Marshal Arup Raha the IAF is working towards the target of inducting around 400 warplanes by 2030. "Over the next 10 years, we must have 200-250 aircraft," Raha, who retired on Dec. 31, 2016, said. "Various options are being considered by the Ministry of Defence to augment the force strength. To start with, the deal for

Photo: G4sp



An Indian Air Force Su-30MKI

to a reduction of 220 aircraft. Without replacements, the IAF strength would deplete to 22 squadrons of fighter aircraft," warns Air Marshal (retd) Padamjit Singh Ahluwalia.

The IAF fighter squadrons nominally consist of 18 aircraft each – sixteen fighters plus two combat-capable trainers. At least three more are kept for Maintenance Reserve and Strike off Wastage (MRSOW).

Currently, the most capable components of the IAF consist of 10 squadrons of Su-30MKIs, three squadrons of MiG-29s, two and a half squadrons of MIRAGE

tracing the IAF's diminishing force levels and is trying hard to make steadfast progress towards achieving the necessary

Photo: Dassault



India has signed a contract for 36 RAFALE aircraft from France.

Author

Jay C. Menon is a senior journalist based in India.

procurement of 36 RAFALE aircraft from France has been signed and it will greatly enhance the operational capability of the IAF. We should receive the first aircraft in 36 months and delivery of all aircraft would be completed by 2019."

The IAF is buying the RAFALE Medium Multi Role Combat Aircraft (MMRCA) under a government-to-government basis and the first contractual payment of 15% was made in November 2016 to seal the deal. "RAFALE is an excellent aircraft. But we have just 36 aircraft; we require more aircraft in the medium-weight category," Raha said.

Indian authorities are on the lookout for single-engined and a twin-engined fighter – but the condition they are demanding is "the line of production should be in-country". "Various options are being considered for induction through the 'Make in India' route. Suitable aircraft will be selected based on certain guiding principles that will govern manufacturing of these aircraft in the country and meet the IAF's operational requirements," Raha said.

The IAF has already issued a global request for single engine combat jets under the government's "Make in India" programme, and manufacturers are jostling to sell their products.

While American defence majors Boeing and Lockheed Martin are offering their F/A 18 SUPER HORNET and F-16 (Block 70), Saab from Sweden is pushing hard to establish a production line of its GRIPEN E in the country. Not to leave out Dassault Aviation, whose CEO Eric Trappier offered to manufacture RAFALE fighter jets in India if the plane is short-listed for a bigger order.

Britain, which is part of the European consortium producing the Eurofighter TYPHOON, has also offered to develop the twin-engine, multi-role canard-delta air-superiority fighter aircraft in India.

The Eurofighter TYPHOON and Dassault Aviation RAFALE were short-listed by the IAF in 2011 as part of its MMRCA competition, but RAFALE was finally announced as the preferred bidder in 2011, following Head-of-State level support. But the MMRCA Request For Proposal (RFP) was scrapped eventually last year.

Though the RFI released by the MoD is for a single-engine fighter, Boeing is hopeful that there will also be a request for a twin-engine fighter at a later date. Russian Aircraft Corporation MiG says it will offer the IAF its latest MiG-35, which it claims "will be the only aircraft with which the Indian military should not have any issues".

It is expected that all the aircraft in consideration will cost somewhere between €75M-€93M apiece – so a requirement for 200 aircraft will add up to a bill of €19Bn-€22Bn at the very least. "Ultimately, the balance in selecting a mix of twin-engine

and single seat fighters will be economic," says Air Marshal (retd) Muthumanikam Matheswaran.

Procurements Across All Categories

The IAF plans to distribute the combat aircraft procurements over the entire spectrum of heavy, medium and lightweight categories, as well as weaponry for various air campaigns and twin/single engine configurations. In the heavyweight category, the IAF continues to rely on a large number of Su-30MKIs.



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Photo: Rahuldevmath

TEJAS was exclusively designed by HAL and ADA for India's Air Force.

So far, the IAF has placed orders for 272 aircraft, of which 50 were delivered by Russia in 2002-2004 and 2007. Another 222 are to be supplied by the HAL Corporation; production under Russian license began at HAL's Indian facilities in 2004. So far, more than 200 aircraft have been delivered, and the Su-30MKI is the most numerous of the multirole fighters currently in service with the IAF.

Besides buying 36 RAFALE aircraft from France, the country's Defence Acquisition Council (DAC) has recently approved a proposal to acquire 83 home-made Light Combat Aircraft (LCA) TEJAS Mk 1-A for the IAF at a cost of €6.9Bn as part of its efforts to replace the ageing fleet of MiG fighter aircraft.

This is in addition to the 40 TEJAS fighters that the IAF has ordered. The IAF has indicated the requirement for 100 of these 4.5-generation aircraft, being made by state-owned HAL. HAL plans to manufacture and complete the project from 2018 to 2022-2023.

The IAF has already started inducting TEJAS, but the aircraft will not take up

combat responsibilities until next year. The specifications derived for design and development of LCA MK 1-A are based on the applicable international military standards: the new specifications were agreed upon and the IAF accepted 43 modifications that could be carried out without changing the existing design. On the list of modifications are five major improvements, including an AESA (Active Electronically Scanned Array) radar, which HAL will co-develop with the Israeli firm Elta; air-to-air refueling facility; externally fitted self-protection jammer to prevent incoming enemy missiles from homing in using radar signature; and a new layout, involving 27 modifications of internal architecture to iron out maintenance issues. An RfP has recently been sent to ELTA, Airbus, Saab and possibly some other companies. ELTA is already supplying many of the on-board electronics. The aircraft will be 1,000 kg lighter than the existing version, which currently weighs 6,500 kg, but will use the same engine – General Electric's 404. T Suvarna Raju, Chairman and Managing Director of HAL says he is hopeful of expediting the process.

Trainers in Demand

The IAF modernisation plan poses a great challenge to its leadership to suitably deploy, adapt and sustain the force levels required to operate the sophisticated systems. The IAF has been trying for years to purchase suitable Advanced Jet Trainers (AJTs) to ease the transition to high performance aircraft.

India is at an advanced stage of discussion in considering the acquisition of an additional batch of BAE Systems HAWK advanced jet trainers. "Talks are underway between HAL and the government for a third contract of about 30 trainer aircraft," reported an official. HAL license-manufactures BAE's HAWK Mk132, and the new deal would build upon previous orders of 66 aircraft in 2004 and another 57 in 2010. Of the first batch of 66 aircraft, 24 HAWKS came in fly-away condition. The remaining 42 were built under license by HAL in India. The second order of 57 units are all being made in India by HAL.

Meanwhile, India has decided to soft-pedal on the development of a combat variant of the HAWK AJT as there has been no demand for it from the IAF. India had contracted 123 HAWK Mk-132 AJT aircraft from BAE Systems of the UK for the IAF and the Navy, and another order for 20 aircraft to equip the Surya Kiran aerobatics team is at an advanced stage. HAWK has been named as India's primary advanced trainer since the country lacks intermediate jet trainers, which are needed to train the country's combat pilots.

In November 2015, the Indian Air Force issued a task directive for the Design and Development of HTT-40. The IAF will acquire at least 68 Hindustan Turbo Trainer-40 (HTT-40), India's indigenous basic trainer aircraft (BTA), which made its first flight, powered by a Honeywell TPE331-12B turboprop engine, last year. The acquisition of these aircraft will be in addition to the 75 Swiss-made Pilatus PC-7 MKII BTAs that IAF currently operates. India has been relying on the Pilatus PC7 Mk2 trainer aircraft that were bought under an emergency purchase from Switzerland after the older fleet of HPT 32 trainers was grounded.

ARDC also touts HTT-40 as the first ever prototype to be manufactured completely based on a digital mock-up and also by using laser-tracked jigs and metal tooling during the prototype phase itself. The ARDC has sought active participation of the Aircraft Division, Bengaluru which has been identified as the production agency for HTT-40.



Photo: Hemant Rawat

India will spend some €2Bn on additional PINAKA multiple rocket launchers.

More Radars

HAL has floated global bids to procure around 100 state-of-the-art AESA radar systems at an estimated contract value of €1.72Bn for the improved variant of Mark-I TEJAS.

"The tender, in the form of an Expression of Interest (Eoi), was floated to five global firms," according to HAL. Bids have reportedly been issued to US defence contractors Raytheon and Northrop Grumman, the French company Thales, the Israeli Elta, Swedish aircraft maker SAAB, and Russia's Rosoboronoex-port.

Shopping Spree

India recently also approved the procurement of 15 indigenous light combat helicopters—10 for the IAF and five for the Indian army at a cost of €398M. The other proposals cleared by the DAC included an Acceptance of Necessity for buying 598 Unmanned Aerial Vehicles under Buy Indian category at a cost of €150M, and opening the path for issuance of a Request for Proposal for six additional regiments of PINAKA rocket launchers at a cost of €2Bn. The IAF has a long list of projects planned for implementation. This includes JAGUAR re-engineering, additional Helicopters, Medium Lift Helicopter upgrade, additional AEROSTATS (radars), additional DORNIER (light utility, mainly transport aircraft), additional Flight Refuelling Aircraft (FRA), additional Airborne Warning and Control System(AWACS), more attack helicopters, heavy lift helicopters, modernisation of Air Field Infrastructure (MAFI) phase II and very short-range air defence systems (VSHORAD).

In addition, design development of a Fifth-Generation Fighter Aircraft together with Russia is in progress. India is also developing a Fifth Generation Fighter Aircraft called Advanced Medium Combat Aircraft (AMCA). India also decided to buy S-400 TRIUMPH, the most advanced anti-aircraft defence system available from Russia. India and Russia also finalised the joint production of 200 Kamov Ka-226T helicopters in India.

Taking stock of the threat perception over the border, the IAF has prepared a 10 year modernisation plan detailing its requirements – from aircraft to aircraft tyres to rotor blades and 3D printing technology at an estimated cost of €34.2Bn.

Though India's defence budget has been growing over the years, the allocations have been increasingly skewed away from procurement and toward salaries, allowances, and pensions for the three services.

"These budgetary trends will negatively impact India's defence posture, particularly with respect to air power," says a report by the Washington DC-based Stimson Centre.

Tanker Contest

India's hunt for a new tanker aircraft continues. The IAF has a requirement for at least six new multi role tankers with the ageing fleet of Russian-origin IL 78 aircraft limited in their capability to meet needs for long distance deployment.

Boeing has set its eyes on the decade-old requirement for six multi-role tanker transport (MRTT) aircraft, after India terminated the tender for the second time. Boeing was not in contention for the previous two tanker tenders of the IAF, as it did not have any aircraft that fitted the Indian require-



Photo: US Air Force

Boeing KC-135 STRATOTANKER lined up as part of an exercise

ment. However, Boeing now has the KC-46A PEGASUS, the tanker aircraft it developed to replace US Air Force's (USAF) older KC-135 STRATOTANKERS.

The previous two attempts to purchase these tankers did not take off. The first tender, in 2006, was won by Airbus with its modified 330-200 aircraft with competition from Russia with its Ilyushin-78. But the tender was withdrawn in 2010 citing high cost. In the next global tender the Airbus A330 MRTT was yet again selected in 2012, but the government terminated the tender in July 2016, citing conflict between procurement cost and life cycle cost.

Transport Aircraft

The government has approved the purchase of one more Boeing C-17 GLOBEMASTER heavy-lift transport aircraft. The IAF currently operates 10 C-17s, which it began inducting in 2013.

India is also likely to sign a contract with Airbus Defence and Space for 56 C295 military transports, by July 2017. Six C295s will be purchased separately for an Indian Coast Guard requirement. Both orders will be delivered by the Tata-Airbus partnership that is India's first-ever private sector aircraft development enterprise.

The IAFs need for a new medium airlifter has become urgent, as the service grapples with ageing An-32s. In the past two decades 15 have crashed, the most recent one last year with 29 people on board.

Upgrade Route

Since the acquisition process in India is very exhaustive, the IAF is also taking the economically-viable path of upgrading its existing aircraft.

The IAF continues to remain in a situation of a strong and unhealthy dependence on Russian combat types, which are poorly supported by Russian OEMs despite India being one of the largest buyers of Russian defence equipment. Presently, out of 33 combat fighter squadrons, 24 IAF fighter aircraft squadrons are made up of the MiG-21, MiG-27, MiG-29 and Su-30 MKI. However, according to MOD figures, 11 squadrons of MiG-21s and MiG-27s (approximately 200 aircraft) will be retired by 2024, on completion of their Total Technical Life (TTL).

Talks are continuing between India and Russia to upgrade the existing and eventually the entire fleet of 272 Su-30MKI to a near fifth-generation level to increase their combat effectiveness.

One highly-placed Defence Ministry official opines that even though the Su-30MKI is one of the most advanced of the Generation 4+ fighters in service with the IAF, the need for its upgrade is becoming ever more

obvious since the first of the planes built to the current specification were delivered to India back in 2004. "Upgrading the aircraft and retrofitting them with new technologies can make them much more potent," he adds.

The IAF has also proposed to upgrade some 100 1970s-generation JAGUARS with more powerful Honeywell engines and better avionics to extend their lives by 10 to 15 years. Late last year, the IAF awarded initial operational capability (IOC) to the upgraded SEPECAT JAGUAR ground attack aircraft. The twin-seat aircraft has been upgraded to DARIN III standard to incorporate new avionics architecture including mission computer, engine and flight instrumentation system, solid state digital video recording system, solid state flight data recorder and addi-

an extended lifespan," said the official. An initial batch of 60 JAGUARS is planned to undergo the Darin III upgrade. According to estimates the IAF has 100 to 120 operational strike and maritime strike versions of the JAGUAR aircraft.

As a big relief to the IAF, HAL has also started upgrading the MIRAGE 2000 fighters. HAL Chief Raju said: "This upgrade for the MIRAGE 2000 gives additional capabilities of air to ground weapons, training, helmet mounted display etc. The system has the unique feature of integrating different types of data bus for Initial Operational Configuration, and Final Operation Configuration is achieved without any degradation. The total design and development was done by HAL which includes mission computer hardware, OFP software, system design, aircraft modification etc."

early warning radars mounted in domes on top of IL-76 aircraft.

The warning system, developed by Bengaluru's Centre for Airborne Systems and integrated on Brazilian-made Embraer-145 aircraft at a cost of Euro 301 Million, has completed tests and certification.

The DAC in March 2016 cleared building of two AWACs. This will involve mounting 360-degree cover-age radars on wide-body Airbus A-330 jets. The €700M project seeks to induct eight such aircraft under AWACs India in seven years.

Compelling Task

Ashley J. Tellis, senior associate at the Carnegie Endowment for International Peace specializing in international security, defence, and Asian strategic issues, says the IAF's desire for 42–45 squadrons by 2027—some 750–800 aircraft—is compelling. "The IAF's likelihood of reaching its 2027 goal with a high proportion of advanced fighters is poor. It is stymied by serious constraints on India's defence budget, the impediments imposed by the acquisition process, the meagre achievements of the country's domestic development organisations, the weaknesses of the higher defence management system, and India's inability to reconcile the need for self-sufficiency in defence production with the necessity of maintaining technological superiority over rivals," he says in a report. According to a report submitted by a defence panel in India's Parliament, the Defence Ministry acknowledged that "the money allocated for capital acquisition is not in accordance with the requirements of the Services (...).While the Ministry of Finance argues that the services have to make do with what they are given, the Indian military is already feeling the pinch of declining capital budgets."

In the May 2016 report, the Lok Sabha's defence committee focussed on the decline in the capital budget, the underutilization of capital funds, and how these two trends will affect India's procurement ambitions.

The ageing fleet of its fighter planes has been a matter of concern for the IAF. A number of older generation aircraft like MiG-21 have been in operation in the IAF since 1963 and have been involved in a spate of crashes in the recent years.

Over the past over four decades, India had lost more than half of its MiG combat fleet of 872 air-craft. According to a MoD official, about 500 MiG aircraft accidents took place in India till December 2016 since their induction. Not to mention the SUKHOIs, JAGUARS and HAWKS that go down once in a while. ■



Photo: António Milena

Formation flight of IAF JAGUARS at the Republic Day Military Parade, New Delhi

tional functions in inertial global positioning system, autopilot, radar and RWR.

The upgrade, which was carried out indigenously by HAL, also covers modern navigation, EW and weapon delivery system, with INGPS using primary and reversionary modes, man-machine interface, with two smart multi-function display and head-up display, according to an HAL spokesman. The Darin III allows the JAGUAR to be equipped with new-generation weapon systems such as the latest air to air missiles, he added. "The upgrade will help in major operational improvement with regard to all weather air-to-ground, air-to-sea and air-to-air capabilities through the incorporation of multimode radar (...).The Darin III upgrade, with re-engining and change over to higher capacity alternators can make Jaguar one of the most potent aircraft in the arsenal of the IAF, with

The IAF is already pursuing the upgrade of its fleet of Soviet-vintage MiG 29 fighters and IL 76 airlifters with the Russians.

The air force has embarked on a Euro 581 Million project for upgrading and enhancement of its IL 78 and 76 aircraft fleet to increase their service life by up to 20 years and give them enhanced avionics. The upgrade will also involve fitting new engines to six of the IL 78 midair tankers that will give the aircraft a longer range as well as the capability to carry extra fuel.

Eye in the Sky

The first indigenously developed all weather airborne early warning and control system – Eye in the Sky – is expected to be inducted into the force this year. India currently has three PHALCON airborne warning and control systems (AWACS), which use the Israeli

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LAZAR 3

MULTI-ROLE ARMORED VEHICLE



MULTIROLE FAST PATROL BOAT



155 mm / 52 cal. NORA-B/52 Armored Truck-Mounted Gun-Howitzer



Fake News, Social Media, and Heavy Metal

As 2016 descended into the mists of time it became clear that some degree of “opinion engineering” had been going on. The sudden failures of opinion polls to get close to the final answer was simply a reflection of the fact that we had all become preoccupied with looking at our peers, our equals and our navels, and we were merely reinforcing this failure through our tweets, posts, comments and opinions on social media. The fact that we were in a minority was no longer recognized – by us. And the fact that in a functioning democracy the wishes of the majority are what counts? – Well, that no longer mattered either, other than for a little reverse schadenfreude.

The relevance of this for the global armoured vehicles industry, observers, military users and practitioners is two-fold. First; the distressing news about the new Russian armour and armaments, as flaunted on the T-15 ARMATA IFV, tilted the armoured vehicle balance wildly away from the West and re-informed everyone with an opinion about the Crimea and Ukraine – unless it was fake news. But of course, we can all tell the difference between real and fake – nyet?

Second, matter-of-fact statements in the mainstream media that the UK would select / had selected the BOXER 8x8 vehicle, and would use OCCAR to run the programme, hence avoiding any legal niceties such as a competitive tender – were really quite successful in creating the fait accompli that the originators wanted. Unhappily, a simple conversation reveals

that OCCAR has not even been approached about this, but the quivers running through the armoured vehicle community were very real – and the outrage on social media was, too: Perfidious Albion...

But has Perfidious Albion got it right? Many observers castigate the UK for having joined the programme and then left it again, thereby saving its own development silver until a propitious moment arrived, and leaving its former team-mates to carry the can, and the bill – until now? (The fact that the budget saved has been frittered away as per UK tradition is entirely irrelevant, of course.)

But the main result of the ARMATA unveiling was the new Western enthusiasm for heavier guns and heavier armour, drawing everyone away from the lightweight, protected 4x4 liaison and scout vehicles of yore and pushing everyone, and Uncle Tom Cobley, and the kitchen sink, into ever-larger, heavier, less tactical and more protected 8x8 vehicles. At some point, much like the wheeled MRAP families, modern 8x8, 30-tonne-plus vehicles are too big and have too many of the family jewels in them. Too many eggs in one basket, you might say. Are we there yet?



Stephen Barnard

Content

- 2 **Wheels in Combat**
Paolo Valpolini
- 10 **Meeting and Managing Challenges and Requirements**
Interview with Général de Brigade Charles Beaudouin, Commander of the Section Technique de l'Armée de Terre (STAT)
- 12 **The ACCDC – Holistic and Effective**
Interview with Brigadier General Bernhard Liechtenauer, Chief of Staff and Deputy Commander, (German) Army Concepts and Capabilities Development Centre (ACCDC)
- 14 **Protection Solutions for Ground Vehicles**
Michael Horst
- 22 **Transparent Protection**
Michael Horst
- 26 **Armoured Vehicle Turret Weapon Trends**
David Saw
- 32 **No Mere Coincidence**
Interview with Amar Karia, Head of Armoured Vehicles Portfolio, Defence IQ
- 33 **Tank-killing Missiles for the Modern Battlefield**
Doug Richardson
- 29 **Masthead**

Index of Advertisers

ARTEC	3
ATM	27
BIDEC	3rd cover
Bren-Tronics, Inc.	13
FNSS	4th cover
Future Indirect Fires Conference	31
General Dynamics European Land Systems	5
GuS Glass + Safety	25
HOMSEC	17
Renk AG	11
Rheinmetall Defence	15
Tyron Runflat Ltd	23
YUGOIMPORT-SDPR J.P.	2nd cover

Wheels in Combat

Paolo Valpolini

As the fight between the track and the wheel goes on, and will never end, numerous requirements for both types of vehicles are coming up in the world. Once mostly “battle taxis”, wheeled vehicles have considerably evolved, some nations, such as France, having even decided to abandon tracked infantry fighting vehicles in favour of wheeled ones.

However, most armies tend to maintain a mix, with wheels being used in “Medium” formations while tracks are the backbone of “Heavy” ones. Most wheeled infantry fighting vehicles are based on an 8x8 chassis, due to payload considerations, although some 6x6 are also being proposed.

Amphibious Combat Vehicle (ACV) Programme

Some major bids are currently ongoing for 8x8 vehicles. One is very specific and deals with amphibious vehicles, the customer being the US Marine Corps. Part of the Amphibious Combat Vehicle (ACV) programme, the Phase 1 Increment 1 (ACV 1.1) inherited most of the requirements of the previous Marine Personnel carrier (MPC) programme and looked for an 8x8 platform vehicle capable of ship-to-shore movements. According to the Request for Information released on April 23 2014, the ACV 1.1 should operate in a significant wave height of two feet with sufficient reserve buoyancy to enable safe operations; provide a high level of survivability and force protection; operate in four to six feet of plunging surf with ship-to-shore operations and launch from amphibious ships as an objective; in terms of land mobility, operate on 30% improved surfaces and 70% unimproved surfaces; have the ability to integrate a .50 calibre remote weapon station (RWS) with growth po-

tential to a dual mount 40 mm/.50 calibre RWS or a 30 mm cannon RWS; provide carrying capacity to include three crew and 10 embarked troops as the threshold, 13 embarked troops as the objective, while carrying mission essential equipment and vehicle ammunition; and have the ability to integrate a command, control and communications suite provided as government furnished equipment.” BAE Systems, GDLS, Lockheed Martin, SAIC and AVDS submitted their proposals and on November 24 2015 BAE Systems and SAIC were awarded two contracts, worth respectively \$ 103.8 million and \$121.5 million to develop and build 13 EMD vehicles each, to be delivered by mid-2017 with three further vehicles on option. In fact each team will deliver 16 vehicles, the option having been confirmed although the extra funding was never announced. An RfP is awaited by late 2017, selection being expected in mid 2018, for an Initial Operational Capability in late 2020 (one

platoon ready to deploy), and full delivery of the 204 planned vehicles by 2023. These, along with refurbished AAV7s, will be deployed into six battalions in 1st Marine Expeditionary Force (MEF) (California), 2nd MEF (North Carolina) and 3rd MEF (Japan), as well as training entities in the US. The BAE Systems/Iveco DV contender is heavily based on the original Iveco DV Su-



A close up of the Iveco DV ACV 1.1 prototype showing the serrated disk located on the propeller hub to clear it from possible entanglements

perAV, which has been adapted to USMC requirements. With an empty weight of 26,000 kg and a 4,000 kg payload, it is 8.8 metres long, 3.1 metres wide and 2,8 metres high, and can host a crew of



The BAE Systems/Iveco DV contender for the AVC programme is heavily based on the original Iveco DV SuperAV.

Author

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Photo: via author

Vehicles of ST Kinetics' TERREX family

three plus 13 dismounts. Powered by an Iveco CURSOR 16 multifuel engine providing 700 hp, it can reach over 105 km/h on roads and over 5.8 knots at sea, being able to sail in sea state 3+. Fitted with 16" tyres rather than usual 14" ones, when hitting the beach both wheels and propellers help it to exit the water. The two propellers axles are fitted with a serrated disc used to cut branches or other debris that might hinder their movement. Its 14m³ internal volume allows it to host the three-man crew plus 13 dismounts with two days of supplies. As for protection, neither the USMC nor the manufac-

turer provided detailed data; the vehicle features a floating floor, which decouples occupants from the V-shaped hull, while ballistic protection fitted to the hull contributes to buoyancy. In June 2016 BAE Systems started welding seven hulls at its York facility (Pennsylvania), while Iveco DV built a prototype on company funding, which started amphibious validation with the Italian Navy and Army in Fall 2016. The vehicle has a 25% residual buoyancy, which would allow adding further subsystems, such as a remote control turret, which underlines a considerable growth potential.

Science Applications International Corporation (SAIC) teamed with ST Kinetics of Singapore, which developed an amphibious version of its TERREX 8x8 vehicle, known as TERREX 2. With a GVW of 30,000 kg and 9,000 kg of payload (which includes the add-on armour), it is 8 metres long, 3.6 metres wide and 2.8 metres high, a three-man crew and 12 dismounts being transported. It is powered by a Caterpillar C9 providing 600 hp and can travel at over 90 km/h on road, while in the water the platform is designed to reach 6.3 knots. As usual, no details have been provided about protection, except



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Photo: via author



The BOXER vehicle has been developed and is produced by Rheinmetall in conjunction with KMW (now part of KNDS following the merger with Nexter) under the ARTEC joint venture.

for the fact that the TERREX 2 is fitted with a V-over-V underbelly. Production of the prototypes has started at the SAIC facility in Charleston, South Carolina. Once the ACV 1.1 gets into service, the US Marine Corps will then move to the next phase, the ACV 1.2, which will aim at improving the vehicles' capabilities, especially in the amphibious domain.

Australian Mounted Combat Reconnaissance Programme

Another major bid is the Land 400 Phase 2 Army's Mounted Combat Reconnaissance capability, which aims at replacing the Australian Army M113s, ASLAVs, and PMVs (Bushmaster) around 2021. The 8x8 platform known as the Combat Reconnaissance Vehicle (CRV) should provide capabilities such as close combat reconnaissance, intimate fire support and

"close combat high survivable lift". Minimum lift is for three crew members and four dismounts, eight dismounts being the preferred capacity. According to the latest document from the Australian Defence Materiel Organisation the expected number of vehicles is 225, split into seven variants; reconnaissance and counter reconnaissance (129), command and control (26), joint fires (8), surveillance (17), ambulance (15), repair (20) and recovery (10). The bid calls for a military off-the-shelf vehicle and Australian industry participation should be maximised. Four bidding teams have lined up for the Australian programme, comprising 1) BAE Systems Australia with Patria, 2) Rheinmetall Defence Australia, 3) GDLS Australia and Thales Australia, and 4) Singapore Technologies Kinetics with Elbit Systems Australia. The shortlisting, which was due to be carried out in March 2016, was postponed until

late July and saw the Rheinmetall and the BAE Systems offers being selected for the following 12 months risk mitigation activity. Announcing the downselection on 28 July 2016, Mr. Kim Gillis, Deputy Secretary Capability Acquisition and Sustainment Group, stated that "when introduced into service [the] Army will have a capability which represents a quantum leap in protection for our soldiers while providing enhanced sensors and weapon systems for the crew." The announcement follows an extension to the Request for Tender (RFT) evaluation period to conduct a review of Australian industry involvement in elements of the LAND 400 Phase 2 Risk Mitigation Activity (RMA), to ensure Australian industry involvement can be optimised. The production contract should be worth some Euros 2.5 Bn.

In 2015 Rheinmetall set up Rheinmetall Defence Australia to improve its commercial activities in the country and to build strong relations with Australian SMEs. The German company is proposing the BOXER vehicle, developed and produced in conjunction with KMW (now part of KNDS following the KMW merger with Nexter) under the ARTEC joint venture, although the Rheinmetall share is nearly two thirds of the total. The BOXER CRV is fitted with the company's LANCE turret armed with a Rheinmetall 30 mm Mk30-2/AMB 30 mm cannon and SPIKE missiles, the command and reconnaissance system being provided by Northrop Grumman. Following deliveries to Germany and the Netherlands, the remaining two countries that originated the programme, the BOXER acquired its first export customer in December 2015 when it was declared preferred bidder for the Lithuanian Infantry Fighting Vehicle Programme, which foresees the delivery of 88 vehicles between 2017 and 2020. Most of those vehicles will be in the IFV configuration, fitted with an Elbit Systems UT30 Mk2 overhead unmanned turret armed with a 30 mm cannon and two SPIKE missiles, while four vehicles will be in the command post configuration. The programme is managed through OC-CAR. The 272 German vehicles of the first batch have all been delivered; an order for a second batch of 131 vehicles was signed shortly after the Lithuanian decision, and all of these will be delivered in the A2 configuration. A1 vehicles of the first batch will be upgraded to the A2 standard from 2017 on. As for the Netherlands, in May 2016 the Dutch Army changed the mix of its requirement, which now consists of 36 command post, 92 engineer group/APC, 52 ambulance, 12 cargo and 8 driver training vehicles, all at the A2 standard. In



Photo: Paolo Valpolini

For the Australian programme Patria teamed with BAE Systems Australia, and proposed its AMV35.

early 2017 all driving training vehicles, ambulances and command posts had been delivered, three cargo vehicles and 62 engineering/APC vehicles still being under manufacturing, latest deliveries being awaited in February 2018. Both Germany and the Netherlands are considering an infantry fighting vehicle version fitted with a medium calibre turret.

The other remaining contender for the Land 400 Phase 2 is Patria's Armoured Modular Vehicle (AMV). For the Australian programme the Finnish company has teamed with BAE Systems Australia, and proposes a modified version of its AMV XP, unveiled at DSEI 2015, which has increased payload, protection and performance. The vehicle, which is a slightly shorter version of the XP, is fitted with a BAE Systems Hägglunds two-man turret armed with an Orbital ATK BUSHMASTER III 35 mm cannon – hence the name AMV35 and currently the only competitor proposing such a calibre. Beside passive protection it is fitted with the Saab LEDS 50 soft-kill system, with provision to adopt also the hard kill element, and it can be fitted with RPG-nets. If the AMV35 is selected it will be mostly built locally, as per Patria strategy; AMV series production is currently ongoing in three customer coun-

Photo: via author



The PIRANHA 5 from GDELS is a contender for the British Army's MIV programme.

tries: Poland, which recently acquired the turreted mortar version of what is known as ROSOMAK; South Africa, where it is known as BADGER and is fitted with a Denel turret; and Croatia. The Finnish company now only produces prototypes in house. Patria has thus acquired considerable experience in technology transfer,

which might become a plus in numerous countries. Beside Finland and the aforementioned nations, the original AMV has been acquired also by Slovenia and Sweden, and lately by the United Arab Emirates, which filed a contract for 40 hulls with an option for 50 more last January. One of the UAE requirements was the

Highest Protection Levels for Tracked and Wheeled Platforms



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Photo: Paolo Valpolini

Another strong competitor for the MIV programme is the VBCI from Nexter (now part of KNDS following the merger with KMW).

ability to install a BMP-3 turret, to maintain commonality with its tracked fleet, so it is possible that the stretched version of the AMV might be the one selected. Patria is looking at further developments in the firepower and protection domains, as well as to cost reduction while maintaining current capabilities.

Wheeled vehicles in the 8x8 configuration might also have a say in the next step of Land 400, Phase 3, which aims at replacing M113s. Although documents state that "Ideally, Defence seeks an IFV with the following characteristics: Tracked and Turreted" they also add "Defence also seeks information on Tracked Armoured Personnel Carriers (APC) and Wheeled Ar-

moured Fighting Vehicle (AFV) in the IFV role." Again, tracks versus wheels; to what extent commonalities with the CRV might overcome preferences for tracks remains to be seen, but this will not be known before 2021.

As for the two other bidders, at Eurosatory 2016 Singapore Technologies Kinetics unveiled the third member of its TERREX family, the TERREX 3. Bigger and heavier than the TERREX 1 and 2, at 8.5 metres long, 3.4 metres wide and 2.8 metres high with a GVW of 35,000 kg and a 12,000 kg payload (which includes add-on armour), it carries a two-man crew and 11 dismounts and is powered by a Caterpillar C13 engine providing 711 hp. STK joined its forces with

Elbit Systems of Australia to form Team Sentinel, the Israeli company providing the MT30 unmanned turret, an updated version of the UT30, armed with an Orbital ATK Mk 44 BUSHMASTER II 30 mm cannon, with integrated SPIKE antitank missile twin-launcher. Dubbed SENTINEL II (the SENTINEL was a cruiser tank designed in Australia during World War II) the vehicle was proposed with Israel Military Industries' IRON FIST active protection system. As for passive protection, STK declared a Level 4a/b for anti-mine while the TERREX 3/SENTINEL II can be fitted with ballistic packages up to Level 6.

General Dynamics Land Systems Australia (GDLS-A), which teamed with Thales Australia, was proposing an Australian-optimised version of its LAV 6, fitted with the Kongsberg PROTECTOR MCT-30 turret armed with the Mk 44 BUSHMASTER II 30 mm automatic cannon. Probably the lighter and smaller vehicle among the contenders, the LAV (CRV) is fitted with a double-V hull. Its vetronic architecture is based on Thales' SOTAS which integrates Elbit Systems TORCH BMS. In different configurations both solutions are also proposed as competitors in other bids, such as that the one emerging in the UK.

UK Demands

The British 2015 Strategic Defence and Security Review marked an evolution in British Army organisation, two of the three existing mechanised brigades remaining while one is disbanded and in its place two "Strike Brigades" are being formed, equipped with AJAX tracked vehicles and with a new wheeled vehicle as troop carrier, the "planned" Mechanised Infantry Vehicle (MIV). The requirement seems to be for an APC, the RCWS being GFE, specialised versions being also needed such as command post, ambulance, repair and recovery; a total of around 300-350 vehicles is forecasted. Beside the APC the variant with the highest priority seems to be the Command Post; how much the MRV-P (Multi Role Vehicle – Protected) programme, which includes 4x4 and 6x6 vehicles, will take over some of the variants remains to be seen. As for the roadmap, answers to the PQQ (Pre Qualification Questionnaire) were collected in mid-November 2016, a decision being expected by Q2 2017, with IOC (Initial Operational Capability) being estimated around late 2022. Two companies proposed their products, one being GDLS, which deployed its LAV demonstrator in the United Kingdom in October 2015, one month before the publication of the UK MoD document. Two options are given to

Image: FNSS



PARS 8X8 IFV with 25mm SHARPSHOOTER turret from FNSS



Photo: Otokar

ARMA 8x8 with MIZRAK-30 unmanned turret system from Otokar

the potential customer, the latest iteration of the STRYKER, adopted by the US Army, and the LAV 6.0, currently being produced for the Canadian Army. As protection will definitely be a priority, both options feature a double-V hull and modular armour packages. Another strong contender is the VBCI proposed by the French company Nexter (now part of KNDS following the merger with KMW). With 630 vehicles in service in the French Army, which deployed them

to Afghanistan, Mali and the Central African Republic, in 2015 the company introduced the VBCI 2, a 32-tonne version with a 13-tonne payload, more internal space and improved protection, with Level 4a/b against mines and IEDs and Level 5 ballistic. A new powerpack was fitted, based on the Volvo D13, providing 600 hp and replacing the 550 hp Volvo D12, which also ensures quick field replacement – not part of the original French requirement but “es-

sential” for the British Army. The electrical output was augmented to cope with the increasing number of power-hungry subsystems, ergonomics having also been improved thanks to lessons learned from “down range”. The British military have already tested Nexter’s VBCI during a visit to France. Other potential contenders showed up at DVD 2016, among them Patria AMV XP, ST Kinetics TERREX 3, GDELS PIRANHA 5, and Artec’s BOXER. Rumours echoed by the press reflected worries of some competing companies of a possible single-source contract being awarded without a competition, the potential beneficiary being Artec’s BOXER, which would be acquired via OCCAR. However, no official source ever confirmed that possibility.

Requirements of the Qatari Army

Most of the aforementioned companies are also involved in the bid for the Qatari Army; numbers should not be high, with 82 as the supposed requirement, and the Rfl is apparently slipping to the right due to defence expenditure prioritisation following the sharp fall in the price of oil. Qatar maintains close ties with Turkey, so both Turkish champions in the armoured vehicle domain, FNSS and

Bren-Tronics Introduces the New 6T 24 V Light-Weight Lithium-Ion-Battery

Military vehicles and equipment such as telecommunications or optronics are increasingly energy intensive. Previous solutions are now too heavy and inefficient, prompting Bren-Tronics to introduce the new, innovative light-weight Lithium-Ion battery, the 6T 24 V.

At 2.7kWh, Bren-Tronics has developed the most capacitive 6T Lithium-ion battery on the market, addressing the three basic requirements of military vehicle manufacturers and customers: energy, weight and space. This 24 V battery replaces two current batteries for one quarter of the weight and half the space and provides all the power needed for starting the vehicle and for silent watch missions. Building a safe and capacitive battery needs real expertise, and Bren-Tronics has been designing and manufacturing Lithium-ion rechargeable batteries for military applications since 1973. Their 6T Lithium-ion battery was designed with in-

ternal protection and CANBus communication protocol access. The charging and discharging process and status are monitored at all times and can be conveyed in real time to the user.

Today’s requirements are ever more challenging, especially when it comes to performance, logistics and storage. The Bren-Tronics goal is to provide the most effective long-term solution with zero maintenance requirement – and the state-of-charge LCD on the battery itself will greatly assist operators and logisticians. Comparing Lithium-Ion technology with lead acid, it has been clearly proven that Lithium-Ion batteries can deliver one hundred times more of cycles: with these figures in mind, the logistic burden can be significantly reduced.



For silent watch missions, the goal is to provide as much energy as possible, always keeping in mind the reserve power requirement. With the CANBus connection the user has the complete battery status on display inside the vehicle and

can confidently concentrate on his mission. Also, the days when vehicles had to be run for hours to charge and recharge their batteries are gone: the Bren-Tronics 6T 24V Lithium-Ion battery can be safely and completely charged in less than two hours.

Today’s missions require a high level of energy and security and Bren-Tronics provides the solution that customers can rely on, with a light-weight, military-compliant, high-capacitive, safe, monitored system, a new-generation 24V Lithium-Ion 6T format battery. (sb)



Photo: via author

Malaysia is producing the AV8 (the first prototype is shown here); a development of the PARS 8x8 from FNSS.

Otokar, might well be in a good position to propose their PARS and ARMA 8x8 APC/IFVs. FNSS is developing the PARS 3, which includes new automotive components and allows carriage of an increased number of dismounts without changing the outside dimensions. Both companies are also awaiting news of a special-purpose vehicle for the Turkish Army. How much the recently failed coup d'état will impact the Turkish defence industry and the Turkish military is still to be seen.

8x8 Vehicles for Spain

Spain is in the process of acquiring an 8x8 vehicle that will be developed in infantry, reconnaissance, recovery, engineer, command post, antitank and forward observer versions, although overall there will be 12 different configurations. The GDELS PIRANHA 5 has been selected as the vehicle, SAPA Placencia providing the powerpack while Indra is in charge of vetronics. A risk reduction phase is being initiated, the contract including the manufacturing of five platforms. It is not clear which variants will be included in the five, but at least one will be in the IFV version to allow testing of the various turret and armament options. Currently five turrets are known to be competing for the contract, Leonardo Sistemi di Difesa (formerly Oto Melara) HIT-FIST, Elbit Systems UT30 and Rafael SAMSON MkII, while two remain undeclared. Tests will continue until late 2017, the acquisition contract being planned for 2018, with delivery of the first vehicles forecast for 2020. The PIRANHA 5 has also been recently ordered by Denmark, which will receive 309 vehicles with first deliveries in

2018. Six different versions are on order, infantry, command, ambulance, engineer, mortar and repair. Options contained in the contract will allow Denmark to increase the final number up to 450, which is necessary to meet the Army's needs. Beside the PIRANHA 5, GDELS has launched the PIRANHA 3+, which secured its first order from Switzerland in the mortar carrier version, fitted with RUAG's COBRA 120 mm mortar system.

Italy's 8x8 Family

Italy continues to develop its 8x8 family based on the CENTAURO H-drive. The latest addition is the CENTAURO II armoured car, which is based on an improved chassis developed by Iveco DV from that of the Freccia IFV, fitted with a wholly new turret armed with a 120 mm smoothbore full pressure gun. With a 30 ton GVW, it is powered by a militarised Iveco VECTOR 8 engine providing 720 hp – a considerable improvement over the other family members. The all-electric turret is fitted with the latest version of the Leonardo Sistemi di Difesa 120/45 mm gun which provides improved accuracy over those used in previous ARIETE and CENTAURO 120s, the pepperbox muzzle brake allowing the use of all types of round, including full-bore fin-stabilised varieties. The turret bustle holds 12 rounds. Six are in a revolver magazine aligned to the breach, permitting semi-automatic loading, the only manual operation being opening the breach. Nineteen more rounds are hosted in the rear part of the hull. The CENTAURO II adopts 3rd generation all-digital optronics by Leonardo Land and Naval Electronic

Division (formerly Selex ES), and hosts six radio sets on UHF/VHF/HF bands as well as Satcom. Unveiled at Eurosatory 2016, the configuration is now frozen and the official launch took place on 19 October, prior to the start of qualification trials by the Italian MoD. The aim is to replace legacy CENTAUROS in the Italian Army cavalry regiments, the Iveco DV – Oto Melara Consortium (CIO) looking of course also at export opportunities.

Worldwide Demands

Brazil has launched a programme known as VBR-MR (Viatura Blindada de Reconhecimento – Media de Rodas). The chassis will be a derivative of the GUARANI 6x6 and it will feature a manned turret armed with a 105 mm rifled gun, the four options being CMI Defence's CT-CV 105 HP, Denel Land Systems' MT 105, Leonardo Sistemi di Difesa HITFACT 105 and NORINCO ST1. With the GUARANI programme drastically slowed down due to financial problems, it remains to be seen how much the VBR-MR programme will move to the right. Russia showed for the first time its new BUMERANG 8x8 at the Red Square Parade in 2015, armed with a 2A42 30 mm cannon, a coaxial machine gun and two KORNET-EM missiles. No detailed information on its production is yet available. In Ukraine Ukroboronprom is actively marketing its BTR-4 APC, which is proposed with different turret solutions up to 30 mm calibre, and its BTR-3E1, the latter heavily based on original BTRs. Leveraging lessons learned in operations, it has been upgraded to the BTR-3DA configuration with improved protection, optronics, and with a new Deutz 360 hp engine. Numerous potent options are to be found in Ukraine. India is looking for an 8x8 IFV and is developing an indigenous solution with Tata cooperating with DRDO on the KESTREL, both Russian and western turrets having been seen on the prototypes. High numbers are considered, over 2,500 being the Indian Army requirement. Malaysia is producing the AV8, a development of the PARS 8x8 from FNSS of Turkey being built locally by Deftech. Following a lengthy selection process the South Korean Army has finally selected the Hyundai Rotem KW2 and KW1 (K808 and K806 in the Korean Army) as its wheeled vehicles, its competitors having been Doosan BLACK FOX and Samsung Techwin MPV. Powered by a 420 hp Hyundai engine, the 8x8 KW2 has a combat weight of less than 20 tons and some amphibious capacity. It hosts 11 personnel, the armament ranging from a light RCWS up to a medium

calibre turret. Overall the South Korean Army should acquire around 600 vehicles, although the split between 6x6 and 8x8 is not yet defined. First deliveries are expected in 2018.

China has made inroads on the export market, with Venezuela having acquired some VN-1 amphibious armoured vehicles, the export version of the ZBL-09, fitted with 30 mm turrets and Norinco HJ-73D antitank missiles. Argentina has also ordered 110 8x8 VN 1: the vehicles are to be assembled locally, fitted only with a 12.7 machine gun.

Conclusion

Numerous acquisition programmes for 8x8 vehicles are up and running, these armoured platforms ranking at the top of the wheeled systems in terms of protection and firepower, and obviously cost. European manufacturers are very active in this field. However other continents are appearing as strong market contenders. The fact that the USMC programme shortlist includes one vehicle designed in the Old Continent and the other in Asia shows well this trend. With China very active in Latin America, and Russia in many former Soviet states and not only, and with potential customers being limited



Photo: Paolo Vaipolini

The CENTAURO II from the Iveco DV-Oto Melara Consortium (CIO) was unveiled at Eurosatory 2016.

by systems costs, a certain overcapacity in this field must be recognised, although most manufacturers are also active in lower tier productions, such as more affordable 6x6 vehicles as well as in 4x4. With most vehicles now over the 30-tonne limit in terms of combat weight, further improvements in protection should come

from active solutions, especially against RPG-type threats, while exotic propulsion systems should soon allow greater design flexibility. As for the fight between tracks and wheels, this will still go on, few nations having decided to use 8x8 together with main battle tanks, France being one example.

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Meeting and Managing Challenges and Requirements

Interview with Général de Brigade Charles Beaudouin, Commander of the Section Technique de l'Armée de Terre (STAT)



Photo: STAT

ESD: Please explain the function of the STAT, and where it fits into the overall Army acquisition structure.

Beaudouin: As part of the armament operations process, as defined by a French ministerial instruction, the first two stages, called initiation and orientation are the responsibilities of the Staff of the armed forces, in other words the user of the future military capabilities. The DGA – French procurement agency – is responsible for the subsequent two stages, design and development of chosen solutions, before their use by the forces. The DGA acts as an interface between the defence company and the customer, in this case the Army. The STAT represents the Army and is the preferred interlocutor of the DGA. Firstly, the STAT has to translate the military requirement stated into operational characteristics and has to make sure, all through the development stage, that the industry solution meets the needs of the land forces. But above all, after the DGA has carried out its technical tests, the STAT conducts all the operational evaluations to verify that the solution is adequate to the need initially stated by the land forces in particular, and by the armed forces in general. Once equipment has been fielded to the forces, the STAT is still active, all through

the “use” stage, to adapt these capabilities to the context of overseas operations and operations in the national territory. This capacity to gather lessons learned in the field allows the STAT to continuously refine specified military requirements into new capabilities.

ESD: You attend certain key events (expositions, conferences) across the year: what are you doing at these events? Looking for something specific or looking for new ideas/inspirations/solutions?

Beaudouin: Firstly, the STAT, as an intrinsic part of the Army, shows the commitment of our land forces in overseas operations and operations in the national territory. As such, during the Eurosatory exhibition, the STAT shares its experience on the use and operation of French Army equipment on the Ministry of Defence’s stand. The STAT is also called upon during demonstrations of equipment in support of export support missions by French defence companies. The expertise of our personnel is recognised as they were able, during equipment evaluation, to extend it to the operational limits required in theatres of operation. Furthermore, STAT programme officers, all of them war college

graduates, take part in conferences in strategic planning institutes where they can highlight their experience in the field of armament operations,

but also put into perspective the changes in war through the translation of requirements into military capabilities.

We are interested in exhibitions and shows as we can meet engineers as well as soldiers from the other services who share their understanding of the new conflicts and their responses to them on both the technical and doctrinal levels. Through these exchanges of ideas, we can enrich the technical and operational ways we address the challenges faced by the French forces deployed in theatres of operations.

ESD: When you find what you are looking for, what happens next?

Beaudouin: Besides my simple task of advising the commander, new technologies or new pieces of equipment can be promoted and put into operational context as part of what we call “reactive experimentation operations”. In association with the DGA, new capabilities are evaluated with the defence companies and we can thus find new potential and

Graphics: STAT



“The succeeding generation of armoured vehicles, among others the JAGUAR (left) and GRIFFON (right), will be fielded to the forces by 2021-2022.”



Battlespace digitisation is one of the major challenges facing the STAT and the French armed forces.

meet the evolving needs of the land forces. Furthermore, new pieces of equipment may fulfil some needs known in the theatres of operations and quickly lead to off-the-shelf purchases through the DGA or other procurement governmental agencies.

ESD: Can you share any examples / case studies? For example, most unlikely successes, or biggest surprises?

Beaudouin: One example comes to my mind ... I don't remember how many types of drones we have seen, purchased, evaluated, or whether they were nano, micro, mini and of any other size, or had fixed or rotary wings. Or indeed how many companies either my teams or I have met. All of them have confirmed that the trend today appears to be towards drones of between 10 cm and 1 metre. These drones can be seen everywhere, on TV or in the toy departments at Christmas, or they have actual applications on railways or for crop monitoring. However, the performance and needs analyses rather guide us towards very light and compact drones measuring less than 10 cm – although that does not mean that we won't evaluate a drone about 1 metre long. Lastly, the rotary wing, that we saw as the solution to

eliminate the need for take-off runways, seems now to be less relevant in view of the dimensions and low ranges of such platforms.

ESD: What are your biggest challenges at present, and what would you wish to have as your legacy at STAT?

Beaudouin: The Army is facing two major challenges now and in the future. Firstly, in the next five years, the Army will experience a change in generation of its major pieces of equipment. The venerable VAB armoured personnel carrier as well as the ERC 90 SAGAIE and AMX 10 RC armoured cars are being progressively withdrawn from service. They have been employed by the Army for 40 years and generals leading the Army have used all of them in operations. The succeeding generation of armoured vehicles, among others the JAGUAR and GRIFFON, will be fielded to the forces by 2021-2022. The STAT has to carry out their evaluations. But all associated command structures will be introduced at the same time and are expected to result in a tactical change in network-centric land warfare. This is the second major challenge facing the STAT and the armed forces: battlespace digitisation. It is not just about linking combat

vehicles together using a more modern communication system, but indeed about providing the theatre commanders with a global command system that allows the optimisation of all joint actions: command, decision support, intelligence, logistics information, 3D fire support, identification friend or foe, interactive mapping. For the STAT, this tactical change raises two major issues. On the one hand, the interoperability of all these systems has to be ensured in terms of data exchange and computer security. On the other hand, the ergonomics have to be adapted to the whole range of users, from the fighter, however trying the conditions of use may be, to staff senior officers, who have to be convinced of the validity to use these new tools.

You can now see the volume of work awaiting us in the years ahead: evaluating major pieces of equipment, integrating them into a new digitised environment, and having them adopted by all levels, from the soldier to the general. As is the case in the civilian world, the Army will have to meet the digital challenge for its combat systems.

Lastly, as I come from the armour and cavalry branch, my spur is to make sure that all our fellow soldiers deployed in very harsh conflicts in overseas operations know that we work tirelessly to help them carry out their mission, that the pieces of equipment on which we are working in France will meet their actual need and be delivered without delay. My men are continuously focussed on these objectives, asking themselves the same question over and over: "What did I do today for my fellow soldiers on operations?"

ESD: Mon Général, thankyou.

The interview was conducted by Stephen Barnard.



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The ACCDC – Holistic and Effective

Interview with Brigadier General Bernhard Liechtenauer, Chief of Staff and Deputy Commander, (German) Army Concepts and Capabilities Development Centre (ACCDC)

ESD: Brigadier, the Army Concepts and Capabilities Development Centre, activated in 2013, is subordinate to the German Army Headquarters: what is its mission?

Liechtenauer: The Army Concepts and Capabilities Development Centre (ACCDC), located in Cologne, is one of the more recently formed agencies of the German Army. The core mission of our Command is to actively and proactively contribute to enabling the German Army to meet the requirement of providing operational forces today, tomorrow and beyond. In doing so, we pursue an holistic approach to Army development, which addresses the German Army as a whole – that is, the Army System as a subsystem of our armed forces – instead of focussing on the individual arms or services, for example. We are very systematic in our efforts to continually build up capabilities that allow us gradually to have a better-postured, better-equipped, better-organised and better-trained Army to accomplish all our operational missions now and in the future. This goal is very well reflected in our motto „Focussed on the Future“.

ESD: That sounds rather rigorous. To that end, how is the Centre organised?

Liechtenauer: Headed by a Commander in the rank of Major General, the ACCDC is broken down into five divisions responsible for Army development and a headquarters section for administrative matters. The five divisions of the ACCDC include: Division I – Policy/Integration; Division II – Combat Development; Division III – Intelligence & Reconnaissance and Support Development; Division IV – Counter-Improvised Explosive Devices; and Division V – Organisation. Let me draw your attention to a particular feature of the ACCDC: its structure is unique inasmuch as Divisions I to III and, in terms of Army development, also Division IV (Counter-Improvised Explosive Devices), work together in what is referred to as a matrix organisation. This organisation requires and promotes an holistic approach to solving complex problems: it allows us



Photos: ACCDC

Brigadier General Bernhard Liechtenauer wears the cap badge of the Armoured Infantry. He joined the Bundeswehr in 1976. He underwent German and Italian general staff officers' training and has a wealth of experience in command, staff and ministerial assignments. In 2012 he was appointed project manager for the establishment of the ACCDC. Since May 2015 he has been Chief of Staff and Deputy Commander of the ACCDC in Cologne.

to accomplish our mission flexibly and rapidly. This calls for team spirit and constructive cooperation, communication and co-ordination and it requires each member of the staff to contribute their share to the overall effort. What is needed is holistic thinking and support of project management activities. This is both challenging and innovative.

Special-to-Arm work is coordinated and directed horizontally by Division I (Policy/Integration) which has a pacemaker function for the matrix to promote an holistic approach within the Army System.

In addition, the ACCDC has been assigned the lead in the fields of Explosive Ordnance Disposal, Joint Fire Support and Bundeswehr Human Intelligence. Division IV, Counter-Improvised Explosive Devices, also performs its tasks as an inter-service function. Being assigned the lead means that one major organisational element, which in this case is the German Army, performs a task not only for itself but also on behalf of other major organisational elements of the Bundeswehr. To conclude my answer to your question, let me stress that the ACCDC is one-of-a-kind in the Bundeswehr: no other armed service

or major organisational element has a comparable agency.

ESD: With reference to your motto „Focussed on the Future“, let me ask how you manage to do this, knowing that the future is all but clearly mapped out. What is your view on this?

Liechtenauer: No doubt, we don't have a crystal ball either! This means that you can never be sure that the conclusions you draw from what is ultimately a subjective look into the future are the right ones. Therefore, any future analysis will imply a risk. What we can do, however, is to make a crystal clear estimate of the situation and as precise an analysis as possible of the tactical and operational missions, as well as of the possible operating environment. To this end, we draw on civilian expertise from research institutes and universities, we assess international findings and experience gained during exercises, and we employ, for example, the Operations Research and Concept Development and Experimentation methods. In this respect we are pretty much up-to-date, too. This is the basis from which we develop capability profiles that are subsequently translated into requirements which ultimately result in projects and products. In my opinion, this methodology places our Command in a good position to address future challenges. But let me be clear: some residual risk remains since forecasts have, by nature, always been difficult to make.

ESD: With that in mind, the ACCDC has become the fulcrum of Army development; the Arms and Service Schools will hence no



The Main Building of the ACCDC in Cologne, Germany



longer play a part in Army development. Does this form of force development actually work?

Liechtenauer: This is clear and easy to answer. The integration of the further development of the arms and services into the ACCDC and the concomitant establishment of a single-tier system that you mentioned – which is not applicable to the Special Operations Forces for whom the two-tier system continues to exist – has proven successful. Let me explain this by reference to the command and control capability of combat troops. This issue not only concerns the armoured forces and the infantry but also the combat support troops, and, in particular, the Army Signals Corps. Their interests require comprehensive coordination and harmonisation, which can only be achieved by taking an overarching view, and that is why we have the capability domain of command and control. In this context, it is invaluable that all users and all capability domains are co-located at the ACCDC, thus allowing the coordination process to be managed from a single source. This prevents redundant and resource-intensive staff work, helps bridge communication gaps and avoids duplicate or even undesirable developments. This may sound as if Army development was a detached, ivory-tower endeavour and tantamount to some academic navel-gazing exercise. But it certainly is not. Irrespective of the fact that all Army development capabilities are grouped together under the roof of the ACCDC, we rely on maintaining an intensive dialogue with the Army Training Command, its training establishments, the units, the capability coordination commands of the other major organisational elements, the Bundeswehr Office for Defence Planning and the Federal Office of Bundeswehr Equipment, Information Technology and In-Service Support, and – last but not least – with the defence industry. You see, we have both feet planted firmly on the ground, developing capabilities that are actually needed for training, exercises and operational deployments.

ESD: Brigadier, you are attending the IAV conference in London to give a presentation. What is your presentation about and what is your personal position on Army cooperation between Germany and the UK?

Liechtenauer: At the IAV conference I am going to present our holistic approach to the further development of the German land forces, especially in the light of the recently-issued 2016 White Paper and the requirements resulting from the decisions taken at the NATO summits in Wales and Warsaw. With a view to implementing the Readiness Action Plan and, in particular, establishing an Enhanced Forward Presence in the Baltic states, the ongoing close cooperation with the United Kingdom is of great importance. In my eyes, it is one of the most crucial and successful pillars of bilateral Army cooperation. In many fields, it is beneficial for both sides. In addition, it provides a capability gain for NATO's Readiness Action Plan. I may remind you that our two nations have agreed to act as framework nations for NATO's Enhanced Forward Presence. This offers a good basis for further cooperation in the areas of interoperability and capability development among our Baltic NATO partners.

But let me add one important aspect in this context. On balance, I must say that the cooperation between the Armies of our two countries has significantly intensified, now covering almost all levels of command. On routine duty, this is illustrated by the German-British Army Staff Talks, the assignment of exchange officers, cooperation between 1 (DEU) Armoured Division and 3 (UK) Division, and cooperation in the field of future/capability development, to mention but a few examples.

Maybe it went largely unnoticed by the public that both the new British National Security Strategy and the latest German White Paper refer to our countries as strategic and/or important partners. I think that says it all!

The interview was conducted by Stephen Barnard.

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Protection Solutions for Ground Vehicles

Michael Horst

Protecting military tracked and wheeled armoured vehicles is a particular challenge given the current threat level.

Vehicles with tactical ground mobility have a decisive role to play in the success of military operations. Protected and armoured tracked and wheeled vehicles enable the application of force upon a target. It is necessary

areas. Generally speaking, shaped charges achieve very high penetration against all armour materials, achieving their effectiveness through particle speed of a shaped charge of around 10,000 m/s. A PG 7 V shaped charge, for instance, has a

from materialising; direct protection consists of both active and passive protective measures.

Active protection focusses on preventing, thwarting, or removing the effectiveness of the measures taken by enemy forces.

Photo: KMW



Results of an IED attack

to protect the vehicle crew and the vehicle itself in order to assure its sustainability, survivability and tactical mobility.

The Threat

In the completely new range of missions, ground vehicles are threatened by weapons including Improvised Explosive Devices (IEDs), Explosively Formed Penetrators (EFPs), mines, splinters, and direct fire weapons including handheld anti-tank weapons. The threat has increased through weapons (guns, RPGs and incendiary devices) being fired from roofs and high-rise buildings, especially in urban terrain. CBRN/NBC weapons, electronic warfare and cyber attacks upon the digital infrastructure of systems make responsive and flexible defensive measures and protection systems necessary.

In current missions the threat posed by mines, IEDs or handheld anti-tank weapons, such as the RPG 7, is especially acute. The danger posed by the RPG 7 comes from its high penetrative capability; it is also an inexpensive weapon built in very high numbers and is available in all conflict

Photo: German Army



FENNEK scout vehicle after RPG 7 hit

penetration depth of around 320 mm in armoured steel. To protect a surface area of one single square metre, armour weighing more than 2.5 tonnes is needed. A vehicle with such a level of protection retains hardly any tactical mobility, so innovative defensive solutions are needed.

A Military Understanding of "Protection" From a military perspective "protection" includes all measures and means for addressing threats, in order to preserve freedom of action including deploying forces and equipment. The focus is on preventing enemy forces from seeking, identifying, engaging and destroying friendly assets. The concept is divided into "indirect" and "direct" protection. Indirect protection comprises measures, procedures and the organisation in advance to prevent threats

The aim of „passive protection“ is to restrict the effectiveness of an attack or its impact, which for the most part is achieved with training, using personal protective equipment, tactical agility, and material protective measures (including protected platforms). The different dimensions of protection are interdependent and must therefore be considered holistically. The following aspects of protection primarily involve „material protection“ and associated material protection measures.

The first principle is that the vehicle's hull will not rip apart. Heat and pressure from an explosion must not get into the interior of the vehicle, so securely sealed doors and hatches, specialised seating (feet off the floor) and restraint systems and detonation-resistant mountings are all



Photo: Iveco

the start of development, during which it is important that the vehicle is also subjected to extreme simulated conditions to identify weaknesses and ensure high overload resistance. Even if injury cannot be prevented, the risk should be reduced to the greatest possible extent. Simulation can expose potential protective weaknesses without time-intensive and costly live explosive work.

Protection – Possible Solutions

Protection requirements have significantly increased over recent years, but higher protection levels cannot be attained simply by adding additional protective elements. Even with the most modern materials (such as nano-materials), the weight limits of the platform are quickly reached, and since significant improvements in material properties are not likely, alternative approaches must be explored. Protection should therefore be considered in the concept phase of vehicle development, especially in the hull/cabin; shaping the hull or cabin can allow a significant proportion of the energy from ballistic and mine attacks to be dispersed or absorbed.

Protected cab with additional armour

required, as well as securing internal fittings that could cause injury. Architects of the interior of the vehicle's hull must take into account storage space, equipment and functions, and the safety and security attributes of the interior. The stowage concept determines which items are to be housed in the cabin and in which positions, and what needs to be placed

in external storage boxes. Considerations must also include personal weapons and their stowage within easy reach. A potential enemy is not limited to pre-designated quantities of ordnance, so threats are simulated through "overload" tests. To ensure the survivability of the vehicle's crew, it is important that the overload situation is taken into account from



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FORCE PROTECTION IS OUR MISSION.



Photo: Horst



Conceptual and current protection solutions from IBD Deisenroth Engineering GmbH on an Iveco LMV

As a general rule, ground vehicles can be protected in three different ways. Traditional wheeled vehicles can be retrofitted to a higher protection level using protection modules. The crews of logistic vehicles have been given extensive protection since the 1990s. In the German Army, for example, protection elements have been attached to existing vehicles as a quick solution. Undesirable effects included axle loads close to limits, additional vehicle width, more difficult handling and overloading of vehicle suspension, hinges and fixtures. Industry offers solutions which are laid out for „add-on“ protection packages. They consist of a reinforced chassis and adapted hinges and fixtures. In any case, the suspension and the attachment points for the cab must be modified to cope with higher

loads: a cab with a higher level of protection can mean up to three tonnes more weight on the front axle. Cabs with built-in protection are heavy, expensive and create unnecessary wear during peacetime operations. A solution is to use replaceable cabs which allow the vehicle to be operated with protected or unprotected cabs as required. Cabs can normally be switched relatively quickly. For ground vehicles with built-in protection housings are manufactured by specialist firms from materials with high protection attributes. Production requires special know-how, in particular when bending and joining. The raw cab arrives at the manufacturer with attachment points for supplementary protection elements and with some of the basic cable equipment which can be installed later, but only at significant expense, which will



Photo: DND

Reactive elements in boxes

Photo: Canadian Army



LEOPARD 2 MBT of the Canadian armed forces with slat armour protection

then add additional equipment to the cab. This includes fitting equipment packages to meet the required protection level. In recent years, IBD Deisenroth Engineering GmbH has developed concepts and solutions that are applied to numerous vehicles. The form and construction of the hulls, plus the use of modern materials, play an important role in optimised energy management. In particular, the pronounced V form of the underbody offers high stiffness and deflects a large proportion of the energy from the blast. This kind of design also reduces the volume to be protected. However, there are also flat underbodies which offer similar protection. If these measures are insufficient to meet the protective requirements, further passive or active protection solutions, or a combination of protection systems, are

Photo: Horst



Transparent protection system after multiple engagements

needed, including modular designs: based on requirements and costs, the user will decide on which solution to pursue.

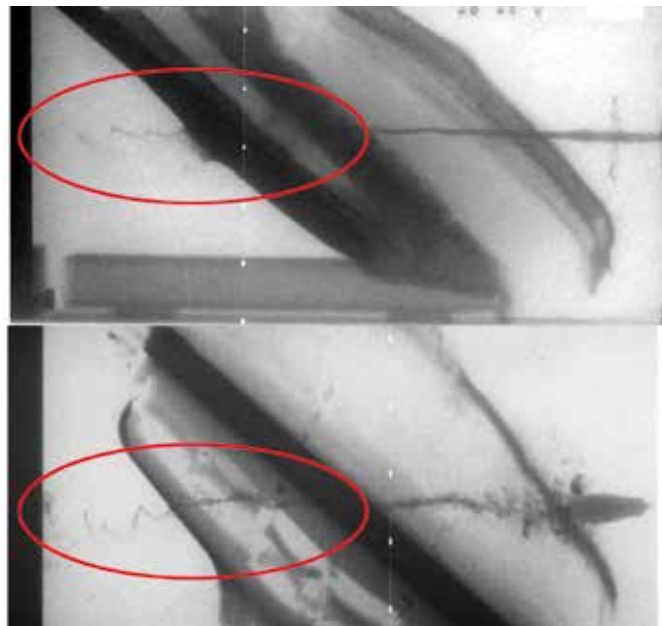
Passive Protection Solutions

In defending against the effects of handheld anti-tank weapons, mines, and IEDs, an early attempt was made to neutralise them by exploiting the characteristics of certain materials. Some very good results were achieved with the use of materials with the same or better performance than steel, such as titanium, which have a lower density or offer more resistance to hydrodynamic penetration (glass, ceramic, composite armour). However, such advantages come at the expense of greater mass and high price. The weight savings available are usually maximised at around 50%.

When it comes to armoured steel, the objective is to improve the available material. With armoured steel, configuring the material to withstand point-based penetration can lead to inadequate protection against an impact over a wider area. Weight savings are achievable along with a higher safety factor, no matter whether armoured steel, new kinds of composite materials or ceramic composite systems are used.

When using composite armour, ultra-tough special material, such as ceramics is used on the external surface to break up projectiles.

Photo: DND



The function of reactive protection in an X ray recording; the blast of the spike is deflected and broken

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Photo: Rheinmetall

Active Defence System (ADS) from IBD Deisenroth/Rheinmetall on the FUCHS armoured transport vehicle



Photo: IDF

TROPHY from Rafael has been used successfully with the Israeli MERKAVA MBT.



Photo: Artis

IRON CURTAIN from Artis



Photo: Ereshkigal

IRON FIST from IMI Systems



Photo: Diehl

AvePS (Active Vehicle Protection System) is a launcher-based protection system, shown here on a MARDER AIFV.

Armoured steel absorbs the kinetic energy. A liner is adhered or screwed into the inner part of the protection cell to capture fragments or reduce the fragment cone. Solutions such as slat armour or nets are lightweight, easy to attach and are fitted to diminish the warhead effect either by preventing ignition or by creating as large a distance as possible between the projectile and the vehicle: the penetrative capability of a shaped charge diminishes very quickly over distance. This does not apply in all cases, however, which is why these measures are regarded as „statistical protection“. Solid slat construction offers better performance, being less susceptible to vehicle vibration and damage from off-road movement.

Transparent passive protection is especially important in vehicles. Driving and reconnaissance both require a large field of view, but the window panes are a primary target of attack as the operators can clearly be seen. Providing the same quality of transparent protection as in non-transparent protection is a challenge, and both legal requirements and costs need to be addressed. Special glass, plastics or transparent ceramics and combinations of these materials are used.

As a rule, transparent ceramics and composite solutions are based on excellent materials with top-level optical and ballistic capabilities. The modern customer is offered a relatively lightweight, dense, durable product at an acceptable price point that provides protection against gunfire and rocks/stones. Development work is still necessary – for example to protect the adhesion of transparent ceramic tiles from the effects of the weather, or the size of tiles and the associated road traffic challenges. In the USA efforts are being invested in a transparent monocrystal solution – so-called sapphire glass from the mineral Corundum, but currently this solution is very expensive and very time-consuming.

Active Protection Solutions

Reactive armour primarily does not use armour to counter a shaped charged blast. It is based on the principle of self-defence, rather than destroying the threat. The system needs to react very quickly as the processes happen at very high speed after the impact of the round. Again, explosives are used as an active element: a layer of explosives is placed between two plates (made of metal or composite material). a shaped charged beam triggers the explosive which accelerates the plates against the threat at an angle, which leads to a significant reduction in depth of penetration.

Naturally, the overall size of the structure and the amount of explosive is driven by the threat. Usually, the protection must be laid out to provide a certain ‚overmatch‘ vis-à-vis high-capability threats.

In current solutions, reactive armour elements in boxes are used. Usually, their effectiveness is limited to one box in the event of a hit. The boxes contain a suitable arrangement of a specific number of active elements within a weight limit to allow them to be fitted/replaced by the vehicle’s crew.

For the practical application in vehicles, the weight and the construction volume of such a protective arrangement is of course of interest when compared with armoured steel: the use of reactive protection may lead to a weight reduction of up to 90% when compared with a pure steel solution.

Only extremely insensitive explosives are used for active protection systems. They only detonate on the impact of a shaped charge and remain passive when hit with machine gun fire, powerful KE ammunition or IED elements: adjacent boxes do not react, either.

The protection is assessed not only in terms of its ballistic effectiveness: system compatibility and compliance with existing safety requirements must also be accounted for. Reactive protection must be able to withstand different environmental



Photo: Hutchinson

Painting flame-retardant polyurethane coating

conditions, as must the vehicle itself, and must do so without losing its effectiveness or sensitivity without a change to its properties. This form of assessment includes standard methods for temperature changes, rain, sand, lightning protection, vibration and fire from various weapon and munitions types.

Fear of collateral damage has been the main reason why reactive protection is met with scepticism, as the plates in the explosive modules use metals which can cause a considerable shrapnel hazard.

Photo: Horst



The Active Blast Countermeasure System (ABDS) from Tencate was functionally tested by the IABG. Shown here is a functional module for ground vehicles on display at Eurosatory.

This concern can be alleviated by using composite plates and plastic screws which are destroyed when the explosive detonates in the immediate vicinity of the vehicle under attack without producing any dangerous fragments. The amount of explosive used in response to the warhead does not result in a significant additional burden on the vehicle or crew. During qualification for two German Army vehicles, concerns could be overcome, leaving an effective, safe product for protecting military vehicles. This reactive protection system is manufactured by Dynamit Nobel Defence GmbH. Reactive protection systems have been used by numerous countries in vehicles for some time. In Germany, the dedicated use of non-fragmenting material and special, insensitive explosive material has recently gained acceptance.

Standoff Active Protection Systems (Hard Kill)

Guided and unguided handheld anti-tank weapons usually operate at relatively low speed (150 m/s to 330 m/s), thus providing a window of opportunity during their time of flight to actively counter them. The basic premise of Hard Kill systems is to detect and track an approaching threat and to engage it using countermeasures (blast or projectile) so it does not cause any significant damage. The effect is created at some distance from the protected vehicle. Hard kill systems require multiple sensors together with launchers and/or active warheads.

Protecting combat and transport vehicles from shaped charge warheads is a particular challenge. Traditional protective materi-

als (steel, ceramics, composites), as well as active protective elements using explosive materials are very difficult to integrate without significant effect on the vehicle's mobility because of their volume and weight. These kinds of threats – especially the RPG 7 – can be countered with active protection systems working according to the hard kill principle.

Active protection systems are offered across the world by a few companies and are already in use on certain combat vehicles. TROPHY from Rafael uses radar to identify, trace and neutralise threats with a series of small metal projectiles, supported by a fire control computer. TROPHY has been used successfully with combat vehicles, such as the MERKAVA Main Battle Tank in Israel.

IRON CURTAIN by Artis uses radar and optical sensors to capture targets and engage them with counter-munitions after calculating the threat. Targets can be countered at a distance of a few centimetres.

IRON FIST from IMI Systems uses electro-optical jammers, smoke screens and a hard kill effector. The system has already been tested with heavy and lightweight vehicles in motion and in urban environments.

The Active Defence System (ADS) from IBD Deisenroth/Rheinmetall has redundant electro-optical sensors which activate a protection sensor when a threat is identified. Threats are destroyed by pyrotechnic energy. The system is especially effective in multi-hit scenarios and can be adapted to all vehicle sizes.

AVePS (Active Vehicle Protection System) from Diehl is a launcher-based protection system for the engagement of ap-



Photo: TenCate

The Active Blast Countermeasure System undergoing tests

proaching threats. Combined radar and IR sensors are used to detect and track the threat at a distance of several hundred metres, also covering close ranges.

When using active protection hard kill protection systems, the remaining kinetic energy of the approaching warhead must be absorbed by a sturdy vehicle hull. Deflecting quick KE fire and additional protective measures required by IED/EFP effects and the dependency on sensors and electronics remain a challenge.

Active hard kill systems offer the potential to improve the protection of forces in missions. New solutions are available and must be evaluated with regard to their potential implementation.

Special Protection Solutions

Vehicle Light Protection Kit

The number of armoured and protected vehicles in service is limited. Sometimes, unprotected vehicles must be deployed which are a particular risk in threat situations. With the Vehicle Light Protection Kit for lightweight retrofit, Hutchinson offers a new product, providing the user a choice of the protection level according to the threat.

The following components can be installed:

- The vehicle glazing is replaced by a specially-developed, lightweight polycarbonate glass. The newly-tested ECE R43 glass can be used to implement protection against gunfire and stones through to class VR6 ballistic protection against the 7.62 x 51 mm NATO Standard.
- The vehicle surface is painted with polyurethane. The enormous resistance attained prevents the vehicle from catch-

ing fire, while the insulating capability of the polyurethane prevents a quick temperature rise in the interior of the vehicle. The crew is not forced to leave the vehicle even if it completely goes up in flames, for example from a Molotov cocktail.

- The wheel assemblies are equipped with emergency running systems so that the mobility of the vehicle is retained under all circumstances, even if the tyres are destroyed.
- The wheel assemblies are equipped with tire saver shields to protect the tyres from damage and fire.
- Optionally and if so desired by the customer, fire-extinguishing systems can also be integrated for the under-floor chassis, wheel housings and the engine compartment.
- Tailor-made ballistic protection elements which protect the interior of the vehicle are integrated with the vehicle structure.

measured are far below the known critical limits for human stress. The development and test phase of the system is advancing to the level of manufacturing maturity.

Electrical Armour

Electrical armour is still at an early stage of testing. This protection system is expected through high voltage to generate a failure of the hollow charge spike of a handheld anti-tank weapon. Lab tests have been successful; the implementation of the lab results for a military vehicle is required via an application-based demonstrator.

Multifunctional Self-Protection System (Soft Kill)

The MUSS active standoff protection system has been developed for armoured vehicles, and has been integrated with the PUMA AIFV. The system works on the soft kill principle. Approaching guided missiles

Camouflage and IR Protection Camouflage nets, -paint and -systems reduce vehicle signatures and can also have limit the effectiveness of thermal imaging devices with a focus on optical reconnaissance: they also offer protection against intense sun damage. ROSY L is a 40 mm rapid-obscuring system for military vehicles from Rheinmetall, which provides protection against unexpected attacks during recce or convoy missions. Unlike traditional screen protection systems, ROSY L generates dynamic smoke screens as well as spontaneous, large-area, multispectral interruption to the line of sight, thus providing sustainable protection for mobile objects. This is a basic system with an operator's station and one to four ROSY launchers per vehicle. Using a one-click adapter, the system can be mounted to the vehicle quickly, without tools, and can be dismounted for reloading. ROSY L can be integrated with the vehicle's onboard information systems. The munitions variants can be individually chosen and fired selectively so that smoke- or screening measures can be optimally positioned. ROSY L can make a significant contribution to force protection. The new ROSY Mod version has been developed especially for small weapon stations and light-weight vehicles. ROSY Mod is directly integrated with the vehicle.

Fire Protection

The integration of a fire-extinguishing system in the engine compartment and a fire suppression system in the crew cabin further reduce the risk of fire: and a further fire protection measure is the avoidance of hydraulic fluids, mostly through the introduction of electric turret drives.

Protecting IT Systems

Today, electrical and electronic vehicle control systems use standardised bus systems (for example CANBus), and IT plays an increasing role in weapons systems. IT systems are used to transmit, gather, analyse and display all relevant information, and to make it available to operators. Crucial data streams must be protected against electronic faults, espionage/falsification and spoofing. Standards are currently being developed for making changes/modifications to open architectures, with one stated aim of the German armed forces being to integrate all functional elements through to the individual soldier into the command and information networks to increase the effectiveness of



Photo: Horst

Camouflage nets and possible camouflage paint on the LEOPARD MBT

With this solution, an adaptive passive protection solution is offered which can be used to close the capability gap in the protection between entirely unprotected and armoured vehicles.

Active Blast Countermeasure System

The detonation of very large amounts of explosive materials deeply burrowed or installed underground mines leads to global rotational movements of the vehicle. TenCate's Active Blast Countermeasure System (ABDS) reduces this rotation through an appropriate counter reaction. The protective impact is attained by „force transformation“ whereby the place of installation of the countermeasure elements can be on either side. Company tests are being carried out with the Danish procurement authorities, and the biomechanical load values

are brought off course by jamming their flight controls, or the target is camouflaged against target acquisition so that hits are prevented. MUSS protects against laser- and wire-guided missiles and is suitable for use against fire-and-forget weapons. The MUSS system was developed by a consortium of EADS Defence & Security (DS) (today Airbus Defence and Space), Krauss-Maffei Wegmann (KMW) and Buck (a subsidiary of Rheinmetall Defence). KMW carried out system integration. Buck contributed the pyrotechnic countermeasure elements. MUSS was developed in the middle of the 1990s. It was first tested on the LEOPARD 2 MBT in 2003. The system was developed for integration with the BOXER APC and the FENNEK scout vehicle as well as the PUMA AIFV.

Photo: Rheinmetall



ROSY launcher unit on a vehicle

the armed forces and – not least – to increase their safety.

Protecting Interior Systems

The entire crew must be in a position, with or without personal protective equipment, to fulfil their tasks quickly and reliably – as per the tactical requirements – inside and outside the vehicle. Seats need to offer settings which take into account different body sizes and weights and various dress options, including body armour. Typically, designs work on to a 150 kg norm, including equipment. Cross-sectional seating systems can be integrated into protected vehicles without restrictions: high mission flexibility is at the fore.

Dynamic load-bearing capacity of seats is subjected to rigorous stress tests, particularly in the case of blast tests with mines and IEDs. COTS seats adapted to military requirements are sometimes used, and special attention is paid to the compatibility of the soldiers' personal equipment.

NBC Protection/Air-Conditioning System

When NBC protection is required, the cabin atmosphere is overpressured, which prevents the ingress of gaseous agents. In modern combat vehicles the NBC protective ventilation system is positioned upstream of the air-conditioning system, and delivers breathable air, free of chemical or biological agents, dust and suspended solids. The use of a modern NBC protective ventilation system in combination with a powerful air-conditioning system and the ability to remove the COX risk based on active catalytic mechanisms is an important component of the overall protective strategy. Sensors for identifying aerosol

agents are also useful, allowing the crew to respond autonomously and without delay to local toxic threats.

Self-Protection and Arming

For many years, the gun mount for an anti-aircraft machine gun – accessible via a roof hatch – was the only piece of equipment for accommodating weapons on military vehicles other than combat vehicles. Under current threat perception, remote-controlled weapon stations have become prevalent for providing crews with self-protection day and night. Depending on the design of the weapon station, weapons ranging from 7.62 mm to 40 mm calibre can be fitted.

Many modern vehicles can bear roof loads between 100 and 200 kg. New weapon stations such as the FLW500 made by KMW use automatic cannons

with a 30 mm calibre and weight of around 500 kg. These weapons stations are bolted to the roof, and control elements are connected electrically through the hull. The controller offers the crew a stabilised image of the environment, with variable zoom sizes used to identify and engage targets. The ZETROS protected transport vehicle from Mercedes-Benz was the first logistic vehicle to be equipped with a remote-controlled weapon station, as a result of which it was designated as a combat vehicle by the German Army.

The Future

The optimum design of protective systems in military vehicles is dependent on the threat situation and can only be implemented using an integrated system approach. The multitude of possible threats from incendiary devices via IED effects through to KE rounds require that individual protective components be optimally aligned in order to attain the highest possible survivability for the soldiers and the vehicle. Individual protection solutions only have an impact on part of the threats. In order to resolve the conflict between technical mobility, weight and cost, setting priorities, using modular solutions and modern technology, plus searching for innovative solutions is required. To align the protective system optimally, early integration of necessary protection requirements in the procurement-relevant documents are of importance. Total, 100% protection for all imponderables in combat is not possible, but the residual risk must be kept as small as possible. ■

Photo: Zwilling



FLW remote-controlled weapon station on a ZETROS protected transport vehicle

Transparent Protection

Michael Horst

For transparent armour manufacturers, keeping pace with the protection levels of opaque armour solutions, countering the threat and maintaining situational awareness in modern, complex operational scenarios is a greater challenge than ever before.

Tactical ground mobility has a decisive role to play in the success of military operations, but a prerequisite for tactical agility is to maintain visibility of the theatre of operations from the driver's station and from the commander's, crew's and combat compartments of armoured vehicles. Today these compartments are used as control and switchgear centres, work stations, rest areas, survival rooms for crews – and of course, fire bases. Unlike civilian vehicles, military vehicles must be provided with armoured or protected transparent protection using safety glass panes, cameras or mirrors and

driver's / commander's optics and electro-optics. For protected logistic vehicles the requirements are more demanding than for combat vehicles, because the areas to be protected are larger, which means engineering attachment to the main structure is harder to solve. High weight and volume plus resistance to impacts, scrapes and falling rock have always been a problem for transparent armour systems. Numerous specialist technologies must work together holistically in order to achieve the required capabilities in all threat situations, as well as the require-

ments under road traffic law and environmental effects.

Threats to Visual Systems

The effectiveness of visual systems can be influenced by a number of aspects: across the entire task spectrum, vision systems are exposed to potential damage and degradation from point impacts (gunfire, fragments, splinters) as well as to the shock effects of IEDs/EFPs explosives, mines, pyrotechnics, fire and so on. Environmental influences (heat, cold, damp and dust) in the theatres of opera-

Photo: IVECO



Comparing the size of transparent surfaces of unprotected (right) and protected (left) cabs of a logistics vehicle from Iveco

Photo: KMW



Dust and sand can be extremely abrasive.

Photo: KMW

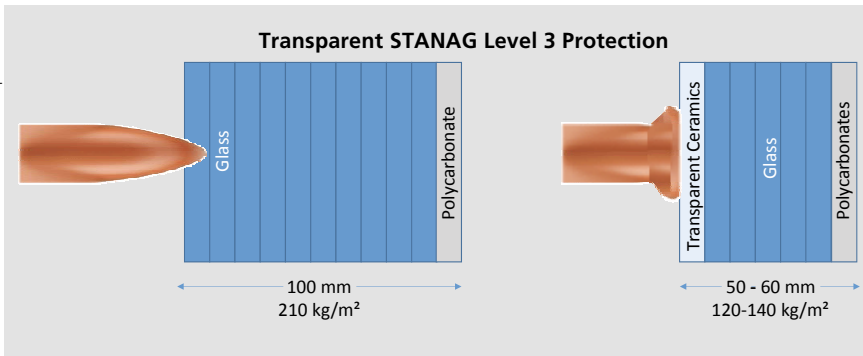


Transparent protective surfaces of the FENNEK

Photo: KMW



Protecting the windscreen against dust is a particular challenge.



Structure and performance comparison of armoured glass for transparent protection

tion have a crucial impact on the visual system.

Military Requirements

Transparent protection is of particular importance for military vehicles. Driving, self-protection and reconnaissance require a large field of view. However, the windows are a primary target, so the challenge lies in providing the same level of protection as offered by non-transparent protection systems and to comply with legal roadworthiness requirements, costs and weight. It is particularly challenging to balance weight, protection and tactical mobility and to achieve a growth potential which is always needed for military purposes yet seldom achieved, as well as cleaning/heating of the windows.

The trade-off between protection, permissible overall weight/air-transport weight and mobility requires as small a surface area as possible for the transparent protection solutions and a manageable construction volume given identical or similar capabilities.

Technical Solution Options

Special glass (armoured glass), plastics or transparent ceramics and various combinations are used.

Armoured Glass and Multi-Layer Glass Composites

Armoured glass panes have been tried and tested with the majority of the vehicles deployed. They generally offer sufficient protection. However, they have the disadvantage of high weight and volume and a loss of transparency under fire, especially when hit multiple times. They also abrade easily and suffer under environmental effects.

However, we can see optimisation potential in terms of weight, construction volume and performance. For example, considerable improvements in the adhe-

sion of the edges are likely which would lead to a significant extension to current warranty times.

Plastic Solutions

Window panes made of plastic can be manufactured flat or arched. They do not shatter under fire, and have already proven their ballistic properties against the effects of blast and splinters. For the assembly of the pane, frame and vehicle structure overall protection against the effects of a blast to the structure has to be preserved, and the very wide range of thermal fluctuation, especially under fire in arctic conditions, for example, and the consequential expansion and contraction cycles have to be accommodated in the design, engineering and manufacture phases of each vehicle.

Transparent Ceramics

Transparent ceramic tiles offer considerable weight and volume savings. With a poly-crystalline ceramic material such as PERLUCOR® from CeramTec-ETEC, the positive attributes of monocrystals (high levels of hardness, strength, and a high melting temperature) are combined with glass (visual and mechanical isotropy).

CeramTec-ETEC is known as a manufacturer of transparent protective ceramics based on aluminium-magnesium spinels—a mineral with similar optical properties to glass. This is the first European company to develop transparent ceramics to series production which has built an appropriate series production facility. With the aid of these transparent ceramic parts, various European and international transparent protection manufacturers have developed more lightweight solutions meeting STAN-AG 4569 Level 2 to 4/ATPD which have also been awarded ballistic certification.

Composite armouring has been in use with the armed forces for more than 20 years. Thanks to intensive research and development work, it has been possible to

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combine the benefits of ceramics with the properties of other transparent materials. Replacing several glass layers in a traditional transparent protection system with a thinner layer of the transparent ceramic PERLUCOR® up to 50% savings can be achieved on the weight and build volume. Contemporary systems have an average surface weight of around 210 kilogrammes per square metre, meeting NATO STANAG Level 3 (NATO Standardisation Agreement) 4569. PERLUCOR® can achieve weight savings of 70 to 100 kg/m². Savings of up to 150 to 170 kg/m² are possible with Level 4 systems.

The system also offers efficient protection against multiple hits. By building a sight window out of tiles, the required resistance versus multiple adjacent hits (multi-hit) is achieved. Using modern adhesives with the same fracture index, it is also possible to protect large vision apertures without visible seams.

Another possible use was found on missions in stony, sandy conditions in Afghanistan. The window panes of the vehicles were heavily affected by the tough environmental conditions. Stones and dust on the windscreen lead to increased wear when cleaning. Scratches reduced mission capability, sustainability and the service life of the panes. By laminating the front pane with PERCULOR® – less than a millimetre – it was possible to successfully protect the

Photo: CeramTec



Ceramics for optical protection

windscreen against damage, thus increasing the service life of the panes by three to ten times.

PERCULOR® offers the same protection to optical equipment such as telescopes, camera lenses, infrared devices or other kinds of sensors. This makes this material an alternative to conventional materials. The transparent ceramic can be used on flat and curved surfaces

thus protecting fragile, sensitive parts. Also in Germany, GuS – working with CeramTec – has developed an innovation for periscopes and driver's optics especially for use in desert regions. These devices have been manufactured with an external transparent ceramic layer. This provides good visibility in areas with a high degree of dust and sand. The external ceramic layer offers high resistance to wear. Compared with a periscope or driver's optics with standard glass, the resistance against abrasion is increased up to four times (as per MIL-STD-810G 510.5), furthermore the remaining visibility after a hit is increased as well.

Composite Solutions

The combination of technical protection benefits offered by plastic composite panes (high performance against IED/EFM effects, multi-hit capability and transparency after fire) and the benefits of transparent ceramics (high performance against KE rounds and low weight) – compared to armoured glass panes – makes it possible to achieve considerable weight benefits for a given assembly depth. The first results were presented at Eurosatory 2016, but further studies are necessary in which the cost of development of these possible solutions must also be taken into account.

Additional Visual Systems

Heated and partly curved mirrors give the vehicle driver the view towards the rear but also to the area immediately in front of and next to the vehicle. The mirrors can be adjusted from the seating position and the



Level 3 transparent protection on a vehicle door

Photo: Horst

driver's size with numerous, often electrical settings. The mirrors extending from the vehicle's signature in the field are at risk from narrow passages, shrubs/trees. Now that the first vehicles have been registered with cameras instead of the mirrors previously specified for use in road traffic – and now that powerful, rugged, compact cameras are available, camera-monitor systems have come under consideration and indeed been offered for military lorries and combat vehicles. Such systems can also be used for reconnaissance as well as steering the vehicle – in particular, when manoeuvring in a constrained space; blind spots can be seen safely, and for tactical purposes the exterior lights of the vehicle can remain switched off in combination with IR cameras or thermal imaging devices.

Outlook

The optimum design of visual systems in military vehicles can only be effectively implemented as part of an overall system. The high number of military vehicles requiring protected visual systems, whether optical or electro-optic – from small, highly agile special forces vehicles to heavy logistics trucks, armoured vehicles and up to Main Battle Tanks – means that optimal coordination of individual components into an overall protective system is required. Setting priorities and using modern technologies and innovative solutions are necessary to overcome the conflict between tactical mobility, weight, cost and battle-field awareness. In general, transparent ceramics and composite solutions have proven to be excellent materials with very good transparent and ballistic capabilities. A product is now presented to the military customer which offers comparable protection against fire,

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impact and wear with less weight and construction volume and a longer service life at a reasonable cost level. Development is still necessary- for example to protect the adhesion of transparent ceramic tiles from


weathering or matching the size of the tiles to acceptable road traffic risks – but progress is being made all the time, and the next new breakthrough may be just around the corner. ■



Photo: GUS

Tank periscope with unique ceramic outer layer for higher resistance to abrasion

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Armoured Vehicle Turret Weapon Trends

David Saw

The objective of this article is to survey the current turret systems for armoured vehicles, specifically Light Armoured Vehicle (LAV) and Infantry Fighting Vehicle (IFV) platforms, with the main emphasis on turrets mounting medium-calibre gun systems.

To assist us in this objective, we will look at a major ongoing LAV/IFV procurement programme to investigate some of

dition, we will look at a number of other turret options and vehicle programmes, both new-build and upgrade.



Photo: Rheinmetall

Under LAND 400 Phase 2 and Phase 3, the Australian Army is engaged in a major update of its light armoured vehicle fleet. Under LAND 400 Phase 2, Australia hopes to acquire 225 Combat Reconnaissance Vehicles (CRV) to replace the existing ASLAV vehicles. The Rheinmetall BOXER is one of two contenders chosen to contest the next phase of this programme.

the turret choices available and explore the question of manned or unmanned turret/weapon station solutions. In ad-

Author

David Saw is a specialist defence writer based in Paris, France and a regular contributor to ESD.

The armoured vehicle and turret combination has been around for a long time; it actually predates the arrival of the tank. Karl Benz is credited with the first production car in 1888, after which automotive advancement was rather rapid, and it soon became clear that this new automotive technology had significant military applications. Initially, the obvious application was in transporting personnel

and supplies. Then, as vehicles developed further, the possibility emerged of having a protected vehicle.

The first true armoured car was the Austro-Daimler PANZERWAGEN of 1904, a fully armoured 4x4 vehicle with a turret capable of 360-degree traverse mounting a single machine gun and 4 mm of armour protection. A second turret variant that was open at the back and mounted two machine guns was also developed. It is believed that only two PANZERWAGEN were completed. The vehicle was evaluated by the Imperial German Army in the 1905 summer manoeuvres and then in 1906 by the Austro-Hungarian Army. Neither was impressed enough to further explore the possibilities.

Elsewhere others were more open minded. The French Charron company had integrated a Hotchkiss machine gun in a protected mounting with their vehicle chassis in 1902, but their first true armoured car would emerge in 1906. Not only was this the first true production armoured vehicle, it was also the first international collaborative armoured vehicle programme! In 1905 Russian Army officer M.A. Nakashidze developed an armoured car design, featuring armour with a thickness of 4-8 mm, and a fully rotating turret: the Russian Army was very interested but there was no suitable manufacturing capability for a vehicle of this nature in Russia and so the work of making the design a reality was sub-contracted to Charron in France.

The armoured car, later called the NAKASHIDZE-CHARRON, was built on a Charron chassis. Eventually, 12 were built for the Russian Army, and these were delivered in 1908. An additional four were built and remained in France and were used by the French Army in 1914. While Charron pulled out of military work, other French companies entered the field and benefitted from a torrent of orders in 1914. These companies included Hotchkiss, Panhard, Renault and Peugeot.

The earliest tanks did not have turrets, mounting their weapons in sponsons or at the front of the vehicle. The British were the first to test a turret on a tank, but the first to get a tank with a turret

into service were the French in the shape of the Renault FT tank in 1917. Initially the FT turret mounted a Hotchkiss machine gun, but later variants were equipped with an SA19 Puteaux 37mm gun. The next step was to fit a long-barrel 37mm gun in the FT, but the end of the war put paid to those plans.

The arrival of the internal combustion engine, the need for mobility, the need for protection and the need for firepower all conspired to make the turret system a reality. Now 112 years after the design of the first armoured vehicle turret, the turret remains a critical factor in armoured vehicle design. For our purposes of describing current turret requirements, a useful place to start is with a look at the turret aspects of some current Australian armoured vehicle programmes.

Selection Scenarios

According to the Australian Army: "Project 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



Photo: US Army

The GDLS bid for LAND 400 Phase 2 offered the Kongsberg Protech MCT-30 unmanned turret mounting the Orbital ATK XM813 30x173 mm cannon. This turret has been selected by the US Army, with 83 turrets to be delivered to the 2nd Cavalry Regiment in Germany to upgrade their STRYKER vehicles.

in the contemporary and future operational environment." Under LAND 400 Phase 2, Australia is looking to acquire 225 Combat Reconnaissance Vehicles (CRV) to replace the current Australian Light Armoured Vehicle (ASLAV) fleet

(the Australian version of LAV-25) comprising 250 vehicles. Contract signature is expected in quarter 4 of 2018, with Initial Operating Capability (IOC) from 2022. The 225 CRV are to fulfill seven combat roles: Reconnaissance and Counter Re-

```

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long five = 5;
double pi = 3.14;
cout << "\n\na=";
cin >> a;
cout << "b=";
cin >> b;
cout
if (a < b)
    cout << "\na < b";
if (a > b)
    cout << "\na > b";
    
```

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Photo: BAE Australia

The BAE Systems AMV 35 is the other contender selected to contest the next phase of the Australian LAND 400 Phase 2 programme. Australia decided not to further evaluate proposals from Elbit and GDLS. The AMV 35 is a combination of the Patria AMV with the BAE Systems Hägglunds E35 turret of the CV9035 IFV mounting a 35 mm cannon.



Photo: Rheinmetall

The Rheinmetall LYNX armoured vehicle family made its public debut at Eurosatory 2016. Available in two versions, KF-31 and the larger KF-41, the LYNX is being offered to meet the requirements of the Australian LAND 400 Phase 3 programme. Australia is looking for a total of 450 Infantry Fighting Vehicles (IFVs) and 18 Manoeuvre Support Vehicles (MSVs) to replace their old M113A4 vehicle fleet.



Photo: CMI Defence

The CMI Defence stand at Eurosatory featured two members of the new modular Cockerill 3000 Series turret family. On the left is the 3030 turret mounting a 30 mm cannon, while on the right is the 3105 turret mounting a 105 mm gun for Fire Support Vehicle (FSV) applications. For medium-calibre applications, the 3000 Series turret can also support 35 mm, 40 mm and 50 mm cannon.

connaissance (129 vehicles), Command and Control (26), Joint Fires (8), Surveillance (17), Ambulance (15), Repair (20) and Recovery (10).

Competitors for the CRV programme were BAE Systems with the AMV 35, a variant of the Patria AMV with the E35 turret of the CV9035 IFV as used by Denmark and the Netherlands. This manned turret mounts an Orbital ATK BUSHMASTER III cannon in 35x228 mm calibre. Another contender was the Elbit SENTINEL 2, which comprises the Singapore Technologies Kinetics TERREX 3 vehicle fitted with the Elbit MT30 turret mounting the Orbital ATK Mk44 30x173 mm BUSHMASTER II cannon and two Rafael SPIKE-LR anti-tank missiles. The MT30 is a manned development of the current UT30 Mk 2 Remote Controlled Weapon station (RCWS). Rheinmetall offered the BOXER vehicle with the LANCE turret, which is a modular two-man turret system that can mount either a 30 mm or 35 mm cannon; for this application the 30x173 mm MK30-2/ABM cannon was fitted. The MK30-2/ABM has a programmable munitions capability including air burst rounds. Thales and the Australian arm of General Dynamics Land Systems (GDLS-A) proposed the LAV 6.0 vehicle from GDLS Canada with the Kongsberg Protech MCT-30 unmanned turret mounting the Orbital ATK XM813 30x173 mm cannon. This was the only totally unmanned turret option offered. As General Dynamics were the supplier of the incumbent ASLAV vehicle in Australia, many believed that they were a very strong contender.

The decision by GDLS-A to offer the MCT-30 turret for the Australian programme had sound reasoning behind it. The US Army has selected the MCT-30 turret for its STRYKER LAV, purchasing an initial quantity of 83 systems that will be fitted to existing vehicles deployed by the 2nd Cavalry Regiment in Germany, with an additional eight prototype systems to be delivered from the end of 2017. The MCT-30 has 156 ready rounds of 30x173 mm ammunition and a coax M240 7.62x51 mm machine gun with 400 rounds. The XM813 is a version of the Mk 44 BUSHMASTER II fitted with a slightly longer barrel (25.4 mm) and the ability to use programmable rounds, including the Mk310 air burst ammunition. In addition to its STRYKER application the MCT-30 turret has also been suggested as a possible upgrade for the M2A3 BRADLEY vehicle.

This segment of the LAND 400 programme has taken a significant step for-

ward. At the end of July the Australian Department of Defence announced that it had selected two designs to go forward into the next stage of the LAND 400 Phase 2 procurement process. The vehicles in question are the AMV 35 and the BOXER.

IFV Solutions

If the Australian LAND 400 Phase 2 programme was impressive, the follow-on phase LAND 400 Phase 3 can be described as extremely ambitious and expensive. The key element here is the replacement of the current fleet of 431 M113A4 Armoured Personnel Carri-

The-Shelf (MOTS) solutions – existing systems that could be adapted to Australian requirements. The Phase 3 requirement calls for systems that offer a technology growth path throughout their service life. An important point to note is that while Australian thinking on the Phase 2 requirement seems to favour a manned turret solution, for Phase 3 they seem happy to look at both manned and unmanned turret solutions. Apart from the 312 turreted IFVs, 85 of the specialist variants will be fitted with a Remote Weapon Station (RWS) mounting either a 12.7 mm or 7.62 mm machine gun, or alternatively a 40 mm Automatic Grenade Launcher (AGL).



Photo: via Author

A KMDB BTR-3E1 of the Royal Thai Army (RTA), equipped with a SHKVAL Overhead Weapon Station (OWS). This mounts a 30 mm ZTM-1 cannon, 7.62 mm coax, 30 mm AG-17 AGL and two SKDB Luch BARYE anti-tank missiles. The SHKVAL is being offered as the turret solution for a new BMP-1 upgrade being proposed by Ukrainian industry.

ers with 450 Infantry Fighting Vehicles (IFVs), with first deliveries of the replacement system in 2025. Also included in LAND 400 Phase 3 is the acquisition of 18 Manoeuvre Support Vehicles (MSVs). The 450 IFVs requirement includes; 312 turreted IFVs, 26 Command variants, 16 Joint Fires vehicles, 11 Engineer Reconnaissance vehicles, 39 Combat Engineer vehicles, 14 Ambulances, 14 Recovery variants and 18 Repair variants. The MSV is an armoured engineer vehicle: capabilities would include minefield clearance and safe-lane marking, plus obstacle construction and clearance, amongst others. With LAND 400 Phase 2, Australia was looking at what it called Military-Off-

As far as the IFV is concerned, Australia is looking for a vehicle that can carry eight dismounts with "full combat ensemble". Protection against KE threats over 30° of frontal arc should be STANAG 4569 Level 6, while protection against mine blast should be STANAG 4569 Level 4a/b. In terms of lethality, the IFV must have a weapon capable of dealing with IFV/AFV target frontal armour at 2,500 metres. This requirement can be met by a 30x173 mm calibre system or larger. The IFV must also be capable of a 'single lift' in a Boeing C-17A transport aircraft (eight of these aircraft are in service with the Royal Australian Air Force). The ballpark requirements for the IFV

Masthead

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Photo: US Army

Indian Army BMP-2 vehicles on exercise. Uralvagonzavod produced 14,000 BMP-2 vehicles in the 1980s, with the vehicle also produced in the then Czechoslovakia, and still in production in India as the SARATH. The 2A42 30x165mm cannon of the BMP-2 is reaching its limits these days, opening the way for future potential BMP-2 turret upgrades.



Photo: Paramount Group

The 8x8 version of the MBOMBE armoured vehicle from the Paramount Group of South Africa was displayed in Kazakhstan in June mounting the Russian AU-220M BAIKAL unmanned turret system. This has a 57x347SR calibre cannon, originally used in the S-60 anti-aircraft system, that offers significant performance against both hard and soft targets.



Photo: via Author

presented above bring us to another critical set of considerations: size and weight. Keeping within those parameters will have a direct impact on the choice of turret. To get eight dismounts and all of their kit into a vehicle requires a certain amount of space; to give the vehicle an acceptable level of mine protection will cost weight; to give the vehicle the desired level of protection against KE and similar threats also costs weight. Sensors, communications, other sub-systems and the automotive elements all carry a weight penalty. Finally, the turret, whether manned or unmanned, of course also incurs a weight penalty. That being said, an unmanned turret solution will be lighter and have fewer

The old BMP-1 with its 2A28 73mm smoothbore gun is of limited utility these days, forcing operators to look for new solutions. Here a Syrian Army BMP-1 has had a somewhat rough and ready upgrade with a ZU-23-2 twin 23x152 mm anti-aircraft gun being fitted on turret mount on the vehicle roof.

space penalties than a manned system. As far as contenders for the programme are concerned, the situation for Phase 3 is not clear-cut at this point. Some potential candidates have emerged in the shape of the BAE Systems Hägglunds CV9035 with the E35 turret. Another contender is the General Dynamics-European Land Systems (GDELS) ASCOD II, which is the basis for the British Army AJAX vehicle. In the variants used by Austria and Spain, the SP-30 turret mounts a 30x173mm MK30-2 cannon, whereas the British AJAX has the 40 mm CTA cannon in a Rheinmetall-designed turret. At Eurosatory 2016 in Paris, Rheinmetall unveiled their new LYNX armoured vehicle family. This is available in two versions: the KF-31 (three crew and six dismounts); and the larger KF-41 (three crew and eight dismounts), with the turret system being the Rheinmetall LANCE turret as offered for LAND 400 Phase 2. It should be noted that a twin-round launcher for the SPIKE-LR anti-tank missile can be fitted to the LANCE turret. Apart from the IFV version, specialist variants of LYNX are also available, such as command and control, repair and recovery and ambulance.

Alternatives

The Australian LAND 400 programme is, without a doubt, an ambitious undertaking and will certainly be very expensive. It will be fascinating to see how much of the original Phase 2 and Phase 3 requirements survive to the point where vehicles actually come into service. On a different level, this Australian programme provides us with some important insights with regard to turrets. For example, to meet lethality requirements the 30x173 mm round, whether used from the BUSHMASTER II, XM813 or the MK30-2, appears to meet the outlined lethality requirements. This reinforces suggestions that the common 25x137 mm calibre may have reached its limits in many vehicle applications.

One could also make the case for a larger calibre, as offered in the E35 turret as proposed with the AMV35 and the CV9035, in the form of the Bushmaster III in 35x228 mm calibre. The downside of a larger calibre is that the rounds require more space in an already space-

constrained environment. On the other hand, the increased lethality of the larger rounds should mean fewer rounds are required to successfully engage a target. Others have opted for larger calibres from the start; for example the Swedish CV90 uses a 40 mm gun, as does the Korean K-21 in the form of the S&T Dynamics K-40 system. And of course there is the 40 mm CTA system selected by the British for the AJAX vehicle. Indeed, growth opportunities exist for BUSHMASTER II operators, as the gun can be upgraded from 35 mm to 40 mm calibre to use the SUPER FORTY 40x180 mm ammunition. For the BUSHMASTER III there is an upgrade path in prospect to 50 mm calibre, with the 50x330 mm SUPERSHOT round currently in development.

Others are looking at larger calibres still. For example, the Russian AU-220M BAIKAL unmanned turret system mounts a 57x347SR cannon, as originally used in the old S-60 anti-aircraft artillery system, and a 7.62 mm coax. In June the Paramount Group of South Africa unveiled an 8x8 version of their MBOMBIE LAV at the Kazakhstan Defence Expo (KADEX) in Astana. This 28-tonne vehicle mounts the AU-220M turret and could be produced by a joint venture, Kazakhstan Paramount Engineering (KPE), in Kazakhstan as the BARYS 8.

A larger calibre cannon might not be the optimal solution at this point though. The 30x173 mm calibre still has plenty of growth potential left, as illustrated by the fact that the US Army Armament Research, Development and Engineering Center (ARDEC) have partnered with CMI Defence of Belgium in a Cooperative Research and Development Agreement (CRADA) to develop an unmanned medium-calibre turret that will integrate the 30 mm XM813 gun with a linkless ammunition handling system. The turret will also receive a new precision fire control system with new user interfaces to allow for rapid and successful target engagement. The new turret is due to be delivered to ARDEC by mid-2017 and can potentially be used in future Stryker vehicle upgrades.

CMI has re-emerged as a major turret supplier. For example, in January Indonesia ordered 50 BADAQ 6x6 Fire Support Vehicles (FSV) from local company Pindad and the vehicles will have a CMI turret mounting a 90 mm medium pressure gun. The recent massive Saudi Arabian National Guard (SANG) order for the GDLS Canada LAV 6.0 will mount a substantial number of CMI turrets including an FSV variant with a 105 mm gun system. At Eurosatory 2016, CMI unveiled a new option, whereby their 3105HP turret, mounting a 105 mm gun, is integrated with a Thales Optronique SPY'RANGER UAV system. This will provide a forward observation capability for indirect fire, a reconnaissance capability and increased situational awareness. The current primary turret offering from CMI is their 3000 Series modular turret system that was first unveiled at IDEX in 2015. This has four variants for medium-calibre weapons in 30 mm, 35 mm, 40 mm and 50mm calibres. For FSV applications, the 3090 turret has a 90 mm medium pressure gun with an optional Gun-Launched Anti-Tank Guided Missile (GLATGM) capability. Then at the top of the spectrum is the 3105 turret with a 105 mm gun with optional GLATGM. The GLATGM is the FALARICK, which was developed by SKDB Luch in the Ukraine.

In the final analysis it is plain that there is no shortage of suitable turret weapon solutions, either manned or unmanned, for operators to consider. In the medium-calibre segment, weapon options extend from 30 mm up to 57 mm, accommodating most operational requirements. However, weight and space constraints in armoured vehicles will continue to act as a limiting factor for operators as they seek firepower solutions. ■

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No Mere Coincidence

Interview with Amar Karia, Head of Armoured Vehicles Portfolio, Defence IQ



Photo: Defence IQ

ESD: What is the UK's global standing when it comes to Armoured Vehicle technology, design, manufacturing and operational experience?

Karia: The UK is, for good reason, still held in the highest regard among international armoured vehicle designers and manufacturers. There is of course a wealth of nations now rapidly building local industries in this field, especially in the emerging markets, but in terms of engineering, expertise and experience – owing much to the UK's investment in mechanical engineering and its culture of promoting innovation and entrepreneurship – British products, on the whole, continue to carry with them a stamp of quality. It's the reason why so many UK vehicle suppliers and OEMs are seeing strong business globally and why British proprietary designs are frequently acquired by bigger foreign manufacturers (for example General Dynamics' purchase of Force Protection). This is good news because the UK market for armoured vehicles is obviously not as strong as it used to be,

ESD: What is there for interested parties – both national and international – to learn from the CHALLENGER upgrade programme?

Karia: Above all else, I would say that it underlines the current commitment and responsiveness of the defence industry when it comes to meeting what are very high-level demands for modern day military systems. We're seeing numerous multinational companies joining forces to bid on the LEP (Life Extension Programme), and often, even if those bids are not secured, the processes and connections formed can lead to further opportunities down the line on other programmes. European cooperation is still happening regardless of Brexit worries. The LEP itself echoes what we are hearing from

Karia: That's a tough question, given how little we know just yet about the MIV. What we do know is that the Army has identified an enduring requirement for this 8x8 – as well as for the concept of multirole functionality – and so there is a certain urgency to ensure the capability is filled on time and within budget. How this programme develops may well shed light on the government's adherence to its commitments to UK industry and jobs, but sometimes sacrifices are made simply to guarantee that the best equipment gets into the field, a very difficult balancing act. Making those decisions is never easy and, as the rumours circling MIV have certainly anticipated more contention. Let's just hope that the experts involved in the programme are doing all they can to balance the impact the contract will have on the wider industry with the real needs of those on the front line.

ESD: And finally: the IAV series of conferences has matured into a well-established and effective event with ever-increasing international potential: would you regard it as an essential piece of professional development a) for the Armed Forces, and/or b) for industry? If yes, why? and if not, why not?

Karia: You only have to ask those in attendance what they think in order to understand the significance of the IAV events. Professionals are getting tired of huge exhibitions offering lots of people traffic, tyre kickers, but not really returning enough quality in customer leads. The IAV conference and exhibition series ensures that the audience is already filtered down to the right people. IAV offers unrivalled business networking options, first-hand updates on where land forces are investing their time and money, and the chance for military leaders to sit down beyond their normal schedules. In other words, it's become critical for many in this global market – industry and end-user – to stamp these events in their calendars. It's no mere coincidence that we have the most powerful figures in the armoured vehicles world converging in the same room this year. ■

The interview was conducted by Stephen Barnard.

Photo: BAE Systems



RG41 with Tactical Remote Turret (TRT)

so engaging with foreign markets is key to survival. Our military also boasts a trove of operational experience in every type of environment, so recent government-funded projects – such as the research and work being accomplished in blast protection or survivability – have outstripped many other nations. Partnerships like that cannot be underestimated.

the community – that the MBT is still very relevant to modern operations, in spite of recent trends toward LAVs and MRAPs. Its role is changing but the tank remains a significant force multiplier in many situations.

ESD: And what should we anticipate – and indeed expect to learn – from the MIV programme, up to today and going forward?

Tank-killing Missiles for the Modern Battlefield

Doug Richardson

Around 50 different types of antitank missile are currently in service or under development, too many to document in a single article. The text that follows will focus primarily on the most significant recent developments in this field, new products from lesser-known manufacturers, weapons that enjoyed significant export success, and the advanced weapons likely to replace the tried and tested systems of yesteryear. It will concentrate on missiles used by infantry, or fired from vehicles, rather than specialised gun-launched or air-launched weapons.

The first generation of antitank missiles were wire-guided weapons of the command-to-line-of-sight type. These relied on having a trained operator with the skill needed to fly a newly-launched missile onto the sight line between the launcher and the target, then keep it there throughout its flight to the target.

and HOT introduced semi-automatic command to line-of-sight (SACLOS) guidance. Following missile launch, the task of the operator is to keep his aiming mark aligned with the target. A sensor at the launcher tracks the missile via an on-board beacon, or tail-mounted flares, allowing the launcher electronics to automatically com-

pute and transmit the corrections needed to keep the round flying along the sight line to the target. Operator training is simplified, but the system still faces the tactical limitation that the operator needs to track the target throughout the entire missile flight, and cannot switch to a new target until the first engagement has been completed. A planned TOW-FF (TOW-Fire and Forget) version fitted with an IIR seeker was cancelled in 2001.

Since entering service in 1970, TOW has been used in seven wars (eight if the current civil war in Syria is included). The main current versions are the TOW-2A (fitted with a tandem HEAT warhead able to penetrate with first and second generation ERA [explosive reactive armour]) and TOW-2B (carrying two top-attack warheads). There is also a bunker-busting variant.

The maximum range of TOW was limited to 3,750 m by the amount of wire that could be carried within the missile, but in 2006 Raytheon was awarded a US Army contract to deliver a wireless version of TOW 2A to the US Army. Use of an RF link increased the maximum range to 4,500 m. The last wire-guided TOW rounds were delivered in 2009.

Initially the wireless version was fielded as a ground-launched weapon, but in 2010 Raytheon announced that it would develop a suitable airborne launcher for RF-guided TOWs. Tested in 2014, this is aimed at the export market.

Originally developed by Euromissile, and now manufactured by MBDA, the MILAN (Missile d'Infanterie Léger ANTichar) was accepted for service in 1972. Like TOW, it enjoyed major export success, being ordered by more than 40 nations. The current production version is the MILAN 3, which is armed with a tandem HEAT warhead and carries a flash lamp rather than a flare to provide a bright source for the tracking system built into the MILAN 3 firing post.

MBDA anticipates a strong demand from existing MILAN operators for an improved variant, and so has developed the MILAN ER (Extended Response). This is based on a fully digital firing post, and uses a redesigned missile with a new rocket motor of increased performance, a new jet deflector subsystem, and a new warhead. It has greater in-flight manoeuvrability than earlier MILAN variants, and a maximum range of 3,000 m.

Photo: US Army



A US Army soldier mans a BGM-71 TOW system in Kunar Province, Afghanistan, in May 2009.

During the 1970s, missiles such as the Raytheon (formerly Hughes) BGM-71 TOW (Tube-launched, Optically tracked, Wire-guided) missile, and Euromissile's MILAN

Author

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



Photo: MBDA

The MILAN ADT firing post was developed for the MILAN ER (Extended Response), a system developed by MBDA for use by armed forces that do not require a fire-and-forget antitank weapon.

In 2014, MBDA qualified the MILAN ER weapon system, and completed a firing campaign intended to validate series production. By that time, three export customers had already chosen the system.

Two European weapon systems have applied SACLOS to a shorter-ranged weapon. MBDA's ERYX has a maximum range of 600 m, and is armed with a tandem HEAT warhead intended to penetrate more than 900 mm of rolled homogeneous armour (RHA) plate protected by ERA. The missile entered French service in 1993, and export sales have included at least six customers. A contract signed by Turkey in 1999 was reported to have been cancelled in 2004, but the weapon was still listed in the 2011 catalogue of Turkey's Mechanical and Chemical Industries Corporation (MKEK).

Serbia's BUMBAR short-range antitank missile system is similar in concept to ERYX and is in the same performance class. However, its development has been protracted; by the time that a small batch of low-rate production systems was delivered in 2012-13, some of its subsystems were already considered near-obsolete. As a result, the firing post had to be redesigned, and the new configuration offers improved capabilities and a lighter weight.

The KBP 9K111 FAGOT (AT-4 "SPIGOT") and 9K113 KONKUS (AT-5 "SPANDREL") systems were the first SACLOS antitank weapons fielded by the former Soviet Union, but neither enjoyed the degree of export success attained by the later KORNET (AT-14 "SPRIGGAN"). The latter is available in ground-based or vehicle-mounted forms, and uses 9P163-1 (tandem HEAT warhead) and 9M113-1 (thermobaric warhead) missiles.

Although many sources report that KORNET uses SACLOS guidance, information released by KBP indicates that it uses a laser beam-riding system. Once the firing post has been aimed at the target, a laser is activated. The missile uses rear-mounted sensors to detect the laser energy and steer itself onto the centreline of the beam. It maintains this position in the beam until impact with the target.

The latest version of the system is known as KORNET-EM. Its firing post can be used with a new generation of missiles, or with the earlier KORNET-series missile. The 9M133M-2 has a maximum range of 8,000



Photo: Doug Richardson

This cutaway model of the BUMBAR was displayed at the 2012 Eurosatory exhibition.

m and carries a tandem HEAT warhead, while the 9M133FM-2 has a thermobaric warhead. The 9M133FM-3 missile has a maximum range of 10,000 m and carries a much smaller warhead. It is intended for use against slow-moving air targets such as helicopters. A KORNET-EM firing post allows a two-missile salvo to be fired at what KBP terms "extra dangerous targets including those protected by ERA".

In the US, the Army Missile Command's Advanced Anti-tank Weapon System – Medium (AAWS-M) programme explored the potential of IIR-based fire-and-forget guidance. Full-scale engineering development of what would become the JAVELIN commenced in 1989, and in 1994 the US DoD had enough confidence in the weapon to authorise an initial Low-Rate Initial Production (LRIP-1) batch.

Work on JAVELIN is divided between Raytheon and Lockheed Martin. The missile is delivered in a sealed launch-tube assembly that the operator attaches to a Command Launch Unit (CLA) incorporating a day/thermal sight. Once the missile's seeker has been locked onto a suitable target, the weapon can be launched. It can fly in direct-attack or top-attack mode, delivering a tandem HEAT warhead intended to defeat targets protected by ERA.

Officially the missile is stated to have a maximum range of 2,500 m. However, it has the performance needed to engage targets at longer range. The basic limitation is that of locating and identifying targets at longer ranges. During trials of vehicle-mounted systems, JAVELIN has successfully engaged targets at a range of more than 4,000 m. Rafael Advanced Defense Systems' SPIKE-MR (medium range) is similar in general concept to JAVELIN, and has a maximum range of 2,500 m. But while the US missile has an IIR seeker, the Israeli weapon has a dual-mode seeker with CCD and IIR channels. Optional day-only CCD and night/adverse conditions IIR seekers were offered at an earlier stage in the Israeli programme.

SPIKE LR is based on the MR version, but has an improved guidance system that gives the missile an effective range of more than 4,000 m. A trailing optical fibre data link allows the operator to observe seeker imagery, refine the missile's aim point or even switch to an alternative target, or steer the missile to a safe impact point if the engagement needs to be aborted. SPIKE NLOS is a heavier missile that uses



Photo: Raytheon

A ready-to-fire JAVELIN system consists of a sealed launch-tube attached to a Command Launch Unit (CLU) incorporating a daythermal sight.



Photo: MBDA

Like many modern antitank missile systems, the MBDA Missile Moyenne Portée (MMP) uses a soft-launch technique that allows a missile to be fired from inside buildings or bunkers. Once the missile has cleared the launch-tube and flown a safe distance from the launcher, the main motor then ignites.

an encrypted radio frequency (RF) two-way data link instead of an optical fibre, and has a maximum range of 25 km. Designed to be launched from ground vehicles, it is powered by a dual-thrust rocket motor. Originally fielded by the Israeli forces, it was ordered by the UK and fielded as the EXACTOR Mk 1. Still mounted in an M113 APC (a vehicle not normally in UK service), it saw combat during British operations in Iraq and Afghanistan. This use of a US vehicle by the UK forces made the system easy for opposition forces to recognise. The UK has since fielded EXACTOR Mk2, which uses a four-round trolley mounted launcher. In 2013 France ordered the MBDA Missile Moyenne Portée (MMP) as its next-generation antitank missile system. Formal qualification trials are due to be completed by the end of 2016, but serial production is already under way to allow first deliveries to the French armed forces to begin in 2017. 400 MMP firing posts and 2,850 missiles have been ordered.

The missile's dual-mode seeker combines an uncooled thermal imaging and a day-light television channel. Missiles can be

launched in fire-and-forget mode, but a trailing fibre-optic link allows seeker imagery to be sent to the firing post, allowing the missile to be retargeted in flight, or steered to a harmless crash location if the engagement needs to be aborted. Its maxi-

mum range is 4,000 m, and its tandem HEAT warhead was designed to penetrate 1,000 mm of rolled steel armour protected by ERA.

China has had some limited success in exporting its antitank missiles. The HONGJIAN-8 (RED ARROW-8) and RED ARROW-9 used SACLOS guidance, but in 2014 its first fire-and-forget system was revealed. Designated HONGJIAN-12 (RED ARROW-12), this uses an uncooled IIR seeker to provide all-weather day and night capability, but a less expensive day-only version based on a television imaging seeker is also being offered.

The launch-tube and missile weigh 17 kg, while the total system weight is 22 kg. Its maximum range is 4,000 m, and the missile can fly either an arched top-attack trajectory, or a direct low-level flight path to the target. Its tandem HEAT warhead is reported to be able to penetrate 1,100 mm of conventional steel armour protected by ERA.

In recent years, several countries have joined the ranks of those offering modern antitank missiles. In Ukraine, State Kyiv Design Bureau Luch has developed three systems – SKIF, BAR'ER and CORSAR.

The SKIF infantry-operated system is based on the R-2 missile, a SACLOS guided weapon that receives steering commands transmitted from the firing post via a laser beam. Luch is responsible for the R-2 missile and launcher tripod, while the Belarusian company Peleng supplies the PN-S optronic guidance system. The SKIF operator can choose between firing modes; the missile can fly directly along the line-of-sight (LOS) to the target, or a trajectory above the LOS. The BAR'ER vehicle-mounted system is another application of the R-2 missile. In this case, Belarus supplies the PN-K1 guidance system.



Image: NORINCO

NORINCO's HONGJIAN-12 (RED ARROW-12) is a fire-and-forget antitank missile for infantry use.



The SKIF infantry-operated system is based on the R-2 missile.

Luch is the overall design authority for the CORSAR system and its R-3 missile, while Beltech Holding of Belarus is responsible for the PN-K1 electro-optical firing and guidance system. The basic version is a man portable system, but CORSAR could be integrated onto tracked and wheeled platforms. The R-3 missile uses the same guidance technique as the R-2. Its tandem high explosive antitank (HEAT) warhead has a claimed penetration of not less than 550 mm behind ERA. The manufacturer has also offered a high explosive fragmentation (HEF) or thermobaric warhead.

Belarus seems to be the lead partner of the SHERSHEN (HORNET), a further evolution of SKIF. It retains the PN-S optronic guidance module and R-2 missile, but the firing post has a lighter-weight tripod made from composite materials, and incorporates modifications intended to increase system reliability.

Iran used TOW as the basis for its TOOPHAN (HURRICANE), a weapon whose existence was first reported in 2000. The first version was TOOPHAN 1, which is similar to the basic BGM71A TOW. TOOPHAN 2 is comparable to the BGM-71C Improved TOW, and carries a 4.1 kg tandem HEAT warhead fitted with an extendable nose probe. Both variants use SACLOS guidance, but the TOOPHAN 5 is reported to use a laser-based guidance system.

Speaking at a 2014 conference on equipment for ground forces held in Tehran, General Mehdi Farahi, Iranian Deputy Defence Minister and Head of Iran's Aerospace Organisation stated that TOOPHAN existed in seven versions (presumably including TOOPHAN 3, 4, and 6), and revealed the existence of further new and planned variants up to and including TOOPHAN 11.

India's NAG (SNAKE) had a protracted development as the programme was started in the 1980s. This 42 kg weapon did not begin user trials until 2008. The initial version to enter production uses a mercury cadmium telluride (MCT) IIR sensor. A day-only variant with a charge coupled device (CCD) seeker is also planned, as is a version fitted with a millimetric wave (MMW) active radar seeker.



The basic version of India's NAG antitank missile is fitted with a nose-mounted imaging infrared seeker.

So far, however, NAG has attracted only a modest order from the Indian armed forces. Guided antitank missiles have traditionally been operated only by the regular or reserve armed forces of states, but recent years have seen them being used by insurgent or irregular forces in several conflicts. During the 2006 Lebanon War, Hezbollah combatants used KORNET missiles against Israeli MERKAVA tanks. Four tanks are reported to have been destroyed, and a further 24 hit. The likely origin of these missiles became clear when KORNET storage boxes captured by the IDF were found to bear the

marking "Customer: Ministry of Defense of Syria". The use of Iranian TOOPHAN missiles was also reported.

During the fighting between Israel and Hamas in Gaza in the summer of 2014, most of the 15 antitank missiles fired at Israeli tanks are believed to have been KORNETS. All are understood to have been intercepted by Israel's TROPHY active protection system.

KORNET missiles have also been used in the 2014-15 fighting in eastern Ukraine. That country is not a known operator of KORNET, so it is likely that these systems were supplied to Ukrainian separatists by Russia as part of its intervention in the conflict.

A video released by the so-called Islamic State in April of this year showed a member of this militant group firing a KORNET missile at a Turkish M60T tank. The missile hit the tank, but apparently did not penetrate the vehicle's upgraded frontal armour.

By April 2014 there was video evidence that TOW had been supplied to some anti-Assad forces taking part in the Syrian civil war. In February of the following year, there were reports that 23 armed groups within the Southern Front of the Free Syrian Army (FSA) had used the system. Larger-scale deliveries to factions affiliated with the FSA had taken place in the first half of 2015.

When Russia attempted a rescue operation following Turkey's downing of a Russian Su-24M at the Syria-Turkey border on 24 November 2015, a video released by the 1st Coastal Division of the Free Syrian Army showed a TOW missile being used to destroy a disabled Russian helicopter. In February 2016, a video showed FSA rebels firing a TOW missile at a Russian T-90 tank, and scoring a hit. There was no evidence that the vehicle's SHTORA soft-kill active protection system responded to the incoming missile, but its Kontakt-5 ERA seems to have blunted the effects of the TOW warhead. ■

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Viewpoint from Islamabad



Peaceful and Stable South Asia Should Be in the Interest of the International Community

Zafar Khan

**Assistant Professor at the Department of Strategic Studies,
National Defense University, Islamabad**

Despite claims from some sections of the world – India in particular – that Pakistan is becoming isolated, I think it is not wrong to argue that Pakistan remains as vibrant a state as it deserves to be in the international political system of the 21st century. Pakistan wants to be well connected in the economically growing and diplomatically interconnected world, and continues to work both for the betterment of its people and the international community. It wishes to have productive social, political, diplomatic and economic relations with all the major powers, including those countries in its immediate neighbourhood. Pakistan has recently achieved great successes in the fight against terrorism in order to bring its house in order.

Pakistan's democracy is getting back on track as the elected representatives of major parties have completed or are completing their prescribed terms of service to the nation. Apparently, the civil-military leadership is working to become integrated and work for the success of Pakistan. The economic indicators are gradually improving, particularly after the remarkable initiatives between China and India by making sure that China-Pakistan Economic Corridor (CPEC) becomes a success story. As Russia and other countries become part of the CPEC, Pakistan can invite India to become part of the growing package of the CPEC. The political as well as economic engagement and integration of all these players increases cooperation and diminishes the possibility of war in the Asian region.

It is rational for both India and Pakistan to reconsider a peaceful resolution to all major issues, including the core issue of Kashmir, with India. Pakistan wants to hold a composite dialogue process with India to discuss all major issues, including the issue of terrorism. In the growing interdependent world where the demise of one state could directly affect others, Pakistan cannot go in isolation. The more one may think of keeping Pakistan isolated, the more complex issues one gets into and the worse it gets for international peace and stability. Therefore, Pakistan remains relevant, significant and essential for the South Asian peace and stability in general and international security in particular. It is important to ask why it is essential for major players to work and engage with Pakistan. For a variety of reasons, en-

gaging and working closely with Pakistan should be the choice of all international actors.

Pakistan has quickly emerged as a responsible nuclear state since it tested its nuclear capability in 1998, only after India tested its nuclear weapons. It is generally argued in Islamabad that if India has not tested its nuclear weapons first, Pakistan could not have gone nuclear. Nevertheless, it has successfully institutionalised its nuclear weapons capability. It has already declared a nuclear moratorium that it will not carry out more nuclear tests. It follows minimum deterrence and strictly avoids a nuclear arms race. It believes in deterrence balance rather than parity. In short, Pakistan's nuclear weapons programme remains India-specific, as it acquired deterrent forces for deterrent purposes only, rather than for military use. Whatever the deterrent force Pakistan develops in response to India, that remains consistent within the parameters of its policy of minimum deterrence. It makes sure that prospects for deterrence are not eroded.

India continues to put strategic pressure on Pakistan as it plans to carry out surgical strikes against Pakistan through its Cold Start Doctrine (CSD). The new Indian Army Chief, General Bipin Rawat, publically confirmed the existence of the CSD for waging limited strikes against Pakistani territories. Moreover, India itself gradually erodes stability in South Asia as it develops nuclear submarines, aircraft carriers, multiple-independently-targeted reentry vehicles, inter-continental ballistic missiles, and ballistic missile defence systems. The growing US-India strategic partnership helps India to modernise its conventional force capability, that in turn enhances conventional force differences in South Asia. Arguably, the more a conventional asymmetry increases between India and Pakistan, the more it increases the effect of reliance on nuclear weapons in South Asia, and the more it could increase the risk of miscalculation.

The international community, particularly the US, can play a central role in South Asia in terms of managing a balancing role, engaging both India and Pakistan for both crisis management and conflict resolution processes, to prevent future crises between India and Pakistan. A peaceful and stable South Asia should be in the interest of both India and Pakistan in general, and the international community in particular.

Filling The Firepower Gap: Mortar Developments

David Saw

The purpose of this article is to look into the subject of mortars, with the low-end of the spectrum from 60 mm, to the widely utilised 81 mm and up to the 120 mm calibre. The utility of mortars is not in doubt, there are however distinct differences between operators on what is the best mix of mortars to have and what is the most effective way of deploying mortar assets.

There is no universally accepted right or wrong way to acquire, deploy and utilise mortar systems. As with so many other areas in the military equipment choices are driven by doctrine, operational capability and, usually most important, by the availability of appropriate funding. In mortars as in so many other areas, what the user community would like to have and what they end up receiving usually remain somewhat distant from each other, but there is nothing unique about that in a military context.

Another factor that must be considered these days when trying to develop doctrine, to build an operational capability in line with the doctrine and acquire the equipment necessary to make the doctrine work, is people. Or, to be more

precise, the lack of people. Europe and other parts of the world are experiencing a demographic deficit, meaning a decline in the military age population. Therefore militaries will have to husband their personnel resources very carefully, especially those in combat roles, seeking to maximise firepower to make up for the lack of people.

60 mm Mortars

Our look at mortars will commence with 60 mm calibre systems, seen by many as exceptionally useful pieces of equipment for the infantry, while others see indirect fire weapons of this nature at platoon and company-level as unnecessary. One military that has been operating the

60 mm mortar since 1940 is the US Army and some 77-years later their interest in employing this category of weapon has not diminished.

Originally each infantry company in the US Army had three rifle platoons and a weapons platoon containing a mortar section with three mortar squads and three M2 60 mm mortars. With a weight of 19.05 kg this was far heavier than the British two-inch mortar system, but the M2 had advantages including a maximum range of 1,815 metres and a higher rate of fire. Ammunition natures included HE M49A2 (weight: 1.23 kg), HE M49A3 (weight: 1.38 kg), WP Smoke M302, Illuminating M83, Target Practice M50A3 and M69. Soon after taking the M2 into service the US decided that it actually needed a lighter weapon and this saw the development of the M19 60 mm mortar system, with the M19 using the same ammunition as the M2. Both of these systems would remain in use for many years, with the US eventually replacing them at the end of the 1970s with the M224 mortar.

The objective of the M224 was to replace legacy US Army mortar systems and equip light infantry, air assault, airborne, ranger and mountain infantry units with a mortar system that offered increased range and rate of fire compared to earlier generation weapons. The M224 was also adopted by the US Marine Corps. Ammunition types include HE, smoke and both visible and infrared illumination. The M242 weighs in at 21.1 kg, it has a crew of three, with minimum range 70 metres and maximum range 3,489 metres.

The M224 is now being replaced in US Army service by the new M224A1 60 mm Lightweight Company Mortar Systems (LCMS) with first deliveries having been made to the 1st Special Forces Group in Fort Lewis, Washington in June 2011. The M224A1 uses new materials and this reduces the weight of the mortar by 20%



Photo: US Army

Soldiers from the Able Company, 2nd Battalion, 503rd Infantry Regiment, 173rd Airborne Regiment, US Army, with their M224 60 mm mortar during a training exercise at Rukla, Lithuania in October 2016. The M224 came into service at the end of the 1970s, since June 2011 it is being replaced by the lighter M224A1 60 mm mortar.

The Mortar Company.



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THE COMPREHENSIVE 60 MM COMANDO MORTAR SYSTEMS.

The 60 mm Cdo systems is the consequent realization of a highly mobile and effective fire support weapon system for infantry units, which can make a difference on the battle field, by providing high angle 60 mm fire support from within. Operated, aligned and commanded by the group commander, the quick and easy usability of the weapon is combined with the high performance of the different types of the Commando mortar ammunition family like high explosives, smoke or illumination. Every element of the 60 mm Cdo system was designed to maintain the high mobility by lowering the man burden and accomplish supremacy in fire power.

With the 60 mm Cdo system every infantry group became one's own 60 mm fire support team.



Photo: Saab

A Danish Army mortar crew prepare to load a Saab MAPAM mortar round into their 60 mm Expal commando mortar during a firing demonstration in Sweden. The MAPAM round provides the same effect as an 81 mm mortar round in its 40-metre lethal zone. First used in combat by the Danish Army in Afghanistan, the MAPAM was subsequently adopted by the US Army as the M1061.

compared to the standard M224, with it now weighing under 17 kg. The new mortar can utilise all current and legacy 60 mm mortar rounds. In addition, the new mortar has reduced maintenance requirements compared to the M224.

The fact that the US Army has introduced two 60 mm mortar systems since the late 1970s to meet its LCMS requirement, demonstrates that they believe that the light mortar still has an important role to play in providing indirect fire for the infantry company. The US Army will standardise on the newer M224A1, with the reduced weight of this system being a significant response to concerns over the excessive weight burdens imposed on the infantry during operations in Afghanistan and Iraq. When you consider the firepower options available to the US Army the fact they continue with the 60 mm mortar is a powerful endorsement of this type of system.

Elsewhere there are plenty of options in the 60 mm mortar area internationally, both in terms of commando and conventional mortars. Hirtenberger Defence Systems (HDS) of Austria has a commando mortar (M6C 640 Mk1), plus the conventional M6-895 and M6-1000 mortars in 60 mm calibre. The British Army purchased HDS systems as an Urgent Operational Requirement (UOR) for Afghanistan, which we will discuss below. Another European 60 mm mortar supplier is Expal of Spain who offer both conventional format and commando

60 mm mortars, as used by the Danish Army in Afghanistan. Other sources of 60 mm systems include Denel Land Systems in South Africa and Elbit Systems in Israel who had acquired the artillery and mortar house Soltam.

60 mm Ammunition

Mention should also be made of the enhanced 60 mm ammunition types that are available. A case in point being the Saab Bofors Dynamics Switzerland MAPAM 60 mm round, which was first used in combat by the Danish Army in Afghanistan. This is an insensitive munition, but the key characteristic is behind the liner of the round, where there is an epoxy matrix containing steel-ball fragments. When the round detonates 2,400 fragments are distributed evenly over the 40-metre lethal zone of the round in a controlled pattern, providing the same effect as an 81 mm mortar round. The MAPAM round can be used with all NATO standard mortar fuses, on charge one to four ranges are 100 to 3,500 metres, with the extended range round capable of 4,500 metres on charge six. The MAPAM round was given full materiel release in the US in October 2016, with the round being classified as the M1061. Thus far Orbital ATK has produced over 12,000 M1061 rounds for the US Army and other customers. The MAPAM round is also available in 81 mm calibre with a range of 5,500 metres on charges one to four.

Increasing the lethality of mortar ammunition is also the objective of HDS of Austria who have developed a new range of HE ammunition for 60 mm commando, 60 mm, 81 mm and 120 mm mortars (HDS manufacture mortars in all of these calibres) using what they call ConFrag technology. This Controlled Fragmentation (ConFrag) technology is designed to increase the lethality of HE ammunition through controlling fragment size and quantity, fragment velocity and the spatial distribution of fragments. With on-target effects significantly enhanced, fewer rounds are necessary to neutralise a target.

The British Experience

The British Army adopted the two-inch mortar in 1938 and retained it in service for more than 40 years. The successor system was the L9A1 51 mm mortar system, this was a light mortar system weighing 6.275 kg and capable of firing HE, smoke and illumination rounds out to a range of 750 metres. Unlike the US 60 mm mortars neither of the British systems had a baseplate or a bipod, they were handheld mortars also known as commando mortars. This explains the range limitation in comparison with their US counterparts, plus the British mortar rounds weighed less and in the context of HE therefore had less effect. However, they were very useful pocket artillery for the infantry platoon and a skilled mortar operator could accurately utilise the capability of the mortar through its full range envelope.

The British Army found itself in intense combat in Afghanistan and Iraq, and by the time it had focused all of its attentions on Afghanistan it was becoming very aware of the fact that it was running out of ammunition for the L9A1 mortar and had no means of acquiring any more. This led to a debate on whether British Army infantry actually needed a weapon like the L9A1 at the platoon-level, and whether the two men who were responsible for the mortar might be better employed elsewhere. It was determined that after more than 60 years of having a platoon-level mortar there was no real requirement to have one, as the job could be performed by the L85A2 assault rifle with the L123A3 40x46 mm Low Velocity Under-Barrel Grenade Launcher (UBGL). Each four-man infantry fire team (two in an infantry section) has the UBGL. Another factor was the manpower shortage of the British infantry. If you have a platoon with a headcount of 20 or less, getting rid

of the mortar and gaining two bodies to use at fire team level has its attractions. The 40 mm UBGL is a wonderful thing, but it is most certainly not a mortar, and the effectiveness of the smoke, illumination or blast produced by a 40 mm LV grenade is significantly less than that of a mortar round. You then have the range issue; a 40 mm LV grenade reaches out to some 350 metres, the L9A1 works out to 750 metres. The end result was that the British Army issued a UOR for new mortar systems which was won by HDS of Austria. This saw the acquisition of M6C-640 commando mortar as the platoon-level replacement for the L9A1 and the acquisition of the M6-895 mortar that could be used conventionally with a baseplate and bipod or converted into a commando configuration. The rationale behind acquiring a 60 mm conventional mortar was that the standard L16A2 81 mm mortar was far too heavy to employ away from the Forward Operating Base (FOB) and forces in the field needed an on-call mortar capability that they could deploy with.

With Afghanistan now behind the British Army, post-conflict operational analysis and studies appear to have found no real role for the 60 mm mortar. One justification is that the handheld mortar is inaccurate, which is an extraordinary admission when you consider that the British have been using similar configuration systems since 1938. Perhaps the explanation behind the inaccuracy issue might be lack of training rather than the equipment. After all, we are not in the realms of super high sophistication with a handheld mortar. As far as the conventional M6-895 mortars are concerned it appears that they will remain for the moment with lighter units such as the Parachute Regiment and Royal Marines.

German Opts for 60 mm

While Britain seems to be moving away from 60 mm mortars, Germany is involved in a procurement programme for a new 60 mm system. Initially the requirement was generated by the KSK (German Special Forces), who wanted a light indirect fire system and then the German Army infantry identified a need for a similar weapon.

In effect, they are looking for a mortar system that could be used in a commando configuration, achieving a range of 100 to 1,000 metres, or once converted into a conventional configuration with bipod and baseplate, achieve a range of out to 3,500 metres. A total of 159 60 mm

mortar systems are to be acquired, of which 37 will only be in the commando configuration, with an initial ammunition requirement of 22,400 rounds, service entry is anticipated by 2020.

81 mm Developments

The standard US Army 81 mm M252 mortar is a derivative of the British L16 mortar acquired during the 1980s. As they did with their 60 mm mortars the US Army is now using a new version of the system that is considerably lighter. The legacy M252 had a system weight of 41 kg, the new M252A1 model is 14% lighter with a 35 kg system weight, according to Picatinny Arsenal. Apart from using new materials to reduce weight, the new M252A1 also has reduced maintenance requirements. The new M252A1 was first delivered in December 2014 and will replace the old M252 in US service.

Elsewhere in the US as a part of the Enhanced Expeditionary Engagement Capability (E3C), the US Navy Office of Naval Research (ONR) is working to provide the US Marine Corps with the 81 mm Advanced Capability Extended Range Mortar (ACERM) round. This is designed to provide a precision indirect fire capability to battalion commanders, via the provision of a round with a 100% to 200% increase in range compared to a standard 81 mm round and a CEP of one to five metres. The aim is to give the 81 mm mortar a 120 mm mortar level of effectiveness. The ACERM round is currently in development.

ACERM has an aerodynamic body with wings and tail surfaces, it has a combined GPS and Low-Cost Semi-Active Laser Seeker (LCSS) that provides an affordable precision guidance capability and it has what is described as an "optimized warhead design" to provide improved



Photo: UK Ministry of Defence

Soldiers from D Company, 5th Battalion, The Rifles, on patrol in December 2011 in Nahr-e-Saraf, Afghanistan. Note the L85A2 assault rifle with the L123A3 40x46 mm Low Velocity Under-Barrel Grenade Launcher (UBGL). Once the L9A1 51 mm mortar was withdrawn from service, it was thought that the UBGL could perform the role of the mortar. Unfortunately, it could not.

on-target effects. Also part of the system is the Miniaturised Mission Setter (MMS). This is an Android-based tablet computer that is a handheld ballistic computer and fuze setter weighing 0.902 kg. The ACERM could be used in conjunction with miniature UAVs that would act as a forward observation capability. Future developments include a rocket-assisted ACERM that would dramatically increase the system range. ONR is also working on a precision-guided 60 mm mortar round. Another innovative 81 mm mortar development is from Expal of Spain in the form of the EIMOS integrated mortar system, EIMOS can also utilise a 60 mm mortar if so desired. The system is mounted on a URO VAMTAC light utility vehicle, with the mortar mounted on a turntable, it has powered elevation and full 360-degree traverse, plus a recoil attenuation system that reduces recoil force by 90% allowing integration on light vehicles. The vehicle has a minimum crew of two, though four would be more usual and carries in excess of 50 mortar rounds on the vehicle. Also stored on the vehicle is a mortar baseplate and bipod if it is necessary to dismount the weapon. EIMOS is designed to get rapidly into action, accurately engage a target and then moving to a new location before any counter-fire is received. On top charge the 81 mm mortar has a range of 6,900 metres, while the 60 mm mortar has a range of 4,900 metres on top charge. Another characteristic of the system is that high rates of fire can be achieved.

Another part of EIMOS is the Techfire fire support information system which acts



Photo: Michael Horst

The electrical drive of the COBRA makes the system highly accurate, while ballistic computing enables MRSI firing (Multiple Rounds Simultaneous Impact).

as a fire control system and integrates data from sensors and the navigation system, as well as external sensors such as Expal's SHEPHERD-MIL mini-UAV system that can be used in a forward observation role. Techfire also acts as a command and control system for multiple EIMOS fire units.

Guided 120 mm Options

The needs of the US Marine Corps for a capability to fit in between smaller calibre mortars and 155 mm artillery lead to the

decision to acquire the TDA 120 mm RT mortar as part of its Expeditionary Fire Support System (EFSS), with the mortar designated as the M327. With a range of some eight kilometres the M327 provided a very useful capability, but more was required and this led to the Precision Extended Range Mortar (PERM) requirement. The PERM programme started in 2011 and in December 2015 a team of Raytheon Missile Systems and Israel Military Industries (IMI) was awarded a US\$ 98 million contract to deliver 4,300 PERM munitions which will enter Marine Corps service in 2018. Having PERM will vastly increase the operational utility of the M327 EFSS, maximum range will increase from 8 to 16 km. Higher accuracy will reduce collateral damage and increase lethality by a factor of three times.

The US Army has also been very interested in precision-guided 120 mm mortar rounds, operational experience in Iran and Afghanistan led to a number of operational needs statements calling for a new mortar round that was far more accurate. This led the US Army Armament Research, Development and Engineering Center (ARDEC) to develop a GPS guided-round known as the Accelerated Precision Mortar Initiative (APMI). The first APMI rounds were deployed to Afghanistan in March 2011. APMI rounds had a CEP of 10 metres, in contrast, according to ARDEC, the CEP for a conventional 120 mm round at maximum range is 136-metres, while a 120 mm mortar with advanced pointing and positioning



Photo: EXPAL

A Spanish Legionnaire operates the EXPAL 60 mm Commando Mortar.

systems could achieve only a CEP of 76 metres. The APMI is an integration of a standard HE 120 mm round with the Orbital ATK XM395 precision guidance kit.

ARDEC's next 120 mm mortar venture was a programme known as the Guided Enhanced Fragmentation Mortar (GEFM). Here the aim was to develop a GPS-guided mortar round that surpassed the APMI in terms of range, lethality and reliability. The GEFM has been described as the government solution to the US Army 120 mm High Explosive Guided Mortar (HEGM) requirement, in fact ARDEC GEFM work was to be made available to industry as a technical data package to provide the basis for their proposals to meet the HEGM requirement. The HEGM Request for Proposals (RfP) is to be issued in the first quarter of FY 2017, with the 18-month Design Demonstration Phase to get underway in FY 2018. An initial production contract for 14,000 rounds is to be awarded in FY 2021.

The fact that the US Army and the US Marine Corps are so enthusiastic about 120 mm mortars and guided-mortar rounds is an excellent endorsement of the utility of these systems. There are numerous guided-options developed by companies such as General Dynamics-OTS, Elbit, Expal, IAI, IMI, Norinco of China and KBP of Russia amongst others. In the end widespread utilisation of guided-mortar rounds will only occur once the procurement cost per unit is reduced and that has yet to occur.

120 mm Systems

In the 120 mm calibre it is not all about guided-rounds there is also activity in terms of new mortar developments. In 2015 RUAG of Switzerland unveiled COBRA, a 120 mm mortar system designed for vehicle-based applications. The system was designed as a private venture with the idea that it could be mounted on a diverse range of tracked and wheeled vehicles, the mortar feature semi-automatic loading and can be into action firing the first round less than a minute after the vehicle halts. All standard 120 mm rounds can be fired, with ranges of between 7,000 and 9,000 metres being achieved. The Swiss Army is reported to have selected COBRA and will install the system in its 8x8 PIRANHA 3+ vehicles with 32 systems reportedly to be acquired.

Elbit in Israel has built on the success of their CARDOM Recoil Mortar System (RMS), introducing a new system called SPEAR (HANIT). While CARDOM was mainly employed from wheeled or tracked armoured vehicles, Spear offers a much wider set of vehicle installation options including 4x4 light tactical vehicles. This is achieved due to the fact that the recoil load of the system is now under 10 tons from the 30 ton recoil force previously encountered in vehicle applications.

Finally, the Patria NEMO system has grown in capability. Initially the system, capable of both direct and indirect fire modes, was turret-mounted on the Patria AMV, the turret is light enough to be installed on both 6x6 and 8x8 armoured vehicles, with Slovenia being the first customer. Then the United Arab Emirates (UAE) purchased the NEMO turret for a naval application where it was integrated on to patrol craft.

According to the media in Finland there is now a third NEMO version mounted on top of a standard 20-ton ISO freight container. This container could be mounted on the back of a truck or on a ship, or even left on the ground. In this application there is a crew of three who are located in the air-conditioned crew compartment of the container, ammunition located within the container is said to be 100 rounds. The containerised NEMO will be displayed at the IDEX exhibition in Abu Dhabi and it is believed that the UAE will be the first customer. ■

Masthead

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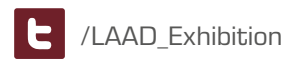
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Satnav and Inertial Sensors Team to Guide the Soldier

Doug Richardson

During his later years, the great American pioneer and frontiersman Daniel Boone was once asked if he'd ever got lost during his exploration of what once had been the yet-uncharted US West. The old man thought for a few moments, then replied "I can't say as ever I was lost, but I was bewildered once for three days."

In modern combat, ground forces cannot run the risk of being bewildered as to their current location. Not knowing where you are, and where other friendly units are located, is the stuff of which "blue-on-blue"

mate measure of distance travelled can be obtained by linking the transmission of the vehicle (and thus the wheels, or in the case of a tracked AFV, the drive sprocket) to an odometer, so that the number of turns re-

the crew to manually input a correction factor in order to compensate for errors in the odometer's output due to factors such as terrain slope, track slippage or due to mud and snow.

Dead-reckoning can also be adapted for infantry use, with a pedometer being used to estimate the distance walked. But while a pedometer may be useful for someone walking or marching on a level surface such as a road, it is of limited use when the walker is on rough terrain, or is moving in an irregular manner. One possible solution is to fit a sensor on the soldier's boots, so as to measure the size and height of each step taken.

Thirty or more years ago, inertial navigation might have seemed an obvious solution, but posed problems of cost and complexity, given that the technology of the day involved mechanical gyroscopes and accelerometers. As a result, they were used largely in roles where their high cost and complexity could be justified. However, one problem remained – the tendency of inertial navigation systems (INS) to drift with passing time. Once mission duration rises above a few hours, errors due to drift become significant, and simple INS are no longer an acceptable solution.

With the arrival of laser gyro technology, followed by fibre-optic laser technology, the bulk, weight and cost of INS were dramatically reduced, and ruggedness was improved. The same technology also allowed the creation of better dead-reckoning systems. The Northrop Grumman LITEF (NG LITEF) LLN-GY is a dead-reckoning navigator based on one fibre-optic gyro (FOG) and two accelerometers, but can receive automatic position updates from a Global Positioning System (GPS) receiver if the latter is available. It weighs less than 2.8 kg, and consumes less than 12 W of electrical power. The LLN-GZ Hybrid Land Navigator is similar in concept but incorporates a six degrees of freedom IMU.



Photo: US Army

Knowing where you, your allies and the enemy forces are has always been key for military success.

incidents are made. The history of the Israeli Army tells of several occasions when friendly forces have fired on one another in the heat of battle.

Navigation aids (navaids) are important to modern land, sea and air platforms. But given the number of systems currently in offer or in service for ground forces, only a small number of systems can be looked at in detail in order to give representative examples for the technology used.

The simplest form of land navigation for vehicular use is dead-reckoning. An approxi-

corded can be related to distance. Vehicle heading can be measured either by means of a magnetic sensor or a north-seeking gyroscope.

Unreliability of the Travelled Distance

For a long time, dead-reckoning systems of this type were the only practical form of land navaid, but given the limitations of the technique, it is hardly surprising that such systems were not widely adopted. The weakest link in any dead-reckoning system is the unreliability of the estimated distance travelled. In the case of a wheeled vehicle, changes in tire diameter due to wear and other factors will introduce error. The former Soviet Union equipped its T-62K command tank with the TNA-3 land navigation system, but this required

Author

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

Photo: US Air Force



Navstar-2F satellites were among the first to transmit the new M-code GPS signal.

GPS as Prime Navaid for Soldiers

Given its global coverage, relatively inexpensive receivers, and high accuracy, GPS has now become, and will remain a primary navaid for soldiers, sailors, and airmen. GPS also has a secondary role of providing pre-

cise time and frequency to military communication systems.

The GPS satellite constellation transmits a Standard Positioning Service (SPS) for civilian users, and a Precise Positioning Service (PPS) used by the military forces of the US and its allies. PPS is more accurate, but uses an encrypted signal use-

where it is used in our cars, and even our cameras are expected to take note of our exact location every time we take a photo. Unfortunately, while civilian SPS receivers are consumer items manufactured on a large scale, PPS receivers are traditional items of military hardware, and are procured in much smaller numbers. As a result, the US DoD faced a shortage of military GPS systems during the runup to the 1991 war to liberate Kuwait.

Procurement of more than 10,000 civilian GPS units, mostly from Trimble Navigation and Magellan Systems allowed GPS capability to be fielded on a much larger scale. Almost 90% of the receivers used in that conflict are reported to have been civilian.

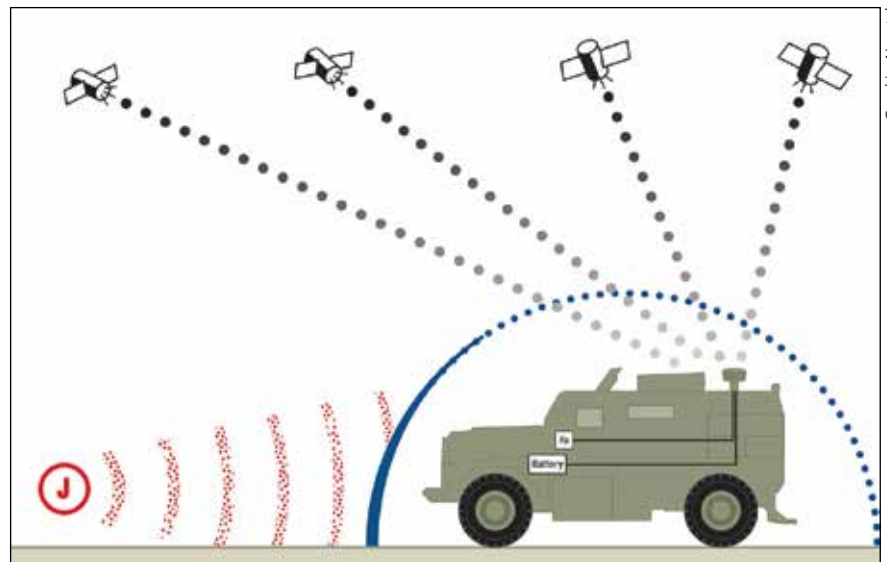
Civil GPS Systems Vulnerable to Jamming

The problem with using SPS in a military operation is that the GPS system is vulnerable to enemy jamming. The signal strength at the surface of the Earth is extremely weak, and has been described as comparable to viewing a 25 watt light bulb from a distance of around 18,000 km. So it can easily be jammed by a signal of the same or similar frequency but greater strength. SPS receivers are also vulnerable to spoofing (an electronic-warfare technique which mimics a legitimate signal in order to introduce erroneous posi-

Photo: Rockwell Collins



As with most types of electronic hardware, the size and weight of hand-held GPS receivers shrink from generation to generation. The ANIPSN-11 Precision Lightweight GPS Receiver (PLGR) seen on the left towers over the later ANIPSN-13 Defense Advanced Global Positioning System Receiver (DAGR).



Graphic: Novatel

This artwork shows the operating concept of the "smart" controlled-reception pattern antenna (CRPA), which is able to maintain contact with the GPS constellation, while blocking the unwanted signal from an enemy jammer (indicated here by the letter "J").

able only by dedicated military receivers. The first GPS systems for army use during the 1980s were manpack sized, but modern technology has shrunk the size, weight, and cost of GPS hardware to the point

tion and time information intended to make the targeted receivers give misleading co-ordinates). A PSP receiver will recognise the presence of jamming, warn the user, and has a good

chance of continuing to provide good-quality positional data. In 1998, the US selected the SAASM (Selective Availability Anti-Spoofing Module) as a future capability, and since 2006, all newly-fielded US military GPS systems have been SAASM-compliant. SAASM uses cryptography to prevent authorised users from being deceived by false satellite signals generated by an enemy. In a future conflict, the (C/A) code signal may be intentionally jammed by the US and its allies to allow only SAASM receivers to access the GPS service.

By 2003, the US Army had forbidden the use of SPS by infantry, forward observers, and other front-line personnel, but some British infantry units taking part in the invasion of Iraq in that year were issued with civil GPS units such as the Garmin 12XL.

The most basic countermeasure to jamming is to use an SPS receiver. This will provide some protection and navigational integrity in low and moderate risk threat environments.

New M-Code Introduced to Improve Security

GPS signals are transmitted on two frequencies: L1 (1,575.42 MHz) and L2 (1,227.60 MHz). The SPS service is provided by the Coarse/Acquisition (C/A code) on L1, but the PPS service uses Precision (P/Y code) signals on both L1 and L2. A new M-code signal intended to further improve the security of military GPS signals was introduced in 2005. Most PPS receivers initially lock onto the C/A code and then transfer to the P(Y)-code, but the M-code is autonomous, so is the only signal that military users will require.

Transmitted on the same L1 and L2 frequencies as the existing PPS service, M-code is radiated not only from a wide angle satellite-mounted antenna that provides full earth coverage, but also from a high-gain directional antenna whose spot beam can be aimed at a specific region several hundred kilometres in diameter. Users within that footprint will enjoy a signal strength that has been boosted by 20 dB. However, the usefulness of this extra M-code power is limited, given that a sophisticated enemy will respond by boosting the strength of his own jammer signal to increase the jammer-to-signal ratio.

New Military Receivers Reduced in Size

The steady reduction in size, weight and power demand seen in civil receivers is being matched by newer PSP receivers. For example, the Rockwell Collins AN/PSN-11 Precision Lightweight GPS Receiver (PLGR) weighed about 1.2 kg, but the same company's AN/PSN-13 Defense Advanced Global Positioning System Receiver (DAGR) weighs less than 500 grammes.

In March 2015, Rockwell Collins signed a contract to provide 5,000 MicroGRAM GPS embedded receivers to Harris Corporation, which will use these to provide secure, jam-resistant GPS capability to tactical radio systems such as the Falcon III AN/PRC-158 and AN/PRC-117G.

The DAGR Distributed Device (D3) is mechanically interchangeable with the DAGR. Several devices that require Positioning, Navigation, and Timing (PNT) data can be plugged into the D3, and all will enjoy the same facilities as if they had been plugged into their own dedicated DAGR receiver. A D3 can be updated by installing the Rockwell Collins GB-GRAM-M Type II receiver, which fits within the volume of the D3, and is able to acquire, track and navigate using C/A, P/Y and M-code.

Adding GPS to a combat radio, either as an embedded system or via an external interface, allows each voice or data message to automatically include position information. Some radios, such as the Elbit CNR-9000, offer built-in GPS as an option, while in others such as the Selex Soldier System Radio

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(SSR) Plus it is integrated into the radio. For the AN/PRC-148 Joint Tactical Radio System (JTRS) Enhanced MBTR, Thales Defense & Security offers a GPS-equipped Remote Control Unit which replicates the front panel of the radio. Another possible configuration adopted by some manufacturers integrates a civil receiver into the radio but allows qualified customers to plug in an external military GPS.

When faced with a higher risk, the use of anti-jam antennas will help to guarantee signal availability. A conventional GPS receiver uses an antenna with full hemispherical coverage, and so can “see” the

PSEUDOLITES (the word is a combination of “pseudo” and “satellite”) are located on the ground or on a low-flying aircraft. These act as extra GPS satellites, and being closer to the user than the orbiting constellation, have a much higher-powered signal that is harder for the enemy to jam. They also provide GPS coverage in terrain such as forests, valleys, canyons, or city streets – regions where it is hard for a ground-based user to see the satellites.

Where the risk of jamming or spoofing is severe, GPS systems will have to be augmented by a second navaid able to monitor heading and distance travelled. The same

is claimed to produce accurate data quicker than any other inertial navigation system as a result of using what the company describes as an innovative alignment method. It weighs 4.5 kg, consumes less than 28 W of power, and is advertised as having an MBTF of more than 50,000 hours. Both systems have a NMEA-0183 protocol GPS interface.

Kearfott’s LANDNAV system uses a Monolithic Ring Laser Gyro (MRLG) and MOD VIIA pendulous accelerometers to provide accurate heading, attitude, velocity and position information. It is available in two configurations weighing around 7 kg and 9 kg respectively, and can be integrated with an embedded or external GPS receiver and a Vehicle Motion Sensor (VMS).

NG LITEF developed its LLN-G1 to meet the environmental conditions within the LEOPARD 2 MBT, and is promoting it for use on all types of wheeled or tracked combat vehicles. Described as a hybrid/inertial navigator, it is based on a full six degrees of freedom IMU that uses FOG technology. When teamed with a GPS system, it typically provides a position accurate to less than 5 m, says the company.

The KVH product range includes the TACNAV 3D, an inertial navigation system that incorporates an embedded GPS subsystem. Designed for use in turreted and non-turreted vehicles it is based on an IMU that combines the company’s DSP-1750 FOGs and micro-electromechanical systems (MEMS) accelerometers. The system can provide heading, pitch, and roll as well as altitude, distance and bearing to waypoint in all terrains. It uses a built-in Iridium transceiver to transmit vehicle position, waypoint, and target location data to a command centre or other vehicles, and to receive tactical data from these. TACNAV 3D can interface with battlefield management systems (BMS), integrated turret data systems, laser range-finders (LRF) and laser warning receiver systems (LWRS), and can use an external GPS in place of its own internal receiver.

As its name suggests, Israel Aerospace Industries’ PENS (Personal Navigation System) is a navaid for use by the individual combatant. It is made up of two main units – the Navigation and Computation Unit (NU) and the Sensors Unit (SU) – and weighs 2.2 kg. Based on a strap-down inertial navigation system with six degrees of freedom, 3-axis magnetometers, a baro-altimeter, and with an input for GPS, it consumes less than 1 A of 28 V DC power.

With such a wide range of nav aids available to the modern army, the era of lost soldiers should for all practical purposes be over, even when in poorly-mapped or featureless terrain. Daniel Boone would have loved it! ■



Photo: US Army

As this US Army photograph of various types of “smart” controlled-reception pattern antennas shows, these are small units that can easily be substituted for normal omnidirectional antennas.

jammer as well as the GPS satellites. A “smart” controlled-reception pattern antenna (CRPA) has the ability to steer multiple narrow beams towards the satellites, while steering a no-reception zone (known as a null) towards the jammers.

Anti-Jam Systems

Installed on more than 30 platforms worldwide, Raytheon UK’s GPS Anti-Jam System-1 (GAS-1) consists of a multi-element CRPA and a separate Antenna Electronics (AE) unit. GAS-1 uses analogue electronics, but the company’s LANDSHIELD is a digital product that combines a multi-element antenna and the anti-jam processing in a single unit that directly connects to the RF input of the GPS receiver. According to the manufacturer, the 1 kg unit “works against a full range of hostile jammers – including narrowband, broadband, continuous wave pulse, swept and spectrally matched – and can protect L1 and L2 GPS frequencies simultaneously for enhanced situational awareness.”

technique is also useful in urban warfare, where the presence of high buildings may prevent a receiver from picking up signals from a sufficient number of satellites. If the satellite signal is lost, a navaid that combines GPS with another system will provide positional data until the signal is re-acquired.

Combination of GPS and INS

The most common solution is to combine GPS and INS, either by providing INS with a connection for an external GPS receiver, or by integrating the inertial navigation system and GPS receiver into a single system. Sagem’s SIGMA 10 and SIGMA 20 are being marketed as non-GPS dependent nav aids. SIGMA 20 is an inertial system based on RLG technology, and has a cited mean time between failures (MTBF) of more than 15,000 hours. It weighs less than 7.5 kg, consumes less than 30 W of power, and is combat-ready within 2 minutes of switch-on. Sigma 20 uses the company’s Hemispheric Resonator Gyros (HRGs) and

Clear the Battlefield and Let Me See

Doug Richardson

Military units operating close to a front line or border need to be able to monitor activity taking place at distances ranging from a short distance in front of their own position to long ranges limited only by the line of sight. Commanders will want to have a good idea of what enemy forces are arrayed against them, and what those forces are doing, but units tasked with peacekeeping operations may also need to monitor an area of terrain in order to detect unauthorised activities.

Unmanned aerial vehicles can provide airborne surveillance, but may not always be available, particularly during extended deployments or peace-keeping operations. So the demand for sensors directly under the control of front-line units has spurred the creation of a wide range of products.

The basic solutions available to front-line units are:

- binoculars, telescopes and similar day-only vision aids,
- hand-held or tripod-mounted image-intensifiers,
- hand-held or tripod-mounted thermal imagers,
- short-range ground-surveillance radars.

Most of the types of equipment described here are available from a wide range of manufacturers, so in each case only a handful of systems are described in order to serve as typical examples.

The simplest surveillance aid remains the traditional telescope or binocular. But, once darkness falls, these basic daylight-only aids are near useless, so more sophisticated sensors are needed. Night-Vision (NV) systems

Photo: Arkadiusz Dwuliatki/SHAPE



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(Photo: AIM INFRAROT-MODULE GmbH)

AIM's HuntIR MKII mounted on an assault rifle

based on either thermal-imaging or image-intensification technology are an obvious solution. Based on cooled or uncooled detectors, these can be hand-held or tripod-mounted.

With the future soldier system "Infanterist der Zukunft" (basic version) Germany introduced AIM's HuntIR in the Bundeswehr. HuntIR is a cooled thermal imager and targeting sight combined in one system. Mounted on a high powered rifle it allows to engage targets in a complete dark environment up to 1.500 m. Meanwhile there

is a second generation, the HuntIR MKII, on the market.

Other armed forces have different approaches: Thales Nederland's LION (Lightweight Infrared Observation Night) sight was originally developed for the Royal Netherlands Army by what were then Signaal USFA and Delft Sensor Systems (both now part of Thales Nederland), and is a classic example of a hand-held, uncooled thermal imager. Operating in the 8-12 micron band, it offers magnifications of X3 and X6. Used in operational service in Afghanistan, Bos-

nia, Iraq and Kosovo, it has a good reputation for reliability. The company has since marketed two improved versions known as LION Advance and LION Advance XP (extended performance).

Selected by the US Department of Defense (DoD) as the AN/PAS-22, Elbit's EMERALD-LRTI is based on a cooled InSb focal plane array, and offers wide and narrow fields of view (FOV). Options offered by the Israeli company include a built-in magnetic fluxgate compass and GPS, or even a laser pointer. These allow the unit to be used as an integrated targeting system.

Combining day and NV sensors into a single unit allowed the operator to select whichever viewing mode provided the best imagery, or to switch quickly from one mode to the other to exploit the data from both sources. Such a group of complementary sensors can be tripod-, vehicle- or mast-mounted.

Observer and Reconnaissance Systems

The Rheinmetall Defence Electronics BAA (Beobachtungs- und Aufklärungsausstattung) observation and reconnaissance system installs a sensor package that includes a thermal imager, CCD camera and

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an eye-safe laser rangefinder, mounting this on a pan-and-tilt head. This package is linked to a control and display unit. A similar array of sensors is used on Elbit's ATLAS PRO and MINI ATLAS systems, and a laser designator can be added if required.

Adopted by the Norwegian and Swedish armed forces, the FOI 2000 forward observer system is marketed by Vinghøg AS. It combines an LP 10TL Target Locator and a FLIR Systems Forward Observation Thermal Imager. The target locator can be handheld or tripod/monopod-mounted, and combines a dual magnification telescope and eyesafe laser rangefinder with a digital magnetic compass (DMC).

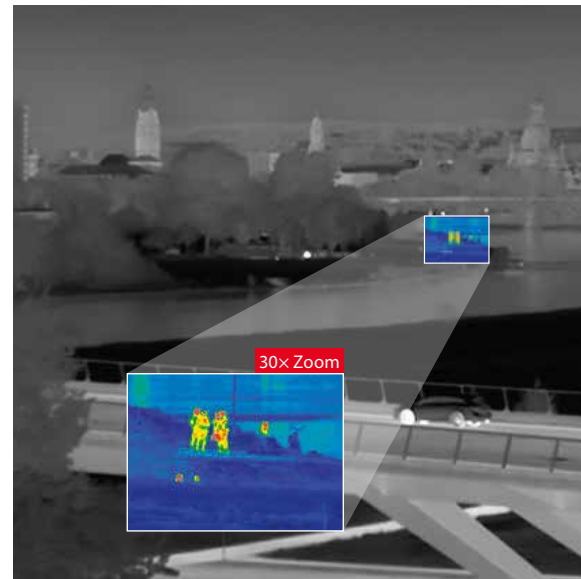
FLIR Systems' AN/PAS-26 Recon III Lite combines an uncooled long-wave infrared

More than 3,500 have been delivered to the US Army.

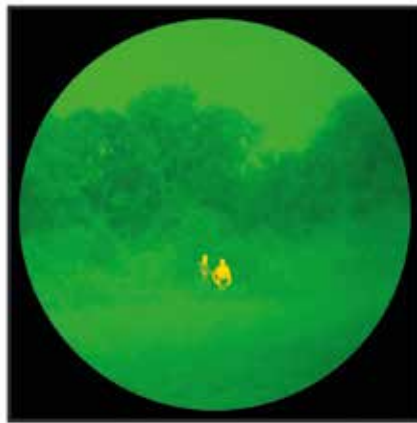
Next Step Image Fusion

The next stage beyond multi-band sensors that allow the operator to switch from one type of image to another are sensor systems in which the two or more image sources can be merged into a single more-useful image. This technique is known as image fusion, and can be achieved either by allowing one sensor to inject its output into the imagery created by another, or by using hardware that has been custom-designed to create a fully fused image.

Several clip-on devices have been developed to inject a thermal image into the



ENVG with I²



ENVG with I² and IR

Photo: ITT

Targets that are invisible in the image-intensified view (left) are easily spotted when the thermal image is added to the output of the ANIPSQ-20A (right).

(LWIR) thermal camera, a colour visible-light camera, a laser pointer, and an integral digital magnetic compass into a single hand-held unit weighing less than 2.3 kg. Controp's SPIDER (Stabilised Panoramic automatic Intruder Detection and Recognition) and SPIDER-LR are stabilised electro-optical (EO) packages offering automatic detection of movements across a wide panoramic area. They combine a thermal imaging camera, daylight TV camera, and an eye-safe laser rangefinder. The panoramic scan mode is used for automatic intruder detection, while an observation mode provides live video for intruder identification.

Able to operate in vehicle-mounted and demounted tripod-based configurations, the Raytheon AN/TAS-8 Long-Range Advanced Scout Surveillance System (LRAS3) teams a thermal imager, a day TV camera, an eye-safe laser rangefinder, and common aperture optics, and a GPS subsystem.

image-intensified output of a standard NVG such as the ITT AN/PVS-14 Monocular Night-Vision Device. These include the Optics 1 Clip-On Thermal Imager (COTI) originally developed for the US Special Operations Command.

Thermoteknix's ClipIR Thermal Imager is an add-on uncooled thermal module that is compatible with NVGs such as the AN/PVS-7, -14 and -18. It provides a thermal overlay for a 40 degree FOV, and when fitted with a Quick-View accessory eyepiece can be used as a stand-alone thermal imager.

The AN/PAS-29 COTI (Clip-On Thermal Imager) was developed by the Swiss-based Vectronix Group. When attached to legacy NVGs, it provides an optically-fused thermal image generated by a 320 x 240 focal-plane array.

Developed by Thales Angénieux, the MINIE-DIR is a modular night-vision system which adds an infrared module to the standard MINIE-D.

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Photo: Thales Deutschland

The GROUND OBSERVER 12 of Thales Deutschland can be manpacked by a single soldier, and has a setup time of less than two minutes.

The logical step after this sort of add-on accessory is to combine the channels into a single EO system custom-designed around the fusion concept. This was done by ITT, whose AN/PSQ-20 Enhanced NVG (ENVG) entered US military service in 2008. The IR sensor (reported to be an 8 to 12 micron long-wave device) provides target detec-

tion, while the I2 sensor provides target identification. For the second round of US Army procurement, ITT Night Vision (later Exelis, and now Harris) created the improved AN/PSQ-20A Spiral Enhanced NVG (SENVG). This combines the output of a Gen 3 standard image intensification (I2) tube with that of a LWIR microbolometer.

A variant of the AN/PSQ-20 designated the Super Enhanced Night-Vision Goggle is available for export to selected countries such as Australia, Canada, Japan and the UK, but sales require prior US Government approval.

“Hardening” Radars Against Detection

Surveillance radar is the main moderate-resolution all-weather sensor. Typically these will operate in I-band, or J-band. In most cases, the RF power is generated by a travelling-wave tube (TWT), but in the most recent designs, a semiconductor power source such as a solid-state amplifier is used.

In order to make the radar as hard to detect as possible, and reduce the risk that it will betray the presence of the unit that is using it, and to reduce the risk of being targeted by enemy jamming, the output power of the radar must be minimised. The use of low-sidelobe antennas and low probability of intercept (LPI) modulation are also advisable.

Potential secondary roles are the detection of low-flying aircraft and helicopters, the control of artillery and mortar fire, or even sea surveillance.

A classic radar of this type is the Thales RASIT E. More than 700 of these X-band pulse-Doppler sets have been delivered in 20 countries, where they served in tripod-

COMINT and SIGINT Systems from BOGER

(wg) On their booth at the IDEX exhibition in Abu Dhabi, UAE, Boger Electronics will present their common solutions for COMINT and SIGINT systems in the field of border control and border surveillance applications.

Boger Electronics is designing, manufacturing and integrating the systems according to current requirements. The offered systems are covering all relevant communication frequency ranges, from HF up to V/UHF and communication networks – always customized according current requirements and end-user needs.



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end-user to detect unauthorised emitters or targets (e.g. crossing unauthorised the border). Systems can consist of single receivers up to powerful remote-controlled solutions contain-

ing of antenna systems, signal-distribution, decoders, receivers, workstations etc.

At IDEX Boger Electronics is presenting on booth 08-E07 their latest developments and projects.

mounted and vehicle-mounted forms. When first fielded, they introduced the then-unique feature of allowing the operator to define an area of interest, so that targets appearing outside of this zone did not trigger automatic alarms.

A more modern example is the Thales Deutschland BOR-A 550 and its more powerful BOR-A 560 variant. These are solid-state pulse Doppler sets which feature pulse compression, spread spectrum technology, frequency agility, and pulse repetition frequency stagger. A neural network is used to provide automatic target classification, and data are presented to the operator on a liquid crystal display. The BOR-A 560 is similar to the 550 but has a 40 W transmitter, double the power of the latter, and so has a longer range. It also offers a wider bandwidth and a greater number of frequency channels.

The same company's GROUND OBSERVER 12 radar operates in Ku-band (12.5-18 GHz) and uses a laptop man-machine interface. The complete system (including a tripod, cables, and batteries for up to six hours of operation) weighs around 30 kg, and can be manpacked by a single soldier. Setup time is less than two minutes. A sector scan



Graphic: Ukrainian Advanced Research Project Agency

The artwork on the left shows the planned configuration of the Ukrainian Advanced Research Project Agency's sniper-detection system. The image on the monitor screen on the right shows how laser energy striking the lens of an enemy optical system produces a visible 'bloom'.

of up to five sectors can be set up by the operator. The unit offers automatic target classification, and track-while-scan capability for up to 40 targets.

Ku-band is also the operating frequency of the Thales Deutschland LYNX, a mast-

tripod- or vehicle-mounted system that weighs only 25 kg. It has a maximum range of about 6 km against an individual, or 12 km against a vehicle. Like many of these small radars, it can also be used to detect helicopters or small boats.



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Examples of New And/Or Proven Systems

The Pro Patria Electronics PGSR-3i "BEAGLE" is an X-band frequency-modulated continuous-wave (FMCW) radar with low probability of intercept features. It has a maximum transmitted power of 2 W, and can detect personnel at 8 km, vehicles at 15 km and heavy vehicles at 24 km. According to its Hungarian manufacturer, digital signal processing is used to differentiate between fixed and moving targets, and to cope with changing environmental conditions. A man-portable load for two soldiers, it weighs 30 kg. When vehicle-mounted, it can be combined with a mast-mounted EOSA-4 thermal sight and daylight camera, the configuration used in Pro Patria Electronics' MGS3 SCOUT mobile ground surveillance system.

Elta Systems' EL/M-2105 X-band 8-12.5 GHz ground surveillance radar is offered in three variants – the ELVM-2105 baseline model, the EL/M-2105ER extended range variant, and the EL/M-2105LR configurations. Suitable for tripod-, tower- and vehicle-mounted applications, all are solid-state low probability of interception

(LPI) radars with a peak output of 10 kW and an average output of 1 W. Their track-while-scan capability can cope with up to 200 targets.

Elta's EL/M-2129 X-band radar can automatically detect moving targets at ranges of up to 30 km, with a track-while-scan capability against up to 100 targets simultaneously. If greater range is needed, this can be obtained by using a power amplifier and/or a larger antenna. If used in portable rather than vehicle-mounted form, it can be deployed in less than ten minutes. LYRA 10 is one of the Lyra series of coherent pulsed radars marketed by Selex Sistemi Integrati. A man-portable set suitable for battlefield surveillance applications, it offers sector surveillance, automatic target classification, target tracking, and audio/video target-detection alarms. Its maximum ranges are 10 km for personnel, 16 km for light vehicles, 18 km for helicopters, and 24 km for heavy vehicles. Developed by Thales Nederland, the Squire series are J-band FMCW radars offering LPI. The power output is selectable between 10 mW and 1W, levels that the company says make the system virtually undetectable by enemy ESM receivers. At the higher power level, personnel are

liberately-released, accidental or natural obscurants, an EO system can be teamed with a radar. Sometimes this is done by combining a radar with an EO sensor package. For example, the Czech SNEZKA tracked recce vehicle has a mast-mounted sensor system that combines a 360 degree radar with a night charge-coupled device (CCD) camera, a near-IR CCD camera, a day CCD camera, a thermal imaging camera, and a laser rangefinder.

One novel sensor for tactical surveillance is what is often marketed as a sniper-detection system. These use a low-powered laser to scan the terrain within their coverage area, and a detector able to respond to the laser energy reflected by optical systems such as telescopic sights and surveillance systems. Modern optics invariably have anti-reflective lens coatings similar to those used on the lenses of cameras and binoculars, but these are not good enough to defeat laser-based detection systems.

Examples include the CILAS SLD 500, which has been used by US forces in Iraq and Afghanistan, and by the UK forces. This tripod-mounted system incorporates a day camera, as well as a thermal imager that can also be used hand-held. As soon as a threat is detected, the system will provide an alarm, and indicate the position of the threat and exact distance, allowing counter-sniping teams to respond quietly and quickly. The system can be combined with various thermal imagers for night operations. There is also an SLD 500 LR (Long Range) version with higher-performance day and thermal cameras. Both versions use the same detection and localisation unit, which has a maximum range of 2 km. According to the Canadian company NEWCON-OPTI, its LAS 1000 Sniper Detection System detects lenses even if these are located behind bushes, windows or windshields. If an optical system is detected, its position is marked with a red dot visible through the eyepiece, and an optional audible alarm can be given. The unit weighs 2 kg, and can be handheld or mounted on a tripod.

The Ukrainian Advanced Research Project Agency has developed a 5 kg system that uses an automatic scan mode to detect optical surveillance systems at ranges of up to 1.5 km, then determine their exact position and range.

A RAND report published in 2000 warned that laser-based anti-sniper systems could use antireflection filters that selectively block the wavelength of the laser, but noted that tunable lasers might prove an effective method of reducing the effectiveness of this sort of blocking filter. ■



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detectable out to 10 km, and tank-sized vehicles out to 48 km.

CNPEP's Observation and Warning Land (OWL) tripod-mounted K-band (18GHz to 26.5 GHz) radar tips the scales at only 8 kg, a weight that most soldiers would consider very man-portable. The radar head is tripod mounted, and is linked to a tablet-style display. Such a small system cannot rival the detection ranges of heavier equipment; the manufacturer cites a range of 2.4 km.

All Weather Surveillance

Where surveillance must be maintained under all weather conditions, or in the presence of de-

Shootout in Virtual Reality

Tamir Eshel

Using weapons and firearms is a basic skill for law enforcement officers and soldiers. It requires to master the technical functioning of the weapon along with instinctive and intuitive use of different techniques with proper judgement about when and what technique should be used.

Training soldiers and policemen in using firearms is a methodical process that begins with technical orientation, repeatedly performed with the weapons or props simulating the actual weapon, as trainees learn to assemble and disassemble the weapon, maintain it and overcome common problems. Shooting practise begins once trainees get familiar with their weapons. This is a complex and dynamic process, limited by exhaustive but necessary safety rules that often limit training effectiveness. In the past, trainees had to go through many “dry” runs until they could perform individual “wet” training, let alone “wet” unit drills that included blanks or live fire. Despite the significant risk and many safety restrictions, these

Sometimes small technical improvements can assist personnel to achieve better performance – for example, getting feedback and corrective advice on weapon handling during live firing. Such guidance is enabled using electronic sensors and trackers that measures the shooter’s aiming and tracking prior and on the trigger pull. Such systems, developed by Targetize for commercial use, are adaptable for law enforcement and military training. When such sensors attach to a handgun they can record the user’s activity on the firing range, providing corrective feedback to trainees. The shooter’s posture, weapon movements, locations of hits and misses are clearly depicted on Targetize’s associated app.

ers to act in the virtual world as they will in the real world.

Effects in Simulation Scenarios

To meet such goals Virtual Simulation Systems (VSS) uses an ultra-fine tracker measuring a sniper tracking and synthetically generated targets in the virtual scenes. It is part of a sniper training simulator developed by VSS for the Australian military. The simulation uses a panoramic display projecting the scene on a wide screen displaying the wide “big image” and injecting part of this “virtual world” into the trainees’ scope, to deliver a combined, realistic experience. The MK2 Sniper Simulator can be used individually with the sniper rifle, or by the sniper team, comprising the sniper and observer (viewing through binoculars). Compensating the instinctive reaction to the weapon’s dynamic recoil effect is a critical parameter in fire accuracy. Soldiers must shoot hundreds of bullets until they get used to the effect. Therefore, simulating such a recoil effect is essential to create realistic and cost effective “dry” firing. Various haptic devices are used to create such effects – using compressed air, CO2 or electromagnetic actuation. Weight and size often limit the use of haptic devices in untethered weapons, but recent developments in electromagnetic devices, introduced by Hapttech, utilize three core motor to provide scalable force feedback, enabling variable levels of recoil from handguns to heavy machine guns. According to the developers, the new recoil simulator can generate up to 2,000 shots per recharge.

Infantry Training Simulation

Firearms training is a basic element in the qualification of infantrymen. Infantry training simulation often requires operating individual, crew served or special weapons following certain procedures, and through coordination with other team members. Using virtual scenes to simulate such activities would improve the trainees’ proficiency and skill over endless repetitive drills. Elbit Systems’ Infantry Gunner Training System (IGTS) provides such a service supporting all operational standard-issue weapons such as handguns, assault rifles and machine guns, and even mortars. 3D audio-visual scenes add to the realism, with environmental effect, communications and ability to use optics. Simulated by firing effects that include muzzle flash and recoil the IGTS tracks the trainee’s performance by recording the weapon movement during the firing process, and uses laser-based aiming to scores hit effectiveness, by counting hit/miss and hit locations.

While laser simulation provides the technical layer that recreates the firing effect it is not designed to perfect the shooting skills of trainees. Firearms training and specifically snipers require extensive training with the actual weapon and use high definition immersive scenes to enable us-



Photo: Theissen Training Systems

Range Control System by Theissen Training Systems.

“wargames” are essential phases in training and are often the most exciting phases of training.

Long practise in the live firing range is essential and cannot be replaced by virtual props. Shooters and marksmen must acquire the fine techniques of firearms operation to acquire lifesaving and effective instincts; they must be familiar with handling weapons in different situations and postures, use different ammunition types, against stationary or moving targets, operate in extended range, under various weather conditions etc.



Photo: Theissen Training Systems

The Tank and Infantry Range in Alaska expands over a huge territory and focuses mainly on infantry and tank training. Especially challenging for Theissen Training Systems were the extrem low temperatures in this area and the wilderness in which the range is set up.

live ammunition in pistols and rifles. While trainees fire blanks to simulate the weapon's effects, actual hits are measured by the target that senses the laser beam sent from the weapon and simulates the hit accuracy.

Force-on-force training exercise, enabling commanders and troops to practise tactics in realistic environment against a human adversary, are much more challenging and less predictive than any computer-simulated game. Laser engagement systems expand this formula over whole units, enabling large groups to roam free in the training area, engaging in a force-on-force exercise that fully simulates shooting effects, hits and casualties. Other methods of training are using paintball technology derived from adventure gaming. Although paintball is challenging and exciting for the trainees, its value as a training aid is questioned, since participants are restricted to use special protective equipment and special-purpose weapons specifically designed to shoot paintballs.

Ultimately, soldiers must leave the safety and security of the virtual world to test their skills and prove capabilities with real weapons, against real targets. Military users are making great efforts and spend lots of money to make this training activity as realistic and challenging as possible. Theissen Training Systems (TTS) is among the leading providers of such advanced combat shooting ranges, providing an array of sophisticated range systems that comprise anything from basic field and indoor firing ranges, to complex marksmanship training and Military Operations in Urban Terrain (MOUT) Close Quarters Battles (CQB) live firing facilities.

These ranges are equipped with remotely controlled stationary and moving targets simulating realistic threats. For example,

moving targets can travel at up to 30 km/h and can be combined with pop-up or pop-up rotary functions to present complex target action. Automatic electronic marking and scoring are also supported, for precision shooting and zeroing. Since shooting skills must be maintained not only in the training base, live-fire training should support military forces in contingency or at near the combat zones. That's why some of those targets are deployable, along with their control systems.

Digital Shoot Houses

A different approach uses "shoot houses": specially designed close-quarter firing ranges equipped with video scenery and targets recreated by Computer Generated Images (CGI) showing live scenes overlaid with computer generated "enemies" that pop up in certain places to simulate threats. Also known as "digital shoot houses", these facilities allow individual trainees or small teams to use all their combat equipment, including real weapons and live fire. Fully immersed in a 4D virtual world that can be enhanced

training realism inside the structures. It is designed to train and practice complex combat skills that involve extensive use of firearms, such as indoor combat, individual tactical movement, breaching and room clearing procedures, fire team manoeuvres, close combat marksmanship etc.

Law Enforcement Training

Law enforcement officers and other agents that operate among civilians should turn to the use of arms as a last option. However, mishandling stressful situations could lead officers and agents to using lethal force prematurely, in situations that should not require such actions. To familiarize them with emergency situations police departments often turn to "Use of Force Firearms Trainers". These devices project pre-recorded scenes of various situations challenging officers to respond to.

The system uses pre-recorded video or computer-generated scenarios from libraries provided by the supplier or created by the user. A live scene is projected on a



Photo: Samantha A. Barajas/US Marine Corps

Inside the Shoot House: Royal Netherlands Marines practice room clearance during a shoot house exercise on the US Marine Corps base at Camp Lejeune.

with special effects such as voices, heat, humidity, dust, wind etc., these facilities can replicate all the tactical and environmental factors of real life close quarters battle.

For example, a Modular Digital Shoot House from Shooting Range Technologies (SRT) uses an armoured exterior construction with interior bullet traps. The walls and ceiling provide screening area to display live targets to create

video wall or panoramic display covering up to 300 degrees, the weapons are usually provided as part of the system, and simulate standard issue weapons, fitted with laser aiming systems and recoil generator that simulate the weapon operation. In addition to determining the point of impact, such systems also collect key parameters such as sight picture, trigger control, posture and stance to determine the shooter's technique in real time.

For simulated training exercises to be realistic and have valid psychological impact, the trainee must consider the people in the scenario to be "human". The human brain is exceptional at detecting a "fake" person when they are closer than about 30 meters. The look and movement of people is perfectly captured by high quality video, but CGI creates "approximations" of people. Even with the latest CGI technology, "generated" CGI humans do not look and move like real people when viewing them at distances closer than about 30 meters.

When dealing with potential threats at closer ranges, military and law enforcement personnel look for threat cues to make split-second life-and-death decisions. This is usually best simulated using actors and high resolution video.

For law enforcement officer training most customers prefer the realism of human actors using high-resolution video for close range training. However, for some military applications users would opt for the flexibility and rich content enabled by CGI scenarios, particularly when "fought" at extended range of 10-30 meters or more.

The PRISim Suits from the Cubic Corporation uses HD interactive videos and game engine technology to create a realistic training theatre for all aspects of firearms handling. Training simulators are available for live firing or laser fire, using modified weapons fitted with coded laser inserts.

The PRISim Judgment Trainer from Cubic Corporation is an example of such a trainer. The judgment calls, indecision, sudden fear, partial understanding, blind side surprise and eye-blink response are all part of the training experience that conditions the trainee for survival.



Photo: Thales Deutschland

Sagittarius Evolution of Thales Deutschland is a small arms trainer that covers all areas of marksmanship training from law enforcement applications, close quarter combat up to full military battlefield engagement training.



Photo: Meggitt Training Systems

Meggitt Training Systems is constantly improving and renewing their core product FATS.

Training realism can be enhanced with "ShootBack" effect, utilizing Cubic's patented cannon that enables on-screen threats to "create" fire back at trainees.

The cannon synchronizes with the video sceneto fire .68 caliber polyurethane pellets when the suspect on the screen shoots at the trainee.



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3D Firearms Training with Tethered Weapons

A different system is the FATS – an advanced reality training simulator from Meggitt Training Systems. FATS implements an advanced 3D game engine for marksmanship training, and man-machine coaching functions. FATS can support unit sizes up to a full infantry squad (15 trainees) concurrently handling up to 30 weapons. These weapons use advanced firing simulation techniques using tethered or tetherless effect generation and mimic direct or indirect effects. Common types include M&P 40, Beretta M9, Glock 17, M4 (AR15 type), Steyr AUG, Browning M2, Remington 870 and Accuracy International sniper rifles, X26 Taser and chemical spray simulators.

Tethered weapons provide the highest degree of weapon control and feedback. They are built with form, fit and function in mind, depicting real weapons within 10% of the live weapon weight and center of gravity. Weapon recoil is achieved with compressed air or CO2 gas, that generate recoil sufficient to activate the autoloading cycle and disturb the trainee sight picture, requiring the trainee to reacquire the target after each shot. Air is delivered through a tether connected to an air source such as an

external air tank or compressor. The instructor can also initiate various weapon jams to test the trainee. The tether also transfers expansive sensor data to the control unit, where real-time assessment is processed for after-action review where instructors can provide feedback to trainees about how they performed and handled the situation. Features include butt pressure sensor, trigger squeeze sensor, cant sensor and muzzle trace, reinforcing the fundamentals of marksmanship training. Optics can be mounted on rails to maximize training potential.

For free roam operation Meggitt also offers the BlueFire wireless weapon simulation technique using Bluetooth communications, providing the same level of control as tethered weapons but with full range of motion. The After-Action Review (AAR) allows engagement and shot assessment in a 3D virtual environment, while providing detailed trainee diagnostics for skill reinforcement or correction. This technology is currently available for Glock 17, Glock 19, Sig P226, Sig P229, Beretta M9, Walther P99, S&W M&P in .40 and 9mm, H&K G36, M4 and SRS Rifle (M16 type) simulators and Carl Gustav 84mm recoilless rifle.

Simulation realism is an important factor for successful training. To gain such realism

Virtra uses high fidelity video and animated graphics, 3D audio and special effects. Training weapons have realistic recoil and the enemy can even shoot back, in case of being hit, a small electric shock will indicate the soldier about his "injury".

The range of firearms and tactics trainers developed by Virtra include high-accuracy marksmanship range that has dozen of built-in environments and scenarios with hundreds of combinations of weather, altitude and 175 different sizes and shapes of targets. Users can move around, shoot with handguns or rifles at any angle. The company offers flat screen, panoramic or an immersive trainer design covering 300-degree experience.

Through the system's control panel instructors can activate audio distractions, such as barking dogs, orbiting helicopters, or environmental noises such as thunder storms. Different branches and outcomes of scenarios can be chosen to prevent predictability and anticipation. Instructors can change the scenario in real-time, based on verbal commands or trainee's actions. During the session the instructors can instantly activate the threat-fire that simulate an injury to the trainee, adding stress and realism to the scenario. Threat-fire activation can also

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The Dismounted Soldier Training System (DSTS), a virtual reality trainer at Fort Leonard Wood. The DSTS translates soldiers' movements into a simulated training environment where soldiers can conduct foot patrols and clear buildings.

be combined with the video recording so a trainee understand why the instructor activated such penalty.

Domes for Increasing Reality

The latest trend in immersive training rely on "Virtual Reality" (VR) by recreating the combat scene in 360-degrees, with surround audio and other visual effects. To enter the virtual scene trainees don VR headsets and use special props that mimic their weapons in the virtual world. Using an actual weapon is not a must, since props designed to 'feel' like the real thing will operate just as well in VR.

The US military deployed several systems of this type, known as the "Dismounted Soldier Training System" (DSTS). The system can simulate various environments, topographic, climatic or combat effects and insert various entities – hostile, non-combatant or friendly forces – to the scenarios.

The system operates in a hangar where each soldier is allocated an area of 100 square foot to move freely. The nine-person system is completely portable and can be used anywhere electricity and about 1,600 square feet of space are available.

The DSTS application of this system is used to enable a small group of soldier to follow the leader's commands, repetitively going through procedures. The system can display the position and performance of each of the squad members at any time, providing corrective feedback to bring them in line with the group.

Each soldier uses a wearable PC that runs the game-based graphics engine and VR displays. The entire group is controlled by instructors from the exercise control sta-

tion. Trainees can practise individually, with virtual soldiers filling the squad, or in a group of trainees forming the squad. Instructors can inject threats, obstacles and buildings, use various distractions, such as dogs, birds, vehicles, non-combatants or IEDs and other combat effects to distract trainees and add more realism to the unfolding scene.

At a cost of \$12M per system DSTS is relatively expensive and, since its operation requires experienced instructors and technicians, some of the bases that already have the system are not fully utilizing them. Part of the problem is the complex and unique equipment the system uses. DSTS uses ExpeditionDI from Intelligent Decisions Inc.

VR technology has made significant progress since ExpeditionDI emerged on the scene in the late 2000s. Today, VR systems designed for entertainment are becoming available, including HTC Vive, Oculus Rift, OSVR and Intel Alloy, which is expected to become the first high fidelity wireless VR headset in the market. This gear is developed for use by gamers but is also suitable for certain training applications. Teta.tech harness-

es VR gaming development technology to train soldiers and first responders to respond to emergency situations. Unlike firearms training simulators that focus on the use of the weapon, Teta.tech exposes the individual to complex, unexpected situations that require instinctive response, where the use of weapons is only one of many other options that should be considered by trainees.

The principle uses specially designed props that integrate into the virtual scene, using miniature sensors that turn any object into a VR controller – from simple batons or fire extinguishers, handguns, radio sets or loudspeakers, all become fully functional in the VR scene. Teta.tech enables adaptation of the real equipment, by attaching the sensors with application kits, or use special props that simulate the equipment in virtual reality to deliver realistic operation in the virtual world.

Military and law enforcement training has gone a long way since implementing laser training systems and video generated scenery in the 1980s. Today, trainees can practice in live fire, in fast paced, life-like, immersive scenarios, fighting computer generated adversaries that can even shoot back for maximum realism, and this is only the beginning. Stay tuned for more... ■



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The Whys and Wherefores of Precision Guided Munitions

Tim Guest

Precision-guided munitions (PGMs) have firmly established themselves as key components in the artillery arsenals of modern armies. While many new developments in precision and near-precision systems are underway, a handful, including some already operationally proven are, for now, leading a field that is likely to become more crowded in the years ahead.

Setting the Scene

When Copperhead and the US Army's APM Programme rubbed shoulders during the 1980s, it became clear that new technologies were opening up a world of precision-guided possibilities for artillery. The future would not simply be massed joint fires using dumb ammunition to achieve a sometimes "eventual" target destruction, but a combined portfolio of systems that could be called on at a moment's notice to handle different targets in different scenarios and in different theatres. In today's geopolitically unstable world, hotspot conflicts, often in urban settings and inextricably involving civilian premises, houses, apartments and the like, have meant traditional artillery usage has given way to more targeted procedures where the use of PGMs is more appropriate in terms of taking out high-value targets with as little collateral damage as possible. These systems have now evolved to enable engagement of point targets, with the US leading the way in terms of usage and manufacturing, through the development and uptake of the M982 EXCALIBUR and the course-correction fuse system – the Precision Guidance Kit (PGK). The latter is effectively a simple, cost-effective way of increasing the accuracy of existing dumb rounds, though not the range. Both have been developed largely for use in Iraq and Afghanistan, with lessons learned through their operational deployment and use feeding back to drive further development and improvements to such technologies. Other systems are being developed, as we shall see.

For its part, EXCALIBUR is a true precision weapon and enables precision engagement of targets up to 42 km away with a radial miss distance of under 2 m. As a result, its first round effects are devastating and further rounds on target are unlikely to be needed. The system has undergone full qualification tests for use by the M777, all M109 series guns, the M198, ARCHER

Photo: US Department of Defense



US Marines fire an M982 EXCALIBUR round from an M777 155 mm howitzer during a fire support mission at Fire Base Fiddler's Green, Helmand province, Afghanistan on 1 October 2011.

and the PzH2000 and is also compatible with the AS90, K9 and G6 howitzers. With its flight dynamics system, EXCALIBUR extends the range of 39-calibre artillery to 40 km and 52-calibre artillery to more than 50 km.

The PGK, on the other hand, while not a true PGM, allows conventional ammunition to be converted cost effectively from traditional dumb HE rounds into near-precision shells. Huge cost reductions are the major aspect of this solution – the cost factor and differentials are significant in the development and use of PGMs. According to industry sources, EXCALIBUR rounds currently cost about US\$68k, while a conventional HE round costs around US\$2k. Fitted with a PGK the cost rises to around US\$12k. Leading industry analysts see the costs for PGMs coming down as demand increases – new/old threats in Europe – and as manufacturing processes evolve.

However, straight unit cost comparisons are deceptive, as the potential for dispatching a high-value target with a single PGM

versus the potential of having to send many conventional rounds over the battlefield to achieve the same end result, has to be considered. Not only that – the cost of the logistics required to transport and load a single PGM versus the same process of delivering many traditional HE rounds to a gun position has also to be taken into account. Also factored into the overall "cost-effectiveness-of-PGMs" equation has to be the effect of barrel wear – a single PGM fired will not deteriorate a rifled barrel as much as 10 HE rounds. Furthermore, beyond effects on the weapon system itself is, is the aspect of collateral damage, such effects on the innocent population and political fall-out from such; traditional accuracies of artillery have often led to unintended casualties and collateral destruction on the ground, particularly when engaging an enemy located in urban areas. PGM use is a way of avoiding this. Even the near-precision Orbital ATK PGK, which incorporates technology to correct the trajectory of the round in flight, though without the

Photo: Orbital ATK



The Precision Guidance Kit (PGK) for 155 mm artillery from Orbital ATK transforms conventional 155 mm artillery projectiles into a near precision weapon, reliably reducing normal artillery dispersion of more than 200 metres to less than 30 metres.

winged element of a PGM like EXCALIBUR to increase the range, can have a dramatic effect on minimising collateral damage. Outside the US, PGM developers include Leonardo-Finmeccanica together with Diehl offering the VULCANO 155 mm PGM, part of a family of systems for both land-based (155 mm) and naval gunnery (127 mm) applications, as well as offering a 120 mm guided mortar round. VULCANO, which will compete directly with EXCALIBUR, is, according to Ben Goodlad, Principal Weapons Analyst, IHS Aerospace & Defence, expected to enter service with the Italians in the 2016 timeframe. It will likely be acquired by “several other navies” after that. According to Goodlad, the German Army is intending to evaluate both EXCALIBUR and VULCANO in head-to-head tests and shoot offs in the future.

Vendor Views

For their qualified views on some of the latest developments in the PGM world, ESD spoke with the top PGM people at certain leading manufacturers: BAE Systems, with its Hyper-Velocity Projectile (HVP), Standard Guided Projectiles (SGPs) and the Silver Bullet PG kit; Diehl Defence – in joint collaboration with Leonardo-Finmeccanica – with VULCANO; and Raytheon with EXCALIBUR..

[Ed note: this is by no means an exhaustive list, with other players, such as Nexter in France, working on precision-guided systems, including its SPACIDO course-correction fuse.

It should also be stated that while EXCALIBUR is a joint development involving

Raytheon and BAE Systems Bofors, in this article, prime contractor Raytheon is appropriately the spokesperson for the system. BAE Systems' role has been to develop the warhead, the spinning base with fins and base-bleed and participates in the overall system integration – the company supplies the complete bases from its production and assembly facility in Karlskoga, Sweden.]

PGMs in a World of Changing Threats

Tom Pfenning, Business Development Director for the Weapon Systems business at BAE Systems, told ESD that, “The role of PGMs is evolving, including a significant need for greater range (> 70 km) 155 mm howitzers, lower collateral damage and the ability to address multiple missions. For instance, the US Navy’s large guns have historically been able to address only Naval Surface Fire Support (land attack) at ranges to 13 nmi from a destroyer or cruiser when fired from the Mk 45 5-inch guns. The ZUMWALT class of destroyers will be capable of firing out to over 60 nmi with pinpoint accuracy. PGMs will be capable of addressing land, maritime, and anti-air targets with the addition of seekers and data-links. Low-cost precision guidance and seeker technologies have enabled rounds to fly farther with significantly more accuracy.” At Diehl Defence, VULCANO Product Manager, Dr. Jürgen Bohl, echoed such thoughts on the evolution of PGMs, citing VULCANO V127GLR and VULCANO V155GLR, the two PGMs being developed collaboratively under the umbrella of a German/Italian government agreement to fulfil

indirect fire requirements for the two nations’ armed forces. “These requirements include range, precision, engagement of single point targets and compatibility to existing weapon platforms and command structures. Other aspects are avoidance of collateral damage and a mission-abort capability.” He added that depending on the mission required, both VULCANO munitions can be equipped with different sensors for precise terminal homing. “The system’s Semi-Active Laser (SAL), is used for man-in-the-loop missions against stationary and moving, single-point targets and/or infrastructure. The Far Infrared (FarIR) sensor is the right choice for autonomous missions against stationary and moving sea and air targets. GPS is used for both mid-

Photo: Diehl Defence



Precision Guided Munitions VULCANO 127 mm (V127GLR; vertical) and VULCANO 155 mm (V155GLR; horizontal)

course guidance and as a back-up mode to guide the ammunition to a programmed coordinate.” He emphasised the fact that VULCANO munitions are “sub-calibre projectiles for extended ranges of 80 km (V127GLR) and 70 km (V155GLR)” and are equipped with high-performance, pre-fragmented warheads.

Sharing his thoughts on PGM developments to meet a world of changing threats, Paul Daniels, business development lead for EXCALIBUR programmes at Raytheon, told ESD that EXCALIBUR had been fielded to “make artillery fires relevant again on the modern battlefield”. He said this had largely involved recognising insurgent forces or terrorists were using urban terrain more

and more to conduct operations while comingling among civilian populations. "EXCALIBUR's extended range (33% increase over conventional rocket-assisted projectiles), its pinpoint accuracy and its ability to penetrate reinforced concrete structures have given the Army, the Marine Corps and its allies an all-weather precision-strike capability immediately available to the support manoeuvre commander." He added that the US military is again focusing on near-peer threats, such as Russia, China,

and offer state-of-the-art capabilities to expand the relevance of ground-based artillery and naval fires. The SGP's solid rocket motor extends the range of 155 mm howitzers to 85 km and naval 5-inch guns to over 54 nmi while providing rapid time of flight. The SGP's 4-canard guidance system provides pinpoint accuracy at all ranges, in GPS-denied environments and in all weather conditions. The SGP modular payload is capable of delivering an HE or non-kinetic payload. The imaging seeker is capable

only detonates after penetrating the target infrastructure, such as bunkers, walls of buildings, ships, or command vehicles.

"Operation is possible under all weather conditions due to the combination of GPS mid-course guidance and terminal homing sensors for the final flight path, Jürgen Bohl told ESD. "Even under low cloud ceiling conditions SAL and FarIR sensor guidance is applicable due to adapted flight profiles for the terminal homing phase. Smoke has no counter effects on FarIR and GPS-guided flights and only minor effects – if at all – for SAL terminal homing." He added that, "GPS jamming is limited due to the sensor-based terminal homing (without GPS being in the loop). For a limited timeframe, mid-course guidance is possible without GPS data, by just relying on the inertial navigation system to meet the rendezvous point where the terminal homing phase takes over." When it comes to mission planning, Bohl said that "mission planning happens at the upper command level coordinating the battlefield, or directly on the theatre [of war] at the weapon site, depending on the combat situation. The Fire Command Solution is based on NABK (NATO Armament Ballistic Kernel – formerly NATO Artillery Ballistic Kernel), either at upper command level or directly at the weapon/weapon site."

On EXCALIBUR, Raytheon's Paul Daniels had this to say about the weapon's capabilities and innovations: "EXCALIBUR is an all-weather weapon. Unlike close air support, which may not be available due to weather, other priorities, or because of inappropriate weapons load out, EXCALIBUR is a weapon employed by artillery units directly answering [requests] to support manoeuvre commanders. Its range is 40 km from US-made howitzers (with 39-calibre tubes) and 50 km from howitzers equipped with 52-calibre tubes. Excalibur 1b – the latest variant in full-rate production since 2014 – is averaging less than two metres impact from its intended target, regardless of range. Its near-vertical angle of fall ensures optimal effects from its fragmentation warhead and mitigates the risk of collateral damage. Foreign customers include Canada, Australia, Sweden, the Netherlands, and an undisclosed critical ally in the fight against ISIS." In terms of technological innovations beyond those already described, Daniels said, "EXCALIBUR's shaped trajectory allows a fly-out that extends range. This means there is no need for rocket motors." He said that the round's "robust anti-jamming capability is unique" claiming that, "anti-jamming capability is not available on other solutions, such as course-correction fuses, or non-US-produced, sub-calibre, guided projectiles". He added that



Photos: Diehl Defence

Different sensors for precise terminal homing of the VULCANO include the Semi Active Laser (SAL; left) and the Far Infrared (FarIR) sensor (right)

Iran, and Korea. "EXCALIBUR's capabilities will be critical in these scenarios as well; its first-round effects against time-critical targets will be extremely important. EXCALIBUR is also the only precision guided projectile with a robust anti-jamming capability and the army is investing in improving its resiliency against evolving near-peer threats to GPS-aided navigation."

Capabilities and Technical Innovation

When it comes to the capabilities of these latest systems, Tom Pfenning told ESD that the BAE Systems' HVP and the SGP rounds are capable of accurately addressing threats to "beyond 50 nmi in all weather and operating environments". He said that the HVP and SGP are capable of addressing rapidly moving targets to expand the effectiveness of PGMs over a wide range of missions, while "significantly reducing the cost of prosecuting these missions by reducing reliance on higher cost missiles, or firing multiple projectiles to achieve desired target effects".

"Our SGP is compatible with 155 mm howitzers," Pfenning continued, "and 5-inch, as well as 155 mm naval guns; it employs a solid rocket motor, a 4-canard guidance system, a modular payload and an imaging seeker. All of these systems are low cost

of detecting lasers or autonomous target recognition against stationary or moving targets."

Diehl's Dr Bohl said of VULCANO, that the ranges for the V127GLR and the V155GLR are greater than 80 km and greater than 70 km, respectively. He added that the accuracy of the munition equipped with the SAL Terminal Homing Sensor is less than 3 m against stationary and moving single-point targets, operating in semi-autonomous mode; using the FarIR Terminal Homing Sensor accuracy is less than 10 m against targets with an infrared signature like sea and air targets, when operating in autonomous mode. When using GPS guidance only, he said the ammunition is "guided to a programmed coordinate – where the target is expected to be!"

In terms of munition effects, Bohl explained the various "Warhead Events" that can be achieved using the high-performance VULCANO warhead with pre-fragmented tungsten splinters. They include: selectable "heights of burst", with heights depending on the type of target, e.g. soft targets in the open. Point impact, where single-point targets such as vehicles, field fortifications, or missile launch sites can be engaged with the projectile detonating on contact. Finally, impact delay, where different "delay times" can be selected depending on the type of targets, ensuring the round



Photo: US Navy

The EXCALIBUR N5 naval variant will soon be fired from ships like the ARLEIGH BURKE Class guided-missile destroyer USS DEWEY

EXCALIBUR's manoeuvrability in flight and modular design allow "capability growth", such as the future integration of a terminal seeker to attack moving/re-located targets, or poorly located targets.

One of Pfenning's colleagues at BAE Systems, David Harrold, who's the director Precision Guidance Solutions at the company and involved with BAE Systems ROKAR SILVER BULLET developments – similar in scope to the PGK from Orbital – said, "SILVER BULLET's roll-controlled guidance section provides a better platform for inertial sensor and seeker integration. The solution has experienced over 150 firing tests, of which 50 were guided flights. Testing in December of 2015 on the M795 shell demonstrated a three-round grouping of less than five metres from the target."

Compatibility: PGMs and Guns

Harrold added that SILVER BULLET can now be fired from all M109 variants and K9 THUNDER and is also compatible with M777 and other systems. The system first entered development in 1997 and, like the Orbital ATK PGK, can be fitted rapidly to standard 155 mm projectiles as a screw-in fuse, effectively changing conventional rounds into cost-effective near-precision guided solutions and making the solution compatible with the fullest 155 mm howitzer/gun inventory.

BAE Systems' Pfenning added that the company's SGP is compatible with 155 mm howitzers and 5-inch and 155 mm naval guns, while the HVP is compatible with 155 mm howitzers, 5-inch naval guns and the electro-magnetic rail gun, scenarios in which they provide the capability of addressing a wide range of targets, including fast-moving maritime and air threats. On VULCANO's compatible gun systems,

Bohl said that the V127GLR is compatible with all 127 mm / 5-inch guns, such as the OTO Melara 127/54-cal and 127/64-cal guns and also with the 5-inch MK45 guns. The V155GLR, on the other hand, is compatible with all 155 mm gun systems, including the PzH2000/52-cal, FH70/39-cal, CAESAR, AS-90, M109 all variants and more.



Photo: BAE Systems

As for EXCALIBUR, Daniels told ESD that, "All US-made howitzers (M109 series, M777,

M198) can fire EXCALIBUR. The German-made PzH2000 and the Swedish ARCHER are fully qualified to employ EXCALIBUR and it has also been tested in the G6, the K9, and the AS90. The bottom line is that EXCALIBUR has been compatible with every howitzer in which it has been tested."

Performance, Results, Customers

"Our SGP has completed over 175 gun tests and has been demonstrated to Technology Readiness Level (TRL) 6", Tom Pfenning to ESD. "Leveraging a sabotaged variant of SGP, we are preparing to conduct additional tests fired from a 155 mm gun system. Our imaging seeker recently successfully completed closed-loop autonomous target detection and guided to a moving target. Our HVP is progressing to mature all components and is on track with our US Government programme schedule to conduct an intercept of an air-target in flight." As for potential customers for

these in-development systems, Pfenning said, "The SGP and HVP are development programmes and have not been fielded. We are under contract with the US Navy for the development of the HVP and there is interest in the SGP from the US and other international countries. Discussions continue to proceed."

One of the key elements in any such discussions will be cost, about which Tom Pfenning had this to say in conclusion to ESD: "While the unit cost of the SGP is higher than traditional artillery ammunition, PGMs like the SGP offer single-shot defeat of targets at ranges four times greater than traditional conventional artillery and naval ammunition. Single-shot defeat of targets provides the ability to protect our troops who are in harm's way while reducing the logistics burden (fewer rounds needed) and significantly reducing reliance on considerably more expensive missiles, such as TLAMs, MLRS and others."

Under a contract through the US Office of Naval Research (ONR), BAE Systems is developing a Hyper Velocity Projectile (HVP) for the US Armed Forces and its allies.

On VULCANO tests, Diehl's Jürgen Bohl said that performance requirements like range, sensor-based terminal homing (SAL, FarIR), GPS guidance and various warhead event modes have been "successfully demonstrated during regular firing trials under supervision of the Italian and German authorities". He concluded, saying, "Currently, both calibres are under joint qualification, scheduled for delivery/fielding beginning in 2018. First customers [for VULCANO] will be the Army and Naval Forces of Germany and Italy."

When it comes to operational use, however, EXCALIBUR is the benchmark and Raytheon's Paul Daniels stated that US forces continue to employ EXCALIBUR in active combat theatres with nearly 1,000 rounds fired against enemy forces to date. He concluded: "Raytheon expects to deliver its 10,000th projectile late in 2016. This number includes all variants – Ia-1, Ia-2, and Ib – and also includes projectiles used in development, testing and for sale to foreign customers." ■

Future Markets and Trends for the Defence Business

Interview with Giovanni Soccodato, EVP Strategy, Markets and Business Development, Leonardo



ESD: Leonardo is not only a new brand – the rebranding stands for the transition to a new structure and a new corporate identity. What are the main features and objectives of this restart?

Soccodato: The new name – Leonardo – is the “final seal” of the transformation project the company has undertaken in the last couple of years. We are now a single, streamlined and efficient industrial company: an integrated entity with a coherent and consistent approach both internally and towards our customers.

The new organisation and new name give us a single, unique voice when talking to customers and other stakeholders, and provide a new image that represents our new way of operating. It is important to note that we are not changing the core business: we are doing the same things that we did before, but more effectively and efficiently, using an improved operating model.

ESD: What is Leonardo today? How many people do you employ at how many facilities and where, what commercial result did you achieve in 2016, how did you integrate former brands like Oto Melara, AgustaWestland and Alenia into your new company structure and what are the company’s main technology fields?

Soccodato: Today Leonardo is among the top ten global players in aerospace, defence and security and has about 47,000 employees. The company is headquartered in Italy with more than 200 sites worldwide and with a significant industrial presence in four domestic markets – Italy, UK, the US and Poland – as well as strategic partnerships in the most important high potential international markets.

The former companies have now become the seven divisions through which Leonardo operates – Helicopters, Aircraft, Aerostructures, Airborne & Space Systems, Land

& Naval Defence Electronics, Defence Systems, Security & Information Systems. We have developed an “integrated” presence strategy, which leverages on the strengths of each division to obtain a much more attractive and competing overall presence and market offering.

When it comes to commercial results achieved in 2016, I can mention the outstanding EUROFIGHTER success in Kuwait, which represents the largest contract ever signed by the company; the new ships for Qatar for where Leonardo will be responsible to deliver the whole integrated combat system; the supply of Air Traffic Control (ATC) radars in Canada, the largest ATC con-



Last years' Eurofighter contract with Kuwait has been the largest contract ever signed by the company.

Photos: Leonardo



The AW159 is Leonardo's latest generation helicopter for maritime and utility missions.

tract award for Leonardo in the last 10 years, besides networked weather radars to the Canadian Department for Environmental Policies and Programmes.

Additionally, Leonardo achieved several significant successes in the helicopter sector ranging from military and parapublic to civil markets. Among them are AW139s for Pakistan's MoD and another six units for the Italian Guardia di Finanza (Customs and Border Protection), two AW159 naval helicopters to the Philippines. In China we sold a total of 55 helicopters, the AW119, AW169 and AW189 models set to establish the largest Emergency Medical Service across the nation. We are the only European company able to provide a complete "unmanned" system including ground control station, aircraft and sensors and 2016 saw indeed great activity in this domain. Our FALCO EVO has been selected by two customers in the Middle East and the Gulf region while the European MALE RPAS programme – assigned to Airbus, Dassault Aviation and Leonardo – took off and we conducted test campaigns for our remotely piloted SW-4 "Solo" helicopter.

2017 got off with a good start with a five year support and training contract for the UK's AW159 WILDCAT fleet, the launch of the new exploration and escort helicopter (NEES) for the Italian Army and a contract for an initial batch of five Aermacchi M-345 trainer aircraft for the Italian Air Force. Finally, we are pursuing interesting developments in the cyber security domain where we are building effective alliances with private companies and institutions to promote common policies and strategies to face the increasing cyber threats.

Main technological fields of the new Leonardo – besides the more tradition-

al microelectronics for advanced radar sensors, unmanned surveillance and environmental monitoring activities, advanced materials – are autonomous decision making and controls, big data analysis and internet of things applied to improve capabilities and performance in our product domains. These are some of the fields in which we operate to improve and enhance our technological capabilities looking at the future with dual use applications in aerospace and electronics for defence and security.

ESD: What major programmes of the Italian Armed Forces are you currently working on?



One of the high technology systems from Leonardo is ATHENA (Architecture & Technologies Handling Electronic Naval Applications), a solution for advanced Combat Management Systems (CMS) from patrol vessels up to aircraft carriers.

Soccodato: This is on top of the domestic markets: besides the recent NEES helicopter and M345 trainer aircraft new developments mentioned before, I need to recall the new Italian naval programme. This important and huge programme shows the Italian Navy's trust in our advanced technologies, which have now taken shape. You could experience them first hand during Euronaval 2016. We are glad to say that once again we are at the very forefront of naval technologies which we are ready to export to international markets to address the most demanding requirements of any navy around the world. We are also working on the largest digitalisation programme for the Italian Army, Forza NEC, for which Leonardo is the prime contractor, design authority and lead system integrator. The project, initiated in 2006 by the Italian defence administration, has the objective of modernising the Italian Armed Forces. The contract covers manufacture and integration of command posts in shelters and vehicles, communications, C4I devices for soldiers, combat and tactical platforms, unmanned vehicles, offering full interoperability between the Italian Armed Forces and the forces of other countries.

ESD: What are the company's most important export markets today and from a strategic perspective in the near future?

Soccodato: Beyond our domestic markets – Italy, UK, the US and Poland – we are more and more a global company which needs to position itself to pursue opportunities in those markets showing solid trends in their defence and security

budgets. First and foremost I would mention the Far East and Middle East: in both these areas we have a good starting point which we achieved in the recent past with our helicopters, radars and electronic systems or aircraft. And we see opportunities to expand our presence exploiting dual use, critical infrastructure and cyber security solutions. Other areas that we are looking at with interest are the entire Caucasian region, including Turkey, and South America, starting with Brazil, where we see notable signs of recovery from the recent crisis.

In North Africa we see significant opportunities in countries like Algeria, Morocco, Egypt. These countries have immediate security and defence requirements which we believe are common to broader areas of the African continent, as demonstrated by some recent successes with our maritime domain awareness, helicopters, tactical transport and security solutions in Sub-Saharan countries.

ESD: Giuseppe Bono, the CEO of Leonardo's Fincantieri shipyard, has recently advocated the creation of a "Naval Airbus" in Europe. What is your attitude towards an overall consolidation of the European defence industry? What are the essential

political preconditions to initiate and to foster a process like this?

Soccodato: The most recent defence budget dynamics and overall political and security landscape in Europe definitely push towards further consolidation of the industrial base, reducing the current duplications and overcapacity in the individual countries. The EU Commission's recent approval of the European Defence Action Plan, with all the related actions and measures is a first step in this direction, foreseeing for the first time funding for defence related R&D and specific projects at EU level.

In any case, this is just the beginning of a long journey towards common standards for interoperability, harmonised requirements across the different armed forces and, finally, more cooperative projects – also through joint procurement. All of this is needed to foster and enable greater integration at the industry level. From a Leonardo perspective, we now believe to have established solid grounds from the economical, financial and industrial perspective to pursue appropriate alliances which will enable us to strengthen our leadership areas in Europe and increase our effectiveness on the export market where the competition with global players becomes stronger and stronger.

ESD: What are the future technologies in the focus of Leonardo's R&D investments?

Soccodato: Leonardo constantly works on innovation investing 11% of revenues in Research & Development. The company invests in and focuses on many innovation-related themes for the future, which include key areas such as cyber security, unmanned systems as well as the potential of new digital technologies such as the Internet of Things and digital manufacturing, with a view also to Industry 4.0.

We have ongoing research projects with Italian and international universities and research centres and are convinced that these are key factors of competitiveness for our product portfolio innovation to face international competition.

ESD: Looking ten years ahead, what will be the status and perspectives of Leonardo?

Soccodato: I see a leading global player in selected business areas, based on core technology capabilities an innovative and affordable product portfolio and service excellence. ■

The questions were asked by Peter Bossdorf.



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International Demonstration Day at EXPAL

Waldemar Geiger

For the first time, the Spanish defence company EXPAL showcased its range of mortar systems in the scope of a demonstration day on 15 November 2016. The event took place at the firing range of the Álvarez de Sotomayor military base in Almeria (southern Spain), the home base of the Spanish Legion, Spain's Rapid Reaction Force.

With the live demonstration supported by the Spanish Legion, customers and national and international journalists had been invited to observe a static and dynamic display of EXPAL's mortar systems. The presentation provided comprehensive information about the company's portfolio of services in the field of infantry indirect fire systems.

A part of the Spanish defence group Maxam, EXPAL specialises in the production of ammunition for land, air and naval forces and in the disposal of all kinds of explosive ordnance. The product range was extended a few years ago, when the firm decided to amend its portfolio of ammunition with more complex weapon systems and associated services. Today, EXPAL's strategy is to provide a one-stop shop for mortar systems. Beside ammunition (high explosive, insensitive high explosive, smoke, illumination and IR illumination), fuses and mortars (bipod and commando versions incl. conversion kit) in all relevant NATO calibres, the firm offers suitable fire control/guidance systems, drone-based observer systems and training resources. It also provides decommissioning services, system integration and integrated logistics support (ILS) services. Worldwide, 60 armies are taking advantage the company's products and services.

EXPAL Integrated Mortar System (EIMOS)

EIMOS is the peak of the evolution of the mortar systems developed by EXPAL. Regardless of platform, the system can be integrated with every military vehicle with a payload of at least 2.5 t and provides pinpoint-accurate fire support in 60/81 mm calibres within a few seconds.

The weapon system is self-directing after the command to fire. It can, however, also be directed manually with a joystick, if required. The weapon system (max. 16 shots per minute) is loaded manually. Combined with TECHFIRE – the company's own fire control and guidance system – a mortar team equipped with EIMOS can conduct fire missions independently of an observer or fire direction element. The operator

can highlight potential areas of danger on a digital map while on the move, in which case EIMOS then automatically aim acquires the target while in motion. Fire support can be provided immediately after the vehicle has come to a stop. If the vehicle breaks down or troops have to dismount for deployment, the mortar barrel can be removed without any special tools and can also be used outside the vehicle in the conventional way using the bipod, base plate and periscope carried on-board the vehicle.

TECHFIRE

The fire control element is the core of indirect fire support. Only fire control enables the troops to engage a target



During the firing demonstration, a conventional 60 mm mortar was employed by the Spanish Legion.

without direct visual contact. However, TECHFIRE offers even more capabilities. The software is platform-independent and can be operated with military laptops, tablets or handheld devices. The system, comprising the sub-systems for the observer, the fire control element and the ballistic calculator for the mortar team, has a common interface and can process external weather data and position information. The system architecture is well thought-through and provides for intuitive operation. Messages indicating the location of an objective can be entered by hand using established observer means via data transfer (e.g. laser range finder) or can be generated by point-and-click on the digital map and sent to the remainder of the data-sharing network at the click of a button.

When GPS is available, the computer with the TECHFIRE software can complement the command and control function with the generation of bearing for mortar teams. In the scope of the live firing demonstration, data transfer and communication were conducted using the Spanish armed forces' radio equipment. Communication was stable without any backup systems. Similar presentations of competitive products already in use by the German military were performed by the German armed forces using multiple backup systems. As with battle management and military training, it would appear that there is a trend towards "the KISS concept" (keep it short and simple) in the field of software development. Compact command and control systems



The mortar crews of the Spanish Legion can conduct fire missions within seconds with EIMOS.

may not provide every conceivable function, but they do operate more stably and can more easily be connected to other systems.

SHEPHERD-MIL

As well as new weapons and fire control systems, the SHEPHERD-MIL mini-drone was also displayed. The drone weighs 2.8 kg and is shaped like a bird of prey. The electrical drive is relatively quiet and the drone can perform observer missions of around 60 minutes. At launch, the drone is thrown by hand and can land on

open spaces without additional technical aids. It can either be controlled via remote control or operated based on a pre-programmed flight path. According to the manufacturer, it has a range of up to 20 km. The drone is equipped with three cameras: a control camera in the wings showing the view ahead, and two observer cameras (one optical, another thermal) in the bird's body. The observer cameras have a tilt of 45° and can return target data with a precision of +/- 20 m by means of the UAV's position combined with a vector projection.

One-Stop Shop

The company's additional services were also introduced. SIMOX is an indirect fire training simulator providing training for the whole mortar network. It combines simulation-based training of fire control elements with multiple forward observers and mortar crews. Depending on the customer's requirements, observer equipment, fire control and mortar systems produced by other manufacturers can also be integrated.

Apart from the product displays, the event focussed on customer support and the strategy to provide a one-stop shop solution. EXPAL cited its collaboration with the Spanish armed forces as an example for such productive cooperation. There is an active exchange of information between the two parties, combined with customer support, from which both sides profit. Ultimately, continued product development and improvement provides better value for the armed forces. ■



Among the advantages of the TECHFIRE command and fire control system is its intuitive handling.

Shared Burden to Gain the Most Modern Air Defence System

Interview with Joe DeAntona,
Vice President and Business Development Executive,
Raytheon Integrated Defense Systems



Photo: Raytheon

ESD: Patriot has been a mainstay of air defence for many nations for a number of years. Let's talk about efforts to modernise PATRIOT. Which PATRIOT users have decided in favour of a modernisation of their air defence systems? Which measures are applied in the scope of these programmes, and what is the status of the individual efforts?

DeAntona: The short answer is all of them. The threat is constantly evolving, so if an Integrated Air and Missile Defence (IAMD) system – regardless of who makes the system – does not continue to evolve, then in a very short while that IAMD system will be incapable of outpacing the threat. However, this continual evolution is very expensive – frankly if one country were to have to go it

R&D. This was on top of additional investments made by individual countries, such as the U.S.

With that said, in the past three years we have seen a large number of PATRIOT partners incorporate those advancements made from that R&D. Space doesn't permit me to cover them all, but here are a few highlights:

- The US has committed to PATRIOT through 2048 and is in the process of modernising its PATRIOTs to Configuration 3+, the most modern configuration currently available.
- The Netherlands committed to PATRIOT through 2040 and a few weeks ago started the process by procuring the Modern Man Station user interface.

€209.3M and €558.1M respectively to acquire additional PATRIOT capability and enhance their existing systems.

ESD: We have heard a lot about Gallium Nitride-based AESA radar technology. What is the status, what the advantages and will it be integrated into PATRIOT?

DeAntona: GaN-based AESA is a mature technology already in use in the US Navy's Next Generation Jammer and Air and Missile Defence Radar programmes.

We are now bringing that technology to PATRIOT. Our GaN-based AESA PATRIOT technology provides unmatched performance, unprecedented operational readiness and the lowest maintenance cost.

The radar is ready. We showed it at the AUSA tradeshow in the US in March 2016. We could go into engineering and manufacturing development tomorrow, and have it fielded in just a few years.

ESD: Are there already clients for Raytheon's GaN-based AESA 360-degree capable PATRIOT? Which countries have indicated an interest in the system?

DeAntona: We anticipate that we will have a customer for our 360-degree capable GaN-based AESA PATRIOT very soon. Germany is very interested in this capability, as evidenced by the fact that TLVS-PATRIOT is the alternative TLVS solution. This capability is also an important part of our WISLA offer to Poland, and as we discussed earlier, Poland selected PATRIOT and negotiations are ongoing between the US and Polish governments on the specifics of that arrangement. We have also briefed our 360-degree capable GaN-based AESA PATRIOT to a number of other international Patriot partners who I am not at liberty to disclose, and some of them are keenly interested.



Photo: Raytheon

Raytheon's GaN-based PATRIOT AESA radar with a 360-degree capability

alone, I am not sure how they would be able to afford it.

Because there are 13 PATRIOT partner nations, the cost of research and development for those upgrades and improvements is shared by all members. To give you an example: in 2016 the partnership invested more than €186M in modernisation-related

- Germany has committed to modernizing its PATRIOTs in order to keep them fielded until at least 2035.
- The Republic of Korea and Kingdom of Saudi Arabia are upgrading their entire inventories to Configuration 3+.
- In the last quarter of 2016, two undisclosed countries invested more than



Photo: Peter Müller/Bundeswehr

Bundeswehr PATRIOT launch during the exercise RAPID ARROW

Based on the broad interest we have seen, it is really not a question of “if” and “who” but of “when” and “who gets to be the first to reap the benefits”.

ESD: The US Government Accounting Office recently published a report on PATRIOT that cited a number of issues with the system. The report stated that the currently fielded PATRIOT has problems with performance in areas such as accurately classify, identify, and discriminate between all aircraft, missiles, and objects and also has reliability issues. How do you respond?

DeAntona: If someone were to quickly skim the report, or, as our competitors have done – to selectively share small portions of the report out of context – it would be possible to draw a number of erroneous conclusions. But anyone who is willing to spend the time to read this document in its entirety will come away with two important conclusions. First, since 2013 the Army invested significantly in PATRIOT and will continue to do so through 2021; when all is said and done, the US Army will have spent more than €2.7Bn on modernisation. So the US Army is committed to PATRIOT. They intend to keep it through 2048.

And secondly, yes, there are some improvements that need to happen with the currently fielded version of PATRIOT. But the billions of dollars the US Army – and the 12 other PATRIOT partner nations – are investing in PATRIOT address those issues. PATRIOT Post Deployment Build 8 is currently undergoing Operational Testing, and is scheduled for fielding in 2018.

The report is available, in its entirety at “<http://bit.ly/2goOafd>” and I would encourage all readers to take the time to get the facts for themselves.

ESD: Yet the US Department of Defence’s operational test and evaluation Directorate identified some problems with PDB-8. For example, the report states: “During the ground test portion using simulated interceptors and mostly simulated targets, PATRIOT did not always properly transmit messages; detect, classify, and discriminate targets; or select the preferred interceptors against targets.” How do you respond?

DeAntona: I was quite happy with the report, because if you read the report in its entirety, it shows that for the most part, PDB-8 is doing exactly what it’s supposed to be doing. The testing process identified a few problems and that is exactly what we want to find during the testing process. For instance, in the example you gave in your question, precisely because we identified these problems during testing, we were able to fix a number of critical issues.

And that is the true value of a test programme. Think about it – we have conducted more than 3,000 ground tests and 1,400 live fires. We have learned something from each and every one of those events, and we used those findings to improve PATRIOT. One thing that is important to understand is that we do not really do demonstrations in the PATRIOT programme. A demonstration lacks realism and rigor, and provides little opportunity to learn. The MEADS development project has a small handful of flight demonstrations to date, but has yet to do a single flight test.

I find that troubling because I do not know how you find defects, much less improve a system if you do not rigorously test it. And as a former soldier, I wouldn’t be here today if PATRIOT did not work as advertised. And the reason PATRIOT works in combat is because it was rigorously tested during peace. So I am proud to say that we are going to continue to test PATRIOT, and we are going to stress PATRIOT and we will find and fix issues during these tests. Because testing it give us the information we need to make the system better. And that’s how you ensure Patriot works when lives are on the line.

ESD: How do you think PATRIOT compares to other IAMD systems or better, why should someone choose PATRIOT?

DeAntona: As a retired soldier who spent his entire 30-year Army career in air defence, my initial reaction to that question is there really isn’t a comparison. PATRIOT is a combat-proven system owned

by 13 nations which contribute to its future growth and evolution. PATRIOT already outpaces the threats of today, and thanks to the investment of current and future PATRIOT partners, it will continue outpacing the threat of tomorrow for decades. In contrast, the MEADS development project was rejected by the US Army, has yet to be flight tested, much less built, and not a single customer has procured it.

It is well known that the most optimistic projections are that MEADS won’t be fielded for almost a decade. Assuming that holds true, and assuming that it works as advertised, it will still be obsolete the moment it is built. This is because there are no other MEADS partner nations to help fund the continual modernisation necessary to ensure MEADS stays ahead of the evolving threat.

The other thing to consider is that from a European security perspective, interoperability is critical. Last year German and Dutch air defenders conducted a major PATRIOT live fire exercise. The Airmen from both countries were able to use each other’s equipment, practice fighting together, and learn from each other. This would have been impossible to do with MEADS.

Finally, let’s look at the industrial and technological benefits of why someone should choose PATRIOT. For many years, German industry has benefitted from being a PATRIOT partner. For example, a few weeks ago Jenoptik was awarded a contract from the US Army for PATRIOT components.

TLVS-PATRIOT represents an even bigger opportunity for German industry. There are more than 220 PATRIOT fire units owned by 13 countries around the world. So, as German industry builds TLVS-PATRIOT for Germany, they will potentially have the opportunity to export and sell that capability to the rest of the PATRIOT community. This is the sort of benefit that any PATRIOT partner can potentially enjoy. ■

The questions were asked by Juergen Hensel.

Photo: NATO



PATRIOT missile training in Poland with US and Polish forces following the completion of exercise PANTHER ASSURANCE

Airbus DS sells its share of ATLAS ELEKTRONIK

(df) Airbus Defence and Space has entered into an agreement to sell its 49 percent share in ATLAS ELEKTRONIK Group to thyssenkrupp AG based in Essen, Germany. With this acquisition, thyssenkrupp, which to date has held a 51 percent share in the company, will become the sole owner of ATLAS ELEKTRONIK. The sale of its shares in ATLAS ELEKTRONIK, a supplier of cutting-edge maritime technology, is part of Airbus Defence and Space's divestment program which will allow it to focus on its core business. Closing of the transaction is subject to customary regulatory approvals.

Bell and IAR Team for Romanian Helicopter

(df) Bell Helicopter announced the signing of a Memorandum of Understanding with the Romanian IAR – Ghimbav Brasov Group. This MoU aims to enhance the already existing close ties between Bell Helicopter and IAR just for the case that Romania might choose to purchase the AH-1Z VIPER attack helicopter, one of the



Photo: Bell Helicopter

most advanced anti-tank attack helicopter. It is designed in partnership with the United States Marine Corps and carries a wide range of precision weapons and advanced sensors. The VIPER has a combat radius greater than 240km when carrying 16 HELLFIRE missiles, 2 AIM-9's, and 650 20 mm rounds.

"The potential for the AH-1Z VIPER in Romania is exciting, and the AH-1Z should be a very strong candidate in addressing the Romanian government's need for an advanced, reliable platform for security and defence", said Lisa Atherton, Bell Helicopter Executive Vice President of Military Business.

Boeing to Acquire Liquid Robotics

(ck) Boeing will acquire Liquid Robotics, a market leader in autonomous maritime systems. Liquid Robotics was founded in 2007 and soon introduced the WAVE GLIDER, the first wave and solar-powered ocean robot. Since its introduction the WAVE GLIDER has travelled more than 1 million nautical miles. Combining Liquid Robotics'

technology and Boeing's surveillance and reconnaissance solutions will help to address maritime challenges. Liquid Robotics integrated Boeing sensors and C4ISR capabilities on the Sensor Hosting Autonomous Remote Craft (SHARC), a version of the WAVE GLIDER that generates its own power and propulsion using solar arrays and water currents. It requires no fuel. On completion of the acquisition Liquid Robotics will become a subsidiary of Boeing, in an arrangement similar to that with Insitu, manufacturer of the SCAN EAGLE military-grade UAS. Just as the fixed-wing SCAN EAGLE can gather and transmit data while airborne, SHARCs can monitor maritime operations and send information to their handlers – via satellite if necessary. Referring to the SHARC, Egan Greenstein, Director of Autonomous Maritime Systems

at Boeing, said: "When you put it to sea it's good for six months without a human touching it." SHARC applications might include situations where navies need to keep a low profile, where long-term persistent surveillance is required, or where potential undersea threats such as submarines have to be monitored.

DCNS Opens Australian Headquarters

(df) In late December DCNS Australia celebrated the founding of their Australian headquarters in Keswick, Adelaide, which will be dedicated to delivering the Future Submarine Programme. "We are planning from the beginning to maximize the participation of Australian business in this €50Bn project," said Sean Costello, CEO of DCNS Australia. "This is an important

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initial milestone in DCNS' decades-long commitment to the design and construction of 12 regionally superior submarines in Adelaide," said Herve Guillou, Chairman and Global CEO of DCNS Group. The facility will become operational in early 2017 to support DCNS' activities around Australia, including the transfer of technology from France to Australia, the development of the Australian supply chain and the design of a new shipyard in Adelaide.

FLIR Acquires Prox Dynamics

(gwh) FLIR Systems has acquired the Norwegian Prox Dynamics AS, the developer and manufacturer of nano-class unmanned aerial systems (UAS) for military and para-military intelligence, surveillance, and reconnaissance applications, for approximately €125M in cash.

Photo: FLIR



Prox Dynamics develops, manufactures, and distributes aerial sensors that are revolutionarily small, light, and covert surveillance systems like the BLACK HORNET, a system that is pocket sized and hand-launched by a soldier in the field. The Black Hornet aerial sensor utilises among others FLIR's Lepton micro thermal camera.

The addition of the Prox Dynamics business will augment FLIR's Surveillance segment by extending FLIR's Airborne sensor product line and fully leveraging Lepton technology. The business will become FLIR's Unmanned Aerial Systems (UAS) line of business operating within the Surveillance segment.

NIMR Wants to Grow in Europe

(ck) NIMR Automotive is one of UAE's premier manufacturer of armoured vehicles. It is among the leading manufacturers of light and medium-weight wheeled military vehicles in the Middle East and North Africa region. The company is based in Abu Dhabi, the United Arab Emirates. NIMR is a subsidiary of the Emirates Defence Industries Company (EDIC), the UAE's integrated defence

Photo: NIMR Automotive



manufacturing and services platform. At the International Armoured Vehicles (IAV) Conference in London NIMR introduced its most recent and highly capable armoured and non-armoured platforms that are tailored for harsh environments, across a diverse scope of mission requirements. NIMR also announced that in the future it will cooperate with the Czech manufacturer VOP CZ in order to support the company's growth opportunities in the European market. NIMR and VOP will sign an agreement of partnership in the coming months.

Safran to Buy Zodiac Aerospace for €8.4Bn

(ck) The French defense manufacturer Safran Electronics and Defense will acquire Zodiac Aerospace for €8.4Bn. The deal will create the world's third-largest aircraft equipment provider, which will have a presence in over 60 countries. "The acquisition of Zodiac Aerospace represents a unique opportunity at this point in Safran's development, just a few months after initiating the refocus of the group on our core activities of aerospace and defense," Safran CEO Philippe Petitcolin said. "Our industrial expertise will also accelerate the return to their historical levels of profitability in the seats and cabin activities." By purchasing Zodiac Aerospace, Safran gains access to the company's assets, which include seats, cabin interiors, power distribution, and fuel equipment. Safran says it will use its new capabilities to push for the development of "more electrical aircraft".

NCI Agency Releases NITEC17 Agenda

(ck) The NITEC17 conference will take place on 24-26 April in Ottawa. It is a 3-day event, organised with AFCEA Europe (the Association for Communications, Electronics, Intelligence and Information Systems Professionals) and in collaboration with the host nation Canada. NITEC17 – a collaboration of the NCI Agency Industry Conference and AFCEA TechNet International – is an annual conference that focuses on innovation, government-industry collaboration and business opportunities with NATO. This year, NITEC17 will focus on the topic, "Sharpening NATO's Technological Edge: Adaptive Partnerships and the Innovative Power of Alliance Industry." NITEC17 will bring together more than 800 high-level defence experts from across NATO, the Allied militaries, industry and academia. The conference will offer a unique opportunity to act on NATO's innovation agenda.

Speakers include high-level NATO officials, defence and cybersecurity industry leaders, and policy experts. Day 1 will include discussions on the global challenges that are driving the need for NATO industry collaboration on innovation. On Day 2, speakers will present new approaches to accessing innovation and how they could apply in the NATO context. The final day will feature the results of a study on NATO cyber acquisition reform and a discussion about the implications of recognizing cyberspace as a domain of operations for NATO capability priorities.

NITEC17 Highlights:

- Discussion with senior decision makers of trends in the innovation landscape, how they are re-shaping traditional government-industry collaboration, and implications for NATO.
- Forum to discuss with industry NATO business opportunities in cyber, air and missile defence, and advanced software, worth €3Bn.
- Interaction with senior NATO programme and project managers
- Break-out sessions to consider challenges and opportunities of re-fashioning NATO-industry collaboration to speed innovative solutions.
- Defence Innovation Challenge and SME Mentoring Programme, aimed at accelerating transformational, state-of-the-art technology solutions from small business and academia in support of NATO C4ISR and cyber capabilities.
- Launch of the Next Generation Innovators Programme.
- AFCEA TechNet International exhibition, B2B meetings and networking opportunities.

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Collaboration, Organisation, Communication – We Are Learning

Interview with Kelly Ortberg, CEO, Rockwell Collins. During one of his frequent European visits to his daughter companies around the world, ESD had the opportunity to meet Ortberg in Berlin together with Claude Alber, Vice President and Managing Director, Rockwell Collins Europe, Middle East and Africa.

ESD: Mr. Ortberg, some people subscribe to the view that the European security and defence market – highly-competitive, with relatively stable but relatively minor growth and challenging in terms of profitability – is “boring”. What do you think?

Ortberg: I think the European Market is not boring. There are a lot of opportunities, particularly in a budget environment in which our overall economies globally are not as robust as anybody would like: there continue to be great challenges to defence spending and allocating sufficient funds for defence projects, and it is going to require force multiplication ideas to do leverage. And that’s where technology and the types of things we do really can help, with advanced communication, dealing with the new threat environment and being able to bring commercial technology that has been developed for the commercial market and then applying that into military applications.

You are going to see more and more civil platforms being reapplied for military missions, and we really specialize in doing that, having a common technology base across our company. In Europe – in Germany, France and the UK particularly, where we have subsidiaries – we focus on taking common core technology and applying that to the local market.

Usually, it requires some customisation; sometimes it requires applying the requirements into our core technology development so that our core product incorporates the needs of the local market as opposed to a purely US-based product. We really transition from a US company trying to sell nationally to a much more global company providing tailored solutions. We do that tailoring with boots-on-the-ground engineering expertise within the region, usually through software – with advanced communications the waveforms that are required in different countries are different and may be classified in a way that only people within

a certain country can work on that. So we develop common technology and use our in-country resources to apply to the local market.

ESD: Is there any sense as far as you’re concerned of a “push back” against American technology, or technology that the Americans push into foreign markets?

Ortberg: I think it depends where and what the environment is: I think that is probably true in the European market, but in the Middle East there are areas where it is pushing American technology – particularly as the US has pulled back from some activities and has left some

making timing. Talking about the GPS environment and all the networks today requiring precision timing, GPS is probably more important for timing than it is actually for navigation these days. And we are able to provide those advanced capabilities – anti-jam communications waveforms, signals intelligence capabilities – things that you need in this kind of environment that fit really well with our portfolio. We are seeing increased market opportunities in those areas.

ESD: As far as exploiting signals security, and in particular UAV command and control, where does Rockwell Collins stand?



Photo: ESD

Claude Alber, Vice President and Managing Director Rockwell Collins Europe, Middle East and Africa; Kelly Ortberg, CEO of Rockwell Collins, and Stephen Barnard (from left to right) meeting in Berlin.

countries to fend for themselves. A good example would be an advanced targeting system; it is fundamentally based in the US but it is not a US product.

ESD: Has the pivot to Asia driven any of your strategy as a company?

Ortberg: It has. The pivot to Asia and what we call A2/AD – anti-access / area denial – drives things like decision-

Ortberg: Well, we are working in technologies to ensure that control links are available, secure and can’t be spoofed, or access denied, or worse yet, taken control. Fundamentally the technologies to keep UAV control links safe are the same technologies associated with communicating and not being able to be detected and have that communication compromised. So things like encryption technol-

ogy, new waveforms that are very robust and can communicate through a jammed environment, for example, are ways that you can deal with that.

ESD: Is hiding a communication link part of that strategy?

Ortberg: Yes. In any communications link part of the signature of that communication is what makes it susceptible. Any time you can make that communication link low probability of intercept or low probability of detection, sitting “below the noise” without some special authority to extract that signal out of the noise level makes it a much more robust line.

ESD: Why are you here?

Ortberg: Europe represents an important market for us. Roughly 20% of our corporate revenues are delivered out of

clude the work we do in Toulouse where EuMEA headquarters are, for Airbus commercial aircraft. It also includes all the work we do for military transport, aircraft, helicopter and UAV systems. Most of the work we do out of our German operations, and out of our work in the UK, would focus on the military market. Probably just because of Airbus being in Toulouse we do a lot more civil work there. So most of our rotary wing, which is dual use – military and civil – is headquartered out of Toulouse.

ESD: Does the structure of the company lend itself well to conveying the real breadth of the company in terms of technology and areas of operation?

Ortberg: Yes, we call it the shared-services model, and it is kind of what I talked about earlier. We try to have

processing architecture, the basic software architecture – we utilize open system standards across our baselines – which allows us to move that common technology from one platform to another is the same. For instance, the display system for the 787 is fundamentally the same that we do for corporate business jets, which is also very common to what we do on the KC-390 programme in Brazil. We are very successful in being able to develop a core platform and apply it to multiple end markets. It sounds easy but it is really hard and requires a lot of collaboration and organisation and communication. It requires us to spend a lot of time working to make sure that we are collecting all the requirements and we are servicing all the end markets in a balanced manner.

Fundamentally our success is driven by our ability to understand the customers’ needs, convert those into requirements and sometimes to anticipate unstated requirements – logical but unstated at the time because these projects can be multiple-year projects. You have to be pretty good at understanding that. Now, a lot of the requirements are fundamentally associated with compliance safety and civil airspace. We very much understand what that takes to do that for our customers and to gain certification from whomever you try to gain certification from.

ESD: Is it easier to work on the civil aspect or military aspect?

Ortberg: I don’t know if I can say it is easier or it is radically different working in those two environments, and I think it is something to think about for our company. You’d think we would take the money we get out of the DoDs or MoDs of the world to develop a product and then apply that to the commercial market: we usually do just the opposite! We define a product for the commercial market, develop it for the commercial market and then apply it to the military market. This lowers the risk, lowers the development costs, and allows us to be very successful in these new programmes. As I said before, many of the programmes are using a civil platform as a baseline anyway, so being able to bring that technology over is important.

ESD: We’ve found recently that the technological lead in certain areas such as simulation and training has gone away from the military, and the commercial world has taken over. Does that apply to you?

Ortberg: Absolutely, but I would say the military is looking at “How can I leverage



Graphic: Rockwell Collins

Going ahead with modern technology, like the F-35 Gen III helmet-mounted display system

our European operations. I am not just in Germany but in the UK as well as in France, and I do this on an annual basis. Two reasons: One is we have a lot of employees here – it is important that I understand how they are feeling and help them understand where the company’s going. It’s always good to talk to employees, but then also to talk to important customers. We have a lot going on. We do a lot of business with Airbus on the commercial side because we balance 60:40 or 50:50 between commercial and government, and we tend to cycle the commercial-government split. So we have a nice mixture of civil customers whether it is business aviation or larger transport aircraft. The 20% out of Europe is a mix of defence and commercial, so that would in-

clude common technology platforms, to get all the requirements for the markets we serve and then develop the core technology – because that is where 80% of the cost comes – and then apply that into the market. Examples are where we are providing cockpit systems that are very common between commercial and military applications, between a big jet or air transport or rotary wing application. A lot of the fundamentals that apply in civil airspace are the same, but then the business units will tailor them a little bit: we might put night-vision goggle capability on one type that is not on the commercial platform. Certainly, rotary-wing platforms require different applications – software applications – than fixed-wing platforms. But fundamentally the pro-

that big investment they are making in the gaming industry and figure out how to apply that to the military problem?" We do that in our simulation and training business, but we do it in our aviation business as well.

The reality is that governments can no longer afford to always develop a unique military product and sustain it for a 20-year life cycle when the technology is fundamentally rooted in civil communications and civil aviation, where cycles move much faster. So you are able to bring technology upgrades in faster, we are able to manage the life support and licensing technology in a much more proactive fashion.

In the US, when we sell to the military and we derived it commercially, we can sell it to our government in a commercial contracting fashion which is also much more streamlined and allows us to gain a higher return on that product so that we can drive further investment, which helps in getting to export.

Commercially-developed usually means a much easier route to export and allows us to export the technology to ourselves and our subsidiaries, so that we can apply that technology to end-markets.

ESD: Is that becoming easier? Is there a sign that export restrictions are being made at least more flexible?

Ortberg: Yes, I think if I look over the last four or five years, as the US defence budget went through its cycle I think we did see more flexibility in recognition that US defence contractors need to look to more global market opportunities. I think we did see a real, sincere effort to make that process more streamlined and more open to exports. Having said that, we still sell to certain people and with the type of work we do we have to comply with all the export regulations that are out there. And that's not just for the US; it is for exporting to many of our subsidiaries.

ESD: Do you direct the activities of your subsidiaries geographically or is it technology-specific?

Ortberg: We have organised our go-to-market in the international market in geographical regions. Claude, for example, runs all of EMEA – all of Europe, Africa and the Middle East. We prosecute those business opportunities from Europe. He has a partner that covers the Asia Pacific region. We prosecute those opportunities out of Japan. Sometimes it's a product whose core was developed in the United States, but the expertise to tailor that to a unique market was in Toulouse

Graphic: Rockwell Collins



Rockwell Collins' TruNet network communications solution was launched at the 2015 LAAD Defence & Security Exhibition.

or in Germany, and now we are selling that to a third market application.

An example of that is where our UK facility is a centre of excellence for our targeting systems and they support our Asia-PAC for selling targeting systems into Australia. We have a pretty nimble organisation to work across boundaries. But generally, if it's Europe, Middle East or African programme opportunities, they're pursued by Claude.

ESD: That is interesting because it requires an understanding of international relations that many US executives don't have.

Ortberg: And that is to my point: many companies – we were at one time – tend to be US product houses trying to sell US products on the international market – and that can get you only so far. So we centralised our international organisation: we always have someone at the table raising the customer voice from the international community, to make sure that's considered in what we do. That has allowed us to think a lot differently, be-

cause historically, particularly for defence business, the US government budget is so much larger than international budgets that international business has tended to be a lower priority, and we knew that if we were going to grow we had to pull it up and make sure that it is getting equal attention from our leadership.

ESD: What's happening for you in Brazil and India?

Ortberg: Well, we've had some success in Brazil. The Brazilian budget and political environment are pretty difficult, but we won a position on the KC 390 down there, which is a major position for us on a new airplane that I think is going to be really successful.

In India it's more about communications (network communications), which is a real growing need. Whenever you go to these emerging markets it takes time and you've got to be very patient and learn that not everything you are pursuing will turn into business. India can be frustrating at times, in terms of the process, and revisiting decisions. We're learning.



Graphic: Rockwell Collins

"Our company is well-positioned for the future and I'm excited about it!"

Having said that, I don't think we're going to run away from our traditional markets: these markets offer long-standing, stable business for us. And we're typically planning up to five years ahead – the 5-Year Strategic Plan, and then we do an annual operating plan, updated each year.

With some technologies we plan much longer horizons. New airborne platforms, for example, we may start planning way beyond the 5-year window.

These are the perils of going into new markets: you have to be patient, you have to have boots on the ground; that's the only way it's going to work, and you can't do it from afar, and you have to understand the local environment.

ESD: What's your level of R&D?

Ortberg: We do about 20% back into R&D – a very high level! Innovation is at the heart of what we do because we're either providing a new capability, or size/weight/power improvements for existing capabilities to our customers. Our electronics, our software-based architecture, are really moving at a very rapid pace, so the reason we're spending so much is to be able to bring these technologies and apply them to the markets that we serve.

ESD: Your background is as a mechanical engineer: how did you end up where you are?

Ortberg: I'm a mechanical engineer, yes, but I've always had a passion for aerospace, and a mechanical engineering background helps with problem solving. Most of our engineers are either systems or software, but they're proud to have a CEO who is a mechanical engineer.

ESD: Three and a half years since you were appointed CEO: what are your main achievements for the company?

Ortberg: One of the first things we did right was to acquire ARINC. The largest acquisition we had ever done, it created a new business segment for the company called Information Management Services, primarily focused commercially – at least initially – around connecting with the airplane and moving information on and off the airplane. The military got that for a long time, but in civil airspace we see a big growth opportunity. I am very pleased with that. We are through the integration; we are through all the growing pains of merging a company, and we are seeing that revenues are as expected.

We also navigated our government business through a pretty tough cycle, and are back to a growth trajectory in our government portfolio which I am really proud of, because we were able to manage that and keep profit margins very good through some pretty tough times, yet still invest in future capabilities and come out of that cycle poised for growth. And last year we had record revenue levels for the company – revenues and profits.

As I look at the next three years we continue to grow our international defence footprint – we actually have grown that for the last several years – and I expect to continue to do that. Our portfolio is well-positioned for the new defence environment, so we've got some exciting things ahead!

The European market is important to us: we have opportunities to go and prosecute, and we're driving employment levels in our European operations; I think we're important to local communities here as well. So our company is quite well-positioned for the future and I'm excited about it! ■

The interview was conducted by Stephen Barnard.

Preview

- **Country Focus: Belgium**
- **Technology Focus: Guides Missiles**
- The Baltic Sea Geostrategic Challenge
- NSPA
- The Croatian Armed Forces
- Eurofighter TYPHOON Programme Update
- Protection Concepts for Naval Vessels
- Ground-Based Radar
- Energy Generation & Storage
- The Brazilian Air Force
- Defence Programmes and Requirements in Malaysia
- Defence Industry in the Netherlands
- Vehicles for Special Forces
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