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27 Stromynka str., 107076,  
Moscow, Russian Federation

Phone: +7 (495) 534 61 83

Fax: +7 (495) 534 61 53

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# CONTENTS

## 06

**AIR POWER**

### **FIGHTER ON THE EDGE OF REASON**

Where fourth generation aircraft shone, and still shine thanks to upgrades, the fifth generation take air warfare to a new level.

*Alan Warnes reports.*



## 10

**LAND WARFARE**

### **SURGICAL STRIKE ARTILLERY**

Calling for artillery support usually mean firing for effect and walking the shells into the target. No more. Today's mobile artillery can compute its position and than of the target to an accuracy gunners of old never thought possible as *Stephen W. Miller* discovers.



## 16

**SEA POWER**

### **BIG DECK, BIG STICK**

*Dr Lee Willett* takes a look at the continuing importance of maritime air power and the nations that are investing in large aircraft carriers.



## 18

**LAND WARFARE**

### **COMMANDING THE BATTLE MEANS BATTER BANDWIDTH**

*Dr. Joetey Attariwala* reports on the Canadian Army's is improving its command and control net-working capability through digitisation.



## 22

**SPECIAL OPERATIONS AND EXPEDITIONARY FORCES DEBRIEF**

### **THERE IS ALWAYS A LESSON TO LEARN**

Whether training Partner Nations, or retraining for the next mission, international special operations forces are continually striving to find the next solution to give them the edge in future fights.



## 26

**ARMADA COMMENTARY**

### **U.S. ARMS SALES - HAS ANYTHING CHANGED UNDER TRUMP?**

We welcome Armada International's new regular columnist, *Andrew Hunter*, director of the Defense-Industrial Initiatives Group and senior fellow in the International Security Program at the Center for Strategic and International Studies in Washington D.C.



**ON THE COVER:**

An F/A-18F Super Hornet from Air Test and Evaluation Squadron 23 flies over the US Navy's lead Ford-class nuclear-powered aircraft carrier Gerald R Ford in July 2017. The carrier was commissioned into service in that same month. (US Navy)

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Publishing Office: Media Transasia Ltd., 1603, 16/F, Island PL Tower, 510 Kings Road, Hong Kong

Editor: Andrew Drwiega

General Manager: Jakhongir Djalmetov

International Marketing Manager: Roman Durksen

Digital Manager: David Siriphonphutakun

Sales & Marketing Coordinator: Wajirapran Punyajai

Graphic Designer: Khakanaa Suwannawong

Production Manager: Kanda Thanakornwongskul

Circulation Assistant: Yupadee Seabea

Chairman: J.S. Uberoi

President: Egasith Chotpakditrakul

Chief Financial Officer: Gaurav Kumar

**Advertising Sales Offices**

**FRANCE/SPAIN**

Stephane de Remusat, REM International  
Tel: (33) 5 3427 0130  
E-Mail: sremusat@rem-intl.com

**GERMANY**

Sam Baird, Whitehill Media  
Tel: (44-1883) 715 697 Mobile: (44-7770) 237 646  
E-Mail: sam@whitehillmedia.com

**INDIA**

Madhavi Gargesh  
Tel: +91 9898 000266  
Email: mgargesh@gmail.com

**TURKEY/EASTERN EUROPE/UK**

Zena Coupe  
Tel: +44 1923 852537, zena@expomedia.biz

**NORDIC COUNTRIES/ITALY/SWITZERLAND**

Emanuela Castagnetti-Gilberg  
Tel: (46) 31 799 9028  
E-Mail: emanuela.armada@gmail.com

**RUSSIA**

Alla Butova, NOVO-Media Ltd,  
Tel/Fax: (7 3832) 180 885 Mobile: (7 960) 783 6653  
Email :alla@mediatransasia.com

**USA (EAST/SOUTH EAST)/CANADA (EAST)**

Margie Brown, Blessall Media, LLC.  
Tel: (+1 540) 341 7581  
Email: margiespub@rcn.com

**USA (WEST/SOUTH WEST)/BRAZIL/CANADA (WEST)**

Diane Obright, Blackrock Media Inc  
Tel: (+1 858) 759 3557  
Email: blackrockmediainc@icloud.com

**ALL OTHER COUNTRIES**

Jakhongir Djalmetov  
Media Transasia Limited  
Tel: +66 2204 2370, Mobile: +66 81 6455654  
Email: joha@mediatransasia.com

Roman Durksen  
Media Transasia Limited  
Tel: +66 2204 2370, Mobile: +66 9 8252 6243  
E-Mail: roman@mediatransasia.com



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Email: accounts@mediatransasia.com

**INDEX TO ADVERTISERS**

BALT MILITARY EXPO	19	KONGSBERG	13
DIMDEX	21	NEXTER	9
EURENCO	11	ROSOBORONEXPORT	COVER 2
EURONAVAL	23	SOFEX	15
IAI	COVER 4	UDT Asia	25
INDO DEFENCE	COVER 3		

**THIS MONTH ON ARMADAINTERNATIONAL.COM**



**■ RT LTA DELIVERED ITS FIRST CROW1 AEROSTAT SYSTEM TO A CUSTOMER IN EUROPE**

RT LTA Systems Ltd, developer and manufacturer of aerostat systems, has recently completed the delivery of its first Crow1 aerostat system to a European customer.



**■ LOAD**

Generally associated with soldier modernisation and future technology programmes, efforts to reduce the burden on Dismounted Close Combat (DCC) personnel continue to proliferate globally, with a number of companies and armed forces engaged in such efforts. – Andrew White



**■ AIRBORNE SYSTEMS WINS AWARD WITH USMC**

Pennsauken, New Jersey [January 5, 2018] Airborne Systems is honored to announce that we have been officially awarded the contract for the Enhanced Multi-Mission Parachute System (E-MMPS) for the United States Marine Corps (USMC).



**■ DETECTING URGENT COMMS CALLS WHILE KEEPING ALERT**

Following substantial orders from the US Army for its communications systems and headsets, Invisio senior VP, Carsten Agesen talks to Armada International about the joint need for clear communications matched with situational awareness.

# Editorial

## Sharing skills - then intelligence?



**N**etworking new weapon's systems into any nation's armed forces is always a challenge, no matter what nation or how much budget is available. The necessity of procuring military aircraft designed and manufactured in the United States (and usually in service there first), has meant that training has had to be part of the acquisition package.

Within the next two decades the United Kingdom's (UK) Royal Air Force (RAF) will be operating an increased number of systems that are comparable to similar types being flown by the armed forces of the United States.

Top of that list will be up to 138 Lockheed Martin F-35 Lightning IIs, initially the Short Take Off Vertical Landing (STOVL) F-35B variant for the UK's Queen Elizabeth Class aircraft carriers, and potentially the F-35A variant (senior sources in the RAF recently indicated that the final decision regarding all aircraft variants has yet to be made). Aircrews and maintainers have been building up their skills with the US Marine Corps in Beaufort, South Carolina, among other locations. Both the US Marines and the RAF will fly the F-35B in the maritime environment.

There will also be nine Boeing P-8A Poseidon maritime patrol aircraft (MPA), which will give the UK back its anti-submarine capability back after the cancellation of the Nimrod MRA.4 in 2010. There has been a deliberate effort by the UK Ministry of Defence to ensure that its pilots learn, and in some cases relearn, flying and mission skills. Where the UK had an excellent reputation for its Nimrod MR.2 anti-submarine operations during the Cold War with Russia, new crews have been training on the P-8A alongside US Navy personnel located in Naval Air Station (NAS) Jacksonville, Florida. Initially labelled Project

*Seedcorn*, UK flight crews and maintainers have learned their skills through 'live' flying as well as through many hours spent in the simulator.

From 2025, the RAF will also be operating 20 Certifiable Predator-B Protector unmanned aerial vehicles (UAVs), the next iteration of the 10 General Atomics MQ-9 Reapers which they will re-place. When training began UK operators were sent to the USAF's Air Force Base Creech in Nevada, Arizona to learn how to operate the UAVs, where the first four remotely piloted air system (RPAS) pilots gained their wings in early 2013.

The UK's three RC-135 Rivet Joint intelligence gathering aircraft, which supplemented the RAF's stunningly successful and much in demand Bombardier Sentinel R1 intelligence aircraft, also saw their crews being trained at the USAF's 55th Wing based at Offutt Air Force Base, Nebraska. While in the states the crews logged over 32,000 flying hours and 1,800 sorties in preparation for implementing an initial operational capability with the RAF.

However, the challenge of operating these aircraft in the role that was intended, and networking their capabilities, brings much greater complexity. This was demonstrated last summer when the fifth generation F-35B Lightning II was networked with the RAF's fourth generation Typhoon through Northrop Grumman's Airborne Gateway. It linked the F-35B's Multifunction Advanced Data Link (MADL) with the Typhoon by translating MADL messages to Link 16 format. Link 16 has become a communication standard linking ground, maritime and airborne armed forces. While a milestone like this should be celebrated, the difficulty of melding this capability within a multi-national NATO context, for example, poses considerable more questions than it answers.

**ANDREW DRWIEGA,**  
*Editor*



Two F-35A Lightnings II from the 33rd Fighter Wing, USAF, taxi towards the runway 14 Nov. 14, 2017, at Eglin Air Force Base, Fla. The 33 FW supported Checkered Flag 18-1, a large scale air-to-air only exercise that emphasises the execution and production of tactics between fourth and fifth generation aircraft.

# FIGHTERS ON THE EDGE OF REASON

Where fourth generation fighters excelled, the capabilities of the fifth generation are still being realised with integration often a challenge as well as a benefit.

**Alan Warnes**

A fifth generation fighter is the term used to describe a fast jet that incorporates the most advanced capabilities currently available. There are no hard and fast rules as to precisely what these are, but it is generally accepted that such an aircraft will have all-aspect stealth even when carrying weapons, a high performance airframe, advanced avionics and a low-probability-of-intercept radar. It will also have highly-integrated computer systems that are able to provide maximum situational awareness by networking with other elements in the battlespace using fully-fused sensor information. The first fifth-generation type to enter operational service was the Lockheed Martin F-22 Raptor, while later examples include the Chengdu J-20, Lockheed Martin F-35 Lightning II and Sukhoi Su-57/PAK-FA.

The earlier fourth-generation fighters are mostly based on design concepts from the 1970s, with these types having generally entered service in the 1980s and continuing in operational use today. However, over the period since their inception, major ad-

vances in technology have resulted in most of these types undergoing considerable upgrades, making them far more capable and sophisticated than early models of the same aircraft of which the F-16 is a classic example. Later fourth-generation designs also incorporated these new systems from the outset and these evolutionary aircraft have been dubbed, by the Russians in particular, as 4.5-generation types. The United States (US) defines 4.5 generation aircraft as fourth-generation types that have been modernised by incorporating airborne electronically scanned array (AESA) radar, enhanced avionics, high-capacity data links and the ability to deploy the latest generation of weapons. Types currently considered to be in the 4.5-generation category are the Boeing F-15SE Silent Eagle, Boeing F/A-18E/F Super Hornet, Chengdu J-10B, Dassault Rafale, Eurofighter Typhoon, Lockheed Martin F-16E/F Block 60 and F-16V/Block 70, Mikoyan MiG-35, Saab JAS39E/F Gripen, Shenyang J-11D/J-15B/J-16 and Sukhoi Su-35.

One of the big challenges facing operators of new generational jets is how to

integrate them. Work is underway in the US and the United Kingdom (UK) to get the fourth generation fighters 'talking' to the very expensive fifth generation types. This would allow the latter to concentrate in the top-end range of operation – flying in high threat areas where the advanced sensor technologies give them the edge.

The following gives an overview of some, but not all, of the major types that fall into these categories.

## LOCKHEED MARTIN F-22 RAPTOR

As already mentioned, the Raptor became the first fifth-generation type to enter operational service. Intended to meet the requirements of the US Air Force's (USAF) Advanced Tactical Fighter programme, it was originally designed primarily as an air superiority fighter. However, it evolved to also incorporate ground attack, electronic warfare and signals intelligence capabilities. The type is a single-seat, twin-engine, all-weather stealth tactical fighter which formally entered USAF service in December 2005, following a protracted development programme. The USAF considers the F-22A

unmatched by any current type, with its combination of stealth, aerodynamic performance and situational awareness giving what the USAF believes to be unprecedented air combat capabilities.

Due to its high cost and a number of other factors, including doubts over its potential air-to-air missions, and in view of delays to rival Chinese and Russian designs, it was decided to end production in favour of the more versatile Lockheed Martin F-35 Lightning II. A total of eight pre-production/engineering and manufacturing development aircraft, followed by 187 operational production Raptors, were manufactured, the last of which was delivered to the USAF on 2 May, 2012.

### LOCKHEED MARTIN F-35A/B/C LIGHTNING II

Lockheed Martin's F-35 Lightning II is a stealthy, single-seat, single-engine, all-weather multi-role fifth-generation fighter that has its origins in the X-35 design, which was the winner of the Joint Strike Fighter (JSF) programme competition. Intended for both ground attack and air superiority missions, it comes in three primary variants. These are: the F-35A conventional take-off and landing version; the short take-off and landing F-35B; and the carrier-based F-35C catapult assisted take-off and arrested recovery variant.

The original intention of the JSF programme was to produce a relatively inexpensive fighter, but it has proved to be one of the most expensive fighter development programmes in history. Although all major variants were intended to have substantial commonality to cut design and maintenance costs, the eventual design commonality has come down to only around 20 percent. Development has also been somewhat protracted.

Lockheed Martin representatives state that the F-35 is designed to have a close and long-range air-to-air capability, second only to the F-22 Raptor. The F-35 incorporates durable, low-maintenance stealth technology, integrated avionics and sensor fusion which provide the pilot with maximum situational awareness by integrating information from on- and off-board sensors. This also improves target identification capabilities and weapon delivery. Although designed for maximum stealth, with weapons carried in internal bays, it can also be configured with underwing pylons for external weapons carriage, which will



One of the latest fifth-generation fighters to appear is China's Chengdu J-20, seen here displaying in November 2016 at the Zhuhai Air Show, where it made its public debut.

Via Chinese internet

compromise its stealth capability but can be used in situations where this is not an issue.

The USAF will be the largest operator by far of the F-35A, with plans to acquire 1,763, while Australia, Denmark, Israel, Italy, Japan, the Netherlands, Norway, South Korea and Turkey are also acquiring this variant. For the F-35B, the United States Marine Corps (USMC) plans to acquire 340, while Italy and the UK are also purchasing this variant. Only the US has so far decided to acquire the F-35C, with the US Navy expecting to take delivery of 260 and the USMC seeking 80 aircraft.

### EUROFIGHTER TYPHOON

As with the F-22, the Typhoon was originally designed primarily for the air superiority role, but has evolved to also undertake air-to-ground and reconnaissance missions. Developed by a European consortium (UK, Germany, Italy and Spain), the definitive prototype of this fourth-generation, twin-engine, canard and delta-wing fighter first flew on 27 March, 1994. It entered operational service in 2003 and is in service or has been ordered by Austria, Germany, Italy, Kuwait, Oman, Qatar, Saudi Arabia, Spain and the UK.

Typhoon is intended as an extremely agile aircraft for effective dogfighting and is equipped with a quadruplex digital fly-by-wire control system, giving 'care-free' handling while preventing the pilot from exceeding the parameters of the flight envelope. Although not specifically stealthy, numerous features are designed to reduce radar cross-section (RCS), including

radar absorbent material coating various surfaces, including wing leading edges and intake lips. Some weapons are also semi-recessed into the fuselage to reduce RCS. Its capability has continually been extended with integration of an increasingly wide range of weapons for both the air-to-air and air-to-ground role. The aircraft's original CAPTOR radar is being superseded by CAPTOR-E, an AESA derivative developed by the EuroRadar consortium.

The Typhoon has a sophisticated and highly-integrated defensive aids sub-system known as Praetorian, which automatically detects and responds to air and ground threats. The type's PIRATE (Passive Infra-Red Airborne Track Equipment) provides passive target detection and tracking.

### DASSAULT RAFALE

France's Dassault Rafale is a twin-engine, canard and delta-wing, multi-role fighter defined by the manufacturer as an 'omni-role' aircraft. It is capable of a wide range of missions, including air superiority, reconnaissance, anti-ship strike, nuclear deterrence, air-to-ground missions, interdiction and in-depth strike. Originally, France had been involved in the Eurofighter Typhoon, but pulled out of the project in favour of going it alone with its own fighter, the Rafale. Developed with high agility, the Rafale uses digital fly-by-wire controls to artificially maintain stability. Although not a stealth aircraft as such, the type has many features to reduce its RCS and infra-red signature, many of which still remain classified.

Considerable use of data fusion is used

Royal Air Force Typhoon FGR4 ZK311 flies in formation with a Qatar Emiri Air Force Mirage 2000-5 over Qatar on 26 November, 2017, during a deployment to Al Udeid Air Base, Qatar.



in the highly-digitised glass cockpit, with the emphasis on reducing pilot workload. Self-protection is provided by the Spectra integrated defensive aids system, while a number of passive sensor systems assist operations in the air supremacy role. Weapons capability has been continually expanded and the type is nuclear-capable when armed with the ASMP-A missile.

Much of Rafale's equipment fit has been developed domestically, including the RBE2 AA AESA radar and infra-red search and track sensor. Three main variants have been produced, comprising the land-based, single-seat Rafale C and its two-seat version, the Rafale B, along with the single-seat, carrier-based Rafale M. Having determined that a second crew member was particularly useful to ease the workload for many missions, the French Air Force decided that the two-seater, originally planned mainly as a trainer, would be ordered in larger numbers as a fully combat-capable aircraft.

It is in service with the French Air Force

and Navy, while after a dearth of orders for many years, it has finally achieved export success with Egypt, India and Qatar.

#### SAAB JAS39 GRIPEN

Saab's JAS39 Gripen is a lightweight, single-engine multi-role fighter designed originally to replace the Swedish Air Force's Saab 35 Draken and 37 Viggen in the fighter, attack and reconnaissance roles. Featuring a canard and delta-wing configuration, it has a relaxed stability design with fly-by-wire controls. It was designed to have low maintenance requirements and the ability to be easily upgraded as new weapon, sensor and computer technology was developed. Saab describes the type as a 'swing-role' aircraft, capable of instantly changing roles in flight to respond to new situations and threats.

The aircraft makes use of sensor fusion and its software is continuously upgraded to incorporate new capabilities. Gripen is designed to operate as a component of a networked national defence system, allowing

information exchange in real time with other aircraft and ground-based systems.

Further development has led to the Gripen E/F (initially known as Gripen NG), which uses a new Raven ES-05 AESA radar with an improved range and substantially increased field of view. Other new features include the Skyward-G IRST, while the sensors of the new variant are claimed to be able to detect low RCS targets at beyond visual range.

In addition to the Swedish Air Force, the JAS39C/D is also being flown in the Czech Republic, Hungary, South Africa and Thailand, plus the ETPS in the UK, which uses an aircraft loaned from Sweden. The JAS-39E/F has been ordered by Brazil.

#### PAK-FA/T-50/SU-57

Russia's PAK-FA was developed by Sukhoi, which gave the type the internal designation T-50, as a stealthy, single-seat, twin-engine fifth-generation multi-role fighter prototype. In production form, it will be desig-





nated the Su-57 and enter Russian Air Force service to replace the MiG-29 and Su-27. Featuring advanced avionics, super cruise and super manoeuvrability, the type will be the first with stealth technology to enter Russian military service, although precise details of its capabilities are classified. Construction includes considerable use of composite materials, while the aircraft will have advanced avionics, including an active phased-array radar and sensor fusion capabilities. The type is expected to be capable of carrying some of Russia's most advanced weapons.

The first prototype flew on 29 January, 2010, with nine prototype development airframes now flying and two more expected to join them imminently. Test flying is expected to continue until 2019, when production is also intended to commence.

#### CHENGDU J-20

Another new fifth-generation type is China's Chengdu J-20, a single-seat, twin-engine, all-weather stealth fighter designed for the People's Liberation Army Air Force.

The first prototype made its maiden flight on 11 January, 2011. It is intended as an air superiority aircraft, but with a precision strike capability. As additional prototypes have flown, a number of design changes have been apparent to overcome shortcomings found during initial testing.


The type features an AESA radar, electro-optical/infra-red targeting system and advanced communications suite enabling datalink to other platforms. It has a glass cockpit with two primary LCD displays and three smaller auxiliary displays. Although there are reported to still be a number of technical problems to be overcome, in October 2017 Chinese media reported that Chengdu had initiated series production. Chinese officials confirmed on 9 March, 2017, that the type had entered PLAAF service and at least six had already been noted in use during the previous year, with six more reportedly due for delivery by the end of that year. An official press release on 28 September, 2017, said that the J-20 had been officially inducted into PLAAF service. However, with develop-

ment still under way, it is likely to be some considerable time before the type can be seriously considered as operational.

#### FUTURE FIGHTERS

A number of other future fighter programmes are currently under way, but still in their early stages. These include Turkey's indigenous TF-X, which is intended to replace the Turkish Air Force's F-16s. A four-year preliminary design contract was signed between Turkish Aerospace Industries and the Turkish Government on 5 August, 2016.

A joint South Korean/Indonesian project is the KF-X, designed to produce a 4.5-generation multi-role fighter for both countries. This has been plagued by delays and postponements, with the programme yet to even reach the prototype stage.

In China, the Shenyang FC-31 is a fifth-generation, stealthy multi-role fighter, the first prototype of which made its maiden flight on 31 October, 2012. The type is still in development, but it is reportedly aimed largely at the export market, although Shenyang is hopeful of also selling the type to the PLAAF. 





USMC

US Marines with the 11th Marine Expeditionary Unit fire an BAE M777 howitzer during a fire mission in northern Syria as part of Operation Inherent Resolve, Mar. 24, 2017.

# SURGICAL STRIKE ARTILLERY

Artillery systems, once considered more of an area weapon than a precision tool, are making 'heads turn' once again though GPS accuracy, digital target processing and advances in guidance and munitions.

**Stephen W. Miller**

Artillery has traditionally held a special place in the combat arms. It is capable of shifting the balance on the battlefield when it is employed accurately and in a timely manner. The size of artillery cannon vary depending on the mission requirements and the level of mobility needed. This was particularly relevant earlier in history when guns were towed as the gun size and thus weight dictated the means required to move it. Broadly modern artillery was classified as light, medium and heavy partly replacing the earlier historic differentiation by its use, for example field guns or siege guns. This classification covers both 'guns', which have flatter trajectory and 'howitzers', which have a higher arching projectile flight.

In the last three decades there has been a consolidation in artillery calibre with the 155mm more a standard in Western armies

and 152mm in the armies of Russia and Peoples Republic of China. This is not to suggest that smaller and also larger calibres are not still found but rather that the focus of development, production and system fielding have been in these gun sizes. As recently as the 1990s artillery units would consist of 105mm or 122mm batteries for direct support roles, the 155/152mm in general support, plus 175mm guns and 203mm howitzers as Corps (higher command) reinforcing assets.

The larger artillery pieces have been largely retired by Western armies (the US M110 203mm howitzer did so in 1991) and replaced by missiles and rockets like the Lockheed Martin Missiles and Fire Control US M270 MLRS (Multiple Launch Rocket System) which is used by 14 armies. This trend was reinforced by the introduction of the more deployable M142 HIMARS firing the same rockets but mounted on a truck chassis. Their rockets can hit targets at up to 82km while its MGM-140 ATACMS missile can travel 300km.

But still the large howitzer persists. Russia displayed a 203mm self propelled

howitzer, the 2S7 'Pion' (S7M 'Malka') as recently as 2017. The 203mm is typically linked to the delivery of tactical nuclear weapons. Beyond this, 'heavy' gun artillery is difficult to find in front line units.

Most 'tube' artillery units today have largely adopted 155/152mm. This move was at least partly the result of advances in cannon technology. According to a Rheinmetall spokesperson, a German cannon developer and manufacturer, "metallurgy and manufacturing improvements allowed longer gun barrels to be made. A longer barrel permits greater propellant charges to be used. Together these give the projectile a higher velocity since there is more propellant (powder) with a longer burn which means that it will fly further. The newest Bundeswehr artillery system, the PzH2000, has our Rheinmetall 155mm L52 cannon (L52 is the calibre i.e. length of the gun barrel). The barrel is eight meters long and has chromium-lining as well as a muzzle brake. Using the standard L15A2 shell the maximum range is 35km. This is significantly greater than the 22km maximum

range of the BAE Systems M109A5 and A6 6 with its 155mm 39-caliber M284 cannon using the same ammunition." Though the PzH 2000 is replacing the M109 in German service both Rheinmetall and RUAG (a Swiss defence firm) have developed versions which substitute the L52 cannon and a Swiss-designed L47 155mm cannon respectively. The later increases the maximum range to 36km. To do so upgrades were also necessary to the chassis to accommodate the higher gun weight and firing forces. They also upgraded other aspects of the M109 including the loading and gun laying which permitted increased rates of fire.

The US Army, the developer and first M109 user, still employs the 39 calibre cannon even in its latest M109A7 for which BAE Systems received a contract in December 2017 to begin fall scale production. The A7, as Col James Shirmer Program Manager Armoured Fighting Vehicles explained, "incorporates a number of automotive, onboard power and reliability improvements that were essential prerequisites to any gun system upgrade. With these underway



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Krauss-Maffei Wegmann

**The PzH2000, developed by KMW and Rheinmetall, is the newest self-propelled artillery system for the German Army. Its capabilities seek to anticipate the tactical employment of artillery. It is also fielded by Italy, the Netherlands, Greece, Lithuania and Croatia.**

it is possible to consider firepower enhancement options.” These include liquid propellant-based cannons which have been in development since the 1990s, or even electro-magnetic rail guns.

Russia, where artillery has historically been highly regarded, has likewise pursued increased gun tube length to gain performance. The 152mm has been the primary focus of new development efforts. The D-20 (towed) gun of the 1950s had a 5.195m barrel length its successor the 2A65 152mm as a towed howitzer and 2S19 Msta-S self-propelled howitzer had this increased to a 54 calibre. The most recent 2S35 Koalitsiya-S unveiled in 2015 has a range of 40km using the same ammunition as the Msta-S. These larger calibres also better support the use of extended range ammunition such as ‘base bleed’ and rocket assisted projectiles which in the case of 2A65 is 45km and 65km respectively. Increasing the range of artillery has always been desired; advances in gun positioning and location determination, fire controls and ballistic calculation, firing

automation, and wireless communication have allowed this to be achieved.

**IMPROVED ACCURACY**

Being able to shoot further is of limited benefit if the rounds fired do not hit the intended target. The basis of a firing calculation is accurate gun position and target locations. The less accurate the gun position information the greater the error will be as the range to

the target increases. The use of GPS, onboard navigation and digital processing has not only sped up determining the firing solution but, when combined with automated laying and loading, has allowed complex target engagement techniques like MRSI (multiple rounds simultaneous impact). As used in the BAE Archer system it automatically adjusts the elevation of each round fired so all arrive on the target together.



BAE

**Sweden’s Archer 155mm wheeled self-propelled howitzer from BAE Haggblunds has a magazine and is fully automated allowing the crew to execute the entire fire mission in under a minute without leaving the armoured cab.**

Two of the key design criteria used by Nexter in the CAESAR 155 self-propelled howitzer were that it be transportable in the C-130 aircraft and that it must be able to halt, aim, load, fire and be on the move within 90 seconds to preclude opposing counter-battery fires.

Nexter



In most engagements artillery is still employed as an area weapon. Placing multiple rounds into the target area at the same time or in rapid succession was the purpose of battery firing by six or eight guns. The increasing vulnerability of artillery to detection by various electronic means and then engagement by opposing counter-battery fires has pushed artillery tactics to prefer smaller gun teams that will shoot and then quickly displace. The problem is now achieving the same target effect with as few as one or two guns. Automating the firing process has provided the solution. This has been widely applied in the latest self-propelled artillery. A PzH 2000 crew of five can fire three rounds in nine seconds and ten per minute at a sustained rate. The Russian military claims a s15 plus average firing rate for the 2S35 due to its pneumatic auto-loader and on-board magazine. Even unarmoured truck mounted artillery like Nexter's CAESAR has adopted an automatic loading system speed when coupled with its FAST-Hit computerised fire management system, developed by Nexter and EADS.

#### TOWED ARTILLERY

Guns towed by prime movers once dominated in artillery. Today they comprise less than half the inventory and are usually found in support of infantry units. A key consideration in fielding towed guns is their transportability, particularly when this can be made by helicopter. The BAE M777 155mm howitzer at 4,200kg (9,300lb) is easily lifted by the CH-47 Chinook and other medium lift military helicopters. Despite its low weight it

has a range of 24km with conventional M107 rounds and 40km with the M982 Excalibur GPS-guided munition. The challenge for such guns, particularly when separated from their prime movers, is in making short distances moves once on the ground. The FH-2000, developed by ST Kinetics for the Singapore Army, addresses this by having its own auxiliary power units and drive unit. A ST Kinetics representative shared that "the FH-2000 is able to manoeuvre at up to 10km/h under its own power. This not only allows repositioning but powers the assisted rammer and on-board fire controls." The company collaborated with Turkey's MKEK in the development of the Panter, which continues to be fielded to its army.

The 105mm howitzer (and 122mm Russian) have become 'light' artillery almost by default as 155s have replaced them. Still they continue in service with many armies but are primarily only found in specialised light infantry support. Thus; the US 82nd Airborne retain the 105mm towed M102 as its direct support artillery and benefits from being able to be transported externally by the Sikorsky UH-60 Blackhawk. The Republic of Korea's (RoK) Army, realising it had a considerable inventory of the M101 105mm towed howitzer, has been determined to convert them into a configuration more suited to the manoeuvre demands of today's battlefield. Their Defence Acquisition Program Administration (DAPA), in cooperation with Hanhwa Techwin, developed the EV-105 which places the gun onto a tactical truck with GPS and automated fire controls. It was announced in June 2017 that



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US Marines assigned to 3rd Battalion 11th Marines 1st Marine Division during push to Baghdad during Operation Iraqi Freedom 2003, prepare to fire a battery of M198 155mm howitzers against confirmed enemy targets in Iraq.

full production would begin in 2018. Despite the limited 11km range this approach does offer a cost effective way to augment indirect fires. Similar projects have been undertaken by Vietnam, Thailand, Jordan and even the US company AM General with its Hawkeye on the HMMWV (Humvee).

The Russian D-30 122mm towed howitzer remains in use by 30 countries despite being introduced in the mid-1960s. It has a modest 15.4km range but is simple and reliable. Its trileg platform allows all-around training and it has been well employed in direct fire as indirect. Its ammunition includes anti-armour HEAT rounds.

### SELF PROPELLED ARTILLERY

The need to move to survive has been a key factor influencing the move to self-propelled (SP) guns. Given new technologies in gun operation automation, computerised firing calculation, on-board navigation, and networked digital communications the SPs are almost independent fire support systems. Korea's K-9 Thunder, manufactured by Hanwha Techwin, is further facilitating this autonomous operational ability by providing a KI-10 Ammunition Resupply


Vehicle (ASV) as a companion. By the two vehicles working together it is more possible to maintain the flexibility offered by tactical mobility while also being able to sustain the high ammunition usage that military planners predict. The latest improvements to the K-10 provide greater automation of the ammunition transfer moving 12 rounds per minute using a conveyor. The BAE Archer uses a similar pair employment, with an accompanying Volvo A30E articulated 6x6 truck configured with ammunition stowage and a handling conveyor system. This concept reinforces the capability of the artillery and one can expect it to become a highly desired if not required feature in future artillery. An indication of this is that Japan's Type 99 155mm SP includes an ASV as does the People's Liberation Army PLZ05 155mm SP.

### MUNITIONS

Much of the enhanced capability of artillery is due to relatively recent advances in ammunition. Ranges have been extended by base bleed projectile designs and the incorporation of flight canards in extended range munitions. Accuracy has been increased with GPS programmed warheads

and laser guided homing seekers. One of the factors influencing the move toward the 155 and 152mm size was its better suitability for carrying 'packaged' sub-munitions. These could allow multiple targets, including armoured vehicles, or larger areas to be attacked with each projectile. Artillery, once considered effective if it paced rounds in a 100m area can now, with the proper warhead and ground coordination, hit not just a specific building but a single room in that building.

### ARTILLERY REBIRTH

Much has been written in the last few years about the renewed recognition of the capabilities and importance of artillery. If there was ever a doubt about its importance it certainly was not a universal view. The Russian emphasis in the use of artillery in the Ukraine demonstrates this comprehensively. As is often the case in warfare the weapons themselves are only one aspect of combat effectiveness. The other, and perhaps more importantly, is how they are employed. In this the advances in artillery are providing new possibilities. 



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# BIG DECK, BIG STICK

The use of maritime air power is one of the fundamental means of delivering effect ashore from the sea. The primary platform used for such power projection is the aircraft carrier.

## Dr Lee Willett

**A**mongst the world's major navies, the 2016-17 period has seen some fundamental developments in aircraft carrier programmes.

In late 2016 and early 2017, Russia's sole aircraft carrier *Admiral Kuznetsov* and its battle-group conducted a high-profile transit from northern waters, through the North Sea, and on to combat operations off Syria before returning via the same route. Numerous NATO surface ships and submarines sailed to shadow the group. Media coverage of the deployment also prompted discussion of *Kuznetsov's* role at the centre of Russia's naval resurgence.

*Kuznetsov* has conducted a large number of deployments to the Mediterranean Sea since Russia returned to the world stage in 2008. It is not clear, however, what the future holds for Russia's carrier capability. *Kuznetsov* is due for significant overhaul, beginning in the 2017-18 period, but it remains to be seen when this work will be carried out, what any upgrade activity will involve, and when – perhaps, even, if – *Kuznetsov* will return to service. Its future remains in doubt.

Beyond that, Russia has revealed plans to build a larger carrier, under the Project 23000E Shtorm programme. The concept is to build one, perhaps two, 100,000-tonne carriers to rival the US Navy's (USN's) Nimitz- and Ford-class ships. In April 2017, the website *Russia Beyond* reported that the carrier project will form part of Russia's armament programme for the 2019-25 period, with an estimated in-service date of 2030 for the first ship. A carrier of such size would provide Russia with a platform from which it could conduct a wider range of air-based maritime power projection tasks, as the USN carriers do.

However, while Russia is seeking to spend more on defence and on its navy in particular, Moscow continues to wrestle with economic and financial challenges. This raises the question of whether such a significant project, particularly one delivering a small number of complex ships, will be affordable and deliverable.

Moreover, Russia's enduring economic disposition plays into the debate about the kind of navy Russia wants and needs to meet its current strategic purposes. *Kuznetsov* is seen by some as an anti-submarine warfare (ASW) platform, rather than a strike carrier. Conducting carrier strike operations also remains very challenging, as was demonstrated in Russian operations off Syria when two combat aircraft were lost at sea. *Kuznetsov* also does not bring the level and range of capabilities that Western



The French aircraft carrier FS *Charles de Gaulle* (left) and the US Navy's (USN's) Nimitz-class carrier USS *Dwight D Eisenhower* in transit in the Mediterranean Sea in December 2016. French Navy surface ships have also recently supported the USN's Bush carrier strike group (CSG) on operations.

carriers bring.

In addition, Russia's current strategic posture – focused, in the European theatre at least, on keeping Western navies at arm's length through the development of stand-off missile capabilities for its surface and sub-surface fleets – seems built around boosting surface and submarine forces, particularly augmenting the capability of smaller and more affordable vessels. In a statement published by the national news agency TASS on 1 January 2018, the navy's Commander-in-Chief Admiral Vladimir Korolyov emphasised the focus on conventional deterrent capability including “vessels armed with long-range precision weapons”. In this context, a strike carrier capability does not appear to be an immediate, primary priority for the Russian Federation Navy.

One country stepping back into the big league of carrier strike capability is the United Kingdom. In early December 2017, the Royal Navy (RN) commissioned HMS *Queen Elizabeth*, the first of two 65,000-tonne strike carriers. In the same month, second ship *Prince of Wales* floated out of dry dock ahead of schedule; its commissioning is planned for 2020. On social media, the RN's First Sea Lord and Chief of the Naval Staff Admiral Sir Philip Jones stated that the UK has “come a long way to close the carrier gap”, a gap that emerged in the 2010 Strategic Defence and Security Review (SDSR) with the withdrawal of the *Invincible*-class carriers.

### QEC

Nick Childs, senior fellow for naval forces and maritime security at the International Institute for Strategic Studies, told *Armada International* that the UK's two *Queen Elizabeth*-class (QEC) carriers are “the result of a deliberate decision to step back up the strategic ladder in terms of the scale of independent maritime power projection that the UK could deliver”.

“The new carriers are not direct replacements for the previous generation of *Invincible*-class ‘mini’ carriers,” Childs added. Instead, he continued, “they will provide the UK with strategic options that it has not enjoyed for four decades.”

The QEC programme has been a long time in gestation, with some analysts suggesting discussions in the Ministry of Defence were underway as far back as the mid-1990s. Plans have also chopped and changed as the programme has evolved and as political, budget, and other issues have been addressed. One change, however, that will boost significantly the UK's prospective maritime air power output was the decision to bring both carriers into operational

service, to enable the UK to provide a continuous high-readiness carrier capability.

The carriers' primary output is based around the short take-off/vertical landing (STOVL) F-35B Lightning II Joint Strike Fighter, with the ships able to accommodate up to 36 of these ‘fifth generation’ aircraft within an overall air package of up to 40 airframes. *Prince of Wales* is optimised, too, for amphibious operations. In terms of amphibious capability, the capacity to embark a range of helicopters including Chinooks and Merlins provides littoral maritime air power projection over, rather than across, the beach.

There are options for augmenting the ships' amphibious and wider maritime air power capabilities further. For example, there has been debate in the UK over whether it should acquire the Bell Boeing MV-22 Osprey tiltrotor aircraft, either for amphibious operations and/or for maritime surveillance tasks. While there are no current plans for such a purchase, the MV-22 would provide a quick step-up in capability for the carriers.

The addition of the V-22, other capabilities such as in-flight-refuelling and carrier onboard delivery, and a wider range of offensive weapons for the F-35B would boost QEC capability, said Childs. “Having said that,” he noted, “with a full complement of F-35s and that aircraft's ‘fifth generation’ advantages, plus the RN's experience of and commitment to operating carriers, [the QEC ships] will probably be the second best carriers in the world after those of the US Navy once fully operational and worked-up.”

While commentators have continually pointed to an absence of aircraft for the carriers, aircraft delivery is driven of course by a set plan, and 2018 will see *Queen Elizabeth* begin first-of-class flying trials for both fixed- and rotary-wing aircraft.

It is reported that initial operating capability (IOC) for *Queen Elizabeth* is due in December 2020.

Childs argued that the QEC carriers' operational service lives will be shaped by ongoing technical developments and how the carriers themselves are adapted. However, despite RN and wider UK optimism about the ships' arrival and anticipation as to what they will bring, Childs sounded a broader note of strategic caution. “The carriers were originally conceived as part of a balanced package that included 32 destroyers and frigates, 10 nuclear-powered attack submarines, and a separate amphibious capability. The RN is a long way from that now,” he said, “so delivering a fully effective overall Carrier Strike capability is going to be an enduring challenge.”





## CAPABILITY AND CO-OPERATION

The USN is also going through the process of bringing a new class of carrier into service, with the Gerald R Ford-class nuclear-powered ships. The lead ship was commissioned in July 2017.

The USN's in-service Nimitz-class carriers have proved throughout their long operational history to have relevance across the spectrum of operations. Third-in-class ship USS *Carl Vinson* was involved in leading strike operations over Afghanistan in late 2001, and also led the international relief operation in the wake of the Haiti earthquake in 2010. According to the USN, the Ford class and its carrier strike group (CSG) will remain "capable of carrying out missions across the full spectrum of military operations, ranging from large-scale combat operations to deterrence to humanitarian assistance".

To the USN, while the Ford-class carrier's basic missions remain unchanged compared to the Nimitz class, the new ships "will deliver greater lethality, survivability, and joint interoperability, along with unmatched versatility and compatibility with continuing joint force transformation – all at a reduced operating and maintenance cost." In terms of strike capability, as well as being able to embark F-35C and F/A-18E/F Super Hornet conventional take-off and landing aircraft, it will also be able to operate US – and UK – STOVL F-35Bs. The class has also been designed to allow integration of future manned and unmanned aircraft "with minimal ship alterations", said the USN.

In terms of USN operations, of particular note has been the returning carrier presence in the European theatre. For some time, with the USN focused on the Gulf (as well as the Pacific), east coast-based CSGs transiting to and from the Indian Ocean region appeared to spend little time in European waters. However, Russia's strategic resurgence and the increasing levels of naval activity in the eastern Atlantic and the Mediterranean are seeing the CSGs conducting more operations in the European theatre. For example, the most recent visit was a lengthy deployment by the USS George H W Bush Nimitz-class CSG throughout 2017, encompassing Atlantic and Mediterranean waters as well as the Indian Ocean.

The CSG included Carrier Air Wing (CVW) 8, the CG 47 Ticonderoga-class guided-missile cruisers USS *Philippine Sea* and USS *Hue City*, and the Arleigh Burke-class guided-missile destroyers USS *Laboon* (Flight I) and USS *Truxtun* (Flight IIA).

Vice Admiral Christopher Grady, commander

of the USN's Sixth Fleet and also Naval Striking and Support Forces NATO, told *Armada International* that, "with the combined mission capabilities of an embarked air wing and supporting combatant ships, a US CSG fights across the full spectrum of warfare. Its presence sends a strong message of reassurance to our partners and allies, deters enemies, and brings a credible warfighting capability and capacity to any theatre, delivering both sea control and power projection."

The USN told *Armada International* that the deployment saw the CSG conduct "a variety of operations and exercises in support of (US) allies, partners and ... national security objectives, including providing support to Operation 'Inherent Resolve' [the US-led multinational operation tackling Islamic State activity in the Middle East] and participating in Exercise 'Saxon Warrior'".

The US/UK-led 'Saxon Warrior' exercise saw the Bush CSG operating alongside Queen Elizabeth. The USN said the exercise "focused on developing combined proficiency in the area of CSG operations, enhancing interoperability, and projecting power from the sea". 'Saxon Warrior' was "a co-ordinated, high-end training exercise, combining all of the mission sets that a CSG can execute", said Vice Adm Grady.

Vice Adm Grady noted that, "within the US Sixth Fleet area of responsibility (AOR), the Eastern Mediterranean serves as a 'sweet spot' for CSG operations." All three of the USN's recent CSG deployments to the AOR – featuring the Harry S Truman and Dwight D Eisenhower CSGs, as well as the Bush CSG – have supported 'Inherent Resolve' from this "strategically ideal location", the admiral said. In addition, he continued, "Geographically, the Eastern Mediterranean provides our CSGs a unique advantage from which we can support three Combatant Commands simultaneously," including projecting power ashore into the AORs of those three commands. The commands are US Central, Africa, and European (CENTCOM, AFRICOM, and EUCOM) commands.

In terms of the European theatre, with naval activity and security concerns both continuing to grow in Northern European waters, it remains to be seen if and when a USN CSG might deploy further north on operations.

France is the other Western power to operate a large deck, high-end Carrier Strike capability, with the nuclear-powered ship FS *Charles de Gaulle*. Reflecting the growing emphasis amongst the Western naval powers on Carrier Strike operations,

*Charles de Gaulle* has recently flown combat sorties in the Middle East from both the Gulf and the Mediterranean, as well as conducting strikes over Afghanistan from the Gulf.

Vice Adm Grady noted that *Charles de Gaulle* has recently operated with the Eisenhower CSG in the Eastern Mediterranean 'sweet spot' to support CENTCOM requirements, and that 2017 saw "multiple" French warships working alongside the Bush CSG.

While *Charles de Gaulle* is, in some senses, still in its early operational years (commissioning only in 2001), debate has continued in France as to whether the navy needs a second carrier. However, this debate now appears focused not on adding a second carrier alongside *Charles de Gaulle*, but on defining France's requirement to maintain and replace the existing ship. Assuming a life expectancy of 30 or more years, replacement in the mid-2030s may seem a while away. However, delivering a programme as complex and costly as a large-deck carrier takes time, particularly in procurement and funding (if not necessarily build) terms.

## BENCHMARK

The established Western carrier navies have set the global benchmark for measuring capability development in projecting maritime air power, and all of these navies are looking to improve their carrier output. Other navies – notably China and India – are trying to close the gap in the short term. In the longer term, China certainly would be intending to keep pace with USN developments. While Western navies are moving forwards, Childs noted that other navies "are not standing still".

China is now progressing with the build of several indigenous carriers, to follow in the wake of the People's Liberation Army Navy's (PLAN's) first carrier, *Liaoning*, which has been operational since 2012. A second ship is due to arrive in 2019, and reports suggest plans for at least two more (with these latter ships being built to an indigenous design). Childs noted China's longer-term ambition to develop a full 'cats and traps' (catapult launch and arrested recovery) capability for its future carrier fleet. However, many analysts have commented on the fact that the established Western navies have taken several decades to build their current carrier capabilities, and that China – while it focuses generically on learning lessons from other navies, in order to accelerate the speed at which it can close capability gaps – still has a fair way to go.

Nonetheless, one of the most significant strategic aspects of China's carrier programme will be if and when it begins to conduct regular carrier deployments to the Indian Ocean. To date, *Liaoning's* operations largely have been confined to home waters. However, with the three Western carrier navies all regularly deploying carriers to the Indian Ocean, with India beginning to build a significant carrier capability, and with China having strategic interests in the region, the Indian Ocean is likely to become a focal point for carrier activity in the medium term. China has clear plans to improve its broader maritime power projection capability into the Indian Ocean and beyond: while it currently supports this aim with a now well-established surface escort group rotation, any future prospective deployment of a carrier to the region would be strategically significant.

For India itself, its first indigenous carrier – *Vikrant* – is scheduled to commission in 2018. Its own strategic intent is to have a carrier programme large enough to support the continuous and simultaneous deployment of two carriers, one operating off each coast. India already has one carrier in service, the Soviet-built *Vikramaditya* that was commissioned into the Indian Navy in 2013. India's second indigenous carrier is reported to be called *Vishal*. ☐



US Navy

The UK Royal Navy aircraft carrier HMS *Queen Elizabeth* (left) and the US Navy's Nimitz-class nuclear-powered aircraft carrier USS *George H W Bush*, supported by the Royal Norwegian Navy Fridtjof Nansen-class frigate *Helge Ingstad* and the USN's Arleigh Burke-class destroyer USS *Donald Cook* (right), during Exercise 'Saxon Warrior' in 2017.

# COMMANDING THE BATTLE WITH BETTER BANDWIDTH

The Canadian Army is showing how the America, Britain, Canada, Australia, New Zealand (ABCANZ) and NATO partners are looking to modernise mobile command centres.

## Dr. Joetey Attariwala

**N**early two decades of counter insurgency operations in Afghanistan and Iraq has resulted in land based mobile command centres becoming static due to the provision of highly connected, high bandwidth Command and Control (C2) systems in a known area of operations. These C2 systems provided standard services such as voice over Internet Protocol (VoIP), e-mail, office automation and some video teleconferencing capabilities. These were mostly standard commercial-off-the-shelf (COTS) networks (i.e. Windows and CISCO) running some specialised military applications.

Initially there were separate Canadian and higher coalition networks, such as the International Security Assistance Force (ISAF) network, run into the HQs. Eventually a number of these networks were connected to form the Afghanistan Mission Network (AMN). As previously mentioned, these COTS networks were pretty much static, however a segment of the network could be moved or transported, but that segment would have to be first deliberately shut down and restarted in the new location - both of which were time consuming. These HQs were housed in buildings located on main bases, such as a Kandahar Airfield or Forward Operating Bases (FOBs). These bases and FOBs were connected using static satellite and microwave communications, and eventually making use of local Afghanistan communications infrastructure. All communications are of course encrypted.

Those campaigns continue today, but when Russia invaded Ukraine, everyone realised that tactical mobility would be essential for peer or near-peer conflicts. To be clear, most ABCANZ and NATO armies had already been working this effort, however the Russia-Ukraine conflict kicked this effort into high gear.

Speaking to Armada International for this topic was Brigadier-General Michael St-Louis, a Canadian Army flag officer currently serving as Deputy Commanding General for Operations at U.S. Army I Corps, who said: "In my two years of command of the 5th Canadian Mechanised Brigade Group and now part of America's First Corps (US Army I Corps), I have been able to deploy a Canadian formation level HQ on a couple of exercises, working alongside

British, Australian and US brigade HQs, and now within a US Army deployable Corps HQ. All these ABCANZ armies are currently involved or contemplating how they deploy-fight-win with their brigade C2 nodes, although they are different in each army. All comprise a slew of vehicles, networks, workspaces and number of personnel. While the threat of ISIS and extremism around the world remains, we need to look to the future and be prepared to face a more complex adversary requiring our brigade C2 nodes to be robust enough to sustain modern decisive action."

Speaking about the Canadian Army specifically, BG St-Louis commented, "For the Canadian Army, the requirement to revisit the way we have structured and equipped our Brigade HQ comes from the fact that counterinsurgency mission in Afghanistan led to equipment solutions that may not serve well against a near peer adversary, the threat now at the forefront of our organisation readiness requirements."

"In Valcartier [Quebec], we were hard at work re-looking at the organisation of a brigade headquarters and its ability to work with current and future C2 systems, while being mobile on the battlefield. In my second year in command, we participated in Army Warfighter Assessment 17 at Fort Bliss [New Mexico] which allowed us to set up our main brigade HQ with all new equipment. These self-contained units were modular, collapsible, easily transportable and provided what is needed to command and control land operations. I believe Canada's continued efforts in improving our logistic trucks and our command and control networks will allow our brigades to operate in a complex conventional warfare environment."

A key challenge for ABCANZ/NATO armies is moving from voice-centric C2 systems, to voice and data centric C2 systems. It is generally understood how to provide voice communications, but there is no standardised or easy way to provide tactical data communications to mobile command centres or HQs - this is often referred to as 'digitising' a headquarters. The question of digital interoperability between the headquarters of different nations makes the problem much more complex as each nation builds and deploys its own tactical digital networks, then tries to make these disparate networks interoperable.

One difficulty is that most NATO nations work at the 'restricted' level at the battalion level and below, while ABCANZ nations work at the 'secret' level making the interconnection of national systems a major challenge.

### THE DIGITAL NETWORK PROCUREMENT CHALLENGE

The world of rapidly advancing, high-tech military C2 systems certainly presents challenges for procurement processes. Generally speaking, military procurement is focused on buying a limited number of large and very expensive systems like planes, tanks and ships. Once procured these platforms are typically used for 20 or more years with modest evolution. In this situation a very deliberate and methodical process needs to be followed to ensure that the right platforms are procured and that taxpayers dollars are well spent.

However, in the case of C2 and C4ISR systems comprise a very large number of smaller, lower cost components that change rapidly, the opposite method needs to be exercised. Canada's new defence policy 'Strong Secure and Engaged' has started to provide the way forward through a significant emphasis being placed on enabling innovation with the Canadian defence industry and to speed up the defence acquisition process. It is likely that every seven to ten years there will need for significant capital investment in hardware and software to upgrade systems architecture to step-up to the next major capability level. Then in each following year, smaller investments will be required to continuously evolve and improve the capability as new technologies appear. This will also facilitate the all-important upgrading of cyber defences. A key basis of this will be the adoption of agile system and software development approaches.

"Strong Secure and Engaged has provided the long term plan, funding and framework to allow the Canadian Army to start enabling a continual programme of upgrades. In terms of tactical mobile HQs, important questions start transitioning from 'what capabilities are you deploying now?' to 'how are you implementing an evolutionary development program?'," said Lieutenant-Colonel Ian Graham, director of Land Requirements 4 for Canada's



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Department of National Defence. “If an army buys the wrong tank, they are stuck with that mistake for a generation. Conversely, if during an annual rapid build cycle the ‘optimal’ C2 capability is not built, well that can be corrected the next year. If five years are spent trying to build the ‘optimal’ system, it will likely be obsolete by the time it is released. Certainly careful planning is still required as large dollar values are still being spent, but regular smaller system procurements and upgrades will provide reduced risks.”

### COSTLY TO KEEP UP

Large staffs in brigade and brigade group HQs are required to process huge amounts of intelligence and to conduct the detailed planning required to fight a war. They are safely located on bases with reliable power, air conditioning and data connections, so these HQs are able to grow to the required size.

Battle commanders have a much smaller mobile tactical HQs (Tac HQ) that typically include around five armoured vehicles which would enable commanders to move forward to directly lead and influence the battle. These Tac HQs would typically have radio voice communications and a low bandwidth tactical satellite connection back to the main HQs. This small data connection allowed key operational files and maybe a few pictures to be pushed forward. Company level operations are typically run on voice, again with a limited data connection from the company command vehicle or command post to higher HQs.

After Afghanistan, the Canadian Army began to re-orientate back towards conventional war fighting. This has been reinforced through the observation of military events in Ukraine, which require smaller, mobile HQs. Large HQs are viewed as too easy for a peer opponent to identify and destroy. A peer enemy also might potentially jam or ‘cyber-attack’ C2 networks.

“There are really two main problems for slimming down Tac HQs and making them truly mobile. The first problem is the ‘which staff and capabilities?’ question. For Tac HQs, one has to determine what staff actually need to be directly on hand and which systems and equipment are really required. Also as the HQ is mobile, the personnel and equipment count has to include all the shelters used

(typically tents) all the vehicles and all the soldiers required to move, set up, operate and locally defend the HQ. This is really a doctrine and operational procedures question,” said LCol Graham. “The second key problem is the C2 system problem. COTS networks need to be made smaller, mobile and tolerant to faults and battle damage. Also, vehicle communications need to be updated so that they have both voice and data connections so that commanders and staff at all levels can remain connected when operating at the tactical level.”

To address these two issues the Canadian Army has a number of experiments, exercises and focus groups updating HQ doctrine and procedures. This is not a case of going back to the ‘pre-Afghanistan’ doctrine as there have been many changes in military technology and practices through the intervening years. What is being seen is that Tac HQs need to be both tailorable and scalable. According to the Canadian Army, there is no ‘one’ perfect HQ organisation or structure size since factors like mission size, focus and duration must all be factored into deploying Tac HQs to address different requirements and skill sets.

“A truly conventional warfighting operation may require a very small HQ, mostly with the operations, intelligence and logistic staff required to plan and manage two to three days of operations. If the operation is in among a civilian population, then a civil-military coordination team needs to be added. Similarly, maybe an air support coordination team might need to be added,” said LCol Graham. “As the operation progresses, the HQ organisation and requirements may have to change accordingly. Certainly there is the concept of forward and rear HQs. The forward HQs are in the battle space and exposed to the enemy and so they need to be small and mobile. The rear HQs will be placed in a safe zone, maybe even back in Canada. They can be much larger, and much like the Afghanistan counter-insurgency style HQs which can be used to do the complex processing and planning required for modern operations. Upgrading the C2 systems is key in enabling these doctrinal shifts.”

### CANADIAN TAC HQS

As noted previously, the Canadian Army primarily has two levels of C2 systems: the high capacity COTS

based networking systems and military specific vehicle / platform systems. Both of these systems are being upgraded.

A number of capital projects will begin fielding in 2018, with the biggest upgrades at this time occurring in the vehicle systems. First, the standard Canadian Army VHF voice radio, typically referred to as the Combat Net Radio (Primary) or CNR(P), is being enhanced by General Dynamics Mission Systems - Canada (GDMS-Canada) to allow it to pass both voice and data traffic. The upgraded radio is referred to as the Combat Net Radio (Enhanced) or CNR(E). Secondly, the Canadian Army had previously procured the Raytheon Enhanced Position Reporting and Locating Radio System (EPLRS) but had not fully deployed this radio; EPLRS is now being reintroduced. Thirdly, an Ethernet based Local Area Network (ELAN), is being installed within certain vehicles by GDMS-Canada. Fourthly, tablet-type data terminals are being installed in the turrets and hulls of armoured vehicles. Fifth and finally, a new tactical software application, called the Tactical Battle Management System (TBMS) has been developed by Thales, supported by CGI Group. These radio and network hardware upgrades provide a secure voice and data network within and between the vehicles, and TBMS pulls this all together. An app will provide a scrolling map that shows vehicle location and shares that location to other vehicles and allows the exchange of small tactical sketches and traces. Collectively, all of these systems are referred to as Capability Pack TOPAZ (CP TOPAZ).

Initially CP TOPAZ is focused at the company level and down. In initial trials in 2017, it was seen to be a very effective tool in the Company level Command Post and in Company Commanders Vehicles. “By displaying all of the Company’s vehicles and enabling rapid exchanges on chat, CP TOPAZ greatly improved the situational awareness levels. The capacity to also send out small graphical tactical overlays also enabled the Company Commander and operations staff to quickly direct and coordinate operations,” said LCol Graham.

At the lower tactical levels of CP TOPAZ, voice interoperability is still the primary means of tactical coordination. Greater connectivity issues among allies do however exist, as most ABCANZ/NATO nations are deploying some form of vehicle tactical data networks but there are no generally accepted and agreed standards so most systems are not interoperable at the data level.

With the base tactical network infrastructure coming into place, the intent is to now start to rapidly evolve the TBMS software application, as well as adding other applications to further support operations. Specifically, an extended version of TBMS, called TBMS Command Post (TBMS CP), is being developed to specifically support tactical HQ operations. TBMS CP will provide the capability to show multiple views of maps and prepare and distribute more detailed orders and tactical overlays.

“The eventual target is for TBMS CP to provide the required capability to support battalion and possibly even brigade level HQs when they are engaged in conventional war fighting operations. Additionally specialised apps, so support functions such as fires, logistics and intelligence will be added to CP TOPAZ. Finally, in the next two to three years a Satellite on the Move (SOTM) capability will be added to CP TOPAZ because the CNR(E) and EPLRS radios typically enable data communications in the 5-15km range, are typically limited by terrain. SOTM will provide a much longer data reach back enabling improved operational range. When fully deployed, CP TOPAZ will provide a truly mobile voice and data network that supports the troops fighting the battle and the Tactical HQs directly supporting them,” concluded LCol Graham. □

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# THERE IS ALWAYS A LESSON TO LEARN

Whether training Partner Nations, or re-training for the next mission, international special operations forces are striving to find the next solution to give them the edge in future fights.

**Andrew White**

**A**s demonstrated with ongoing campaigns in the Middle East and North Africa, operational focus of international special forces continues to be dominated with military assistance missions aimed at developing the capabilities of Partner Nation Forces (PNFs).

Designed to increase competency levels as well as multinational cooperation with regard to training, operations and materiel, most notable Military Assistance (MA) campaigns include the likes of the US-led *Operation Inherent Resolve* in the Middle East which comprises a coalition of special forces components 'training, advising and assisting' indigenous combat units including the Iraqi Special Operations Forces (ISOF) and Kurdish Special Mission Units.

Such a strategy allows commanders to force-multiply their effects on the ground which is always an attractive concept of operation (CONOP) considering the limited numbers of SOF available to commanders.

These types of training programmes, designed to develop doctrine, CONOPS, tactics, techniques and procedures (TTPs) of indigenous force elements however, lack technological support given their expeditionary nature where task forces are often working in denied or deprived environments.

As an example, SOF components from Canada and Denmark conducted training serials at forward operating bases and patrol bases in northern Iraq, relatively close to the front lines of Islamic State and therefore lacking any specialist training infrastructure.

In January 2017, Denmark's government elected to deploy a Special Operations Task Force (SOTF) to Al Asad Air Base, northern Iraq, to train indigenous forces. Featuring a 60-strong team of operators from the army's Jaegercorps and navy's Frogman Corps, the SOTF relied upon relatively basic training real estate to teach small unit TTPs including close quarter battle and urban warfare. This involved dug-out range complexes and basic urban complexes for building clearance drills.

Such capabilities provide a minimum requirement for the development of indigenous units, although improved facilities must be provided in order for the maturation of SOF components to continue into the future beyond limited small unit TTPs.

## NEXT GENERATION TRAINING SOLUTIONS

Conversely, the wider SOF community is building up its own capabilities with dedicated and specialist training centres designed to best prepare combat elements for the battlefields of today and tomorrow where emphasis is likely to focus on small unit teams operating in "complex, contested and congested" environments, defence sources highlighted to *Armada International*.

According to media reports arising out of the US on 21 November 2017, the Department of Defense (DoD) is seeking to more than triple expenditure for SOF training. According to Bloomberg's director of government contracts research Kevin Brancato, the move is a "reflection of the rapid changes that the military's most elite fighters must adapt to, in a widening array of theatres".

US Army Special Operations Command training, for example, is supported by dedicated training facilities including the JFK Special Warfare Center and School at Fort Bragg, North Carolina. The Center of Excellence's remit is to "train, educate, develop and manage Civil Affairs, Psychological Operations and Special Forces warriors and leaders in order to provide our nation with highly educated, innovative and adaptive operators," official literature describes.

However, addressing delegates at the SOF Industry Conference in Tampa, Florida on 16th May 2017, the commander of the USSOCOM Gen Tony Thomas, warned that his force must maintain currency in light of emerging complex challenges and requirement to maintain tactical overmatch over adversaries and near peer forces in the contemporary operating environment. This, he urged, would include close cooperation with industry, particularly in the areas of artificial intelligence

and machine learning.

In response, the organisation is now considering next-generation capabilities capable of providing operators with a fused and integrated live, virtual and constructive test environment (LTE) with winning solutions capable of being networked into training environments at the JFK Special Warfare Center and School as well as other SOF-specific training areas.

Following the publication of a Request for Information (RfI) on 26 October 2017, the army is seeking "new and emerging systems" to provide exercising troops with live-synthetic simulations capable of producing "operational realism to provide an accurate battlefield test environment", service officials explained.

This, official sources confirmed, would allow directing staff to capture, record and transmit test data for analysis and visualisation. Technologies being considered include Real Time Casualty Assessment effects including position location information; health and status of live and simulated players; and lethality and survivability outcomes.

Additionally, the army is seeking the integration of real-world synthetic environments including the combination of live, virtual and constructive player units; as well as connectivity between multiple training areas.

"The synthetic environments may be created within a single computer or over a distributed network connected by local and wide area networks and augmented by realistic special effects and accurate behavioural models to provide visualisation of and immersion into the environment being simulated," official documents explained. The army is seeking to award a contract in the second quarter of 2020.

Similar thought patterns regarding next-generation SOF training are being implemented by the Canadian SOF Command (CANSOFCOM) which is spending \$257 million (CAN\$319m) on a new training compound at the home base of the Canadian Special Operations Regiment (CSOR) in Petawawa, Ontario.

According to the Department of National Defense (DND), the government is committed to optimising the "next generation Special Operations Forces integrated soldier system equipment, land mobility, and maritime mobility platforms and fighting vehicle platforms," as well as training requirements.

Due to be opened in 2021, the facility will be capable of supporting unit member preparation for "future operational challenges", explained Major General Michael Rouleau, Commander, CANSOFCOM, at a ribbon-cutting event on 1 December 2017. The new training compound features a total of ten buildings including office space for theoretical training and after action reviews; training infrastructure; warehouse storage facilities; and medical facilities; providing a one-stop shop for CSOR training activities.

Previously, CSOR force elements were dispersed across the wider base location. However, official sources confirmed to *Armada International* how a single site would allow for "increased collaboration and efficiency" for the regiment.

No further details have been disclosed by CANSOFCOM. However, defence sources associated with the effort explained to *Armada International* how the new facility would comprise a variety of complexes designed to assist training in air, land and maritime environments.

The upgrade falls in line with the DND's Science and Technology Call for Proposals to Enhance Defence, published on 27 October 2017, which has a remit to improve small unit capabilities of CANSOFCOM.

"The investments made in SOF and joint capabilities by Canada's defence policy will support their unique requirements to ensure long-term continuity and effectiveness," the document reads with particular focus on the procurement of integrated soldier systems; mobility platforms and vessels; chemical, biological, nuclear, radiological and explosive (CBRNE); electronic warfare; and cyber warfare capabilities.

A similar concept was opened in New Zealand in April 2016. The Special Operations Battle Training Facility (SOBTF), which directly supports the NZ Special Air Service (NZSAS), is worth \$33.7 million (NZD\$46m) and provides force elements with a next-generation training facility to support current and future operational requirements.

Particularly focused on counter-terrorism training, the SOBTF includes a series of indoor and 360-degree live fire ranges measuring between 20m and 50m in length which is ideally suited to the training of ground assault forces (GAFs) operating in confined urban areas.

Describing to *Armada International* how the SOBTF satisfies emerging requirements from the battlespace, defence sources explained how the range complex could be 'blacked out' for low light operations with operators cleared to fire ammunition types from 9mm x 19mm up to 7.62mm x 51mm. Additionally, range complexes come with a series of modular furniture to recreate room formations and streets, allowing directing staff to mould training environments accordingly.

Furthermore, the SOBTF is equipped with multiple capabilities for insertion, extraction and method of entry. Most legacy SOF training facilities feature mock-ups of airliners, buses and train carriages. However, the SOBTF features a mock-up NH90 helicopter (the New Zealand Air Force has a small fleet of the type) for fast-rope/heli-abseiling insertion onto target rooftops for example; as well as lift shaft with functioning elevator for more covert method of entry drills.

Also designed to support maritime special operations, the SOBTF features a 6m deep diving pool as well as mock-up bow of maritime vessel, both of which are designed to support covert entry in sub-surface and surface environments respectively.

SOBTF training is also supported by a series of networked camera systems providing directing staff with not only a safety mechanism during live serials but also the ability to conduct hot debriefs with after action reviews.

In Europe, an undisclosed NATO SOF organisation is also working up plans to establish a dedicated SOF Training Centre aimed at satisfying the next-generation demands of the battlespace. However, *Armada International* is unable to provide further details due to operational security concerns.

Industry sources have also described how the US Navy Special Warfare Command is now exploiting similar after action review technology to debrief SEAL Team training.

According to Emerging Technology Ventures (ETV), the Navy Special Warfare Basic Training Command is now operating Vertical Take Off/Landing Unmanned Aerial Vehicles (UAVs) to film small unit training in both daylight and low light conditions.

Awarded a \$19,000 contract on 28 September 2017 to support the Basic Training Command, ETV is providing a pair of custom-manufactured quad-rotor air frames fitted with electro-optical/infrared cameras providing a birds-eye view of the TTPs used by operators.

According to USSOCOM sources, the UAVs will provide the Command with "detailed near real-time video play-back of tactical movements and safety concerns", providing an alternative procedure for directing staff who had previously relied upon "verbal feedback to students after live-fire training evolutions".

These, officials explained, comprised "off-the-cuff debriefs without the ability to show the students specific details of exactly what safety, tactical, or individual issues they may be having".

"Procurement of UAV quad-copters will give the instructor cadre the ability to capture and store both still images and video, highlighting student performance and enabling the instructor cadre to provide more comprehensive debriefs.

"This will significantly improve the student's ability to understanding training related learning objectives as well as overarching tactics, techniques and procedures. Additionally live video play-back will also facilitate

resolution of any safety or tactical concerns that may have arisen during training," USSOCOM documents concluded.

**THEORETIC SOF TRAINING**

Meanwhile, SOF components are also exploring alternative training requirements to encourage bilateral cooperation in the joint operating environment. SOF and security agencies from Singapore and Indonesia conducted a table-top 'rock drill' designed to encourage further collaboration and interoperability into the future- the first time Singapore's Special Operations Task Force (SOTF) has completed such a programme internationally.

Building on a three-day counter-terrorism in 2012 exercise involving 150 SOF operators from both the SOTF and Indonesia's KOPASSUS (Army Special Forces Command), this latest iteration conducted on 28-29 November 2017, involved commanders from the same SOF components discussing a simulated terrorism scenario at the Sheraton Towers hotel in Singapore.

The main effort of the exercise was to consider and play out multiple courses of action involving the return of foreign fighters from Violent Extremist Organisations (VEOs) across Asia Pacific as well as Iraq and Syria in the Middle East.

Such a threat was highlighted in June's publication of the Singapore Ministry of National Defence's Terrorism Threat Assessment Report, which highlighted foreign fighter flows as an increasing risk in the region.

The two-day exercise featured response to terrorist incidents including a mass casualty situation in a shopping centre, with SOTF and KOPASSUS force elements responding in a joint operation with law enforcement and other security agencies, exercise officials explained to *Armada International*.

"The Singapore Armed Forces and Indonesian National Defence Forces shared knowledge and operational responses to various terrorist-related scenarios, such as bomb threats in public areas, in their first Counter-Terrorism Table-Top Exercise," Singapore

Ministry of Defence officials confirmed.

Head SAF Current Operations Group Colonel (COL) Lim Kok Hong, added how the exercise had allowed both armed forces components to "better understand operational challenges and responses when we encounter terrorism, which will help to enhance inter-agency cooperation between Singapore and Indonesia".

"With the two countries facing similar threats of returning Islamic State in Iraq and Syria foreign fighters, it is paramount to share information with each other so that we are alerted to these fighters who are attempting to enter our countries."

**CYBER FOR SOF**

Finally, the global SOF community continues to ramp up cyber capabilities to support SOF at the tactical edge with USSOCOM's Gen Thomas expressing how he viewed Cyber Warfare as a significant challenge to counter 'aggressive' developments by adversaries in the same area.

Addressing delegates at an Association of the US Army event in Arlington, Virginia on 13 December 2017, Thomas called for commanders to be given the ability to "...employ cyber at the strategic, operational and tactical levels".

Tactical SOF components are now benefiting from a variety of dedicated cyber training courses, designed to assist operators working in contested and congested electromagnetic spectrums, he highlighted.

Options include the Cyber Operator Greyhat training programme which has been established by the US Combating Terrorism Technical Support Office. According to CTTSO officials, a total of 120 personnel from USSOCOM and other government agencies have already completed the training between 2015 and 2017 with the programme transitioning to the operational control of USASOC this year.

CTTSO officials described to *Armada International* how the "digital domain will be key terrain on future battlefields where the US and allies continue to encounter

an increasing cyber threat where a 'Digital Divide' exists between the US and our cyber opponents".

The Cyber Operator Greyhat programme is designed to train tactical operators to "understand the cyber domain and to identify and mitigate cyber threats" with a five week course covering computer science; information security; social media; and advanced computer networking. Skill sets are confirmed with a practical field exercise designed to transition classroom based theory into real time fieldcraft and TTPs. Training is delivered by Advanced Mission Systems and SensePost.

Meanwhile, USSOCOM personnel also retain access to the CTTSO's Cyberspace Open Source Methods and Operations (COSMO) course, designed to train operators in protection against digital threats.

According to CCTSO officials, 21st century social media is being "leveraged and exploited by both state and non-state actors to recruit, command, control, and conduct illegal and terrorist activities against the US and allied interests".

Hence the establishment of COSMO which comprises a three-week course aimed at enhancing the open source intelligence capabilities of SOF small unit teams operating at the tactical edge.

Devised by White Canvas Group, the course teaches operators how to enforce digital force protection and operational security for publicly available information with utility of social media tools.

CTTSO literature describes how COSMO students are taught to "find, gather, and analyse online data and metadata via a hybrid process of iterative search, discovery, and analysis".

**CONCLUSION**

Disparities in training regimes and infrastructure between 'western' SOF components and the PNFs remain extensive. However, for PNF SOF capabilities to reach greater levels of maturity in the future, fixed training infrastructures must be implemented to provide solid and consistent expertise across force components. ■

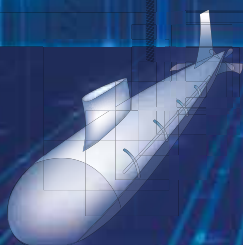


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# U.S. ARMS SALES - HAS ANYTHING CHANGED UNDER TRUMP?

Andrew Hunter



While the first year of policy making in the Trump Administration has been anything but focused and consistent, they have established a clear policy priority of supercharging U.S. arms transfers to the rest of the world. This objective started to become clear with the high profile announcement of major new arms sales when the President made Saudi Arabia his first overseas trip in May 2017 (although this had to compete for attention at the time with an epic sword dance), and has continued since with several additional arms sales announcements made by the President in Korea and Japan.

Another clear signal came with the prominence given to providing support to allies and partners in Secretary of Defense Jim Mattis's succinct list of priorities, which set three major priorities for the Department of Defense (DoD). Close observers of the arms sales business will note though that several new Administrations in recent years have started with the ambition, laudable in my view, of streamlining and improving foreign military sales and modernising technology and export controls. How successful is the Trump Administration likely to be in this effort compared to those who have come before?

There is room for both optimism and doubt at this early stage. Consider the splashy weapons sales announcements that were made early in the new Administration. When carefully scrutinised by reporters, these announcements have included a mixture of sales that have long been in process (and in some cases were previously announced), sales that represent new and near term promising opportunities to support U.S. partners and allies, and aspirational statements of intent to work towards future arms sales (some of which likely won't be realised). In other words, the eager credit taking evident in these announcements may be genuine in some cases, misplaced in others, and premature in yet a third group of cases. But there can be little doubt that accelerating and increasing arms transfers is a priority given the prominence of the issue on the

President's agenda. And this is no small thing, since at least half the battle in making policy change in Washington is getting and keeping the senior leader attention needed to make bureaucracies move. Furthermore, on an issue like arms transfers, leadership from the White House is essential because of the inherently interagency

nature of the processes in play. At this stage, it certainly seems as though all the relevant government agencies have got the message that the President is looking for results: more deals, bigger deals, and faster deals.

The question, however, is whether the Administration can assemble and leverage the technical expertise necessary to modernise a complex and long-lived system like the one governing arms transfers and whether the Administration will persist when it faces the inevitable criticism that results from pushing changes in a system intended to protect national security. Industry is on the Administration's side in this effort, and industry has or can get access to much of the technical expertise required to drive change. The Administration's characteristic boldness and capacity for absorbing or ignoring criticism may carry it a long way. The Clinton Administration was quickly boxed-in when it tried export control reform by the charge that it was selling out national security for campaign contributions. The Bush Administration was also stymied to a great extent by charges of being too cozy with arms exporters. The Obama Administration was critiqued for being too incremental in its approach to arms transfers, and too focused on other priorities such as protecting human rights.

The Trump Administration is unlikely to be particularly sensitive to any of these critiques. Its focus is set on basic outcomes - more deals, bigger deals, and faster deals - which may allow it to drive the current bureaucracies to accommodate lasting changes. However, there are also less encouraging signs. The Administration has been slow to staff senior positions with oversight of these issues, undermining its ability to drive change. The State Department, which has a leading role in arms transfer policy, is in a state of turmoil. And the Administration faces the challenge of trying to transform a system based on a few central statutes at a time when Congress is challenged to pass even the most urgent and seemingly simple of legislative priorities. Changes to arms transfer policy have rarely been viewed in Congress as either urgent or simple, and passing major legislation in this area probably remains a long shot.

*Andrew Hunter is director of the Defense-Industrial Initiatives Group and senior fellow in the International Security Program at the Center for Strategic and International Studies in Washington D.C. The views presented in this commentary are his own. Email: AHunter@csis.org.*





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