

# Air & Space Power 2020

Information Advantage for the Next Generation Air Force





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# Air & Space Power 2020

Information Advantage for the Next Generation Air Force

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Printed by Pensord

Front cover image: Air and Space Power Association

Published by



Chantry House, Suite 10a High Street,  
Billericay, Essex CM12 9BQ  
United Kingdom  
Tel: +44 (0) 1277 655100



On behalf of the Royal Air Force  
Ministry of Defence Main Building,  
Whitehall, London SW1A 2HB, UK  
[www.raf.mod.uk](http://www.raf.mod.uk)

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# Contents

## Forewords

- 13 **Rt Hon Ben Wallace MP**  
Secretary of State for Defence
- 19 **Air Chief Marshal Sir Mike Wigston**  
KCB CBE ADC, Chief of the Air Staff
- 24 **Admiral Tony Radakin**  
CB ADC, First Sea Lord and Chief of the Naval Staff
- 26 **General Tod D Wolters**  
Commander, United States European Command
- 28 **Simon Michell**  
Editor, *RAF Air & Space Power 2020*

## Gaining and exploiting Information Advantage

- 31 **Gaining Information Advantage – a return to strategic thinking**  
Air Marshal Edward Stringer highlights the importance of gaining Information Advantage prior to and during operations
- 37 **Multi-domain operations and Information Advantage**  
Air Vice-Marshal Ian Duguid, Commander of Number 11 Group, explains how his organisation is helping the RAF undertake multi-domain operations and achieve Information Advantage



- 40 **Sir Simon Bollom**  
CEO, Defence Equipment and Support (DE&S)
- 42 **Paul Everitt**  
Chief Executive, ADS Group
- 43 **Information Advantage through the ages**  
Seb Cox, head of the RAF's Air Historical Branch, explains how being able to take to the air had a decisive impact on the quality and speed of information, leading to a number of spectacular successes in both world wars
- 46 **Beyond collection – the challenges of exploiting intelligence to maintain Information Advantage**  
Wing Commanders Andrew Myers-Hemingway and Nev Morgan explain why the collection of raw information is only part of the intelligence cycle
- 49 **Data fusion and distribution – 'everyone by nature desires to know'**  
Brigadier Paul Lynch MC RM, Commander of the National Centre for Geospatial Intelligence, discusses how the ability to distribute and display pertinent situational awareness enables its foremost proponents to gain battle-winning advantage
- 52 **Major General Francis Omondi Ogolla**  
MGH, EBS, HSC 'ndc' (K) 'psc' (Fra),  
Commander, Kenya Air Force
- 53 **Information Advantage at home and abroad**  
Air Commodore Lol Bennett, Commander of the Joint Force Air Component, talks about the challenges of achieving and maintaining Information Advantage within UK forces, as well as with NATO allies
- 56 **Timber Sour**  
Northrop Grumman's Paul Tremelling explains why maintaining airborne tactical data links has become a major priority for the modern warfighter
- 59 **Space vision**  
An interview with Air Vice-Marshal Harv Smyth, who assumed the role of the UK's first Director Space at the Ministry of Defence earlier this year



- 62 **Operation Olympic Defender**  
Group Captain Darren Whiteley details the duties of the UK's team of space experts supporting the US-led Operation Olympic Defender
- 66 **General James H Dickinson**  
Commander, U.S. Space Command
- 68 **Virgin Orbit**  
Virgin Orbit is offering a radical alternative for organisations looking to place small satellites into earth orbit. Flight Lieutenant Mathew Stannard talks about this game-changing breakthrough
- Ad Astra – preparing for the future**
- 70 **The Astra initiative – in the information age**  
Air Vice-Marshal Ian Gale, Assistant Chief of the Air Staff (Strategy), reveals how the Astra initiative will turbocharge change in the Royal Air Force
- 72 **The future of Combat Air**  
Air Commodore Dan Storr offers an update on the work to ensure that the UK remains at the forefront of Combat Air System development
- 75 **The challenge of the Combat Air Strategy**  
Andrew Kennedy, Strategic Campaigns Director at BAE Systems, explains why the UK is destined to remain a world leader in the design and production of Combat Air Systems for many years to come
- 78 **Mark Goldsack CBE**  
Director of the UK Government's defence exports department – DIT DSO
- 79 **F-35B Lightning Force evolution**  
Air Commodore David Arthurton offers his vision for the evolution of the F-35B Lightning, which has reinforced the RAF's reputation as a truly advanced air and space force since entering service
- 83 **Introducing P-8A Poseidon**  
Wing Commander James Hanson, Commanding Officer of No 120 Squadron, explains how the first of nine P-8A Poseidon maritime patrol aircraft was ready to go straight into operation as soon as it was delivered to the UK
- 85 **Typhoon spiral development**  
Chris Kelly, UK and Europe Programme Director, BAE Systems – Air, explains why the Typhoon will be developed to become a complete battlefield controller and, in doing so, help to develop some of the innovations that will be deployed on Tempest
- 87 **Major General Amikam Norkin**  
Commander of the Israeli Air Force
- 88 **Qatari cooperation**  
Air Commodore Chaz Kennett highlights the benefits of the collaborative effort between the UK and Qatar in the procurement of 24 Typhoon fast jets for the Qatar Emiri Air Force

- 91 **Potent protector – Protector RG-1 developments**  
Wing Commander Iain Hutchinson explains how RAF operators and engineers are helping the remotely piloted Protector air system fulfil its potential
- 93 **MQ-9B – pushing the boundaries**  
Dr Jonny King, Vice President at General Atomics Aeronautical Systems UK Ltd, explains how Protector – a certifiable MQ-9B SkyGuardian – will revolutionise RPAS operations for the UK
- 95 **Counter-drone technology**  
Peter Clarke, head of the Defence UAS Capability Development Centre’s C-sUAS Rapid Innovation Cell, highlights work to ensure that the UK can defend against unwanted drone activity
- 98 **Air mobility**  
Air Commodore Domonic Stamp, Air Mobility Force Commander, reveals how he squeezes the optimum output from his fleet of transport and air-to-air refuelling aircraft
- 100 **General Maryanne Miller**  
Commander, U.S. Air Mobility Command
- 101 **People of the Next Generation Air Force**  
Air Vice-Marshal Maria Byford QHDS explains how the RAF is adapting to meet the needs of the Service and the people who serve within it



## Safety, training and operations

- 103 **Safety first**  
Air Marshal Sue Gray, the RAF’s most senior female officer, discusses the principal challenges facing the RAF and Defence in ensuring the very highest standards of safety
- 106 **F-35B Lightning on Westlant 19**  
Captain James Blackmore (RN) gives an update on the F-35B Lightning and Queen Elizabeth-class progress towards Initial Operational Carrier Strike Capability at the end of 2020
- 108 **Lightning Dawn**  
Wing Commander John Butcher, Commanding Officer of No 617 Squadron, explains why last year’s F-35B Lightning deployment to RAF Akrotiri in Cyprus was more than just routine training
- 110 **Red Arrows over North America**  
Wing Commander Andrew Keith recounts some of the highlights of the Red Arrows’ first tour of North America in more than a decade
- 112 **Building bridges – support to civil authorities**  
A look at the critical role played by RAF Chinooks, working alongside civilian authorities, to shore up the dam at Toddbrook Reservoir and save the town of Whaley Bridge in August 2019
- 115 **Helicopter Interim Course Capability – UKMFTS**  
Group Captain Chris Mullen, Commandant of the Defence Helicopter Flying School, on a major milestone for the rotary-wing element within UKMFTS

# Looking forward

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# Rt Hon Ben Wallace MP

Secretary of State for Defence

**2020** reminded us of the value of airpower. In the midst of the Covid pandemic, our aircrews set up helicopter hubs, delivered PPE, airlifted patients from remote locations, and supplied medical reservists to the wards.

The RAF also continued to show it is a force for good across the globe. Whether flying a field hospital to aid workers in West Africa fighting the virus, scrambling to defend Eastern European skies from aggression or striking Daesh terrorists in their Middle Eastern hideouts.

Yet our opponents continue testing us, seeking to go higher, faster and further. The old notions of static peace and war have crumbled in the face of a new age of constant competition. So the RAF must be nimbler than its enemies. We need to hide from and find our opponents – whether in the physical world or in cyber space.

But change is coming. Our RAF is rebalancing from Industrial Age to Information Age capabilities – investing in cyber, space, electronic warfare, AI, robotics and autonomy – while integrating with the best of what we've already got.

We've purchased our first ground-breaking Protector – a remotely piloted aircraft with extraordinary endurance and surveillance capabilities. Our world leading F-35s offer unrivalled intelligence gathering capabilities as well as providing the strike element of our Carrier Strike. And we're developing a new generation of radar for our Typhoons, complete with the ability to locate, identify and suppress enemy air defences using high-powered jamming.

Meanwhile, we've trialled new autonomous swarm technology that can trick enemy radar. Our new fleet of E7 Wedgetail surveillance and airborne control aircraft based at RAF Lossiemouth can simultaneously track



During 2020, F-35s continued their preparation for HMS *Queen Elizabeth*'s first operational deployment (PHOTO: CROWN COPYRIGHT/MOD)

multiple targets in the air and at sea. And they will join forces with our rapidly growing fleet of P8 Poseidon – the world's premier maritime reconnaissance aircraft.

In future, however, it will no longer be enough to rely on one fighter, or one type of aircraft. To defend, police, control and command the battle space of the 2030s, 2040s, 2050s and even the 2060s, we must have multi-role and flexible capabilities with greater integration between the services.

So we're looking decades ahead with our Future Combat Air Systems. We're embracing artificial intelligence, deep learning, novel sensors and communications technologies. We're investing in technologies to rapidly and seamlessly connect operations and share magnitudes of data across every domain.

Our new systems will switch at will from manned to unmanned while utilising directed energy and high-speed weapons. And they will be built around open architecture – allowing for constant upgrades while retaining that all-important human finger on the trigger. Today, well in excess of 90 per cent of our RAF Combat Air Vehicles are manned and the rest unmanned. I fully expect a major reversal of those proportions by 2040.

Yet the challenges we face come as much from space as from the air. Space is fundamental to our way of life. Our adversaries are using a plethora of space-based communications,

cyber and electronic warfare and unmanned drones to unsettle us. Last year, I called out Russia's aggression in orbit with the provocative test of a weapon-like projectile from a satellite threatening the peaceful use of space. Russia is not alone. China, too, are developing offensive space weapons.

So we're working very closely with the UK Space Agency to create a National Space Operations Capability that will help us act unhindered to secure our national interests in space. Our UK Space Command also becomes operational this year. It will strengthen our sovereign Intelligence, Surveillance and Reconnaissance capabilities, allowing us to launch our first satellites, as well as our first rocket from Scotland. And, with SKYNET now brought into Defence ownership and our SKYNET 6A contract signed, we're making sure we can provide continuous communications support to our deployed forces for many years to come.

Covid has reminded our nation of the urgent need for resilience. We must be ready for whatever lies around the corner. To win the conflicts of tomorrow we must be more assertive, more innovative and more integrated. We must push back against our adversaries every single day. Our Integrated Review and our multi-year £16.5bn settlement have put Global Britain on the right path. But we must summon the daredevil spirit of our aviators if we're to lift our country to even greater heights. ◉



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A close-up photograph of a silver car wheel and headlight, set against a blurred background of a factory interior. The wheel has a multi-spoke design and a black center cap. The headlight is highly reflective, showing the surrounding environment. The overall scene is brightly lit, suggesting an industrial setting.

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# Air Chief Marshal Sir Mike Wigston

KCB CBE ADC, Chief of the Air Staff

I am delighted to welcome you to another edition of *Air and Space Power*. In this eventful year, we have been reminded constantly how important effective communication is, so it is fitting that, this year, Information Advantage is our core theme. The topic is introduced by Air Marshal Edward Stringer on page 31 and is followed up with a range of fascinating articles by people within the Royal Air Force and across the global Defence enterprise. Information Advantage was at the heart of this year's virtual Air and Space Power Conference, delivered online to our largest-ever audience, and we intend to repeat and improve that format for next year.

It has been an extraordinary year for all of us, and I am extremely proud of the way the Royal Air Force has continued to deliver on our commitment to United Kingdom Defence, the way we have supported the national effort against COVID-19, and the

way we have supported our international allies too. This year, we also welcomed Typhoon personnel from the Qatar Emiri Air Force to the UK as we formed 12 Squadron, the first joint Royal Air Force & Qatari squadron. Air Commodore Chaz Kennett outlines this outstanding example of international cooperation on page 88.

Meanwhile, we have continued to operate continuously in support of operations against terrorism in Afghanistan, Iraq, Mali, Syria and beyond. Our Air Transport force is a constant wherever we operate, and Air Commodore Dom Stamp brings us up to date with what our highly effective movers have been up to on page 98. And, whilst a relatively newer capability, the Reaper Force's relentless contribution to intelligence, surveillance, reconnaissance and attack missions is highlighted. General Atomics outlines the centrepiece of our current remotely piloted capability on page 93. Last, but not least, the Royal Air Force became a maritime air



**As part of Operation Rescript, more than 170 members of the Royal Air Force arrived in Merthyr Tydfil, South Wales, in support of the national effort to combat COVID-19, helping to deliver the second round of whole-town testing (PHOTO: CROWN COPYRIGHT/MOD)**

force once again this year with the operational declaration of our Poseidon maritime patrol aircraft and the continued operational work-up of our Lightning Force, alongside the United States Marine Corps, on the Royal Navy's HMS *Queen Elizabeth*. On page 106, Captain James Blackmore describes HMS *Queen Elizabeth*'s 2019 deployment, while Group Captain John Butcher writes about No 617 Squadron's first operational deployment with Lightning.

On 19 November, the United Kingdom Prime Minister announced the biggest investment in the country's Armed Forces since the end of the Cold War, confirming an injection of £16.5 billion over four years. That announcement will enable us to invest in next-generation military capability, defending our people from new and evolving threats, and protecting the world's most vulnerable. This clear signal of intent confirms the UK's position as a global leader in Air and Space Power. For the Royal Air Force, this means the next step in the development of the Future Combat Air System, uninhabited and swarming systems, Artificial Intelligence and other novel capabilities.

We are also taking rapid steps in advancing our Space capabilities, headlined by the announcement of the formation of Space Command and the intent to demonstrate a sovereign launch capability in 2022. The Space domain has long been critical to military success, but it now permeates every aspect of day-to-day life. In recent years, advancements in miniaturisation, combined with a quantum leap of commercial investment and interest, have resulted in the fastest rate of progress in Space since the 1960s. We have an abundance of Space content in this issue to bring you up to date, from our Virgin Galactic partnership to our contribution to the Olympic Defender debris warning and protection capability. To cap this collection off, I commend to you Air Vice Marshal Harv Smyth's piece on page 59, covering the Royal Air Force Space Vision.

I hope you enjoy these and all the other fascinating articles in this volume. The Air and Space Power Conference theme for next year will be the Air and Space Force of 2040. I look forward to sharing that journey to the future with you. 

QINETI



# Delivering Information Advantage

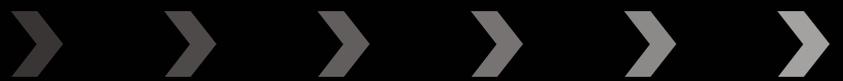
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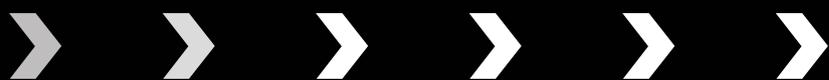
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# Admiral Tony Radakin

CB ADC, First Sea Lord and Chief of the Naval Staff

I am delighted to have been asked to contribute a foreword to this year's *RAF Air and Space Power* publication. We live in an era of unprecedented transformation. We are all aware of the huge changes brought about by the ever-increasing rate of technological development. However, in recent months, the COVID-19 pandemic has also changed the world, in ways that we are only just beginning to understand.

Given this, it is more important than ever that we ourselves transform. The Royal Navy and the RAF have been working in parallel on transformation initiatives designed to make our two services even better, more efficient and ready to face the challenges of tomorrow. And we are working together with the rest of Defence; this truly is a joint effort.

Many of the most exciting developments for both our services involve working together. Our shared priority – indeed, Defence's highest priority – is the delivery of the Continuous at-Sea Deterrent. The P-8A aircraft will be genuine game-changers in terms of delivering ASW (anti-submarine warfare) from the air, and we are now together relearning the expertise that we perhaps took for granted when I was a junior officer. The fact that the US is already operating P-8A, and Norway and potentially

other NATO nations are committed to doing so, increases our ability to work and share data with our NATO allies.

And, of course, perhaps the biggest change of all is that we are once again becoming a carrier strike nation. When the Queen Elizabeth-class aircraft carriers go to sea operationally, they do so with Royal Navy and RAF personnel on board and, potentially, Army and StratCom and international partners as well. We operate them in a task group with international allies, and we embark jets from partner nations. This really is a joint and multinational endeavour.

Reading this publication, I am struck by how many aspects of air and space power are relevant to other domains as well. From developing information advantage, through to the better use of drones, to ensuring safety in training and operations – these are areas that matter to us all. And, so, I am really pleased by the breadth of contributors working together, from different services, different specialisations and different nations. Learning from one another and harnessing our common expertise is the best way of delivering what we all need, intelligently, efficiently and swiftly. We are entering an exciting future, and we are entering it together. 🗨️



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**Leading The Situational Awareness Revolution**



# General Tod D Wolters

Commander, United States European Command

The men and women of our armed forces remain vigilant and work tirelessly to deter aggression, defend national interests and sustain peace. Information Advantage advances decision quality and speed of action over potential adversaries... improving outcomes in competition, crisis and conflict. The competition for Information Advantage must be inherent in coalition all-domain operations. We achieve game-changing significance when we focus Information Advantage through the lens of our 21st-century warfare pillars, improve transparency and alignment, and enhance our posture.

We live in an increasingly complex and contested world. Threats and challengers seek to take advantage of force presentation imbalances in every domain to improve their position. As such, our approach to deterrence and defence must be all-domain. Increasing Information Advantage requires laser-focus on improving Indications and Warnings, Command and Control, as well as feedback and Mission Command. These 21st-century warfare pillars are essential as we perpetually compete for Information Advantage, and they underpin all other deterrence and defence activities.

We strengthen these pillars as we improve transparency and alignment across military service components, Allies and Partners, and whole-of-society organisations and efforts.

Increased person-to-person and machine-to-machine exchange will add to our data sets and enhance our ability to create frameworks that place activities in historical, geographical and cultural context. This is ever-important in an age of exponentially growing data and often-opaque decision space.

We must relentlessly strive to improve our stance (posture) in the Euro-Atlantic. Every day, we must continue to ensure we have the right forces, in the right place, at the right time, in all domains. The right stance enables speed of action to counter malign activity in one domain, or exploitation of advantage in others. Placing speed relative to potential adversaries as an imperative for everything we do increases the likelihood of obtaining favorable outcomes... this saves lives and preserves peace.

The United Kingdom's investments in a range of advanced interoperable platforms, contributions to combined air, space and cyberspace operations centres, intelligence centres, and deliberate investment in purpose-built organisations like RAF No 11 Group are pivotal. Further integration in exercises and operations add scale, scope and innovation to what the US and other Allies and Partners are doing in the daily pursuit of Information Advantage.

We deeply value the relationship we have with Allies and Partners and are honoured to stand shoulder-to-shoulder in every domain as we sustain peace together... across the Euro-Atlantic, and around the globe. 🌐



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# Simon Michell

Editor, *RAF Air & Space Power 2020*

This *RAF Air and Space Power 2020* publication covers a wide spectrum of activities and capabilities, and, like the 'virtual' conference that replaced this year's Chief of the Air Staff's 'physical' July Conference, it focuses on Information Advantage. We are, consequently, extremely grateful to Air Marshal Edward Stringer for his in-depth and fascinating feature on the subject. This illuminating piece is backed by a series of supporting articles that illustrate the importance of information on Multi Domain Operations, as well as the key facets of collecting, distributing, fusing and exploiting this priceless asset.

Another key topic for the publication is the growing importance of Space as an operational domain and to both civil and military interests. We are indebted to the MOD's first Director Space, Air Vice-Marshal Harv Smith, for his explanation of the UK's Space strategy and his plans for enhancing UK Space policy and capability, in partnership with the US and other key allies.

The airborne foundations of the UK's Next Generation Air Force are being established along a coordinated pathway. The F-35B Lightning continues its impressive progress into service, with the carrier-based exercises in the Atlantic proving the awesome capability of this fifth-generation fast jet. The coverage by Captain Blackmore (RN) of the evolution in the nation's carrier-enabled power projection is a fascinating account of how the aircraft is steadily assuming its central role in the UK defence posture. Wg Cdr John Butcher, 617 Sqn 'Dambusters' Commander, also highlights the F-35's first operational sorties during Exercise Lightning Dawn.

The first three of 16 replacements for the Reaper remotely piloted air system (RPAS) have been ordered, quickly followed

by the establishment of a wide-ranging Statement of Intent with Belgium to cooperate on the maintenance, training and support of both countries' Protector/MQ-9B aircraft. And, whilst efforts to further update the Typhoon fast jet are in play, the international project to design and produce its sixth-generation successor, under the Team Tempest banner, met with a further boost when first Sweden, then Italy, officially joined the group.

Whilst all these activities were under way, the coronavirus pandemic raged and the nation was locked down. Throughout this worrying time, the RAF and its sister services not only continued to undertake their given responsibilities, taskings and operations – albeit under socially distanced conditions, wherever possible – but also stepped up to offer military aid to the civilian government. As part of the Covid Support Force, the RAF (Auxiliaries, Regulars and Reserves) helped to repatriate stranded tourists from far afield, assisted local planners in addressing their coronavirus challenges, set up mobile testing teams and ferried key pandemic advisors and practitioners around the nation. Whilst this is far from business as normal, the RAF embodies the levels of flexibility and agility that are needed to address the cataclysmic impacts of this type of disease.

In addition to the introduction from the Secretary of State for Defence, Rt Hon Ben Wallace MP, and the Chief of the Air Staff, ACM Sir Mike Wigston, we are proud to welcome insights and perspectives from partners and friends. This year we are particularly grateful to the First Sea Lord, Admiral Tony Radakin, and General Tod Wolters, US EUCOM Commander, as well as the Chiefs of the Israeli and Kenyan air forces, Major Generals Amikam Norkin and Francis Ogolla. 🇮🇱



**Protector RG Mk1**

# AIRSPACE ACCESS

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The RAF's Protector RG Mk1 is based on the new generation MQ-9B SkyGuardian and will operate in non-segregated civilian and international airspace. It has been designed to the same stringent airworthiness standards as manned aircraft, will have a detect and avoid system and be certified by the UK Military Aviation Authority (MAA).

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**Leading The Situational Awareness Revolution**



# Advanced electronics for information advantage



## Norman Bone MBE FRAeS

Chair and Managing Director,  
Leonardo UK

### Delivering 'Information Advantage for the Next Generation Air Force' is at the core of what we do at

**Leonardo.** From our electronic warfare and radar technologies, to our capabilities in mission data analytics and our responsibilities leading the development of complex electronics for the Tempest programme, supporting information advantage on operations is at the heart of our work. At the same time, our enduring commitment to UK research, skills, advanced manufacturing, exports and jobs throughout the country means that we are closely aligned with our partners in the RAF and international allies.

A great example is the next-generation ECRS Mk.2 radar for RAF Typhoons. That radar, currently being designed and built by Leonardo in Edinburgh and Luton and integrated onto the Typhoon aircraft by BAE Systems, will be the most capable radar system ever produced for a fighter

jet. Typhoon pilots will be able to engage targets while outside of the reach of threats, detect and jam enemy systems and operate inside the range of opposing air defences – all examples of information advantage in-action.

We're taking this concept even further as we forge ahead with research and development work as part of Team Tempest. The Tempest system is being designed from the inside out, with information advantage front of mind. On operations, Tempest will be constantly mining multiple sources of data, with the on-board processor coordinating them to provide extremely reliable, usable information. By using this information to make correct decisions faster than the adversary, we estimate that the Tempest operator will be able to stay two to three steps ahead in a combat situation – a battle-winning information edge.

Maintaining this kind of advantage in the long term, as our adversaries continue to invest in their own technology, is no small challenge. However, I'm confident that we can do it for two reasons. First, is that we have, here in the UK, the specialist skills, research and facilities we need

to produce world-class capabilities for the RAF. Second, because of the close working relationships Leonardo and our industry partners have established with the RAF over the years. Our people work side by side with RAF personnel on a daily basis and we're privileged to be able to see up-close how what we do supports those serving on the front line. These relationships keep industry in tune with the real demands of operations.

Take, for example, our partnership with the Rapid Capabilities Office, which continues to invest in disruptive technology that will revolutionise warfare. Projects such as BriteCloud, which saw us working together to develop the world's most advanced expendable decoy, and ongoing research into swarming drones, are both projects that exemplify the role of information advantage in meeting operational needs.

In a time of global challenge and unpredictability, one of the rock-solid constants that the UK can rely on is the security provided by the RAF. We're proud to be contributing to the information advantage that will underpin the delivery of this security in the future.





# Gaining Information Advantage – a return to strategic thinking

Director General of Joint Force Development and the Defence Academy  
**Air Marshal Edward Stringer** highlights the importance of gaining Information Advantage for exploitation prior to and during operations

**“Strategy without tactics is the slowest route to victory; tactics without strategy is the noise before defeat.”** – Sun Tzu

**T**he rapid evolution of the internet, and the global market in the data it has created, are altering the fabric of society, the economy and the labour market. This is usually described as the dawn of the Information Age. Businesses that saw the possibilities early and adapted have thrived; those that have clung to the ways of the Industrial Age are withering.

We are still coming to terms with its ramifications: the influence of the echo chambers of social media; the effect on markets of companies that can eavesdrop on the fears and desires of its customer base, and manipulate them; the philosophical and legal implications of an artificial intelligence that can tell us what to do, but cannot tell us why. These phenomena have almost perfect parallels in the Defence and security arena.

Just as the factory, telegraph, railroad and machine gun ushered in industrial warfare and wars of production, the information age will bring in

**Before the internet, the defence industry would have worried more about the vulnerabilities of their equipment in battle than the likelihood of their design plans being stolen** (PHOTO: ISTOCK/ GORODENKOFF)

information warfare in turn. We have seen how the introduction of cyber, space, electronic warfare and drones has altered the 'ways' of the final chapter of industrial warfare. It has been a rapid evolution. But the convergence of four key technologies of the information age – cloud computing, robotics, artificial intelligence and big data – promises to revolutionise warfare as surely as the Industrial Revolution did.

Industrial Age Warfare was continental in scale, yet by the end of the Second World War (WWII), the Allied Powers had constructed a genuinely global, intercontinental strategy that unwound the Industrial Age power of the Axis. Air and sea power was key to this strategy. Information Age warfare has taken this to a new level. The information environment is inherently global in its nature, and the revolution it has caused must be viewed in global terms. There is no 'home and away' anymore. Military strategies must be global in outlook too.

### Industrial espionage at scale

We are now seeing how our competitors are exploiting the more sinister possibilities of this global revolution as they use the speed, reach and ambiguities inherent in the information environment and the cyber domain to continually influence, subvert and conduct industrial espionage on a truly industrial scale. Traditionally, we would have worried about the air-defence threat to the F-35, not that competitors might have stolen its detailed technical plans before it was even built. The information environment is not one that can be entered episodically on a contingent basis – and, as the cyber domain is the enabling arena of the information battle, then neither can it.

Military operations can no longer be considered as stand-alone, localised interventions. Conditions will have been set long before we consider mounting them. Conditions in the technical arena of cyberspace, where we may find that our vital systems have been compromised by intrusions on our networks; and conditions in the more cognitive arena of the information environment, where the narrative held in the public consciousness, and, therefore, public will, may already have been undermined by a continuous drip-feed of corrosive disinformation that we ignore at our peril.

In the same way that the UK, as the leading maritime power, dominated the maritime environment in all its dimensions in the 18th and 19th centuries, enabling global trade and the Industrial Revolution, and western air power dominated the 20th century, so the UK must become an international cyber power, and in all its dimensions too, in the 21st.

**Space has been an extension of the UK's aerospace effort since the end of the Second World War and has become a crucial warfighting domain** (PHOTO: ISTOCK/3DSCULPTOR)





Those dimensions are multifold – academic, industrial and financial, political, social, military. Coordinated well, they will present the UK to friend and foe as formidable, itself a useful deterrent in an environment where the subtle ways of deterrence are still hotly contested. If we do not, then we will always be wondering whether we can escalate any confrontation from a position of advantage or not; and without confidence in our answer we will be hesitant and indecisive. We cannot realise all the possibilities of the future manned/unmanned/autonomous force, alluded to earlier, if the networks of information on which it relies are more in the control of our opponents than ourselves.

So, operating continually on those multiple networks to seek advantage is what we must be about. It was why the phrase 'Information Advantage' was chosen, rather than, say, 'Digital Capability'. But cyberspace is an intellectual construct, a phrase used to capture quite an amorphous idea. In reality, it has a physical form: it is the rapidly expanding, myriad interconnected nodes

## We are now seeing how our competitors are exploiting the more sinister possibilities of this global revolution

of servers, bearers, computers, satellites and, yes, even soon your fridge, which form the internet of everything. This physical/virtual construct is ethereal in nature, but presents the same range of attack surfaces that air forces and their space, cyber and electronic warfare specialists have been exploring, and targeting, for decades. And, usually, as part of an integrated national and international coalition.

### Air and cyber supremacy

So, air forces are well placed to lead in this genuine revolution in military affairs, not least because they have been in the vanguard of those linking accelerations mentioned earlier, such as the emergence of space and cyber as vital warfighting domains. Space has been an extension of the national aerospace effort since the end of WWII. Original thinking on a comprehensive concept for warfighting in the cyber domain arose from GCHQ and Air Warfare Centre discussions in 2009. The core ideas behind cyber and air supremacy have a common root.



**The technical attributes required to gain Information Advantage are held most comprehensively within air forces**

(PHOTO: CROWN COPYRIGHT/MOD)

What is now required is a marriage of that demonstrated technical competence, the air forces' ease in operating within an integrated force, and the strategic thinking of our WWII forebears, who imagined a way of denuding the enemy of its power before it got to the conventional battlefield. In attempting this, air forces, and the Royal Air Force in particular, can draw on a proud tradition of strategic thought and innovation – innovation in its use of demographics and manpower, command and leadership style, centralised control and decentralised execution, technological development, and operating persistently. But, all these facets will be covered in more depth, and no doubt better, in the following essays. Pulling all these together will be required to deliver an Information Advantage.

### Entering the Information Age

The conclusion of the foregoing is that we are entering the Information Age and an arena of persistent competition in the information environment, where the most salient warfighting domains may well be those of air, cyber and space. To prevail in the military sphere cannot be achieved by tactical competence in episodic military interventions. Military success must be built on strong strategic foundations that are created and reinforced by persistent military engagement, integrated with national and allied partners, to build resilient information age power. Most of the attributes required are already held by air forces – they need to assess which are vital, and then polish them to a sheen! 🎯



# Innovating for a sustainable future



## Dave Gordon

Senior Vice President UK, Rolls-Royce

### How will Rolls-Royce revolutionise propulsion systems as part of Team Tempest?

The future defence environment is becoming increasingly complex, with rapid technological advancements and an evolving threat picture. One predictable constant amongst an unpredictable future is the requirement for ever-increasing, on-demand power in order to gain military and commercial advantage.

It is against this backdrop that we are revolutionising the power and propulsion systems as part of Team Tempest. The increased importance of power and introduction of more power-hungry systems for sensing, computing and weapon systems will result in readily available high-density power being at the forefront of future capabilities (eg energy as ammunition). We are developing solutions in a digital environment that not only provide

the flexibility to iteratively respond to counter new technological threats at pace, but also drive efficiency into the design and development programme.

### What do recent announcements such as the MoU with Virgin Galactic and strategic partnership agreement with Reaction Engines Ltd mean to Rolls-Royce?

Rolls-Royce is working on several future projects to design, develop and deliver propulsion and power technologies for a multitude of applications across land, sea, air and space. The recent announcements are great examples of us collaborating with key industry players on the future power and propulsion technologies we believe are needed for civilian and military use. We have been working closely with Reaction Engines for the past two years, including exploring the potential of high-Mach systems for Defence. This, coupled with our recent announcements with Boom Supersonic and Virgin Galactic, demonstrate our commitment to developing the power and propulsion technologies of the future.

### How is Rolls-Royce innovating in space-related systems and propulsion?

Rolls-Royce is the only company in the world with a singular focus on creating mechanical, electrical and nuclear power solutions – solutions that will be essential in tackling the challenges facing tomorrow's world. We see Space as one such exciting and growing market in which we forecast propulsion, power

and thermal management to play a significant role. Be it electrification, digitalisation or provision of high-density power solutions, we are currently applying our broad capabilities and creativity to support the growing Space industry and customer base with specialist materials, manufacturing techniques, novel nuclear technologies and integrated power and thermal management know-how.

### Can you explain Rolls-Royce's approach to sustainability and the environment?

Rolls-Royce has publicly endorsed the UK's net zero carbon target by 2050 and signed the United Nations' race to zero' initiative, and we believe the UK Government will need to work in partnership with industry, academia and society as a whole to be able to achieve the 2050 ambition. This can be achieved through a change in society's attitudes and behaviours, but also through investment in low-carbon technologies.

Rolls-Royce has several capabilities across its Power Systems, Civil Aerospace and Defence businesses that can deliver world firsts in sustainable power from the UK. The role of alternative sustainable fuels, an increasing demand for future hybrid and electric vehicles, and the increasing use of novel nuclear solutions for energy and fuel are great examples of multi-domain capabilities that underpin our experience and thought-leadership in this field. We are enthused by the challenges this presents and look forward to leading the UK on the drive for a more sustainable future.



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# Multi-domain operations and Information Advantage

Simon Michell asks the Commander of Number 11 Group, [Air Vice-Marshal Ian Duguid](#), how his organisation is helping the RAF undertake multi-domain operations and achieve Information Advantage

**M**ulti-domain operations (MDO) require a networked joint force across all the main areas of operations – air, land, sea, cyber, space, and even the electromagnetic spectrum. This network enables a seamless command and control (C2) capability that is able to gather and supply information at the speed of relevance.

Achieving this Information Advantage through the networked joint force would, according to Air Vice-Marshal (AVM) Ian Duguid, Air Officer Commanding Number 11 Group, enable UK armed forces, either operating alone or with

partners, to get inside the adversary's decision space. "The goal is to get the best and richest information to commanders in the most expedient way, so that decisions can be made rapidly and the efficacy of our output is increased. That is why we need to have a networked force."

Number 11 Group was re-formed in November 2018 to drive this concept through the RAF and beyond. The Chief of the Air Staff at the time, Air Chief Marshal Sir Stephen Hillier, gave the newly re-formed Group a clear directive to develop an operations hub within Air Command that would be able to cohere

**As well as its multi-domain operations remit, Number 11 Group runs the nation's Quick Reaction Alert air defence capability.**

(PHOTO: CROWN COPYRIGHT/MOD)

activities and understanding across different domains to create more decisive effects. MDO and Information Advantage are, therefore, No. 11 Group's overriding *raison d'être*. AVM Duguid also acts as the air and space component commander, delivering functions such as the nation's QRA (Quick Reaction Alert) air defence capability. The two things are inherently connected.

### From interoperability to interactivity

MDO is not necessarily a revolutionary concept; it has evolved over decades through initiatives such as network-centric warfare (NCW) and net-enabled capability (NEC). However, whereas the focus used to be on 'interoperability', it has now moved up a notch to 'interactivity'. It is not enough for systems to be linked: they also have to be able to communicate with each other – ideally automatically. Another difference is that there are also more domains than there were 20 years ago. Space and cyber have been added recently as operational domains, and the electromagnetic spectrum is another arena that continues to develop in importance.

After almost two years in the job, AVM Duguid and his team have achieved a great deal, but there is – as always – much more to do. Not all of it is about new technology and space-age capabilities, although these account for a fair portion. At the simplest level, it requires integrating the Defence IT and C2 systems, so that people can actually work seamlessly across the domains. Much of that work is under way.

**“We need to embrace new technologies, such as artificial intelligence and machine learning, so that a lot of the hard graft can be done automatically”**

Additionally, as the complexities increase and data volumes explode, new technologies will be required to get the most out of it as quickly as possible. “We need to embrace new technologies, such as artificial intelligence and machine learning, so that a lot of the hard graft can be done automatically by computerised systems. And, as more information floods in, there is an increased risk of misinformation and disinformation, which has to be filtered out of the system. Machines can help us do this,” says AVM Duguid.

At some stage, quantum computers will enter the fray, but their presence in the hands of an adversary will also present a significant threat to data security. Encryption will need to be rethought and revitalised. Number 11 Group is already working through the implications of these digital innovations. “As a technology-driven Service, this comes naturally to the RAF. We dig it. It is our bread and butter.”

Number 11 Group is also increasing the RAF's collective understanding of space. “Our understanding and employment and our recognition of the viability and the utility of space has improved vastly. Not just for things like weather predictions or geospatial surveillance of faraway lands, but also the absolutely essential nature of space in terms of providing a global network of secure communications,” reveals Duguid.

Not surprisingly, cyber is another domain in which Number 11 Group is driving the RAF's thought leadership. And, with the establishment of the National Cyber Force (NCF) announced in November 2020, the Group is working out how it can add value to the NCF's work on offensive cyber operations. “What we are discussing now is how can we play a role in supporting cyber operations and help the NCF achieve political intent and government policy. We have individuals within Number 11 Group who are cyber aware and understand both defensive and offensive cyber capabilities. They will be a vital assistance to the NCF, now it has been established.”

## THE ASTRA PROGRAMME

The recently launched Astra Programme is designed to help the RAF create the Next Generation Air Force over the forthcoming 20 years. As such, it is a core activity in the achievement of Information Advantage. “It is about getting the most out of people, their ideas and the technology they operate,” reveals AVM Duguid. “Astra will try and define what the future air force will look like, and then implement it on a step-by-step basis. It isn't just about high-end weapons systems, it is more about the people. What sort of people will we employ? How and where will they work? What will they do? It is a really significant conceptual refresh.”

The COVID-19 crisis has started to crystallize some of these concepts. As the pandemic took hold of the UK, the RAF had to guarantee that its duties and taskings were undertaken without interruption. QRA (Quick Reaction Alert) is just one example. “We have introduced some new technology in our IT systems, which has got some fantastic utility, especially some of the applications around teams and working together,” says Duguid. As a consequence, “The vast majority of the Air Force, particularly at HQ Air Command at RAF High Wycombe, is working remotely from home. We are using video conferencing and Skype, we are exchanging documents, presentations and files electronically – business is continuing.” Having gone into a second lockdown in November, this is a prescient snapshot of what the future may bring under the Astra Programme.



# Information Advantage – the key to battle-winning capability



## Nick Chaffey

Chief Executive UK, Europe and Middle East, Northrop Grumman

### What is Information Advantage from Northrop Grumman's perspective?

Information Advantage is the discriminating capability given to the warfighter through the provision of relevant, timely and accurate information. That can mean everything from the fuel status of an aircraft to high-quality targeting information being provided to a pilot. High-capacity data conduits between machines allow better quality information to be presented to the warfighter, which should add greatly to mission effect. In today's air warfare environment, it is critical to deny the enemy the basis of a kill chain by avoiding detection. This means that information increasingly has to be provided with a low probability of the transmissions being detected and, indeed, a low probability of being intercepted, if the forces are not to expose themselves to substantial risk.

### What are the key challenges in realising Information Advantage for a fighting force?

The challenge comes from many perspectives, of which the most pressing is to determine what information actually needs to be passed, between which assets, and for what mission effect. Development of leading-edge technologies is necessary to aggregate and analyse information prior to transmission using appropriate communication links. Intelligent capabilities, such as a Resilient Network Controller, will also be necessary to merge data from disparate cross-domain sources in order to yield persistent, low-latency and high-fidelity common operating pictures.

Operational doctrine changes may be necessary to leverage and exploit the capability and new dimensions needed to be managed – in particular the far more active management of the electromagnetic warfare environment in which we operate today, versus that of the past. The mission network of the future requires operation in real time if it is to deliver mission effect to the commanders who will rely upon it.

This all demands that air forces take a fresh view of how they operate, often moving away from a platform-centric view of the world. Most air forces have taken a positive step in recognising that many different types of assets form nodes in the wider

communications and electromagnetic network, but a further step is required to achieve Information Advantage. This will facilitate better understanding of the requirement for information flow and how best to achieve it on a 'transmission-by-transmission' basis. Only then will we know which nodes to use, and when and how to operate networks in real time.

### What are the key next steps?

As many air forces around the world begin to operate fifth-generation assets, such as the F-35, the opportunity and challenge is beginning to become apparent. The ability to communicate, particularly within denied environments, is a key differentiator. Therefore, assuring communications, both between fifth-generation platforms and other assets, is a focus. Understanding the information and communications architecture across the whole of the warfare environment must be a priority as well, if this is to be achieved.

And, of course, this will be across services, not just between air platforms. Understanding the current and developing a clear view of the future information architecture across all the warfighting domains – from sub-surface to space and into cyber – is one of the key first steps to positioning for success in next-generation warfare.

**“The mission network of the future requires operation in real time if it is to deliver mission effect”**

# A unique and symbiotic relationship with the RAF

**Sir Simon Bollom**, CEO of the UK's Defence Equipment and Support (DE&S) organisation, highlights its close ties to the RAF and the benefits these bring



**The partnership between Defence Equipment and Support and the RAF is a unique and symbiotic one.**

Although not all our staff share my previous and personal attachment with the RAF, we are all in a position to celebrate some momentous milestones with them, recently the delivery of P-8A Poseidon and the introduction of yet another step change in capability for our forces.

With over 600 RAF personnel working directly within the organisation, and DE&S civilian staff embedded at 18 RAF sites around the country, we are close partners in delivering their world-leading capabilities, and our civilian personnel benefit from the wealth of experience and perspective on capability that our Service colleagues bring.

The pace of technological change and growth means that innovation for us is more than just innovative equipment. It also means innovative solutions to the way we support our in-service equipment and the way we contract for equipment and services.

We must strive to reduce our delivery timelines to ensure the equipment we deliver is still at the leading edge of technology when aircrew and support staff come to use it. The RAF have been forward-leaning into this – Project Centurion and TyTAN Typhoon support are excellent examples. Through a strategic approach, and partnering with industry, we delivered the RAF increased aircraft availability, 38% reduced cost and, with Centurion, three new weapons systems and two significant avionic software upgrades in record time and below budget. For the RAF, this meant no capability gap with Tornado, allowing the platform to graciously retire from service as our staff watched the flypast from MOD Abbey Wood with pride.

The next generation of ISTAR (intelligence, surveillance, target acquisition and reconnaissance) asset for the RAF will provide a significant capability increase and much-needed information advantage in the future

battlespace. Protector builds on the success of Reaper, which was procured as an Urgent Operational Requirement some 13 years ago, and will provide a fully certified persistent Air ISTAR capability. Taking an innovative approach to procurement for Protector has seen a novel hybrid of Direct Commercial Sales and US DoD Foreign Military Sales approaches. Away from commercial and project-speak, this means the RAF has UK-specific modifications and requirements on Protector, whilst retaining the unique elements of technology provided by our US allies, all meeting time and cost requirements.

It is easy to feel detached from the effect that the RAF brings to bear, but our constant liaison, presence on main operating bases and resultant close bond creates the excellent working relationship that has been at the centre of past successes and will be the foundation for the future.



**The delivery of the first four P-8A Poseidon maritime patrol aircraft is a boost to the UK's ability to gain Information Advantage** (PHOTO: SGT ASHLEY KEATES RAF/CROWN COPYRIGHT/MOD)



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# Supporting the development of future technologies

ADS Group Chief Executive **Paul Everitt** looks ahead to the prospects for industry to work closely with the RAF to make sure the right technology is in place to secure information advantage



**Developing the next generation of combat aircraft and air technology is a great opportunity for the UK defence industry, one that is being driven forward by the Future Combat Air Strategy and Team Tempest.**

The new Defence and Security Industrial Strategy is also a major focus for the UK defence sector, which can help to support the development and manufacture in this country of new technology that will be vital to the future operating capabilities of the Royal Air Force.

Increasingly, air platforms of all types are data collectors, analysers and disseminators. Many of the platforms exist to share the data that their sensors collect and deliver to another part of the Armed Forces. The air domain is vital for the delivery of effective Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance (C4ISR). We must ensure that the UK maintains its global leadership in these capabilities, and the RAF will have a big role to play in that with the UK, having already



The collaboration between industry and the Ministry of Defence on the Team Tempest project is bringing together a broad range of expertise (PHOTO: BAE SYSTEMS)

established its prominence in the field, alongside the US, under NATO.

The RAF's future force structure will rely on significant interoperability with the other Services, as exemplified by the development of Carrier Strike. A common information picture across all the operational domains will be especially important, as will securing information advantage on the logistical and support aspect of air platforms. Future platforms will be ever more capable and, more than likely, expensive, so ensuring that we are extracting as much value and capability from each platform is vital.

Just as essential as the core capabilities of these digital platforms of the future will be protecting them. Factors such as electronic warfare and cyber are already affecting air superiority. Preventing adversaries

accessing your data is a vital element in retaining and gaining information advantage, so the challenge for the air force of the future is making sure platforms are built to the right grade and with long-term resilience. Digital protection of air platforms is the minimum standard for securing the ability to operate in the air and space domains. Platforms no longer just face the physical threat; all will be subject to cyber attacks too, and the technology and protection must be in place to prevent damage and interference.

It is clear that there are a variety of factors at play in gaining and retaining information advantage, and industry and the RAF must work together to ensure the right technology is in place to secure our place on the world stage, protecting the nation.

# Information Advantage through the ages

**Seb Cox**, head of the RAF's Air Historical Branch, explains how being able to take to the air had a decisive impact on the quality and speed of information leading to a number of spectacular successes in both world wars

From ancient times, all military commanders have sought the benefit of occupying the high ground. Originally, this was simply the topographical advantage of being uphill of the enemy, allowing a better view of them. This view, however, extended only as far as the next hill. To see beyond the next hill meant sending cavalry patrols, themselves still subject to the limitations of the topography. When balloons first extended human reach into the air, a possible military application quickly became apparent.

The first recorded military use of balloons took place in 1894 at the Battle of Fleurus, where French revolutionary forces deployed a hot-air balloon that allowed them to observe and defeat their Austrian opponents. Height was now no longer a function simply of the ground beneath the general's feet; it now encompassed the atmosphere above. The utility

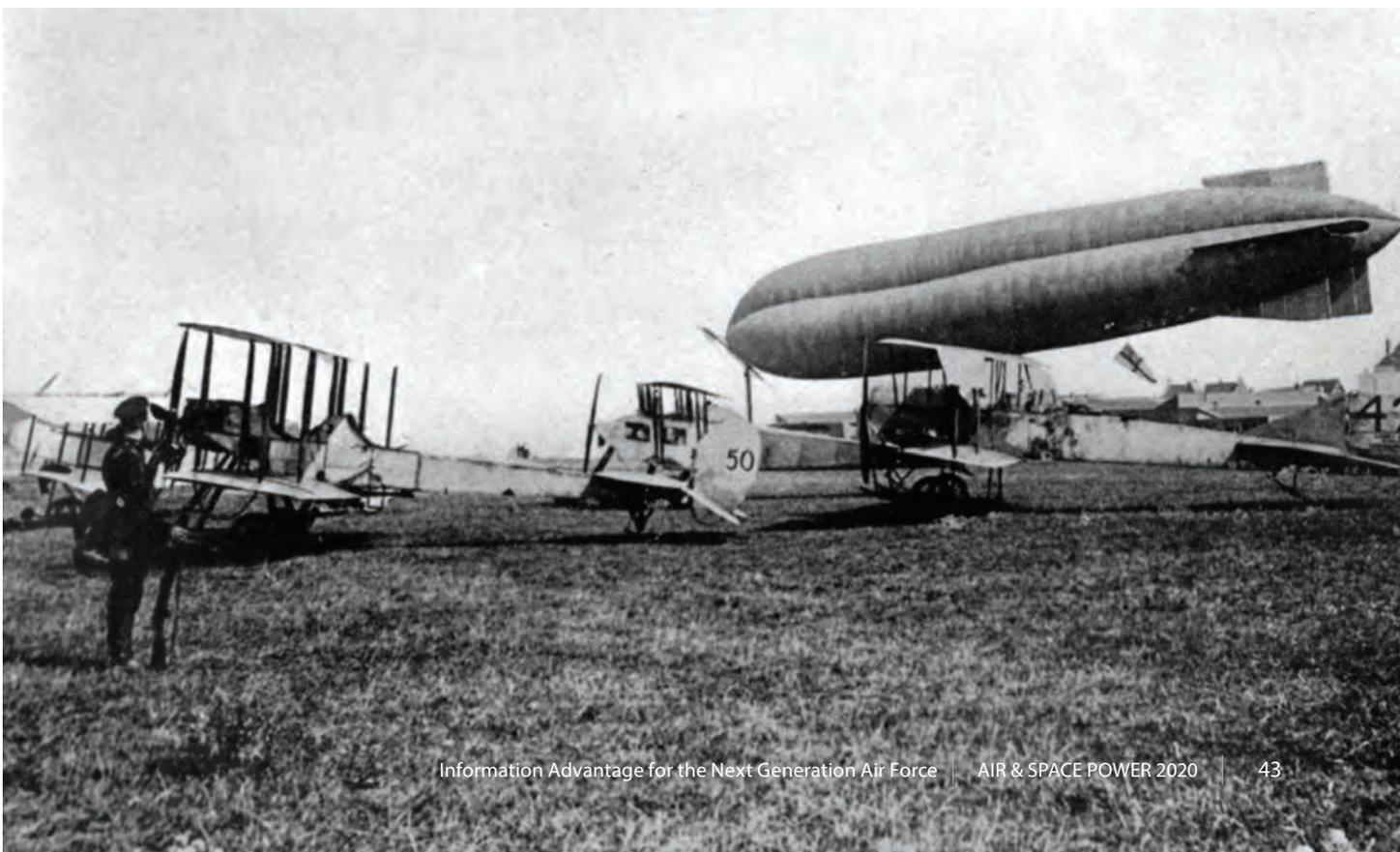
of balloons in mobile warfare was limited, however, although both sides used them in the American Civil War, without notable success. The British Army used balloons in 1885 in Bechuanaland (modern-day Botswana) and the siege of Suakin in Sudan. The static trench warfare of the First World War saw both sides make extensive use of tethered observation balloons.

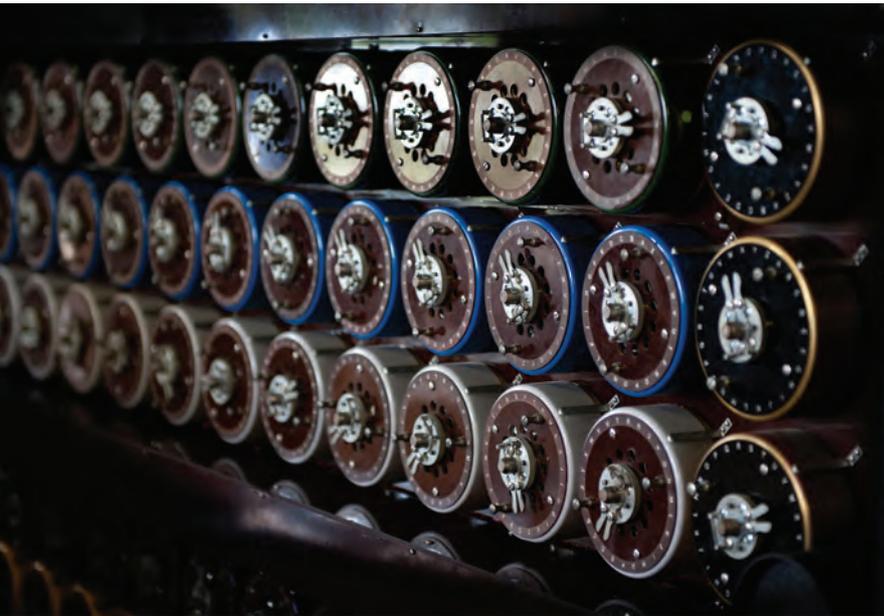
## First World War – the Battle of Marne

Nevertheless, the relative immobility of balloons in comparison with the greater speed and reach – and, thus, capability – of powered aircraft meant the latter swiftly became a vital source of information on the enemy, providing both situational awareness and targeting information. Initially suspicious of the new aviation technology, generals on both sides quickly became converts. In the early campaigns of 1914, aircraft reconnaissance missions enabled the British

**The ability to see out to the wide horizon from a balloon offered battlefield commanders a distinct information advantage**

(PHOTO: WORLD HISTORY ARCHIVE/ALAMY)





**Breaking the German Enigma codes quickly by using computers was perhaps the most decisive capability that the Allied Forces had against the Axis powers**  
 (PHOTO: BRIAN HARRIS/ALAMY)

Expeditionary Force to extract itself from a potentially catastrophic situation at Mons, and, subsequently, both French and British sorties provided the French high command with accurate information on the wheeling movement of the German armies near Paris, leading to victory at the Battle of the Marne.

Likewise, the victorious German commanders at the Battle of Tannenberg on the Eastern Front were crucially dependent on their air arm, allied with signals intelligence, to provide an accurate picture of Russian movements – an information advantage that enabled a crushing German victory. Once the Western Front stabilised, cavalry patrols were incapable of performing their reconnaissance role and aircraft became the principal source of intelligence information.

The introduction of aerial cameras enabled enemy defences to be comprehensively mapped, which was essential for briefing the assault forces prior to any concerted offensive. The fight for air superiority was almost entirely predicated on the need to facilitate effective reconnaissance and consequent Information Advantage, and the equal need to deny it to the enemy. In the inter-war years, the RAF was involved in operations in many diverse parts of the world and quickly realised that an understanding of the culture of the indigenous populations was a key enabler, hence the introduction of the practice of embedding so-called Special Service Officers to live with the local populace and provide an intelligence and, indeed, information channel – in both directions.

**Bletchley Park**

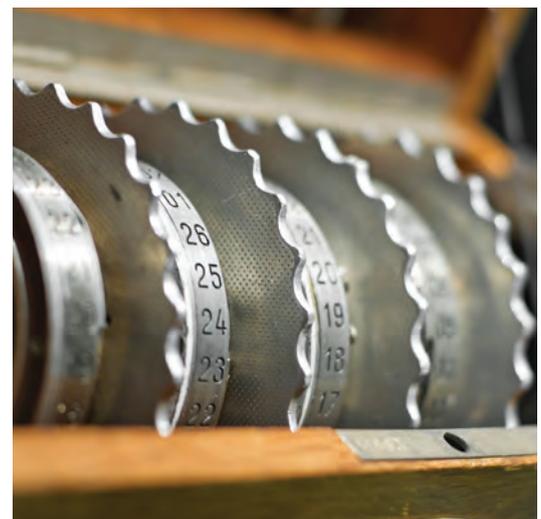
During the Second World War, all sides were heavily dependent on intelligence in the conduct of effective operations. Among the many sources of information,

aerial reconnaissance allied to effective interpretation remained key, along with the Ultra codebreaking activities at Bletchley Park. The blending of data from many sources, Signals Intelligence (SIGINT), photo-reconnaissance, Prisoner of War interrogation and others became integral to winning the military battle.

**Need for speed**

Today, much of the Information Advantage battle is fought in the cyber domain, but we should remember that it was at Bletchley Park that the application of computers to information exploitation was first practiced. Those involved in gathering and interpreting data understood the need for speed. Information was of decreasing utility the older it became, hence the need for computing power to break the German codes, or for three-stage photo interpretation, with the first rough-and-ready product available within hours of the aircraft landing. Today's timescales may well be minutes or even less. Identifying military vulnerabilities was clearly an important function of intelligence information, but accurate intelligence and a keen understanding of the enemy's psychological weaknesses also enabled the Allies to deceive him with notably successful deception campaigns.

Then, as now, kinetic effect could also be linked to psychological operations, as when RAF Mosquitoes bombed Berlin at 1100 on 30 January 1943, disrupting a propaganda broadcast by Herman Goering on the 10th anniversary of the Nazi accession to power. More recently, the UK prosecuted coordinated cyber campaigns, kinetic fires, and overt and covert messaging, alongside the military campaign, significantly undermining Daesh's previous information advantage. However, though the enemy, technology and terminology may change, not all is new in the world of Information Advantage. ◉



DAVID TAYLOR/ALAMY

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# The utility of Mission Data



## Vicki Saward

Information Advantage Global  
Campaign Director, QinetiQ

### How does Mission Data (MD) help Warfighters achieve an Information Advantage?

The production and effective use of MD for military platforms, sensors and systems significantly enhances their operational utility above a baseline technology standard. In a similar way to a modern smartphone 'out of the box' with good hardware and OS, it has low potential unless combined with the best applications and supporting data. MD optimises hardware, both individually and collectively, to enhance operational performance and the likelihood of mission success.

Effective MD, when combined with the best technology and tactics, increases the prospects of favourable operating conditions. A host platform has the potential to persist longer in the battlespace with greater tactical influence and is able to increase the levels of information gained and shared to support operational and strategic aims. Furthermore, with platform persistence comes the ability to assess MD in live representative environments, thereby



## Mark McNulty

Head of Division, Strategic, Information  
& Data Services, Inzpire

gaining valuable performance feedback for the MD community who, in turn, refine MD products. This valuable feedback is combined with common data formats and production processes, as well as efforts to build strategic governance frameworks to maintain MD community unity. The end result is the production of high-fidelity and interoperable data that is easily shared as part of a growing community of allied MD production centres and Intelligence Agencies; this creates an Information Advantage for the Warfighter.

### How does MD need to evolve?

To continue building an Information Advantage through MD, the host technology (platform) needs to be designed with interoperability from the outset, with open architecture by design to allow for agile adaptation when future change occurs. The people element of MD production needs to be nurtured across the 'Whole Force' to maintain unity. Specialists in MD production need to be grown and then retained by providing them with rewarding, flexible and modern career paths that

complement their specific terms of service. Embracing intergenerational strengths, novel thinking, experimentation and challenging historical norms all need to become commonplace in order to produce the fidelity of MD needed both now and in the future. Finally, building sustainable and positive partnerships between Defence and Industry, through the removal of adversarial contracts and establishing higher degrees of trust, will bring clear mutual benefits and lead to an operational and information advantage.

### What role does collaboration play in enhancing MD in order to maintain an operational advantage for Defence?

Collaboration is, and will continue to be, an integral part of producing the high calibre of MD needed to maintain an advantage. At an international level, bilateral and multilateral collaboration between nations allows for the 'pooling' of data and ideas to bring a greater result for each individual participant.

At a national level, collaboration between Defence and Partners Across Government (PAGs) builds richer source data, which is required for continuous MD improvement. At an organisational level, collaboration between Defence and Industry is essential for combining the very best tools and equipment with operationally focused people to ensure timely delivery of MD to the front line.

Encouragingly, activity is already taking place at all levels of MD collaboration, and none more so than at the organisational level between Defence and Industry. Leading companies in MD production have already formed strategic intercompany partnerships to bring together the required niche tools and skills in one place to support Defence in this vital activity.

# Beyond collection – the challenges of exploiting intelligence to maintain Information Advantage

The collection of raw information is only part of the intelligence cycle – deciding what to collect, exploiting the data and disseminating it quickly to the people and networks that need it is at the heart of Information Advantage. **Wing Commanders Andrew Myers-Hemingway** and **Nev Morgan** from 1 Group (the collectors) and Strategic Command (the users), respectively, explain how their processes combine to assure Information Advantage for the warfighter

When reviewing famous intelligence failures such as Pearl Harbor, recurring weaknesses in the way intelligence communities exploited collected data can be seen; many persist even today. Enemies continue to deceive or deny collection; intelligence organisations are reluctant or incapable of sharing information; and masses of irrelevant data often obscure those vital pieces that could provide insight. The range and scope of today's missions also mean that collection now spans a far broader range of interests. The multipolar world created by the end of the Cold War, the dramatic increase in well-armed regional powers, and the rise of highly capable violent extremist organisations all provide today's analysts with an increasing challenge to exploit the right information, at the right time, for the right

customer. UK Defence's plans to increase collection capabilities in the maritime, land, air and space domains over the next five years will only compound these problems, unless we find solutions now.

Working with emerging technologies and methodologies, HQ Strategic Command personnel on behalf of UK Defence have several programmes aimed at better Processing, Exploiting and Disseminating (PED) collected data, and creating information networks capable of ensuring improved intelligence support to decision-makers. One of the major projects is to connect existing and new data networks with cloud storage areas using 'big data'.

## Volume of information

While this will solve some of the sharing problems, the sheer volume of information will create its own difficulties, potentially drowning the analysts with data. Machine learning (ML) and artificial intelligence (AI) have therefore been introduced as part of the analysts' toolsets, triaging data before any human views it. Repetitive, less demanding tasks, such as identifying tanks, battleships or aircraft as part of the Order-of-Battle analysis will be done, at least in part, by machines. Future developments could see this expand to better countering 'fake news', warning of impending humanitarian crises, assisting in war-crime investigations, or facilitating appropriate responses to natural disasters.

Trials are under way with elements of the RAF's Intelligence Surveillance, Target Acquisition and

Accessing data in a 'problem-centric' manner, rather than from just a single sensor, will enable analysts to look for the tell-tale signs of potential threats, such as IEDs, more successfully

(PHOTO: ALAMY)





Reconnaissance (ISTAR) Force Headquarters (FHQ), as part of its ongoing mission to deliver understanding and force protection to commanders at every level. Analysts within the ISTAR Force's Number 1 ISR Wing are working with industry and allies, helping to refine many of the algorithms used in AI and ML. In part, this has been made possible by moving away from 1 ISR Wing's legacy systems towards a common PED architecture. Although nascent, this connectivity is already improving oversight and integration across Defence, national agencies and allies, allowing tasking to be federated between UK intelligence organisations or burden shared with allies. HQ Strategic Command is also beginning to optimise the way Defence analysis works, establishing common standards, working practices and connectivity policies to better facilitate federated work across different time zones 'following the sun'.

### Exploiting data

The exponential growth of future data, particularly with the increase in ISR airborne platforms, has also resulted in an uplift in 1 ISR Wing's analytical cadre and a change in the way it exploits data. In the near future, it will move away from the traditional exploitation of single-platform or sensor data, towards adopting a 'problem-centric' PED methodology. Analysts will be able to access greater amounts of relevant sensor data, including non-traditional ISR feeds from Typhoon and F-35, open source and historic data-sets. Overlaid on multilayered displays,

it will allow better change detection, identification of patterns and the ability to recognise anomalies very rapidly, thereby better facilitating the discovery and exploitation of that vital piece of data.

An example could be an analyst searching for signs of a roadside bomb. They would be able to search data clouds for all collection activity in an area. Data such as mapping, culvert overlays or previous attack information could be quickly added. Analysts

**“Fully exploited data has the potential to provide a much richer, deeper understanding to the decision-maker”**

could then display historical data, searching for signs that local villagers may be avoiding certain roads, or for analysts to look for signs of disturbed earth, indicating a possible bomb-emplacement site.

In sum, the growth of collected data over the next five years poses perennial, as well as new, problems. Today, the challenges are much more demanding, but, if the current upgrade programmes are successful, fully exploited data has the potential to provide a much richer, deeper understanding to the decision-maker, unlocking many of the intelligence questions we had previously struggled to answer. ●

**Some of the intelligence failures that enabled the attack on Pearl Harbor in 1941 remain today**  
(PHOTO: ALAMY)



# Enhancing Information Advantage from Space



## Phil Brownnett

Managing Director, Surrey Satellite Technology Limited (SSTL)

### How does SSTL support Defence organisations with space-based capabilities?

SSTL has been at the forefront of small satellite innovation for decades and has the ability to adapt its product designs to meet the demands of both Defence and commercial partners. Traditional space-based Defence capabilities have relied on single, large assets, which are costly to build and launch, and provide an obvious target for adversaries. More than 30 years ago, SSTL pioneered an approach that is enabling low-cost constellations of small satellites to be deployed in conjunction with the large, exquisite assets, to provide greater resilience and an opportunity for mixed-sensor systems, with faster revisit times. The high launch tempo that SSTL achieves also provides an ideal proving ground for new technologies – getting new ideas into space faster.

### How will SSTL help the RAF and other Defence organisations achieve Information Advantage?

A key element of Information Advantage is the richness and freshness of the data available; two parameters that can be dramatically improved with the use of multiple satellites coordinated as part of a larger system. SSTL's missions cover a range of applications, including Earth observation, GNSS (Global Navigation Satellite System), science and communications, with a focus on innovation and technology demonstration. Through continued innovation and development, SSTL's new concepts can quickly transition into operational systems, ensuring that Defence organisations remain at the forefront of the Space domain.

RAF and Defence organisations will be also be able to tap in to SSTL's

enabling the Ministry of Defence to experience the benefits that small satellite constellations can bring to the ISR (intelligence, surveillance, reconnaissance) domain. The OCD will showcase launch plus the space and ground segments, as well as the downstream data processing from capture through to actionable intelligence. A multi-sensor constellation approach will deliver a multitude of timely data to bring intelligent information to Defence organisations and their allies.

### What other future space systems is SSTL developing and how will they improve UK Defence capabilities?

We have provided data to the RAF from our Carbonite satellite, which is a revolutionary new Earth observation

## “A key element of Information Advantage is the richness and freshness of the data available”

breadth of heritage and expertise via our highly respected customer training courses, which complement space-based capabilities.

### How will Team Artemis advance the military use of small satellites?

Team Artemis brings together trusted partners to launch an end-to-end Operational Concept Demonstrator (OCD),

system built in just six months. Now, SSTL is adding other sensor capabilities and technologies for the ISR domain and developing its deep expertise in GNSS signals to ensure that the UK remains a significant player in this key area. SSTL succeeds by continually evolving its product portfolio to keep abreast of the latest technological advances, whilst aligning with the capability requirements set by the UK Space & Defence Strategy.

# Data fusion and distribution – ‘everyone by nature desires to know’

The ability to distribute and display pertinent situational awareness enables its foremost proponents to gain battle-winning advantage. The Commander of the National Centre for Geospatial Intelligence, **Brigadier Paul Lynch MC RM**, highlights how this task is undertaken

Helping decision-makers to understand what is going on in a way that delivers a battle-winning advantage is a mixture of an art and a science. As the UK’s primary geospatial intelligence (GEOINT) organisation, the National Centre for Geospatial Intelligence (NCGI), as part of Defence Intelligence, is working hard to develop continually and enhance how this task is undertaken. NCGI provides assured data and unique exploitation and analytical expertise of imagery and geospatial data from intelligence, surveillance and reconnaissance (ISR) capabilities to meet the requirements of the UK Government and Defence. Its output is enabled by three component areas, which provide foundation – GEOINT, GEOINT analysis, deployable GEOINT support – and operate in close conjunction with open-source intelligence (OSINT).

Today’s complex operating environment requires decision-makers to understand, plan, navigate and target across five domains, against adversaries conducting both conventional and

ambiguous warfare. Successful situational awareness is critical to delivering decision-making advantage by bringing clarity to a complex situation through effective visualisation. GEOINT delivers a clear visual representation of the actions of our adversaries and other actors, within a specified time and space, through the exploitation of multiple ISR capabilities.

Those capabilities, used in the air and on land and sea, can provide direct access to a specific area of operations, making them essential in developing understanding of the nature of our adversaries’ actions. Capabilities based in space can provide access to areas beyond the reach of other sensors and enable a worldwide level of access and persistence, making them essential in highly

**Geospatial intelligence consists of layers of information and imagery that give a decision-maker an opportunity to gain the upper hand over an adversary or a situation**

(PHOTO: FRANK RAMSPOTT/ISTOCK)





**The Sentinel R Mk 1 provides long-range, wide-area battlefield surveillance, delivering critical intelligence and target tracking information**

(PHOTO: NIK HOWE/  
MOD/CROWN  
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contested terrestrial areas. OSINT can deliver increased awareness of what is happening across all domains and can add further fidelity when combined with traditional capabilities. This multi-domain approach provides the decision-maker with increased situational awareness and a better chance of battle-winning advantage.

The more that decision-makers understand what GEOINT and OSINT can offer, the more active they can be in the process that is aimed at delivering decision advantage. For NCGI, this means a significant change to the relationship between people, data and technology. NCGI intends to bring them closer together to improve the ability to deal with increased volumes of data and cope with uncertainty at pace. Using modern processes and technology in data collection, ingest and management, NCGI will enable the human and the machine to deliver an increase in the number and value of analytic insights available to decision-makers.

### Rapid situational awareness

By developing GEOINT as a Service (GaaS) for our customers, NCGI will deliver rapid situational awareness to decision-makers. GaaS ranges from server-side analytic processing and visualisation of geospatial, mission or open-source data, to the provision of finished intelligence products being made discoverable and exploitable in near-real time. NCGI's programme of GEOINT modernisation will

enable a shift from product-based processes and output to a service-based, data-centric ecosystem. The value of data as an enabler and service-based provision is the starting point for these changes.

The OSINT capability within Defence also continues to develop at pace. The ability to collect key information efficiently and process it quickly to yield intelligence insight requires specialist programmes. While commercial partners continue to support much of the capability, Defence is bringing expertise in-house to drive its development into increasingly specialist areas to meet Defence's complex requirements.

The ability to provide the essential data that accurately describes a situation is the very essence of customer-driven visualisation. A greater range of sources from multiple agencies, including partner nations, will provide an improved baseline of information to be exploited. The application of analytics on that huge amount of data will allow it to be processed at scale, using increasing levels of automation. This will generate greater clarity about what is happening, and tailored visualisation will deliver that knowledge quickly to decision-makers.

The modernisation of GEOINT and OSINT must be driven by our people, processes and tools being able to adapt more quickly to the information age, and is fundamental to our new operating model. This should help produce a greater chance of achieving decision advantage for those who make tough choices in the modern operating environment. 



# Delivering improvements from the Enterprise to the Edge



## Neil Fraser

Director of Defence and Space Programmes, NSSLGlobal

### How do you see Space contributing to Defence?

Space helps answer three important questions: 'Where am I?' (GPS/GNSS); 'What is going on around me?' (EO/ISR); and 'Who can I talk to?' (Satcom). All three elements contribute to Information Advantage and enable, for example, targeting and fires.

Lines are increasingly blurred between peace and war into the grey zone, and Space – in a return to great power competition – sits across the whole spectrum, presenting risks and opportunities for defence, wider government and industry in the delivery of both military and commercial systems.

### Can you outline what NSSLGlobal does?

We are a leading provider of satellite communications and IT support, bringing best-of-breed technologies together to provide seamless solutions. Whilst

maritime communications are what we are best known for – including commercial shipping companies, coast guards and naval vessels of several nations – we also deliver land and aero solutions. My role is to bring together military experience with emerging technology and industry best practice to deliver improvements to Defence users from the Enterprise to the Edge.

### How does your background help you in this?

I spent 26 years in the British Army in various roles, including three tours in Afghanistan between 2001 and 2009, and service in the Balkans in the 1990s. Every tour involved working with the RAF, including having a Squadron from 90 Signals Unit (SU) providing the comms to UK units on Kandahar Airfield within the Joint Force CIS organisation, formed around my Regiment. As the military lead on Skynet for three years, the bulk of the military element of my team were from the RAF, in part the legacy posts from 1001 SU (which, until Skynet 5 commenced, flew the UK's military spacecraft).

### What does NSSLGlobal do specifically for the UK Ministry of Defence and the RAF?

We provide the bulk of commercial Satcom to the Ministry of Defence via a contract with Airbus Defence and Space under the Skynet 5 PFI. This is for a mix of operational and welfare services to almost every Royal Navy platform, as well as several RAF aircraft, such as the Airtanker fleet and the BAe 146 aircraft.

We also provide a significant number of Satcom and baseband capabilities to land-based users, including RAF bases, mountain rescue teams and 90 SU, and to the Army and Royal Marines for early entry and small team tasks.

### How do you see this developing, perhaps with wider Space-based capabilities?

Demands change and, for example, whilst many RAF aircraft have some form of Satcom for C2/VIP, early-entry deployment and ISR, the UK lags behind the US. With the F-35 Lightning now operational afloat, it is likely there will be greater demand for connectivity and throughput, and a resurgence in Anti-Submarine Warfare and protecting UK airspace all place greater demands on networks.

The US Space Force is leading work on a shift from bespoke 'as is' architectures of 'government specials' towards diversified 'to be' space architecture, including allies, private-sector and government capabilities better enabling military forces and mitigating threats from adversaries.

This brings more choice, more collaboration, better resilience and improved cost profiles, but needs to be underpinned by open architectures and requires acquisition flexibility to weave private-sector investment and technology into the Defence architecture. The UK is involved in some of this work, and also has key space programmes under way. As ever, NSSLGlobal will be bringing the best of these approaches and solutions to our Defence customers.



## Major General Francis Omondi Ogolla

MGH, EBS, HSC 'ndc' (K) 'psc' (Fra),  
Commander, Kenya Air Force

**When I joined the military in the 1980s, information was still key and central in decision-making, but its modes of transmission were few. Delays made real-time access to information very rare.**

The current data-rich information age has seen a combined power of exponential growth in computer capability, data and digital connectivity, which is fundamentally shaping warfare. Information is no longer just an enabler; it is a lever of power, a critical component to understanding, decision-making, tempo, and a weapon to be used at both a strategic and tactical level for military advantage. Timely and coherent use of information can generate advantage over an adversary.

Today's challenge with information is twofold. First, there is information overload, where the existence of too much information on a subject matter slows analysis and effective decision-making. Secondly, there is the authenticity or credibility of the information. Just as adulterated fuel and poisoned food are dangerous to consumers, information that is not authentic will undermine decision-making processes, negatively impacting on results. Furthermore, information today is technology-based and driven. The biggest challenge we, the 'young' air forces, face, is coping with rapidly advancing technology that the current information age is based on. In addition, training in competencies that effectively and



**For 'young' air forces such as the Kenya Air Force, the biggest challenge is coping with rapidly advancing technology** (PHOTO: YASUYOSHI CHIBA/GETTY IMAGES)

efficiently manage these information systems is always a challenge.

Information has been core to the Kenya Air Force in the fulfillment of its mission. It has been effectively integrated into every aspect of Kenya Air Force operational doctrine and serves as the enabling role of effective and efficient coordination. An information-centric approach has become a key pillar in our engagement. Given that the world has become a global village, challenges that it faces require cooperation and collaboration. This means forces across continents should have compatible information exchange systems. However, this will only be possible if the technology gap between them is narrowed.

New operational tools, such as offensive cyber and associated

information systems are such examples that form the new domain of warfare, but these, too, are a big challenge to the 'young' air forces in developing countries. However good your equipment or technology may be, without sufficiently trained, educated and equipped personnel to exploit the same, it is futile. Kenya Air Force looks forward to future engagements with its partners and allies for further training in information-related fields.

There will always be the need for a strategic and prioritised information advantage posture at the centre for any military warfare to gain an operational upper hand. This can only be achieved by a paradigm shift in the way we think and act in relation to the use of information in defence and security.

# Information Advantage at home and abroad

David Hayhurst asks the Commander of the Joint Force Air Component, **Air Commodore Lol Bennett**, about the challenges of achieving and maintaining Information Advantage within UK forces, as well as with NATO allies

**A**ir Commodore (Air Cdre) Lol Bennett, recently appointed Joint Force Air Component Commander (JFACC), is one of many RAF personnel who have been tasked with defining and overcoming the challenges involved in creating a continuously available, fully comprehensible and sufficiently agile Information Advantage environment. He and his colleagues have to establish how best to achieve and sustain the upper hand, while being constantly forced to cope with an adversary's often ultra-sophisticated disinformation measures and countermeasures, nearly always being deployed in cyberspace or an electromagnetic environment at ultra-high speed.

"Presently, this is done through all-source information and intelligence, everything from classified means through to open-source activity, to get the best picture of what is going on at any given time," explains Air Cdre Bennett. In future, various technological areas, such as artificial intelligence, machine learning and cloud-data computing, will prove critical in gathering and presenting coherent information, at pace.

"The key will be presenting it in a format that is useable and allows for timely decision-making. Where we really need to be is in a place where we can ask questions, then rapidly integrate and analyse the all-source data to quickly get answers in what is likely to be both a confused and contested environment."

## Integrating activities

Clearly, recognising and coping with an adversary's ability to flood the information environment with misinformation is paramount. In order to win the battle narrative, activities that are not based on the delivery of kinetic weapons, such as cyber, will need to be more thoroughly integrated in order to present the adversary with multiple dilemmas, limiting their ability to predict what will happen next. Moreover, Air Cdre Bennett feels that critical combat response capabilities are also likely to require



battlefield commanders to have access to cyber information – and the ability to integrate it into their thinking and planning, as well as their response options – further down the chain of command than is currently permitted. Delegating permissions will be critical to sustaining operational tempo.

The recent reformation of the RAF's Number 11 Group, responsible for multi-domain operations (MDO), has involved the development of an

**Information operations are already integrated into routine operations, including NATO air policing duties**  
(PHOTO: NATO)

## “We have seen an increase in the level of understanding, to a point where Information Advantage is really part of our DNA now”

Information Advantage pillar, in conjunction with existing Ops (Operations) and JFAC pillars. Information operations are already integrated into routine operational activity, including areas such as NATO air policing. There have also been several recent MOD and international initiatives concerned with how best to cohere Information Advantage priorities across domains, including collaborative projects between the RAF and the United States Air Force on space and cyber integrated effects.

With respect to cohering Information Advantage across NATO, there are clearly a number of additional challenges. According to Air Cdre Bennett, “Different nations have different policies and positions on how

and willingness among certain NATO member states contribute to an enhanced Information Advantage picture across the Alliance as a whole.

The new JFAC Commander has high hopes that the RAF JFAC’s holding of the NATO Response Force (NRF) readiness for 2020 will result in opportunities to cooperate on Information Advantage thinking across the NATO Alliance. In fact, close ties to NATO Allied Air Command in Ramstein have already allowed the JFAC to collaborate in its conceptual development of future command and control (C2) procedures, delivery of ‘Combined Effects’ and Information Advantage-related innovations.

### Trusted sources of information

In Air Cdre Bennett’s opinion, two elements are critical in countering the types of misinformation that adversaries like Russia and Daesh have consistently proved so adept at generating. The first is being able to identify what actually constitutes ‘misinformation’, as grey areas between fully verifiable truth and falsehoods are inevitable. Second, the UK and NATO must be seen as trusted sources of information. “We are very careful in the narrative that we put out, to be clear and correct, so as to be a trusted source for all the agencies that depend on the quality of information,” he says.

“In the past 12 to 18 months, we have seen an increase in the level of understanding, to a point where Information Advantage is really part of our DNA now. But we are still developing how we actually deliver it, in terms of turning Information Advantage concepts into the practical policies that will allow us to exploit the adversary’s information while protecting our own.” These changes, in terms of organisational and process reform, will affect how the Whole Force thinks and operates, creating the mindset to deliver the next-generation RAF.

Information Advantage posts, including a Squadron Leader IA, have been established within JFAC and Number 11 Group to provide a ‘petri dish’ for ideas to grow and help to effect the wider cultural changes that are required. “The technology is really exciting. But it is the people who will actually make the difference,” says Air Cdre Bennett. “Their ability to deliver simultaneous action, through and across the cyber and space domains, is the most important thing we are focusing on right now”. ◉



**Close ties with NATO Allied Air Command at Ramstein Air Base have enabled the JFAC to jointly participate in the development of future procedures supporting Information Advantage policies** (PHOTO: SENIOR AIRMAN JOSHUA MAGBANUA/U.S. AIR FORCE)

they do Information Advantage. They also have different delegated permissions around what they can and cannot do at different levels of command. This includes everything from the classification levels of IT systems to the release of information policies. That said, Air Cdre Bennett stresses there are also clearly areas where higher levels of both technology

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# Timber Sour

Maintaining airborne tactical data links has become a major priority for the modern warfighter. Northrop Grumman's **Paul Tremelling** explains why

**By decentralising network services, it is possible to deliver a resilient Mission Network**  
(IMAGE: NORTHROP GRUMMAN)

**T**imber Sour – two codewords used by aircrew to describe a Tactical Data Link (TDL) that is operating inefficiently. Until fairly recently – no big deal. The implications, though, in modern warfare would be significant: it means that a warfighter has become a very needy 'mouth to feed', and that certain tactics might be impossible. It could potentially spell the end of the mission, or worse, for the aircrew.

This hasn't always been the case. In the airborne arena, many platforms have existed without a TDL, but the advent of data links – particularly within the RAF – brought a step-change in capability. The Tornado F3, for example, used Link-16 technology to terrain mask fighters who were Emissions Control (EMCON) silent, being

'fed the picture' by Airborne Warning and Control System (AWACS) until it was time for their ambush to be sprung, effectively mitigating performance deficiencies against superior platforms. Latterly, through the Tactical Information Exchange Capability (TIEC), the Tornado GR4 joined the digital classes.

TDLs, within the appropriate groups, allow the sharing of targeting plans, weapon expenditure, fuel load, air-to-surface target points – the list goes on. TDLs allow you to speed up your 'observe-orient-decide-act' (OODA) loop, which means you can decide better and act quicker. Speed kills, and adds as much to lethality as it does to survivability and the avoidance of fratricide. You make better defensive decisions because you know not only where the threat is, but where mutually supporting or friendly assets are. Timber Sour is a very big deal indeed.

The latest systems now enable users who understand the mission to build networks to perform specific functions. A net tailored to a specific mission is provided through software, by a warfighter who never leaves the ground, and whose interaction with those that do is probably limited, but critical.

Examples of advances dependent on tailored nets include Manned-Unmanned Teaming (M-UMT). M-UMT promises the opportunity to enhance Combat Air mass for the RAF, to use autonomous systems for dangerous and mundane jobs, whilst acting in



**Data must multipath through and between networks – from the terrestrial, to the airborne layer, and to space**  
 (PHOTO: LPHOT LUKE/MOD/CROWN COPYRIGHT)

concert with a manned platform. If M-UMT is going to work then the team is going to have to be able to communicate where the M-UMT is thought to offer the most benefit – in the heart of the darkness and to display autonomy when communication is denied. Resilient communications, such as those provided by the Multi-Function Advanced Data Link (MADL) will be key, as will Battle Management technologies.

### Threats to Tactical Data Links

In the contested/dark environment, UHF/VHF voice communications and GPS will probably be denied and therefore reliance on TDL will increase. A TDL has, therefore, become entry level, and resilience is not a 'nice-to-have'. But there are threats to TDLs themselves.

No sooner did we get into the foothills, than the threat made the mountain bigger. The warfighting force that goes into combat in the current threat with just a single TDL ought to brace for disappointment. Threat response times are quicker, jamming is more powerful, frequency coverage more thorough, and multiple frequencies can be affected by techniques simultaneously. This threat picture significantly increases the benefits of fielding a Low Probability of Detection (LPD), Low Probability of Interception (LPI) link.

Rapid progress is, however, possible if we move from the platform-centric view of capability and embrace the network-centric alternative. In order to deliver resilience, and preserve the capacity to act, data must be able to multipath through and between networks – from the terrestrial, to the airborne layer, and to space. There will be temporal and geographical areas where TDLs will work and, conversely, those in which they will not. The more resilient the

communications, the smaller these areas or time windows will be. This requires the ability to maintain network services in a Mobile Ad-hoc Network (MANET), which will form as an isolated blister, leaving the wider network, but rejoining where/when possible. This means having decentralised services in all layers to maintain the network, and controllers that can assess network health and direct the multi-pathing; capabilities that are platform-agnostic. In providing options for data passage, and managing and fighting the network in real time, technologies such as the state-of-the-art network controllers generate resilience. To fully exploit and realise the

## The warfighting force that goes into combat in the current threat with just a single TDL ought to brace for disappointment

operational capability from these developments requires cultural change as much as it does technical.

Multi-domain players must be networked using networks tailored to specific needs. By understanding what information is critical and how it flows, accurately assessing where issues are, harnessing current technology to control the flow – to decentralise network services, to multi-path, it is possible to deliver a resilient Mission Network. Data and information getting to those that need it, when they need it.

The technical solutions to achieve Timber Sweet are available, if the cultural motivation is present. 

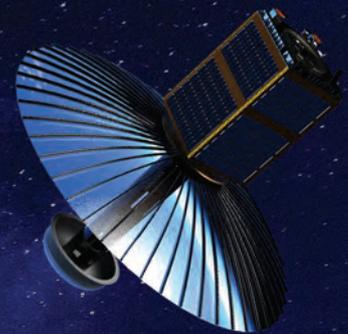
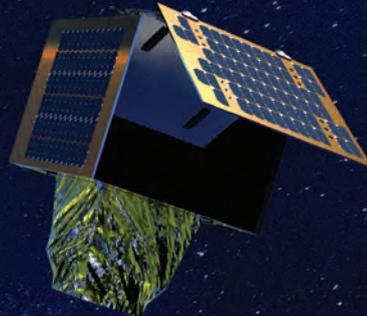
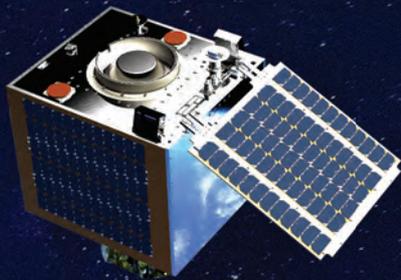


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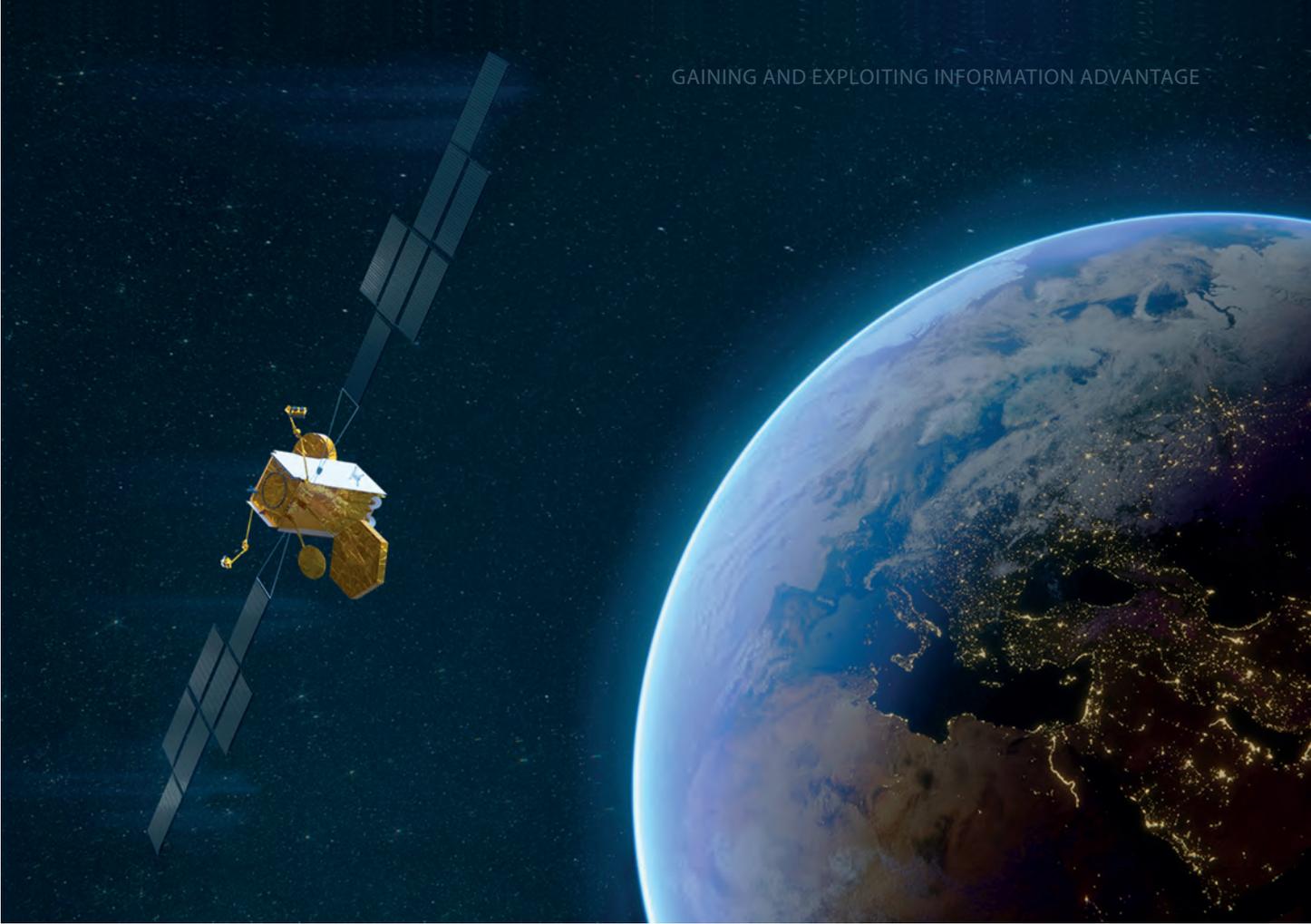
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# Space vision

Barely a month before the first lockdown, **Air Vice-Marshal Harv Smyth** assumed the role of the UK's first Director Space at the Ministry of Defence. Simon Michell outlines the lofty ambitions of this appointment

**Skynet 6 will offer advanced Satcom services, as well as the ability to carry payloads currently under development as part of the Defence Space Enterprise Portfolio**  
(PHOTO: AIRBUS)

**"A**s a nation the UK is fundamentally reliant upon Space as a domain. Moreover, the UK has extensive expertise and capabilities in the Space arena, with some first-class commercial companies, R&D programmes and operational experience. The trouble is, we have not been organised in a very coherent manner," explains Air Vice-Marshal Harv Smyth, the UK's first Director Space at the Ministry of Defence (MOD). This a polite way of saying our space activities and operations are scattered across the MOD in an ad hoc and sometimes confusing manner. Those wishing to initiate or expand Space activities with UK MOD often don't know who to approach, as, hitherto, there has been no single point of contact with whom to engage.

With AVM Smyth now in position, supported by a team of 12 within the nascent Space Directorate, all this is changing. "Put simply, my role, and that of the Space Directorate, is to improve coherency for MOD's Space efforts: 'down and in' across the Front Line Commands, and 'up and out' across Government, with the UK's Space Sector, and with international partners and allies."

## An ambitious proposition

Working with colleagues across Government, in particular the UK Space Agency, AVM Smyth and his team have put in place an ambitious space proposition that will establish the UK in a leading role in Space across the realms of defence, commerce and diplomacy. "If we get this right, it will be an elegant, joined up, national effort. We will no longer be working in silos, but instead delivering a National Space Strategy that will benefit the whole of the UK. From an MOD perspective, we already know that our Skynet Satcom capability is world-beating, and this will only improve throughout this decade as we deliver Skynet 6. In parallel, we have ambitions to further explore the use of small satellite constellations in Low Earth Orbit (LEO) to conduct ISR missions across the EM spectrum, to include electro-optical, infra-red, synthetic aperture radar and hyperspectral solutions. Such capabilities would prove game-changing to Defence in terms of providing commanders with true global reach and

high-fidelity, decision-quality information at the speed of relevance. Moreover, when coupled with the UK Space Agency's efforts in developing UK Spaceports in England and Scotland, an effervescent UK Space Sector, and an aspiration to develop a truly joined-up National Space Operations Centre, opportunities to develop a collaborative and coherent national space effort have never been more accessible."

For that vision to become reality it will need to be delivered, unpacked and explained across all parts of government, the military, industry and academia. That is what Smyth and his team are doing now. As he points out, it can't be achieved by the military alone. Nor should it. It is not solely a Defence programme: it must be a national effort to embed security and resilience, as well as grow prosperity for the entire nation.



**The United Kingdom is a world leader in the manufacture of small satellites**  
(PHOTO: SSTL)

So, exactly what is the Space Directorate doing at present? "I probably spend 70% of my time engaging across other government departments rather than delving down into the MOD. For example, my team is currently working very closely with the UK Space Agency on multiple topics, but of particular note is our co-authoring of the National Space Strategy. We are also working closely with Number 10, the Cabinet Office, the Department for Business, Energy & Industrial Strategy (BEIS) and the Foreign, Commonwealth & Development Office (FCDO). In particular, we are supporting the FCDO in its effort to establish a refreshed regulatory framework at the United Nations (UN) regards behaviours in Space, and we were incredibly heartened recently to see this resoundingly pass its first hurdle at the UN's 1st Committee. This is extremely important, as so many of our day-to-day activities are underpinned by space-based systems: ATMs; traffic lights; the stock exchange; the internet – just a few of the things that our digital world depends on. And

the more competed, contested and congested Space becomes, the more we need to modernise the international regulations that govern its use, especially if we are to guarantee the safe, secure and stable use of the Space domain into the future."

### A new UK Space Command

The much-vaunted Defence Space Strategy, much of which has since been subsumed into the National Space Strategy, currently being co-authored by the Space Directorate and the UK Space Agency, will put flesh onto the bones of what AVM Smyth hopes will keep him occupied in his tenure at the Space Directorate. Smyth comments, "Its an incredibly exciting time to be doing this work. The PM's recent announcement regards Defence's settlement from the Spending Review was incredibly welcome news, both for Defence as a whole but also specifically for us in the Space arena. We already have plans agreed and in place regards the construct of a new UK Space Command, a 2-star-led Joint organisation that will focus on day-to-day Space business, to include Space operations, force generation and training, and Space capability delivery.

"At this moment we are working through the final details of when Space Command will stand up, but, all things being equal, hopefully this will happen during 2021. Furthermore, we are working very closely with the UK Space Agency on the matter of UK Space Launch, to understand the best path forward to deliver our aspiration of launching our first UK-built satellite and payload from UK soil by 2022." In advance of this, though, Smyth is able to shed some light onto the sorts of space-related research and development his team is currently overseeing within the Defence Space Enterprise Portfolio (DSEP).

Intriguingly, there is consideration being given to additional payloads for Skynet 6. There is also some ground-breaking work on interaction between small satellites in LEO and large geostationary satellites. However, the DSEP is much broader than that. "We are looking at alternative methods of delivering positioning, navigation and timing (PNT) signals, to bolster resilience in this critical area. We are investigating how to increase our Space domain awareness, so that we not only know what is in Space, but also what it is actually doing. Further areas being considered include optical communications, different types of sensing, and the use of on-orbit artificial intelligence, so that we process data on the satellite before it is downloaded to Earth."

Once the programme starts delivering on the vision, the UK will not only be more secure and prosperous, but, as a meaningful player in the Space domain, it will also be able to offer allies unique space capabilities that further build resilience and capacity across coalitions. ○



# From the trenches to outer space – supporting the UK Armed Forces for over a century



**Ed Stainton**

Director of Major Government, BT

## What capabilities does BT offer the UK Ministry of Defence?

We've been supporting the Ministry of Defence (MOD) for more than a century. During the First World War, the General Post Office (GPO), as BT used to be called, lived alongside the military in the trenches providing communications. We laid the first ever undersea cable between the UK and France to allow Whitehall to communicate with the front line, and provided air defence to the UK in the form of an early-warning system to detect German Zeppelins.

During the Second World War, it was a GPO engineer, Tommy Flowers, who designed and developed Colossus – the first large-scale electronic computer – which went into operation in 1944 at Bletchley Park, where it played a key role in cracking the Enigma code.

Today, we're the backbone of connectivity and resilience for UK Armed Forces, enabling information superiority at home and abroad. With BT's lead in 5G, the Emergency Services Network and significant R&D, we are providing the MOD with mobility solutions, helping them in their own digital transformation journey. This will include the use of satellite communications, already an integrated part of our intelligent connectivity approach to our global customers.

## How does BT offer the UK Information Advantage and what effect will this have?

BT knows that information is the lifeblood of decision-making for our massive global customer base of SMEs, major corporates and national governments. Those who don't adapt wither. We go beyond limits to help businesses with their digital transformation, whilst protecting them from the asymmetric threats of cyber-attacks. Access to data in the information age, and its protection, are vital to the

**“Information is the lifeblood of decision-making for our massive global customer base”**

UK's national security. BT is proud of its national role at the heart of enabling Information Advantage for the private sector, wider government and Defence.

## How can BT develop new technologies and roles to enhance UK resilience?

We're witnessing an alarming increase in the rise of tier-one actors causing a fragility in world order. This is especially prevalent in cyberspace, so at BT we're making significant investments in cyber security, robotics and artificial intelligence to help our nation stand up to these emerging risks.

## What enhanced role might space-based technologies play in BT's future capabilities?

As a leader in technology innovation, we put the interests of the nation at the heart of our business by developing ground-breaking technologies that protect the security of our country.

One of our most crucial and innovative developments is Quantum Key Distribution (QKD). Rather than using traditional mathematical encryption, BT is using photons of light to transmit secure data that cannot be intercepted or cracked. We have already built one of the world's most advanced fibre-based QKD networks and, working with industry leaders, are now planning a satellite version, which we foresee as being a key component of ultra-secure satellite command, control and communications.

# Operation Olympic Defender

Having become the first international member of the US-led Operation Olympic Defender, the UK is supporting this endeavour with a team of space experts.

**Group Captain Darren Whiteley**, a UK Exchange Officer who is serving as the Deputy Director of the Combined Space Operations Center (CSpOC), details their duties and how the UK's contribution is adding value

The British Defence Secretary's July 2019 announcement that the UK had become the first international partner in the US-led Operation Olympic Defender left many in the defence community wondering what this little-known operation was all about. Although the RAF has been involved in space operations for over half of its existence – dating back to the Thor ballistic missile programme in the late 1950s – the rapid expansion of the space sector, increased threat from adversaries and the involvement of new commercial actors required a new approach to our command and control of the space domain. Operation Olympic Defender is the international response to these challenges and aims to strengthen deterrence against hostile actors in space.

In harmony with political intent, the UK increased the number of RAF exchange personnel at the Combined Space Operations Center (CSpOC). Based at Vandenberg Air Force Base, where all of the UK Thor missile launches took place, the CSpOC is the lead integrating operations centre supporting the delivery of Operation Olympic Defender and executes operational command and control of space forces to achieve theatre and global objectives. It operates 24 hours a day, coordinating, planning, integrating, synchronising and executing space operations.

Providing tailored space effects on demand to support theatre commanders and warfighters operating in multi-domain environments, it enables the national security objectives of several countries and increasingly enhances the operations



of commercial partners. It is just as important to the delivery of global space effects as the Combined Air Operations Center at Al Udeid is to air effects in the CENTCOM area of responsibility.

## Key leadership roles

UK members of the CSpOC are all exchange officers, allowing them to fully participate in the missions. Moreover, the UK holds key leadership roles in the Strategy and Plans, Current Operations, and Intelligence, Surveillance and Reconnaissance Divisions. These roles provide the UK with a

**A United Launch Alliance Delta 4 rocket launches, carrying the US Air Force's tenth SATCOM satellite, WGS-10**  
(PHOTO: UNITED LAUNCH ALLIANCE)



detailed insight to the totality and dynamism of space operations and will do much to aid our own development and enhanced integration. Furthermore, the UK currently fills the Deputy Director role, which, in addition to providing a leadership role to the more than 450-strong CSpOC team, is responsible for signing the Combined Space Tasking Order. This is the space domain's equivalent of the Air Tasking Order and directs over 70 terrestrial and on-orbit space assets. Tasks range from tracking space-based objects, using a variety of optical and electrical means, to the provision of missile warning and the delivery of electronic warfare effects. Ultimately, for the CSpOC, the main aim is to ensure the right effect is available at the right place at the right time.

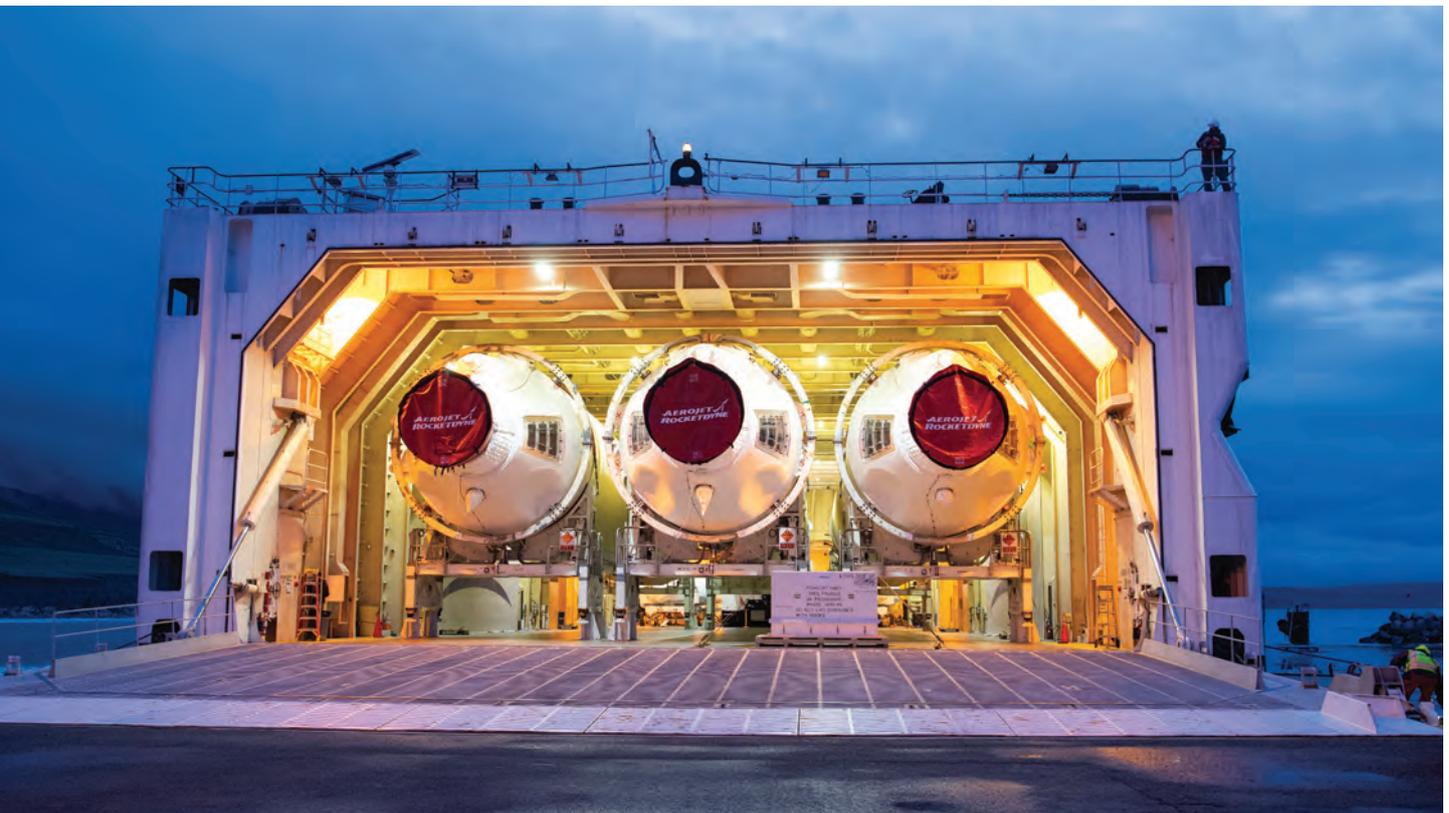
**At the heart of decision-making**

The UK also provides junior Non-Commissioned Officers to the tactical-level 18th Space Control Squadron, co-located at Vandenberg. As the principal space domain awareness unit, it tracks thousands of space-based items and, last year, notified a satellite owner of a risk of collision every three seconds. The UK's footprint, alongside Australian and Canadian colleagues, demonstrates Britain's commitment to strengthening collective abilities to deter hostile actions by adversaries. The nature of the roles held by British personnel places the UK at the heart of all operational-level decision-making

and provides ample opportunity to advise and influence operational-level plans and senior decision-makers up to four-star General (Air Chief Marshal). Whereas the US has the mass and deep mission expertise, the UK team adds value through providing a wealth of command and control, intelligence, targeting and joint and coalition warfighting expertise, which is essential to the development of the coalition space enterprise. Further, the UK perspective is respected and adds value to US leadership as they prepare courses of action. Perhaps less obvious, the UK's integration in the CSpOC provides encouragement to other nations to commit resources to Operation Olympic Defender by demonstrating it is a truly multinational endeavour. With over 100 companies, nations and academic partners having Space Domain Awareness agreements with U.S. Space Command, there is scope for Operation Olympic Defender to become a true global operation.

Unbeknown to many, vital civil and military systems are dependent on satellite technology, and states are increasingly reliant on the space domain for many aspects of life. Accordingly, Operation Olympic Defender is likely to be a cornerstone of UK Defence and National Security Policy for decades. The UK's early commitment has given it the opportunity to shape the Operation's evolution and gives the UK a seat at the high table as the US Space Force matures. ●

**A United Launch Alliance barge, known as the RocketShip, delivers Delta IV Heavy booster rockets to Vandenberg for a forthcoming launch** (PHOTO: SENIOR AIRMAN AUBREE OWENS/ U.S. AIR FORCE)





**Steve Beeching**  
Managing Director, Viasat UK

The Ministry of Defence (MOD) is soon expected to announce its future priorities and objectives as part of Government's Integrated Review. Whilst driving industry, prosperity, sovereignty and innovation, it should, no doubt, reflect that we are in an era of unrestricted and highly competitive warfare – often in the grey zone. With a new 'Space and Digitisation Race' emerging, our defence and security community faces relentless and demanding challenges and is under pressure to act and move faster than its adversaries.

To keep pace with transformational changes in technology and become a leader in this constant competition against highly capable and peer adversarial threats, the MOD could in the future benefit from evolving commercial-sector procurement procedures to support the desired agile approach to rapidly evolving mission outcomes and capabilities.

To assess the technology available, we need to identify and establish the best ways to experiment and deliver game-changing capability at pace, offering bite-sized innovation incrementally for sustainable mission success. This agility comes from a mission focus, simplifying documentation, placing integration

requirements on industry and delivering solutions rather than products. It promotes continual spiral innovation, looking at each required outcome and technology as it occurs, to drive incremental innovation and mission-centric solutions ahead of adversarial threats.

Viasat has applied such agile methodologies when looking to maximise the outcomes from next-generation tactical data link technologies in allowing seamless ground-to-air communications – especially when deployed at the tactical edge. Recent demonstrations of developments in both the US and UK have shown reduced time on target (from as much as 45 minutes, down to as little as 90 seconds), alongside improved situational awareness for lethality and reduced likelihood of fratricide.

The seismic increase and use of data offer further opportunities for the MOD in enabling responsive, real-time planning and execution of integrated operations. These commercial-sector procurement practices also promise more value and capability from platforms and service personnel across all domains, thanks to immediate access to effective and efficient information networks that deliver speed for decisions and intelligence across the battlespace.

Considering that many of the technology visions, espoused by UK Defence of late, were feasible and delivered across the private sector a considerable time ago, Viasat can help the MOD recalibrate expectations and possible outcomes and empower immediate improvements and collaboration to drive investment in support of Defence needs.

With the Space and Digitisation Race now in progress, many misconceptions and anxieties need to be debunked – particularly those relating to capacity restrictions, use of transponders and

the worries over jamming and control of the space network and spacecraft.

Today, it is possible to already have virtual private networks in space that are segregated from commercial networks as needed, and which can flex secure, assured, resilient capacity and move data demands seamlessly in real time around the globe. With the 'best available' network accessible since 2002, service delivery is now integrating low and medium Earth orbit (LEO, MEO) and geostationary (GEO) satellite constellations across broadband, narrowband and Link 16 connectivity for tactical-edge advantage. Viasat continues to demonstrate and invest in the benefits of executing these types of concepts and technologies to support common operating standards and future architecture.

Having worked with the MOD, as well as extensively across Five Eyes nations' governments and militaries, Viasat believes the path forward starts with building trusted partnerships between the MOD, Government and the private sector. These partnerships need to move to open dialogue about each other's vulnerabilities, so they can be resolved through collegiate team engagement that moves away from complex contract models and extensive change-control processes. Viasat's 'New Defence Industrial Base' approach uses multiple competitive and cooperative companies working together in an ecosystem with sustainable and integrated solutions, focused on mission outcomes. This paradigm shift shares risks and design obligations, moves integration ownership to industry and allows 'test-before-you-buy' sustainable solutions to reduce MOD costs and risk.

This is how we can win the Space and Digitisation Race and address persistent threats as our adversaries engage in unrestricted warfare.



## General James H Dickinson

### Commander, U.S. Space Command

Never a day without Space

**U.S. Air Force General Bernard Schriever postulated in 1957 that future, important battles would be space battles. We are beginning to see that theory come to fruition.<sup>1</sup>**

Intense study of strategic competitors suggests that Russian and Chinese military doctrine emphasize capabilities for attacking our Space systems in order to disrupt, blind, and disconnect our joint land, sea, air, and cyber forces at the outset of war. In recent years, both countries have developed and demonstrated anti-satellite capabilities, going as far as destroying their own systems in order to demonstrate their progress. In doing so, they have not only challenged the security and prosperity of the United States, its allies, and partners, but have also turned a once peaceful environment into a warfighting domain.

To acknowledge that level of threat, we must recognize the inherent value and significant influence Space has in the security and economic prosperity of our nation. Space capabilities provide worldwide coverage, access to otherwise denied areas, freedom of action, overflight, global perspective, and responsiveness that create decisive military and information advantage. Our prosperity is powered by Space as global economies and commerce are dependent and heavily reliant on the free flow of information in, from, and to space. Our way of life, security, and economic

prosperity are fully dependent on our ability to access Space.

Strategic competitors like China and Russia may seek to challenge our way of life and our way of war, but they lack one of our most significant force multipliers – strong allies and partners. To outpace the rapidly emerging threats from near-peer competitors, the U.S. Space Command is training alongside our allies and partners in collaborative

## We will not yield any advantage in the Space domain

efforts such as Operation Olympic Defender, Schriever Wargames, and the Combined Space Operations Initiative. These exercises and operations provide the perfect venue to deepen our interoperability and fine-tune lines of communication, maximize Space domain awareness, and ensure freedom of operation in Space. Paraphrasing the former Chief of Staff of the U.S. Army, General Mark Milley, the only thing worse than fighting a war in Space is losing a war in Space.<sup>2</sup>

Thus, the development of common tactics, techniques, and procedures, along with the proper

integration of Space capabilities across all warfighting functions and operational domains, is a strategic imperative. As we look to the future, together we will continue to use the aforementioned collaborative efforts to help identify future capabilities needs and hone the combined warfighting skills required to deter, and, if necessary, fight and win in the digital-age space domain.

The United States established the Space Force as a new branch of the Armed Forces, and the United States Space Command as a warfighting Combatant Command in recognition of the threats posed by strategic competitors like Russia and China, and with the commitment that we will not yield any advantage in the Space domain. In concert with our allies and international partners, U.S. Space Command will use the combat power generated by our combined team of warfighters to secure freedom of access to this important domain in order to ensure there will never be a day without Space.

1. Maj Gen Bernard Schriever, ICBM: A Step Towards Space Conquest, Speech delivered at the Astronautic Symposium, San Diego, CA, 19 February, 1957
2. GEN Mark Milley, AUSA Eisenhower Luncheon, Speech delivered at the 2016 Association of the U.S. Army Annual Meeting and Exposition, 04 October, 2016, [wpswps.org/wp-content/uploads/2016/11/20161004\\_CSA\\_AUSA\\_Eisenhower\\_Transcripts.pdf](https://wpswps.org/wp-content/uploads/2016/11/20161004_CSA_AUSA_Eisenhower_Transcripts.pdf); GEN Milley currently serves as the U.S. Chairman of the Joint Chiefs of Staff



# Delivering cutting-edge ISR on Earth and in Space



## Jeff Lewis

Chief Executive Officer and  
Managing Director, Raytheon UK

### How is Raytheon UK delivering ISR innovations to the RAF and allied nations?

Agile and robust ISR technologies are a force multiplier across the battlespace, and their importance will only increase over the next decade. For many years, Raytheon UK has been a world leader in supplying cutting-edge ISR sensors and systems to NATO nations, and our Broughton facility in North Wales is the nexus for all of our UK ISR capabilities. More than that, we provide complete end-to-end solutions for our customers in manufacturing, aircraft modification, sensor integration, testing and training.

The key to staying ahead on the global stage for defence and ISR is a nation's ability to create a layered approach across a multi-domain operational environment. We strongly believe Raytheon UK's operational philosophy on ISR exactly fits this concept.

The top layer is space-based, centring on satellite surveillance. The second layer

is tactical and strategic air platforms equipped with leading-edge technology, such as Raytheon's Shadow R. Mk II. This is a flexible and agile system providing operational freedom of action. The third layer consists of a variety of unmanned air systems, attritable or survivable, which perform low-level surveillance. The fusion of information from across the layers enables seamless operations.

### How will participation in Team Artemis enhance UK Space capabilities?

Project Artemis is a first step in the UK Ministry of Defence launching and operating a small-satellite resource – satellites that are cheaper, but robust, and that can be replaced rapidly, if need be. With satellite data dependency ever more crucial, ensuring resilience of constellations and rapid response is indispensable –

## “The key to staying ahead on the global stage for defence and ISR is a nation's ability to create a layered approach”

a goal made more complicated by the proliferation of anti-satellite capabilities.

First and foremost, satellites need command and control. For decades, Raytheon Technologies has been building and deploying assets for tracking and directing satellites. The company has been at the forefront of long-distance space communications since the beginning – including microwave-amplification voice links with astronauts on the moon.

Raytheon UK brings the best of cutting-edge global space technology to the UK. We are building skills and capabilities to support a Global Britain in this sector and our extensive apprenticeship scheme demonstrates our continued commitment to UK onshore aerospace capabilities. Our teams are highly versatile and our space engineering hub in Scotland will be capable of rapidly shifting focus to meet future needs.

### In what other technology efforts is Raytheon UK involved to enhance RAF capabilities?

We're immensely excited about the possibilities of next-generation combat air systems and are developing potential electrical systems architectures for the Tempest platform. We will be making recommendations for future work streams through Feasibility Assessments

in the coming months. Getting power management right for future combat aircraft is absolutely essential. Sixth-generation fighter capability will constitute a step-change in warfighting capability and embraces the digital transformation that accompanies it, affording the pilot a tighter decision-making loop in air operations. That means greater combat effectiveness and control. Raytheon UK is ready to be part of that transformation.



# Virgin Orbit

Virgin Orbit is offering a radical alternative for organisations looking to place small satellites into earth orbit. Mike Bryant asks **Flight Lieutenant Mathew Stannard** why he has been embedded with the company and how this breakthrough represents such a fundamental game-changer to the RAF's space capability

**Virgin Orbit's 'Cosmic Girl' gives UK Defence the potential to launch satellites within days of the requirement becoming necessary** (PHOTO: VIRGIN ORBIT/GREG ROBINSON)

**H**eadquartered in Long Beach, California, and part of the Virgin Group, Virgin Orbit is to launch small satellites into space from a rocket called LauncherOne, carried under the wing of a modified Boeing 747-400 aircraft. Known as 'Cosmic Girl' and able to operate from any airfield that can handle a 'jumbo', the groundbreaking aircraft will provide a ready platform for frequent launches. When fully operational, this capability will eliminate much of the current need for complex ground-based rocket launchpads that must be booked months or years in advance.

Flight Lieutenant (Flt Lt) Mathew Stannard, an RAF test pilot, took up his new role as a space capability test

pilot in Long Beach in early Spring 2020. He will work full-time with the company, whilst remaining very much an RAF officer. The secondment may be for as long as five years, but the timeframe is variable, and will depend on how the Virgin Orbit programme progresses and what the RAF can learn from it.

"So much has changed over recent years that the private sector frequently leads the way in investing in pioneering new technologies, such as those involved in the exploitation of space," says Flt Lt Stannard. "As such, the RAF can learn much from working closely with an enterprise like Virgin Orbit."

## Invaluable experience

Flt Lt Stannard has two primary roles with the company. First, as a serving RAF pilot, he acts as captain and pilot of the Boeing 747 from which the LauncherOne rocket will be launched. In doing so, he will experience how a non-military operation goes about test flying and operating such a unique platform, including launching an under-wing rocket. Moreover, he will also learn how the private sector prosecutes a complex programme of capability development in such a short timeframe. Both these lessons will be significant learning curves for the RAF when he brings this experience back home.

His second role is as a liaison between Virgin Orbit and the RAF. Given that it is anticipated that Virgin Orbit will become the RAF's preferred satellite launch provider long into the future, if

Virgin Orbit plans to launch small satellites into space from a rocket carried by a modified Boeing 747-400 aircraft (PHOTO: VIRGIN ORBIT/ GREG ROBINSON)



**Speed and flexibility**

Virgin Orbit, on the other hand, offers a dedicated service from a UK ally, tied to a specifically selected low-earth orbit and geared expressly to the launch of small satellites (typically about 500kg). Perhaps best of all, it offers the potential for great speed and flexibility. All this represents a game-changer in terms of capability, especially now that the need to put satellites into orbit is growing exponentially. "It would change the way we think of putting satellites into space," explains Flt Lt Stannard, as, for the first time, the UK will have access to a tactical launch capability.

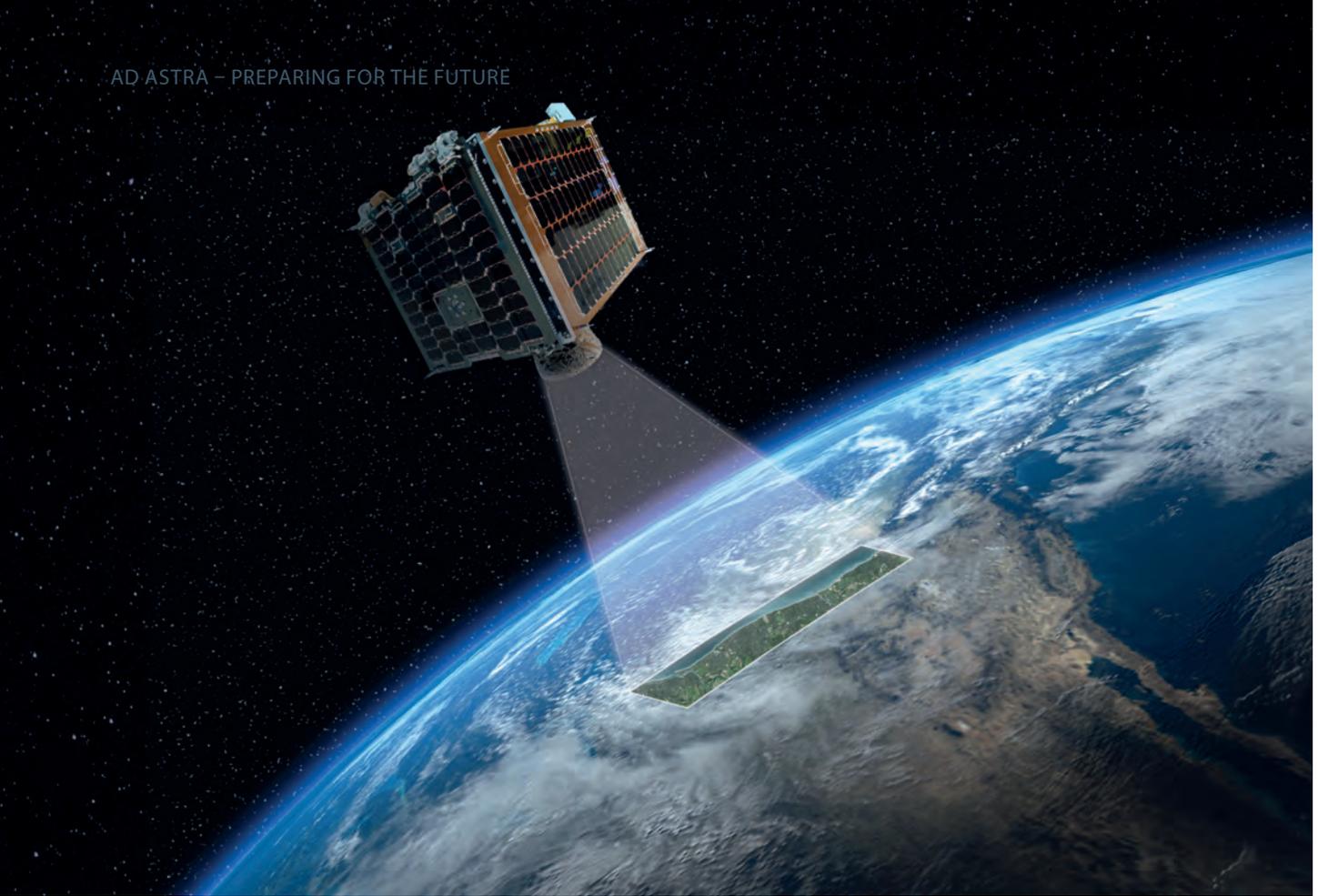
In the short term, it is hoped that Virgin Orbit will act as launch provider for the Team Artemis constellation of small satellites (a programme not to be confused with NASA's next human moon-landing project). The hope is that the first launch of a Team Artemis satellite may take place before the end of 2020. "The biggest value of Artemis will lie in its role as a capability demonstrator of the speed and flexibility of the new launch procedures," says Flt Lt Stannard. 

all goes well, then effective liaison early in the relationship is likely to prove invaluable. The capability that Virgin Orbit is pioneering could prove key to future RAF operations as it is developing the capability for customers, such as the RAF, to put small satellites into a dedicated orbit in just a few days from when the requirement is first identified. That would allow the RAF to meet a new tactical requirement – observation/ reconnaissance of a specific area of interest, for example – in a matter of just days or weeks.

This is very different to the capability that is available to the RAF today. Currently, it – and the UK more generally – must outline any satellite launch requirement months, or sometimes years, ahead of the ground-based rocket launch that would be needed. Its satellite would probably have to 'hitch a ride' with other customers' larger payloads, possibly taking a subordinate place as a result. In addition, the launch provider that is best placed to meet the requirement may not always be a natural ally of the UK, and the orbit into which the rocket could place its payload might not be the ideal one for the RAF's needs.



Flt Lt Stannard's background as an RAF test pilot qualifies him for piloting a very wide range of fixed-wing aircraft types (PHOTO: SAC BEN MAYFIELD/CROWN COPYRIGHT/MOD)



# The Astra initiative – in the information age

Assistant Chief of the Air Staff (Strategy), **Air Vice-Marshal Ian Gale**, reveals how the Astra initiative will turbocharge change in the Royal Air Force to ensure that it retains its winning edge throughout its second century

**The Astra initiative will offer a more flexible work-life balance and enhanced career opportunities in the space, software-coding and Information Advantage fields**

(PHOTO: SSTL)

**T**he requirement for change has always been clear; even before a global crisis that has touched us all. Technology, the nature of our work and complex geopolitics have all driven this necessity for change. We need to evolve to survive, flourish and win. So, I'll not dwell on the 'why', but rather the 'what' and the 'how' change will occur. For the RAF, this is outlined in 'Astra', the transformational initiative to deliver the #NextGenRAF.

Astra has quickly become the touchstone for deep and fundamental change, with a network of over 300 ambassadors on stations and units both taking the message out to our people on their own terms, and harvesting great ideas to incrementally improve the Service. The key is letting innovation run its course

and stepping in only to help remove obstacles or to help scale ideas that could work everywhere.

This isn't a free ride though – the internal mechanisms of large-scale institutions are often resistant to change and, therefore, our challenge is significant. Most large organisations are 'spring-loaded to zero' and we all have to work hard, from the Chief of the Air Staff (CAS) to the latest Halton entrant, to keep cynicism in check, believe in change and then make it happen. Innovation is never straightforward, but, for those willing to persevere and be the leading edge of next-generation working practices, policies and tech, the reward will be a place in changing our Service forever.



Some 80 years after the Battle of Britain, the Astra initiative will introduce another era of rapid change and innovation (PHOTO: CPL ALEX SCOTT/CROWN COPYRIGHT/MOD)

#### Astra focuses on four key areas for the Service:

- 1 People** – to offer flexible career pathways, including a growth of the space, coding and Information Advantage cohorts;
- 2 Training** – to maximise resilience, flexibility and effectiveness, including the use of advanced synthetics to reduce the time in training and offer more on-the-job learning;
- 3 Infrastructure and support** – to address immediate deficiencies across stations, working towards a carbon-neutral footprint in an effective and efficient estate we can be proud of;
- 4 Equipment** – with a focus on interoperable air, space and cyber systems that bring clear financial and skills benefits to the nation. As a technical Service, we must avoid the temptation to, as Lt Col USMC (Retd) Frank G Hoffman says, “laminare new technology on top of old processes”, and therefore it is imperative that these priorities also remain calibrated by a strong degree of conceptual rigour. So, new effort is already under way to regain our cognitive edge by properly devoting time and effort, all ranks and roles, to developing our future work – I encourage all members of the RAF’s Whole Force to get involved: we need and will welcome your input.

So, what about the ‘how’? Fundamentally, Astra is about empowering our network of people. Using ‘Defence Ideas’ and our current ambassadors, that network now exists; and, rather than a tired old ‘suggestions’ scheme, the Air Force Executive



Committee and I are directly linked to the scheme, supporting where needed, especially where frustrating policy stands in our way. Early wins include CAS’s statement that his successor ‘doesn’t have to be aircrew’, which has caused a huge change in career management and has generated our first non-aircrew Main Operating Base commander. This has truly made us the Service where we reward talent and effort, without discrimination of any kind. In the infrastructure sphere, project Hydro has invested reprioritised money into fixing the most pressing life-support issues, mainly heating and hot water – we are listening and we’re doing it first, before any more ‘glitzy’ work.

Additional examples include innovative working-from-home solutions (implemented before the COVID-19 outbreak!), the ‘My RAF’ app, and the development of Tempest (and if you haven’t heard of RAFX, Air Information Experimentation or the Rapid Capabilities Office, now is also a good time to find out). We’re working with other Services and UK industry to fast-track to the future; to create a slicker, more lethal, engaging and competitive RAF than ever before – one that is a strong direct contributor to UK values and, of course, to our recovery from COVID-19.

So, on this 80th anniversary of the Battle of Britain (another time of rapid change, innovation and effort), I’m delighted to bring you this short Astra article. Please get involved, please fight cynicism to avoid self-defeat, and help to play a part in changing our future! 🗳️

**Enhanced synthetic training, using computers as well as virtual and augmented reality systems, will reduce costs and enable more on-the-job instruction**  
(PHOTO: DAN HAWKINS/ U.S. AIR FORCE)



# The future of Combat Air

**Air Commodore Dan Storr**, Head of the Ministry of Defence's Combat Air Acquisition Programme, offers an update on the work to ensure that the UK remains at the forefront of Combat Air System development

**Options for an eventual replacement for the Typhoon fast jet are being worked through by the Combat Air Acquisition Programme**

(PHOTO: CROWN COPYRIGHT/MOD)

Launched two years ago, the UK Combat Air Strategy recognised that Combat Air is one of a few capabilities where sovereignty really matters. It provides us with an ability to protect and use the complex technologies that give us an advantage over our adversaries. A globally competitive UK Combat Air sector also helps ensure that our equipment programmes and capabilities are both affordable and at the leading edge of technology. It helps sustain an effective and productive sector, in which over 18,000 highly skilled people are directly employed, and are supported by an additional 28,000 in the wider supply chain. The sector supports strong Government finances which, in turn, help secure

the budgetary settlement that the Ministry of Defence (MOD) needs to maintain the required capabilities. If lost, the Combat Air sector would be incredibly difficult and costly to regain.

Informed by the need to replace Typhoon, the Combat Air Strategy recognised that the operating environment is getting more challenging and that new capabilities are required to stay ahead of the threat. Consequently, the Combat Air Strategy launched the Combat Air Acquisition Programme to define and deliver the capabilities required when Typhoon leaves service.

Analysis clearly demonstrates that a Combat Air System will be required for Control of the Air, and some intelligence, surveillance and reconnaissance (ISR) and attack functions. Ground-based air defences, space-based sensors and long-range weapons all have a part to play, but are not able to perform the roles we need by themselves. Therefore, the Combat Air Acquisition Programme aims to deliver a Future Combat Air System (FCAS) whose composition continues to be defined by comparing different combinations of manned aircraft and a variety of unmanned air vehicles operating in concert. The MOD is working with industry and international partners to ensure that we have a collaborative option, which the UK terms Tempest, to deliver this FCAS.

While confidence in autonomous systems and artificial intelligence is growing, the complexity of some dynamic tasks – aspects of Control of the Air, in particular – is likely to require a manned platform



in the system. Separately, policy requires human control or supervision of lethal force, and the remote supervision associated with unmanned systems will be challenged by a future threat environment where we expect our long-range communications to be heavily disrupted. Consequently, a manned core platform is also likely to be needed to provide human supervision of unmanned elements operating in relative proximity. We currently envisage three broad categories of unmanned vehicles that could operate alongside a manned platform:

- disposable and usually small;
- 'attritable' (vehicles we would like to reuse, but are prepared to sacrifice); and
- survivable.

These unmanned vehicles may increase our combat effectiveness, especially in the most contested environments, or might seek to reduce overall system costs. The overall system architecture will be equally (if not more) important than the platforms.

Multi-domain sensing combined with data fusion and high connectivity – in bandwidth, speed and number of users – will be key to delivering information advantage for the FCAS and the wider Joint Force. In circumstances where the electromagnetic spectrum is highly contested, connectivity may be reduced and require the FCAS to have significant on-board processing to astutely transmit the most relevant information when able. These circumstances will also require a high level of autonomy and self-reliance.

### Significant opportunity

The System and technologies involved represent a significant ISR and command and control (C2) opportunity, which could be further expanded through the carriage of additional sensors in the

payload bays of some platforms and combining information from disaggregated sensors, both within and outside of the System. The FCAS will also have the added benefit of being able to deliver ISR and C2 in a full range of threat environments and at closer ranges to protected areas, providing greater fidelity of information. Consequently, while the FCAS aims to fill the void left by the eventual retirement of Typhoon, it also provides a significant opportunity to rationalise or 'sunset' other more niche ISR capabilities and platforms that have less utility in a broad range of operational scenarios.

The Combat Air Strategy set out a systems approach to defining and delivering the capabilities required when Typhoon leaves service, and the work so far in the Combat Air Acquisition Programme continues to validate this approach. 

**The Future Combat Air System, also known as Tempest, is being developed by a multi-disciplinary and international partnership**

(PHOTO: JACK ECKERSLEY/CROWN COPYRIGHT/MOD)



**The UK's Combat Air Strategy calls for an independent and sovereign aerospace capability built on international partnerships and collaboration** (PHOTO: BAE SYSTEMS)



# Demonstrating our resilience through challenging times



## Duncan Eldridge

Managing Director, Military Aerospace,  
Marshall Aerospace and Defence Group

### How has Marshall ADG fared throughout the constraints of the COVID-19 pandemic?

There is no getting away from the fact that these are challenging times.

However, our team has done a tremendous job to make sure we've been able to deliver for our customers in the most difficult of circumstances. We managed to get around 800 team members up and running and working efficiently from home in less than 48 hours, whilst our front-line teams did an incredible job to ensure we could maintain production throughout both lockdown periods.

We were fortunate that our customers, and the Ministry of Defence (MOD) in particular, were very clear about the criticality of the work we do for them and supported us in prioritising our activities, so that we could maximise fleet availability through the initial peak of the pandemic. Internationally, we

saw a lot of our customers use their C-130 fleets as part of their COVID-19 relief efforts, which was, of course, an enormous source of pride for our teams.

Clearly nobody can predict how things will unfold with the virus in the longer term, but, to date, we have really demonstrated our resilience as a business. I hesitate to use the phrase 'business as usual' because it has taken a huge effort, but that has pretty much been the case for us.

Our Military Aerospace business has continued to deliver large numbers of aircraft back to our customers and our larger projects, including the Centre Wing Replacement Programme for the Royal Air Force, all remain firmly on track. It's been a similar picture in our Land and Advanced Composites business as well, where we have been able to maintain production across all our key programmes.

### How is the C-130J Centre Wing Replacement Programme progressing?

The installation of Enhanced Service Life Centre Wing kits on the UK C-130J fleet will enable the Royal Air Force to perform its critical air transport role for many more decades to come. The programme is progressing very well, with the first aircraft having been returned to the RAF in August, following replacement of the Centre Wing and completion of scheduled maintenance, and the second aircraft modification well under way.

We will continue to combine the modification activity with maintenance inputs, as fleet availability

is key. This is the latest in over 1,500 modifications we have completed on the C-130 platform and another fantastic demonstration of us working closely with the MOD and Lockheed Martin.

### How has Marshall been supporting the effort to address the COVID-19 pandemic?

We define our organisational purpose as 'protecting people in critical situations' and that has never been more relevant than during the COVID-19 crisis, when we have stepped up to do just that. But that's not something new to us; this business has a long and proud track record of being there when the nation needs us. There are so many great examples in our 110-year history, whether that's delivering training for 20,000 pilots during the Second World War or developing air-to-air refuelling solutions during the Falklands War.

COVID-19 has been no exception. We've been involved in a whole host of activities, but probably the most significant has been our role in the Exovent Taskforce, supporting the development of a new type of negative pressure ventilator. It's still relatively early days, but, because of its non-invasive nature, Exovent has the potential to be a real game-changer in the treatment for acute respiratory failure. We are very proud that it was Marshall engineers who designed and built the prototype in a matter of days, along with the four subsequent beta models used for clinical trials – another great example of our agility, collaboration and innovation.

# The challenge of the Combat Air Strategy

The UK is destined to remain a world leader in the design and production of Combat Air Systems for many years to come. **Andrew Kennedy**, Strategic Campaigns Director at BAE Systems, explains why



The 2018 Farnborough International Airshow was a watershed moment for the Combat Air sector in the UK. The publication of the Combat Air Strategy, combined with the launch of the Combat Air Acquisition Programme (CAAP) and the establishment of Team Tempest, began a series of activities that will ensure that the UK remains a world leader in this sector for many decades to come.

The Strategy had three broad aims, all welcomed by Industry: to encourage investment into the sector; to inspire current and future generations; and, importantly, to deliver a statement of intent that the sector is a strategic asset for

the UK and that industry has a vital role to play in supporting the sector for decades to come.

To continue to play this vital role, however, Industry knows it needs to meet the challenge posed by the Strategy, which is to deliver world-leading military capability quicker and cheaper. To do this, the whole sector needs to fundamentally transform how it brings military capability to the front line.

## Team Tempest

The launch of the Team Tempest partnership was the first step in this transformation and signalled the start of a more productive and collaborative relationship between Industry

**When Tempest enters service in 2035 it will have revolutionised the way the UK designs, builds and tests Combat Air systems**

(PHOTO: BAE SYSTEMS)

## Team Tempest is focused on empowerment at the most appropriate level to facilitate rapid decision-making

and Government, which began with the broad consultation that Government instigated with industry while gathering evidence for the Strategy.

The four Industry partners (BAE Systems, Leonardo, Rolls-Royce and MBDA), along with the RAF Rapid Capability Office, are working closely together to deliver the technology, processes, skills and experience that will be necessary for the UK, in collaboration with international partners, to design and develop a next-generation Combat Air System.

### Increased efficiency

This new way of working has delivered tangible results, with examples of work that traditionally took years now being done in weeks. Using the latest technology and thinking based on digital tools and model-based systems engineering, the partnership has registered a saving of over three million working days from comparable programmes. The partnership has also registered a number of specific patents, already generating and safeguarding the Intellectual Property that provides the lifeblood of any leading industrial sector.

By challenging the traditional paradigm of how a Combat Air development programme is run, Tempest will deliver on the cost and time challenges. As well as using the latest tools and technologies, we are also changing organisational structures. Team Tempest is

focused on empowerment at the most appropriate level to facilitate rapid decision-making. The Team is also delivering a changed approach to requirements setting to allow a clearer understanding of the cost of requirements and encouraging innovative ways of building-in flexibility to the system. One particular area of focus is on Test and Qualification, where the Team is focused on identifying the optimal mix of synthetic and live testing to deliver the required level of safety, while shortening the traditional timescales process. This work is focused across all the Defence Lines of Development to ensure that, from the first day, the system is ready to operate, the whole Combat Air enterprise is ready to go, whether that be on the ground or in the air.

### International partnership

There is, however, much to be done to maintain this momentum. One important objective is to build an international partnership, bringing together like-minded nations in a partnership focused on the same objectives. This partnership needs to deliver a capable, affordable and flexible solution in the timescales the Strategy outlined. The UK has made huge progress in discussions with international partners, not just on how any partnership will deliver these transformation objectives, but equally as much as on the military solution itself.

The next milestone for Tempest comes with the submission of the Outline Business Case at the end of 2020. This needs to show that the Tempest partnership is on track to meet the objectives of the Strategy and provide clear evidence that Industry has embraced the challenges posed in July 2018 to deliver the CAAP solution. It has been an incredibly exciting and productive 24 months for the sector, with much more to come. 



As part of Team Tempest, the RAF Rapid Capabilities Office is working with industry to deliver the next-generation combat air system  
(PHOTO: BAE SYSTEMS)



# Team Tempest: partners in the UK's future air combat capability



**Chris Boardman**  
Group Managing Director,  
BAE Systems – Air

## What is Team Tempest's vision for the future of the UK's air combat capability?

The ambition that the Government set out to UK industry two years ago was for the nation to remain a world leader in the combat air sector, and this remains our driving force.

Team Tempest's shared aim is to deliver a UK-led international collaborative future combat air system that maintains the UK's leading defence and security capabilities and provides the flexible and affordable solution the RAF needs. This will not only maintain the UK's sovereign capability and freedom of action, it will also support strong international relations, and ensure the UK combat air sector continues to make a significant contribution to national prosperity.

The sector adds £6 billion of revenue to the UK, directly employs 18,000 people and supports a supply chain employing at

least another 28,000. Through this balanced approach of operational capability, international influence and economic benefits, we can deliver this vision for a stronger, more prosperous nation.

## How will BAE Systems and its partners help the RAF achieve its aims through Tempest?

I know that all the Team Tempest industry partners are very proud of their long-standing relationship with the RAF, and the role we collectively play in supporting the air force as it delivers its mission. At BAE Systems, we have worked side by side with the RAF to develop, produce and support the aircraft that have secured our skies for generations.

The Team Tempest partners are currently working on over 60 technology demonstrations. BAE Systems is leading this work in a number of areas. This includes development of next-generation technologies, such as future cockpit and flexible payload bay development. We are investing in cutting-edge UK technology, intellectual property and research in areas such as augmented and virtual reality and the exploitation of artificial intelligence as part of that work.

To make this Tempest vision a reality, we have a remit to demonstrate that we can deliver a future combat air system – with all the cutting-edge technology that entails – faster and more cost-effectively than ever before. One way in which we are meeting this challenge is by looking beyond the defence sector to draw on some of the most advanced technologies that already exist and assessing how we could apply them to combat air. Work

in the development of technologies such as engines, sensors and weapons systems will help us refine concepts ready for the important decisions that will have to be made in the near future. But our innovative approach is about more than adopting new technologies; it applies to everything we do on Tempest, right down to developing new ways of working, both in Team Tempest and with our international partnerships, to ensure we can deliver flexible and affordable next-generation capability.

## How is BAE Systems ensuring the RAF has the information advantage it needs in future?

Delivering an 'information advantage' is at the centre of our combat air system vision, enabling the RAF to make informed decisions quicker than their adversaries. Platforms across all domains will be able to seamlessly exchange and interpret huge amounts of data to provide armed forces with a complete picture of that future battlespace.

We see a connected, agile, flexible future combat aircraft as a central controller within that wider system, able to interact with all other domain assets to provide a powerful and unique advantage.

One example of how we are doing this is Sceptre, our mission-planning technology, which we are delivering for the RAF's Typhoon fleet. It draws in huge amounts of information, simplifies it and presents it to pilots and mission planners, enabling them to make rapid and accurate decisions. Having an open architecture means Sceptre can be tailored for any future fleet mix.

# Understanding the market and removing trade barriers

**Mark Goldsack CBE** explains his strategy for expanding the UK's defence exports to Simon Michell



**According to Mark Goldsack, Director of the UK Government's defence exports department – DIT DSO, "Our job can be synthesised into three core tasks: understanding the market, reducing trade friction and refining the export offering."**

Hence, since his arrival in early 2019, the organisation has been working very hard to deepen its understanding of the defence export markets it is trying to expand into and increase its footprint in those it already serves.

The trick is to get ahead of the competitors and to be properly prepared to capture forthcoming demand before it is announced. It is, therefore, essential to get a clearer picture as to when potential customers actually need to buy new equipment before everyone else does – the so-called refresh rates. "We now have a very rich picture of what is going on in the international markets and, particularly, the stage at which each of the core procurement opportunities we are

targeting are at. This is helping us to match the UK offering into them."

Beyond that market understanding, DIT DSO's role is also to reduce trade frictions by smoothing out the wrinkles that exist between the UK's regulatory trading system and that of the export customer, as well as removing some of the trading barriers. "Ultimately, though, what really matters is whether the UK's export 'apparatus' is more efficient than its competitors," says Goldsack.

A core DIT DSO function is to help companies, and especially SMEs, reach out to the international market and enhance their awareness of the intricacies involved in exporting products and services overseas. In Goldsack's words, "We can help them meet the customer, understand the market-entry conditions and the barriers they have to contend with. This helps to build confidence and increase awareness. What has become clearer as we have increased our efforts this year is that many of these SMEs were not fully aware of how strong their offering actually is."

## Providing partnership

Another key element in expanding export opportunities is recognising that times have changed and many countries no longer want to buy a turnkey solution off the shelf. Instead they want to share some of the technology and the financial benefits. In short, they want a partnership. "They need to see some joint value and they need to see a return on their

investment. They want to share IP and create new IP as part of a team, so that both sides can reap the financial, industrial and social rewards," explains Goldsack. He is convinced that the UK defence and security sector is in a unique position to offer these sort of partnership deals, thanks to a more benign attitude from the UK Government in terms of trading and aggregating IP and the excellent support that exporters receive from UK Export Finance (UKEF).

## Close relationship

A good example of this is the close relationship the UK defence community, supported by DIT DSO, is building with the Indian Government. In February 2020, the UK India Business Council (UKIBC) signed an MoU with the Society of Indian Defence Manufacturers (SIDM) to forge closer defence ties.

Goldsack was in Lucknow to witness the signing and enthuses, "This exemplifies how we can support SME's, not just domestically, but also in our export customer's countries. In India's Uttar Pradesh Defence Industrial Corridor there are now about 170 SMEs that have recently emerged and are a part of our supply chain.

"There is some world-class engineering taking place by new Indian SMEs, and people are starting to understand the value of linking up these companies with ours and de-risking each other by becoming part of each other's supply chain. That's what makes for a secure relationship going forward."

# F-35B Lightning Force evolution

Since entering service, the F-35B Lightning has reinforced the Royal Air Force's reputation as a truly advanced air and space force, but to maintain this strategic advantage, the Lightning will need to evolve. Lightning Force Commander, **Air Commodore David Arthurton**, offers his vision for this evolutionary journey



**New concepts on how to get the best out of the F-35B Lightning were explored during its inaugural deployment to Exercise Red Flag**

(PHOTO: SENIOR AIRCRAFTMAN AMY LUPTON RAF/CROWN COPYRIGHT/MOD)

The inaugural deployment of UK F-35B Lightnings to Exercise Red Flag – a demanding near-peer scenario Combat Air exercise – provided the perfect opportunity to explore employment of the RAF's latest multirole fighter. Furthermore, the exercise allowed the Lightning Force to consider how the RAF might preserve its operational edge well into the 21st century. Prior to Red Flag, it was assumed that fourth- and fifth-generation capabilities would operate homogeneously across the battlespace, with the low-observable and data-driven capabilities of fifth-generation aircraft providing the older fourth-generation platforms with the information and protection required to strike deep into adversary territory. However, experience

gained on Red Flag suggests that the F-35 Lightning and other fifth-generation aircraft will adopt a phased approach, temporarily generating a more permissive environment where a broader range of less survivable platforms can then operate. During the exercise, the high-end capability of F-35, amplified by seamless connectivity between UK and US platforms, allowed domination of the contested battlespace.

To employ the Lightning effectively, pilots must adopt an agile, multi-domain mindset that allows them to exploit their superior situational awareness, derived from fused data, and leverage the fighter's capability across the air, cyberspace and space domains. Importantly, the multi-domain approach must extend beyond the cockpit; to achieve this,

we must overcome institutional inertia, break down parochial stovepipes across Defence and embrace the capabilities we have at our disposal today, casting aside legacy thinking. Transition to a joined-up, multi-domain approach will not happen overnight and, if it is to be effective, must be led by future-facing professional military education, use focused collective training and employ a cadre of non-kinetic professionals that can ably identify warfighting synergies across platforms.

### Sharing decision-quality information

The processing power inherent in the F-35 enables the exploitation and dissemination of decision-quality information across the battlespace, although fifth-generation networked Command and Control (C2) is beneficial to fully exploit this advantage. While this processing power can also be harnessed by the F-35 itself (allowing exploitation of fleeting opportunities in

The human element of mission support is a critical area in which we must urgently invest. Currently populated with single-discipline practitioners from communications engineer, intelligence and flight ops specialisations, mission support is ripe for evolution through the development of tactically savvy multidisciplinary operatives. Furthermore, these individuals must operate well beyond the boundaries of their legacy trades; F-35 demands mission-support specialists that possess a tactical mindset and intrinsic understanding of multi-domain operations.

Such a vision does not sit comfortably with the RAF's legacy branch and trade structure. However, if we can get this right, rapid evolution of mission data through both sovereign and combined efforts will allow the UK to stay ahead of its adversaries.

### Working with partners

With 13 other nations in the F-35 Lightning programme at time of writing, there is great potential to work with partners to enhance resilience and deliver operational output when it is not possible to mount a mission from a home operating base. The development of an agile basing concept, which exploits opportunities created through a shared platform and the ability to conduct cross-servicing, could provide a powerful force-multiplier effect. Security and technical restrictions will need to be overcome, but this is already a focus of collaborative working groups and is something we must continue to pursue to increase F-35 resilience.

Finally, we must protect our battle-winning fifth-generation capability by remaining responsive to all threats as our enemies seek to gather intelligence and exploit weakness. Non-traditional attack vectors, such as social media and information networks, are as relevant as physical threats to our infrastructure and people.

We must strive to better educate our personnel, developing a robust security culture that strikes the right balance between protecting our capability and enabling our personnel to engage, with confidence, at a given classification. To date, classification has been used to unnecessarily mask and obfuscate, rather than promoting advocacy for F-35, allowing its intelligent incorporation into operational plans. Effective mentoring of our people will be essential if we are to turn our aspirations into reality.

The F-35 Lightning has only just commenced its operational service in the UK, and while the aircraft already offers a step-change in capability, there remains considerable untapped potential. If we embrace iterative capability development and tackle the deeper-rooted impediments to progress, the UK's Lightning Force will continue to deliver multi-domain battle-winning capability well into the 21st century. ●



**Working with the wider F-35 community will offer many advantages, including an agile basing concept**

(PHOTO: SAC MARK PARKINSON/CROWN COPYRIGHT/MOD)

denied and contested environments), there is arguably greater benefit to sharing decision-quality information with other friendly entities. Sharing of decision-quality information reduces exposure time for less survivable platforms and increases lethality. With reliable access to networked, high-quality information and a clear understanding of commander's intent, the F-35 can enable the devolution of battle-winning decision-making to a single aircraft.

The Lightning is data-hungry and requires teams of specialists to prepare and exploit that data. Much to the detriment of the pilot's ego, these less obvious team members drive survivability and lethality, giving the fighter an edge in high-end contested scenarios. We have learnt much about mission data from the expertise that exists in Typhoon and must draw best practice through to the F-35 if we are to develop and maintain a competitive advantage.



GO BEYOND

# F135 – readiness and reliability



## Bev Deachin

Vice President, F135 Program,  
Pratt & Whitney

### How is the F135 engine performing in the field?

From an operational perspective, the combat-proven F135 – which powers all three variants of the fifth-generation F-35 Lightning II – continues to demonstrate a generational leap in readiness and reliability. With over 550 P&W-powered F-35 aircraft operating from 24 bases worldwide, and with more than 300,000 flight hours across the global fleet, the F135 has maintained propulsion mission capability rates consistently exceeding 95%. Additionally, the F135's Unscheduled Engine Removal (UER) rates demonstrate a more than 250% improvement over fourth-generation fighter engines. These metrics speak for themselves – the F135 is the most dependable fighter engine we've ever built.

### Can you provide an update on P&W's cost-reduction efforts for the F135 engine?

P&W is delivering exceptional fifth-generation propulsion capability at great value for our US and international

customers. Since the first low-rate initial production lot of engines, P&W has reduced the average cost of an F135 engine by more than 50%. A range of affordability initiatives focusing on value-engineering and supplier long-term agreements that leverage our commercial and military volume, and finding best-value suppliers in our domestic and international partner base, will provide more than \$7 billion in estimated cumulative programme savings.

As the fleet grows, P&W remains committed to the affordable sustainment of the F135 and is targeting a 50% reduction in cost per flight hour to meet a steady state goal of \$3,500. P&W is advancing F135 sustainment affordability by addressing both scheduled and unscheduled maintenance costs, through component improvements such as life extensions and limits expansion; developing and deploying new repair processes; spare-part cost-reduction; and digital technologies. The team will also be able to apply lessons learned from the first scheduled depot overhauls in the early 2020s to further advance sustainment cost-reduction.

Moving forward, cost-reduction efforts will be challenged by both the loss of low-cost Turkish suppliers, as well as adverse COVID-19 impacts. We are working closely with the F-35 Joint Program Office to continue to adapt our affordability initiatives in light of this challenging environment.

### How is P&W planning to sustain the growing global fleet of F135 engines?

The F135 was designed for ease of maintenance and affordable sustainment. The 84% tri-variant

propulsion commonality of the F135 allows for common fleet sustainment solutions and economies of scale. The unique F135 Global Supportability Solution concept leverages a shared spare-parts pool – reducing initial inventory requirements – across all F-35 operators, and a regionalised MRO&U network that competes on best value to drive affordability. Additionally, the advanced digital health management system designed into the F135 provides real-time monitoring of component usage, accelerating maintenance diagnostics and supporting part-lifting assessments, enabling further reductions in sustainment costs.

### What capabilities does the F135 propulsion system offer F-35B operators?

The F135 propulsion system for the F-35B includes the Rolls-Royce-produced LiftSystem® which provides short take-off and vertical landing (STOVL) capability to the RAF and other F-35B operators. The F135 propulsion system provides 116% more powered lift and enables an increase of approximately 4,000lbs of vertical bring-back capability over fourth-generation fighter engines.

Coupled with an adaptive control system that allows the aircraft to transition from hover to flight mode at the push of a button, these technologies enable the F-35B to operate from austere land bases and a range of air-capable ships. Additionally, the F135 was designed to enhance the low-observable capabilities of the F-35 aircraft, incorporating unique fifth-generation stealth technologies that enable the F-35B to conduct operations in modern advanced threat environments.



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# Introducing P-8A Poseidon

When the first of nine P-8A Poseidon maritime patrol aircraft arrived in the UK in 2020, it was ready to go straight into operation. Lindsay Peacock asks the Commanding Officer of No 120 Squadron, **Wing Commander James Hanson**, how this was possible

Nearly a decade after the last Nimrod left service, delivery of the first Poseidon MRA.1 (ZP801 “Pride of Moray”) to Kinloss on 4 February 2020 was a keenly awaited event and came more than five years after the first indications that the Boeing design would be chosen to be the next-generation RAF maritime patrol aircraft. Amongst the throng eagerly awaiting the arrival at Kinloss was the current Chief of the Air Staff, Air Chief Marshal Sir Mike Wigston, who remarked, “The Poseidon is a game-changing maritime patrol aircraft. I am delighted and proud to see the Pride of Moray and her crews here in Scotland.”

The arrival of ZP801 in Scotland was merely the latest chapter in a saga that began in November 2015, when the UK announced that the Boeing P-8A had been selected. Subsequently, the first two examples for the RAF were formally placed under contract at the end of March 2017, the first of which made

its maiden flight on 12 July 2019. This was formally accepted by the RAF at Seattle on 29 October and had been flown across the continent to the main US Navy patrol community training base at Naval Air Station (NAS) Jacksonville, Florida, by the end of the month. Further purchases mean that all nine of the planned fleet are now on order, and these will eventually equip two squadrons. Traditionally a maritime unit, No 120 Squadron reformed at Lossiemouth on 1 April 2018; the second unit, No. 201 (Guernsey’s Own) Squadron, will follow in 2021 and complete the force generation process to Full Operating Capability.

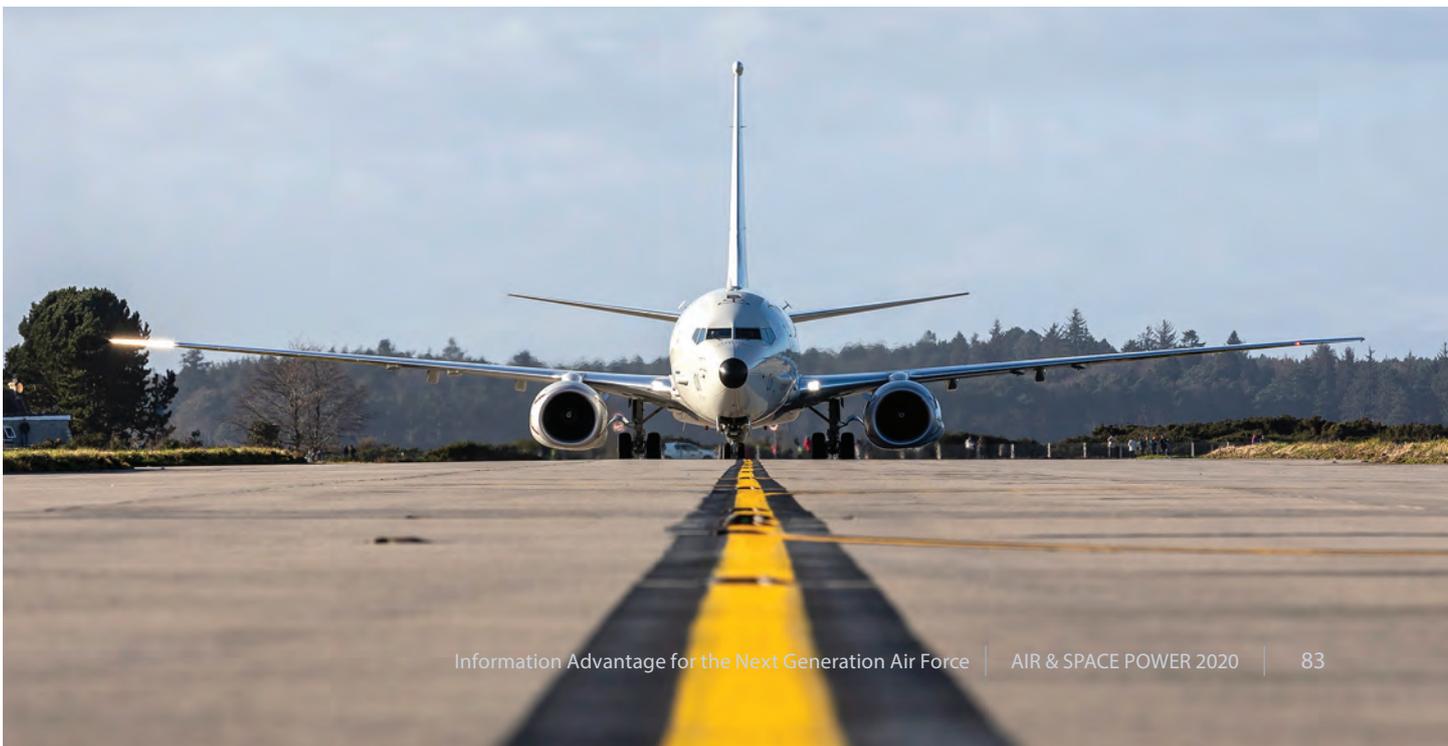
Extensive infrastructure and organisation works are currently under way at RAF Lossiemouth, with a new Poseidon Strategic Facility opened in November 2020, along with resurfacing of the main runway to accommodate the heavier aircraft. With everything going to plan, RAF Lossiemouth managed to begin Poseidon operations before the end of 2020, cementing the base as Poseidon’s permanent home. Overall, the RAF Lossiemouth Development Programme is an investment of £450 million and includes other upgrades to air traffic control, personnel accommodation and airfield services.

## Project Seedcorn

Following the 2010 Strategic Defence and Security Review, Defence recognised there might be the need to rapidly regenerate a long-range maritime patrol capability, reflecting that the United Kingdom is an island nation, reliant on orderly global movement and with a submarine-based strategic nuclear deterrent as the ultimate guarantee of sovereignty. Maintaining expertise in this unique discipline for nearly a decade was accomplished by virtue of Project Seedcorn, whereby approximately 30 RAF personnel were attached to maritime patrol units of allied nations.

**The first RAF P-8A Poseidon touched down in the UK on 4 February 2020**

(PHOTO: SGT ASHLEY KEATES RAF/CROWN COPYRIGHT/MOD)



These included the United States, with some joining P-8A squadrons active with the US Navy. However, their future was by no means assured, until the 2015 Strategic Defence and Security Review provided affirmation that a national long-range maritime aviation capability would be restored with purchase of the P-8A Poseidon. Thus, when the time came to take delivery of the first Poseidon MRA.1, there was already a cadre of trained personnel available, even as others were receiving instruction with the US Navy's Fleet Replenishment Squadron at NAS Jacksonville.

However, purchasing aircraft under a Foreign Military Sales contract and Project Seedcorn to maintain the required skills to undertake maritime patrol duties on such an aircraft would not have been enough in itself to secure the immediate commencement of operations when ZP801 arrived in the UK. According to Wing Commander (Wg Cdr) Hanson, Commanding Officer of No 120 Squadron, "The concerted effort across Defence to maintain and foster international partnerships and pan-service relationships was key to the rapid introduction to RAF service of Poseidon. At the aircrew and engineering level, a strong relationship with United States Navy Patrol and Reconnaissance Wing 11 and, particularly, VP-30 Squadron provided a ready resource of expertise, with some RAF aircrew already having eight years of Poseidon flying experience to pass onto the new cohort.

"In procurement, Defence Equipment and Support (DE&S) has worked hand in glove with the United States Naval Air Systems Command (NAVAIR) and a strong partnership with industry to ensure a seamless start to operations, with Boeing taking the lead in generating the flying programme for the first six months. At the operational level, the United Kingdom maintained a coherent command and control network at Northwood Headquarters, with direct involvement of RAF operations personnel,

**The second of the RAF's P-8A Poseidon maritime patrol aircraft arrives in Scotland. The fourth of the nine new aircraft was delivered in November 2020**

(PHOTO: SAC CIARAN MCFALLS RAF/CROWN COPYRIGHT/MOD)



**Thanks to careful preparations and extensive training prior to the delivery of the first P-8A Poseidon maritime patrol aircraft to the UK, the aircraft was able to assume her taskings straight away**  
(PHOTO: SGT ASHLEY KEATES RAF/CROWN COPYRIGHT/MOD)

continually tasking and exploiting allied maritime patrol missions in the United Kingdom area of interest.

"Finally, at the strategic level, the relationships between allied nations, including Australia, Canada, New Zealand and Norway ensured a coherent approach to the renewal of maritime patrol aircraft fleets, exploited interoperability opportunities and is now generating a collective capability able to face the challenges of an increasingly unstable and unpredictable international system."

**Collective training**

In future, the focus on training will progressively shift from the US to the UK. In the meantime, operations have already commenced. "Pride of Moray took to the air on the first RAF training mission on 13 February 2020 and, since then, a relentless programme of training activity has been achieved, including essential collective training with the Royal Navy and allied forces," explains Wg Cdr Hanson.

Coincident with the first delivery to the UK, the pace of activity on the other side of the ocean was given a significant boost with the delivery of the second Poseidon MRA.1 (ZP802 "City of Elgin") to Jacksonville at the beginning of February 2020. This aircraft flew for the first time in September 2019 and was delivered to Kinloss on 13 March 2020, but some later RAF aircraft may be retained in the US to help with crew training until mid-2021, when responsibility for this task is scheduled to transfer to Lossiemouth. That transfer is closely linked to final delivery, with all nine Poseidon aircraft due to have arrived at Lossiemouth by November 2021. That will pave the way for working up to full operational capability, which is presently expected to be achieved in 2024. ○



Continued investment in Typhoon cements its position on the frontline of air combat  
(PHOTO: SAC ASH REYNOLDS/CROWN COPYRIGHT)

# Typhoon spiral development

**Chris Kelly**, UK and Europe Programme Director, BAE Systems – Air, explains why the Typhoon will be developed to become a complete battlefield controller and, in doing so, help to develop some of the innovations that will eventually be deployed on Tempest

A fully loaded Eurofighter Typhoon was the cover star of the UK's Combat Air Strategy, published two years ago, outlining an ambitious future for both the RAF and the defence sector.

The photograph showed Typhoon loaded with a Centurion fit of weapons, the latest evolution in the capability of the jet at the forefront of securing our skies, and recognised its role in realising our future potential.

Typhoon's next evolution will see it become a complete battlefield controller, ensuring it provides air, land and sea forces operational advantage in the future battlespace. Whilst delivering this capability to the frontline, it will also develop and deploy technologies at the heart of the UK's future combat air ambitions through Tempest.

Chris Kelly, UK and Europe Programme Director, BAE Systems – Air, explains, "The Typhoon that defends the interests of the UK and its allies would be unrecognisable to those who brought it into service initially, and the capability of the platform will continue to be enhanced well into the future.

"Typhoon was designed to constantly evolve to outpace the threats we face, and this makes it the perfect testbed to mature technologies that will be crucial to the success of Tempest. These include investments in sensors, data management, connectivity, communications and weapons, which be central to future combat air systems like Tempest."

Typhoon's capability evolution is aligned to the Tempest programme, as it is the aircraft on which key technologies will be developed and deployed – ensuring that investment benefits both programmes. "You can see that in the work we are doing on developing Typhoon's next-generation radar as part of a package of sensor upgrades, and on our Striker II pilot's helmet, where we



**BAE Systems continues to develop the Typhoon with its international partners to transform it into a complete battlefield controller** (PHOTO: BAE SYSTEMS)

are developing displays that will be at the heart of a digitally driven Tempest,” explains Kelly.

The programme of investment in radar, communications, data management, weapons and connectivity will further strengthen Typhoon’s survivability, as well as its interoperability, alongside platforms including F-35, ensuring Typhoon provides air, land and sea forces with the freedom of action and operational advantage necessary to win in the complex future battlespace. This development will ensure Typhoon’s role well in to the 2060s, making it the ideal interoperable partner to fly alongside any future combat aircraft. Kelly

highlights the benefits of this plan: “There is a double positive here, we mature and de-risk technology at the same time as bringing it to the frontline, and ensure Typhoon is the perfect interoperable partner for Tempest for decades to come.”

**European alliance**

The strength of the European alliance behind Typhoon leverages the combined skills, experience and investment of the industry and air forces of the four Eurofighter core nations – Germany, Italy, Spain and the UK. Today, engineering teams across the European partners are developing new capabilities that will go into service with Kuwait and Qatar. These will bring the number of air forces operating the jet up to nine by 2022.

At the heart of this work is the next-generation electronically scanning radar, alongside a package of further upgrades that include new targeting pods, human-machine interface enhancements, and improvements to the cockpit. “This same partnership delivered the Centurion upgrades in service with the RAF today, and will continue to do so whilst securing the highly skilled jobs and sovereign capability which exist across the core nations,” explains Kelly. “Across the Eurofighter partnership, we are seeing continued investment in Typhoon, ensuring its place in their frontline for decades to come and putting it at the centre of their future combat air ambitions. This investment will bring benefits to us all and can provide great confidence that Typhoon has a long future securing our skies.”



**Development of numerous upgrades to Typhoon will help ensure that the aircraft will serve air forces for decades to come** (PHOTO: BAE SYSTEMS)



## Major General Amikam Norkin

Commander of the Israeli Air Force

**Marking 72 years this past May, Israel and the Israeli Air Force (IAF) have seen their share of battles and operations. Warfare tactics that once depended on dogfighting and individual pilot skills are now led by fifth-generation ingenuity, efficient data analysis and strategic targeting.**

Over the past few years, the IAF has been involved in an increasing amount of operational activity, some of which is conducted within one of the world's most dense and advanced SAM environments. Our activity has been contested with over 700 enemy SAM launches, and resulted in hundreds of targets and dozens of SAM batteries destroyed. This achievement is based on reliable intelligence and careful risk management, with the ultimate responsibility to minimise chances of escalation to full war.

Our current operational capabilities are an outcome of a long journey involving several milestones, such as the destruction of Syrian Air Defense Systems in Lebanon (1982), which marked the first IAF real-time information sharing between UAVs and jet fighters.

Fast forward to the present day, where we operate improved fourth-generation jet fighters, fifth-generation F-35 aircraft, assault and attack helicopters, C2, reconnaissance and transport platforms, as well as various Israeli-made UAVs. As the only aviation in the Israeli Defense

Forces, and home to all Air Defense Units, it is imperative that our aerial activity be deeply coordinated with the IAF's Air and Ballistic Missile Defense Units. Our offensive effort should enable striking thousands of targets per day, with Automated Battle Intelligence and BDA processes, based on Geographic Pixel as the common targeting language.

Looking forward, one of the most crucial components needed in order to take our effectiveness to the next level is enhancing connectivity. This includes connecting manned and unmanned fourth-generation platforms to the F-35 through a Combat Cloud, thus creating advanced and actionable information sharing. In fact, we are not integrating the F-35 into the IAF, but are rather seeking to integrate the IAF into the F-35.

This Multi Node Approach is part of a larger-scale concept, known as Joint All-Domain Warfighting, which enables exploitation of cross-service data and other information resources to their maximum potential – an all-encompassing, composite battle picture, comprised of ground, maritime, cyber, air and space elements. In this regard, our main challenge becomes identifying the relevant information and distributing it effectively, in a timely fashion, to the fighting forces.

International cooperation proves to be an asset when it comes to

building a community and expanding upon each other's experiences. We have seen this promising potential while participating in international exercises such as Blue Flag and Tri-Lightning, as well as all USAFE sponsored syndicate-based F-35 conferences. We believe that a critical component of the Information Advantage is the cooperation between

### A critical component of the Information Advantage is the cooperation between fellow air forces

fellow air forces and militaries facing a variety of common adversities.

As we enter a new generation of airpower, I believe that the Information Advantage will become a principal compass in changing how the IAF maintains air dominance and faces multi-dimensional threats. As threats continue to develop, it is becoming evident that the Multi Domain concept is not only applicable to the IAF in the Middle East, but also to our allies operating around the world.

# Qatari cooperation

The acquisition of 24 Typhoon fast jets for the Qatar Emiri Air Force represents a significant collaborative effort between the UK and Qatar. The RAF Programme Senior Responsible Owner, **Air Commodore Chaz Kennett**, outlines how this procurement will boost interoperability between the two air forces



In 2017, the Governments of the State of Qatar and the United Kingdom signed a Statement of Intent, which confirmed the scope of cooperation and assistance that the UK Government offered to provide the Government of Qatar in support of the purchase and operation of Typhoon multi-role combat aircraft. This was quickly followed by a Qatar Armed Forces MOD and UK MOD Memorandum of Understanding within which the UK agreed to train up to 32 Qatari pilots, stand-up and operate a joint RAF-Qatar Emiri Air Force Squadron and deploy the Joint Squadron to Qatar in the latter half of 2022 (coincidentally aligning with Qatar's hosting of the FIFA World Cup 2022 competition). In addition, both the UK and Qatar agreed that the Typhoon would be placed at the heart of their defence relationship.

The UK's 2015 Strategic Defence and Security Review made International Defence Engagement one of the MOD's core tasks. Given the nature of the Qatar Typhoon Programme as an international partnership, and its broad contribution to all three of our National Security Objectives (Protect Our People, Promote Our Prosperity, Project Our Influence), it is easy to see the strategic benefits of such engagement. However, it would be a simple, yet significant oversight if one were to lose sight of the more operational-level benefits. In military parlance, focusing solely on the first-order consequences (the contribution to the National Security Objectives) risks undervaluing the second- and third-order consequences, which, for this programme, are the realisation of interoperability across not only the technical boundaries, but across the procedural and human boundaries as well.

Interoperability is an oft-used phrase, but the majority of discussion on this subject focuses





**Former Defence Secretary Gavin Williamson and the Emir of Qatar, Sheikh Tamim bin Hamad al-Thani, at the standing up ceremony of the joint RAF-Qatar Emiri Air Force Squadron in July 2018** (PHOTO: CROWN COPYRIGHT/MOD)

on equipment, characterised by ‘bits of electric string’ sending and receiving ‘ones and noughts in the right order’. While technical interoperability is important, the value offered by being able to communicate with each other is denuded if one does not understand how our allies operate (procedural interoperability) and, perhaps more importantly, why they operate in a particular way.

The ‘why’ is a combination of context, historical experiences, cultural and social factors that sit under the umbrella of human interoperability. It is the procedural and human aspects of interoperability that underline the RAF Exchange Officer programme, through which the RAF has a large number of reciprocal arrangements with other nations’ air forces to place personnel within our respective services. However, when one considers the scale of the Qatar Typhoon Programme, aligned to the fact that this is the first joint squadron that the RAF has operated since the Second World War, one can begin to appreciate the significant opportunities to develop our procedural and human interoperability with our partners.

### Deep-rooted history

We would all agree that interaction with a broad range of cultures enriches our own experience, and this is becoming increasingly apparent with a focus on diversity and inclusion. However, we are often guilty of assuming our knowledge-transfer is one way; to do so risks missing out on a vast array of invaluable experience, and this is especially true in the case of our relationship with Qatar. The UK has a deep-rooted history with Qatar

and we must ensure that we capitalise upon the opportunities that this programme presents to learn from our Qatari colleagues, who operate in a vastly different geopolitical environment.

### Powerful learning tool

The profound and, in relative terms, rapidly changing context within which Qatar finds itself has resulted in a seismic shift in Qatar’s acquisition and development of military capability. The scale of such a change programme is laudable, and for the UK to be offered front-row seats is invaluable. We must, however, recognise that the RAF does not have a monopoly on good ideas, and the Joint Squadron is, perhaps, the most powerful tool that we have in learning how one of our closest allies in this region approaches the use of air power.

In return, we offer over 100 years of experience alongside a world-leading training system that is at the forefront of the development and use of air power. Such an environment is a protein-rich learning environment for both of our nations.

When viewed solely through the lens of the National Security Objectives, this programme ticks all three boxes: it promotes our prosperity, it projects our influence and, in forging close relationships, it protects our people. However, the operational-level benefits are equally as important – they promise to enrich both of our air forces significantly, leaving a lasting footprint beyond the confines of the programme. If ever there was a flagship programme for the rationale of International Defence Engagement, this programme must be it. **Ⓞ**

**(left) The joint RAF-Qatar Emiri Air Force Squadron offers unique opportunities to embed technical, operational and human interoperability lessons for both air forces** (PHOTO: CROWN COPYRIGHT/MOD)

# DRAKEN

## From Cobham to Draken – over 30 years of continued operational readiness training



**Paul Armstrong**  
CEO, Draken Europe

**In our former guise as Cobham Aviation Services, Draken Europe has delivered Operational Readiness Training (ORT) support to the UK Ministry of Defence (MOD) for over 30 years, and we remain as firmly committed today as when the service began.** This year, we joined with Draken International, providing a complementary capability, and now as Draken Europe we will continue to provide stability, operational assurance and vital training expertise required by the Royal Navy and Royal Air Force to enable front-line training in a degraded and contested environment. We are excited by the option of merging the agile adversary air capabilities delivered by Draken International to the United States Air Force across a range of fast-jet aircraft with our own delivery of warfighter essential training.

At Draken Europe, we deliver a complex, diverse and frequently evolving training service using our 15-strong Falcon aircraft fleet and wealth of highly experienced specialist qualified aircrew, as well as technical and ground support personnel. Each year, this system delivers over 6,000 hours of Electronic Warfare (EW) and Target Tow air support to operational training, with an additional 500 hours of full-motion video support.

Under a Whole Force Commercial Owned Commercial Operated approach, and supporting interoperability between allies, we deliver training to the UK Forces and our coalition partners from NATO, USAFE and others, providing high-performance air-to-air and air-to-surface training in complex, hostile and immersive environments, including the recent Carrier Strike Group exercises.

### Optimised training

The integration of innovative technologies to deliver EW and synthetic effects and multi-level Encrypted ACMI systems on-board live training assets, offers militaries the ability to 'train as we fight', utilising a blended mix of training techniques across the Live Virtual Constructive spectrum that can be shaped dynamically to deliver optimised and immersive training scenarios.

As technology advances further, through the progressive introduction of such superiority platforms as the F-35, we consider the deeper integration of live training into the synthetic

ground- and maritime-based training environments as critical to developing complex challenging real-world effects.

### Helicopter academy

Furthering our operational training offering, the Draken Helicopter Academy, based at Newquay Cornwall Airport, provides a range of international defence helicopter training services under MOD sponsorship. These contribute directly to the enhancement of the operational capabilities of the UK's international partners through the delivery of basic to advanced helicopter training for both pilots and rear crew, including tactical skills and search and rescue. Our delivery of this training directly supports the ability of multinational helicopter crews to work effectively and safely, within complex and high-threat dissimilar platform air and maritime scenarios, alongside allied air forces.

The COVID-19 pandemic has been challenging for us all, but we have continued to deliver mission-critical training without interruption by working in partnership with our military colleagues. We have also continued our wider service support to the E-3D Sentry, the Reaper system and military/government helicopter operations overseas in Bahrain, Brunei, Cyprus and the Dutch Antilles. Now, as Draken Europe, we look forward to continuing this partnership and contributing to mission success for many years to come.

# Potent protector – Protector RG-1 developments

The RAF's Protector remotely piloted air system is due to enter service in the early 2020s, building on the superb reputation that has been achieved by the Service's Reaper Force over the past decade. Combined Test Team leader **Wing Commander Iain Hutchinson** explains how experienced RAF operators and engineers are helping Protector fulfil its potential as it progresses through its demanding test phase, and how the system will complement other RAF ISTAR and combat air capabilities in the decades to come

The term 'drone', which originates from a pilotless version of the de Havilland Tiger Moth known as the Queen Bee, developed in the 1930s by the Royal Navy, belies the advanced capabilities that remotely piloted air systems (RPAS) provide in modern military operations. RPAS have evolved rapidly over the last two decades, quickly becoming a stalwart component of an air commander's arsenal of capabilities in operational theatres worldwide. The Protector RG-1 – a weaponised, medium-altitude, long-endurance RPAS, being designed and built for the RAF in the 'combat ISTAR' role – represents the ground-breaking next step in this evolutionary chain.

The role of Protector will build upon the successes of the MQ-9 Reaper, which has been in RAF operational service continuously in the Middle East region since 2007. Indeed, Protector is a product of the same manufacturer as Reaper – General Atomics Aeronautical Systems Incorporated (GA-ASI), based in California. However, Protector is not just a Reaper replacement; look beyond the outwardly similar appearance and you soon realise that they are very different beasts.

## Seamless integration

With a 20% longer wingspan, Protector benefits from more fuel, next-generation sensors and an increased weapons capacity over its Reaper forebear. The air system will also be certified to meet industry-standard safety and airworthiness requirements – a world first for this type of aircraft. Significantly, this will allow Protector to integrate seamlessly in airspace shared with manned aircraft, civil and military, both in the

UK and elsewhere around the world, able to be flown directly to wherever the broad set of Protector capabilities are required to support UK interests.

As an intelligence-focused platform, the primary payload of Protector comprises a complex suite of sensors providing a persistent and reliable surveillance and reconnaissance capability across the electromagnetic spectrum. In addition, sovereign UK weapons are being integrated on the aircraft – Paveway IV laser/GPS-guided bombs and Brimstone 3 air-to-surface missiles – with scope for future integration of role-specific sensors and more advanced weapon capabilities. The configurable combination of sensors and weapons gives Protector a wide degree of flexibility and utility for military commanders. In fact, the potential roles for Protector stretch beyond traditional military capabilities, covering niche support roles for civil authorities in areas such as search and

**The Protector RG-1 benefits from a greater fuel load, improved sensors and an increased weapons capacity, in comparison to its predecessor, the MQ-9 Reaper**

(PHOTO: CROWN COPYRIGHT/MOD)





**Next-generation sensors provide Protector with an enhanced surveillance and reconnaissance capability**

(PHOTO: GENERAL ATOMICS AERONAUTICAL SYSTEMS INC)

rescue, counter-terrorism and disaster-relief. With sortie durations in excess of 40 hours possible, the Protector system is an adaptable and persistent enabler across a variety of operating contexts.

Aside from the sensors, there are numerous other novel aspects to the Protector RG-1. Firstly, Protector is equipped with a fully automatic take-off and landing system, which is based upon a capability that has been proven on another GA-ASI platform, the US Army Gray Eagle, over many years. This is significant because Protector is the first system of its kind to operate exclusively over a beyond-line-of-sight (BLOS) satellite link for control of the aircraft, both on the ground and in the air. The automatic take-off and landing system is a key enabler for BLOS satellite operation of the aircraft, as manually flying it during these critical phases of flight over a satellite link would be potentially unsafe, due to the satellite link latency.

Another key Protector enabler is an entirely new ground support system, known as the 'Protector pre-flight/post-flight equipment, or P3E, which has been developed to support maintenance and ground handling tasks. The combination of BLOS ground operations and P3E significantly reduces the personnel footprint. Reduced numbers of maintenance

personnel and no requirement for any deployed aircrew when the aircraft is operating away from its home base will maximise operational flexibility.

### Remote cockpit

Finally, a significant point of difference for Protector over previous systems is the advanced remote cockpit. Just like the aircraft itself, the cockpit will meet certification and airworthiness requirements and is configurable to the task. It provides the baseline crew of three (pilot, sensor operator and intelligence analyst) with an environment much more aligned with modern fast-jet cockpits, and much more suited to effective operation of the system than its Reaper predecessor.

The Protector developmental test programme has accumulated over 500 flying hours since the first prototype made its maiden flight in November 2016, and work continues to integrate and assess all the capabilities Protector will bring to the RAF, in advance of its entering service in the next few years. Before long, it will become commonplace to see the RAF's newest innovative capability patrolling the skies to support commanders' requirements and protect UK interests wherever and whenever required. ●

# MQ-9B – pushing the boundaries

The RAF's new Protector remotely piloted air system (RPAS) is a certifiable MQ-9B SkyGuardian. **Dr Jonny King**, Vice President at General Atomics Aeronautical Systems UK Ltd, explains how it will revolutionise RPAS operations for the United Kingdom

**A**ble to remain airborne for more than 40 hours, carry over two tonnes of mission payload and operate in international airspace mixing with other traffic, this new-generation Protector is a truly game-changing capability. Designed, developed and built by General Atomics Aeronautical Systems Inc. (GA-ASI), this innovative unmanned aircraft continues to push the boundaries for persistent wide-area Intelligence, Surveillance & Reconnaissance (ISR).

## Blending with other air traffic

The primary driver for the development of the new MQ-9B SkyGuardian (Protector) was to design and build a remotely piloted air system (RPAS) to

existing airworthiness standards. This ensures that SkyGuardian/Protector can be certified to fly in non-segregated airspace, which was achieved by a completely new design, while still leveraging and enhancing the heritage of the original MQ-9 Reaper.

These developments include re-factoring the software in all flight-critical avionic systems, use of advanced composite materials and manufacturing processes, additions such as fire bulkheads, and incorporation of lightning protection. The UK's Military Aviation Authority is expected to be the first to independently certify the system.

When certified as safe to fly in non-segregated airspace, Protector will need to be operated safely in proximity to other air traffic in Class A to C airspace that is under Air Traffic Control, and in Class G airspace, where the pilot's ability to "see and avoid" is the primary method to avoid collisions with other aircraft.

For the past five years, GA-ASI has been working with the US Federal Aviation Administration (FAA) and National Aeronautics and Space Administration (NASA) on a Detect and Avoid (DAA) System. The DAA system's Airborne Processor Component (APC) uses industry-standard systems such as ADS-B In (automatic dependent surveillance-broadcast) and TCAS (traffic alert and collision avoidance system) to track other aircraft in the vicinity of the RPAS (so called 'cooperating' aircraft).

GA-ASI has also developed an air-to-air radar to detect and track 'non-cooperating' aircraft that are not broadcasting their position. The pilot on the ground is presented with all this information to provide a situational picture of other traffic, and receives notifications of any potential future conflicts. The remote pilot can use this to make course changes as appropriate, while still following the rules of the air.

**A computer-generated image of the MQ-9B SeaGuardian. A brand-new design means that MQ-9B can be certified to fly in non-segregated airspace**  
(IMAGE: GA-ASI)





**The first flight of the BC04/UK1, the RAF's first Protector aircraft, was completed successfully in September 2020**

(PHOTO: GA-ASI)

In the unlikely event that the pilot has not made a course correction, the APC provides commands to the pilot to manoeuvre the aircraft and avoid a collision.

### Robust satellite communications

The original Predator was the first-ever RPAS to use satellite communications (SATCOM). A robust, high-bandwidth, reliable link is crucial for effective long-range RPAS operations.

GA-ASI continues to develop the SATCOM capabilities with a modular system that allows customers to choose different SATCOM links – for example, the legacy MQ-9 Reaper uses Ku-band satellite networks, but Protector will use the UK's X-band Skynet system. There are also backup SATCOM links to ensure command and control of the platform is maintained in case of failure, jamming or flying outside the coverage area of the primary SATCOM system. GA-ASI has also flight-tested laser-based SATCOM links that are immune to jamming and interception.

The company continues to develop options that ensure operations are possible anywhere in the world, including polar regions that are not well served by satellite coverage. These advances are particularly important in the maritime domain for operations at long range and in remote regions.

### The maritime role

With the RPA's long endurance, ability to carry significant payload and operate anywhere in the world, the MQ-9B is an ideal platform for the maritime domain, where persistent presence is required for missions that can be long and tedious, and which are performed at significant distances from the safety of land.

The US Department of Homeland Security has been operating a maritime version of MQ-9 for over a decade; GA-ASI has developed a role-fit maritime mission kit from world-class UK systems that can be added to Protector. GA-ASI has been working with Leonardo to integrate their Seaspray V2 multimode radar and SAGE Electronic Support Measures onto MQ-9B/Protector. The Seaspray radar can detect, identify and locate shipping, while SAGE provides an additional tool to monitor, categorise and locate radio-frequency emissions across a broad region. SAGE was flight-tested on an MQ-9B in autumn 2020 and Seaspray will be flight-tested later in 2021.

Additionally, GA-ASI has been developing an Anti-Submarine Warfare (ASW) capability utilising sonobuoys. In November 2017, during MQ-9B flight tests, the monitoring and control of sonobuoys proved that an underwater target could be located and tracked remotely over a SATCOM link. In that test, the sonobuoys were placed by a US Navy helicopter. GA-ASI has been developing a pod to carry both traditional A-size sonobuoys and the latest advanced miniature G-size sonobuoys, developed by Ultra Electronics in the UK. MQ-9B/Protector can carry four pods, and each of these can be loaded with 10 A-size or 20 G-size buoys, giving a total of 80 buoys. The new sonobuoy dispensing pod will be flight-tested in 2021.

### Coordinating the fleet

As RPAS are coming of age, it is important to have effective, joined-up mission control over the fleet and the ISR 'product' that they generate. GA-ASI has developed an Integrated Intelligence Centre for the command and control of the entire RPAS fleet (and other ISR assets) with live feeds from their various sensors. The Integrated Intelligence Center is built on advanced artificial intelligence tools that support: efficient and effective mission tasking (and importantly re-tasking) of each aircraft within the fleet; control of multiple aircraft by a single operator during more routine tasks, enabling respite for the crew; and powerful Processing, Exploitation and Dissemination (PED) of the huge volumes of ISR data that are collected, to ensure it can be used and reused to greater levels of effectiveness than ever before. With the nine hard points of MQ-9B/Protector, there can be rapid integration of sovereign payloads, while the mission sets continue to expand with a similar expansion in data being generated.

RPAS continue to be an indispensable capability for the military, but with MQ-9B SkyGuardian (Protector) being the first certifiable RPAS of its kind allowing routine operations, the capability is becoming more and more attractive to non-military customers. 🗳️



# Counter-drone technology

**Peter Clarke**, head of the Defence UAS Capability Development Centre's C-sUAS (Counter-small Unmanned Aerial Systems) Rapid Innovation Cell at Boscombe Down, highlights the work under way to ensure that the UK can rapidly and consistently defend against unwanted drone activity across the country and on operations

**As drone technology develops and becomes increasingly accessible, misuse of these small aircraft is a growing threat**

(PHOTO: MONKEY BUSINESS/ISTOCK)

**T**he misuse of small unmanned aircraft systems (sUAS) represents a significant and growing risk to operations and day-to-day Defence activity, both in the UK and overseas. This risk is exacerbated by the pace at which the underpinning technologies are evolving. The ability of adversaries to quickly react in terms of technology, tactics, techniques and procedures to any countermeasures we deploy means that we cannot expect to mitigate these risks with rigid solutions. Our Counter-sUAS (C-sUAS) capability needs to be adaptable, upgradeable and tailorable to specific threats.

Therefore, our procurement approach needs to be rapid if we are to keep up with, and get ahead

of, the threat. Rapid Innovation is central to the UK Ministry of Defence's (MOD's) strategy. Delivery of a coherent and enduring C-sUAS capability will be achieved through a pan-Defence Lines of Development approach. Leading this work on behalf of the Ministry of Defence (MOD), Air Command is working to recognise the differing capability requirements for the protection of Defence Critical National Infrastructure in the UK and overseas, and for the different operational domains and environments.

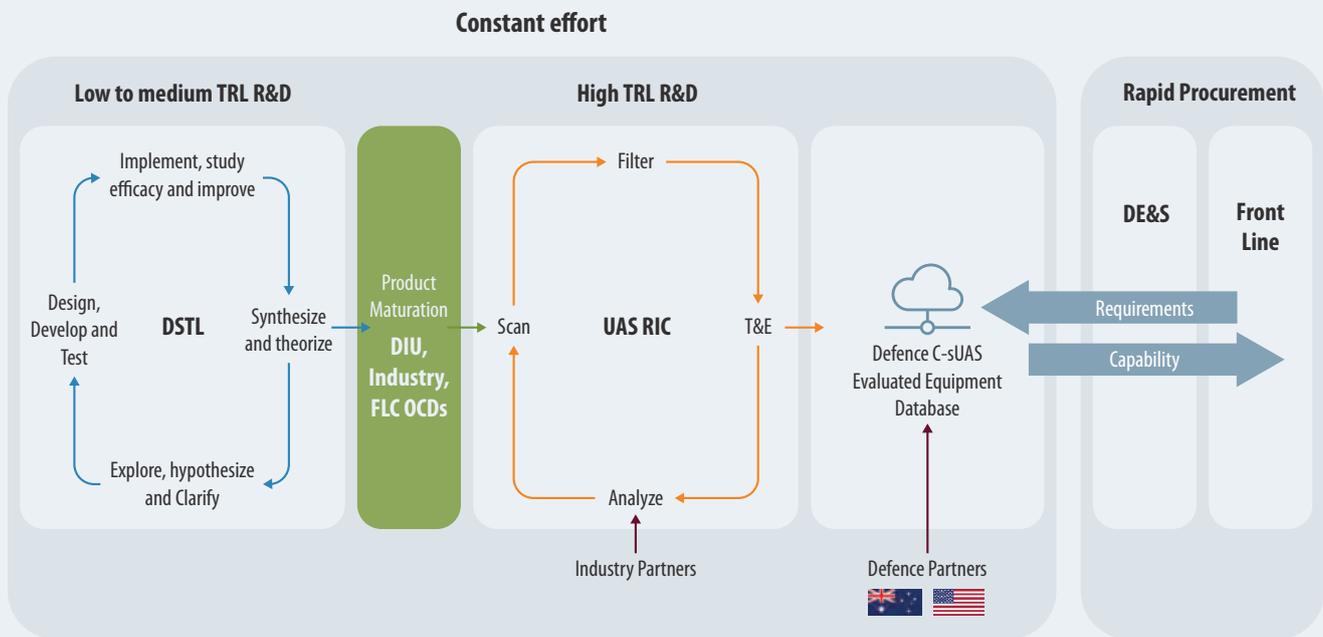
The exploitation of science, technology and innovation will continue through the Defence Science and Technology Laboratory (Dstl), the C-sUAS Rapid Innovation Cell (RIC) and the Defence Innovation Unit (DIU). The mechanism for this activity is illustrated in Figure 1.

## Open architecture

To prevent capability gaps and ensure interoperability, all Defence C-sUAS systems will use the same open architecture, based around the Dstl-owned 'Sensing for Asset Protection with Integrated Electronic Networked Technology' (SAPIENT) standard. Manufacturers are being encouraged to design systems with this common interface to support 'plug-and-play' capabilities with rapid integration to other systems. This will also ensure that our systems can evolve at the component level, enabling the rapid spiral development of capability to keep up with the threat.

The UAS Capability Development Centre (UAS CDC) was established by the MOD's Weapons Evaluation & Capability Assurance (WECA) team

FIGURE 1: C-SUAS SCIENCE, TECHNOLOGY AND INNOVATION EXPLOITATION



in 2014 to support coherence across Defence UAS test, evaluation and experimentation. The RIC, endorsed by the Military Capability Board (MCB) and funded by WECA, has been stood up within the UAS CDC to assess the performance of emerging C-sUAS capabilities and generate a managed Defence Database of available

capabilities and help determine where capability gaps exist that may require targeted investment.

The RIC will also increase broader awareness of the C-sUAS market, promote UK innovation and industry to wider markets and provide a more agile method of delivering capability to the front line. The priorities of the RIC are set by the Defence C-sUAS Capability Development Working Group, chaired by Air Command.

## Our procurement approach needs to be rapid if we are to keep up with, and get ahead of, the threat

capabilities; an objective and credible source of information for MOD that will also serve to support defence exports wherever it can.

### Centralised Test and Evaluation

The RIC has a centralised, transportable C-sUAS Test and Evaluation (T&E) capability, which works to protocols compatible with the US Defence Threat Reduction Agency (DTRA), enabling the MOD and the US Department of Defense to share information effectively and share the burden of C-sUAS development. Through a regular programme of T&E events, it will establish the efficacy of mature, commercially available

The RIC is developing a programme of C-sUAS testing, leading out until at least 2024, with routine test cycles, nominally in the spring and autumn, supplemented by additional test activities, as directed. The RIC is capable of testing fully integrated C-sUAS systems, typically consisting of multiple sensors and effectors coordinated through dedicated C2 software. It is also capable of testing specific components that are compatible with the SAPIENT open architecture.

As the testing programme progresses, the number and detail of tested systems and components in the database will become extensive, giving the MOD the opportunity to have adaptable systems that can use components that are particularly relevant to a given threat situation and/or to quickly adapt an in-service system to an emerging threat.

Rapid Innovation is vital in the fight against rogue sUAS. The RIC is a key part of this fight and, with the direction of Air Command, will accelerate our response to this key threat. ○



# From Reaper to Protector

## Dr Jonny King

Vice President, General Atomics  
Aeronautical Systems UK Ltd

### **At 12:45 on 30 March 2020, unmanned aircraft number BC03 took off from the General Atomics Flight Operations Facility in El Mirage, California.**

This highly significant event marked the debut flight of the first MQ-9B that has been built on the production line to the certified standards stipulated for all subsequent operational aircraft. The next aircraft to come off the line, BC04 (also known as UK1), was the first MQ-9B remotely piloted aircraft destined for the RAF. BC04 successfully completed its first flight in September 2020.

The successful flight of BC03 is a milestone in the programme to deliver the MQ-9B to the RAF, where it will be known as Protector, and will gradually supersede the MQ-9A Reaper, which has been consistently on operations since it entered service in 2007. The UK Ministry of Defence confirmed the order for the first three of 16 Protector Remotely Piloted Air Systems on 15 July 2020.

Reaper was procured under a Foreign Military Sale (FMS) contract via the US Air Force in order to rapidly introduce the capability into UK operations in Afghanistan. Protector, on the other hand, has been procured primarily as a direct commercial sale contract between the UK Ministry of Defence and General Atomics. "We need to be ready to support the RAF as they make a phased transition from Reaper to Protector. This means working out how to transfer seamlessly from the FMS contract that underpins Reaper to the commercial contract for Protector, covering everything from maintenance to training," says

Jonny King, Vice President of General Atomics Aeronautical Systems UK Ltd.

The challenge is to maintain the high levels of collaboration between the RAF and General Atomics to ensure there is not a pause in the RAF's Reaper/Protector capability. This is particularly important as RAF crews are trained in Grand Forks, North Dakota, at the company's Flight Test and Training Center (FTTC). "We are training new RAF Reaper crews at the FTTC and will be initiating Protector crew training ahead of in-country training being set up," explains King. "We are acutely aware that Reaper continues to be on operations and Protector needs to come in seamlessly as Reaper is phased out, without affecting operations. So, we are ensuring that whatever we do is factored around that transition, and we are trying to be as flexible as possible throughout that transition."

### **UK industry involvement**

Although designed, built and tested in the US, the Protector programme, which is on schedule for initial operations by mid-2024, leverages a number of UK industries. Abaco Systems and Daco Hand Controllers are subcontractors for the Ground Control Station, having been selected on merit as part of the company's global supply chain and not as part of an offset deal. Likewise, GKN has recently been approved as a manufacturer of composite structures at its factories in the UK.

Cobham has been working with GA-ASI to maintain Reaper ever since the early days and is expected to continue to support Protector. Another long-standing partner is Leonardo UK, which has committed its own money on a joint investment to fit its SAGE electronic support measures and its Seaspray

maritime radar onto MQ-9B – both to be flight-tested over the next year. Leonardo's BriteCloud expendable decoy system is also being proposed for the MQ-9B. General Atomics has been investigating the use of Ultra Electronics miniature sonobuoys as part of a maritime role-fit kit.

According to King, "this maritime mission-equipped MQ-9B (also referred to as SeaGuardian) with SAGE, Seaspray, BriteCloud and sonobuoys, as well as air-deployed life rafts for search and rescue missions, makes perfect sense as a persistent maritime patrol aircraft (MPA), particularly over inhospitable seas like the North Atlantic." Using unmanned aircraft

**"A force mix with P-8 and Protector working as a partnership ensures that vast areas can be monitored in an affordable way"**

to patrol this vast region from Canada to Greenland, over Scotland and all the way to Norway, is a great solution, especially when they are networked via data links with modern manned submarine hunters such as the P-8 Poseidon. "A force mix with P-8 and Protector working as a partnership ensures that vast areas can be monitored in an affordable way while making the best use of the capabilities of each platform," says King.



# Air mobility

**Air Commodore Domonic Stamp**, Air Mobility Force Commander, reveals to Simon Michell how he squeezes the optimum output from his fleet of transport and air-to-air refuelling aircraft

From his Oxfordshire headquarters at RAF Brize Norton, the Air Mobility Force (AMF) Commander, Air Commodore (Air Cdre) Domonic Stamp, oversees a complex spider’s web of daily flights across the globe. “At any one point in time there may be as many as 30 different locations around the world that rely on the AMF for their supplies,” he says. More than half of these locations are deemed to be “non-benign”, meaning that aircraft flying into them require some form of defensive equipment to guard against attack.

On top of the freight and passenger transport role, his force also undertakes air-to-air refuelling (AAR) for fast jets and large aircraft. It is no surprise, therefore, that there is a constant flow of flights in and out of RAF Brize Norton every day. To make sure he can keep up with the demand, Air Cdre Stamp has a fleet of extremely modern and

versatile aircraft, supported by an equally multitalented group of engineers, aircrew and logisticians, who arrange and undertake the massive schedule of taskings and missions. During planning stages, the flights are influenced by a Fuel Efficiencies and Emissions Reduction Project Team, which regularly switches refuelling stops to take advantage of the cheapest prices as they fluctuate daily.

## Versatility is key

Perhaps one of the most versatile aircraft in the Force is the Voyager. Based on the Airbus A330-200, it is the only aircraft in the RAF inventory to be certified to simultaneously undertake three separate mission types – AAR, troop/freight transport and medical evacuation. It is, therefore, an extremely busy fleet.

“There are always two or three Voyagers on standby or actually deployed on AAR taskings every day. In addition, there could be another two or three undertaking additional AAR duties, such as supporting F-35B Lightnings en route to training exercises like Red Flag in the US, refuelling Typhoon multi-role fast jets on operations over Iraq and Syria [Operation Shader] and possibly replenishing UK and partner air force aircraft as they train in the UK,” Air Cdre Stamp explains.

The AMF also undertakes strategic transport duties – the equivalent to commercial long-haul flights. Several times a week, personnel and supplies are flown out on Voyager and C-17 Globemaster III aircraft to RAF Akrotiri in Cyprus and the broader Middle East, as far out as Afghanistan.

According to Air Cdre Stamp, “The Voyagers do most of the passenger movements because they are more comfortable than the Globemasters, which, predominantly, but not exclusively, carry equipment. And then, on a roughly three-week rotation, A400M Atlas and Globemasters will resupply all of our operational deployments in and around Africa – especially the RAF Chinook unit supporting the French-led counter-terrorism mission down in Mali.”

**Two of the newest aircraft in the Air Mobility Force: A400M (top left) and Voyager (top right)** (PHOTO: (TOP LEFT) SAC NICHOLAS EGAN RAF/CROWN COPYRIGHT/MOD (TOP RIGHT) CPL LEE MATTHEWS RAF/CROWN COPYRIGHT/MOD)



Away from RAF Brize Norton, there are intra-theatre supply duties carried out by the AMF with deployed aircraft heavily utilized around their host regions, to make sure that everything and everybody gets to the right place at the right time. Two C-130J Hercules transport aircraft support Operation Shader, with an Atlas supporting the broader Middle East. Additionally, there are the BAe146s and Augusta A-109s based at RAF Northolt that undertake Command Support duties from the UK. “This task is very dynamic and consists of getting strategically important politicians, diplomats and military personnel to destinations where they are needed to meet up with other leaders,” the AMF Commander explains.

The British Overseas Territories in the remote South Atlantic also come under the AMF’s remit. Accordingly, a Voyager from RAF Brize Norton flies to the Falkland Islands several times a week, with a mid-Atlantic stopover at Cape Verde. In addition, there is an A400M permanently based at RAF Mount Pleasant on the Falkland Islands. This again underscores the versatility of the AMF fleet. Thanks to its impressive endurance, and using its powerful radar (supplemented by the crew acting as lookouts), the A400M routinely undertakes maritime reconnaissance and Search and Rescue flights around the islands to make sure there are no unwanted visitors, and to come to the aid of anyone unfortunate enough to be lost at sea. “It was an RAF A400M that directed vessels to the wreckage of a Chilean C-130 that tragically ditched at sea in 2019,” reveals Air Cdre Stamp.

A couple of times a year, the Atlas will also fly over the South Georgia and the South Sandwich Islands to make sure everything is in order. As if all these activities were not enough, the AMF also

arranges for a C-130 to airdrop supplies to the British Antarctic Survey community near the South Pole.

### Information Advantage

Fitting the secure beyond-line-of-sight (SBLOS) Satcom equipment, which is installed on the C-17 Globemaster IIIs, to more aircraft types within the AMF fleet could have a big impact on the RAF’s ability to transmit data and voice communications around the world quickly. “It is the ability to be able to communicate securely in real-time that we are looking to benefit from in the future. After all, we resupply a lot of places around the world and our presence in these locations, married with our exceptional endurance, means we could act as airborne relay stations if required. There are infinite possibilities in that respect,” Air Cdre Stamp concludes. 🎯

**As well as its many other taskings, the Air Mobility Force also supplies the aircraft and trains UK Armed Services personnel in the art of parachuting**

(PHOTO: CORPORAL ANDY REDDY RLC/CROWN COPYRIGHT/MOD)

### OVER A 12-MONTH PERIOD FROM FEBRUARY 2019 TO FEBRUARY 2020, THE AIR MOBILITY FORCE:

- supplied UK Armed Forces with **10,160 tonnes of freight** and **448 tonnes of mail**
- provided ongoing resupply support to **24 different military operations**
- supported **93 military exercises**
- RAF Brize Norton handled **2,054 flights** and processed **126,622 passengers**
- RAF Voyagers transferred **5,272 tonnes of fuel** to **2,356 British and partner aircraft**
- Command Support Air Transport undertook **285 tasks for The Royal Family, senior military leaders and Government Ministers**, including extensive support to BREXIT negotiations



## General Maryanne Miller

### Commander, U.S. Air Mobility Command

Information dominance through global air mobility

**In today's world, information is ubiquitous. While the abundance of information helps decision-makers burn through the fog of war, the sheer volume induces friction as leaders wade through observational data, separating the wheat from the chaff, the actionable from the superfluous, the accurate from the illusive.**

The nature of the information domain necessitates a coordinated effort among services and allies to perceive the environment and transmit relevant data to the appropriate audience. Air Mobility Command (AMC) is central to this effort for the U.S. Air Force.

Utilizing our core missions – airlift, air refuelling, aeromedical evacuation, and air mobility support – AMC has always been in the business of connecting. Whether extending the reach of combat aircraft, delivering combat troops, airdropping resupply or opening a new airfield, we connect the warfighter to the front line. These capabilities supply flexibility to the joint and coalition team. When the force needs to pivot, mobility warriors provide the means to do so rapidly.

As AMC steps into the future, modernisation efforts provide additional layers of connection, yielding increased battlespace awareness. Aligning with the U.S. operating concept of Joint All-Domain Command and Control (JADC2), modern mobility aircraft are becoming more than meets the

eye. With enhanced communication suites and advanced processing, mobility aircraft will be plugged into a network able to reach all users in every domain – air, sea, land, space, and cyberspace. We are aggressively adopting redundant, secure, beyond-line-of-sight communications as we assimilate into the Advanced Battle Management family of systems, the technology engine that powers JADC2 for the U.S. Air Force.

The core missions of an air force are always oriented to the strengths of the mission set employed. For AMC, the requirement for versatility is intrinsic to the mobility mission. Our operational sphere spans the globe and traverses every operational environment – we are everywhere. In a single mission, an aircraft may depart a main operating base far from the threat, transit the airspace of multiple partner nations, perform an airdrop in contested territory, and then land on an unimproved dirt strip amid mountainous terrain. When mobility assets remain connected throughout such endeavours, the joint force benefits as data from all domains provides awareness and clarity of the battlespace at the tactical level in real time. When the joint force is able to harness the unique information characteristic of the mobility mission, decision dominance will be the outcome. This is a strategic advantage and the end goal of information exploitation.

These capabilities did not originate in isolation. AMC – and, more broadly, the USAF – has enjoyed symbiotic relationships with many allies and partners as we collaborate toward more effective tactics and techniques. Not only do we often operate the same equipment, but we intentionally exercise together to build operational synthesis. For example, in September 2019, 29 international partners and allies – 500 personnel – joined our U.S. forces to conduct the world's largest mobility exercise, Mobility Guardian. For three weeks, our aircrews, maintainers, flying medics and airfield operators put every aspect of the mobility machine to the test. We gleaned new perspectives, developed new techniques and strengthened relationships. These partnerships are evidence that Air Mobility is an essential contributor to the 21st-century operations and a testament to the value of linking those operations to gain information superiority.

As we look to the future, we recognise the challenges of the strategic environment require our collective diligence today. Building the JADC2 architecture across all missions – such as Air Mobility – will help us separate the actionable from the superfluous and reduce the friction inherent in the ever-expanding information domain. In so doing, we will guarantee the information advantage for our respective nations, as well as for our allies and partners.

# People of the Next Generation Air Force

Attracting, recruiting and retaining the required people and skillsets to undertake the huge spectrum of activities with which the RAF has been tasked is a challenge. **Air Vice-Marshal Maria Byford QHDS** explains how the RAF is adapting to meet the needs of the Service and the people who serve within it



## 'PEOPLE, IDEAS, HARDWARE – IN THAT ORDER!'

**M**ilitaries across the world find themselves at a crossroads: they can continue along the well-trodden path of the base-fed organisation with rigid employment structures, archaic people policies and processes, tied to monolithic equipment programmes that span decades; or they can embrace the new reality, in which the pace and span of change in the people area tracks Moore's law, where technical development cycles compress, our competitors advance unseen, and the accepted economic underpinnings of society – including careers and the traditional workplace – become shifting sands.

It was the air power luminary and military strategist USAF Colonel John Boyd, who conceptualised the OODA (Observe-Orient-Decide-Act) loop and developed the mantra 'People, ideas, hardware – in that order!', and it would be hard to find many dissenters to this approach in today's RAF; after all, it is an approach that is entirely consistent with the Service's strategy, which places the principal focus on our people. In an era of unprecedented and rapid change, people remain the one constant as the character of war, technology, politics and economics morphs around us.

The RAF's 'Astra' Directive sets out the conceptual journey and campaign to create the Next Generation Air Force and build a workforce fit for the future. The RAF is not unique as an organisation seeking to

**The RAF's People Transformation Programme has already improved recruitment, retention, career and talent management, workforce planning and data analytics.**

(PHOTO: CROWN COPYRIGHT/MOD)

**The coronavirus pandemic marks a tipping point in the way airmen and women will operate in the next-generation air force** (PHOTO:

SAC SAMANTHA HOLDEN RAF/CROWN COPYRIGHT/MOD)

innovate and, over recent years, the people foundations that will underpin the RAF’s continued success have been laid.

The Astra People Portfolio (APP) builds on the success of the People Transformation Programme, which has already delivered benefits in recruitment, retention, career and talent management, workforce planning and data analytics. When coupled with the Defence People Strategy and Centre-led initiatives (such as the Future Accommodation Model and Flexible Working programme), it is clear that we are making a difference for our people, and there is more to come.

**A paradigm shift**

APP moves the RAF from a Cold War people footing and places it firmly in the 21st century: world-class, integrated, capable and inclusive, delivering decisive effect across all domains. A paradigm shift in career management, talent, data analytics, workforce mix, recruitment and retention activity is absolutely necessary to ensure the continued, successful delivery of air and space power for the UK.

Shifting demographics, societal changes, new career expectations, a shortage of critical skills (most acutely in STEM), and digitalisation of the workplace have shaped our thinking against a backdrop of accelerating change and global uncertainty. We must be reflective of the society that we serve, embracing diversity and promoting inclusion and equity of opportunity, and we are committed to challenge and eradicate behaviours that do not align with the core

**The Astra People Portfolio builds on the People Transformation Programme and aims to make the RAF a more inclusive organisation**

(PHOTO: MISS LUKA WAYCOTT/CROWN COPYRIGHT/MOD)



values and ethos of our proud Service. We will strive to find innovative ways to recognise, reward and empower our uniquely talented and skilled people.

**Recognise, reward and empower**

Today’s aviators are different from the airmen and women of the past; they expect and deserve to be treated as individuals. Enhanced career management has moved away from the legacy ‘one-way’ career conversation that risked failure to prioritise personal and family circumstances.

Our ‘Rejoiner’ programme is bringing back skills and experience in the hundreds, swiftly and efficiently revolutionising processes and policy, without the need to retrain or requalify. Recruitment and selection are being transformed, reducing recruiting time and digitising processes to make for a better, more relevant candidate experience, saving time and money. Furthermore, moving from the traditional branch and trade structure to a more agile and relevant group of professions will herald our commitment to change for the better.

This is particularly salient in a year that has seen the prospect of a long-feared global pandemic turn into reality. A true ‘Black Swan’ moment has disrupted all aspects of life and may become a global inflexion point that reaches across politics, society and economics. Innovative ways of working were evolving, but have been accelerated by necessity, exploiting agile working, virtual teaming and the use of technology to bridge physical divides.

The lessons identified now will change the way we operate in future, and how we shape our Next Generation Air Force. Ultimately, people are at the heart and soul of the RAF, and critical to our success. The RAF Strategy and the Astra Directive are clear – we must strive to maintain their importance: ‘People, ideas and hardware – in that order!’





# Safety first

The RAF's most senior female officer, **Air Marshal Sue Gray**, explains her role as Director General of the Defence Safety Authority to Alan Dron, and discusses the principal challenges facing the RAF and Defence in ensuring that the very highest standards of safety are maintained in training and on operations

It is an indication of how seriously the Services take safety that Air Marshal Sue Gray reports directly to the Secretary of State for Defence.

It is an independent route, outside the normal chain of command, that she can take if she feels that safety is being compromised in some way. This system was put in place following the 2009

Haddon-Cave review into the crash of a Nimrod reconnaissance aircraft over Afghanistan.

So far, Gray has not needed to use that direct channel. Indeed, if it ever became necessary, she would count it as a failure "because I need the Department to be acting and thinking in such a way that I don't need to go to the Secretary of State. My role is to make sure that we are operating as safely as possible".

Accidents are, thankfully, an increasingly rare phenomenon in the Services these days. "We're now very good at investigating accidents; it's now the near-misses we've got to concentrate on," says Gray. Given the nature of military life and the equipment that RAF personnel use, it is impossible to eliminate risk; but where it does exist, the focus is on reducing it to its lowest tolerable level and, if normal limits have to be exceeded in emergencies, then the decision to go outside those limits and take risks is done consciously,

**Thanks to higher safety standards and rigorous inspections, accidents are becoming a rare feature in today's RAF** (PHOTO: SGT NIK HOWE/CROWN COPYRIGHT/MOD)

## “It’s complicated, but it’s about understanding how we make Defence safer without losing our mission edge and taking society with us”

With a direct telephone line to the Secretary of State for Defence, Air Marshal Sue Gray must ensure the highest standards of safety for UK military aviators

(PHOTO: CROWN COPYRIGHT/MOD)



with knowledge of the possible consequences coupled with responsibility and accountability.

The importance of safety to the RAF is also exhibited by the extremely short chain of escalation on deciding whether a high-risk activity should go ahead. The initial decision lies with the safety ‘delivery duty holder’, typically the station commander. If they are unable to make the decision, it is escalated to the Air Officer Commanding, whose role is to ensure that personnel are suitably trained and that the equipment that comes to them reaches the required standard. If they, in turn, judge that the risk is one that is greater than their position can reasonably hold, the issue goes right to the very top – the Chief of the Air Staff.

### Ensuring lessons are learnt

When issues do arise, one of the responsibilities of Gray and her staff is to ensure that lessons learnt from near-misses and accidents are permanently assimilated. The nature of RAF life means that Servicemen and women are regularly reassigned to different appointments, and corporate memory can be lost in the process. That memory has somehow

to be culturally embedded “so people aren’t always relearning lessons”. The more that safety forms part of the bedrock of Service personnel’s *modus operandi*, the fewer investigations into accidents will be needed and the more effective Defence will become.

Sometimes, safety risks that are identified in wider society impinge on the military too. In the aftermath of the 2017 Grenfell Tower fire disaster in London, for example, the entire Defence estate had to be checked to ensure that buildings were not clad in inflammable materials.

### Three major safety issues

Gray says she has three major issues on her desk: keeping pace with technology and what it means for safety; checking whether, if equipment is compromised – for instance, by cyber-attack – does it become unsafe; and keeping pace with changing cultural and societal norms.

For example, the mantra ‘train as you fight’ was a perfectly valid one for many years, but attitudes change and the RAF cannot afford to put the lives of its personnel at excessive risk in the training environment. “It’s complicated, but it’s about understanding how we make Defence safer without losing our mission edge and taking society with us, because those are the people who staff the Forces. If parents think we can’t be trusted with their children, then clearly, we’re not going to be able to recruit. Much of today’s safety culture revolves around education and training. The Military Airworthiness Authority, for instance, are now much more proactive and act as a critical friend, rather than someone who comes along with a big stick, saying “You shouldn’t be doing that.”

Gray has a staff of around 420, split roughly evenly between military and civilian personnel, including what she calls ‘deep specialists’ in technical areas. The military aviation side of her department, naturally enough, has a high proportion of aircrew in its ranks. She herself, however, is an engineer by profession. This is somewhat of a departure from the norm, as the previous holders of the post were pilots.

Gray and her team place considerable emphasis today on the measurement of safety. In other words, “How do we know how good we are?”. She also depends greatly on having a slick process that allows her team to discuss action and improve things that they think are the real priority issues. ⦿

# THALES

## Adapting to the modern learner



**Daz Rawlins OBE**  
Managing Director, Thales Training  
and Simulation, UK

### What is your perception of UK military aircrew training?

It is important to recognise the incredible role that our aircrew play in the defence of the UK. To maintain this capability they need a safe, efficient, flexible and relevant training apparatus to fully prepare them for modern warfighting. The UK has a very solid reputation through our Central Flying School (CFS) and, whilst our military aircrew training is still highly respected around the world, much of the training architecture is based on concepts largely unchanged over the past 30 to 40 years.

Although a strength in its foundation, this legacy is increasingly manifesting itself in widely disparate learning environments between those experienced by students leaving academia and the learning environment they enter when they join the military. We must design a new architecture based around the expectations of the modern learner. The RAF has recognised the need for change within Project Astra for the Next Generation Air Force.

### How does Thales currently support aircrew training?

Thales has several well-established, world-class aircrew training activities in the UK, ranging from engineering support for Typhoon synthetic training, through to full instructional turn-key services of the A400M School House and Voyager Academy at RAF Brize Norton, as well as the High-G training and test facility at RAF Cranwell. We currently support aircrew training in a very traditional way, but we recognise the need for change and have, therefore, aligned our future thinking and development with that of the RAF's Project Astra. In fact, Thales began a process to disrupt the current training market well over a year ago and intends to add a much-needed layer of innovation.

### How does Thales' AircrewNext concept support next-generation aircrew training?

When we recognised the need for change, we didn't want to offer a solution based on the same old traditional concepts. We wanted to be seen as design architects. The result was AircrewNext, which will deliver modern aircrew warfighters all the tools they need to train for the difficult job they do. The concept will provide individualised learning elements with collective competence and fuse technologies, such as mixed reality (MR), with human performance-measurement capabilities using data analytics.

This fusion technique will give us the ability to dynamically feed the analysis back into the training architecture, benefiting both the individual learner and the perpetual refinement of the overall training content or pipeline – thus giving true adaptability. By doing this, you have all the components required to enable the student to attain competency progression

at their own pace – an important factor in developing the training flexibility required for Next Generation Air Force under Project Astra. Ultimately, this approach allows students to progress to the front line quicker, saving costs for the MOD.

### What challenges and opportunities do you foresee?

The COVID-19 pandemic has highlighted the need for adaptable training regimes that are less reliant on immediate human interaction, but retain the provision of constant coaching direct to the student to prevent any gaps in the training pipeline – so-called socially distanced point-of-need training. The pandemic has also brought into focus the known, but growing, shortage of flying instructors – hence, through AircrewNext, Thales seeks to address these challenges with the increased, but safe and ethical, use of Artificial Intelligence and data-driven instruction.

Another area on which Thales is working is cleaner, greener training. One of the ways we are doing this is by maximising the balance between live flying and synthetic concepts. Through our recent MoU with AERALIS, we are developing a truly integrated training system that exploits a modular aircraft to reduce the number of platforms and associated support required, blended with a software architecture that facilitates seamless training between ground synthetics and airborne Live Virtual Constructive training. This will deliver a significant reduction in terms of both cost and environmental impact. Add to that the ability for AERALIS to be configured as an unmanned loyal wingman, or red air training asset, then the fleet-wide economic returns truly address the Project Astra aspirations.

# F-35B Lightning on Westlant 19

British F-35B Lightnings undertook tests off HMS *Queen Elizabeth* during the Westlant 19 deployment. UK Carrier Air Wing and Strike Warfare Commander, "CAG", **Captain James Blackmore (RN)** underlines the significance of these trials and offers an update on the F-35B Lightning and Queen Elizabeth-class progress towards Initial Operational Carrier Strike Capability at the end of 2020

**H**MS *Queen Elizabeth* (QNLZ) has now completed three major trials periods since she was commissioned at the end of 2017. Following sea and flying trials in early 2018 to achieve the initial integration of Merlin and Chinook helicopters, QNLZ deployed in September on Westlant 18 to the eastern seaboard of the United States. The principal activity during this deployment was to conduct flying trials with the F-35B, ensuring that the aircraft could be operated safely from the ship through the generation of the operating envelope for the QNLZ-class carriers. This involved launches and recoveries at different weights in varying environmental conditions, including 'wind over the deck' and pitch, roll and heave limits of the carrier in varying temperatures.

Two test F-35Bs were embarked for the trials, and Captain Blackmore reveals, "The trials were a phenomenal success, with the generation of an operating envelope far beyond that expected, and certainly a huge improvement over the Harrier. The aircraft provides massive operational freedom and flexibility." He points out that this should not have been a surprise as the ship had been designed specifically to operate the F-35B Lightning, which is a rare occurrence; historically, it has been the other way around.

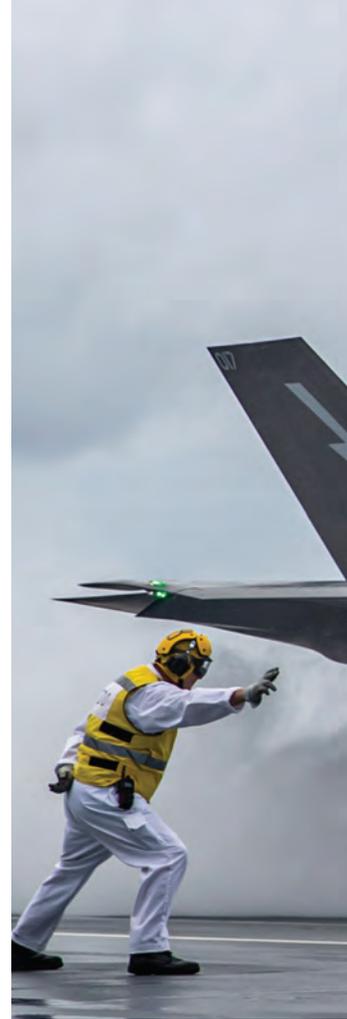
Captain Blackmore also notes that computer simulation had been extensively used in the design, which proved to match 'real life' very closely. This is important, he explains, as it gives confidence in the simulation model, proves that "we got what we asked for" and means that future flight trials can be confidently de-risked using further simulation.

Having established that the F-35B Lightning could be safely operated from QNLZ in 2018, in 2019 the focus shifted to *operational* testing on Westlant 19. For this deployment, six UK aircraft were embarked, three from No 17 (Test and Evaluation) Squadron

based at Edwards Air Force Base in California, and three from No 617 'Dambusters' Squadron in the UK, together with helicopters from the Air Wing. The latter were used to conduct further rotary-wing (RW) flight trials to widen the RW envelope and prove the use of extra RW spots during fixed-wing operations.

The test period was aimed at developing the operational capability of the carrier strike group (CSG). "We had to prove that we can not only operate the jet safely, but also 'fight' the aircraft just as effectively in the maritime environment as from the land," declares Blackmore. "We have established that QNLZ is a well-founded, flexible, defended operating base for the F-35B; we further needed to confirm that the aircraft could operate with the other platforms in the CSG – the destroyers and frigates – and that all the communications and procedures worked."

The test programme was run by the UK Air & Space Warfare Centre to assess all the core missions within the maritime environment: Air Interdiction (AI),



## EXERCISE LIGHTNING FURY

Over three days in the first week of February 2020, Exercise Lightning Fury gave the Royal Air Force's F-35B Operational Conversion Unit (OCU), No 207 Squadron, a chance to conduct night operations from HMS *Queen Elizabeth* in the North Sea. This highly successful training event helped to ensure that the UK F-35B Lightning fleet will have generated a sufficient number of appropriately qualified instructor pilots and students to build the Lightning Force as it moves from IOC to Full Operating Capability.

The specific purpose of Exercise Lightning Fury was to conduct training flights over the North Sea to enable No 207 Squadron to gain essential carrier-flying and Landing Signals Officer (LSO) supervisory qualifications. Beyond that, however, the training also set the conditions for warfighting exercises later in 2020 between the operational Squadron and the ship.



Offensive Counter Air (OCA), Defensive Counter Air (DCA), Air Defence (AD) and Close Air Support (CAS). “We proved that we could move live ordnance from the ship’s magazines using the automated Highly Mechanised Weapon Handling System (HMWHS) to the aircraft, launch a multi-aircraft mission safely, drop the weapons on the target, conduct rapid battle-damage assessment, recover to the ship, and conduct a full mission debrief. And then do it all again.” The AD mission used a Royal Navy Type 45 Daring-class destroyer as the controlling platform, which Blackmore explains was key to “confirming interoperability and group warfighting effect”.

### US interoperability

Also, during Westlant 19, pilots from VMX-1, the United States Marine Corps (USMC) Test and Evaluation Squadron, conducted ‘fly to’ operations with QNLZ, so that the USMC could become familiar with the ship’s procedures and Marine Corps pilots could achieve carrier qualification on the QNLZ class. A USMC squadron – VMFA-211 – will form part of the Air Wing for the 2021 CSG deployment, so this was the start of the familiarisation process. The ship also embarked USMC handlers, maintainers and equipment to confirm that the latter could be integrated with the ship’s equipment.

The focus in 2020 has been the continued development of CSG integration and training;

in essence, bringing all the force elements together. This included a synthetic (simulator-based) exercise in the spring to develop group command and control, carrier qualification (CQ) for 617 Squadron, and a basic maritime exercise through June. These events culminated in a major group exercise (Joint Warrior) in the autumn, encompassing destroyers, frigates, a submarine, a tanker and all the squadrons, including USMC VMFA-211, operating together; in total 10 ships, 26 aircraft and over 2,500 personnel, working up for the 2021 CSG operational deployment, Operation Fortis.

The culmination of all this will be the declaration at the end of the year of ‘Initial Operating Capability (IOC) Maritime’ for the F-35B, and ‘IOC Carrier Strike’ as a whole. “We’re confident that we will have enough evidence to enable the senior responsible officers for both these capabilities to make the declaration,” predicts Blackmore.

“We will have achieved this against quite an aggressive timeline, allied with successful collaboration between the Royal Navy and RAF, industry and Defence, along with phenomenal assistance from our US allies. We will be able to provide one of the most well-founded, defended and secure, versatile and survivable operating bases for the F-35B – a national capability that can be deployed by the UK Government worldwide at a time of its choosing.”

**Flights from HMS Queen Elizabeth during Westlant 18 proved that the aircraft could be operated safely from the new aircraft carrier**

(PHOTO: LPHOT KYLE HELLER/CROWN COPYRIGHT/MOD)

# Lightning Dawn

The Commanding Officer of No 617 Squadron, **Wing Commander John Butcher**, tells Alan Dron why last year's F-35B Lightning deployment to RAF Akrotiri in Cyprus was more than just routine training

A significant milestone in the Lockheed Martin F-35B Lightning's progress towards full operational capability with the RAF came in 2019 when a small detachment of aircraft from No 617 Squadron 'The Dambusters' deployed to RAF Akrotiri, Cyprus. The objective of this first operational overseas deployment was to evaluate how the aircraft would perform away from the extensive facilities of its home base of RAF Marham and what skills the ground crews needed for future forays away from their own turf.

Appropriately, the deployment was given the title 'Lightning Dawn', which signified the start of the aircraft's operational service with the UK. Six machines flew out to Cyprus for the deployment, together with

around 120 No 617 Squadron personnel, plus a further 20 people from the wider Marham team. They were accompanied by a Deployable Special Access Facility, which serves as a mission-planning system for the F-35.

Although only six of the Squadron's aircraft made the trip to the Eastern Mediterranean, all of the Squadron's pilots and line maintenance personnel rotated through Akrotiri during the deployment, which ran from mid-May to the end of June. "We already knew what the aircraft could do. Now we needed to try it away from RAF Marham and see how we would function on a deployed base," explains Wing Commander (Wg Cdr) John Butcher, Officer Commanding (OC) No 617 Squadron.

To make things slightly more challenging, rather than trying to carry enough material to handle any eventuality, the deployed force only took enough spares, support equipment and tooling appropriate to that scale of deployment, so they could see how they handled any unforeseen or exceptional situations.

## More than just an exercise

An important point to make, according to Wg Cdr Butcher, was that Lightning Dawn was not only an exercise: "The fact that we undertook operational flying as part of the activity meant that, in my mind, it wasn't just an exercise. The operational flying that we were doing was in support of the UK's contribution to the military intervention against Daesh – Operation Shader. As such, we were carrying out similar missions as the Typhoons were prosecuting at the same time."

The RAF already has plenty of experience of that type of operational environment as it has been

**Lightning Dawn was designed to challenge both pilots and ground support teams away from their home base**

(PHOTO: CROWN COPYRIGHT/MOD)





flying Typhoons and the now-retired Tornados in the region for many years. However, this was the first time that the Lightning was added to the force. “We flew 18 operational missions during our time there,” Butcher reveals. “In addition to those sorties, we were doing routine training flying, including bilateral sorties with the US and Israeli air forces, both of which also operate the F-35.”

The deployment aimed to set a benchmark for the aircraft’s service in a deployed setting and the multi-week spell in Cyprus generated several important lessons. According to Wg Cdr Butcher, “What we learnt was that it’s a very deployable capability. We were very impressed with its performance in a deployed location – not just the air system itself, but all of the support structure surrounding how we operate.”

Neither did the transportation of spares and tooling to Akrotiri generate any problems. “There was not really anything unexpected. Areas where we thought we would struggle came through pretty well, but those were the sorts of things we had planned for and for which we had put contingencies in place. Whenever those occasional unplanned or unexpected cases materialised, we found the broader programme was able to cater for them.”

### Rising to the challenge

Not only did the plans and equipment pass muster, the personnel also rose to the challenge. “They did great,” says Butcher. This was undoubtedly helped by the fact that, although Lightning Dawn was the first overseas deployment for

the F-35, Akrotiri is an established base with well-understood procedures and facilities.

What also makes this deployment significant is that it has to be seen within the context of how soon it came after No 617 Squadron arrived at RAF Marham following its work-up training in the US, not to mention how soon the deployment to Cyprus came after declaration of the type’s Initial Operating Capability (IOC). “It was remarkable, having arrived back in the UK less than a year prior to us going out on Lightning Dawn. IOC was declared in the first week of January, and by the middle of May we were deployed overseas,” notes Wg Cdr Butcher. 

**Israeli Air Force F-35As flew alongside British F-35Bs for the first time during Exercise Lightning Dawn** (PHOTO: STAFF SGT KEIFER BOWES/ U.S. AIR FORCE)



**During Exercise Lightning Dawn, a British F-35B from No 617 Squadron flew missions in support of Operation Shader** (PHOTO: CROWN COPYRIGHT/MOD)



# Red Arrows over North America

In 2019, for the first time in more than a decade, the Red Arrows toured North America. **Wing Commander Andrew Keith** recounts some of the highlights and the influence that the tour generated for the UK

Performing at iconic locations, from the majestic Niagara Falls to California's golden beaches, the Royal Air Force Aerobatic Team's (RAFAT) North American tour was its biggest ever.

Tens of millions of people saw dynamic, colourful displays and precision flypasts by the Red Arrows. However, although high-profile, the flying was only one way in which the Team and the tour projected a Global Britain and supported the UK's broad range of interests. More than 125 ground events were staged over 11 weeks – spanning business receptions promoting trade, workshops on leadership and school visits highlighting science,

technology, engineering and mathematics (STEM). The Red Arrows, as a brand, have huge soft power and appeal, with the ability to reach a large and diverse range of individuals.

The North American tour proved this yet again, building on a successful track record of helping to promote strategic interests and key messages to new audiences, often enabling access to otherwise unreachable areas. Using the visual appeal of the displays and flypasts, the Red Arrows are a convening asset – this aerial activity draws massive crowds and attracts positive headlines. However, it is through working alongside colleagues from other Government departments at the associated ground engagements that the Team can really reap the benefits of face-to-face engagement with those attending.

## Enhancing international trade

The Red Arrows last flew in North America in 2008, but the latest visit was the most extensive to date and an indication of the UK's continuing commitment to enduring relationships, mutual prosperity and extensive security cooperation in the region. The tour helped to celebrate and enhance international trade and investment between the UK, Canada and the US – worth more than £208 billion in 2018.

Naturally, planning for such an expansive undertaking involved not only RAFAT personnel, but also an Air A7 Delivery team and specialists sourced from across the RAF. The tour began on 5 August. A dozen of the team's Hawk T Mk 1 jets departed RAF Scampton, while more than 80 personnel and 12 tonnes of freight and equipment

**The 2019 Red Arrows tour helped to boost trade, good relations and educational interest across Canada and the United States**  
(PHOTO: CROWN COPYRIGHT/MOD)

were flown in two Voyagers and a pair of A400M Atlas air transport aircraft.

Together, these aircraft were crucial in getting the Red Arrows' single-engine jets safely to North America – this being one of the main hurdles of the entire deployment. Without the ability to refuel in the air and not possessing the range to make the transatlantic crossing in one sortie, the Hawks were flown, over three days – via stops in Scotland, Iceland, Greenland and Goose Bay – to reach Halifax, Nova Scotia.

On board the lead Voyager, Detachment Commander Group Captain Tony Franklin maintained contact with the various aircraft and personnel orchestrating the trail and providing critical C2 (command and control) and safety functions. The 12 fast-jets were split into two sections to minimise risk at some of the single-runway, no-diversion staging locations. Each location had a team of engineers and support staff pre-positioned by the air transport fleet.

A Challenger aircraft from the Royal Danish Air Force provided crucial search-and-rescue cover, demonstrating the close cooperation from a NATO partner. The fact that the Red Arrows arrived on time, to the minute, at Halifax International was testimony to the detailed planning and professionalism of everyone involved and set the tone for entire tour.

Remaining with the Red Arrows throughout the tour was one A400M Atlas, which moved equipment and reliably shuttled the detachment's support staff – a Whole Force comprising regular personnel, full and part-time reservists and Civil Servants.

### Stunning displays and flypasts

Once in North America, the tempo of activity was incredibly high. There were 21 displays and 30 stunning flypasts completed over major landmarks and iconic locations, ranging from a baseball stadium in Washington DC to a mixed formation with the Royal Canadian Air Force's Snowbirds team over Toronto.

Among the largest events was the Great Pacific Airshow at Huntington Beach, California, where three million people watched. In New York, the Team participated in a 19-aircraft flight down the Hudson River, leaving signature red, white and blue trails over the Big Apple. The Red Arrows flew with the F-16s of the US Air Force Thunderbirds, two F-35 Lightning IIs and a pair of F-22 Raptors.

What made that day in New York even more impressive was what happened after the flight – demonstrating the tour's ambitions and remit to influence and inspire. Just minutes after landing from this complex sortie, the pilots were driven into central Manhattan to carry out a wide-ranging six-hour engagement programme, finishing with the Red Arrows and the GREAT Britain campaign branding being displayed in Times Square. It was typical of

the carefully choreographed and potent combination of air and ground activity seen across the tour.

This type of innovative marketing and media campaign made it the Red Arrows' most visible overseas activity yet. Almost two billion people were reached via all media channels. The tour's official logo was omnipresent and #RedArrowsTour trended on social media. There were 300 million Twitter impressions alone – many posts featuring striking imagery taken by the four deployed RAF photographers. A weekly podcast was made available via the BBC Sounds app – another RAF first – and an embedded television documentary team followed every moment, with a four-part series broadcast on Channel 5.

Already, the impact of the tour has been recognised by the air show community, with the Red Arrows receiving a major award from the International Council of Air Shows (ICAS).



Speaking after the Red Arrows returned to the UK, Antony Phillipson, HM Trade Commissioner for North America and British Consul-General in New York, remarked: "Their being here provided invaluable support to the work of Her Majesty's Government in North America, whether connecting UK exporters with potential buyers, engaging current and potential investors to the UK or helping to build transatlantic partnerships across STEM fields – a huge priority for all three countries. The Reds, and their fabulous support team, the Blues, demonstrated once again that they are incredible ambassadors for the UK and showcased all that is great about Britain."

The tour demonstrated the power, influence and value of a truly collaborative and multi-spectrum soft-power campaign. A fantastic example of the Whole Force working together alongside NATO partners and Government departments producing remarkable results, the trade and business-related success generated by the tour will be felt in the months and years to come. 🌐

**An A400M Atlas supported the Red Arrows during their tour of North America**  
(PHOTO: CROWN COPYRIGHT/MOD)



# Building bridges

– support to civil authorities

In August 2019, media coverage of RAF Chinooks working alongside the civilian authorities to shore up the dam at Toddbrook Reservoir and save the town of Whaley Bridge dominated the news headlines. **Patrick Allen** reveals the critical role that the RAF played throughout the operation

On 1 August 2019, a major incident was declared when holes started to appear in the dam wall of the huge Toddbrook Reservoir in Derbyshire. As the reservoir held over 1.3 million tonnes of water, the holes were deemed a serious threat to the nearby town of Whaley Bridge and the countryside beyond. Without delay, the Environment Agency issued a 'danger to life' warning and local residents were evacuated. Then, Operation Initiate to save the town began.

"Whaley Bridge was a textbook example of 'military support to civil authorities'," says

Wing Commander Gary Lane. As one of 10 RAF Regional Liaison Officers (RAFRLOs), located around the UK, he became the air-ground liaison officer during the effort to repair the dam.

It began when the emergency services initiated a 'strategic-tactical-operational' command structure, which is generally used for major operations. The Strategic Command Group (SCG) – based within Derbyshire Police HQ in Ripley, Derbyshire, and comprising all the emergency services and various government agencies, including structural engineers from Mott McDonald Kier – established three priorities:

- lower the water level in the dam by using high-volume pumps;
- reduce the flow of water into the reservoir;
- stabilise the dam wall as quickly as possible.

The engineers soon realised that the only way to stabilise the dam was by using helicopters. A request was quickly made for military assistance through the SCG to the Ministry of Defence, and Wing Commander Gary Lane was deployed to Whaley Bridge.

"I quickly deployed to Toddbrook Reservoir to meet the engineers, assess the situation on the ground, and plan on what we could provide," explains Lane. "It soon became clear that the main priority was to stabilise the dam wall as quickly as possible. Cranes were not an option, and the situation was becoming increasingly perilous. The engineers suggested using aggregate from a local quarry, which could be dropped into the dam wall. From my

**The Chinook's triple hook system enables as many as six one-tonne loads to be carried underneath the aircraft**

(PHOTO: CROWN COPYRIGHT/MOD)



previous Support Helicopter background, I knew that the Chinook, which had previously been deployed on flood operations, could carry one-tonne under-slung cargo bags, which, although designed for operations in Afghanistan, would be ideal for the task."

Once the plan was approved, RAF Odiham deployed a Chinook from 27 Squadron, plus a load-handling team from the Joint Helicopter Support Squadron (JHSS) at RAF Benson, and the Tactical Support Wing (TSW) from Stafford to provide an on-site refuelling facility. "Having established a suitable Helicopter Landing Site (HLS) and refuelling point, the aggregate was loaded into the one-tonne bags, and the Chinook, using its triple hook system, was able to deliver six tonnes of aggregate in a single sortie.

The first sortie was undertaken before dawn on 1 August. Over the following week, crews from 18 and 27 Squadrons flew over 66 hours and delivered over 660 tonnes of aggregate. "Once we had filled in the initial holes, we had to wait for the aggregate to settle and for the engineers to assess the situation. We then returned on the following Tuesday to fill in the remaining holes. The engineers, by this time, had placed a 'grid square' all the way down the dam wall to help them decide where to deploy any additional aggregate. This part of the operation tested the skills of the Chinook aircrew as they had to carefully position and drop the loads in the precise positions as directed by the JHSS radio operator, according to the exact grid-square for each bag."

### Planning, training and exercising

Throughout the year, RAFRLOs exercised with their police and emergency services counterparts on a number of different scenarios, ranging from training with police firearms units to helping the fire service move high-volume water pumps. This training is an essential part of the Support to Civil Authorities concept, as it enables them to react with speed and cohesion whenever they are called upon to work together.

According to Wing Commander Lane, "The speed of response and the ultimate success of Operation Initiate clearly demonstrated how the smooth integration of military, civilian and emergency services enables them to quickly adapt and successfully plan and execute an emergency situation. This is achieved by using a tried-and-tested chain of command, together with regular exercising and training between the military and emergency services. A big part of this training obviously includes the vital role that the RAFRLO plays."

During 2019, the RAF responded to several other requests for military assistance via the RAFRLOs. This included sending RAF Chinook and Puma helicopters (alongside the JHSS) to Wainfleet in Lincolnshire to plug gaps in flood defences after the River Steeping burst its banks in June. And, again, in November, RAF Chinooks and the JHSS dropped 60 tonnes of aggregate in Bentley, Doncaster, to shore up flood defences after a month's rain fell in 24 hours. 📍

**A network of 10 RAF Regional Liaison Officers (RAFRLOs) help coordinate support to the civil authorities across the UK**  
(PHOTO: CROWN COPYRIGHT/MOD)



# Delivering live flying and synthetic air crew training



## Tim James

Managing Director, Ascent Flight Training Ltd

### How is the overall UK Military Flying Training System (UKMFTS) programme progressing?

The UKMFTS programme is progressing well, and we have continued to deliver training during COVID-19, whilst adapting to Government social distancing measures.

As a reminder, Ascent was awarded the RAF Valley Advanced Jet Training contract in 2008 and the RNAS Culdrose Rear Crew contract in 2010. Advanced Jet and Rear Crew training commenced in 2012, with our first MFTS students graduating in 2013. The main Fixed Wing and Rotary Wing contracts were awarded to Ascent in 2016, with Rotary and Elementary training commencing in 2018 and Multi-Engine Pilot and Basic Flying Training commencing shortly thereafter in 2019.

This progress is made possible through the UKMFTS Ministry of Defence (MOD) partnership and our

300+ dedicated Ascent staff. Across our six UK sites we operate 106 aircraft, over 50 high-fidelity simulators and a range of complex infrastructure projects on behalf of the UK MOD, our customer and UKMFTS partner. This year alone we will be delivering over 60,000 hours of live flying and synthetic training to our UKMFTS students, and these totals will continue to grow as we seek to expand areas of the service to meet the UK MOD's evolving requirements.

### What is the latest on rotary-wing flight training?

Ascent delivers Rotary Wing training at RAF Shawbury and RAF Valley using the Airbus H135 Juno and H145 Jupiter aircraft. We currently operate a fleet of 36 helicopters and a suite of 14 high-fidelity simulators to support rotary pilot and rear crew training. The UK MOD has certified for use all of our infrastructure, courseware, aircraft and simulators.

For the remainder of this year and next we are focused on the final remaining aircraft modifications to unlock our overwater winching capability. In addition we were awarded a £183 million contract in December 2019 to expand our Rotary Wing capacity to meet the UK MOD's SDSR15 requirements. In October 2020, we achieved the Ready for Training Use milestone on our four additional H145 aircraft, which took the UK MFTS rotary fleet to 36 aircraft in total and enables us to create future capacity to offer Rotary Wing-only training to the UK MOD customers.

### What is the current status of the fixed-wing element of the contract?

Ascent delivers Fixed Wing training across three UKMFTS sites – RAF Barkston Heath, RAFC Cranwell and RAF Valley. The programme involves a total of 70 aircraft and 24 simulators covering the Prefect, Phenom, Texan and Hawk T2 aircraft types.

Currently, we are uplifting the Fixed Wing programme to create SDSR15 capacity within Basic Flying Training with the recent provision of four additional Texan aircraft, with new infrastructure, additional instructional staff and increased simulator capacity for RAF Valley to follow. In addition, we are actively progressing a number of innovations to further advance the balance of live:synthetic training in line with the RAF ASTRA strategy.

### How is rear-crew training progressing?

In April 2020, we signed a three-year extension to our current Rear Crew Stage 1 contract at RNAS Culdrose. That extension secures our current Rear Crew capability, which involves four Avenger aircraft, infrastructure, instructional staff and simulators at RNAS Culdrose. This year, we have also delivered a number of simulator projects for interim Rear Crew training at RAFC Cranwell.

We are actively engaged with the UK MOD to assess Future Rear Crew training options to meet the ever-increasing demand for modern Rear Crew training capacity.



# Helicopter Interim Course Capability – UKMFTS

On 23 August 2019, 22 aircrew from the three UK Armed Services graduated from the Defence Helicopter Flying School (DHFS). This date coincided with the declaration of Interim Course Capability (ICC) for the rotary-wing element within UKMFTS. The Commandant of the DHFS, **Group Captain Chris Mullen**, explains why this is a major milestone and offers a foretaste of future programme landmarks

**T**he UK Military Flying Training System (UKMFTS) represents a significant and long-term transformation of the tri-Service flying training pipeline. Under UKMFTS, a £1.3 billion investment has enabled the complete overhaul of the rotary-wing (RW) training facilities at the Defence Helicopter Flying School (DHFS) as part of a 20-year contract with our Defence Partner, Ascent Flight Training.

The key aims of MFTS are to reduce the time spent in the flying training pipeline, close the

capability gap between Phase 2 training and the front line, and deliver better value for money for Defence. To do this, there has been a wholesale replacement of our legacy RW fleet with 29 Airbus HC135 Juno and three HC145 Jupiter helicopters, and the establishment of a purpose-built infrastructure with state-of-the-art ground-based training equipment, including simulators and virtual-reality training devices. The facilities are spread across two locations: four squadrons at RAF Shawbury (705 Naval Air Squadron, alongside the RAF's 60 Squadron and

**The Airbus Juno and Jupiter helicopters have introduced state-of-the-art technology equivalent to the front-line helicopters that the graduates will go on to operate**  
(PHOTO: CROWN COPYRIGHT/MOD)

The graduation of 22 aircrew on 23 August 2019 coincided with the declaration of Interim Course Capability  
(PHOTO: CROWN COPYRIGHT/MOD)



660 and 670 Army Air Corps Squadrons) delivering the basic and advanced phases, with 202 Squadron at RAF Valley delivering specialist maritime training.

**Combined expertise**

The route to ICC, defined as the system being capable of delivering meaningful training, presented many of the challenges expected with a programme of this scale and complexity. However, the combined expertise of the Delivery Team, RAF Air Command's Air Capability team, Ascent Flight Training and DHFS personnel

provided the necessary wherewithal to overcome these hurdles and reach a successful outcome.

The new military-owned and registered aircraft represent a step-change uplift in capability, compared with the previous platforms. For example, they incorporate a full glass cockpit and a digital auto-pilot with the functionality that matches that of the front-line aircraft. If required, there is also the ability to install role-specific equipment.

Using aircraft designed for the civil sector to deliver military training has presented challenges, particularly in the low-level and night environments; developing procedures to deliver effective rear-crew training has also been difficult. However, the aircraft are designed for ease of maintenance, which, coupled with the use of the design organisation to deliver maintenance, has ensured an exceptional level of mission availability that routinely exceeds 98%. The complete revision of the syllabus and courseware was also a significant challenge, especially given the delivery timescales; here, a collaborative approach between Ascent and the Directorate of Flying Training, 22 Group, enabled rapid incorporation of lessons and development of streamlined processes to enable success.

The final (and, possibly, most complex) challenge was the delivery and acceptance of the seven Flying Training Devices (FTDs), which would enable approximately 45% of the syllabus. As the Delivery Duty Holder, I had to be assured that the flight model and overall training environment would not result



Four additional Jupiter helicopters were delivered to RAF Shawbury at the beginning of June 2020 (PHOTO: IAN FORSHAW/CROWN COPYRIGHT/MOD)



in a transfer of risk to the aircraft. With support from expertise within the ATEC (Air Test and Evaluation Collaboration, Flying Division, MOD Boscombe Down), the MFTS Delivery Team and our industry partners, we were able to tune the flight model, identify the key areas that would present risk and map them across the syllabus to ascertain the effect on the training plan. The result was a position where we were able to assure the use of the FTDs to deliver meaningful training, with an agreed and deliverable plan for correction of the remaining deficiencies.

In this context, declaration of ICC not only captured the point at which the training system was able to deliver meaningful training to our tri-Service RW aircrew, it also marked the culmination of over 16 months of focused activity across the Whole Force that had enabled the complete overhaul of DHFS.

### Additional capability

Clearly, there is more activity required to release additional capability and enable declaration of Full Course Capability. This already includes the provision

of software uploads to the FTDs that have expanded our training capability; enablement of over-water operations on 202 Squadron and progression of our maritime capability, and modification of our Jupiter aircraft to enable rear-crew night-flying training.

The key milestone for the near future remains the expansion of the training system funded by the 2015 Strategic Defence and Security Review, including four more Jupiter helicopters, an additional FTD and an uplift of instructors and support staff. Delivery of all four Jupiters to RAF Shawbury was fulfilled at the start of June and, once final checks and the transfer to the military register was completed, the helicopters have been employed in operational service at RAF Shawbury and Valley. These additional resources will enable the delivery of a streamlined 'RW-only' training package, initially for the Army Air Corps and then the Royal Navy, that will further reduce the time in training, whilst providing the enhanced level of capability across our output to all three Services.

On 28 February 2020, DHFS was rebadged as No 1 Flying Training School. 

**About 45% of the helicopter training syllabus can be delivered by the brand-new Flight Training Devices**

(PHOTO: CROWN COPYRIGHT/MOD)



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**TOTAL LIVES SAVED 7638**



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