Future Technology and International Cooperation

A UK perspective

In 2011, NATO's Integrated Air Defence (NATINAD) and the supporting NATO Integrated Air Defence System (NATINADS) marked 50 years of safeguarding NATO's skies. In order to successfully reach future milestones NATO must continue (and in many cases improve) its air defence interoperability across the strategic, operational and tactical domains. In order for this to become reality a combination of exploiting synergies and acknowledging that the whole is greater than the sum of its parts[1] is required at all levels. Recent improvements and a greater focus on future capability within the UK's Joint Ground Based Air Defence (Jt GBAD) will enable the Formation to deploy its units and sub-units in order to operate the latest air defence weapon systems, within a multinational environment, against a near-peer adversary or asymmetric threat, and win.

*Major Charles W.I. May RA – 14 (Cole's Kop) Battery Royal Artillery**

> *'If I didn't have air supremacy, I wouldn't be here.'*
> *(SACEUR, Gen. Dwight D. Eisenhower, June 1944)*

This article will highlight the UK military's strategic situation, perception and understanding of the air threat before explaining the new military structure to which the Formation is adapting. It will then describe future UK AD technologies prior to focusing on the UK's essential cooperation with its partners and allies. There has been a significant change in the strategic direction of the British Armed Forces, and subsequently the operational level construct. As the new direction is towards Joint Force 2025 (JF2025) it is pragmatic for this paper to focus on the next 10 years. The purpose is to identify and highlight the pertinent capability enhancements and future vision of the UK's Ground Based Air Defence Formation and its developing role within the NATO construct.

The UK's Strategic Defence and Security Review 2015 (SDSR 2015) and the Defence Strategic Direction 2016 (DSD 2016) forms the UK Government's latest review on all national security matters and provides high level direction to UK Defence out to 2025. SDSR15 stated that the MOD and Armed Forces were to be reformed, including the improvement of the

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1 Major General T Urch CBE, *GOC FTC DIRECTIVE 2016/17 dated 28 Sep 16*, 3.

procurement process, to ensure that the UK could maximise investment in the front line. The Government pledged £178 billion over the next decade on equipment and equipment support.[2] The requirement for a period of national austerity, combined with political reticence to investment has resulted in a limited procurement budget for the three services. To meet that increased level of Defence ambition as part of SDSR15 the Secretary of State announced Joint Force 2025 – a resource-informed and time-bounded aiming mark to ensure Defence's increased utility over the coming years.[3]

Joint Force 2025

JF2025 aims for the ability to deploy a larger force more quickly than is currently the case. By 2025, it is planned this highly capable expeditionary force of around 50,000 will include a land division with three brigades (two Armoured Infantry (AI) and the new Strike Brigade, capable of assuming command of a fourth coalition brigade, and one of the UK's Very High Readiness Air Assault or Littoral Manoeuvre Task Forces, supported by an air group of combat, transport and surveillance aircraft. JF2025 will be capable of deploying on an enduring medium-scale operation, often drawing mostly on just one Service, such as the current counter-ISIL mission in Iraq.[4] This new policy demands that the UK is able to field a modernised division, capable of war fighting as the principal output of the Army. The Army's ability to deliver a war-fighting division aimed at deterring or defeating a near-peer enemy has required refinement to the Army 2020 (A2020) force structure integrating an Army of Regular and Reserve components which will deliver the contribution to the JF2025.[5]

United Kingdom Joint Ground Based Air Defence

The UK's Air Defence (AD) capability, and within that the Ground Based Air Defence (GBAD) capability, is based on modern, high intensity manoeuvre warfare in conditions in which air supremacy or superiority cannot be guaranteed.[6] The GBAD formation is commanded by a Royal Artillery Colonel and is under Operational Command (OPCOM) to 1 Group Royal Air Force (1 Gp RAF). The formation's LAND coordinating and Budgetary Control (BUDCON) 2* HQ is Force Troops Command. This chain of command necessitates that any requirements for equipment capability must be staffed through the AIR chain of command.[7] The UK's current GBAD engagement capability consists of two systems. The VSHORAD High Velocity Missile (HVM) system with a range of approximately 5.5km (12 000ft ceiling) and 24hr capability which is deployed for route/vital point defence and protection to manoeuvre forces. It can be mounted on the Stormer CVR(T) self-propelled vehicles (SP) or employed in the Lightweight Multiple Launcher (LML) role. The SHORAD Rapier FSC capability with a range of 8.2km (16 000ft ceiling) has a 24hr capability and is employed as area air defence, route defence, vital point defence of base defence zone roles.[8]

The Current State of UK GBAD

The UK's GBAD capability has reduced by 84% since 2004.[9] UK SHORAD capability is primarily focused on the GBAD protection in the Falkland Islands (FI). Contingent SHORAD capability can only be achieved at 'best effort' and is not resourced in equipment or structural terms. UK SHORAD (Rapier FSC) holdings are now 14 platforms following a saving measure in 2011.

2 UK Government, *National Security Strategy and Strategic Defence and Security Review 2015* (Crown copyright, 2015), 27.
3 Defence Strategic Directive 2016. Accessed on 18 December 2016, http://defenceintranet.diif.r.mil.uk/News/ BySubject/DefencePolicyandBusiness/Pages/publicationoftheDefenceStrategicDirective.aspx.
4 Ministry of Defence, '*Joint Force 2025*' (Crown copyright, 2015).
5 General Sir Nick P. Carter KCB, CBE, DSO, ADC Gen, *Chief of the General Staff Message*, letter dated 15 Dec 16, 2.
6 Director General Joint Doctrine and Concepts, Joint Warfare Publication 3-63.1 (JWP 3-63.1), *Ground Based Air Defence* (December 2003) 1-1.
7 Joint Ground Based Air Defence Headquarters, MOSS homepage. Accessed 09 December 2016, http://cui5-uk.diif.r.mil.uk/r/593/default.aspx.
8 United Kingdom, Joint Doctrine and Concepts Centre. *Ground Based Air Defence. Joint Warfare Publication 3-63.1*. (Shrivenham: JDCC, 2003), 3-1.301.
9 Capt S. Miller RA, 'Joint Ground Based Air Defence', Journal of the Royal Artillery (March 2016) 3.

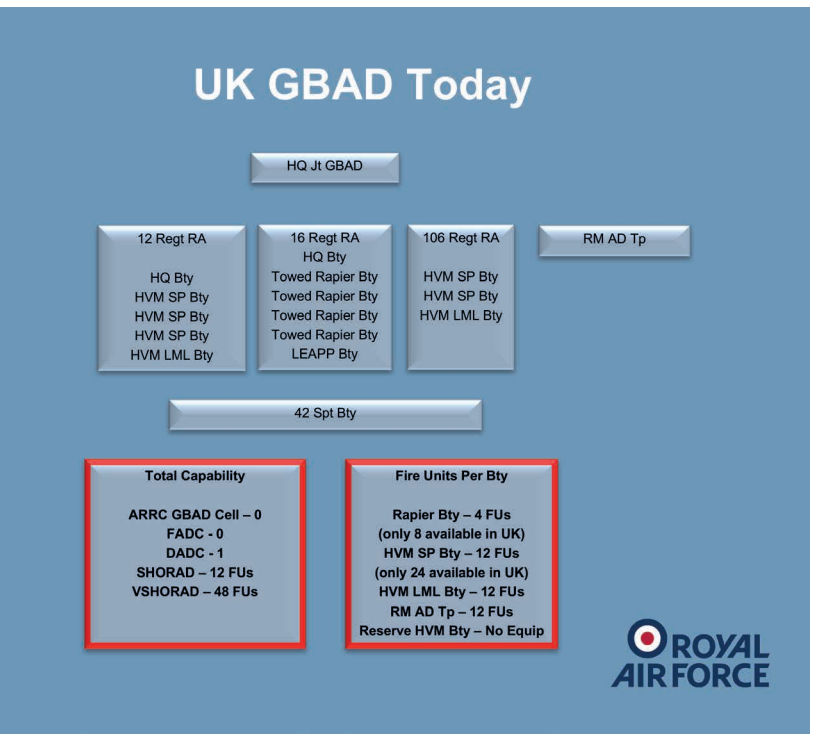

Figure 1 The UK's Jt GBAD Formation Laydown (as at January 2017)

The platforms are manned by a single Regiment who are permanently committed to providing persistent GBAD to the Joint Prioritised Defended Asset List (JPDAL) in the Falkland Islands (FI). The Rapier Out of Service Date (OSD) is 2020 when it is due to be replaced by SKY SABRE, a Beyond Visual Range (BVR) MRSAM system, procured to replace Rapier FSC in The Falklands. UK VSHORAD (High Velocity Missile (HVM)) numbers have reduced from just under 400 platforms in the early 2000s to 82 (44 Self Propelled (SP) and 38 Lightweight Multiple Launchers (LML)). The correct 'unit of measure' for VSHORAD is the Fire Group[10] (F Gp), and it is more informative to describe UK capability now as 6 x SP and 4 x LML F Gps.
The introduction of Land Environment Air Picture Provision (LEAPP) has enhanced the detection range for some categories of hostiles, improved Air Surveillance (AS) and provided early indications and warnings for other systems, whilst providing organic Link-16 capable Situational Awareness (SA) to Land HQs, through dissemination of the Recognised Air Picture (RAP). LEAPP provides a 150km surveillance coverage and IFF Mod 5 capability.

UK GBAD BMC4I capability is currently limited; neither VSHORAD nor SHORAD systems are Link-16 (L16) enabled, cross-tell (by choice) remaining the means of passing situational awareness derived from the LEAPP SIAP/RAP, or from external sources. The Battlefield Communications and Information System (BatCIS) remains the battlefield communication system, using HF and VHF; it is the bearer for GBAD Battlefield Information System Application (BISA), a planning tool which enables site recce and consolidation. It currently lacks Shared Situational Awareness (SSA) and the capacity to plug all capabilities into a common (networked) architecture.

The UK's Headquarters Jt GBAD transformation vision is given below:
Contemporary and future air-enabled threats pose a severe risk that we are currently ill-prepared to counter. Jt GBAD will therefore transform and adapt over the next 3 years in order to ensure the supported arms can operate effectively even when our adversaries are able to make use of the air environment. This will be done through refining BMC4I to enable effective engagement decisions, reconstituting operational C2 and by reorganising structures to make better use of scarce resources. Jt GBAD aims to harness NATO operations and becoming the recognised Defence experts in PASSIVE AIR DEFENCE MEASURES, develop Defence's understanding of ACTIVE AIR DEFENCE MEASURES in operational design; and pioneer the integration of Air Surveillance (AS) and GBAD into OFFENSIVE ACTION through timely support to full spectrum targeting.[11]

This Jt GBAD direction highlights the importance of regaining its previous high level of expertise on three of the key areas of ground based air defence:

10 A F Gp consists of 6 x Fire units, or weapon platforms, deployed in mutually supporting and overlapping arcs.

11 Colonel N.T. Sawyer (Late RA), Commander Jt GBAD, *JT GBAD DIRECTIVE 2016* dated 14 May 2016, 1.

- Passive Air Defence Measures (such as camouflage, concealment, deception, dispersal and EMCON).
- Active Air Defence Measures (such as radars, missiles and guns).
- Offensive Action. This is activity undertaken to prevent or disrupt an adversary from conducting future air missions.

There are several transformation work streams (WS) that will deliver this vision. The key workstreams are:

- Developing Passive Air Defence (PAD) Expertise.
- Developing Air Observers.
- Converting 16 Regt RA to SKY SABRE.
- Reconstituting NATO and Higher HQ GBAD Cells.
- GBAD support to Offensive Action.

The Air Breathing Threat

The current fixed and rotary wing threat from a near-peer adversary remains extant. British Army doctrine states that the potential air threat also includes Space Operations, Theatre Ballistic Missiles (TBMs), Tactical Aerodynamic Missiles (TAMs) (including Cruise Missiles (CMs)), aerial surveillance platforms (including Unmanned Aerial Vehicles (UAVs)), Stand-off Systems, Electronic Warfare and a Suppression of Enemy Air Defence (SEAD) capability.[12]

In an analysis undertaken by the Think-Tank RAND, in which six potential future worlds were characterized, ranging from US unipolarity to anarchy, in order to ascertain how different political situations would affect the air threat, CMs were the only threat present in every scenario.[13]
The only nation that has an effective cruise missile capability is Russia.[14]
CMs present a significant threat to access to Airports of Disembarkation (APODs). Whatever the type of operation, military forces will require early access to airports, which are easily threatened by even unsophisticated CMs. Thus, the requirement for GBAD to be able to defend against the CM threat is of a particularly high priority. Furthermore, there is an ever increasing risk of swarm attacks – an attack of sufficiently large number of CMs or UAVs designed to overwhelm air defences – which currently very few countries have the ability to counter. Generally, the increasing amount of UAVs presents a threat beyond that of a swarm attack.

PHOTO UK MINISTRY OF DEFENCE

LEAPP's Giraffe- Agile Multi-Beam (G-AMB) Radar

In order to effectively defend against the UAV threat, the defensive capability needs to be long range. This would deny UAVs the ability to collect information from range and would prevent the adversary with the an ability to strike effectively. Therefore, the most likely threats to the UK, at home or on operations, are the propagation of cruise missiles and the globally increasing amount of UAVs.[15] The advances in UAV technology and usage represent the biggest shift in recent threat development. Class 1 UAS and below (Mini, Micro and Nano) are considered Difficult Aerial Targets

12 Director General Joint Doctrine and Concepts, *Ground Based Air Defence*, 1-3.
13 Frances Lussier et al., *Army Air and Missile Defenses: Future Challenges* (Santa Monica: RAND, 2001), vii.
14 Admiral William Gortney, Commander of U.S. Northern Command, *Defense One*, http://www.defenseone.com/threats/2015/06/ pentagon-building-cruise-missile-shield-defend-us-cities-russia/115723/.
15 Lt M. Dalgarno RA, *Duncan Essay Submission: In a congested air operating environment is this approach still valid compared to the use of cheaper MANPADs in greater numbers?,* 2016, 2-3.

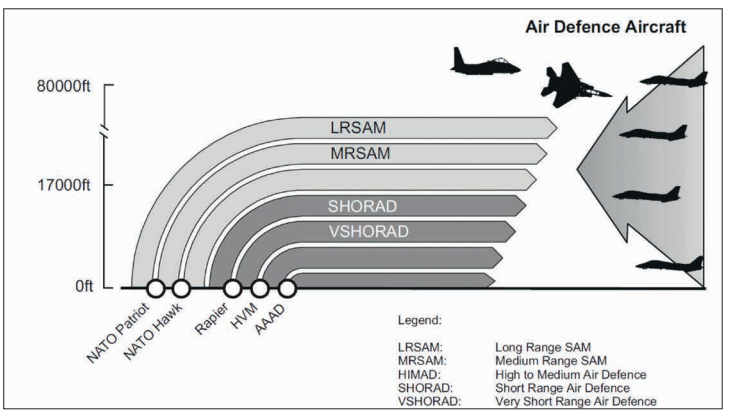

Figure 2 Layered Air Defence in a Multinational Environment

(DATs) being both difficult to detect and difficult to engage with our current in service systems.

The result of a capable mini-UAS threat can be catastrophic. In the summer of 2014, at least two Ukrainian Battalion Taskgroups were destroyed (in under 15 minutes) by surface-to-surface rockets. The Ukrainian forces were detected by mini-UAS and the fires were directed by mini-UAS. Larger Tactical UAS (similar to the UK's Watchkeeper and Reaper, and the US' Predator) are also being used by non-state actors[16], often enabled through a 'sponsoring state'. Whilst open war with a near-peer enemy is considered possible, conflict with a foe indirectly supported by a non-friendly nation, is almost a certainty.[17]
In Nov 2016 Kurdish forces fighting the Daesh in northern Iraq shot down a small drone the size of a model airplane. They believed it was like the dozens of drones the terrorist organization had been flying for reconnaissance in the area, and they transported it back to their outpost to examine it. But as they were taking it apart, it blew up; killing two Kurdish fighters in what is believed to be one of the first times the Daesh has successfully used a drone with explosives to kill troops on the battlefield.[18]

Lt General (Retd) Naresh Chand, Ex-Director General of Corps of Indian Army Air Defence, suggests that the Future Trends in Air Threat will encounter a variety of airborne dangers focused on the increased use of UAVs, armed UAVs and micro/mini-UAVs. There will be an ever increasing missile threat with a proliferation of precision guided munitions (PGMs) and a more effective use of electronic warfare capability for jamming air defence systems by future adversaries. All of the above will result in multi-platform, silent and stand-off threats.[19] As at January 2017 the British Army recognises the latest significant potential threats to the UK are from Russia and Daesh (in addition to Boko Haram and Cyber Warfare).[20]

Future Technologies – High Tech

The UK Government has stated that it will ensure that the Armed Forces will project power, be able to deploy more quickly and for longer periods, and make best use of new technology.[21] Future technologies may also include Electro-Magnetic (EM) guns, Directed Energy Weapons (DEW) and Surface-to-Air Missile (SAM) Systems but all of these require one common capability; a Fire Control System working within a Universal Battlefield Management Command, Control, Communications, Computers and Information (BMC4I) network. A BMC4I system enables effective and timely engagement decision making. To maximise the capability it must integrate all the sensors and all the effectors available on the battlefield. Along with AD sensors this is the most vital element of AD on the battlefield and, arguably, one of the most difficult to achieve. The vast array of capability within NATO nations' AD systems combined with differing complexity creates a less than ideal platform for integration.

16 Hezbollah currently operates more UAS that the British Army and RAF combined.
17 Capt S. Miller RA, 'Joint Ground Based Air Defence', 4.
18 Michael S. Schmidt and Eric Schmitt. *Pentagon Confronts a New Threat From ISIS: Exploding Drones*. Accessed 11 December 2016, http://www.nytimes.com/2016/10/12/world/middleeast/iraq-drones-isis.html?_r=0.
19 Lietenant General Naresh Chand, *Future Trends in Army Air Defence Systems*, http://www.spslandforces.com/story.asp?id=274.
20 The Army Knowledge eXchange Newsletter (Jan 17 – Issue 8), http://akxportal.landforces.r.mil.uk/sites/akx/operations/threats.
21 UK Government, *National Security Strategy and Strategic Defence and Security Review 2015*, 29.

This situation generates an element of operational and tactical uncertainty which can only be overcome through investment: financial investment in procuring appropriate systems and investment in time by deploying and putting procedures into practice. The spectrum and sophistication of the modern air threat poses a difficult task to GBAD organisations. It is essential for overlapping and integrated air defence coverage in order to counter this wide range of threats, possibly deployed simultaneously.

PHOTO AP, S. GRITS

Rebels driving past destroyed Ukrainian military vehicles near Novokaterinivka, Ukraine, September 2, 2014

Converting 16 Regt RA to SKY SABRE – 'Back To The Future'

The key workstream enabling GBAD high-tech advancement is the conversion of the formation's SHORAD Regiment from Rapier, a visual range SHORAD system, to SKY SABRE, a BVR MRSAM system using the Common Anti-Air Modular Missile (Land) (CAMM(L)). This new capability will considerably enhance UK GBAD's capacity to engage the wide spectrum of air threats up to a range of 25km. 16th Regiment Royal Artillery will convert to SKY SABRE by 2020 and has investigated any lessons identified during its previous conversion from QF 3.7in guns to Thunderbird BVR capability during the late 1950s. In terms of having a BVR capability the Regt is, in an extremely positive way, going 'Back to the Future'.

SKY SABRE will include delivery of BMC4I functionality, integrated with networked Land-Ceptor Launchers into a primary Fire Control Centre (FCC) which will centrally Command and Control missile engagements within the context of a wider Air Defence Command and Control (C2) Battle Management (ADBM) environment. The CAMM (L) missile conducts 'intelligent' targeting once launched from the ground and can engage target sets such as helicopters, fast air (low/medium altitude), sub/supersonic missiles and tactical UAS. Intercept ranges are between 1km and 25km. With the engagement of Beyond Visual Range (BVR) targets possible through the use of mid-course guidance and radar updates, it heralds a step-change to the GBAD system.[22]

Whilst the SKY SABRE is a very different capability to Rapier, the Regiment has the benefit of already being equipped with the G-AMB Radar system. The familiarity and experience that 49 (Inkerman) Battery RA has developed whilst bringing the Giraffe radar into use, in the Recognised Air Picture (RAP) role, should stand the Regiment in good stead during the transition to SKY SABRE. SKY SABRE will be a paradigm shift in terms of capability, effectiveness and complexity.[23]

A key point is the importance of integration and communications in enabling the maximum possible effectiveness of SKY SABRE. Airspace coordination and control measures will become commensurately more complicated for SKY SABRE operators than they were for Rapier. With the through- life design of SKY SABRE there is significant potential to continue integration and development, with the use of Link 16, and the future Network Enabled Airspace Defence and Surveillance (NEADS) project among others.[24]

The Lightweight Multirole Missile (LMM) is a low cost, lightweight, precision strike missile for use on existing Starstreak HVM platforms (it can also be integrated onto some UK helicop-

22 Capt S. Miller RA, 'Joint Ground Based Air Defence', 4.

23 Lt H.D.S. Blanshard RA, *Duncan Essay Submission: What lessons can be drawn from 36 Regiment's conversion from 3.7 inch guns to Thunderbird after WW2,* 2016, 7-8.

24 Lt H.D.S. Blanshard RA, *Duncan Essay Submission: What lessons can be drawn from 36 Regiment's conversion from 3.7 inch guns to Thunderbird after WW2,* 8.

ters, Light Armoured Vehicles and UAVs for Air to Surface, Surface to Air, Surface to Surface and Air to Air attack). This Thales produced missile will be used by Jt GBAD's VSHORAD Regiment providing an extended range of 6km with a blast-frag warhead using laser beam riding guidance. Utilising the updated Stormer tracked vehicles of 12th Regiment Royal Artillery the Thales produced LMM will enhance the AD capability and also provide ground attack capability to the supported formation. Thales has already test-fired the LMM from a rotary UAV demonstrating possible future usage in the AD role.

Sensor clusters and Networking

NATO interoperability through the Link16 JRE Network is already achievable. Multifunction sensors are available or in development. They could be networked into clusters utilising the L16 Network to increase the system's capacity and Open Architecture – IAMD networking kits will also allow a nation to 'plug and fight'. This is essential for NATO interoperability. Multi-function Radars (MFRs) offer new capacities for air and missile defence due to SA sharing, plus sensor functions resources management extended via the network (cluster). Clusters of fire control sensors could enhance the interoperability between NATO nations, at sensor level, as an extension of the current NATO BMC3 backbone.[25]

Future Technologies – Low Tech

When coordinated properly All Arms Air Defence (AAAD) can provide an effective deterrent and, if required, destruction of l ow level air threats to friendly troops and protected locations. Although included in UK AD doctrine, AAAD has not been at the forefront of GBAD's training objectives, or practised, over the last decade. As part of GBAD's transformation AAAD has been recently practiced by sub-units. It is, by its very name, designed to be a procedure that is utilised as a capability (up to 1000m) by all ground forces although preferably coordinated by AD or Artillery advisors.

Developing Air Observers

As one of Jt GBAD's transformation workstreams, developing air observers is key to countering Low, Slow, Small, Stealthy and Swarming (LS4) targets. With mini-UAS prevalent on the modern battlefield, and the likelihood of a stringent EMCON environment that only allows GBAD radars to operate on an 'radiate then vacate' basis, we are re-learning the role of Air Observer.

Technology has changed dramatically, but the requirement for a single air picture and a timely and effective response has not. The modern day Air Observer will take recent lessons learned during Op OLYMPICS to develop the skills required for the modern GBAD battle. Air Observer CONOPS are being developed by HQ Jt GBAD.[26]

International Cooperation – NATO and the Strategic Level

'Thus, no matter how much Brexit changes other aspects of British life, I predict the impact so far as our Armed Forces are concerned will be negligible.'[27]
The security and stability of the UK has long depended on its strong partnerships in the Euro-Atlantic area, including NATO. The UK Government wishes to deepen its security, intelligence and defence relationships in particular with the US, France and Germany. The USA is likely to remain the world's leading military power in 2035, although its military advantage is likely to be challenged increasingly by China.[28] Working within international organisations, or with allies and partners, is likely to remain the preferred method of

25 LUC DINI, Thales, *A perception of the threat and IAMD*, RUSI Missile Defence Conference London, 13 April 2016, https://rusi.org/sites/default/files/luc_dini.pdf.
26 Capt S. Miller RA, 'Joint Ground Based Air Defence', 3.
27 General Sir Graeme Lamb, *While Europe Blusters: Britain's military will still be a force to be reckoned with after Brexit*, Telegraph, 08 Dec 2016, http://www.telegraph.co.uk/news/2016/12/08/europe-blusters-britains-military-will-still-force-reckoned/.
28 United Kingdom Government, *Future Operating Environment 2035* (Crown copyright) 5.23.

international engagement for the UK in 2035. The EU is also likely to continue to play a greater defence and security role. Interoperability and adaptability will be key as bespoke alliances and partnerships are formed, both between nations and with non-state actors.[29] The mission of NATO Air Defence – to achieve and maintain air superiority to protect NATO territory in peace, crisis and conflict – remains as relevant today as when it was established in 1961.[30]

In 1961, US President John F. Kennedy described America's commitment to support European countries vulnerable to Soviet domination as ''our central and most important defensive alliance''. Since his victory, President Trump has been more emollient; General Richards described Mr Trump as a 'pragmatic man, who wants to see a stable relationship with Russia and with Mr Putin that is in the interests of all NATO members.'[31]
The UK aims to intensify its security and defence relationship with Germany whilst keeping open the possibility of cooperation with Russia.[32] The UK will continue to seek to engage with Russia on global security, including international efforts to tackle the ISIL threat, building on the successful cooperation that we shared in negotiations on Iran's nuclear programme. While our Armed Forces can and will whenever necessary deploy on their own, we would normally expect them to deploy with allies such as the US and France, through NATO, or as part of a broader coalition.[33]
The UK Government aims to further strengthen the UK-France defence and security relationship.[34] Building on the Lancaster House Treaty signed in 2010, the agreements further the security and prosperity of the two nations through commitments to jointly invest in the procurement of defence equipment, the joint training of armed forces and the continued development of the Anglo-French Combined Joint Expeditionary Force.

PHOTO MBDA, C. MILES

MBDA's Land-Ceptor Vehicle and CAMM(L) Missile, SKY SABRE

International Cooperation (Operational and Tactical Level)

In a national context, the operational level is the responsibility of the Joint Commander. The tactical level of warfare is the level at which formations, units and individuals ultimately confront an opponent or situation within the joint operations area.[35] Direction from HQ Jt GBAD states that a Future VSHORAD (FuVSHORAD) force must be Combined, Joint, Intra-governmental, Inter-agency and Multinational (CJIIM) by design, with priority

29 United Kingdom Government, *Future Operating Environment 2035*, 5.23.
30 North Atlantic Treaty Organisation, Fifty Years of Defending NATO's Skies. Accessed 9 July 2011, http://www.nato.int/cps/en/natohq/news_76598.htm?selectedLocale=en.
31 General D.J. Richards, Baron Richards of Herstmonceux, GCB, CBE, DSO, DL, BBC Radio 4, *The World This Weekend Programme: Baltic states fearful of Trump's Nato views.* Accessed 04 December 2016, http://www.bbc.co.uk/news/world-us-canada-38051155.
32 UK Government, *National Security Strategy and Strategic Defence and Security Review 2015*, 52.
33 General Sir Nick P. Carter KCB, CBE, DSO, ADC Gen, *Chief of the General Staff Message*, letter dated 15 Dec 16, 2.
34 UK Government, *National Security Strategy and Strategic Defence and Security Review 2015*, 56.
35 JDP 0-01 (5th Edition), 1.60, 1.61, https://www.gov.uk/government/ uploads/system/ uploads/attachment_data/file/389755/20141208-JDP_0_01_Ed_5_UK_Defence_ Doctrine.pdf.

PHOTO SCHIEBEL

The Lightweight Multi-role Missile (LMM) aboard a Schiebel Camcopter S-100 UAV

given to US and FR interoperability; Effective Maritime and Air integration will require commitment to routine Jt readiness training, to include JEF FEs and Jt Enablers.[36] The Principles of Joint Air Defence[37] are the doctrinal guide for all UK GBAD FEs to exercise interoperability with NATO partners.

As US AD is composed of mainly air defense systems such as the PATRIOT Missile System, Terminal High Altitude Air Defence (THAAD) and Avenger, any future NATO or 'ad hoc' coalition deployment will more than likely depend on US involvement. In addition to the integration of capabilities it is essential to continue to understand US AD doctrine and operational/tactical procedures in order to be able and ready to link in for any future deployments.

The Netherlands Ground-based Air Defence Command operates various ground-based air defence systems including PATRIOT, National Advanced Surface to Air Missile System (NASAMS), Fennek Stinger Weapon Platform and the TRML system (airspace monitoring radar).[38] Tactical deployments of Dutch and UK AD sub-units have demonstrated the benefit of a common understanding within a NATO setting. Ex JOINT WARRIOR 15/1 in Scotland witnessed the first combined AD CP that included a UK Rapier FSC sub-unit, Air Defence Troop Royal Marines (HVM), Dutch Stinger Platoon and a combined C2 element. Along with attached RAF TACP personnel it was the first time a tri-Service, multinational AD CP had deployed in support of this NATO exercise. Future deployments must continue in quick succession in order to develop confidence in common operating procedures. All NATO air defence capabilities differ in modernity, procedural function and complexity although each user nation should have the common goal of defending the skies from attack by many different potential adversaries. The key areas that will dictate whether the mission is achievable will be the C2 and BMC4I capability and capacity.

Future NATO AD Exercises will be vital to the readiness of all partnership forces. Exercise TOBRUQ LEGACY (TOLY) 2016 was visited by a UK contingent in order to assess the practicalities of deploying AD FUs and a command structure during future Exercise TOLY deployments. The exercise provided an excellent opportunity for multinational SBAD FEs to operate within a NATO environment in order to improve levels of training and interoperability for potential contingent deployments.[39] Exercise TOLY presents an opportunity for FEs from Jt GBAD to operate alongside NATO counterparts. The training benefit is significant and is realistic in terms of potential operational deployments in a contingent capacity, especially given the increased focus on Trans-Atlantic Capability Enhancement Training (TACET) Initiative and Enhanced Forward Presence (eFP). The Exercise will allow the UK to deploy assets in order to operate and practice procedures alongside other NATO SBAD sub-units. This will enable forces to exercise interoperability, interconnectivity, C2 and communications in a multinational SBAD environment (NATO SBAD

36 Future Very Short Range Air Defence (FuVSHORAD) – Concept Briefing Note, 30 June 2016, 6.

37 Defence (Concentration of Force, Mutual Support, All Round Defence, Defence in Depth, Engagement Before Kill Line, Cooperation and Integration).

38 Royal Netherlands Army, *Defence Ground-based Air Defence Command*, https://www.defensie.nl/english/organisation/army/contents/units/defence-ground-based-air-defence-command.

39 Major C.W.I. May RA, *EXERCISE TOBRUK LEGACY 2016 (TL16) Report* (dated 03 Oct 2016) 2.

PHOTO UK MINISTRY OF DEFENCE

5-7 Air Defence Battalion and 16 Regiment Royal Artillery liaison visit Baumholder, September 2016

interoperability (LINK-11B, JREAP-C, LLAPI)). It also provides a platform to validate NATO SBAD common and Full Scale Scenario Reaction procedures; a key element in NATO training considering the potential threats. The creation and testing of SBAD Taskforces also provides common training which fulfils the NATO Annual National Targets for the political level. The first Rapier FSC sub-unit to deploy on Exercise TOLY in Jul 17 will be 14 (Cole's Kop) Battery, 16 Regiment RA.

Anti-Access/Area Denial (AA/AD) systems in Kaliningrad and the threat of Russian first use of Weapons of Mass Destruction (WMD) are likely to force any NATO/JEF land defence or reinforcement of the 3 Baltic States (3BS) and Poland, to operate in contested airspace. As part of the NATO Readiness Action Plan the US, Germany and UK implemented the TACET initiative. UK GBAD forces are currently deploying active and passive capabilities in order to ENABLE 3BS GBAD integration into NATO IADS, and conduct integrated training in order to DETER, DETECT and DOCUMENT (D3) hostile incursions into 3BS airspace, focussed on the spectrum of LS4 targets and low flying rotary wing assets. Whether deploying as part of a multi-national Alliance (NATO) or an ad hoc coalition, the UK's Jt GBAD units and supporting HQ element are currently reorganising in order to support these deployments. It is evident that interoperability at the tactical level is improving with the increased training opportunities that are available to NATO SBAD/GBAD units. Interoperability at the strategic level is a direct result of international cooperation and, as such, is required to shape itself in order to conform to political will and intent. Cultural challenges in terms of a common understanding of NATO AD doctrine and procedures (particularly ROE and WCS at the tactical level) remain. True interoperability at the tactical level will require heavy investment in exercising operational and tactical interoperability, C2 and live firing opportunities. The extent of NATO nations' AD commitment to these deployments will indicate the true strength of NATO's integrated and rehearsed AD capability. The exploitation of synergies and enhancing AD cooperation will ensure that the whole is greater than the sum of our parts. ■