Future Air and Space Operational Concept

FUTURE AIR AND SPACE OPERATIONAL CONCEPT 2009 (FA&SOC 2009)

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CONTENTS

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PREFACE

1. Air and space power is coming of age and promising to deliver capabilities that its early advocates only imagined. Control of the air, global mobility, persistent surveillance and reliable precision air attack, unrestricted by geography, are now commonplace. However, a significant effect of this post-Cold War combat power asymmetry in our favour is the intelligent reaction of our adversaries, who have recognised these strengths and who have adapted their tactics accordingly. They misrepresent air power as a cruel overmatch and have successfully influenced diverse audiences to believe that it is a blunt instrument of power. And the more precise that we have become with air delivered weapons, the greater the expectation has risen that air power will create little or no collateral damage. These perceptions are encouraged by our adversaries, who rightly fear air power's reach, precision and coercive potential. Emerging technology offers much promise for reduced collateral damage and significant potential for new non-kinetic effects, but air power advocates must also engage in the battle of ideas and win an information war if they are to preserve the enormous current utility of air power's combat advantage – and then fully exploit its future potential.

2. The new definition of air and space power below underlines its broad utility, from strategic through to tactical levels, using both kinetic and non-kinetic means:

> '*Air and space power is the capability to project power from the air and space in order to influence the behaviour of people or the course of events.*'[1]

3. Sortie rates, tonnage, weapons delivered and targets hit will not suffice to capture the true impact of future air and space power. With its ability to influence the two-dimensional battlespace (the surface of the land or of the sea), exploit height (the third dimension), and (thanks to speed) exploit the fourth dimension (time), air and space power can achieve influence quickly and almost anywhere in the world, if necessary by projecting the threat or use of force. However, adversaries are now driven to hide in complex terrain, from the deep oceans and littoral waters to urban and subterranean infrastructure. This battlespace is characterised by low signature fleeting targets in high clutter environments and it represents a significant challenge for air power. In Lebanon in 2006, Hezbollah used over 500 km of tunnels to evade surveillance. Similarly, quiet diesel submarines with air-independent propulsion are proliferating, because they have no need to expose themselves routinely to powerful above and below surface sensors.

[1] Air Publication (AP) 3000 (4th Edition) *British Air and Space Power Doctrine*.

AIM

4. To articulate the operational concept for UK air and space power, in order to inform concept, force and capability development.

PROVENANCE

5. The Future Air and Space Operational Concept, 2009 (FA&SOC 2009) replaces the first edition (FASOC). It is an extrapolation of the policy outlined in *Defence Strategic Guidance 08* and the *High Level Operational Conceptual Framework* (HLOC). It is also consistent with Joint Doctrine Publication (JDP) 0-01, *British Defence Doctrine* (3rd Edition) and other capstone Joint doctrine publications.[2] The paper complements its sister environmental operating concepts[3] and the endorsed interim concepts.[4] Therefore, while making the case for air power capabilities and limitations in the round, as each of the other 2 Services has already done within their respective environmental concepts, FA&SOC 2009 does not pre-empt any subsequent policy judgements about the balance required between the different Services' capabilities. But it does offer the potential *within* the Service to rebalance, for example between manned and unmanned systems. Security in its broadest sense is not the sole preserve of the Ministry of Defence (MOD). Therefore, to capture a more complete picture of Government policy and aspirations, FA&SOC 2009 should be read in conjunction with other Government Departments' publications, particularly where reference is made to Cyber Security and aspects of Space Security.[5] The cyber domain is not exclusively linked to the air or space domains and in many respects, the MOD will be supporting the lead given by another Government department. However, the implications are strong enough to warrant capture in this concept. However, readers should note the stand-alone Future Electromagnetic Operational Concept (FEMOC),[6] work ongoing at Development Concept and Doctrine Centre (DCDC) to develop a separate cyberspace concept, and the recent establishment of the Cyber Departmental Strategy Planning Group (DSPG).

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[2] DCDC also manages the MOD *Global Strategic Trends* programme. While this does not represent formal policy or doctrine, its analysis nonetheless underpins some of the deductions in FA&SOC 2009.
[3] Maritime, Land and Electromagnetic.
[4] Operate, Command, Inform, Prepare, Project, Protect, Sustain.
[5] Note the rapidly emerging national security initiatives such as the *National Cyber Security Strategy* and the *National Space Security Policy*.
[6] DCDC FEMOC dated 14 November 2008.

SCOPE

6. **Context**. FA&SOC 2009 is an analytical concept[7] with a 2030 reference point to provide the conceptual underpinning for future air and space concepts of employment and concepts of use. By examining how the strategic context is developing and the character of warfare is evolving, it establishes an operational framework, around which Defence Lines of Development (DLOD) champions can consider policies for development, force structure and operations. It suggests evolutionary rather than revolutionary change in the near term, but acknowledges some potentially game-changing technology for the longer term. FA&SOC 2009 is consistent with, and draws on, Royal Air Force (RAF) Strategy papers and work for the future of the other Services.

7. **Timescale**. FA&SOC 2009, consistent with HLOC and its sister environmental operating concepts, looks forward 20 years in 4 x 5-year epochs. However, the impact of technology, which has always strongly driven developments in air and space power, will be especially marked as emerging technologies are exploited. Historically, the impact of most technology occurred sooner than was predicted.

8. **The Defence Industrial Strategy and Novel Systems**. The Defence Industrial Strategy judged that:

> '*Directed Energy technologies (lasers and radio frequencies) could be highly significant in the future, particularly for protecting our Forces from a range of threats, including Improvised Explosive Devices. They could also offer the UK non-kinetic and/or less-lethal options to replace, enhance or complement traditional kinetic weapons, such as missiles, and offer significant opportunities to reduce collateral damage, notably in urban areas. Due to the reusable nature of the technology and some of its potential applications, there is also potential for a significant reduction in the logistic footprint and whole life costs compared with conventional weapons...*' [8]

9. **Timescales for Emerging Technologies**. It is feasible that the impact of Directed Energy Weapons (DEW), Computer Network Operations (CNO), the next generation of Unmanned Aerial Systems (UAS) and virtual knowledge bases will mature in a broadly similar timescale.[9] CNO includes both Computer Network Defence and Computer Network Attack, the balance between which is driven by

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[7] Analytical Concepts are responses to changes in policy, future trends and innovative thinking; they form the basis and authority for the development of interim and applied concepts. Applied, unlike Analytical, Concepts are bound by policy and resource considerations.

[8] *Defence Industrial Strategy* (London: HMSO, December 2005, Cm 6697).

[9] Virtual knowledge bases already exist, but technology promises greater ability to deal with the increasing data deluge. It is feasible that new search engines will be powerful enough to allow rapid retrieval and even automatic information distribution of information to those authorised for access.

national priorities outside the classification of this paper. There is strong evidence to suggest that DEW and CNO will transform air and space power as early as the middle of Epoch 3 and more certainly by the end of Epoch 4.[10] UAS are already in service, but the next generation of capabilities could provide low observable platforms and performance approaching that of some current manned aircraft, making them more survivable in high threat environments.

STRUCTURE

10. FA&SOC 2009 comprises 2 parts and 3 supporting annexes. Part 1 sets out the strategic environment for the duration of this Concept, and draws first order deductions. Part 2 is in 2 sections. The first section looks mainly to the end of Epoch 3, but depending on how rapidly technology matures. It considers how emerging technology and the first order deductions might influence the development of each of the 4 air and space power roles. The second section, necessarily more speculative, asserts that the 4 roles will endure, but considers how maturing technologies will more radically shape air and space power capabilities in Epoch 4. The annexes in turn provide an introduction to CNO, space power and a concept of Operationally Responsive Space.

[10] Anne-Marie Slaughter, *America's Edge: Power in the Networked Century*, Foreign Affairs, January/February 2009; *A World of Connections: Economist Special Report on Telecommunications*, The Economist, 28 April 2007; *Let It Rise: Economist Special Report on Information Technology*, The Economist, 23 October 2008; United States National Intelligence Council, *Global Trends 2025: A Transformed World* (Washington DC: US Government Printing Office, November 2008); RAND Corporation Research Brief, *Global Technology Revolution 2020: Technology Trends and Cross-Country Variation* (Santa Monica: RAND Corporation, 2006).

PART 1 – THE STRATEGIC ENVIRONMENT OUT TO 2030

NATIONAL SECURITY STRATEGY

101. In March 2008 the Government published the first National Security Strategy of the United Kingdom (NSS),[1] sub-titled *Security in an Interdependent World*, which identified why we face security challenges, and where the country would engage to defend its interests. The Cabinet Office refreshed the NSS in June 2009 and re-confirmed the major challenges to the rules-based international system: the economy, technology, demography, migration, climate change, the competition for energy, and poverty, inequality and poor governance.[2] It also indicated the threat from instability and conflict, failed and fragile states, and the overall interdependence of these threats.[3] There are particular dangers inherent in regions where multiple stresses overlap and these could become our future theatres of operation.

SECURITY CHALLENGES: THE STRATEGIC TRENDS[4]

102. The defining feature of future conflict will be the insecurity created by the imbalance between population and resources and the proliferation of Weapons of Mass Effect (WME). The world's population is likely to rise from 6 to 8 billion by 2030. By 2035, more than 60% of it will live in urban environments, with the majority of urban growth occurring in the littoral. Populations will be ever more mobile with significant immigrant and emigrant populations. World food costs will rise due to shortages of rice, wheat and maize. Oil will become scarcer and prices will rise. 450 million people will face severe water shortage. Meanwhile, global economic inter-dependence will make it difficult to contain the effects of a crisis within a particular region and make national self-interest more difficult to discern. Moreover, global inequality will continue and conflict will be ignited by radicalisation. Today, the world's richest 225 people earn the same as the poorest 2.7 billion and this gap between rich and poor will increase. One billion people currently live in slums and this will rise to 1.4 billion by 2020 and almost 2 billion by 2030. Global communication will allow the *have-nots* to perceive considerable injustice. Furthermore, climate change may precipitate conflict. Arctic sea ice could melt by 2040. Desertification is occurring at 70,000Km^2/yr and has already triggered some of the world's most violent conflicts in sub-Saharan Africa. Environmental fragility threatens 1.4 billion people.

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[1] The Stationary Office, London; Cm 7291 dated March 2008.
[2] The Stationary Office, London; Cm 7590 dated June 2009 pp. 6 – 7.
[3] Ibid, p 10.
[4] Derived from both the NSS and the *DCDC Global Strategic Trends Programme 2007-2036* (3rd Edition) (www.dcdc-strategictrends.org.uk).

CRITICAL NATIONAL INFRASTRUCTURE: UK DEPENDENCE ON SPACE AND COMPUTER NETWORK OPERATIONS

103. In common with the rest of the developed world, the UK has a profound dependence on space and Computer Network Operations (CNO); most people simply do not understand the depth of our dependence.[5] All 9 sectors of the UK's Critical National Infrastructure[6] (communications, emergency services, Government and public services, finance, energy, food, health, transport and water) are interdependent and they all rely - to a greater or lesser degree - on space and CNO. Conflict is already taking place in these domains; potential adversaries have conducted attacks against political and economic targets and against military command and control systems. Developed Western economies are especially vulnerable and we should expect our adversaries to exploit this. States may, for reasons of deniability or expertise, contract-out their attacks and non-state actors will exploit the same asymmetric opportunities. Terrorists may target computer-controlled infrastructure and safety controls. Criminals will exploit computer network attack for financial gain. The potential impact, including the financial cost, is not yet fully understood, but could conceivably be catastrophic in a well-developed economy. It may be difficult during CNO to tell who is conducting an attack or why they are doing it, and it may therefore be difficult to legitimise national responses. Of note, since the first Gulf War, UK military reliance on space and CNO has increased to the point of a critical dependence. Recent studies estimate that up to 90% of UK military capabilities have a direct dependence on space-based capabilities alone, from communications to surveillance, reconnaissance, position, navigation and, most fundamentally, the timing signals upon which so much capability directly depends.

THE EVOLVING CHARACTER OF CONFLICT

104. **General Trends**. While the nature of warfare remains constant, the character of conflict continues to evolve. Historically, this trend is normal, although the evolving character has always been hard to predict. There is now more blurring between the boundaries of state and non-state actors as our opponents seek to adapt and attack what they perceive as our weaknesses. Adversaries therefore now include insurgents, terrorists, irregulars, criminals and cyber-warriors who are more frequently combining to produce hybrid threats. They sometimes form clearly defined groups, but may also favour loose affiliations. Some social networks are potential threats, but opaque to Western eyes, with no discernable command and control, no recognisable structure and often no easily-identifiable centres of gravity. The predominant features of such conflicts will be low signature, fleeting targets operating in complex terrain, where adversaries will adapt quickly to our tactics.

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[5] UK Space Report, *Space Secures Prosperity*: *The Security and Defence Case for Space* 2008.
[6] See: www.cpni.gov.uk

105. **Iraq 1991 – 2003**. Since the end of the Cold War, Iraqi conventional military capability has been defeated twice by US-led coalitions. The utility of conventional air power reached a new apogee in the second Gulf War. The percentage of air sorties flown in support of land operations increased from 55% in the first Gulf War to 78% in the second. The dominance then enjoyed by the West suggested that anyone fielding armoured formations against a US-led Coalition was inviting comprehensive destruction from the air. In 2003, when conventional operations in Iraq were complete, the *Fedayeen* shifted their conventional units into irregular formations and adopted new tactics. The US-led Alliance initially failed to respond quickly to this shift and was unable to turn warfighting prowess into a successful stabilisation campaign. Air power was also slow to adapt to the new context.

106. **Lebanon and South Ossetia**. In 2006, Hezbollah hid its forces so well in Southern Lebanon that the Israeli Air Force could only destroy an estimated 7% and Hezbollah attacked the Israeli homeland uninterrupted throughout the conflict. Air power thus failed to deliver the much-anticipated knockout blow. The Israeli Army had to be committed in strength to fight for the ground in which Hezbollah's capability was hidden. Notwithstanding any perceptions generated by Israeli and Hamas information operations, the air power contribution to Israel's subsequent campaign in Gaza 2 years later was more successful. In 2008, although Russia deployed an overwhelming conventional capability against Georgia during operations in South Ossetia, it also used asymmetric tactics, employed irregular forces, undertook information operations and exploited CNO to considerable effect.

107. **Iraq 2003 – 2008 and Afghanistan**. In Iraq and Afghanistan, coalition forces faced nebulous enemy networks that enjoyed degrees of state and criminal sponsorship, often unconstrained by legal frameworks. In both of these theatres, adversaries adapted fast. There is evidence that the success enjoyed by Hezbollah against Israel inspired other groups elsewhere, not least because of Hezbollah's effective propaganda. For example, the Jaish Al Mahdi operations in 2007 had characteristics remarkably similar to those seen in Lebanon the year before. Similarly, the Taliban in Afghanistan adapted to exploit Improvised Explosive Device technology developed elsewhere, better to coordinate their suicide attacks and to target international aid workers. Air power faced the challenge of target ambiguity as opponents moved in and out of the populace; in such environments air power in isolation still lacks discrimination and, through the collateral damage sometimes generated by its powerful weapons, risks precipitating strategic failure.

108. **Implications**. While responses to insecurity will continue to include combat operations, security and stabilisation, the notion of binary choices will be an oversimplification that would ignore the inevitable concurrency. Information dominance and the speed of reaction will be paramount, particularly when WME are involved; and the Government's reaction will not always be discretionary. To prevail

against adaptive adversaries, we must also adapt at pace; current force structures may not be best matched to the emerging threat. Air and space power practitioners will need to develop not only a better appreciation of their intended effects, but also an ability to sense and respond quickly to what happens vice what was intended. Future capability development must also enable air forces to address the challenges of failing states and wars amongst the people – both directly as air and space practitioners and, where integration and synchronisation cannot be achieved, indirectly as a supporting or supported component – rather than simply enabling response after failure occurs. Influence may be as important a capability as kinetic effect. Finally, embodying measures of effectiveness in planning and the means to assess them will become as important as nominating the intended effect.

THE IMPACT OF TECHNOLOGY

109. **Capability Growth**. The scientific community is on the cusp of significant technology breakthroughs. These developments, particularly in information and computer technology, nano-technology, cognitive science, smart materials, biotechnology and energy will, unlike previous centuries, increasingly be driven by commercial rather than military interests. However, many of these areas will present opportunities for military exploitation. The global pace of research and development will make regulation difficult and will also increase the opportunities for adversaries to exploit technologies, while our increasing reliance on technology, in particular for space, increases our vulnerability. Some nearer-term technologies have the potential radically to change air and space power capabilities and force structures. For example, Directed Energy Weapons (DEW) will deliver a credible alternative to conventional kinetic attack against some difficult target sets, while extreme-endurance Unmanned Aerial Systems (UAS) might significantly compress the sensor-to-shooter loop and provide potential to operate across the full spectrum of air power roles. Such breakthroughs could revolutionise many aspects of air and space power in the later period of this concept to the extent that some current capabilities and thinking could be rendered obsolete. Change will impact all Defence Lines of Development (DLODs).

110. **Cost Growth**. One RAND study[7] has identified that by 2054 the entire US Defence budget could be spent on a single aircraft platform if present cost growth and inflation in defence procurement continues. While pragmatism would never seriously allow that extreme option, the cost growth trend is important. Notwithstanding efforts to streamline the procurement chain, the Ministry of Defence (MOD) must find new ways to reduce the overall cost of platform ownership. Importantly it should also examine the trend towards fewer, but more complex and expensive aircraft, including the impact of different manned-unmanned force balances. The thinking for use of unmanned systems is potentially constrained by the evolution of manned aircraft, rather than by active capitalisation of new technology. High fidelity distributed

[7] www.rand.org/pubs/monographs/MG588.

simulation, already within technological reach, presents one potentially radical way to reduce training costs.

THE RESULTING OPERATING ENVIRONMENT

111. **The Character of Future Operations**. Future operations are most likely to be expeditionary, of varying endurance and intensity, and typified by the multiple challenges of littoral-urban complexity, target discrimination, operations in CNO and integration with Joint, inter-agency and multinational capabilities. There will be less tolerance of casualties, constant media scrutiny and high expectations for force protection; public support cannot be assumed.

112. **The Land Environment**. The predominant feature of the Land environment will be the congested urban and littoral areas, where the majority of the world's population will live. Urban clutter will provide sanctuary for our adversaries, by allowing them to exploit our requirement to minimise collateral damage. The environment will be densely populated, often with dissatisfied and disadvantaged people concerned only about the essentials of life. There will be other forms of complex terrain, including mountains and jungles, where small targets, including people, will be difficult to find. Even where they can be found, understanding their motivations, fears and perceptions will challenge what air and space (and maritime) power can do; there are limitations to *what* can be imaged, counted or tracked from remote platforms. This will demand that we focus less on the collection of data and more on how we direct the platforms and then merge information with other sources, process and disseminate it. The most powerful capabilities will be integrated combinations of maritime, land, air and space power. The air and space perspective, largely unhindered in its reach and look, integrated with the surface perspective, which will provide greater depth and granularity of critical information, will allow the strength of air-derived situational awareness to become the basis of a land commander's situational understanding.

113. **The Maritime Environment**. The UK remains a maritime trading nation; our prosperity, security and stability still depend on access provided by the sea and on the maintenance of an international system of law and free trade. Beyond its territorial limits, the UK has an interest in maintaining its share of the oceanic competition for resources (including deep-sea mining and fishing) and also the freedom of navigation for commercial shipping. The UK will need to discharge its sovereign and wider responsibilities to protect political and economic interests. A high proportion of future conflict is likely to occur inside, or in proximity to, a zone of maritime influence. Traditionally, maritime operations have favoured sea room and manoeuvre space and this requirement will endure for certain operations. However, maritime operations are increasingly likely to take place in complex and congested littoral areas. Operations in this environment will be characterised by shallow water, short distances to the coast, busy and contested shipping-lanes, ports, canals and waterways against a backdrop of

maritime crime. The deep ocean is also likely to increase in strategic importance as the scramble for resources intensifies.

114. **The Air Environment**. Montgomery's maxim that '*if we lose the war in the air, we lose the war, and we lose it quickly*' will hold true. Our land and maritime (and air) forces have become accustomed to, and dependent on, freedom of manoeuvre because we have not faced a sustained challenge to control of the air since the Korean War and a serious challenge since the Falklands War. This carries with it a risk. Air transport aircraft and support helicopters will continue to operate in the threat envelopes for simple yet effective anti-aircraft artillery, small arms and man-portable air defence missiles. Therefore, air control will very rarely be absolute. Yet integrated air defence systems and the proliferation of modern surface to air missiles suggest that we could face even bigger challenges for air control. It nevertheless remains an indispensable condition for all operations and we must be prepared to fight for it. However, the fight for air control may in future take place not just in the air and on the ground, but also in a combined exploitation of air, space and CNO. Additionally, the pace of development of air power, coupled with what some would see as a natural antipathy to formalising doctrine among air power advocates is such that capturing best practice is at times difficult.

115. **The Space Environment**. As our dependency on space continues to grow, we will face 3 specific challenges: space control;[8] our reliance on the US; and the weaponisation of space. Freedom of manoeuvre in space and access to US space products have been taken for granted, but both face increasing pressures; many developing nations now have access to space and contest it, while the erstwhile surfeit of US capacity to support its allies is being driven steadily down by commercial pressure to use spare space systems capacity, for example in bandwidth.[9] Moreover, the weaponisation of space may occur within the next 20 years.[10] Although detail is beyond the classification of this concept, it is feasible that some nations could undermine Western air and space technical superiority by 2030. Expeditionary operations are particularly reliant on satellite communications and space-derived imagery, and therefore also on assured space support.

116. **Joint, Inter-agency and Multinational Operations**. Future conflict will be complex and invariably prolonged, requiring the coordinated use of all levers of national power within an information framework in which the battle of ideas will take place; a battle that will be central to 21st Century conflict. The military will continue to work within a political framework and strive to be better integrated with other government departments through ongoing pursuit of more comprehensive approaches

[8] 'The conditions, bound by time, that enable effective space support of military operations', AP3000 (4th Edition).
[9] The growing capability and capacity of the commercial sector in supplying high-grade imagery to end-users should be noted. Such access may be provided both to state and non-state actors.
[10] Dr John Sheldon, from the Air University, Maxwell AFB, speaking at the City Forum Space and Security Conference, London, March 2009.

to operations. As a permanent member of the United Nations Security Council, the UK will retain international obligations. We may also need the ability to undertake small-scale operations independently, but operations will normally be in formal alliance or ad hoc coalition. Our foremost treaty obligations will be through the North Atlantic Treaty Organisation (NATO) and the European Union (EU) and the UK's most important ally will be the US.

117. **Societal Pressures**.[11] In the UK, the demographic balance is changing; British birth rates are rising once again, but remain below replacement rate. People are staying in education longer and the population is ageing. There is far less tradition of military service, the attitude to authority is changing, the vocational culture has been replaced by shorter contracts, and the competing demands for technologically literate individuals are rising. Furthermore, those joining the Armed Forces are doing so at a later age and are not always committed to full careers, seeking more flexibility in employment, but offer less mobility. By contrast, in some immigrant communities the birth rate remains high, but these communities are not always well integrated into society, offer poorer recruiting grounds and may have less affinity with a UK global role.

118. **Environmental Lobbying**. Environmental awareness in society is rising and the Armed Forces are not immune to the associated pressures. Air vehicles have already been identified as a target by the environmental lobby. Technologies to reduce the carbon footprint by producing cleaner or alternative energy solutions are available and the rising cost of fuel and increasing opposition to noise pollution may increase pressure for reduced performance military aircraft and increased use of simulation.

119. **International Law and Ethical Constraints**. Legal demands are already being exacerbated by complex weapons such as UAS, Directed Energy Weapons (DEW) and CNO, and the challenge of combatant and non-combatant discrimination. The requirement for legal support, for both the training role and in support of operations, will increase. Moreover, the use of force in general will be subject to media and judicial scrutiny, driving more robust audit structures for post-event investigations. Flight data monitoring may become a pervasive legal requirement. Meanwhile, the ethical debates on the use of UAS and DEW are gathering momentum. This may result in policy constraints on their use, and ultimately in legal regulation by the development of new international treaties. For space, the 1967 Outer Space Treaty[12] remains in force. But as space becomes more contested, with useable orbital slots already close to full, it is highly likely that some states will seek to develop international space law over the next 20 years. Overall, it is possible that international transparency could increasingly guide and even limit air and space operations.

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[11] See: *The DCDC Global Strategic Trends Programme 2007-2036* (3rd Edition) page 8.

[12] Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and other Celestial Bodies (also known as the Outer Space Treaty) 1967.

FIRST ORDER DEDUCTIONS

120. From the above, the Concept derives 7 first order deductions:

Geopolitical

121. **Expeditionary operations will continue, and probably alongside the US.** For as long as we seek to influence and shape events globally, or meet our extensive overseas responsibilities, the UK will require an expeditionary capability. Furthermore, the UK will remain an active member of the UN, NATO and the EU with associated treaty obligations. The extended duration of some operations will continue to place significant demands on sustainment. The UK must therefore maintain global reach through air capabilities and access to space capabilities. We will continue to structure, equip and train for operations with US forces influencing other partners accordingly through the formal alliance mechanisms for interoperability and standardisation. As a supporting partner in US-led operations, the best way to achieve influence will be through our own credibility. Therefore, knowledge of US doctrine and procedures, where necessary by training *within* the US system, will remain fundamental to the preparation of credible air operations staff.

122. **Future operations will be more complex.** Unity of effort and supported-supporting relationships may be inadequate responses for operations in which the centrality of people will frequently be the object – both of our operations and the environment within which we operate. The associated Joint, inter-agency and multinational responses will demand much closer integration and synchronisation. The battlespace will be complex, making surveillance and attack difficult, with low signature targets and fleeting windows of opportunity to engage. Space-based surveillance, with its freedom of over-flight and increasing capability, will therefore remain critical. Demands for air-based surveillance will also increase, driving the balance between the intelligence and situational awareness, or *find* function, and the *attack* function. Given that *attack* will be ever-more precise, that future weapons will be more discriminate, but also that targets will be well hidden with only fleeting opportunities to engage, the future emphasis will be on the more complicated task of *find* and the associated Command, Control, Communications and Intelligence (UK)-related processes. Air platforms that combine both find and attack functions, which would help to compress the sensor-to-shooter decision cycle, could be both operationally robust and cost effective.

Air

123. **The UK needs to institutionalise its strategic and operational level air and space power thinking**. The RAF, Fleet Air Arm and Army Air Corps have developed tactical skills second to none and the RAF has made progress with higher level air power education. Strategic and operational air power thinking, however, is not institutionalised, which has an adverse impact on the rapid development and exploitation of both capability and strategy. This also currently inhibits adaptability. As the principal UK advocate of air power, the RAF should take an even stronger lead role in consolidating air power education and development.

124. **The implications of Unmanned Aerial Systems are not yet fully identified**. UAS offer much of the capability of manned platforms, at lower or even zero risk to the operator. The ability to undertake the routine, dull and dangerous tasks that do not need or benefit from a manned cockpit is attractive. Although current speeds and payloads are less than for manned platforms, which reduces absolute flexibility, UAS endurance, and therefore responsiveness when on task, is high. Moreover, technology will improve range, speed, endurance and overall responsiveness of UAS. However, some manned aircraft will still retain an edge of speed, flexibility, discrimination and situational awareness that may not be achieved by UAS and their remote operators until the very end of this concept timeframe. The legal and ethical implications of UAS in civilian controlled airspace, the role and status of the UAS operator, and increased automation of task are also emerging as significant issues, which will also apply to long-loiter munitions. Furthermore, the psychological and behavioural impact for UAS operators, such as simulator sickness,[13] are not yet fully understood. Air power proponents need urgently to consider these cultural, organisational and operational implications to help determine the optimal manned-to-unmanned balance.

Space

125. **The UK needs to acknowledge its dependency on space and invest appropriately**. All elements of the UK critical national infrastructure epitomise our reliance on space. So too do most military capabilities, especially those used on expeditionary operations. To date, the UK has enjoyed assured access to space from the US. However, as US dominance in space is challenged by China, India and others, it will devote more of its assets to preserving assured access to space for its own purposes. Although the UK has reasonable confidence that it can rely upon the historical levels of US space-based support, it would be wise to consider early – for increased robustness of this critical enabler – the possibilities for alternative support, perhaps by bolstering links with Europe. In parallel, the UK might address its own resilience through a modest, indigenous capability. In particular, we could exploit

[13] See: Eugenia M. Kolasinski, *Simulator Sickness in Virtual Environments* (United States Army Research Institute for Behavioural and Social Sciences Technical Report 1027, May 1995).

niche capabilities where we still have a global lead, for example in small satellite technology, which has high potential for an Operationally Responsive Space (ORS) concept.[14] With space becoming a dominant requirement for operations, we need to invest in space specialists. These experts will offer advice to senior commanders, act as conduits and advocates for the exploitation of allies' space assets and lead the development of UK capability. A cadre of trained personnel, rather than a distinct career stream, would be a cost effective approach, given the pressure on manpower budgets that is likely to endure.

Technology[15]

126. **The UK needs to invest more in Computer Network Operations**. Air and space power are increasingly reliant on, and vulnerable to, CNO. Information networks offer a battle-winning edge, but they also represent a weakness that we may be failing to defend. CNO may also have a deterrent potential that has yet to be understood or exploited.

127. **Directed Energy Weapons will significantly change how air and space power is employed**. DEW represents a new class of weapon that can disable or destroy systems, potentially with very low collateral damage. Its employment will need clear policy and legal guidance because, as with any novel weapons system, its utility is not yet fully understood.

[14] See Annex C.
[15] The following 2 deductions were validated within the Future Air and Space Wargame held in May 2009, which also revealed the limited cadre within which they are understood – a consequence of the necessarily tight security associated with them.

PART 2 – IMPLICATIONS FOR AIR AND SPACE POWER

201. **Platforms, Roles and Dependencies.** Current air and space power roles are increasingly conflated with role-specific platforms. For example, fast jets are perceived too often as only being attack platforms and large aircraft as restricted largely to combat support functions. This tends unhelpfully to type-cast specific equipment and it also masks the potential that technology could markedly increase the overall flexibility of all aircraft. Similarly, Unmanned Aerial Systems (UAS) have potential to be employed across the full spectrum of air power roles, not just for intelligence, situational awareness and attack, which has been their current niche. For example, tilt-rotor technology has already been demonstrated as a UAS, offering potential new approaches to mobility and lift in hostile environments. Similarly, UAS may also be able to provide air-to-air refuelling capabilities toward the end of this concept timeframe. By the end of the period considered by this Concept, there will be few single-role platforms, instead they will offer multiple ways and means to deliver air power. For example, nearly all platforms, from high performance fighters to rotary wing aircraft, manned and unmanned, could provide significant Intelligence, Surveillance, Target Acquisition and Reconnaissance (ISTAR) capabilities.[1] The limiting factor will no longer be platforms and (for example) their collection capability, but the ability to direct, process, disseminate and access information. Many platforms will be capable of attack, intelligence gathering and control of the air in a single mission. These capabilities will be enabled by space, but our reliance on space will have increased to the extent that we will need assured access. Currently, much of that assurance is provided by access to the products of allies; such dependencies should be recognised, recorded and mitigated by diversification of sources and development of organic capability where possible. The UK, in common with many nations, has a very high dependency on Global Positioning System (GPS) for both civil and military applications. The timing signal is used widely. With GPS technology embedded in more consumer products as unit costs fall, the dependency will increase over time. Yet UK air power no longer retains many of its otherwise desirable reversionary options, such as non-GPS or non-network capabilities, because training margins have been eroded. The UK could seek increased GPS security or access to existing and planned alternate positioning systems. Alternately GPS dependency may put a higher premium on reversionary mode training to protect robust military capabilities. For both air and space power, real-time tracking and de-confliction and a high degree of confidence in a common operating picture would allow more automated control functions, enabling centralised or distributed planning and highly de-centralised execution.

[1] For example by fielding electronically scanned phased array radars or SIGINT receivers.

202. **Timescales for Emerging Technologies**. The ability routinely to exploit UAS, Computer Network Operations (CNO), the entry into service of Directed Energy Weapons (DEW), and the wherewithal to data mine virtual knowledge bases for information should be broadly coincident in time, offering the potential to transform air and space power capability. What is less clear is when this will occur: it may be as early as the middle of Epoch 3; but is more certain by the end of Epoch 4. This has profound implications, particularly for training, equipment, personnel and the organisation of air and space forces; therefore, now is the time to consider the required changes.

203. **Aspects of Air Power in Epoch 4**. The 4 fundamental air and space power roles (Control of the Air and Space; Mobility and Lift; Intelligence and Situational Awareness; and Attack)[2] will endure. However, whereas in Epochs 1 through 3 they will continue in part to be aligned to platforms, as manned and unmanned aircraft become more truly multi-role, air power will be delivered in different ways. Part 2 of FA&SOC 2009 is therefore in 2 Sections: Section I will focus on Epochs 1 – 3; Section II, necessarily more speculative, will consider air and space power in Epoch 4. However, the implicit overlap between the 2 sections highlights the uncertainty of when the anticipated step change in capability will occur.

204. **Combat Support and Combat Service Support**. The fragility and short supply of air power has implications for combat support and combat service support functions; the protection of air assets will be an enduring requirement. Space assets are subject to unusual environmental constraints and both air and space capability are increasingly procured through novel mechanisms involving reliance on commercial partners. These factors have implications for capability development that are best addressed through the intervention of specialist force protection staff and robust testing of partnering arrangements against credible operating scenarios to ensure freedom of manoeuvre.

SECTION I – EPOCHS 1 - 3

205. We can already witness the blurring of air power roles and capabilities that will characterise Epochs 1-3. For example, the US B-1B, originally conceived as a long range strategic bomber, has routinely been employed in a Close Air Support role. Similarly, in the relatively near future, the Joint Strike Fighter, procured principally as an attack platform, will have enormous potential for ISTAR. This trend will continue over time. However, a common theme across all 4 roles will be the centrality of the fight for information; although this trend is already evident today, it will dominate the force structure for air and space power by Epoch 4. Whether seeking to control air and space, mounting or defending against an attack or seeking to exploit an asymmetric advantage in surveillance and reconnaissance, the ability to collect,

[2] AP 3000 (4th Edition).

process and disseminate information will dictate success or failure. The Concept will now consider each of the air and space power roles in turn.

ROLE 1 – CONTROL OF THE AIR AND OF SPACE

206. Although surface operations can be undertaken without air control, operational success would at best be subject to high risk and at worst fatally compromised. Air control enables freedom of air, surface and sub-surface manoeuvre and therefore the ability of commanders to gain and retain the initiative.[3] For the UK, space control depends primarily on the ability to assure access through cooperation with allies – particularly the United States' freedom of action in orbit – and the exploitation of specialist knowledge rather than indigenous capabilities.[4]

207. In Epochs 2-3, while the integrity of UK airspace will remain paramount, in an expeditionary posture, we must remain capable of achieving air control at considerable distance from the UK base. The increasing sophistication and proliferation of Integrated Air Defence Systems (IADS), including advanced Surface to Air Missiles (SAMs), represents a particular threat to alliance and coalition access, in some cases reducing the effectiveness of low observable technologies. Space will play a vital role in achieving the required degree of air control, which in turn implies a degree of space control. CNO will thus be vital as we continue to build ever more sophisticated networks to support and enable air and space control. All networks, friendly and adversary, will be vulnerable to CNO, which provides both an opportunity to attack IADS using non-kinetic means, but also a threat to our own systems against which we must defend. The current asymmetric use of CNO by many potential adversaries suggests that there is as much opportunity as threat.

208. Technology will continue to feature heavily in air and space control. For the former, UAS will undertake a greater proportion of intelligence and situational awareness tasks. Air and space control will also be markedly affected by the advent of DEW, which will offer great potential to attack key vulnerabilities in IADS. These new means will also present new challenges for measuring attack effectiveness.

209. **Defence Lines of Development Implications**. Air and space control will require continuing investment in traditional specialised equipment, including aircraft, missiles and radars for example, but balanced against new investments in DEW and CNO. Although air and space control will remain the primary responsibility of air forces, there is a growing contribution from land and maritime forces,[5] which will

[3] Air Control is 'the freedom, bound by time, to use an area of airspace for one's own purposes while, if necessary, denying its use to an opponent' (AP3000 (4th Edition)).
[4] Space Control is 'the conditions, bound by time, that enable effective space support of military operations' (AP3000 (4th Edition)).
[5] Exemplified in Epoch 1 by LEAPP and the Type 45 Destroyer.

require better integration and synchronisation of capabilities emerging in all 3 environments and also of the effects that they will be able to create.

ROLE 2 – MOBILITY AND LIFT

210. Air mobility and lift enable the global, regional and local deployment of people and materiel, military and civilian. With acknowledged limitations in payload compared with surface lift, it is a fast way to deploy forces. Like air control, mobility and lift is also a fundamental enabler of manoeuvre. It has high utility for light and special forces and where surface threats to freedom of movement are high.

211. With adversaries increasingly hiding in the noise of high clutter environments, specialist forces, with their strong reliance on mobility, lift and air-based firepower, will be more to the fore. Combined with the requirement to undertake expeditionary operations, some of which will become enduring, the demands for mobility and lift are therefore set to increase. The competition for specialist manpower in this role will become more of a challenge as the civilian airline and helicopter sectors continue to expand in the medium term.

212. **Defence Lines of Development Implications**. The increasing proportion of military operations devoted to security and stabilisation with their high demand for mobility and lift suggest a re-balancing of air forces' structures. Manpower will be scarcer and there will be a requirement to further adapt our deployed mobility and lift support infrastructure.

ROLE 3 – INTELLIGENCE AND SITUATIONAL AWARENESS

213. Surveillance and reconnaissance are the means by which air power provides intelligence and contributes to situational awareness. The vantage of air and space allows sensors to provide an almost unhindered view of the operating space across the electromagnetic spectrum. However, it is difficult to plumb the depths of strategic nuance and tactical complexity from the air. Technology cannot map the social terrain and there is a danger that imagery and signals will create an illusion of situational understanding. Air and space power alone cannot create that; it will require better integration of air-, space- and surface-derived sources of information.

214. Intelligence- and data-gathering will become even more reliant on space, on UAS and on the electro-magnetic spectrum for gathering and passing information. Our dependency on the US, whilst reasonably well assured, could still represent a significant lack of robustness. UAS may proliferate, including those that will operate on the boundary between air and space. These will offer significant advances in persistence and will be potentially far cheaper and more flexible than satellites. Both satellites and UAS are, though, reliant on the electromagnetic spectrum for command, control and communication of products; because space will be contested by ever more

nations, this further increases our vulnerability to both CNO and direct attack of space or surface-based space control capabilities.

215. **Defence Lines of Development Implications**.[6] We must broaden our base of cooperation with non-US space-capable nations and consider a limited, but responsive space capability. To fully appreciate the implications and properly inform the debate, a space cadre is essential. Our reliance on space will soon be represented in our doctrine, but the degree to which the demand for intelligence and situational awareness will grow has not been fully recognised. A greater proportion of UAS – in all 3 Services – will require a re-appraisal of force structures. The challenges and potential within CNO demand urgent, widespread education and investment in both attack and defence capabilities.

ROLE 4 – ATTACK

216. Air power's reach is measured in hundreds or even thousands of miles and responsive precision attack at range will in future remain one of air power's greatest strengths. It will continue to underpin coercion by holding an adversary at continuous risk. This fundamental capability to attack will strengthen a graduated range of credible threats from diplomatic warning and military signalling through to the actual use of force. What will change is the means available to attack.

217. Kinetic attack will continue to dominate force-on-force engagements, but will retain its known limitations in security and stabilisation. DEW and CNO could revolutionise how and what air power attacks, while the employment of UAS on all attack missions – kinetic and non-kinetic – will increase. The policy and legal implications of DEW and CNO are not yet fully understood.

218. **Defence Lines of Development Implications**. As new options for attack emerge, the concepts of employment and supporting doctrine, must be developed in parallel with the technology. This is currently inhibited by the security requirements of compartmentalised classified technology, therefore technology project leaders must consider how to develop the concepts cross-Defence Lines of Development (DLOD). Present structures, particularly manpower, will come under strain as more unmanned vehicles enter service. Training may need to include more emphasis on legal, ethical and moral issues, while the emergence of new attack concepts will require broader cross-Service education.

[6] See also Paragraph 125 in respect of these implications.

IMPLICATIONS FOR AIR AND SPACE POWER IN EPOCHS 1 - 3

219. **Conceptual Themes for Epochs 1-3.** The potential step-change in air power capability forecast for Epoch 3 will only be fully exploited if the foundations are laid in Epochs 1 and 2. Recruiting and training personnel, changing structures and developing new concepts are all lengthy processes, for which DLOD proponents must give early consideration. An analysis of the development of the fundamental air and space power roles through Epochs 1 – 3 suggests 5 major conceptual themes on which air and space power will be built for the future: the air/land/maritime seams; DEW and CNO; people; structures; and above all better institutionalised thinking about air and space power.

220. **The Air/Land/Maritime Seams**. Future conflict will most likely occur in those regions subject to multiple stresses. With people increasingly moving into urban areas which are predominantly in the littoral, the complex urban-littoral setting could dominate future operations. While much work has been undertaken in the past 5 years to improve air/land integration, and into improving the efficacy of air and space power in the urban environment, the air/maritime seam has been neglected. Future air and space power must have the capabilities, concepts of operation and training to operate in the land-urban-littoral environment. These follow-on concepts should incorporate the capability offered by offshore maritime assets to project multi-role air platforms. They should also consider the blue-water air capability to address the maritime security issues outlined in Part 1.

221. **Directed Energy Weapons and Computer Network Ooperations**. DEW will occur early in the period covered by this Concept, while operations in cyberspace are already a reality; however, while there are small cadres of technical specialists, the wider conceptual thinking is markedly under-developed. Both technologies will have a profound effect on air and space power, not least for legal and ethical reasons such as proportionality, target discrimination and the attribution of effect. DEW could also be a significant driver in the manned/unmanned debate. As a developed economy, the UK is significantly vulnerable to CNO attack, with all 9 strands of our critical national infrastructure potentially open to attack and the technologies not yet widely understood by Defence. Moreover, the difficulties in accurately measuring effectiveness in these arenas will present particular difficulties for targeting. Air and space power practitioners stand to gain particularly from these new technologies, but for the same reasons are equally vulnerable. Therefore, we need to invest in both attack and defensive capabilities.

222. **Time, Timing and Synchronisation**. Some CNO targets will, like many other low signature targets in high clutter environments, provide only fleeting windows of opportunity to attack. But the difference with CNO is that windows of opportunity might be measured in only microseconds. While CNO will thus in theory take place at near to the speed of light, for example the time taken to deliver a virus into a

Command and Communications (C2) system, the effects in many cases may inevitably take much more time to register, let alone be visible enough to measure. Moreover, with the possibility of networks that will self-heal without human intervention after an attack, the sequence and timing of actions will become ever more critical. The implication is new concepts of timing and synchronisation will inevitably become part of the future operational art. We must build sufficient expertise in this area, not just to conduct discrete CNO, but to understand the complex relationship between time, timing, synchronisation of actions and the observed effects.

223. **People**. The operating environment is set to become ever more complex and make greater demands on air power practitioners. Role-specific training will still be required, but there should be a greater emphasis on education to equip our personnel with the ability to appreciate the broader implications. This may also influence recruiting policies. Air and space power will remain highly technical arenas, but new technologies will require new skills. Armourers, for example, may need to understand safe handling of both DEW and high explosive systems. The UAV operator will experience different thresholds of interest compared with the person in a cockpit who is continually immersed and focused on the tactical environment; this may require recruiting people with different personal attributes, since motor skills could be less important than information assimilation and detached decision-making. Taken together, this will place new future demands on the people who will deliver air power.

224. **A Re-Balanced Force Structure**. The present balance of investment in air platforms represents a preponderance of conventional attack capabilities for major combat operations. An analysis of recent history and the implications of multiple stress zones highlighted in the National Security Strategy of the United Kingdom (NSS) suggests that security and stabilisation operations will be more frequent, but an ability to undertake major combat operations, if only in alliance, will prevail. This may require a re-balancing of force structures. The recent increased requirements for mobility, lift, intelligence and situational awareness will endure. If IADS can be attacked with DEW and CNO, then the overall performance of kinetic and non-kinetic attack platforms may allow scope for re-balancing. The emphasis for intelligence and situational awareness must be in the direction, processing, dissemination and exploitation of information, not just on the collection platforms; collection will naturally increase, as almost all air platforms, like Joint Strike Fighter, fully exploit their ISTAR potential. UAS could in part help the necessary force re-balancing.

225. **Institutionalised Air and Space Power Thinking**. Historically, air power has created the most impact when employed offensively and air power's recent claim to have come of age is due to its ability to apply force with ever greater physical precision. However, influence is central to contemporary and future operations where the emphasis will be on shaping behaviour, rather than on destroying capability. Fires and other physical effects will still have their place, but populations' attitudes and

responses (friendly, neutral and adversarial) will be central to the outcome of any campaign. Adapting to these new realities will need more emphasis on strategic and operational thinking, rather than just tactical proficiency. Therefore, through-life *education*, from initial air power schooling to late-career scholarships and advocacy must better complement our current high standards of tactical training and proficiency.

SECTION II – EPOCH 4

226. **Directed Energy Weapons and Computer Network Operations**. The impact of technology will not be limited solely to the air and space environments, as is clear from the Future Maritime Operating Concept (FMOC),[7] the Future Land Operating Concept (FLOC)[8] and the Future Electro-magnetic Operating Concept (FEMOC).[9] However, advances in technology will have the most significant impact in the air environment, where it is feasible that the convergence of 2 technologies, DEW and CNO, will lead to a revolution. Firstly, DEW will transform control of the air and attack missions. An aircraft can carry finite conventional ordinance (bombs and missiles), but DEW effects are repeatable; it may simply be a case of waiting for capacitors to be re-charged by on-board generators between successive engagements. Moreover, DEW may be tuned to disrupt electronic devices rather than to destroy. Long-endurance UAS armed with DEW could significantly increase persistence of effect against certain target sets. Operations in CNO could also allow us to disrupt an adversary's IADS, for example, without flying dedicated high risk traditional suppression missions.

227. **Increased Computing Power**. Further and likely very large increases in computing capability, data-links and electronically scanned arrays will provide the potential for any air platform to act as an ISTAR collector, bearer and disseminator. Meanwhile, data-mining algorithms could continuously trawl databases and push information to users at all levels. IBM already has the capability to trawl the entire internet twice a day. Pattern recognition technology will be used to highlight events of interest, correlated information will be pulled from databases and information presented in a manner that will allow the user to trace the provenance of the information; something that will be of vital importance in targeting decisions.

228. **True Multi-role Platforms**. This technological potential may allow us to move beyond the traditional platform-centric view of air power, the present close association of platform and role will fade as we move towards more flexible views of the relationship between air powers role, platform, capability and task. Consequently, although we will still seek to achieve control of the air and space, or undertake attack, they should more often be delivered through multi-role platforms and CNO. All

[7] See: FMOC 2007, page 1-6, paragraph 115.
[8] See: FLOC 2008, page 1-2, paragraph 105.
[9] See: FEMOC 2008, page 5, paragraph 17.

platforms, air and space, will contribute to intelligence and situational awareness – and ultimately situational understanding – by feeding their Intelligence, Surveillance and Reconnaissance (ISR) products into virtual knowledge bases. Any one platform may undertake one or more of these roles simultaneously or sequentially, sometimes pre-programmed and therefore with or without the conscious decision or intervention of the operator.

229. **Mobility and Lift**. Only mobility and lift will be undertaken in a manner similar to today. Within the theatre of operations the ubiquity of air power will continue to project force rapidly, and mobility and lift will still be delivered by a mix of strategic and tactical air transport aircraft and support helicopters, supported by air-refuelling aircraft. But even these platforms will contribute to ISR and could, with in-built DEW, also contribute to control of the air or attack. Advanced counter-measures might enable them to operate with greater confidence in some hostile environments.

230. **Exploitation**. The way in which we exploit our forces in future will change:

> *'A re-balance may therefore be required between agile forces for major combat operations that provide high impact, small footprint solutions, optimised at high readiness for operations of varied duration, and those forces that can undertake low impact, large footprint operations requiring sustainment for enduring periods and often more manpower intensive tasks. The notion that major combat operations will always be settled decisively within short duration should be challenged and may have a significant impact on many of our planning assumptions.'*[10]

231. **Balancing Air Power**. Air and space power must be capable of rapidly projecting joint manoeuvre forces to the area of interest, either to deter, coerce or defeat an adversary. It should have the ability to hold what the adversary values at risk, even when that is deep inside his own territory. In future, we will achieve this by balancing air power's current and planned capability for kinetic attack with the potential offered by space, UAS, DEW and CNO.

DELIVERING THE FOUR AIR AND SPACE POWER ROLES

232. **Rapid and Ubiquitous ISTAR and Air Command and Control**. By 2030, information management, exploitation and assurance will dominate many aspects of future conflict. Technology, specifically the combination of electronically scanned phased arrays, automated data collection, processing and dissemination, should enable nearly *all* future air and space platforms to directly support intelligence and situational awareness. Control of the air and attack will be delivered by multi-role platforms

[10] FLOC 2008, page 1-6, paragraph 112.

capable of both. Even single fighter-sized aircraft may be capable of concurrently conducting 3 out of the 4 air roles. Intelligence and situational awareness missions will be highly automated to obviate pilot loading, and C2 could conceivably enable real time mission management using electronic reach forward techniques. This would allow capacity for pilots to concurrently conduct man-in-the-loop attack and air control missions.

233. **The Manned/Unmanned Balance**. Missions would be delivered by a mix of manned and unmanned systems, and by technical operators and intelligence analysts able to help commanders develop situational understanding. The ability to fuse air- and surface-derived information will be a key to successful exploitation of situational awareness. Platforms will be capable of penetrating, operating in and surviving in hostile airspace. Although in the immediate future this capability could be provided by high performance fighter size aircraft, by 2030 this will not necessarily be the case. There will be a range of air platforms, some large and of sub-sonic performance, some unmanned, but all capable of weapon carriage for kinetic and non-kinetic effects. There will be an increased emphasis on platform survivability, today provided primarily by stealth and manoeuvre, but in the future not only with advanced stealth technology, but also multi-spectral counter measures. By 2030 these platforms will be equipped with DEW that will allow simultaneous targeting of multiple air and ground systems. Unmanned platforms will predominate in hostile environments with a requirement for persistence in contested air space, or in homeland resilience tasks. There must be no preconceptions about the capability of unmanned systems based on legacy or platform-specific thinking; their employment should depend solely on demonstrated capability, value for money and the impact of any legal issues that emerge.

234. **Information Warfare**. The fight for information that will characterise future conflict will manifest itself as a requirement for situational understanding and decision superiority. By 2030 networked operations are likely to predominate, with computer communications underpinning the C2 capability of the air domain. Air platforms will invariably be nodes in networks every time they are airborne, as both automatic bearers and disseminators of information. Increased access to information should promote greater decentralisation of control, underpinning mission command.

IMPLICATIONS FOR DEVELOPING AIR AND SPACE POWER IN EPOCH 4

235. **Investing in Future Technologies**. There will be 3 capability areas to develop if we are to exploit the potential of emerging technologies in the future operating environment. First is an increased investment in air mobility and lift. Second is combat ISTAR, specifically the ability to take the current concept of multi-role aircraft to its logical conclusion, namely that a single platform could contribute to: intelligence and situational awareness; air control; and attack. Third is C3I,[11] which will become fundamental to the standards of information management, exploitation and assurance that must underpin all future operations, especially those that involve DEW and CNO. The possibilities offered by new technology will require changes not only to our equipment and infrastructure but most critically for our training and personnel. All of these are long-lead items and we need to exploit opportunities from early in the period to invest in these areas. In particular, the present construct for delivering personnel and training is focused on the delivery of aircrew for combat missions. With multiple air power roles being delivered by a mixture of manned and (possibly increasingly) unmanned vehicles, the majority of aircrew in flying appointments could specialise in intelligence, situational awareness, mobility and lift operations. This may have career paths implications.

236. **The Future Role of the Commander**. Developing commanders for information-dominated warfare will be a distinct challenge, because their experience of combat and of decision making could be unrecognisable to today's leaders. The future airman will not necessarily be more technically minded than today; his technical grasp is already substantial. What will change will be his (or her) ability to *exploit* technology and understand CNO. The air and space commanders of Epoch 4 will have acquired significant experience from the complexity of current operations, which should be exploited through deeper investment in education, rather than just training.

237. **The Limitations of Technology**. Finally, we must exploit technology, but not be in thrall of it. Technology will be of limited value if our personnel are unable to exploit it. If we are to keep pace with technological changes and ahead of adversaries, we should exploit commercial advances more effectively and share costs better to develop further collaborative working with our major partners. Fewer and more expensive platforms, the present trend, is approaching the point of diminishing returns, lacks resilience and suggests that we should also seek to rediscover the advantages of numbers and mass.

[11] C3I – Command, Control, Communications and Intelligence.

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ANNEX A – COMPUTER NETWORK OPERATIONS[1]

A1. Computer Network Operations (CNO) are often referred to colloquially as operations in cyberspace. No matter what timescale we look out to, the human being will remain the focus of information and CNO, although the degree of control which the human being has over CNO will fluctuate. At times we will be – or perceive ourselves to be – in control of information; at other times we will struggle to exercise effective control. There are 2 factors central to the effective manipulation and management of CNO: control of technology; and the mental capacity to exploit available information. Predictable trends (not surprises) will drive enhancements in CNO, change the capabilities of (and threats from) our potential enemies, and impact wider society.

A2. From a defence perspective, a number of themes underlie future challenges. First, levels of command will alternately blur and become more distinct; in both Estonia (2005) and Georgia (2008), CNO had both strategic and tactical implications, but it was not always immediately clear at what level attacks were taking place. Moreover, while no state has acknowledged perpetrating such attacks they are becoming routine. Next, the widening use of CNO has given rise to some novel themes. CNO is being used by some states for espionage as part of their standard armoury. Meanwhile, some states, and even non-state actors, may conclude that attacking their potential enemies through their CNO vulnerabilities is not only less expensive than conventional warfare, but is more difficult to detect and prove, and will probably also lead to imposition of fewer international sanctions and condemnation. Third, threats of terrorism and criminality through CNO will increase. Finally, target sets for CNO will be difficult to determine, as civilian and military information sources, both national and coalition, will co-exist and super-impose with ever changing boundaries. Conversely, defending against such attacks will, due to the inter-related nature of information and the systems on which the data is stored, be difficult.

A.3 At the international level, there are few laws to control CNO and national interests may delay progress towards agreements on new treaties, although the International Telecommunication Union may assume a greater prominence in policing standards and imposing regulations. However, access to and the use of CNO will continue to expand. Neither Moore's Law[2] nor Butter's Law[3] show signs of ending their upward exponential trend. Processing power and bandwidth seem set to increase, but moving and manipulating data will still be by recognisable networks. Meanwhile

[1] This Annex is based on an early draft of the forthcoming 4th Edition of *DCDC Global Strategic Trends* due for promulgation in late 2009.
[2] The number of transistors that can be placed inexpensively on an integrated circuit has increased exponentially, doubling approximately every 2 years.
[3] The amount of data coming out of an optical fibre is doubling every 9 months.

the core technologies that enable CNO are widely available; this, taken in conjunction with increased capacity of commercial, off-the-shelf technology and the wide availability of data-mining, underlines the global technological parity of CNO.

ANNEX B – SPACE POWER

B1. **The Current UK Dependence on Space**. While the concept of air power is well understood, that of space power is not. And yet space matters to the UK. It is a highly significant area of national policy, benefiting the UK and offering great economic potential.[1] Within the last 25 years, space has changed from an environment in which human interest focussed principally on scientific endeavour and a strategic vehicle for the Cold War, to an environment that is now vital both to economies and armed forces. The UK economy and infrastructure relies on space to a degree barely appreciated by society at large, with all nine strands of our Critical National Infrastructure (communications, emergency services, Government and public services, finance, energy, food, health, transport and water)[2] dependent to a greater or lesser extent on space. The MOD relies on space for satellite communications and uses space to enable surveillance and reconnaissance, missile warning, position, navigation and timing, meteorology and oceanography and network enabled capabilities. And yet we have no ability to respond rapidly to events in space, or those on Earth that involve space assets. This has led to the US concept of Operationally Responsive Space, which is explored further at Annex C. The UK economy relies on space for voice and data communication, television broadcasts (the UK is home to Europe's most successful TV broadcast network), weather forecasts (satellite data has enabled an improvement in Meteorological Office forecast accuracy of 25% over 10 years), PNT and environmental monitoring. Space communications also enable financial markets, allow the global tracking of assets and significantly improve transport management and logistics on land, by sea and by air. The shift in the UK towards service industries, including financial markets that rely upon space, suggests that space is increasingly important to the national economic infrastructure; the UK and global financial markets would not function without space-based communication and timing. Increased commercial availability, including ISTAR, has increased the number of actors able to exploit space and the dual use of satellites is typified in the field of Earth observation, where the increasing resolution of civilian satellite imagery has created significant military utility.

B2. **Possible Developments in Space Capability**. In the period up to 2030, developed societies will increasingly seek international agreements for equitable access to the electromagnetic spectrum and to key orbital positions. The 1976 Bogota Declaration, when 8 equatorial nations claimed sovereignty over the geostationary orbits above their territory (rejected by, among others, the US and the Soviet Union) was an important indicator of the potential for international disputes about critical space resources. The commercial and security stakes are increasing as more nations develop space capabilities. Space tourism is already underway, the US intends

[1] Discussed in greater detail in *2007:A Space Policy*, Chapter 1. The UK Space industry is expected to grow and deliver by 2015 a 60% increase in real terms on its current contribution of £2.4bn to GDP.
[2] www.cpni.gov.uk

manned missions to the Moon and possibly Mars within the first half of the 21st Century; Russia and China may soon follow. The drivers are principally economic (although national prestige plays its part) and the potential rewards vast. For example, it is estimated that a 1.5 km metal-rich asteroid has the potential value of $US 9 trillion while the Moon would be a good source of Helium 3, a potential clean fuel for nuclear fusion. However, it is uncertain whether such resources could be exploited by 2030. Commercial exploitation will create its own pressures on international agreements, with jurisdictional, ownership and exploitation rights to the fore. The Outer Space Treaty of 1967 states that 'outer space, including the moon and other celestial bodies, is not subject to national appropriation by claim of sovereignty, by means of use or occupation, or by any other means'.[3] However, the tension between Russia, Canada, Norway and Denmark in the summer of 2007 over commercial exploitation of the Arctic is prescient.

B3. **Space Weaponisation**. By 2030, human activity associated with space could be prolific. Although space is widely used for military purposes it is generally accepted that it is not yet weaponised. While there is no internationally agreed definition for space weaponisation, the Soviet Union, the US and China have all tested anti-satellite weapons. However, many commentators believe that weaponisation is inevitable, with estimates ranging from 2015 to 2030. Some states and even non-state actors will not have the technical or economic capacity to put weapons in space, but they will still attempt to exploit or degrade space capabilities by using Earth-based weapons and by targeting communications or ground-based space infrastructure. The increasing dual-use of space technology, such as the Ikonos satellite that provides imagery for both the military and commercial sector, will complicate targeting. However,

> '*Anything of great strategic importance to one belligerent, for that reason has to be worth attacking by others. And the greater that importance, the greater has to be the incentive to damage, disable, capture, or destroy it*'.[4]

B4. **Space as a Contested Environment. The implication is clear: space is already a contested environment. The consequence of lost or even reduced access for the UK would be critical to both our economic viability and our military effectiveness.**

[3] Outer Space Treaty 1967, Article 2.
[4] Colin S. Gray, *Another Bloody Century* (London: Weidenfeld and Nicolson, 2005), page 307.

ANNEX C – OPERATIONALLY RESPONSIVE SPACE

C1. **Tempo and the Development of Space Power**. The earliest military space systems were configured to support strategic, as opposed to operational or tactical missions. Examples included strategic reconnaissance in support of nuclear targeting and deterrence, missile launch warning and nuclear detonation detection. Additionally, while satellite communications had utility at all levels of operation, their scarcity ensured that they were almost by default reserved for high-priority traffic. Even as space capacity matured, little changed as far as users were concerned. Space systems remained costly both to build and to launch, procurement was often slow, and the tempo of operations reflected strategic rather than operational or tactical timelines. These constraints created a self-sustaining cycle, where systems were optimised technically to support strategic missions, at a cost that ensured this was all they were likely to be used for. Additionally, the inherent stability of bi-polar Cold War deterrence did not encourage the development of adaptable systems.

C2. **The Need for Responsive Space**. The Operationally Responsive Space (ORS) initiative is an attempt to break this cycle, to deliver space capability within shorter timelines in a more flexible way. Its formal existence in the US reflects a growing awareness of the spread of space capability, including the counter-space capability of emerging nations, the changing nature of security threats and the likely responses to them.

C3. **Operationally Responsive Space Tiers**. ORS is sometimes felt to be synonymous with *small satellites*. Although the emerging ability to construct effective systems quickly and cheaply is plainly a major component of ORS, it is not the only one. Changes to command and control arrangements, developing the ability to field adaptable systems that have utility at all levels of operations, and improvements to ground infrastructure all have a part to play in constituting effective ORS. As currently envisaged by the US, ORS capability will be deployed across 3 tiers:

a. Tier 1 (*Employ*) envisages an ability to meet space requirements on demand, potentially in any role, using existing on-orbit assets. This could include exploitation of commercial assets or those operated by allies. Typical timescales are described as *minutes to hours.*

b. Tier 2 (*Launch/Deploy*) enables rapid fulfilment of new requirements through responsive launch of ready-to-field assets. This might include optimisation of coverage in a chosen area through redeployment of on-orbit systems. Timescales are intended to be *days to weeks*.

c. Tier 3 (*Develop)* would compress current development timelines to enable the rapid delivery of new or modified capabilities in response to emerging needs, for example major events caused by adversary action or

natural disasters. This could be enabled by developing modular platforms using common interface standards. Timescales are described as *months not years*.

C4. **The Need for Operationally Responsive Space**. Successful delivery of ORS capability should have utility in many areas. It would assist the rapid reconstitution of lost capability, would provide a surge capability against short-notice and/or short duration demands (or other unanticipated gaps in service), would allow rapid and cost effective exploitation of technical innovation and, through demonstrating survivability, would enhance deterrence.

C5. **Personnel and Training Aspects of ORS**. The US has noted that pursuit of ORS goals in isolation will not encourage effective employment of the new capability by operational commanders. Accordingly, proof of concept demonstrators, to build commanders confidence in technical aspects of ORS, and investment in training, to allow effective and rapid employment by fielded forces, are seen as critical elements of the concept.

LEXICON OF ACRONYMS AND ABBREVIATIONS

C3I	Command, Control, Communications and Intelligence
CNO	Computer Network Operations
DCDC	Development, Concepts and Doctrine Centre
DEW	Directed Energy Weapons
DLOD	Defence Lines of Development
DSPG	Cyber Departmental Strategy Planning
FA&SOC	Future Air & Space Operational Concept
FEMOC	Future Electro-magnetic Operational Concept
FLOC	Future Land Operating Concept
FMOC	Future Maritime Operating Concept
HLOC	Higher Level Operational Conceptual Framework
IADS	Integrated Air Defence Systems
ISR	Intelligence, Surveillance and Reconnaissance
ISTAR	Intelligence, Surveillance, Target Acquisition and Reconnaissance
JDP	Joint Doctrine Publication
MOD	Ministry of Defence
NATO	North Atlantic Treaty Organization
NSS	National Security Strategy of the United Kingdom
ORS	Operationally Responsive Space
PNT	Position, Navigation and Timing
RAF	Royal Air Force
ROP	Recognised Operating Picture
SAM	Surface-to-Air-Missile
UAS	Unmanned Aerial System
UK	United Kingdom
US	United States of America
WME	Weapons of Mass Effect

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